Infrastructure

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Chapter 24 - Table of Contents

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24.1 Introduction

This chapter of the EIS provides an assessment of the energy, water, sewage treatment, telecommunications and associated service corridor requirements necessary to service the proposed development. Consistent with White Horse Australia Lindeman's environmental policies and commitment to ecologically sustainable development, all infrastructure has been designed to be efficient and enhance the environmental values of the site. Apart from the existing jetty, no existing infrastructure external to the project area will be impacted by the development. Water supply is further addressed in **Chapter 18 – Water Resources.**

Addendum: *This EIS was initially prepared assuming that the safe harbour was to be part of the Lindeman Great Barrier Reef Resort Project. With the commencement of the Great Barrier Reef Marine Park Authority's (GBRMPA) Dredging Coral Reef Habitat Policy (2016), further impacts on Great Barrier Reef coral reef habitats from yet more bleaching, and the recent impacts from Tropical Cyclone Debbie, the proponent no longer seeks assessment and approval to construct a safe harbour at Lindeman Island. Instead the proponent seeks assessment and approval for upgrades to the existing jetty and additional moorings in sheltered locations around the island to enable the resort's marine craft to obtain safe shelter under a range of wind and wave conditions. Accordingly, remaining references to, and images of, a safe harbour on various figures and maps in the EIS are no longer current.*

24.2 Energy Supply

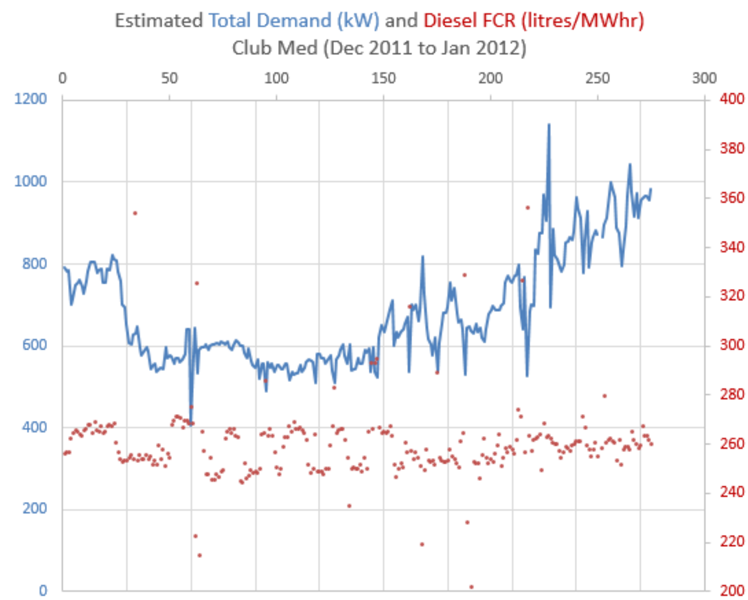
A previous energy study undertaken by Perigon Engineering (in October 2015) provided an analysis of both capital and operating cost estimates for energy supply options for the Lindeman Great Barrier Reef Resort including a grid supply from the mainland, diesel generators and a hybrid diesel solar system. Perigon's report identified that a solar-diesel hybrid system would have the lowest cost per annum following the initial up-front capital cost. Consistent with White Horse Australia Lindeman Pty Ltd's vision to develop a truly sustainable and world-class eco-resort, the option to further investigate the hybrid system (i.e. Solar and Diesel) was identified as being the preferred option. The system which was studied by Cardno comprises a "mini-grid" system of solar generation, large scale battery storage and diesel backup to provide an environmentally friendly, reliable and cost effective energy supply to the island. Cardno and its specialist solar energy sub-consultants, Conergy conducted a desktop feasibility and preliminary design study on the potential implementation of a solar hybrid "mini-grid" power system based on varying levels of renewable energy from 0% up to 100%.

The concept design of the proposed system, and the outcome of Cardno's modelling (including cost estimates for capital and operating) is provided in the following sections of the report, while the complete technical assessment is included in **Appendix M - Solar-Diesel Hybrid Feasibility Study.**

24.2.1 Historical Situation

All power to the previous resort was supplied entirely by diesel generators located at the power-house. Diesel generation numbers were obtained for the existing resort for the period December 2011 to January 2012, before it was closed, as shown in **Figure 24-1**. The diesel generation figure suggest the existing resort had a peak load demand of between 1.0 to 1.2 MW.

Figure 24-1. Diesel Generation (Existing Resort).



A previous power study was undertaken by Perigon Engineering (in October 2015). Perigon estimated the total load demand for the new development to be ~ 4.1MW, which is about 4 times the load demand of the existing resort. In order to provide for projected demand, the existing generators and powerhouse facility would need to be upgraded to cope with the increased power demand of the new resort facilities and additional resort precincts. The Perigon "*Site Investigation Report – Electrical Services*" provided both capital and operating cost estimates for the energy supply options which were considered, including:

- Grid Power supply from the mainland;
- Continuation of power generation entirely from Diesel Generators; and
- Hybrid Diesel-Solar generation (utilising Distributed Solar).

Perigon's conclusions are summarised below (reproduced from the report).

Table 24-1. Assessment of Energy Supply Options (Perigon, 2015).

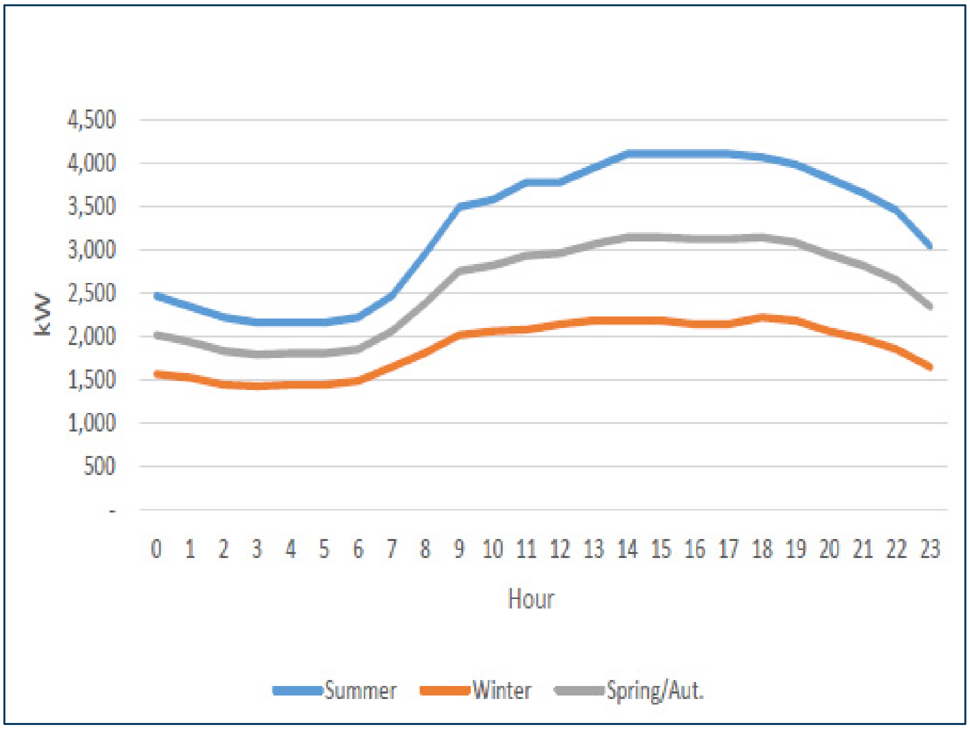
Option	Estimated Up-front Capital Cost	Expected Cost / Annum	Notes
HV From Mainland (incl. Powerhouse Cost)	**$108,135,500**	**$3,313,750** (Based on Ergon HV Tariff 47 at time of report)	Assume 50% average loading (2,050kVA) for 24hours/365 days per year = 17,958,000 kWhr/year)
Central Diesel Powerhouse	**$5,550,000**	**$5,256,000**	Assume 50% average loading (2,050kVA) for 24 hours/365 days per year. Consumption for Generators would average approximately 400 litres/hour @ an assumed rate of $1.5/L for Diesel. Generator Maintenance cost and Diesel Fill Labour not included.
Central Diesel Powerhouse with 3.8MW of Solar Dispersed around Development	**$14,100,000**	**$3,604,000**	Based on true historical factor of 22kW/Day return from 5kW System (4.4x Factor). Assume 16MW/Day return from 3.8MW System. 2MW average over 24 Hours = 48MW Total Daily Consumption. Saving is 33% Government Grants could also be sought for this economically sustainable initiative.

In line with WHA's vision to develop a truly sustainable and world-class eco-resort, the option to further investigate the Hybrid System (i.e. Solar and Diesel) was commissioned with Cardno BEC.

24.2.2 Proposed Load Profile

One of the most sensitive parameters which could affect the sizing of any proposed solar system is the correlation of the solar generation with the load consumption. The solar generation profile must be carefully balanced with the load profile, in order to most effectively size any solar system (including the storage system). In lieu of actual historical load profile data from the previous Club Med resort, the load profile used in the Cardno models has been based on load profile data obtained from Ergon Energy, for similar resort islands in the Whitsundays. Load metering information was formally obtained from Ergon Energy's Shutehaven and Mt. Rooper zone substations (*which supplies other resort islands such as Hayman, Hamilton, South Molle, Long and Daydream Islands*). The profile was assumed to be comparable and representative of the profile of Lindeman Island when the development is fully realised. The Ergon substation load profiles were scaled to match a 4.1 Mega Volt Amp (MVA) peak load estimated form the development, during the summer months. Cardno utilised the load profile as shown in in **Figure 24-2** the models.

Figure 24-2. Load Profile assumed for Lindeman Island.



Seasonal variations have been considered by Cardno in its models. Using this load profile, the following applies:

- Average daily consumption: 62,000kWh
- Average annual consumption: 22,350MWh

Note: For any final system design, it is absolutely essential to have a load profile as accurate as possible. Therefore, any recommendation given in this report must be reviewed once information on real expected load profile is available during the detailed design phase.

24.2.3 Comparison of Scenarios

Cardno has analysed and modelled the hybrid system based on the following scenarios:

- 20 year system life;
- Base case of diesel-only (for comparison); and
- Renewable energy ratios of 35%, 50%, 75% and nearly 100% (i.e. 93%).

While 100% renewable is technically possible to achieve, there is very limited available land area for the purpose of installing ground mounted PV arrays. Examination of available land area suggests a diesel substitution level of between 35% and 44% could be achieved, on a staged basis. The ‘base case’ (with 0% renewable) reflects the diesel-only generation scenario, and provides a comparison for all of the different renewable energy ratios.

The ‘base case’ is not recommended under any circumstance, as it presents the highest operating cost option for the resort owners, and it is Cardno’s opinion that this option is un-sustainable. The following tables provide a summary of the following, for each renewable energy ratio scenario:

- Estimated Capital and Operating costs
- Recommended System sizes (MWp) – both roof-top and ground mounted Solar Arrays
- Recommended Storage battery sizing (MVA and MWh)
- Diesel generator sizing (MVA and quantity)
- Estimated Solar System Generation (MWh)
- Estimated levelised Cost of Energy ($/kWhr)
- Estimated total annual operating cost
- Estimated diesel usage and savings (litres)
- Indicative Pay-back period (in years) for the capital investment

Table 24-2. System Configuration.

SYSTEM DESIGN								
Scenario	Renewable Energy	Diesel Gen #1 (kVA)	Diesel Gen #2 (kVA)	Diesel Gen #3 (kVA)	Solar PV Rooftop (MWp)	Solar PV Ground Mounted (MWp)	Battery capacity (MWh)	Battery Power (MVA)
1	0%	3000	1000	1000	NA	0	NA	NA
2	35%	3000	1000	750	3	1.5	2.5	4.5
3	50%	3000	1000	1000	3	3.5	16.7	4.5
4	75%	3000	1000	1000	3	7	33.2	4.5
5	95%	3000	750	-	3	15	46.2	4.5

Table 24-3. Estimated Energy Production.

ENERGY PRODUCTION					
Scenario	Renewable Energy	Annual Total System Generation (MWh)	Annual Solar Generation (MWh)	Excess Production (%)	Diesel Displacement (Litres)
1	0%	22,352	NA	NA	NA
2	35%	22,625	8,072	1.01%	1,926,738
3	50%	22,695	11,803	1.20%	2,843,794
4	75%	23,663	18,331	1.80%	4,249,394
5	95%	34,272	33,252	30.85%	5,342,462

Table 24-4. Financial Modelling Results.

FINANCIALS (excl. GST)									
Costs						Revenues		Savings	
Scenario	Renewable Energy	Cost of Energy ($/kWh)	Indicative Outlay/Capex ($)	Total Annual OPEX – Diesel and O&M ($)	Annual Diesel Usage (L)	Annual LGCs (QTY)	Annual LGCs (at $55/LGC)	Annual Diesel Savings ($)	Estimated Payback (Years)
1	0%	0.49	2,775,000	10,754,490	5,599,271	NA	NA	NA	NA
2	35%	0.35	14,735,250	7,147,906	3,672,533	8,072	443,960	3,468,128	5
3	50%	0.30	28,162,000	5,347,586	2,755,477	11,802	649,110	5,118,829	6
4	75%	0.22	45,962,000	2,646,223	1,349,877	18,330	1,008,150	7,648,909	7
5	95%	0.19	69,800,250	634,526	256,809	33,252	1,828,860	9,616,433	8

Table 24-5. Breakdown of Component Costs (Capital).

COMPONENT COSTS ($ excl GST)							
Scenario	Renewable Energy	PV Rooftop	PV Ground Mounted	Battery System	Battery Converter	Diesel Generators	Total
1	0%	0	0	0	0	2,775,000	2,775,000
2	35%	3,000,000	5,400,000	1,620,000	2,079,000	2,636,250	14,735,250
3	50%	7,000,000	5,400,000	10,908,000	2,079,000	2,775,000	28,162,000
4	75%	14,000,000	5,400,000	21,708,000	2,079,000	2,775,000	45,962,000
5	95%	30,000,000	5,400,000	30,240,000	2,079,000	2,081,250	69,800,250

Notes:

The rows highlighted in Blue reflect the ‘practical’ option, of:

- Using the roof-spaces in the central retail precinct / village / staff accommodation and aircraft hangar areas for roof-mounted solar panels, and
- Using the land area shown to the north of the run-way for ground mounted solar panels.

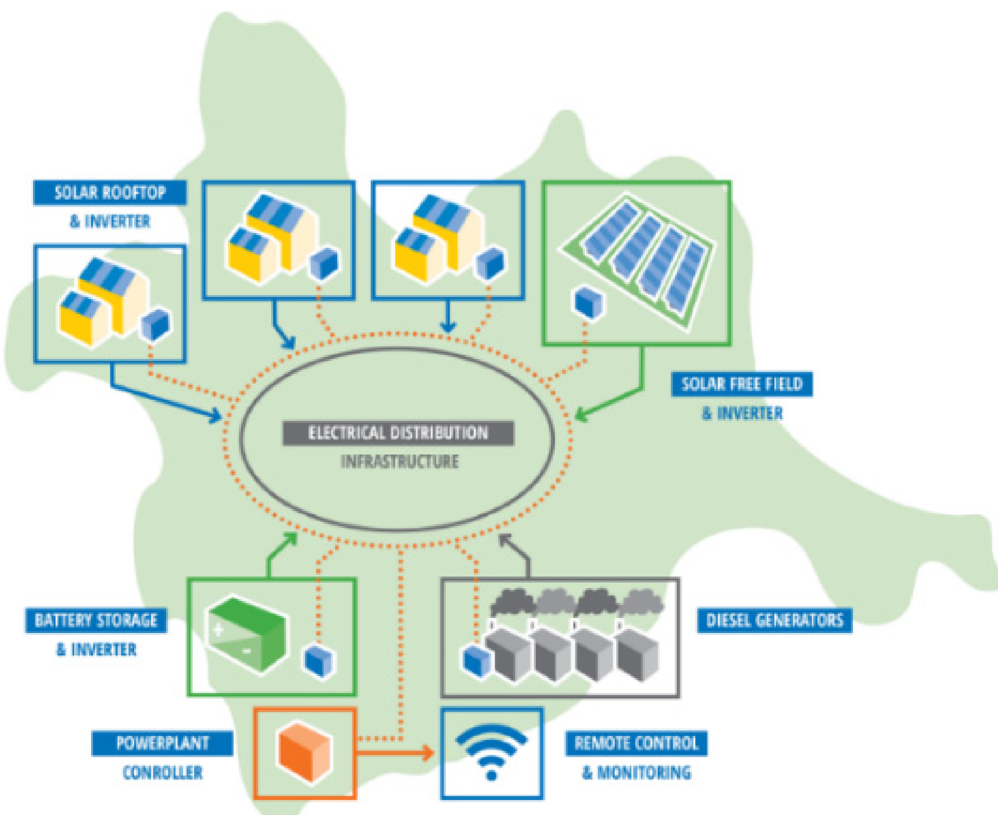
The maximum renewable energy percentage (diesel usage substitution) that can be achieved by utilising all of the known and available land areas (shown as Locations 1, 2 and 3 in **Figure 24-5**) is 44%.

24.2.4 Solar-Diesel Hybrid Mini-Grid Concept

The proposed Hybrid System is illustrated as in **Figure 24-3** which shows the contribution of both roof-top and ground mounted solar generation (through inverters) to a commonly connected Electrical Distribution System, into which the power generated from Diesel Generators is also fed (as is required to meet load demand), and any excess power from all generation sources (solar and/or diesel) is stored in centralised storage systems (batteries with inverters). The entire system is seamlessly integrated, managed and controlled using the proprietary controls system, with local and remote 'on-line' monitoring abilities. The power-house is also the location where the battery storage and system control / monitoring equipment would be located.

If the resort wished to raise the profile of the renewable power generation on site, this can be facilitated via animated live screen displays in selected locations around the resort.

Figure 24-3. Hybrid Solar-Diesel "Mini-Grid" System.



Refer to **Appendix M - Solar-Diesel Hybrid Feasibility Study** for further information.

24.2.5 Target Locations for Solar Panels

24.2.5.1 Roof-Top Solar Panels

The target buildings for the installation of roof-mounted solar panels are located around the central village, retail precinct, staff accommodation and the aircraft hangars as shown in the extract of the masterplan in **Figure 24-4**. The total available roof-space allows for a minimum of approximately 3 Mega Watt peak (MWp) of solar arrays to be installed (based on using the roof-space on buildings No.3, 4, 5, 6 and 7). If additional and suitable roof-space is available from other buildings in this central area, the solar capacity could be increased slightly above 3MWp. The density of roof-mounted solar arrays will depend largely on the final designs of the roofs, but as a general guide, the density of roof-mounted systems is higher than ground mounted solar arrays.

The concept design does not recommend the installation of roof-mounted panels on the roofs of the facilities around the beach resort, spa-villas, eco-style villas or the tourist villa precincts, for various reasons:

- Overall preference is for a bulk and centralised installation of roof-mounted solar panels on large and predominantly flat (or slightly angled) and contiguous roof-surfaces - to minimise capital, installation and maintenance costs;
- The central facility buildings are well away and hidden from the general view of the guest living, recreational and accommodation areas, and does not detract from the owner's vision of having minimal impact both visually and environmentally (with regards to clearance of natural vegetation);
- The central areas identified are not as 'architecturally sensitive' relative to the villa's or main buildings (e.g. signature restaurant in the 6-star spa-precinct, or main restaurant in the beach-precinct, or the guests welcome centre);
- The central facility location is more cleared of trees and hence less impacted by any shading from tall trees as it is close to the airport runway (compared to the eco-villas which are in more heavily wooded areas);
- The panels on the roof-space of the central facilities can be more easily aligned with the ideal NW-N-NE facing orientation, compared to the smaller roof-spaces of the eco-villa's and spa-villa's (which would only be scarcely aligned with the ideal NW-N-NE facing orientation, and would necessitate additional mounting brackets and create visual impact).

Figure 24-4. Target buildings for roof-top solar panels.

24.2.5.2 Ground Mounted Panels

In addition to the centralised roof-mounted solar panels, Cardno's concept design requires the installation of ground-mounted solar panels to provide the necessary and additional solar generation capacity to displace the amount of diesel usage. The land area which is required varies and depends on the amount of diesel fuel usage which is intended to be displaced by solar generation as outlined in the following table.

Table 24-6. Concept Design.

Diesel Displacement (%)	Roof Mounted Solar (MWp) based on available roof area in central facility	Ground Mounted Solar (MWp)	Approximate Land Area required (Note 1)
35%	3.0	1.5	18,000 m²
50%	3.0	3.5	42,000 m²
75%	3.0	7.0	84,000 m²

Note 1: As a rule of thumb, the solar capacity from ground mounted arrays is ~ 1.2 Ha per MWp based on today's high efficiency panels.

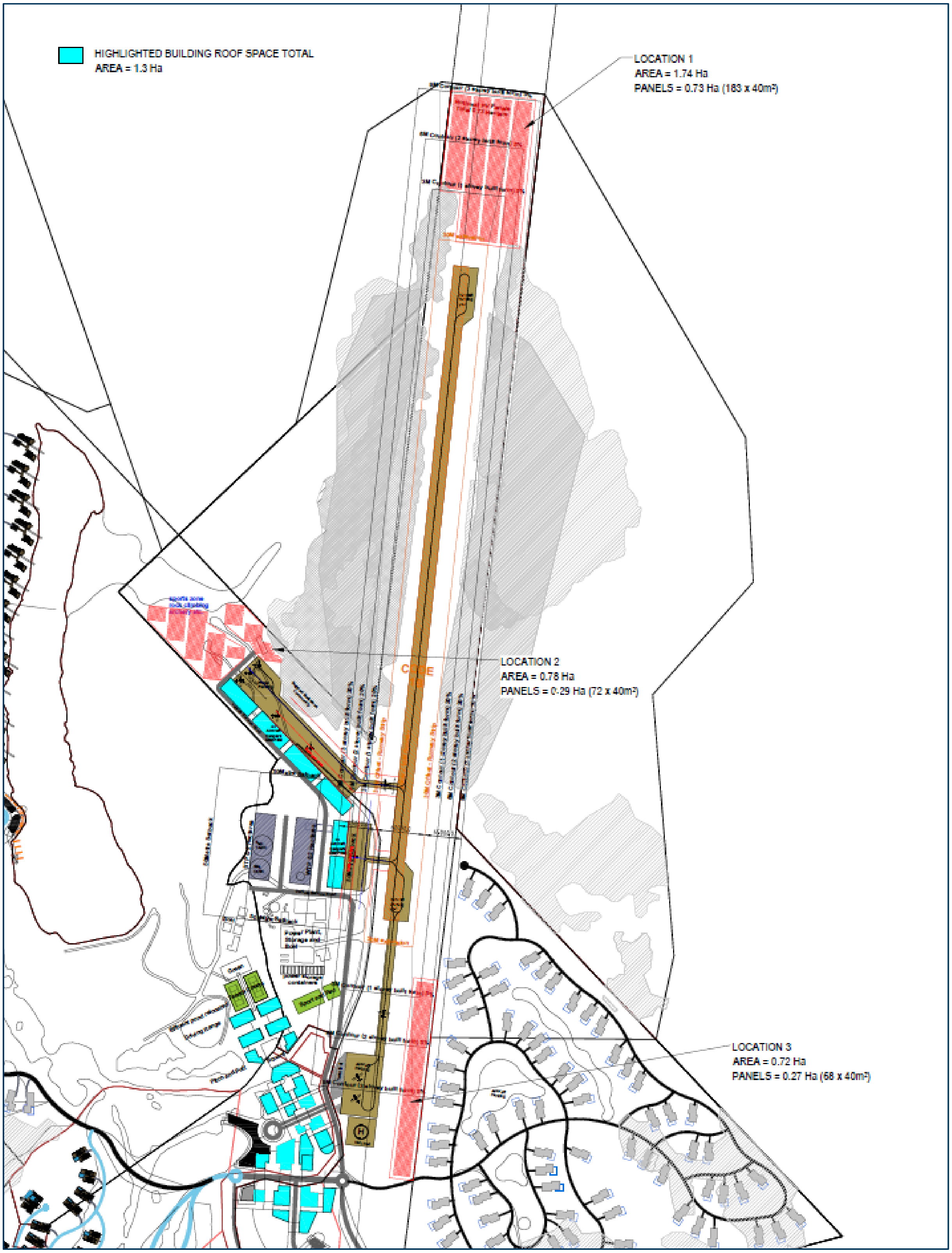
The recommended land areas for the installation of ground mounted solar arrays are well hidden from the general view of the guest living and accommodation areas, and do not detract from the owner's vision of having minimal impact both visually and environmentally (with regards to clearance of natural vegetation). These land areas are also reasonably flat, and largely devoid of natural vegetation and/or are outside of the protected vegetation areas, as shown on the master plan. With careful planning during the detailed design stages, it is possible to maximise the solar generation from the limited land areas surrounding the airport run-way, through compact array designs and low profile layouts which comply with the Civil Aviation requirements as well as manage any glare-risks from the solar panels. Solar PV panels are designed to absorb, not reflect, irradiation. However the sensitivities associated with glint and glare, and the landscape/visual impact and the potential impact on aircraft safety, must be a consideration during the detailed design stages – no different from glare sources from e.g. tarmac surface or water on tarmac, building roofs, nearby body of water, etc.

In reference to the latest masterplan, the available land areas which Cardno recommends would be suitable for the installation of ground-mounted solar arrays, are as shown in **Figure 24-5** and include:

- Location 1 - This area is immediately north of the run-way, total area ~ 1.74Ha, and is estimated to yield ~ 1.5MWp;
- Location 2 - This area is to the north-west of the aircraft hangars, total area ~ 0.78Ha and is estimated to yield ~ 0.7MWp; and
- Location 3 - This area is to the south of the run-way, total area ~ 0.72Ha, and is estimated to yield ~ 0.5MWp.

The maximum Renewable Energy percentage that can be achieved by utilising all of the available land areas (shown as Locations 1, 2 and 3 refer to **Figure 24-5**) is 44%.

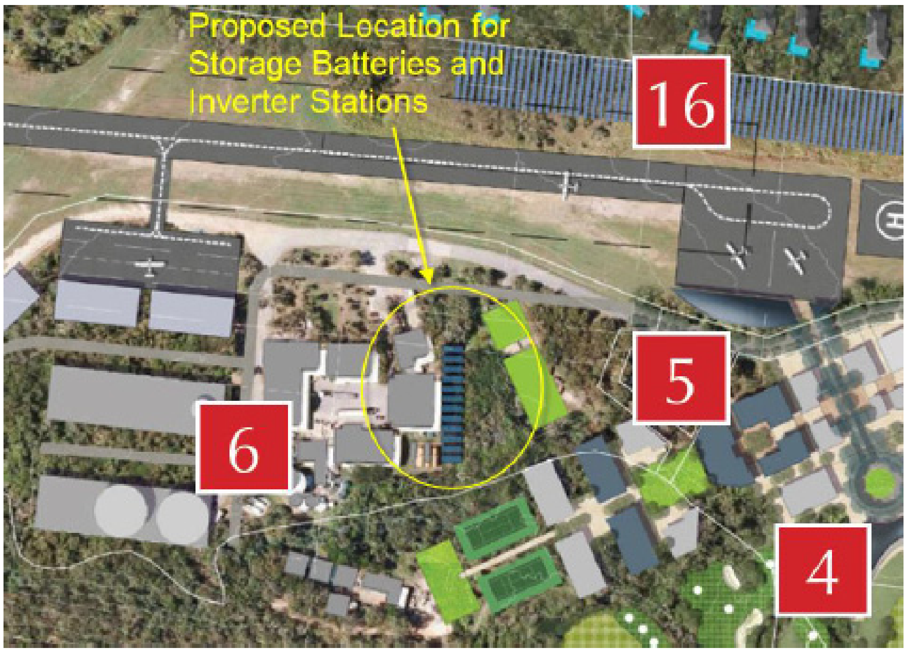
Figure 24-5. Recommended Land Areas for Ground Mounted Solar Panels (Red).



24.2.6 Target Location for Centralised Energy Storage

The existing powerhouse area (which is between the Retail Precinct / Commercial Centre and the Aircraft Hangers, shown circled below) is ideally suited to house the central energy storage system, power management and "mini-grid" control systems (refer to **Figure 24-6**). This location was previously used for the diesel generators to power the island from its central location and has been preserved for the same intention in the latest masterplan. The power generated by the solar panels will be transported to central facilities precinct through electrical cables that will follow the existing service corridor alignments where possible.

Figure 24-6. Proposed location for storage batteries and inverter stations.



24.2.7 Summary

Based on Cardno's study and models, a system with a target of ~75% renewable ratio provides the best theoretical financial and risk balance for the owner, with regard to fuel savings, cost of energy and risk mitigation for the island's ultimate development. However, with the limited available land area for ground-mounted solar arrays, the level of renewable energy which is likely to be achieved is between 35% to 44% based on the latest masterplan (as at November 2016). The estimated capital investment for this level of renewables is between $15M to $25M, with an estimated payback period between 3 to 8 years, depending on the pace of development, timing of investment and load demand/energy consumption.

The exact level of renewable energy investment will largely depend on the owners views on capital costs, return on investment, sustainable operating costs as well as land area which is available for the installation of ground mounted solar arrays. While the last item may be ameliorated partially by installing additional solar panels on roof-spaces of villas and other buildings in the various resort precincts, in practice this will require very careful consideration during the detailed design stages of the villas and facilities to ensure that civil, architectural and solar system designs inputs are carefully coordinated.

In any case, the scalability of the hybrid solution as proposed by Cardno allows the resort to 'grow into' the technology whilst it learns more about its actual consumption patterns, and upscale the renewable energy ratio even further in future years, and especially as the cost of the renewable energy systems are expected to drop in future years.

24.3 Wastewater Infrastructure

Wastewater generated onsite will be collected and pumped for treatment at a new wastewater treatment plant located to the north of the existing maintenance area (refer to **Map 24-1**). A new collection network will be constructed consisting of low diameter pipes and pumps to transfer flows to the treatment plant. The wastewater will be treated at the treatment plant to produce a high quality treated effluent capable of use as recycled water within the development (refer to **Map 24-2**). Discharges of water and contaminants will occur as recycled water discharged to land for irrigation purposes, and discharge from the site via the Gap Creek waterway during extreme wet weather events when irrigation is unable to occur and storages are at capacity (refer to **Chapter 17 – Water Quality**).

As such the recycled water quality to be achieved aligns with the following:

- *Great Barrier Reef Marine Park Regulations 1983;*
- *Great Barrier Reef Marine Park Authority Wastewater Discharge Policy 2005;*
- *The Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006; and*
- *Queensland Public Health Act 2005*.

The *Great Barrier Reef Marine Park Regulations 1983* and the *Great Barrier Reef Marine Park Authority Wastewater Discharge Policy 2005 for Wastewater Discharges from Marine Outfalls to the Great Barrier Reef Marine Park* specify effluent quality criteria for discharge of recycled water to the Great Barrier Reef Marine Park. These criteria are shown in **Table 24-7**.

Table 24-7. Recycled Water Quality Requirements for Discharge to Great Barrier Reef Marine Park.

Contaminant	Unit	Limit
Biochemical Oxygen Demand	mg/L	20
Total Suspended Solids	mg/L	30
pH	pH units	6.0 – 8.5
Total Nitrogen	mg/L	5
Total Phosphorus	mg/L	1
Dissolved Oxygen	mg/L	2 (minimum)
E.coli	cfu/100mL	<200 (mean)
E.coli	cfu/100mL	<1000 (80^{th} percentile)
Total Oil and Grease	mg/L	<10
Other Requirements		
Effluent does not produce a visible slick or sign of oil or grease		
Effluent does not contain by-products of chlorine disinfection that may pollute water in a manner harmful to animals or plants in the Marine Park		

The Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006 requires treated effluent used for dual reticulation and irrigation of open spaces, sports grounds, golf courses, dust suppression or unrestricted access and application to meet the water quality standards to contain E.coli concentrations of <1 cfu/100mL. The *Queensland Public Health Act 2005* also requires water to be used for dual reticulation to contain E.coli concentrations of <1 cfu/100mL. Although it is not required that private operators comply with *Queensland Public Health Act 2005* the Act reinforces the limits set out in the Australian

Guidelines. Based on these requirements, the adopted treatment standard for wastewater generated within the Lindeman Great Barrier Reef Resort development is shown in **Table 24-8**. A comprehensive sampling and monitoring program will be developed and maintained to ensure the quality of the recycled water is meeting required standards prior to reuse.

Table 24-8. Wastewater Treatment Standard Required by GBRMPA Regulations and Adopted.

Parameter	Unit	GBRMPA Regulations/Policy	Upper Limits Adopted
Biochemical Oxygen Demand	mg/L	20	20
pH	pH units	6.0 – 8.5	6.0 – 8.5
Total Suspended Solids	mg/L	30	30
Dissolved Oxygen	mg/L	2 (min)	2 (min)
Total Nitrogen	mg/L	5	5
Total Phosphorus	mg/L	1	1
Turbidity	NTU	-	2
E.coli	cfu/100 mL	<200 (mean)	<1 (median)
Total Oil and Grease	mg/L	<10	<10 (max)
Free Chlorine Residual	mg/L	-	1

Therefore, all discharges of recycled water from the Lindeman Great Barrier Reef Resort Project will meet the requirements of the *Great Barrier Reef Marine Park Regulations 1983* and the *Great Barrier Reef Marine Park Authority Wastewater Discharge Policy 2005 for Wastewater Discharges from Marine Outfalls to the Great Barrier Reef Marine Park.* With regard to E.coli levels, the adopted treatment standard is more stringent than required by the regulations.

24.3.1 Quantity and Location of Discharges

24.3.1.1 To Land

Recycled water will be discharged to land via irrigation of the golf course and landscaped areas across the development (refer to **Map 24-3**). The estimated total annual volume for discharge via irrigation is approximately 67 ML. This is based on the results of Modelling of Effluent Disposal via Land Irrigation (MEDLI) modelling. The MEDLI modelling is and the output reports included in **Appendix O - Water Infrastructure Assessment**. **Map 24-3** shows the location of the proposed irrigation areas. A summary of the land areas to be irrigated and the estimated annual irrigation volumes is shown in **Table 24-9**.

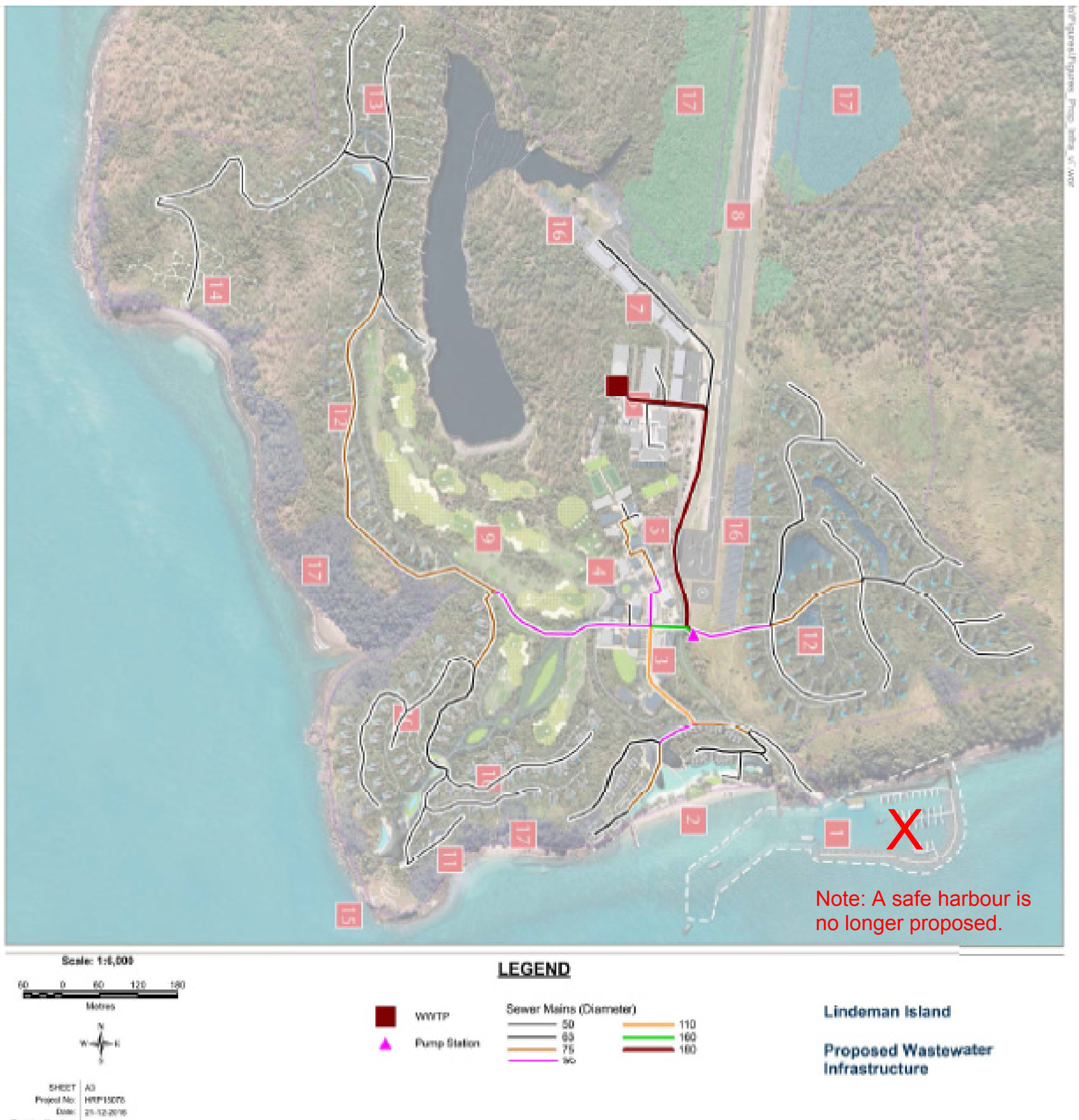
Table 24-9. Discharge Volumes of Recycled Water to Land via Irrigation.

Irrigation Land Areas	Area (ha)	Discharge Volume
Golf Course	9.1	51
Spa Resort Entrance	1.6	9
General Landscaping	0.22	1.2
Airstrip Buffer Zones	0.96	5.4
TOTAL	**11.88**	**66.5**

24.3.1.2 To Ocean

Modelling of Effluent Disposal via Land Irrigation (MEDLI) modelling identified, based on a 50 year modelling period, and adopting a range of conservative assumptions relating to per person water use and resort occupancy rates, no recycled water is required to be discharged to the ocean via Gap Creek downstream of the dam wall.

Map 24-1. Proposed Wastewater Infrastructure.



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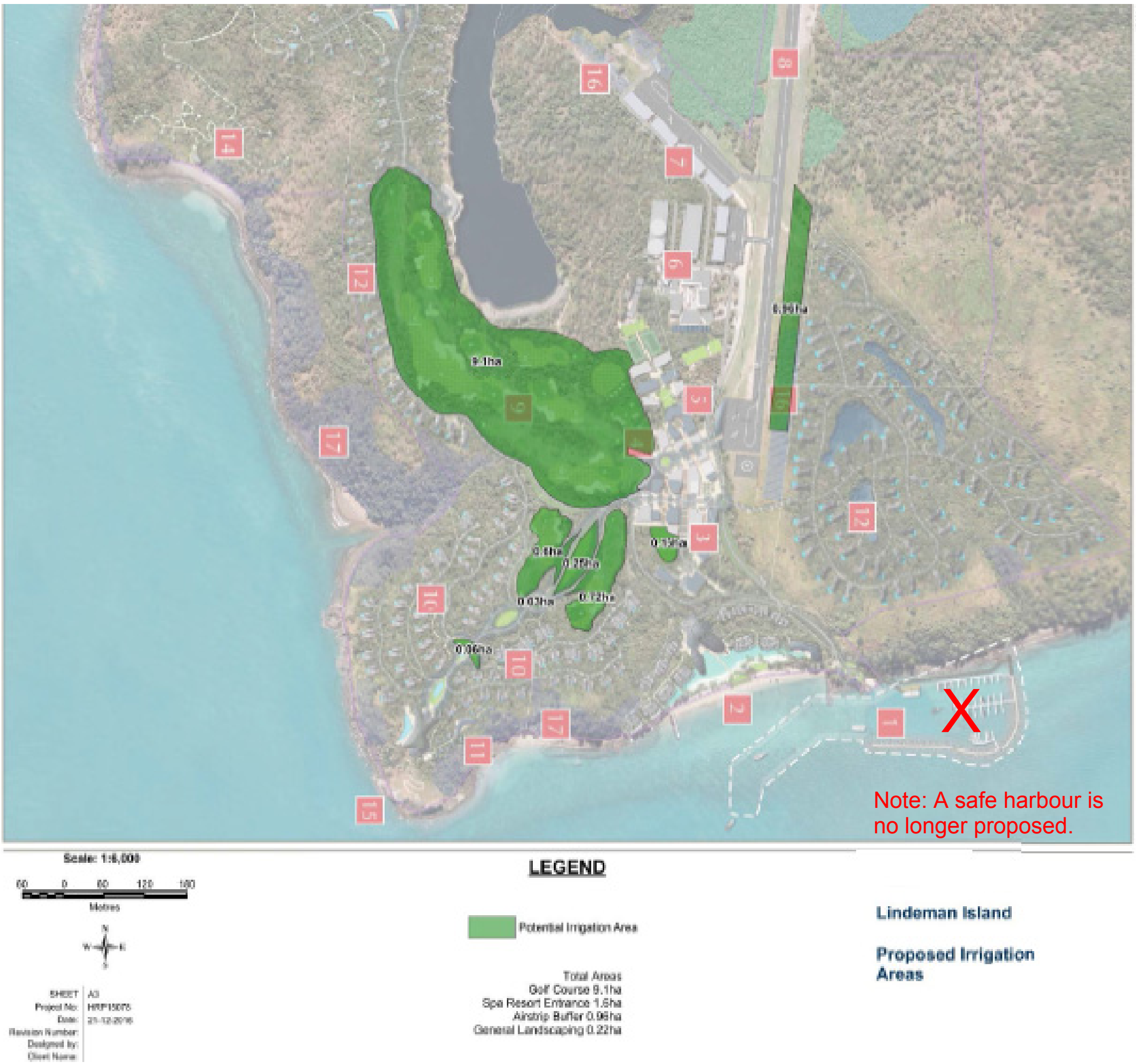
Map 24-2. Recycled Water.

Map 24-3. Proposed Irrigation Areas.



24.3.2 Environmental Regulation Compliance

The existing secondary wastewater treatment plant which operated under Environmental Authority (EPPR00854613) for ERA 63-(1b)(i) - Sewage treatment > 100 to 1500EP, is currently decommissioned and will be demolished as part redevelopment of the site. A new tertiary wastewater treatment plant will be constructed for treatment of wastewaters generated within the development and is to operate under a new Environmental Authority. The *Environmental Protection Act 1994* provides for the granting of environmental authorities for wastewater treatment activities referred to as Environmentally Relevant Activity ERA 63. The *Environmental Protection Regulation 2008* includes the requirements for protection of receiving environments for activities relating to wastewater treatment works. The *Model Operating Conditions for ERA 63 – Wastewater Treatment* published by DEHP in 2014 provides a framework of conditions to apply for applications for wastewater treatment works within Queensland.

The wastewater treatment plant at the Lindeman Great Barrier Reef Resort will require approval for operation as described by Schedule 2, Part 13, 63 Wastewater Treatment of the *Environmental Protection Regulation* 2008 with a threshold of 100 -1,500 EP. Compliance with the relevant model operating conditions is deemed to satisfy the requirements of the *Environmental Protection Act 1994* and the *Environmental Protection Regulation* 2008. The Lindeman Island wastewater treatment plant will comply with the relevant conditions within the *Model Operating Conditions* as described in **Table 24-10.**

Table 24-10. Compliance with Model Operating Conditions for ERA 63 – Wastewater Treatment.

Condition Requirement	Demonstration of Compliance
General	
Adequate sizing and operation of the wastewater treatment plant	The wastewater treatment plant is sized to treat the anticipated flows from the development at 100 percent occupancy, despite the highest occupancy rate expected based on historical data of 62 percent. The flows are based on a wastewater generation rate of 300 L/EP/day which is greater than the 200 L/EP/day specified in the *Environmental Protection Regulation 2008* Schedule 2 Part 13 for calculation of the daily peak design capacity of a wastewater treatment plant and considered a conservative generation rate based on the absence of laundry, kitchen and outdoor uses typical of urban domestic wastewater generation. The wastewater treatment plant will be sized to cater for three times the average dry weather flows to enable wet weather flows to be treated to the required standard. An offline storage will be provided to store flows unable to be fed through the plant due to extreme wet weather events or plant failure. The storage will have capacity for four hours of peak flows. Operational and maintenance procedures will ensure activities are carried out in a way which does not cause environmental harm.
Activities and all operational and management actions are undertaken in a way which does not cause or threaten to cause environmental harm.	All actions taken and equipment used will be carried out in a way to minimise risk to the environment. Wastewater treatment is achieved with membranes and technologies are to be selected aimed at minimising the need for chemical use within the plant. Any chemicals that are required will be transported and stored in accordance with regulatory requirements and standards with appropriate bunding.

Condition Requirement	Demonstration of Compliance
Recording and reporting	Records will be maintained of daily inflows, outflows, effluent quality monitoring results, discharges and any complaints received. Annual reports will be prepared and submitted to the regulator. The regulator will be notified promptly of any breaches of the Environmental Authority. A sampling and monitoring program will be prepared that will provide for the transfer of the necessary samples to the mainland for analysis by a NATA accredited laboratory.
Environmental Monitoring Program	An Environmental Monitoring Program will be prepared to monitor the environmental impact of wastewater treatment activities
Air	
Contaminants released to air as a result of the activity do not cause environmental nuisance.	Odour control measures will be implemented to ensure odours do not cause nuisance to resort guests or staff. These measures may include odour treatment units and enclosure of processes likely to emit odours. The wastewater treatment plant is located north of the maintenance area away from the resort accommodation and recreational precincts.
Land	
Discharge of waters to land must comply with water quality and volume release limits of the Environmental Authority	The wastewater treatment plant will be designed, constructed, operated and maintained to produce a consistent Class A+ recycled water. The recycled water will be monitored to ensure the required water quality prior to irrigation. Application rates will be based on MEDLI modelling which considers local climate conditions, soil and vegetation types, irrigation water quality, land area and wet weather storage availability. MEDLI modelling has been carried out for the proposed irrigation scheme. Refer to Section 3.2.2 for details. Adequate buffers will be maintained around irrigation areas to maintain public and environmental health and safety.

24.3.3 Monitoring and Auditing

Management strategies will be developed and implemented to monitor the performance of the wastewater collection, treatment and reuse infrastructure. Prior to operation, a monitoring program of the receiving environment will be implemented to establish background data. Regular sampling and monitoring of the receiving environment will be carried out during the operation of the collection, treatment and reuse scheme and compared to the initial background data to monitor environmental impacts. In the event a negative impact is observed, actions will be taken to minimise the impact and avoid further impacts. Actions may include ceasing of irrigation within a nominated area, or increasing storage capacities within the collection system, or at the treatment plant.

24.3.4 Potential Impacts and Mitigation Measures

The risks and proposed mitigation strategies associated with the operation of the wastewater collection, treatment and reuse infrastructure are detailed in **Table 24-11.**

Table 24-11. Risk assessment matrix -wastewater collection, treatment and reuse infrastructure.

Potential Impact	Significance of Impact: Unmitigated	Mitigation Measure			Significance of Impact: Mitigated
		Design	Construction	Operation	
Conveyance					
Failure of wastewater collection system resulting in overflow and discharge to ocean	(6) Medium	• Wastewater collection, treatment and reuse infrastructure and equipment will be well designed and will undergo regular inspections and maintenance for proper operation. A preventative maintenance program will be developed and implemented to ensure required replacements and servicing is undertaken. Records will be maintained of all faults and failures. • In the event of a wastewater overflow, flows will be contained through the use of temporary bunding. Flows will be vacuumed into appropriate collector tanks/trucks and transferred to a pump station or the wastewater treatment plant. Remediation works will be undertaken as required.			(4) Low
Treatment					
Failure of wastewater treatment plant resulting in overflow and discharge to ocean	(6) Medium	• A high level of redundancy is to be built into the wastewater treatment plant including duplication of key items of infrastructure. This will allow treatment to continue during periods of malfunction or equipment replacement/repair. • Back-up power supplies will be provided at the plant in the form of diesel generators to ensure uninterrupted operation during power failures. • In the event the plant loses power, flows will be diverted to an offline storage pond capable of retaining up to 4 hours of peak flows for treatment upon return of treatment capabilities.			(4) Low
Energy Supply					
Failure or interruption with power supply resulting in impacts to waste water treatment and water treatment.	(6) Medium	• In the event the plant loses power, flows will be diverted to an offline storage pond capable of retaining up to 4 hours of peak flows for treatment upon return of treatment capabilities. • Rainwater tanks can provide back-up water supply.			(4) Low

Potential Impact	Significance of Impact: Unmitigated	Mitigation Measure			Significance of Impact: Mitigated
		Design	Construction	Operation	
Reuse and Management of Wastewater Effluents					
Irrigation of recycled water results in runoff potentially causing contamination of surface water resources	(4) Low	• A detailed water and nutrient balance has been undertaken to ensure no direct runoff of recycled water will occur. An Irrigation Management Plan will be developed to ensure irrigation is managed in an environmentally sustainable manner aimed at protecting the receiving environment. • The areas for irrigation are located outside of the Gap Creek Dam catchment area. • Recycled water to be of very high quality with low nutrient concentrations.			(1) Low
Irrigation of recycled water results in leaching of nutrients causing contamination of groundwater resources.	(4) Low	• Geological investigations identify limited, distant groundwater resources on the island unlikely to be effected by irrigation of nominated areas. • Recycled water to be of very high quality with low nutrient concentrations. • MEDLI modelling carried out identified limited leaching of nutrients though the soil profile. Refer to Section 3.2.2 for MEDLI modelling analysis.			(1) Low
Recycled water discharged during extreme wet weather events results in reduced water quality and adversely impacts on ecological communities.	(6) Medium	• Recycled water to be of very high quality with low nutrient concentrations. MEDLI modelling results indicate no discharges of recycled water to ocean. • To manage recycled water volumes during wet weather, 12 ML storage is to be provided to contain flows during occasions when irrigation is unavailable due to wet weather. • In the event recycled water must be discharged, a sampling and monitoring program would be implemented with results compared to background monitoring data to ascertain the impact of the discharge. It is likely in these circumstances, receiving waters would feature elevated levels of freshwater runoff from the island and higher turbidity levels due to wave action and runoff from coastal rivers. • Remediation actions would be developed in consultation with relevant regulators including DEHP and GBRMPA.			(2) Low
Discharge to Gap Creek is unavailable	(6) Medium	• In the event discharge is required but unavailable during extreme wet weather events, options for discharge will be explored in consultation with the regulator and may include additional irrigation of nominated areas.			(2) Low

24.4 Water Supply

The raw water supply source is Gap Creek Dam located on the island to the north of the development. Raw water will be transferred to the water treatment plant sized to meet the demands of the development based on 100 percent occupancy, however, the extraction rates will depend on the actual demands of the development and the extent of supplementation with recycled water. Recycled water produced at the new wastewater treatment plant will be used for a range of non-potable uses within the development, including toilet flushing, washdown and irrigation of the island's golf course and landscaped areas. The volume of recycled water available will vary with occupancy. Desalination of seawater is not proposed for the provision of water supply requirements of the Lindeman Great Barrier Reef Resort but a small desalination plant is proposed to treat the water to be discharged from the lagoon for maintenance purposes, prior to treatment at the sewage treatment plant. Gap Creek Dam has a 10 to 15 metre wide spillway channel located at the western end of the main wall. The spillway is approximately 1.7 m lower than the crest of the wall. A new transfer main will be constructed to transfer raw water from the spillway to the new water treatment plant. Water supply options for the proposed resort are also discussed in **Chapter 18 – Water Resources.**

24.4.1 Water Act 2000 Approval

Rights over water in Gap Creek Dam is vested in the state of Queensland. An approval under the *Water Act 2000* is required for extraction of waters from Gap Creek Dam for use within the resort. It is noted that Gap Creek Dam was established as a raw water supply to service the previous Lindeman Island resort and is an existing element of the resort infrastructure. A permit will also be required for excavation of the dam as proposed. This matter is further assessed in **Chapter 6 – Tenure.**

24.4.2 MEDLI Modelling

For modelling irrigation schemes, the use of a mass balance approach ensures the application rate of any component of irrigation water does not exceed the natural take-up rate of the vegetation, storage within the soil or lost to the environment. The mass balance approach is the basis of the computer-based mathematical Model for Effluent Disposal to Land using Irrigation (MEDLI) Version 2 developed by the Queensland Department of Science, Information Technology and Innovation in 2015. MEDLI simulates the behaviour of water and nutrients in the soil column and the growth of irrigated pastures or crops in response to climatic conditions and nutrient and salt loadings. The model is based on historic climate information including temperature, rainfall, evaporation, and solar radiation, estimates of the effluent quality and quantity, and soil properties. For the Lindeman Island redevelopment, MEDLI is used to assist in designing a sustainable irrigation scheme and identifying wet weather storage capacity requirements based on site specific conditions.

24.4.2.1 Modelling Inputs

The MEDLI modelling program requires the input of several site-based parameters. Information is sourced from field investigations, government records, and proposed development details.

Climate

MEDLI requires daily weather data for estimating crop requirements, simulating crop growth and carrying out water balance computations. The required climate data was sourced from Data Drill data prepared by SILO

(Scientific Information for Land Owners), a database of historical climate records for Australia based on observational records provided by the Bureau of Meteorology. Data Drill data are temporal datasets consisting of interpolated data, available at any point on a 0.05 by 0.05 grid over Australia. The data details daily evaporation rates, rainfall and maximum and minimum temperatures for a 100 year period from 1 January 1915 to 31 December 2014. A summary of the average monthly rainfall and pan evaporation for Lindeman Island used in the MEDLI modelling is shown in Table 24-12.

Table 24-12. Average Historical Monthly Rainfall and Pan Evaporation for Lindeman Island.

	Monthly averages (mm/month)												Annual Percentiles (mm/year)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave	10th	50th	90th
Rainfall	285.5	348.6	273.6	173.8	134.4	82.0	52.9	31.9	26.3	32.0	69.9	164.2	1,675	1,068	1,584	2,477
Evaporation	192.2	161.0	168.3	143.0	119.9	102.7	111.9	133.7	163.2	195.0	203.1	214.1	1,908	1,797	1,911	2,008

Further climate details are included in the MEDLI output reports in **Appendix O - Water Infrastructure Assessment.**

Soil

The *Preliminary Geotechnical Assessment Lindeman Island Redevelopment* prepared by Cardno in September 2015 indicate the redevelopment site consists of soils comprising a various combination of fine grained gravel, clay and sandy soils down to a depth of around 300mm with 30 - 50 % clays or silts, overlaying rock. Based on the information in the geotechnical report, the MEDLI default soil Duplex 2 is adopted for modelling with an upper layer of 300 mm of medium pervious soils overlying very low permeability soils. A summary of the soil water characteristics is shown in **Table 24-13** with further details available in the MEDLI output reports are included in the MEDLI output reports included in **Appendix O - Water Infrastructure Assessment.**

Table 24-13. Soil Water Characteristics Selected as Input to the MEDLI Modelling.

Soil Parameters – Duplex 2	Unit	Value Adopted
Profile Porosity	mm	1359.62
Profile saturation water content	mm	1327
Profile drained upper limit (or field capacity)	mm	1042.2
Profile lower storage limit (or permanent wilting point)	mm	771.2
Profile available water capacity	mm	271
Profile limiting saturated hydraulic conductivity	mm/hour	0.1

Soil Parameters – Duplex 2	Unit	Value Adopted
Surface saturated hydraulic conductivity	mm/hour	10
Runoff curve number II	coefficient	82
Soil evaporation U	mm	8
Soil evaporation Cona	mm/sqrt day	4

Vegetation

Irrigation of recycled water will occur on the golf course, and on various landscaped areas across the development. Based on existing natural vegetation, a single vegetation type, a non-rotated blady grass, is assumed for all sites and the default MEDLI parameters for blady grass pasture are used to characterise the vegetation under irrigation. The MEDLI default trigger for harvest of blady grass of 5,000 kg/ha is adopted for modelling, however it is expected that the golf course and landscaped areas will be well maintained and therefore mowed at a much greater frequency, resulting in removal of the biomass and associated nutrients. Therefore, the nutrient removal scenario modelled represents a conservative approach. A summary of the vegetation characteristics is shown in **Table 24-14** with further details available in the MEDLI output reports included in **Appendix O - Water Infrastructure Assessment.**

Table 24-14. Vegetation Characteristics Selected as Input to the MEDLI Modelling.

Vegetation Parameters – Blady Grass	Unit	Value Adopted
Average monthly cover (minimum - maximum)	%	32.40 (26.88 - 36.79)
Maximum crop factor at 100% cover	mm/mm	0.8
Non-transpiring cover remaining after harvest	%	20
Maximum potential root depth in defined soil profile	mm	800
Salt tolerance	-	Moderately tolerant
Salinity threshold EC sat. ext.	dS/m	1.5
Proportion of yield decrease per dS/m increase	%/dS/m	2

Advice from the turf specialist for the redevelopment expects the use of Winter Couch on the golf course which has salinity and water requirements consistent with the Blady Grass vegetation adopted in the MEDLI model.

Irrigation Water Quality

The nutrient and salinity concentrations within the irrigation water adopted for MEDLI modelling are based on the proposed treatment standards summarised in **Table 24-15.**

Table 24-15. Irrigation Water Quality Adopted in the MEDLI Modelling.

Irrigation Water Quality	Unit	Value Adopted
Total Nitrogen	mg/L	5
Total Phosphorus	mg/L	2
Total Dissolved Solids	mg/L	1000

Electrical Conductivity	dS/m	1.56

Recycled Water Volumes

Produced recycled water volumes are based on the hydraulic loading on the wastewater treatment plant. It is assumed 100 percent of the wastewater entering the plant is converted to recycled water. Therefore, the recycled water volumes are based on the ultimate design hydraulic loading of the treatment plant which is 124 ML/year. The recycled water volumes are summarised in **Table 24-16.**

Table 24-16. Recycled Water Volumes Adopted in the MEDLI Modelling.

Recycled Water Volumes	Unit	Value Adopted
Equivalent Persons	EP	1,478
Recycled Water Produced	kL/day	340
Recycled Water Produced	ML/year	124
Occupancy Rate	%	100

Irrigation Scheduling

The modelling scenario involves spray irrigation each day to a fixed depth of 5 mm. The actual irrigation schedule will take into account climate conditions and the soil moisture content of the receiving land.

Land Area

The land nominated for irrigation includes the golf course and landscaped areas within the development. The land areas available for irrigation are shown on the plan in **Appendix O - Water Infrastructure Assessment** and summarised in **Table 24-17.**

Table 24-17. Land Areas of Nominated Irrigation Areas.

Irrigation Land Areas	Area (Ha)
Golf Course	9.1
Spa Resort Entrance	1.6
General Landscaping	0.22
Airstrip Buffer Zones	0.96
TOTAL	**11.88**

Storages

It is proposed to construct a new recycled water storage adjacent to the new wastewater treatment plant. The capacity of the storage will be determined through the MEDLI modelling. For modelling purposes, the storage is considered a facultative pond as recommended by the MEDLI model for use for waste streams that do not contain solids and is recommended for use for treated wastewater effluent. However, it is more likely the recycled water storage will consist of a covered steel panel tank.

24.4.3 Modelling Results

The MEDLI model was run based on the inputs described above. A control scenario was also modelled where no irrigation occurred. The results are detailed in the MEDLI output reports included in **Appendix O - Water Infrastructure Assessment.**

Hydraulics

Based on the irrigation schedule modelled, the results indicate a volume of irrigation water applied to the irrigation area of 66 ML/year, with an application rate of 5.6 ML/ha/year. At this application rate, there is less than 4 mm runoff each year due to irrigation, with deep drainage increasing over the 50 year period from 304.32 mm/year to 368.16 mm/year. Based on an irrigation area of 11.88 hectares, an irrigation rate of 5.6 ML/ha/year and a storage of 15 ML, the model results indicate zero overflow or discharges.

Soil Nutrients

As is typical with effluent irrigation schemes, the nutrient uptake and the subsequent growth and biomass of the vegetation increases in proportion with increases in irrigation rates. For the Lindeman Great Barrier Reef Resort, MEDLI modelling results indicate while an additional 24.77 kg of nitrogen is added to each hectare each year of irrigation, due to the increased crop biomass, the crop is removing 115.08 kg/ha/year of nitrogen, compared to the control scenario of no irrigation where the crop is removing 86.16 kg/ha/year. The results also indicate a reduction in the leached annual soil nitrogen and the average and maximum nitrate-nitrogen concentration of the deep drainage with irrigation.

The modelling results indicate an additional 9.91 kg of phosphorus is added to each hectare each year of irrigation. However, as for nitrogen, greater amounts of phosphorus are taken up due to the increased crop biomass with 13.12 kg/ha/year of phosphorus taken up when irrigated compared with an uptake of 4.13 kg/ha/year under the no irrigation scenario. The final concentrations of phosphorus in the soil is unchanged from the no irrigation scenario for dissolved phosphorus with irrigation, and slightly increased for adsorbed phosphorus (from 4,777.74 kg/ha under no irrigation to 4,814.06 kg/ha under irrigation), however the modelling indicates no change in the average and maximum concentrations of phosphate-phosphorus in the rootzone and deep drainage.

Vegetation

The modelling results indicate irrigation is beneficial for the vegetation, including grasses proposed as part of the golf course. The dry matter yield increases from 8221.35 kg/ha/year under no irrigation to 10,866.83 kg/ha/year under the irrigation scenario modelled, with an increase of almost 7% in monthly plant cover. The roots are extending deeper into the soil profile with an increased depth of 177 mm with only 24% of the crop deaths that would occur with no irrigation. Further, the water deficit stresses currently experienced (with no irrigation), decrease from 13 to 5%.

Salinity

After 50 years of irrigation, the modelling indicates a soil solution salinity at the drained upper limit at the base of the rootzone to be 2.18 dS/m. The crop is not impacted by the salinity of the irrigation water with the model results indicating a relative expected crop yield over the 50 years due to salinity of 100%, that is, no change to the crop yield.

Recycled Water Storage

MEDLI modelling results indicate, based on an irrigation area of 11.88 hectares, recycled water storage of 15 ML will provide the necessary storage with zero overflows. The modelling is considered conservative based on the following:

- The modelling results are based on the use of recycled water only for irrigation. An additional 17 ML of recycled water is predicted to be used for toilet flushing and wash down annually.
- The modelling is based on 100% occupancy to provide the worst possible scenario. The average occupancy rate is estimated to be 56% and therefore the volumes of recycle water produced will be significantly lower than the MEDLI model predicts.

Based on the above, it is considered a storage of 12 ML will provide sufficient storage of all recycled water. The modelling is based on the previous 50 years of climate data. Changes in weather patterns resulting in prolonged or extreme wet weather events may result in discharges of recycled water.

Table 24-18. MEDLI Modelling Outputs Summary.

Parameter	Units	Result	
		No Irrigation	Irrigation
Hydraulics			
Average annual rainfall	mm/year	1675.16	1675.16
Irrigation area	ha	0.00	11.4
Irrigation water applied over entire irrigation area	ML/year	0.00	73.5
Irrigation water applied per hectare	ML/ha/year	0.00	6.45
Irrigation runoff	mm/year	0.00	0.01
Deep drainage	mm/year	304.32	375.51
Storage capacity	ML	N/A	10
Average annual overtopping	ML/year	N/A	0.3
Soil Nitrogen			
Average annual nitrogen added in irrigation water	kg/ha/year	0.0	29.74
Average annual soil nitrogen removed by plant	kg/ha/year	86.16	120.47
Average annual soil nitrogen leached	kg/ha/year	5.51	4.48
Average nitrate–N concentration of deep drainage	mg/L	1.81	1.19
Maximum annual nitrate-N concentration of deep drainage	mg/L	20.68	19.44
Soil Phosphorus			
Average annual phosphorus added in irrigation water	kg/ha/year	0.0	5.95
Average annual soil phosphorus removed by plant	kg/ha/year	4.13	9.41
Final dissolved phosphorus	kg/ha	0.71	0.72
Final adsorbed phosphorus	kg/ha	4777.74	4801.45
Average phosphate-P concentration in rootzone	mg/L	0.01	0.01
Average phosphate-P concentration in deep drainage	mg/L	0.10	0.10
Maximum annual phosphate-P concentration of deep drainage	mg/L	0.10	0.10
Soil Salinity			
Salt threshold Electrical Conductivity of blady grass pasture	dS/m	0.02	0.02
Average annual salt added by rainfall	kg/ha/year	200.80	200.80
Average annual salt added by irrigation water and leached at steady state	kg/ha/year	0.00	4959.14
Final salinity of soil solution at drained upper limit at base of rootzone	dS/m	N/A	2.06

Parameter	Units	Result	
		No Irrigation	Irrigation
Vegetation			
Average annual shoot dry matter yield	kg/ha/year	8221.35	11327.22
Average monthly plant cover	%	26	34
Average monthly root depth	mm	516.80	738.51
Average number of crop deaths per year	No./year	1.5	0.18
Average monthly water stress	%	13	4
Crop yield expected to fall below 90% of potential due to salinity	Proportion of years	N/A	0.00

24.4.4 Water Supply Balance

A water balance was undertaken to identify the demands of the development and the capacity of the available water resources to meet these demands. The methodology used for the water balance is described as follows:

1. Estimation of equivalent populations and occupancy rates for the development. Refer to **Table 18-2. Water Supply Equivalent Populations**;
2. Estimation of total water demands based on development type;
3. Estimation of wastewater flows and recycled water produced;
4. Identification of suitable uses for recycled water;
5. Establishment of split between potable and non-potable demands; and
6. Estimation of potable and recycled water demands. MEDLI modelling was undertaken to identify sustainable rates for the application of recycled water to land.

The assumptions, inputs and results of the water balance are detailed in the following sections.

24.4.4.1 Equivalent Populations

Equivalent populations are required to be estimated for the development to inform the design of water and sewerage infrastructure. Equivalent populations were calculated based on the development types and areas as detailed in the Lindeman Island Redevelopment Development Area Schedule Issue K 16/02/16 and the *Water Services Association of Australia Sewerage Code WSA 02-2014*. The *Code* provides estimates of contributions to equivalent populations from residential and commercial development based on a unit rate such as gross hectare or occupant. Based on the gross floor areas provided in the Development Area Schedule and the density of development, the equivalent population for the site is estimated at 1,478. The calculation of equivalent populations are conservative as they relate to fully occupied typical urban development, as opposed to partially occupied island resorts with a contained population. Refer to **Table 18-2. Water Supply Equivalent Populations.**

24.4.4.2 Occupancy Rates

Occupancy rates for the proposed development are based on typical occupancy rates from the Queensland Government Destination Q website (https://www.destq.com.au/squiznew/resources/research/statistics), which reports tourism statistics from the Australian Bureau of Statistics. For the Whitsunday region average occupancy for hotels and motels with over 15 rooms from 2002 to 2012 is shown in **Table 24-19.**

Table 24-19. Estimated Average Occupancy for Lindeman Island Resort Redevelopment.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Occupancy Rate (%)	52	52	52	49	49	49	62	62	62	62	62	62

Based on the above occupancy rates and the total EPs, the monthly EPs are shown in **Table 24-20**.

Table 24-20. Monthly Equivalent Populations Based on Anticipated Occupancy Rates.

Location	100% Occupancy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marina													
Retail/Beach Club	2	1	1	1	1	1	1	1	1	1	1	1	1
Visitor Centre	2	1	1	1	1	1	1	1	1	1	1	1	1
5 Star Beach Resort													
Pool Bar	1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Central Facilities	29	15	15	15	15	14	14	14	18	18	18	18	18
Hilltop Suites	123	64	64	64	64	60	60	60	75	75	75	76	76
Pool Suites	218	114	114	114	114	107	107	107	134	134	134	136	136
Future Tourist Villas													
Villas	312	163	163	163	153	153	153	192	192	192	194	194	194
6 Star Spa Resort													
Central Facilities	12	6	6	6	6	6	6	7	7	7	7	7	7
Type 'A' Courtyard Villa	30	16	16	16	15	15	15	18	18	18	19	19	19
Type 'B' Cliffside Villas	38	20	20	20	18	18	18	23	23	23	23	23	23
Type 'C' Hilltop Villas	55	29	29	29	27	27	27	34	34	34	34	34	34
Type 'D' Exclusive Villa	35	18	18	18	17	17	17	22	22	22	22	22	22
5 Star Eco Resort													
Central Facilities	9	5	5	5	4	4	4	5	5	5	5	5	5
Eco Butterfly Villa	73	38	38	38	36	36	36	45	45	45	45	45	45
Eco Treetop Villa	30	16	16	16	15	15	15	18	18	18	19	19	19
Boat House	1	1	1	1	1	1	1	1	1	1	1	1	1
Boat Club	60	31.4	31.4	31.4	29.5	29.5	29.5	37.0	37.0	37.0	37.4	37.4	37.4
Village and Maintenance													
Airport Lounge	5	2	2	2	2	2	2	3	3	3	3	3	3

Location	100% Occupancy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conference Centre	8	4	4	4	4	4	4	5	5	5	5	5	5
Retail	21	11	11	11	10	10	10	13	13	13	13	13	13
Sport Centre	8	4	4	4	4	4	4	5	5	5	5	5	5
Staff Accommodatio	320	167	167	167	157	157	157	197	197	197	199	199	199
Maintenance	52	27	27	27	25	25	25	32	32	32	32	32	32
Airport													
Hangers	5	3	3	3	2	2	2	3	3	3	3	3	3
Lakeside Restaurant													
Restaurant	29	15	15	15	14	14	14	18	18	18	18	18	18
Day Spa													
Day Spa	5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL EPs	**1,478**	**773**	**773**	**773**	**727**	**727**	**727**	**910**	**910**	**910**	**921**	**921**	**921**

24.4.4.3 Recycled Water Supply Locations

Recycled water is to be distributed to the beach resort, village and maintenance areas, airport, lakeside restaurant and day spa. Distribution of recycled water to the eco resort villas and tourist villas was not deemed beneficial as these villas will be fitted with rainwater tanks to supply non-potable uses and pool top ups.

A plan showing nominated locations for recycled water use within the resort is shown in **Map 24-4** and **Appendix O - Water Infrastructure Assessment**.

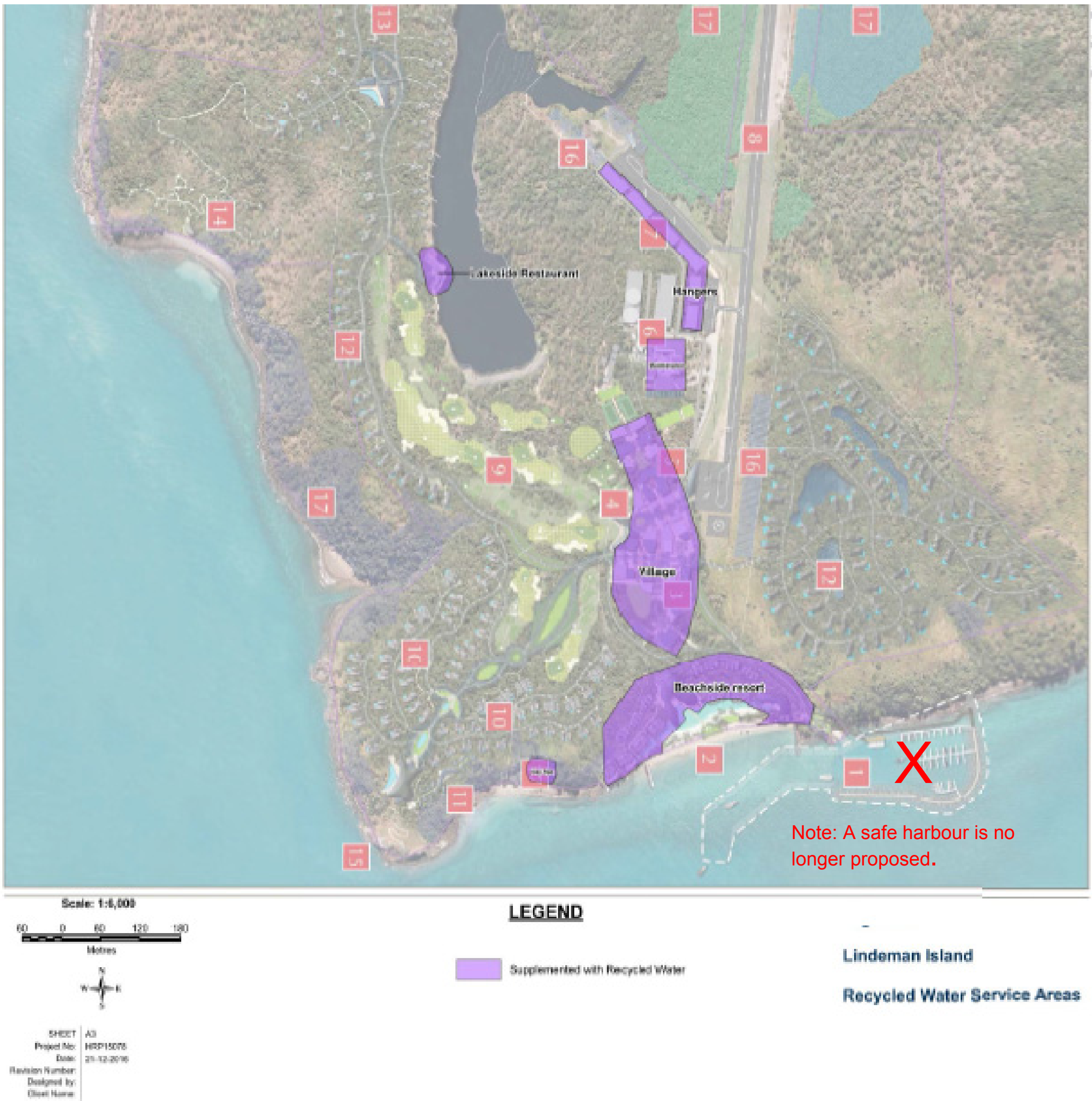
24.4.4.4 Historical Water Demands

Historical water demand records are available for the existing resort, however, when calculating future demands these are not considered reliable or applicable due to:

- The extensive gaps in data availability
- The type and extent of the redevelopment in comparison to the existing resort
- The sustainability targets of the redevelopment
- The use of recycled water and rainwater to supplement water supplies

Therefore, the water demands are estimated based on the estimated daily water consumption per capita multiplied by the calculated equivalent population and estimated occupancy rates.

Map 24-4. Recycled Water Service Areas.



24.4.4.5 Daily Per Capita Consumption

The daily per capita water consumption is influenced by a number of factors including the opportunities for water use within the villas and suites (for example the inclusion of spa baths, kitchenettes etc.), the perceptions of resort guests relating to water availability, water saving initiatives and education programs, and climate conditions. Lindeman Island lies within the Mackay Regional Council jurisdiction. The Mackay Regional Council Planning Scheme specifies a daily per capita residential water demand of 300 litres. This is based on typical urban dwellings with larger lot sizes and more extensive garden areas. The following water savings initiatives are proposed for the development (refer *The Lindeman Island Redevelopment Civil Infrastructure Concept Cost Estimates* prepared by Flanagan Consulting Group in July 2013):

- Installation of water efficient taps and shower fittings
- Installation of 4 star WELS dual flush systems
- Installation of waterless urinals
- Encourage guest re-use of linen and towels
- Operation of washing machines when fully loaded and minimum 4 star water efficiency rating for all washing machines
- Diversion of filtered backwash from pools and spas for reuse on landscaping
- Use of low water gardens including local natives or other water wise plants and the addition of compost and mulch to increase moisture retention.

The potential for increased usage due to guest perceptions is expected to be offset by water savings initiatives and education programs and therefore a daily per capita demand of 300 litres is considered an appropriate consumption value for the development. Villa pool top-ups are expected to be met with rainwater and are excluded from consumption estimates.

24.4.4.6 Potable and Recycled Water Usage Assumptions

Potable water use is assumed for kitchens, showers and hand washing, with recycled water used for toilet flushing within the beach resort, village and maintenance areas, airport, lakeside restaurant and day spa. A split of 60/40 is assumed between potable and recycled water based *Water Services Association of Australia Water Supply Code WSA 03 – 2011* Table 2.1. Further, a split of 30/10 is assumed for toilet flushing and basin use. The adopted splits are shown in **Table 24-21.**

Table 24-21. Potable and Recycled Water Usage Assumptions.

Location		Use	Source	Proportion of Total Demand %
Beach Resort	Pool Bar	Toilets	Recycled Water	30
		Basins	Potable	10
		Kitchens	Potable	60
	Central facilities	Toilets	Recycled Water	30
		Basins	Potable	10
		Kitchens	Potable	60
	Suites	Toilets	Recycled Water	30
		Basins	Potable	10
		Kitchens	Potable	60
Village/Maint'nce	Airport Lounge	Toilets	Recycled Water	60
		Basins	Potable	40
	Conf. Centre	Toilets	Recycled Water	60
		Basins	Potable	40

Location		Use	Source	Proportion of Total Demand %
	Retail	Toilets	Recycled Water	60
		Basins	Potable	40
	Sports Centre	Toilets	Recycled Water	60
		Basins	Potable	40
	Staff Accomm.	Kitchen	Potable	60
		Toilets	Recycled Water	30
		Basins	Potable	10
	Maintenance	Toilets	Recycled Water	60
		Basins	Potable	40
		Washdown	Recycled Water	Additional
Airport	Hangers	Toilets	Recycled Water	60
		Basins	Potable	40
Lakeside	Restaurant	Kitchen	Potable	60
		Toilets	Recycled Water	30
		Basins	Potable	10
Day Spa	Day Spa	Toilets	Recycled Water	30
		Basins	Potable	10

24.4.4.7 Internal Water Demands

An annual total of 74 ML of potable water is estimated to be required to meet the potable demands of the Lindeman Great Barrier Reef Resort, and an annual total of 17 ML of recycled water is estimated to be required to meet the internal non-potable uses of the development. The total annual internal potable and non-potable water demands are estimated at 91 ML. The monthly water demands for each of the uses within the beach resort, village and maintenance areas, airport, lakeside restaurant and day spa are shown in **Table 24-22.**

Table 24-22. Potable and Non-Potable Water Demands for the Lindeman Island Development.

Potable and Non-Potable Demands	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEARLY TOTAL (ML)
Total **Potable** Water Demands (kL)	5840	5275	5840	5317	5494	5317	6879	6879	6657	6957	6732	6957	**74.14**
Total Internal **Non-Potable** Demands (kL)	1342	1212	1342	1222	1262	1222	1580	1580	1529	1598	1547	1598	**17.03**
MONTHLY TOTALS (ML)	7.18	6.49	7.18	6.54	6.76	6.54	8.46	8.46	8.19	8.56	8.28	8.56	**91.18**

24.4.4.8 External Water Demands

Recycled water is to be used for irrigation of the golf course, spa resort entrance, either side of the airstrip and for general landscaping, as well as for wash down of trucks and maintenance vehicles and areas. The total anticipated annual recycled water demand for irrigation is 67 ML and for washdown is 0.3 ML. The monthly demands for external uses for recycled water are shown in **Table 24-23**.

Table 24-23. Recycled Water Demands for External Uses.

Recycled Water Demands (kL)	Area (ha)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEARLY TOTAL
Irrigation														
Golf Course	9.1	0	0	0	0	2,548	5,096	5,096	10,192	10,192	10,192	5,096	2,548	51
Spa Resort Entrance	1.6	0	0	0	0	448	896	896	1,792	1,792	1,792	896	448	9
General Landscaping	0.2	0	0	0	0	62	123	123	246	246	246	123	62	1.2
Airstrip buffers	0.96	0	0	0	0	269	538	538	1,075	1,075	1,075	538	269	5.4
TOTAL	11.9	0	0	0	0	3,326	6,653	6,653	13,306	13,306	13,306	6,653	3,326	66.5
Washdown														
Maintenance Area		25	22	25	24	25	24	25	25	24	25	24	25	0.3

24.4.4.9 Recycled Water Demands

Combining the recycled water demands for non-potable use within the development, with recycled water demands for irrigation and washdown results in a total annual recycled water demand of 83.85 ML. A summary of internal and external recycled water demands is shown in Table 24-24. Summary of Recycled Water Demands for the Development.

Table 24-24. Summary of Recycled Water Demands for the Development.

Recycled Water Demands (kL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEARLY TOTAL (ML)
Internal Non-Potable use	1,342	1,212	1,342	1,222	1,262	1,222	1,580	1,580	1,529	1,598	1,547	1,598	17.03
Irrigation	0	0	0	0	3,326	6,653	6,653	13,30	13,30	13,30	6,653	3,326	66.5
Washdown	25	22	25	24	25	24	25	25	24	25	24	25	0.3
TOTAL	1,367	1,234	1,367	1,246	4,613	7,898	8,260	14,911	14,859	14,929	8,224	4,950	83.85

24.4.4.10 Quality of Water Supplied

Potable water will be supplied to the development by the water treatment plant. Recycled water will be produced at the wastewater treatment plant to Class A+ standard.

24.4.4.11 Construction Phase Water Supply

The existing water treatment plant supplies the island's current non-potable water demands. Bottled water is brought over from the mainland for drinking. The new water treatment plant is to be constructed within the first 6 months of construction. During this period, the current water supply arrangements will continue. Following commissioning, the new water treatment plant will provide all water demands during the construction period. Based on a maximum construction workforce of 300 full time employees and an equivalent population of 0.8 per employee, the estimated equivalent population is 240 EP. At a water demand of 300 litres per EP, the expected peak daily water demands during the construction phase are estimated at 72 kL/day. This is able to be provided by the new water treatment plant, which is estimated to have a capacity to produce 443 kL/day.

24.4.4.12 Site Plan – Water Supply Contingency

In accordance with the *Water Supply Safety and Reliability Act 2008* a Drinking Water Quality Management Plan will be prepared and submitted to the regulator for approval. The Plan will include contingencies for provision of water supply requirements in the event of a failure of the main supply. The levels within Gap Creek Dam will be closely monitored. This data will be used to assess the capability of the Dam to provide the expected short and long term potable water supply demands of the development. In the event the water demands are expected to exceed the capacity of the Dam, alternative supply strategies will be investigated and may include:

- Supply of potable water from potable water storage tank;
- Supply of bottled water from the mainland;
- Temporary reduction/cessation of visitors to the island; and
- Investigation of alternative potable water supplies such as further provision of rainwater tanks

A Water Contingency Action Plan will be developed in consultation with the regulator and implemented in the event of an unexpected failure of the main water supply to the resort or low dam levels (refer to **Chapter 28 – Environmental Management Plan**). The Plan will take into consideration the following:

- The location and extent of damage or failure;
- Local conditions such as flooding, climate, bushfire, acts of terror;
- The expected timing for repair/recommissioning of relevant infrastructure;
- The existing and projected occupancy of the resort and associated water demands; and
- Alternative water supply options (e.g. rainwater tanks/barge from mainland).

24.4.4.13 Water Act 2000

An approval under the *Water Act 2000* is required for extraction of waters from Gap Creek Dam for use within the resort. To reduce the demands from the Dam, recycled water is to be used for non-potable uses. Rainwater and seawater will further supplement raw water supplies where practical for use within pools and lagoons.

24.4.4.14 Proposed Water Conservation Measures

A number of water savings initiatives are proposed for the development. These include:

- Recycled water use for non-potable uses - recycled water will meet the demands of the development for non-potable uses and irrigation, reducing the demands on Gap Creek Dam by an average of 84 ML per year.
- Rain water harvesting and reuse – rainwater tanks will be provided to each villa for pool top-ups.
- Planting of native species in landscaped areas – low water gardens including selecting local natives or other water wise plant and adding compost or mulch to increase moisture retention.
- Water efficient fixtures and fittings – water efficient taps and shower fittings, 4 Star WELS dual flush systems and waterless urinals will be fitted in villas and throughout the development.
- Water saving awareness program – an education program will encourage guests to conserve water through the re-use of towels and linen, and the use of fully loaded washing machines and dishwashers.

Diversion of filtered backwash from pools and spas for reuse on landscaping.

24.5 Existing Infrastructure

24.5.1 Existing Water Treatment Plant

There is no town water supply on the island. A water treatment plant meets the island's water supply demands. The existing water treatment plant consists of coagulation, settling, media filtration and UV disinfection with an estimated maximum treatment capacity of 600 kL/day. Treated water is stored in two 600 kL storage tanks adjacent to the plant. The treated water is pumped to a Clearwater Storage tank located on a high point to the southeast of the airstrip. Treated water is then distributed throughout the network under pressure. The water treatment plant is providing water for domestic purposes on the island. Bottled water is used for drinking and cooking. This approach will be maintained during the construction phase until such time as the Clearwater reservoir is decommissioned or works impact on the existing distribution network. At this time, the new water treatment plant and distribution network will be constructed to provide both potable and non-potable water demands during the remainder of the construction phase. Sampling and monitoring of the water supply from the existing water treatment plant will include weekly testing at the outlet of the water treatment plant, at the outlet of the storage reservoir and throughout the distribution network for process monitoring and to ensure the water is safe for the intended uses (i.e. non potable). As bottled water is to be used for potable uses, quality monitoring is not required. The sampling and monitoring program will continue throughout the construction and operation phases until the new water treatment plant is commissioned.

Following commissioning of the new water treatment plant, a sampling and monitoring program will be developed for the water treatment plant, storages and reticulation network in accordance with the regulator's Planning Guidelines for Water and Sewerage which requires where there is a reticulated drinking water supply, water of drinking water quality should be used for human consumption, food preparation, utensil washing, oral hygiene and bathing (AS/NZS 3500, AS/NZS 4020, WSAA, 2002, Water Supply Code of Australia). All potable water supplies to the Lindeman Great Barrier Reef Resort will be required to comply with the Australian Drinking Water Guidelines (NHMRC & NRMMC, 2004).

The existing water treatment plant has an existing Environmental Authority ERA 64-(1a) - Water treatment >0.5 but <5ML water per day seawater for Lot 2 CP858366. It is proposed that this approval be cancelled and that a new application for this ERA be applied for.

24.5.2 Wastewater Treatment

The existing wastewater treatment plant is off-line. A temporary treatment plant treats wastewater currently generated on-site. The temporary treatment plant will continue to treat wastewater during the construction phase until such time as the new wastewater treatment plant is commissioned.

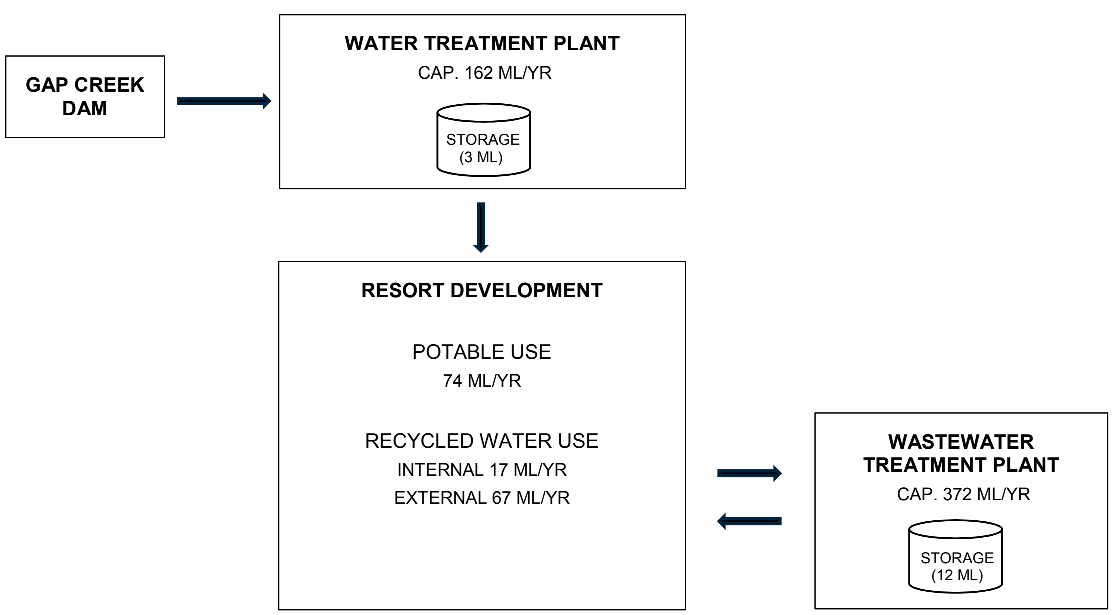
24.6 Decommissioning of Water and Wastewater Infrastructure

The existing water and wastewater treatment plant will be decommissioned following successful commissioning of the new water treatment plant. The existing wastewater treatment plant is currently off-line and is to be decommissioned. Decommissioning of the plants will involve draining the tanks, disconnection from the main electrical system, and demolition and removal of physical infrastructure. Where practical, all pipework will be capped and removed, the sites filled, graded and compaction tested undertaken as required. Mains and pumping stations associated with the existing water supply and wastewater collection network will be decommissioned as required. Where practical, mains will be capped and removed. Pump stations will be electrically isolated, demolished and the physical infrastructure removed. Any equipment or stock items of value that may be salvageable will be identified and isolated, removed, cleaned, wrapped, labelled and stored appropriately. This includes any chemicals remaining on site. All rubbish will be removed in accordance with the Waste Management Plan.

24.7 Waste Management - Water Flow Diagram

At the anticipated occupancy rates, the water treatment plant extracts 74 ML from Gap Creek Dam annually at an average of 0.2 ML per day. The raw water is treated at the water treatment plant and stored in a Clearwater storage. The treated water is then transferred as required to the resort development to meet potable demands. The wastewater generated within the development is collected and transferred to the wastewater treatment plant which is sized to treat daily flows of up to 1 ML. Recycled water produced at the wastewater treatment plant is stored before return to the resort for non-potable use, estimated at 17 ML annually for internal use, and 67 ML for irrigation and washdown purposes, totalling 84 ML per year.

The flows are based on expected occupancy, and the treatment plants are sized based on 100 percent occupancy rates. During detailed design, the projected occupancy rates, demands and the required capacity and redundancy requirements of the treatment plants will be confirmed.



24.8 Infrastructure Reticulation

To service the resort development, the following new infrastructure is proposed to be constructed:

- Raw water supply main;
- Water treatment plant;
- Water supply reticulation network;
- Sewerage collection network;
- Wastewater treatment plant;
- Desalination plant; and
- Recycled water scheme.

24.8.1 Raw Water Supply Main

Gap Creek Dam has a 10 to 15 metre wide spillway channel located at the western end of the main wall. The spillway is approximately 1.7 metres lower than the crest of the wall. A new transfer main will be constructed to transfer raw water from the spillway to the new water treatment plant.

24.8.2 Water Treatment Plant

A new water treatment plant will be constructed to produce potable water in accordance with the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2004) suitable for use within the development (refer to **Map 24-5**). The treatment plant will be located north of the existing plant and will be upgraded to consist of modular treatment units consisting of membrane microfiltration. These units are preferred as they are fully automated, require minimal plant operation and do not require any polymer or coagulant, reducing the possibility of spills and associated environmental impacts. If required, further disinfection will be provided by ultra violet irradiation and chlorination. The detailed specification of the treatment system will be confirmed during the final design phase. The water treatment plant will be sized to meet the demands of the development based on the conservative design assumptions of 100 percent occupancy and the water treatment plant providing all water demands (that is, assuming no use of recycled water). Based on an equivalent population of 1,478 EP, the plant will have the capacity to produce a daily flow of potable water of 0.44 ML. Potable water will be stored in a 3 ML potable water storage tank located at the water treatment plant. This includes an allowance of 0.14 ML for firefighting purposes, and an emergency storage of seven days average day demand or 3.5 days peak day demand.

24.8.3 Water Supply Reticulation Network

24.8.3.1 Design Criteria

The water supply infrastructure requirements for the proposed redevelopment were identified in accordance the Mackay Regional Council *Water Supply Design Planning Scheme Policy No.15.12*.

The following references are also relevant for the design of water reticulation networks:

- Department of Natural Resources & Mines Planning Guidelines for Water Supply and Sewerage (April 2010, Amended March 2014)
- Water Supply Code of Australia V3.1 WSA03-2011

The design criteria adopted are summarised in **Table 24-25**.

Table 24-25. Design Criteria.

Description	Design Criteria
Water Demands	
Average Daily Consumption (AD)	300 L/EP/day
Peak to average demand ratios: Mean Day Maximum Month (MDMM) Maximum Day (MD) Peak Hour (PH)	 1.50 x Average Day demand 2.0 x Average Day demand 1/12 x Maximum Day demand.
Pressure Requirements	
Minimum Residual Pressure	22 m head at peak instantaneous demand
Maximum Residual Pressure	80 m head
Fire Fighting Requirements	
Fire Flow	15 L/s for 2 hours with a background demand of PH demand for Residential Areas 20 L/s for 4 hours with a background demand of PH demand for Commercial and Industrial Areas
Residual pressure during fire flow	12 m minimum at an adjacent hydrant 6 m minimum residual pressure in the mains for all other areas of the water supply zone at 2/3 PH demands Positive residual pressure in the mains for all other areas of the water supply zone at PH demands
Sizing of Pipes	
Trunk main requirements	Two or more mains as a looped main system to avoid the loss of supply in the event of maintenance or breakage Minimum DN150 duplicate mains are required for all commercial areas
Minimum pipe size	100 mm diameter unless otherwise approved by Council 150 mm diameter for all industrial/commercial uses
Maximum head loss for mains less than or equal to DN150 Maximum head loss for mains less than or equal to DN200	5 m/km 3 m/km
Maximum allowable velocity	2.5 m/s
Storage Reservoir (ground level)	
Capacity	3 (MD – MDMM) + (greater of emergency storage/firefighting storage)

24.8.3.2 Distribution System

The proposed potable water distribution system will consist of the following:

- One potable water storage tank to be located adjacent to the water treatment plant.
- One booster pump station to be located at the potable water storage tank. This booster pump station is required as the proposed location of the potable water storage tank is level with or below the elevation of a proportion of the sites to be serviced.
- Potable water mains to service all resort and staff accommodation, commercial and retail facilities and maintenance areas.

Pressure reducing valves are proposed on the potable water mains servicing the low lying areas of the development, including the facilities at the jetty, portions of the Beach Resort, the Day Spa and portions of the Spa Resort. These pressure reducing valves are required to divide the system into pressure zones in order to service the wide range of elevations across the site. A proposed distribution system layout and preliminary sizing of the elements of the proposed distribution system was undertaken based on the site layout provided in the *Lindeman Great Barrier Reef Resort & Spa Masterplan Concept* (DBI Design Pty Ltd, 16 February 2016). The layout and preliminary sizing of the water mains is shown in the preliminary layout plan provided in **Map 24-5** and **Appendix O**.

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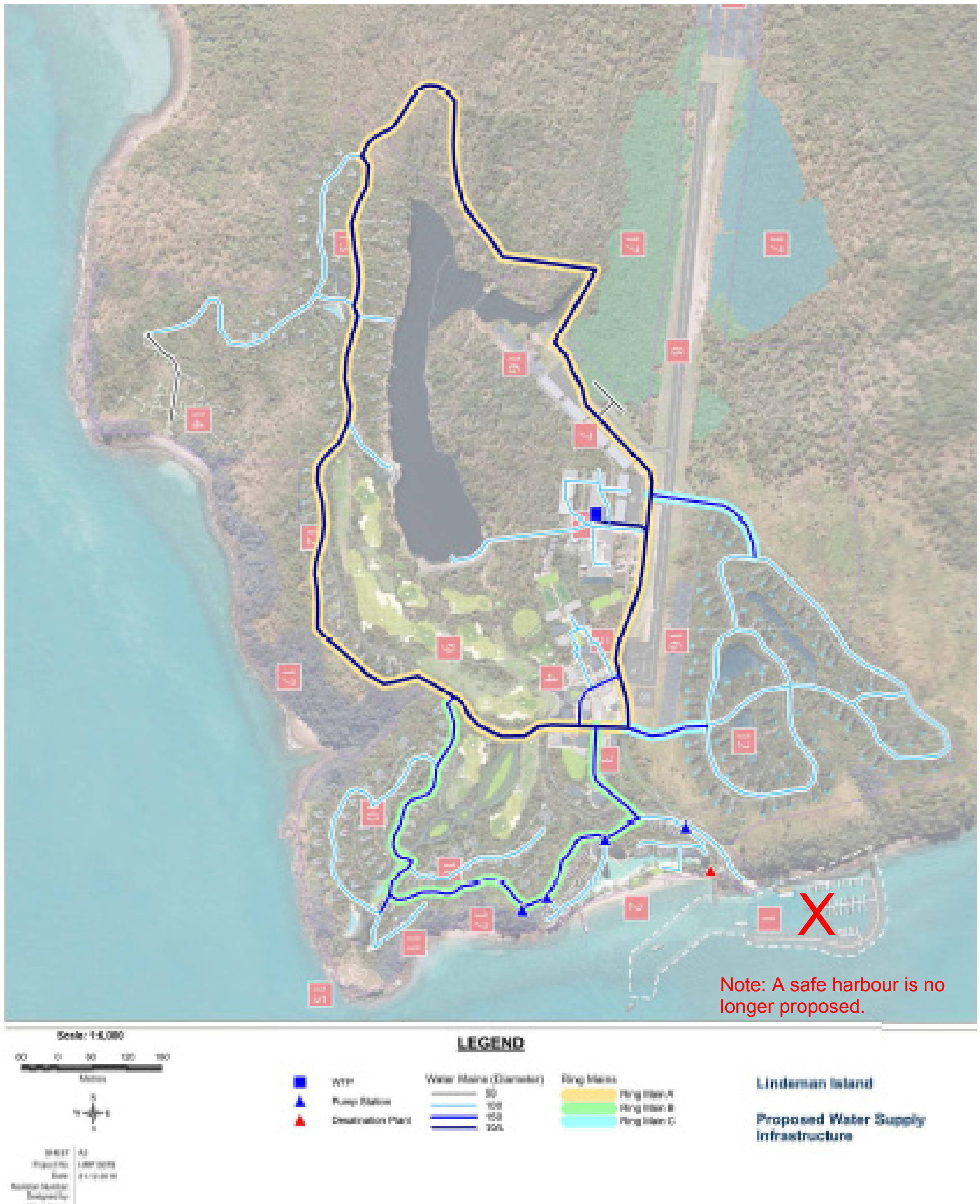
Map 24-5. Proposed Water Supply Infrastructure.



24.8.3.3 Fire Fighting Facilities

Hydrants will be supplied on the trunk water mains located on trunk roads where access by the island's on-site firefighting trucks is available. These trunk roads will generally provide access to the larger buildings, such as central facilities at each of the resorts, conference centre, retail centre, sports centre, maintenance areas and airport buildings. Some villas will also have access to fire hydrants. The trunk water mains containing fire hydrants will be sized to convey the design firefighting flows in accordance with the relevant design criteria. For the remaining buildings which are accessed only by buggy tracks, it is anticipated that the on-site firefighting trucks will not be able to access these sites. Therefore, an alternative solution will be required for firefighting. Refer to the Bushfire Report for further details. A network of fire trails and the use of internal and external firefighting sprinkler systems may be proposed for this purpose. An external sprinkler systems generally comprises an independent water supply (on-site swimming pool or rainwater tank), pump system, sprinkler heads and associated pipework.

Bushfire hazard assessment is further addressed in **Chapter 21 – Bushfire Assessment.**

24.8.4 Sewage Collection System

A pressure sewer system is proposed to service the Lindeman Great Barrier Reef Resort. Pressure sewer systems typically consist of a collection tank fitted with a grinder pump located at each property to be serviced connected to a common pressure main collection system which discharges to a downstream gravity sewer, pump station or wastewater treatment plant. Pressure sewerage systems experience much less inflow and infiltration than conventional gravity systems, which combined with the use of grinder pumps results in the use of smaller diameter pipes. As the system is pumped, these pipes are not limited by the same grade controls as a gravity system. Pressure sewerage systems therefore consist of smaller diameter pipes which can be laid at minimum depths. Depending on the terrain of the site, this can result in significant reductions in the construction depths in comparison with conventional gravity sewerage systems with associated minimisation in the environmental impact of the construction of the system.

The use of a pressure sewer system is considered to be more appropriate than a conventional gravity sewerage system for Lindeman Island due to the following:

- There is a wide range of elevations across the area to be serviced, with elevations ranging between approximately 4 m AHD and 65 m AHD. Pressure sewer systems are well suited to sites with undulating terrain.

- The proposed new wastewater treatment plant is to be located at a similar or higher elevation than a portion of the serviced area.

- A significant portion of the site contains volcanic rock, making excavation of deep sewers difficult. The smaller and shallower sewers associated with pressure sewer systems are ideally suited to this application and will result in significantly reduced construction costs.

- Network layout for a pressure sewer system is similar to water reticulation and does not depend on ground contour. A large portion of the proposed sewerage pipelines can therefore be laid along the alignment of the proposed roads and buggy paths on the site.

- It is necessary to minimise the environmental impact of the construction of the site to keep in line with the overall objectives of the development. This can be achieved through the use of a pressure sewer system.

The wastewater collection system for the Lindeman Great Barrier Reef Resort is expected to consist of the following elements:

- A pressure collection system servicing the Eco Resort, lakeside restaurant, tourist villas, Spa Resort, Beach Resort and village.
- A central pump station which will receive flows from the pressure collection system.
- A central pressure main from the central pump station to the wastewater treatment plant.
- Pressure sewer collection systems for the maintenance and hanger areas which discharge to the central pressure main.

The following contingency measures will be incorporated in the design for use in the event of a power failure or equipment breakdown:

- The individual collection tanks with grinder pumps will incorporate a storage capacity within the collection tank of at least four hours of average dry weather flow. This will typically be in the range of 100 litres to 135 litres of storage for each villa, depending on the type of villa.
- The central pump station will be provided with the following:
    - 100% standby pumping capacity within the pump station.
    - Emergency bypass connection point in accordance with the requirements of the Mackay Regional Council *Design Guidelines.*
    - An alarm system to advise maintenance staff of a power or mechanical failure.
    - Provision of an emergency back-up generator or provision within the pump station for a portable generator to be bought to the pump station to cover power failures.
    - Emergency storage capacity of a minimum of four hours of average dry weather flow to be incorporated within the pump station wet well. The emergency storage capacity requirements is to be confirmed with Council.

Odour control within the collection would be achieved by sealing all collection chambers and pump stations, containing odours within the system and allowing all odours to be treated at the wastewater treatment plant.

A proposed collection system layout and preliminary sizing of the elements of the proposed collection system was undertaken based on the site layout provided in the *Lindeman Great Barrier Reef Resort & Spa Masterplan Concept* (DBI Design Pty Ltd, 16 February 2016). The layout and preliminary sizing of the pressure mains is shown in the preliminary layout plan, provided in **Map 24-1** and **Appendix O**.

24.8.5 Wastewater Treatment Plant

A new wastewater treatment plant will be constructed to produce recycled water suitable for use within the development for the proposed uses. The wastewater treatment plant will consist of a membrane bioreactor treatment process with disinfection to produce Class A+ recycled water with very low nitrogen and phosphorus levels. The treatment plant will consist of screening, activated sludge reactor with compartments for treatment in the presence and absence of oxygen, microfiltration and ultra/nanofiltration membranes, and ultra violet disinfection. The biosolids will be dewatered on site and transported to the mainland for disposal at a registered facility. The treatment plant will be constructed in a single stage with a daily treatment capacity of one megalitre. This capacity provides treatment for three times the average dry weather flow based on 100 percent occupancy at an equivalent population of 1,478 EP. A wastewater generation rate of 230 L/EP/day has been used to size the treatment plant and is greater than the average dry weather flow used for calculating peak design capacity for ERA 63 – Sewerage treatment works under Schedule 2, part 13, item 63 of the *Environmental Protection Regulation 2008*, which is 200 L/EP/day. This ensures a conservative estimate of infrastructure requirements. Additional storage will be constructed offline to provide four hours storage of three times the average dry weather flow (estimated at 170 kilolitres, based on 100 percent occupancy). This provides contingency storage in the event of excess flows which may occur during extreme wet weather conditions. Flows diverted to this storage will be fed back through the plant for treatment following return to normal conditions. Due to the negligible increase in flows expected to intercept the new sewerage system through inflow and infiltration, the diversion pond is provided as a contingency only and is considered to be required in only rare extreme weather events. If discharge is required from the recycled water storage tank, flows will be discharged via Gap Creek downstream of the dam.

24.8.6 Desalination Plant

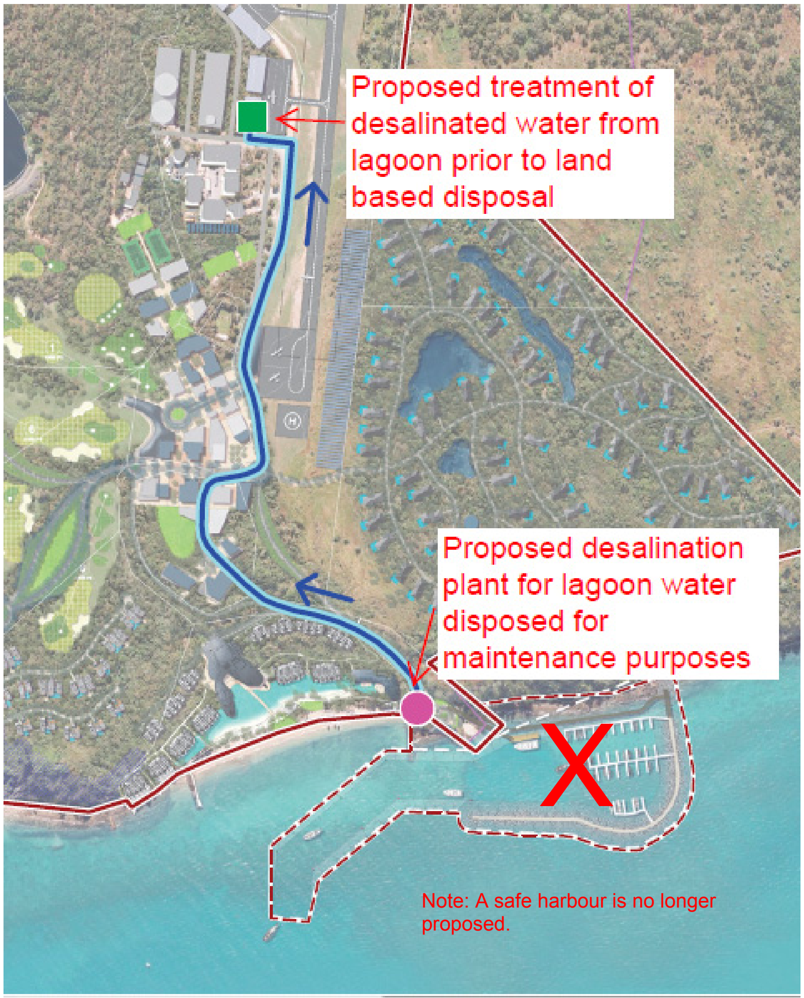
The proposed lagoon at the Beach Resort will be filled with seawater pumped from the ocean in accordance with required permits. Water to be discharged from the lagoon as part of the cleaning and maintenance program would be pumped to a small desalination plant to be installed near the lagoon to remove the salt concentration of the water (refer to **Figure 24-7** and **Map 4-1**). This water would then be pumped to the sewage treatment plant for treatment prior to discharge on the site. The salty brine residue from the desalination plant will be removed from the island by barge. No outfall pipes to the ocean from the lagoon are proposed.

The desalination plant is to be located at the eastern end of the lagoon pool. An intake system will convey seawater from the ocean to the lagoon pool via an intake pipeline located in the marine water to the south of the lagoon pool. Seawater will enter the pipeline through an intake head with screening designed to minimise the ingress of marine fauna. The design, construction and operation of the intake system will be in accordance with regulatory requirements and standards to consider:

- Location and alignment of intake structure to minimise entrainment or entrapment of marine organisms or sediment taking into account distance from seabed and mean sea levels,
- Low seawater intake velocities to minimise disruption to marine life,
- Screening of seawater to restrict ingress of marine fauna, and
- Prevention of erosion of seabed around the intake structure,
- The requirements for dosing of anti-fouling chemicals into the intake pipeline. Any chemicals used in the intake system will be prevented from release into seawater through incorporation of control interlocks and appropriate flushing to prevent chemical residuals remaining in the intake pipeline.

A monitoring program will be developed to monitor entrainment of marine biota.

Figure 24-7. Proposed desalination plant for treatment of lagoon water.



24.8.7 Recycled Water Scheme

Recycled water is to be used, as a minimum, in the following locations:

- Staff accommodation and village
- Beachside resort
- Maintenance area
- Airport buffer zones
- Golf course
- Landscaped areas
- Toilets

The recycled water quality will be classified as Class A+ (E.coli concentration of <1 cfu/100mL) and be of the quality as described in **Table 24-8**. Recycled water will be stored in a new recycled water storage located adjacent to the wastewater treatment plant. The storage will be a covered steel panel tank with chlorination on the outlet to maintain the water at the quality required for recycling. A booster pump station will be located at the recycled water storage tank as a large proportion of the sites to be serviced are level with or above the elevation of the recycled water tank. A distribution network will deliver the recycled water from the recycled water storage to the required locations. The proposed distribution system layout for the recycled water scheme was undertaken based on the site layout provided in the Lindeman Great Barrier Reef Resort & Spa Masterplan Concept (DBI Design Pty Ltd, 16 February 2016). The layout is shown in the preliminary layout plan, provided in **Map 24-2** and **Appendix O.**

24.9 Service Corridors

Generally, water and sewer mains will be located on either side of the pathways to provide for access during construction, and repairs and maintenance. Adequate access will be provided and maintained where the water or sewer main is not located along the pathway to provide access to all parts of the main and associated infrastructure for repairs and maintenance. Relevant vertical and horizontal clearances for the water, sewer and recycled water mains proposed for the development will be in accordance with *WSAA 03_2011_Part 1_3_1* and *WSAA 02_2014 Part 1_3_1* as shown in **Table 24-26** and **Table 24-27.**

Table 24-26. Typical Vertical and Horizontal Clearances for Potable Water and Recycled Water Mains.

Existing Service	Horizontal Clearance	Vertical Clearance
Telecommunications	150 - 300 mm	150 mm
Electricity	500 mm	225 mm
Stormwater	150 - 300 mm	150 mm
Sewer Mains	600 mm	300 mm
Kerbs	150 mm	150 mm

Table 24-27. Typical Vertical and Horizontal Clearances for Sewer Mains

Existing Service	Horizontal Clearance	Vertical Clearance
Telecommunications	150 – 300 mm	150 mm
Electricity	500 mm	225 mm
Stormwater	150 – 300 mm	150 mm
Water Mains	600 – 1000 mm	500 mm
Kerbs	150 mm	N/A

24.10 Telecommunication

Telstra has an existing telecommunication tower number 4741009 located on Lot 2 HR1351 which provides 3G services (850MHz) (refer to **Figure 24-8**). Optus is also investigating options to establish a mobile phone tower on the island in a location where visual impacts can be appropriately mitigated. These towers will provide the telecommunication facilities necessary to support the operation of the resort.

Figure 24-8. Location of existing telecommunication tower.

Source: OzTowers, 2017 (https://oztowers.com.au/Home/FullSiteInfo?siteId=13576).