Water Resources

18

Chapter 18 - Table of Contents

VERSION CONTROL: 29/06/2017

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18 Water Resources

18.1 Introduction

The resort's current and proposed water supply source is Gap Creek Dam located to the north of the existing resort development. Recycled water produced at the new wastewater treatment plant is proposed to 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. Separated reticulation networks consisting of pipelines, pump stations and storage tanks will be constructed to deliver potable and recycled water to the required areas within the resort. A water balance model was set up in GoldSim to determine the water demand for the site and likely reliability of supply, noting that in accordance with the Geotechnical Assessment (refer to **Appendix F - Geotechnical Assessment**), it is unlikely there are substantial groundwater resources and as such no extraction or use of this resource is proposed. The GoldSim model was set up based on 50 years of climate data from 1950 to 1999 for Lindeman Island, sourced from Queensland Government Department of Science, Information Technology and Innovation (DSITI) SILO program. The GoldSim model was able to model the complex interactions between different water demands and flows. It was also able to model the potential impact that reduced rainfall could have on the reliability of supply.

This section provides a summary of the technical assessment provided in **Appendix P - Stormwater Management Plan and Water Balance Modelling.**

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.*

18.2 Legislation

The *Water Act 2000* was introduced to establish a system for the planning, allocation and use of water. Rights over water in Gap Creek Dam is vested in the state of Queensland. An approval under the *Water Act 2000* will be 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.

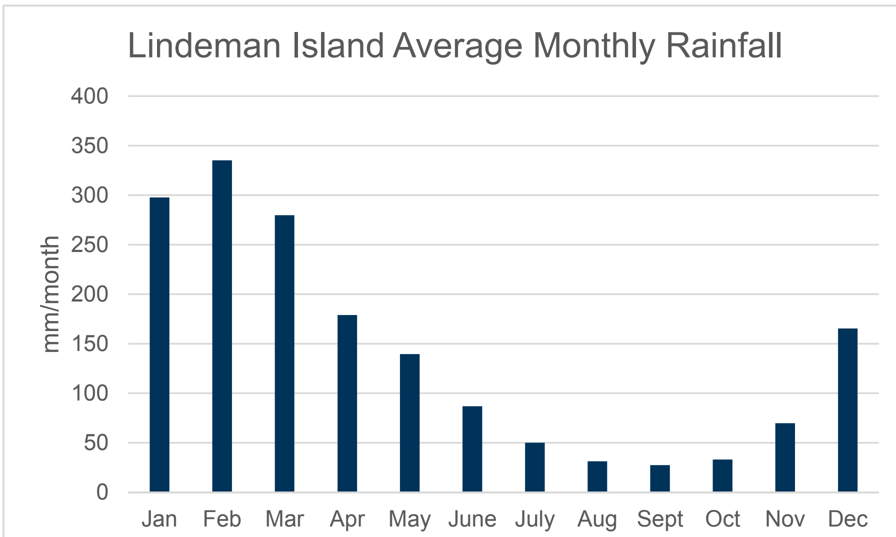
18.3 Groundwater Resources

The geotechnical assessment undertaken for the project found that the geology of the island is not one that is conducive to the formation of aquifers and if groundwater does occur, it will be limited to areas of intense fracturing of the rock (refer to **Appendix F - Geotechnical Assessment**). A review of historical data regarding bore water extraction confirms this assessment and indicates that any groundwater resource is limited and usually limited to short period of time following a rainfall event. Due to the unreliability and limited nature of this resource, no extraction of groundwater resources is proposed.

18.4 Climate

The Bureau of Meteorology (BoM) had a rainfall station (033042) in operation at Lindeman Island from 1950 to 2011. From 1993 until 1995 the rainfall station was not in operation. For this period, SILO used surrounding rainfall stations to estimate the likely rainfall patterns. The average annual rainfall from at Lindeman Island between 1950 and 1999 was 1695mm/year. The average evaporation is 1927mm/year. The average monthly breakdown in rainfall is shown in **Figure 18-1**. As shown by this graph, the wet season occurs between January and March and the dry season is between June and November. The wettest year from the SILO data was 2974mm in 1936 and the driest year was 767mm in 1902. On average, in 1 in every 10 years, the yearly rainfall is greater than 2500mm or less than 1060mm.

Figure 18-1. Average Monthly Rainfall.



18.5 Existing Site Assumptions

Water supply for the resort is provided by the existing dam (Gap Creek Dam) (no town water available) which has a catchment area of 43.57 hectares. The area of the dam is 5.9 hectares, and it has a volume of 199.6ML at the spillway level of 51.33m AHD. The stage storage relationship for the dam was calculated from survey and is shown in **Table 18-1** below. The dead storage level was assumed to be 20ML.

Table 18-1. Existing Dam Stage Storage Relationship.

Level (mAHD)	Volume (ML)	Area (ha)
43.00	0.3	0.12
44.00	2.7	0.35
45.00	7.7	0.72
46.00	17.5	1.28

Level (mAHD)	Volume (ML)	Area (ha)
47.00	33.5	1.95
48.00	57.7	2.84
48.50	72.9	3.24
49.00	90.1	3.65
49.50	109.4	4.07
50.00	130.8	4.51
50.25	142.4	4.74
50.50	154.5	4.97
50.75	167.3	5.21
51.00	180.6	5.56
51.25	194.9	5.80
51.33	199.6	5.85

The runoff from the dam was calculated using MUSIC, based on rainfall-runoff parameters recommended for upland soil types in the Mackay Regional Council MUSIC Model Guidelines (2008). The catchment was assumed to be 14 percent impervious due to the dam surface area. The resultant average annual runoff into the dam was calculated as 314 ML/year. This is equivalent to an Annual Volumetric Runoff Co-efficient (AVRC) of 0.44. If the catchment was assumed to be fully pervious then the AVRC would reduce to 0.36, or 257 ML/year. If regional rainfall-runoff relationships recommend by Boughton and Chiew (2007) for ungauged catchments were used then the expected runoff from a fully pervious catchment would be 239 ML/year. The runoff volume estimate calculated from MUSIC was therefore considered to be reasonable. Sensitivity testing on the runoff volume was also conducted. The water level in the existing dam and local rainfall has been recorded weekly by the island caretaker Darren Stuart for 21 weeks since the start of July. In this period only 80mm of rain was recorded in relatively light events which would have been unlikely to result in runoff from the catchment. The volume of water extracted from the dam was also recorded. Using this data, and assuming a pan factor of 0.9, the typical seepage rate was able to be calculated. The results of the analysis are summarised below. The seepage rate was calculated as 0.4mm/day.

- Days of record: 147
- Recorded reduction in water level: 710mm
- Increase in water level due to rainfall: 80mm
- Reduction in water level due to extraction of 2.34ML: 42mm
- Typical evaporation for time period: 759mm
- Resultant pan evaporation: 683mm
- Resultant seepage: 65mm (0.4mm/day)

During the final year of operation of the existing resort, the water demand from the Water Treatment Plant (WTP) was 103 ML. This included pool top up and some irrigation of landscape areas. The existing resort had on average 200 staff and 485 guests (based on the last two months on operation only). This is a water demand of 412 L/PP/day. GoldSim modelling of the existing development, with a yearly demand of 103 ML showed that the existing dam ran dry during 7 times in the 50 year simulation. It is therefore necessary to significantly reduce demand and/or utilise alternative sources of water.

18.6 Proposed Demands

18.6.1 Equivalent Population

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.

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. The equivalent population (EP) for the proposed development with full occupancy was revised down from the originally proposed 1604 to 1493, which includes staff, guests and day visitors. This was broken down into:

- 320 staff;
- 617 villa guests; and
- 556 hotel and day guests.

The final proposed EP for the development was calculated as 1478; however, as this was not significantly different to the previously assumed 1493, the higher number was adopted. The breakdown in EP calculations is summarised in **Table 18-2.**

Table 18-2. Water Supply Equivalent Populations.

Development Type	No.	EP/unit	Gross Floor Area (Ha)	EPs	Comments
Jetty Precinct					
Retail/Beach Club	1		0.02	2	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Visitor Centre	1		0.02	2	
5 Star Beach Resort					
Pool Bar	1		0.01	1	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Central Facilities	1		0.39	29	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Hilltop Suites	49	2.5	0.24	123	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - High Density multi storey apartments.
Pool Suites	87	2.5	0.43	218	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - High Density multi storey apartments.
Future Tourist Villas					
Villas	89	3.5	1.78	312	Based on 3.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Single Occupancy Lots.
6 Star Spa Resort					
Central Facilities	1		0.16	12	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial

Development Type	No.	EP/unit	Gross Floor Area (Ha)	EPs	Comments
Type 'A' Courtyard Villas	12	2.5	0.11	30	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Medium Density
Type 'B' Cliffside Villas	15	2.5	0.16	38	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Medium Density
Type 'C' Hilltop Villas	22	2.5	0.29	55	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Medium Density
Type 'D' Exclusive Villa	10	3.5	0.2	35	Based on 3.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Single Occupancy Lots
5 Star Eco Resort					
Central Facilities	1		0.12	9	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Eco Butterfly Villa	29	2.5	0.32	73	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Medium Density
Eco Treetop Villa	12	2.5	0.24	30	Based on 2.5 EP/unit. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Medium Density
Glamping Facilities	1		0.01	1	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Glamping Tent	30	2	0.1	60	Based on 2 EP/site - 1 bedroom tents
Village and Maintenance					
Airport Lounge	1		0.06	5	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Conference Centre	1		0.11	8	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Retail	1		0.28	21	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Sport Centre	1		0.10	8	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Staff Accommodation	400	0.8	0.98	320	Based on 400 single beds. Assume 1 bed = 0.8 EP for residential demands
Maintenance	1		0.69	52	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial
Airport					
Hangers	7		0.53	5	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Sewerage Code - Local Commercial. Adjusted - predominantly storage
Lakeside Restaurant					
Restaurant	1		0.03	29	Based on 500 EP/built up ha. Refer WSA 02 2002 Tables A2 and A3. Classification 8. at N=1, EP is 500 EP/built up hectare
Day Spa					
Day Spa	1		0.12	5	Based on 75/gross ha. Refer Table B1 WSA 02 2014 Gravity Sewerage Code - Local Commercial – Adjusted for expected usage
			TOTAL EP	**1,478**	

18.6.2 Occupancy

To determine the likely fluctuation in occupancy over the year, typical occupancy rates were taken 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 was:

- January to March: 52.3%
- April to June: 49.2%
- July to September: 61.6%
- October to December: 62.3%

The peak period coincides with the driest period of the year. 100 percent occupancy was conservatively assumed for the peak period, with the occupancy scaled down in accordance with typical occupancy rates for the region. The EP over the year was therefore assumed to be:

- January to March: 1253
- April to June: 1179
- July to September: 1470
- October to December: 1493

The average EP is 1351.

18.6.3 Water Demands

The average water demand was assumed to be 285 L/EP/day based on required levels of service for Mackay Regional Council. Applying this to 1351 EP, results in a total annual water demand of 140.5 ML. It was originally estimated that 45.6 ML/year will be required for irrigation based on irrigating 11.4 hectares at 4 ML/ha/year. This will be supplied by recycled water. This reduces the remaining annual water demand to 94.9 ML. Applying this to 1351 EP, results in a daily demand of192.5 L/EP/day. The split in water demands referenced the Healthy Waterways MUSIC Modelling Guidelines (2010). For hotels and resorts with full water saving devices they recommend:

- Laundry - 5 L/EP/day
- Toilet – 25 L/EP/day
- Kitchen – 13 L/EP/day
- Bathroom – 94 L/EP/day

TOTAL – 137 L/EP/day

The remaining demand (56 L/EP/day) was assumed to be for the communal areas of the resort. This was assumed to be split 60:40 for potable and non-potable uses. The water demands listed above do not include the demand for pools. There will be 189 pools for villas throughout the development (assumed to be 25m^2 each) and communal resort pools with a total area of around 3000m^2. The pools will be initially filled up during the wet season during the main rainfall event and will be topped up via rainwater tanks. They will also be provided with backwash recycling tanks to reduce top-up demand. During periods of prolonged dry weather, the pools will be topped up with potable water when the resort is at low occupation. Each of the 189 villas will have a 10kL rainwater tank that will drain at least 100m^2 of roof area. The rainwater tank will be used for pool top up and toilet flushing. The rainwater tanks will provide approximately 74.3 percent of the water demand.

If larger pools than specified are adopted, then the roof area and/or tank size should be increased. Preliminary analysis found that a pool area of $40m^2$ would require a tank size of 20kL or a roof area of at least $180m^2$ in order to provide the same water yields for the villas. It was assumed that a minimum of $3500m^2$ of roof area would be directed to a 500kL rainwater tank for resort pool top up. This would provide 49.4 percent of the resort pool water. The rainwater tanks and roof area would be distributed proportionally for the numerous communal pool areas. Additional top up for villa and resort tanks would be supplied by the WTP.

Recycled water will be used to irrigate golf courses and landscape areas. A total of 11.4 hectares was assumed to be available for irrigation at a rate of 4ML/ha/year. Recent MEDLI modelling (refer to **Appendix O - Water Infrastructure Assessment**)has indicated that higher irrigation rates and more irrigation area is available. The irrigation was scaled based on potential evapotranspiration. No irrigation was applied if there had been more than 6mm of rainfall in the last 3 days. The majority of laundry uses will be conducted at communal facilities where recycled water will be able to be used. It was therefore assumed that the incidental laundry demands of each villa would be supplied by potable water. An additional 350kL rainwater tank will be provided for roof area (from surrounding hangars and buildings) near the WTP. This will direct roofwater as a first preference source to the WTP for treatment. It was assumed that at least $6300m^2$ of roof area was available. The hotel, staff accommodation and communal facilities will have non-potable water demands (i.e. laundry, toilet flushing and washdown) supplied by recycled water. The total recycled water demand (excluding irrigation) was calculated at 18.3 ML/year. The recycled water network was not extended to all villas throughout the site as the potential non-potable uses in these areas were not significant enough to justify the expense.

All potable water demand for the site will be supplied by the WTP. Additional losses were allowed for in the water balance. These included:

- 10 kL/day for reservoir and distribution losses;
- Splash and evaporation losses from pools. As each pool will be provided with backwash recycling tanks, minimal backwash loss was assumed; and
- Usage losses of 10 percent (i.e. internal water demand lost from system).

The resultant total water demand for the site was 160.1 ML/year including irrigation and pool top up. This is equivalent to a total water demand (including pool top up) of 325 L/EP/day. Excluding irrigation (45.6 ML/year) this is equivalent to an average water demand of 232 L/EP/day.

Allowing 56 L/EP/day for communal areas of the resort, the average water demand is 176 L/EP/day. The split in water demands is as follows:

- Laundry - 5 L/EP/day
- Toilet – 25 L/EP/day
- Kitchen – 13 L/EP/day
- Bathroom – 94 L/EP/day
- Pool top-up – 39 L/EP/day

  TOTAL – 176 L/EP/day

Water demands and the source of water meeting those demands are summarised in **Table 18-3.**

Table 18-3. Water Demands Summary.

	Per Capita Demands	Annual Demands	Water Source
	L/EP/day	ML/year	
Internal	137	68	Potable
Pool top up	39	19	Rainwater and Potable
Irrigation	92	46	Recycled
Losses	57	28	-
Total	**325**	**160**	

The proposed water supply for the resort (dam and rainwater tanks) will only capture a small component of the total water that flows over the site and will have a minimal impact on the flow regimes and volume of water discharged to reef waters during a rainfall event.

18.6.4 Proposed Water Conservation Measures

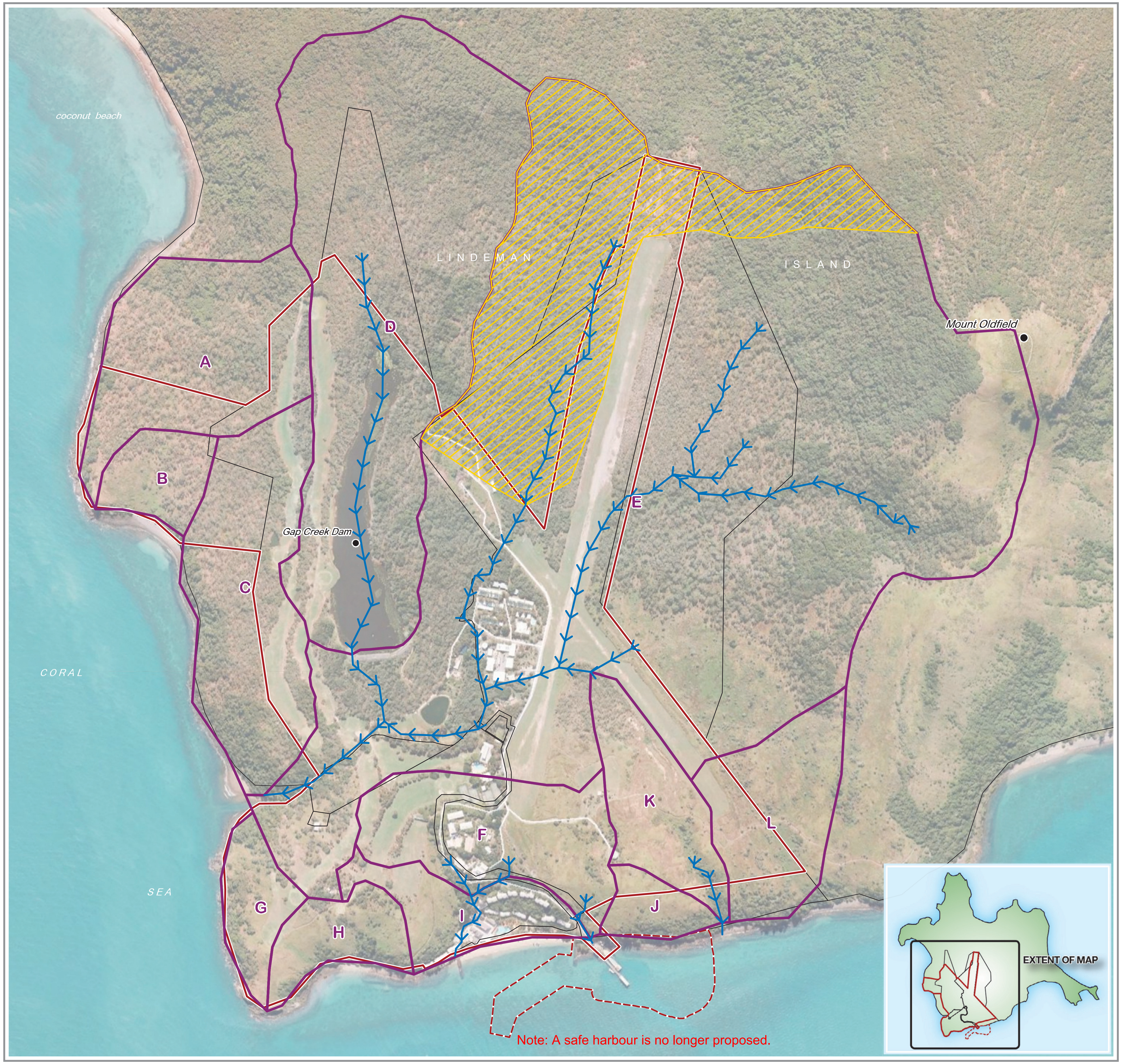
The following water conservation strategies will be adopted throughout the site:

- Water efficient fittings and appliances will be used;
- Water saving showers to be installed in preference to baths and spas;
- Awareness programs for guests and employees will be run to encourage efficient use of water;
- A minimum 10kL rainwater tank will be installed at each villa which will be connected to a minimum roof area of 100m^2. The rainwater tank will be used for pool top up and toilet flushing;
- A 500kL rainwater tank (total combined size) for resort pool top up will be connected to 3500m^2 of roof area;
- A 350kL rainwater tank will be connected to a minimum of 6300m^2 roof area surrounding the WTP. This will be used as a first preference for water for the WTP;
- Recycled water will be used for toilet flushing (communal areas and resort units), laundry, irrigation and washdown; and
- Backflow recycling tanks will be used for all pools.

18.7 Proposed Dam Diversion

Preliminary analysis in GoldSim found that with the originally proposed EP of 1604 and the existing catchment area draining towards the dam that the dam would be empty for 4 to 5 dry seasons of the 50 year simulation. The months when this is likely to occur are September to January. A reduction in EP and an increase in catchment area was therefore proposed in order to increase the reliability of supply. An additional 27 hectares will be diverted towards the dam (refer to **Map 18-1**). This catchment area was added to the MUSIC model as a fully pervious additional catchment. It was assumed that only low flows, less than 6ML/day, would be diverted to the dam, with larger flows being directed down the existing drainage path. The total dam diversion was 71.6 ML/year. The total flow from this catchment area was 163.1 ML/year. The dam diversion channel will also change the stage-storage relationship, increasing the volume of the dam from 199.6 to 207.3 ML, as shown in **Table 18-4**.

The proposed dam diversion will involve a cut of 37,860m^2 and disturbance to additional areas required for the proposed channel diversion earthworks (refer to **Map 18-1** and **Figure 18-2/Figure 18-3**). The runoff from the runway will need to be ensure it does not drain to the lake but is diverted to downstream stormwater treatment. The natural and cultural values of this proposed diversion are assessed in **Chapter 6 – Tenure**.



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LEGEND

Existing Catchments and Flowpaths

- A Catchment Boundary
- Diverted Catchment
- Flowpath

Other

- Proposed Site Boundary
- Proposed Sea Bed Lease Boundary
- Cadastral Boundary

N S E W

0 75 150 225 300 375

1:7,500 (metres)

original map compiled at A3 size

DRAWING TITLE	Map 3-10: Existing Catchments and Flowpaths
DRAWING DATE	20 December 2016
DRAWING VERSION	2.0
COORDINATE SYSTEM	GDA 94; MGA Zone 55
MAP PRODUCED BY	Cardno QLD Pty Ltd
JOB NUMBER	HRP15078

DATA SOURCE

Google Earth: Date of Photography 07/03/2008.

Cadastral data: State of Queensland (Department of Natural Resources and Mines) 2015; Property Boundaries Queensland; Publication date: 02/04/2015.

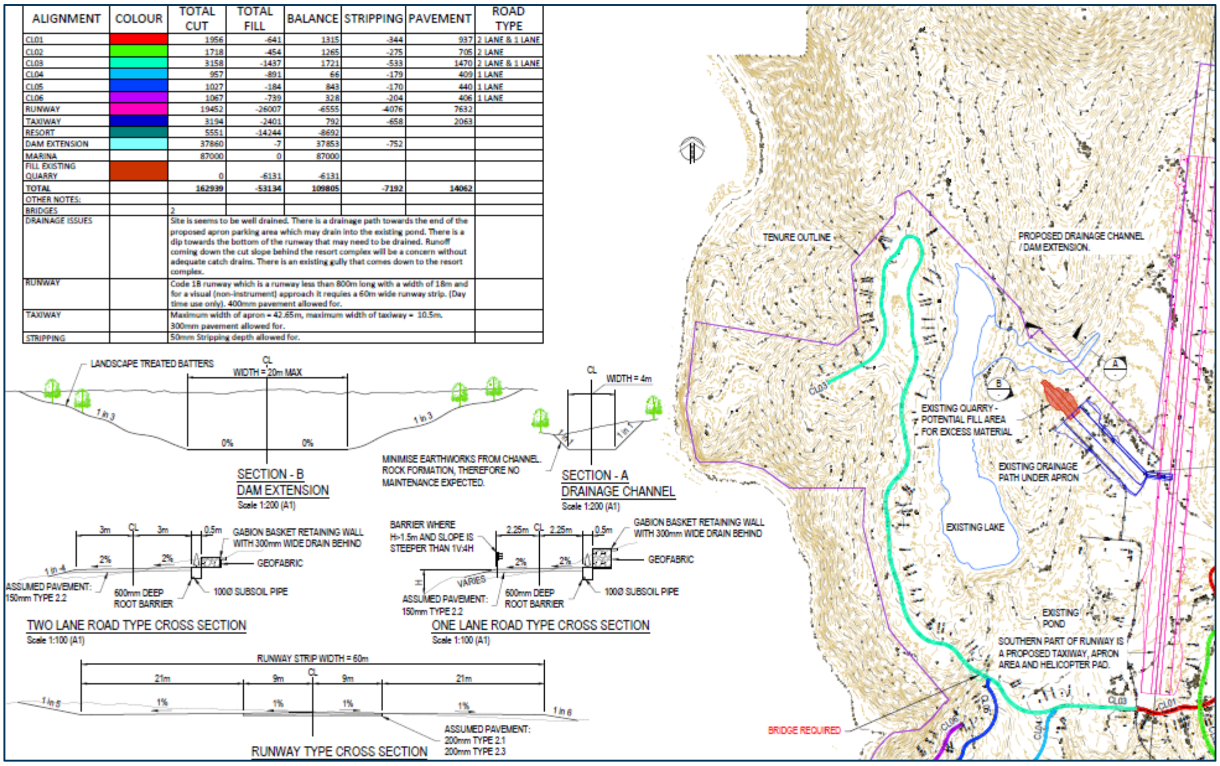
Lindeman Great Barrier Reef Resort & Spa

ENVIRONMENTAL IMPACT STATEMENT

Existing Catchments and Flowpaths

Map 18-1

Figure 18-2. Proposed Dam Diversion Engineering Details (overview).



ALIGNMENT	COLOUR	TOTAL CUT	TOTAL FILL	BALANCE	STRIPPING	PAVEMENT	ROAD TYPE
CL01		1956	-641	1315	-344	937	2 LANE & 1 LANE
CL02		1718	-454	1265	-275	705	2 LANE
CL03		3158	-1437	1721	-533	1470	2 LANE & 1 LANE
CL04		957	-891	66	-179	409	1 LANE
CL05		1027	-184	843	-170	440	1 LANE
CL06		1067	-739	328	-204	406	1 LANE
RUNWAY		19452	-26007	-6555	-4076	7632	
TAXIWAY		3194	-2401	792	-658	2063	
RESORT		5551	-14244	-8692			
DAM EXTENSION		37860	-7	37853	-752		
MARINA		87000	0	87000			
FILL EXISTING QUARRY		0	-6131	-6131			
TOTAL		**162939**	**-53134**	**109805**	**-7192**	**14062**	
OTHER NOTES:							
BRIDGES		2					
DRAINAGE ISSUES		Site is seems to be well drained. There is a drainage path towards the end of the proposed apron parking area which may drain into the existing pond. There is a dip towards the bottom of the runway that may need to be drained. Runoff coming down the cut slope behind the resort complex will be a concern without adequate catch drains. There is an existing gully that comes down to the resort complex.					
RUNWAY		Code 1B runway which is a runway less than 800m long with a width of 18m and for a visual (non-instrument) approach it requies a 60m wide runway strip. (Day time use only). 400mm pavement allowed for.					
TAXIWAY		Maximum width of apron = 42.65m, maximum width of taxiway = 10.5m. 300mm pavement allowed for.					
STRIPPING		50mm Stripping depth allowed for.					

Figure 18-3. Proposed Dam Diversion Engineering Details (enlarged).

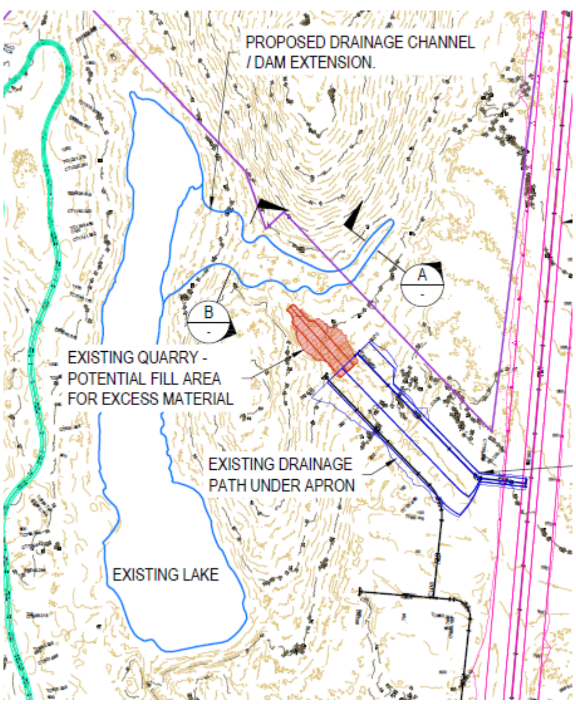


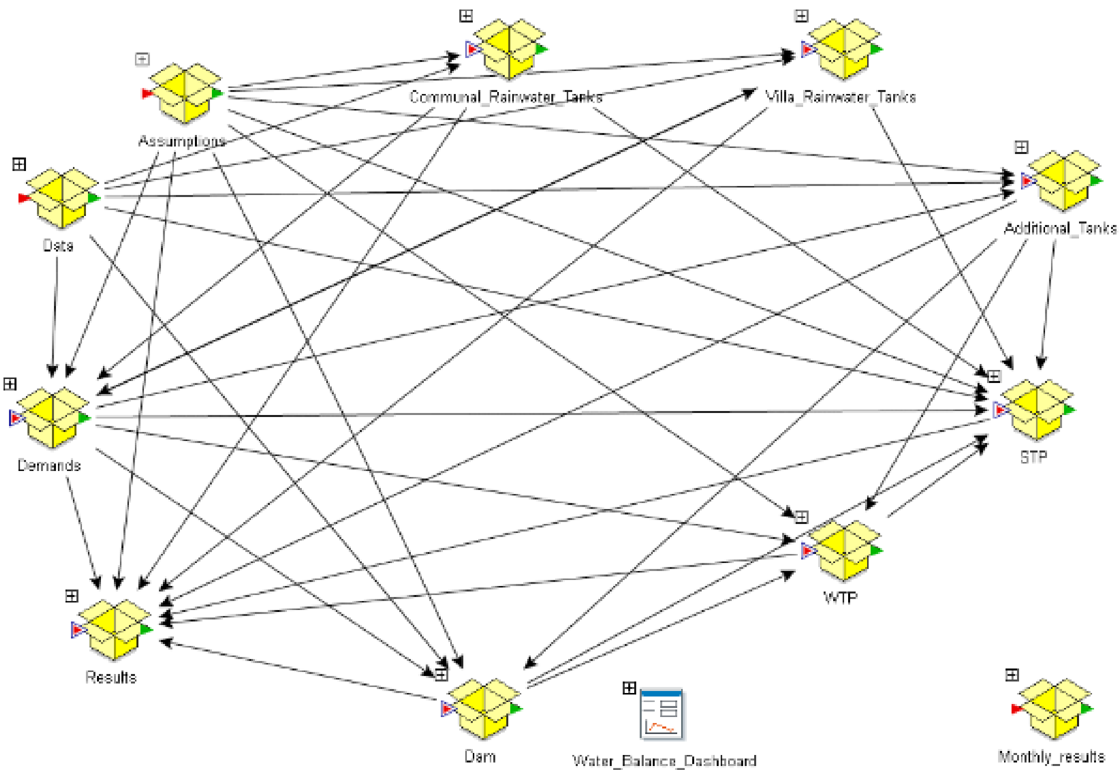
Table 18-4. Revised Dam Stage Storage Relationship.

Level (mAHD)	Volume (ML)	Area (ha)
43.00	0.3	0.12
44.00	2.7	0.35
45.00	7.7	0.72
46.00	17.5	1.28
47.00	33.5	1.95
48.00	58.1	2.94
48.50	74.0	3.40
49.00	92.1	3.87
49.50	112.7	4.35
50.00	135.6	4.83
50.25	148.0	5.08
50.50	161.0	5.34
50.75	174.7	5.59
51.00	189.0	5.95
51.25	204.2	6.20
51.33	207.3	6.25

18.8 GoldSim Model Setup

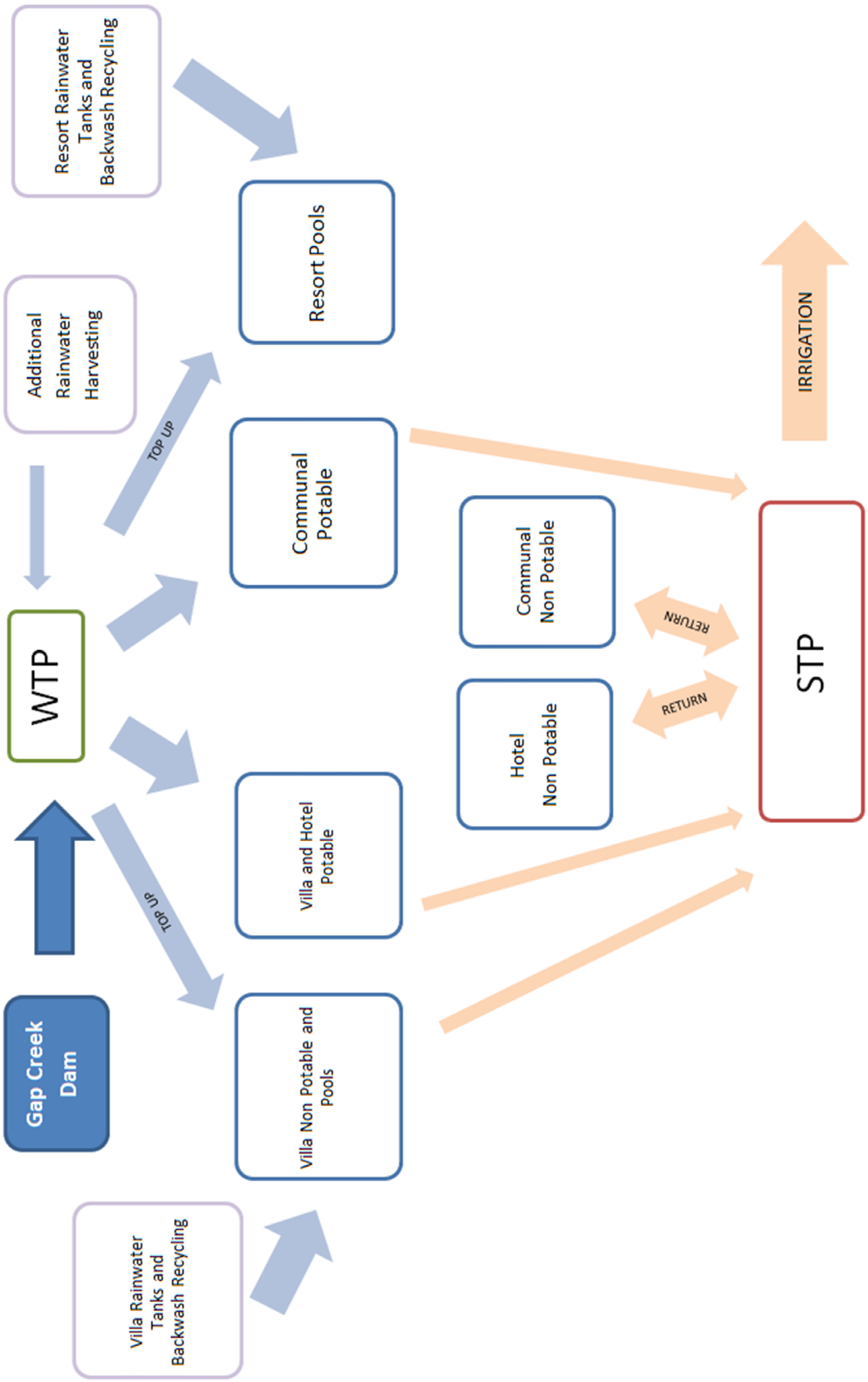
The GoldSim model layout is shown below in **Figure 18-4**. As demonstrated by this image the interactions between flows around the site are complex. The water balance was calibrated to historic level records in the dam and includes seepage loss which was calculated at 0.4 mm per day. Water quality is assessed separately in **Chapter 11 – Water Quality** and **Appendix P**.

Figure 18-4. GoldSim Model Setup.



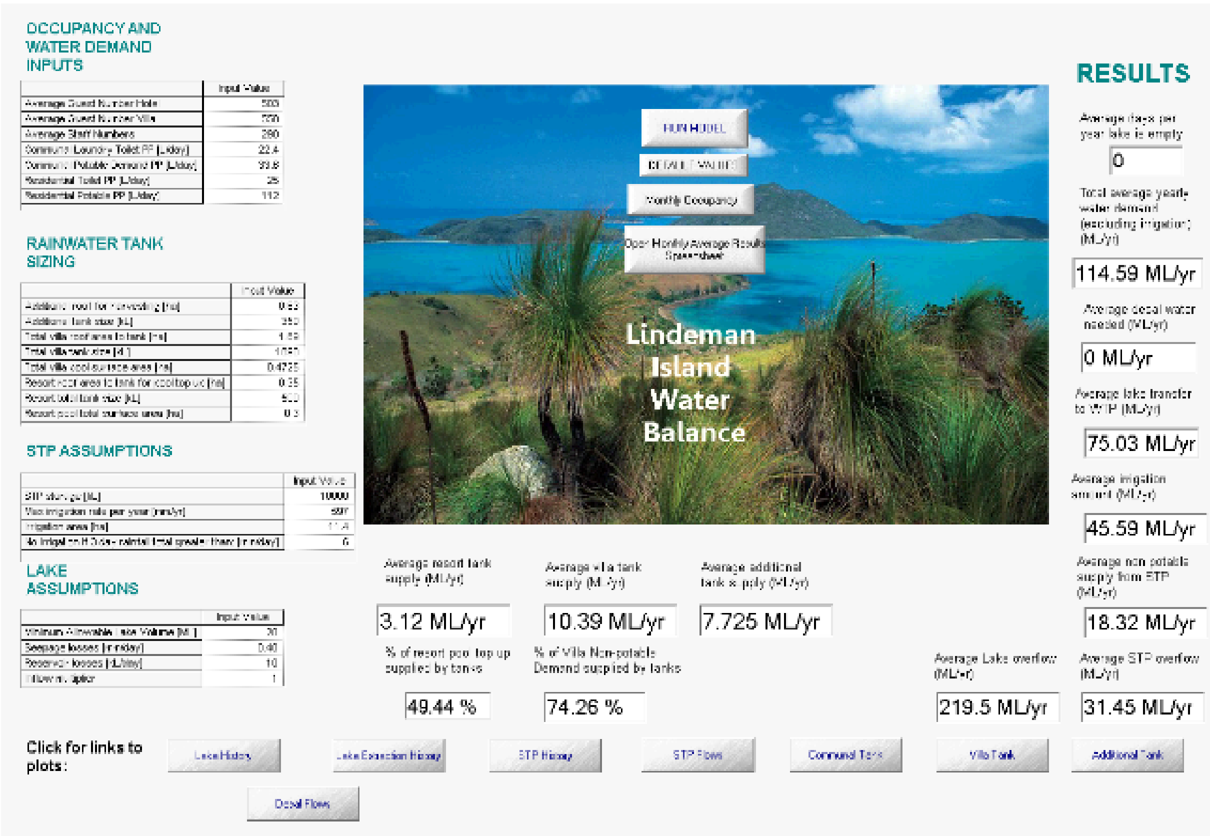
The flow interactions are shown in **Figure 18-5.**

Figure 18-5. GoldSim Flow Interactions.



The GoldSim model player is shown in **Figure 18-6** below. This will be able to be used by the operators of the resort to determine likely impacts of water management strategies on their water supply based on historical rainfall.

Figure 18-6. GoldSim Model Player.



18.9 GoldSim Results

The resultant total water demand for the site was 160.1 ML/year including irrigation and pool top up. This would be supplied on average by:

- 75.0 ML/year from the dam;
- 21.2 ML/year from rainwater tanks;
- 18.3 ML/year from recycled water for non-potable internal demands; and
- 45.6 ML/year from recycled water for irrigation.

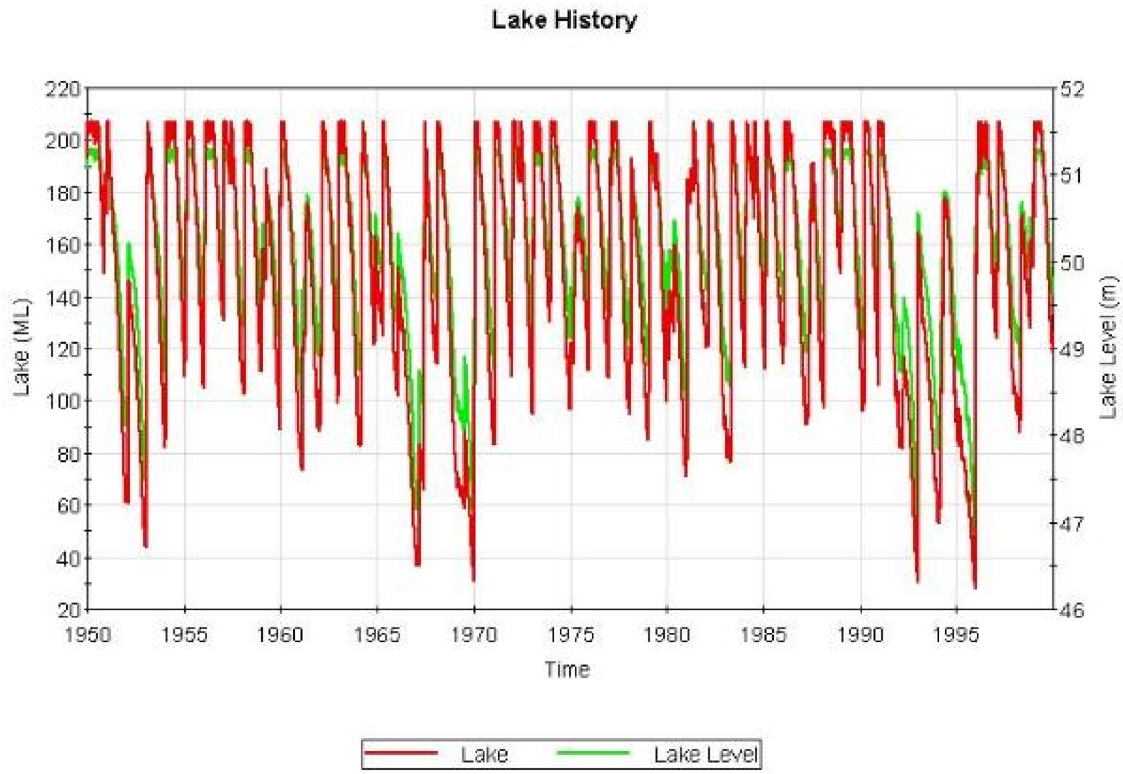
This is equivalent to a total water demand (including pool top up) of 325 L/EP/day. Excluding irrigation (45.6 ML/year) this is equivalent to an average water demand of 232 L/EP/day. With the proposed water recycling, improved water efficiency and rainwater harvesting the demand from the dam has reduced from 103.0 to 75.0 ML/year. Therefore the reliability of the water supply will be improved by the proposed development. The dam had been known to run dry during the previous operation of the resort, which was confirmed by the results of the GoldSim modelling. With the reduced demands and dam catchment diversion the results of GoldSim modelling showed that the dam was unlikely to go empty during the 50 years of simulation. If no additional tank is provided near the WTP, then the dam would go empty in 1 dry season in 50 years, with the average amount of water being extracted from the dam rising from 75.0 to 82.7 ML/year and as such no desalination plant is proposed to provide potable water. A small desalination plant is proposed to treat water to be discharged from the lagoon as part of the cleaning and maintenance process to remove the salt concentration of the water prior to treatment of the water in the waste water plant (refer to **section 4.4.12** for further information). It should be noted that the assumed water demands for the GoldSim analysis are conservative and full occupancy has been assumed during the peak periods.

The resultant average monthly water sources are provided in **Table 18-5**. The lake history plot over the simulation period is shown in **Figure 18-7**.

Table 18-5. Average Monthly Water Sources.

Month	Average Source of Water (kL/day)				
	Recycled Water for Irrigation	Recycled Water for Internal Non Potable	Rainwater Tanks	Dam	TOTAL
Jan	154.2	47.5	77.6	177.6	456.9
Feb	113.1	42.7	86.0	142.5	384.2
Mar	99.2	47.5	80.9	165.4	393.1
Apr	76.8	43.3	65.5	160.0	345.6
May	62.4	44.5	60.3	166.9	334.1
June	63.7	43.3	49.9	173.5	330.3
July	75.6	55.3	47.0	230.0	407.9
Aug	100.3	55.3	39.8	243.4	438.7
Sept	144.1	54.1	23.9	264.0	486.2
Oct	189.9	56.5	23.0	281.0	550.5
Nov	215.4	54.7	36.8	262.0	568.9

Figure 18-7. Lake History Plot.



18.10 Impact of Climate Change

The potential impacts of climate change in the Mackay Whitsunday region are summarised in the 2014-2021 WQIP. The climate change trends for the Mackay Whitsunday region include:

- Increased atmospheric CO2;
- Increases in average air temperatures, more hot days and fewer cold days. On a national basis, Australia's climate has warmed by 0.9ºC, with more extreme heat and fewer cool extremes (Bureau of Meteorology and CSIRO 2014). Projections for the Mackay Whitsunday region show that average maximum temperatures may increase by 1ºC by 2030 and 2ºC by 2070 (RPS 2014);
- Annual rainfall is not expected to change, however the intensity of extreme events is expected to increase (Hilbert et al. 2014). Projections for the Mackay Whitsunday region indicate baseline (1995) 1 in 100 year rainfall events may occur every 70 years by 2030 and every 60 years by 2050 (RPS 2014);
- The intensity (not frequency) of tropical cyclones is expected to increase (Hilbert et al. 2014);
- Evapotranspiration is expected to increase in all seasons (Hilbert et al. 2014);
- Wind speeds are expected to increase across eastern Australia (Hilbert et al. 2014); and
- Sea levels will continue to rise, and the frequency and height of storm surges are expected to increase (Hilbert et al. 2014).

Although the average annual rainfall is not expected to change, the increases in rainfall intensity during the wet season, likely reductions in rainfall intensity in dry seasons and increases in evapotranspiration indicate that an overall reduction in runoff is likely, and the reliability of the water supply will be decreased. Increased evapotranspiration will also increase water demands. Due to the difficulties predicting the impact of climate change on rainfall and runoff patterns the sensitivity analysis assumed that rainfall (for rainwater tanks) and runoff was reduced by a global 20 percent. The water demands were not changed. The results of the GoldSim analysis showed that if a reduction in rainfall and runoff of 20 percent was to occur then the dam would likely go empty 5 times during the 50 year simulation. While this not a desirable outcome, the following measures could be adopted in the event that these changes to rainfall patterns eventuate:

- Temporary reduction in occupancy rates during prolonged dry periods;
- Staff and visitor awareness programs to encourage reductions in water use; and
- Install pool covers to reduce evaporation losses.

It should be noted that the GoldSim modelling has assumed full occupancy during peak periods and it is likely that more roof area than assumed in the modelling will be able to be diverted to rainwater tanks. Therefore the results of the analysis are conservative. The proposed development is well placed to handle the potential impacts of climate change due to the following reasons:

- The use of recycled water provides an alternative source of supply that is not reliant on rainfall. It is proposed to use recycled water for the majority of non-potable uses on site;
- The proposed water demand from Gap Creek Dam is significantly less than the existing resort; and
- The population at the resort is not permanent, and can be controlled if necessary during prolonged dry periods.

18.11 Sewage Treatment Plant Flows

The Sewage Treatment Plant (STP) storage was assumed to be 10ML, and no evaporation losses were allowed for as it will be a closed storage. Based on an irrigation rate of 4ML/ha and irrigation area of 11.4 hectares the STP will overflow every wet season. This is due to inflows being significantly greater than the recycled water and irrigation demands assumed in the GoldSim modelling. The non-potable water demand provided by recycled water was assumed to be 63.9 ML/year (18.3 ML/year for non-potable internal demands and 45.6 ML/year for irrigation). The results of the GoldSim modelling showed that the average irrigation rate would need to be increased to 77 ML/year for there only to be overflow from the STP approximately once in every ten years. The detailed MEDLI modelling conducted for the site calculated that an irrigation rate of 67 ML/year would be possible and that this would result in no overflows from the STP. The flows for this modelling were based on expected average occupancy rates, i.e. a maximum EP of 921. As highlighted the predicted STP discharges compared to the existing case are significantly reduced.

18.12 Potential Impacts and Mitigation Measures

The following table provides an assessment of potential impacts and mitigation measures associated with water resources on the island.

Table 18-6. Risk assessment matrix – water resources.

Potential Impact	Significance of Impact: Unmitigated	Mitigation Measure			Significance of Impact: Mitigated
		Design	Construction	Operation	
Reduced reliability of the water supply (e.g. contamination of water supply or drought).	High (15)	• Diversion of 27 ha of catchment into water supply dam.	• Hazardous materials shall not be stored within the dam catchment area	• Reduce potable water demand by: – Using recycled water for the majority of non-potable uses on site to minimise potable water use; – Use rainwater tank water where possible; – Use of water efficient fittings; – Recycling of pool backwash water; – Temporary reduction in occupancy rates during prolonged dry periods; • Awareness programs to encourage water conservation; • Implementation of Water Contingency Plan in the event of low dam levels e.g. reduce occupancy or barge water from mainland; • Recycled water shall not be applied within the dam catchment area; • Hazardous materials shall not be stored within the dam catchment area.	Low (4)

18.13 Summary

The water balance modelling in GoldSim for the proposed development identified that additional sources of water were required for a reliable source of water. The proposed water strategy for the site includes:

- Diversion of an additional 27 hectares towards the dam;
- Water efficient fittings and appliances will be used;
- Water saving showers to be installed in preference to baths and spas;
- Awareness programs for guests and employees will be run to encourage efficient use of water;
- A minimum 10kL rainwater tank will be installed at each villa which will be connected to a minimum roof area of 100m^2. The rainwater tank will be used for pool top up and toilet flushing;
- A 500kL rainwater tank (total combined size) for resort pool top up will be connected to 3500m^2 of roof area;
- A 350kL rainwater tank will be connected to a minimum of 6300m^2 roof area surrounding the WTP. This will be used as a first preference for water for the WTP;
- Recycled water will be used for toilet flushing (communal areas and resort units), laundry, irrigation and washdown; and
- Backflow recycling tanks will be used for all pools.

The resultant total water demand for the site was 160.1 ML/year including irrigation and pool top up. This would be supplied on average by:

- 75.0 ML/year from the dam;
- 21.2 ML/year from rainwater tanks;
- 18.3 ML/year from recycled water for non-potable internal demands; and
- 45.6 ML/year from recycled water for irrigation.

This is equivalent to a total water demand (including pool top up) of 325 L/EP/day. With the proposed water recycling, improved water efficiency and rainwater harvesting the demand from the dam compared to the existing resort development has reduced from 103.0 to 75.0 ML/year. Due to the proposed recycling of water the STP flows compared to the existing resort have also been significantly reduced. MEDLI modelling showed that if average occupancy rates are assumed then discharges to the ocean are unlikely.

Climate change may reduce the reliability of the water supply in the future. However, the proposed development is well placed to handle the potential impacts of climate change due to the following reasons:

- The use of recycled water provides an alternative source of supply that is not reliant on rainfall. It is proposed to use recycled water for the majority of non-potable uses on site;
- The proposed water demand from Gap Creek Dam is significantly less than the existing resort; and
- The population at the resort is not permanent, and can be controlled if necessary during prolonged dry periods.

The proposed water supply for the resort (dam and rainwater tanks) will only capture a small component of the total water that flows over the site and will have a minimal impact on the flow regimes and volume of water discharged to reef waters during a rainfall event.