Technical Note

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Subject	*Stormwater Drainage Strategy – Revision 2*		

1 Scope

This Technical Note provides a summary of the proposed stormwater drainage strategy for the KUR-World Eco resort Development in Kuranda, QLD. It describes a high-level, conceptual stormwater quality assessment, undertaken for the purposes of informing the reference design of the proposed stormwater drainage system as part of the environmental impact assessment. Further, more detailed assessment will need to be undertaken as part of future planning and design stages to confirm design of all drainage systems and stormwater quality improvement devices.

The KUR-World stormwater drainage strategy has been developed to meet the requirements of the FNQROC Development Manual for Stormwater Quality Management, 2014.

In accordance with FNQROC (2014), the stormwater drainage strategy has been developed to ensure:

- Water quality interception devices or a combination of interception devices are integrated into the stormwater system to achieve the following levels of pollutant reduction from the overall site, when compared to the developed site with no stormwater quality improvement:
  - 90% of total suspended solids of size greater than 3.0mm as well as sand;
  - 60% of total phosphorus; and
  - 40% of nitrogen
- Water quality interception devices shall be configured to prevent re-injection of captured contaminants into receiving waterways;
- Water quality interception devices or a combination of interception devices and treatments are designed to treat all first flush runoff, defined as that volume of water equivalent to the runoff from the 3 month ARI storm event (60% of the 1 year ARI storm event); and
- Stormwater treatment measures improve the quality and reduce the flow of water discharged to waterways.

2 Existing and Proposed Catchment Description

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

The proposed development is an integrated eco-tourism resort, comprising of residential lots, theme parks, golf courses, business centres, resorts and university campuses. A breakdown of the proposed precincts and land-use areas used as the basis for the stormwater assessment is provided in Table 1, based on the KUR-World Concept Master Layout, Revision F (Arup, 11 September 2017).

The proposed development is divided as below into catchment areas and perviousness:

Table 1 Catchment areas and perviousness

Precinct	Road area (ha) (100% impervious)	Roof area (ha) (100% impervious)	Landscape area (ha)	Pervious fraction of Landscape area
Farm Theme Park	1.56	1.53	17.72	99%
Produce garden	0.00	0.04	2.47	100%
Business centre	0.18	0.77	2.12	96%
KUR village	0.59	1.15	0.97	88%
Rainforest education centre	0.00	0.79	16.34	100%
KUR world campus	0.68	0.83	2.51	97%
Sporting precinct	0.88	0.52	1.12	95%
Golf clubhouse	0.16	0.32	0.21	85%
Golf course	0.00	0.00	46.39	100%
Five star eco resort	0.34	1.45	4.42	97%
Health and well being retreat	0.47	0.92	4.27	98%
Premium villas	2.82	5.60	11.80	95%
Lifestyle villas	2.94	0.97	10.27	99%
Queenslander lots	0.56	0.17	1.03	98%
Open space	0.00	0.00	1.75	100%

3 Proposed Stormwater Strategy

The proposed stormwater strategy is illustrated in the schematic in Figure 1.

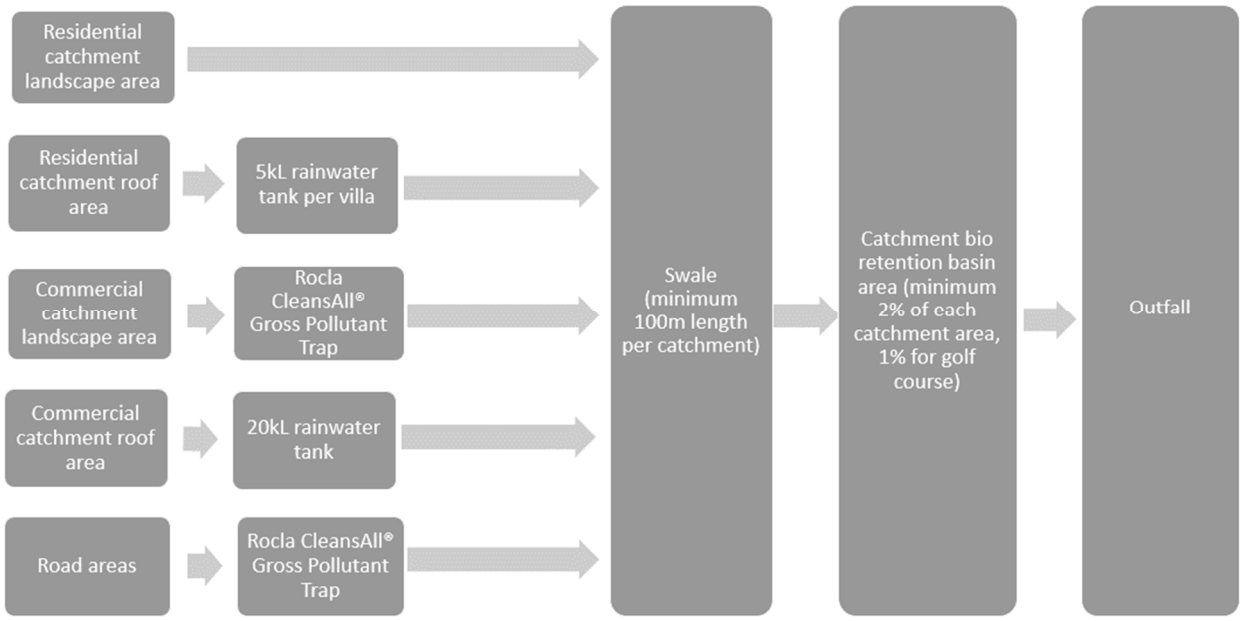

Figure 1 Proposed stormwater drainage strategy schematic

As shown in the figure:

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

It is noted that the high level reference designs for all stormwater drainage infrastructure have been developed to limited level of detail, sufficient to confirm the technical feasibility and assess the potential environmental impacts of the proposed works. Further investigations and design will be required as part of future planning for KUR-World to develop the designs and ensure compliance with all relevant guides and standards.

More detailed analysis of stormwater hydraulics and water quality will need to be undertaken at the sub-catchment scale, to ensure appropriate stormwater detention and treatment devices are appropriately located and sized, in accordance with the general principles described in this report.

In general, it is proposed that:

- Gross Pollutant Traps (GPTs), are used to provide pre-treatment of stormwater generated from all significant road and hardstand areas across the site, and will be located, sized and designed in accordance with FNQROC design requirements;
- Swales and vegetated buffer strips provide pre-treatment of all stormwater across the site, with a minimum of around 100m of treatment length on average;
- Bio retention basins are integrated throughout the development, within a minimum treatment area equivalent to at least 1% of the catchment area for the golf course, and 2% of the catchment area for all other catchments; and
- Stormwater detention is integrated through the bio retention basins and other detention basins as required, with the required sizing to be confirmed through more detailed hydraulic analysis.

4 Stormwater Quality Assessment (MUSIC)

A high-level stormwater quality assessment has been undertaken to inform the reference design using the stormwater quality performance tool Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

4.1 Model Setup

4.1.1 Model Configuration

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

This coarse modelling approach was taken as means of specifying the required elements of the overall stormwater drainage strategy, which will need to be achieved in the stormwater drainage system design. In reality, the site will contain a diverse network of catchments, swales, stormwater quality improvement devices and bio retention devices, discharging to the various water-courses across the site. An indicative stormwater drainage system is shown in the KUR-World reference design, which will need to be further analysed and refined as the project progresses in detail.

The meteorological date (rainfall and evaporation), soil parameters and pollutant generation parameters applied in the MUSIC model were adopted for Cairns, Queensland using a 6-minute time step.

Figure 2 overleaf shows the general layout of the MUSIC model used for the assessment. Figure 3 provides ‘close-ups’ showing the configuration of the model in two example precincts.

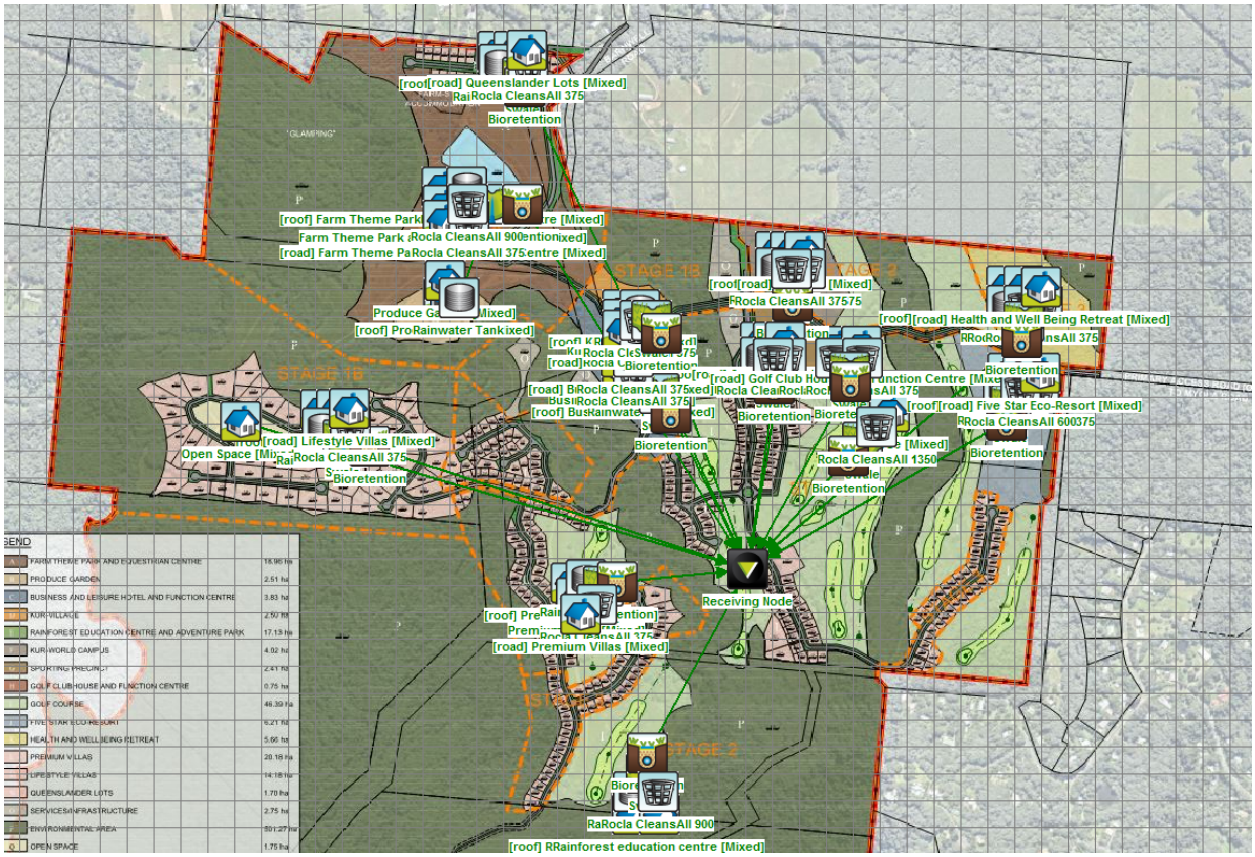

Figure 2 Overall MUSIC Model Layout

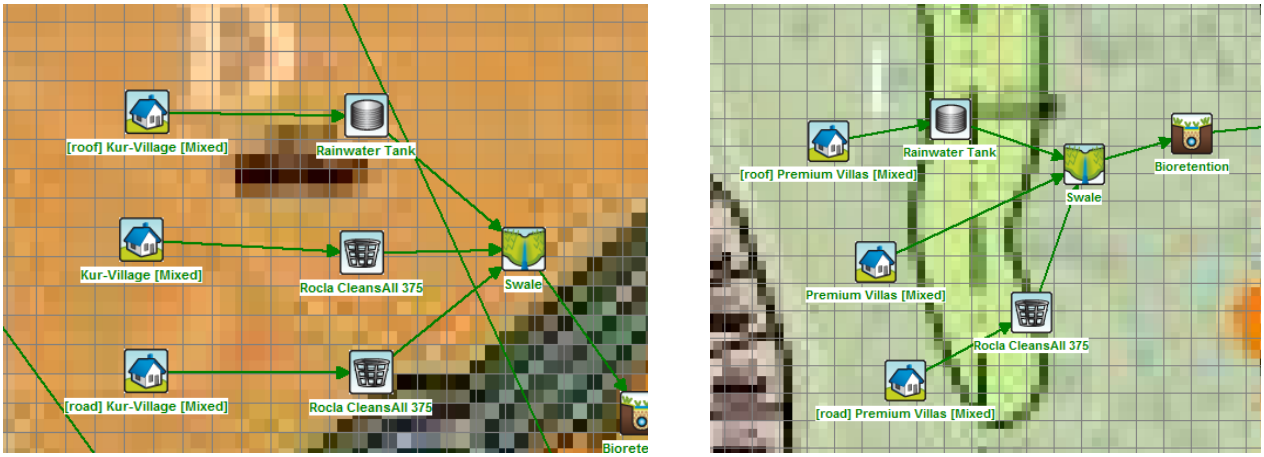

Figure 3 MUSIC Model Layout Close Ups

4.1.2 Treatment Measures

In accordance with the proposed stormwater strategy described in Section 3, the following treatment measures were modelled:

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

The modelled design characteristics for the treatment measures within each precinct are summarised in Table 2.

Table 2 Treatment measure design specification

Precinct	Rocla CleansAll® GPT - Road Treatment	Rainwater Tank Size – Roof Treatment (kL)	Rocla CleansAll® GPT - Landscape Treatment	Swale length – Catchment Treatment (m)	Bioretention Area – Catchment Treatment (m^2)
Farm	CA375	20	CA900	100	3543
Produce garden		5			
Business centre	CA375	20	CA375	100	423
KUR village	CA375	20	CA375	100	194
Rainforest education centre		20	CA900	100	3268
KUR world campus	CA375	20	CA375	100	503
Sporting precinct	CA375	20	CA375	100	223
Golf clubhouse	CA375	20	CA375	100	43
Golf course			CA1350	100	4639
Five star eco resort	CA375	20	CA600	100	883
Health and well being retreat	CA375	20	CA600	100	853
Premium villas	CA375	5 per villa		100	2361
Lifestyle villas	CA375	5 per villa		100	2053
Queenslander lots	CA375	5 per villa		100	206
Open space					

4.2 MUSIC Modelling Results

Table 8 summarises the MUSIC Model results.

As shown in the table, the proposed stormwater strategy for the post developed site complies with all of the FNQROC criteria for stormwater quality improvement.

Requirements for stormwater detention, to mitigate the impacts of increased stormwater flows from the site, will need to be confirmed through separate hydraulic studies.

Table 3. MUSIC Model Results

Parameter	Sources	Residual Load	% Reduction	FNQROC Criteria	Criteria Achieved?
Flow (ML/Year)	1090	934	14%	n/a	n/a
Total Suspended Solids (kg/yr)	156000	9140	94.2%	90%	Yes
Total Phosphorus (kg/yr)	366	123	66.3%	60%	Yes
Total Nitrogen (kg/yr)	2890	888	69.3%	40%	Yes
Gross Pollutants (kg/yr)	9500	0	100%	100%	Yes

Table 4, Table 5, Table 6,Table 7 summarises the peak day maximum concentration and loadings for Total Suspended Solids, Total Nitrogen, Total Phosphorous and Gross Pollutants respectively.

Table 4 TSS Daily Maxima Statistics

	TSS Concentration (mg/L)	TSS Load (kg/Day)
Mean	12.3	2.97
Standard Deviation	16.1	26.6
Median	2.92	1.09e-3
Maximum	77.3	405
Minimum	0.00	0.00
10 Percentile	2.15	790e-9
90 Percentile	36.8	0.226

Table 5 TN Daily Maxima Statistics

	TN Concentration (mg/L)	TN Load (kg/Day)
Mean	1.57	0.134
Standard Deviation	1.61	0.937
Median	0.668	235e-6
Maximum	5.97	14.9
Minimum	0.00	0.00
10 Percentile	0.600	99.5e-9
90 Percentile	4.45	46.6e-3

Table 6 TP Daily Maxima Statistics

	TP Concentration (mg/L)	TP Load (kg/Day)
Mean	0.208	2.97
Standard Deviation	0.163	26.6
Median	0.129	1.09e-3
Maximum	0.671	405
Minimum	0.00	0.00
10 Percentile	0.119	790e-9
90 Percentile	0.503	0.226

Table 7 GP Daily Maxima Statistics

	GP Load (kg/Day)
Mean	0.00
Standard Deviation	0.00
Median	0.00
Maximum	0.00
Minimum	0.00
10 Percentile	0.00
90 Percentile	0.00

5 Recommended Design Criteria

As the proposed stormwater strategy for the post developed site complies with the FNQROC Development Manual for Stormwater Quality, 2014, the following design criteria is recommended:

Table 8 Recommended design criteria

Catchment	Treatment Measure	Design Criteria
Residential roof area	Rainwater Tanks	5kL per villa
Commercial landscape area	Rocla CleansAll® GPT	Sized as per supplier specification
Commercial roof area	Rainwater Tanks	20kL per catchment
Road area	Rocla CleansAll® GPT	Sized as per supplier specification
All	Swale	Minimum 100m length per catchment
All	Bio retention basin	Minimum 2% of catchment area, 1% for golf course
All	Stormwater detention basins	Requirements to be confirmed through hydraulic analysis

It is noted that the high level reference designs for all stormwater drainage infrastructure have been developed to limited level of detail, sufficient to confirm the technical feasibility and assess the potential environmental impacts of the proposed works. Further investigations and design will be required as part of future planning for KUR-World to develop the designs and ensure compliance with all relevant guides and standards.

DOCUMENT CHECKING (not mandatory for File Note)

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Signature			