AURA PRECINCTS 11 AND 12

STORMWATER QUALITY MANAGEMENT PLAN

DesignFlow
Prepared for Stockland
19 December 2017

Document Control Sheet

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SUMMARY

This stormwater quality management strategy covers 128ha of Precincts 11 and 12 of the Aura masterplan development (The Site) including residential, small commercial, school, sports field and recreation park land uses as well as various environmental buffer zones. Note that this SQMP covers the 128 hectares of Precincts 11 and 12, however the development layout which forms part of this application only covers Precincts 11.1, 11.2, 12.2 and 12.2 (~85ha). The SQMP covers the whole catchment areas draining to the proposed treatment systems, hence the 128ha,

This document describes a stormwater quality management strategy for Aura Precincts 11-12 to meet required stormwater quality objectives.

The site drains in two general directions. Two thirds of the site (84 ha) drains southwards via a constructed channel into Bells Creek South and one third of the site (44 ha) flows directly into Bells Creek North. Bells Creek North and South converge approximately two kilometres to the east of the Site.

All runoff from the site flows into a State Government declared High Ecological Value area (Pumicestone Passage) as well as Ramsar listed wetlands. Consequently requirements for comprehensive stormwater quality improvement from the site are imperative. Stormwater quality objectives for development runoff from Aura have been determined as part of a wider water quality assessment of Bells Creek and Pumicestone Passage and were approved in a recent development application (Application 4).

This strategy proposes a comprehensive combination of treatment systems responding to the very high value receiving waters. Treatment will occur via end of line wetland and bioretention basin integrated into linear open spaces, buffers and drainage reserves around the perimeter of the development. In addition, rainwater tanks are used on allotments for water reuse in toilets and outdoor demands. These systems combined provide required stormwater treatment prior to discharge into Bells Creek. At-source bioretention (biopods) will be also used in the residential streets to provide extra treatment beyond the objectives.

The treatment systems have been all be located within the constraints of site levels, available space and requirements for environmental buffers (e.g. frog habitat).

The treatment strategy meets the requirements for stormwater quality improvement to ensure there are no adverse impacts on Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by the required 95% for total suspended solids (TSS), 90% for total phosphorus (TP) and 70% for total nitrogen (TN).

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1 Introduction

The Aura development site has been the focus of extensive water quality and stormwater quality management investigations over the last 10 years. This work has established the water quality characteristics of the receiving waterways (i.e. Bells Creek), monitored the quality of stormwater quality exiting the site, completed extensive catchment and receiving waterbody modelling, established water quality objectives and defined stormwater treatment strategies to meet these objectives. These requirements are now included in Federal and State Government approvals for the site.

This report focusses on 128ha of Precincts 11 & 12 (referred to herein as "the site"). This includes land uses including residential, commercial, school, sports field and recreational parks as illustrated in Figure 1 and Figure 2.

This report presents a SQMP for Precincts 11 & 12 of Aura reflecting recent investigations and consideration of site constraints and proposed development land uses and levels. The strategy ensures the stormwater quality objectives for Aura are achieved using treatment measures that respond to the site constraints while providing flexibility through future detailed design.

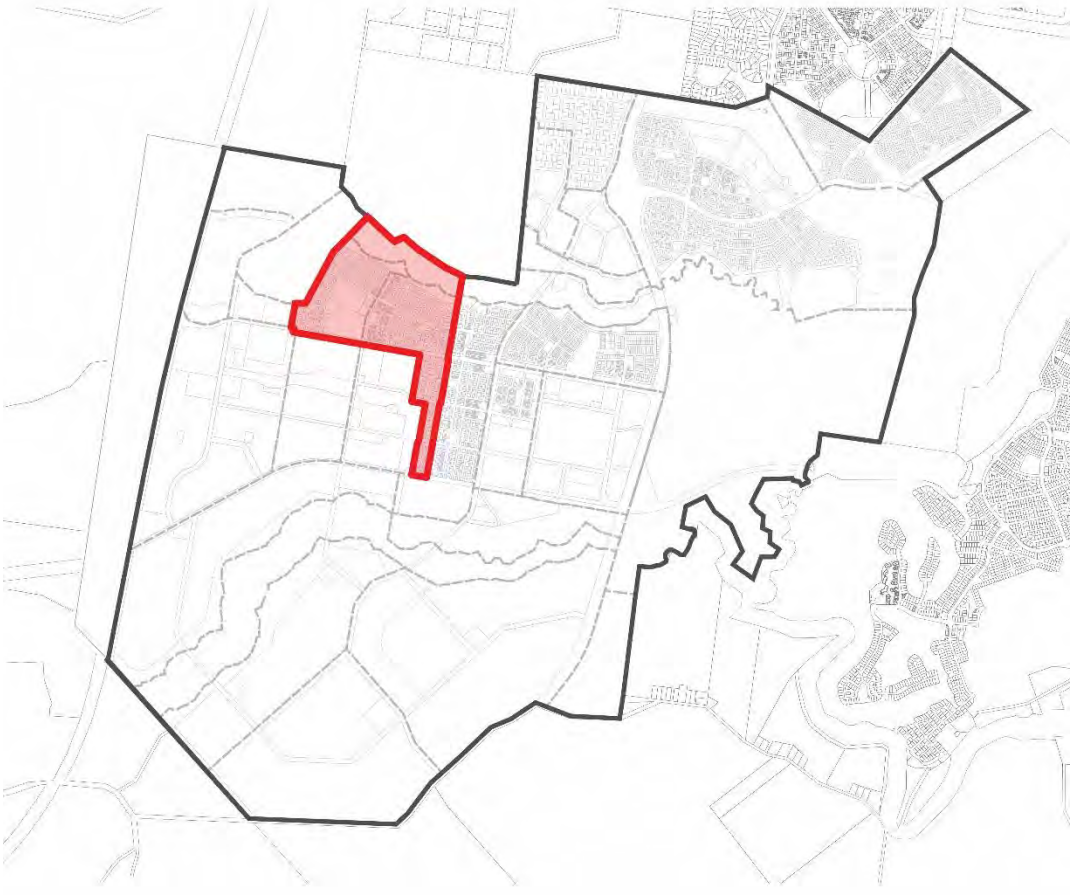

Figure 1 Aura Precincts 11 & 12 Location

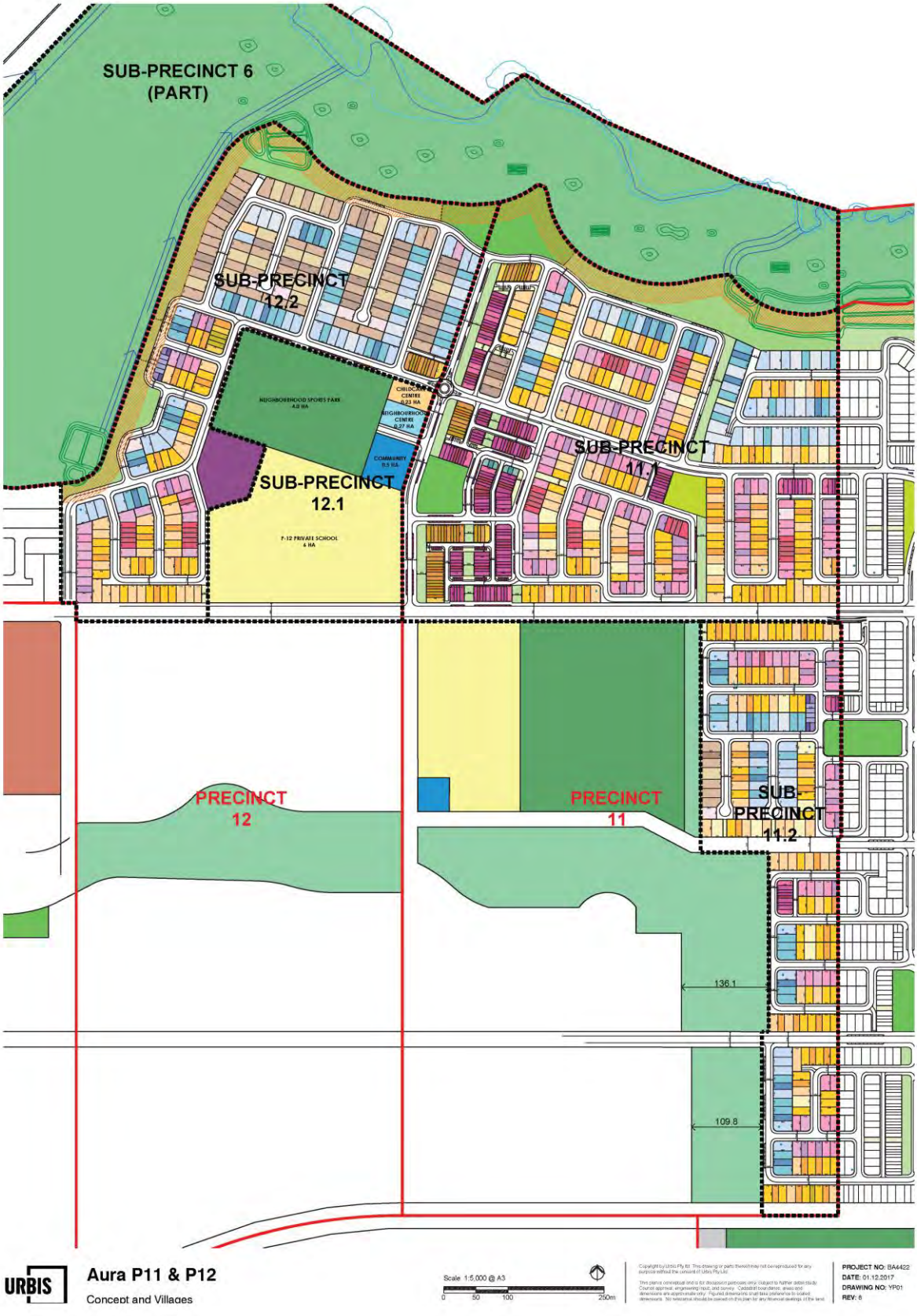

Figure 2 Aura Precincts 11 & 12 Layout

2 Site Characteristics

The description of the site presented here relates to elements that affect the stormwater quality management strategy for Precincts 11-12 (Part). More thorough site descriptions of soils, geology, climate, vegetation and habitats are not replicated as these are covered in other reports relating to the site.

2.1 Current land use

Precincts 11-12 (Part) are located on cleared grazing land that is relatively flat, with existing elevations of between RL 8–10 m AHD.

The area is bordered by Bells Creek North to the north, Precincts 6-10 to the east, a planned constructed waterway leading to Bells Creek South to the south and further planned precincts of Aura to the west (Figure 3).

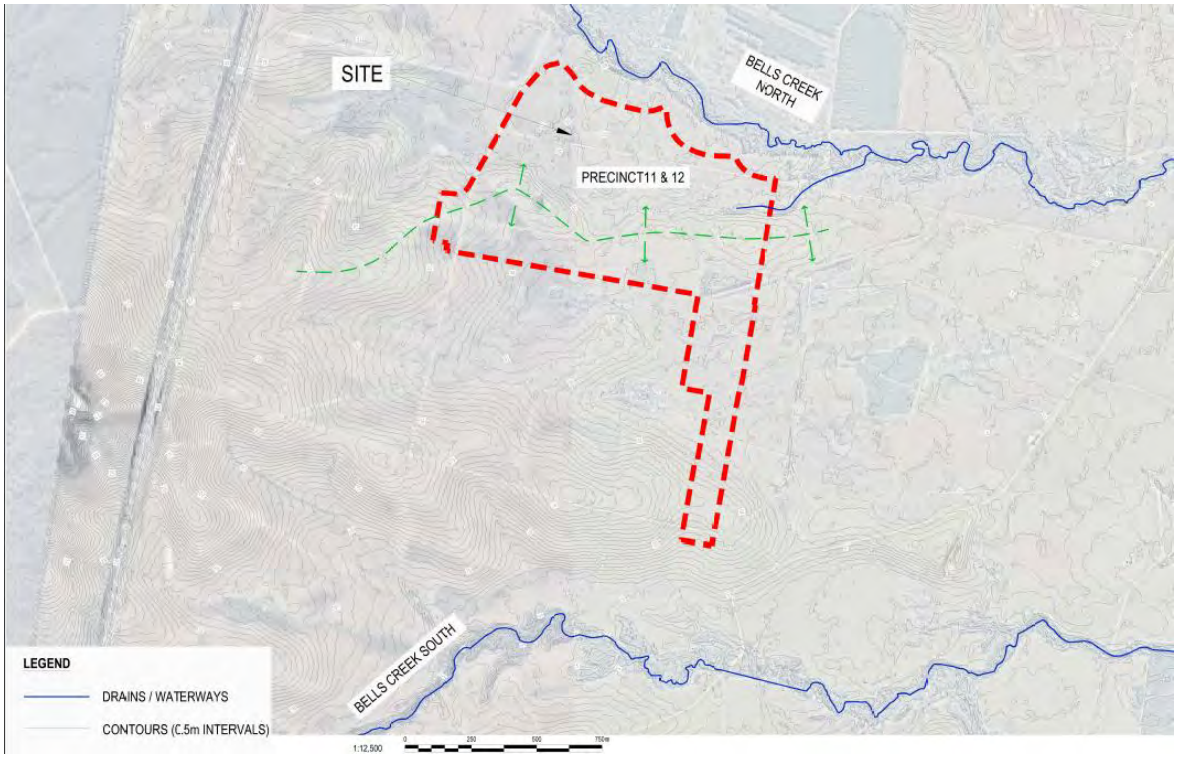

Figure 3 Existing land use, topography and drainage

2.2 Topography and drainage

Approximately half of the current site slopes very generally towards the north into Bells Creek North. The balance of the site also have very mild grades and generally drains to the east and eventually meanders its way into Bells Creek South.

Planned earthworks as part of Aura will include reshaping the southern section of the site to create a waterway that will flow southwards and into Bells Creek South from Precincts 11-12 (part). The earthworks will also change the catchment boundaries such that two thirds of the site flows southwards and one third northwards. The ultimate receiving waters (i.e. Bells

Creek and Pulmicestone Passage) remain unchanged and therefore treatment objectives are the same regardless of discharging into Bells Creek South or North.

Bells Creek North has water levels of approximately RL 8.5m AHD at the western edge and RL 6m AHD at the eastern edge of the development area. These levels are a critical consideration when establishing the stormwater network layout and operation of treatment devices discharging into Bells Creek North.

The constructed waterway leading to Bells Creek South is planned to have levels of RL 8-10m AHD in the west and RL 3.5 m in the south.

Using this information in the development of the stormwater treatment strategy a catchment plan was developed.

2.3 Bells Creek North and South

Bells Creek North and Bells Creek South (tributaries of Bells Creek) are healthy waterways that support a range of wetland and riparian flora and fauna (see photo below). The condition of the creeks, including water quality, has been extensively monitored and presented in other reports and is not covered here.

The total catchment of Bells Creek including the Aura development is 4,660ha. Precinct 11 & 12 are approximately 128ha of this catchment with commercial, industrial and road land uses (this represents 2.9% of the total Bells Creek catchment) with development application area Precinct 11.1, 11.2, 12.1 and 12.2 being 85ha. The context of Precincts 11-12 (Part) in the wider Bells Creek catchment is shown in Figure **4**.

Protection of Bells Creek and the downstream Pumicestone Passage are a critical component of the Aura development and stormwater runoff from the whole area is required to meet a general "no worsening" water quality condition in Pumicestone Passage. This is discussed further with regard to the stormwater treatment objectives (Section 3).

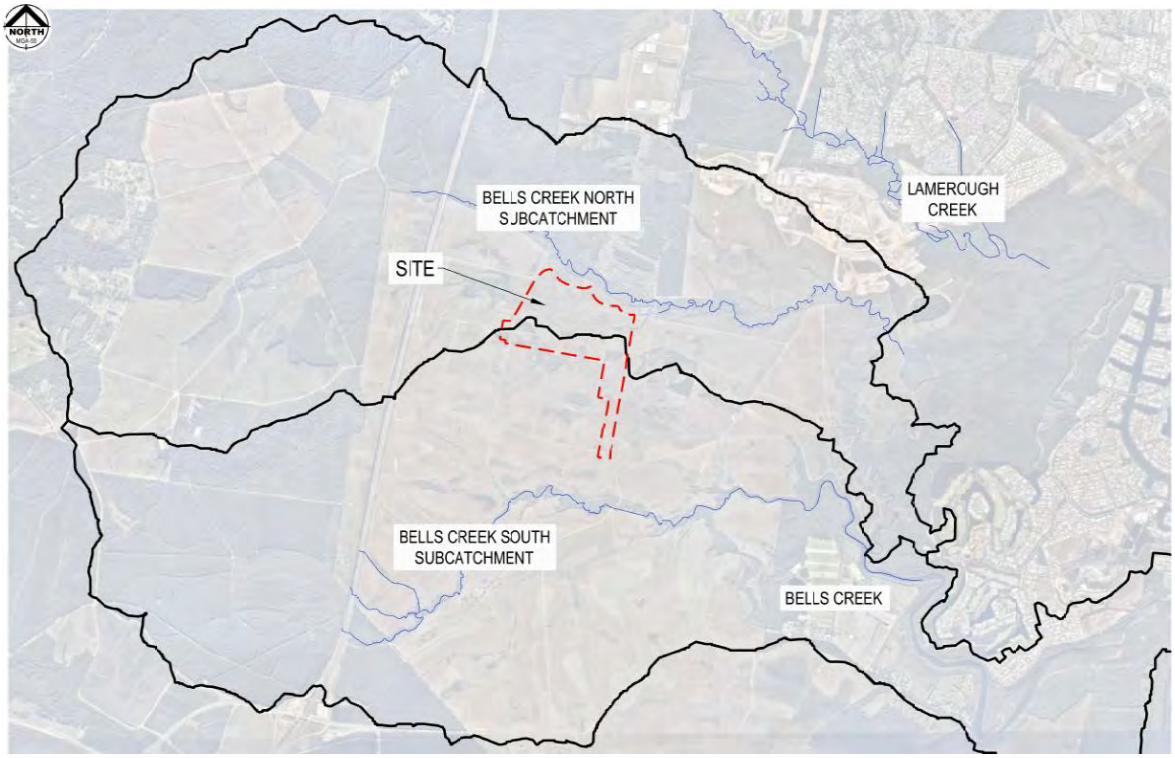

Figure 4 Bells Creek Catchment

2.4 Frog habitat

Frog habitat has been identified across the Aura development for the following frogs which have federal or state significance:

- Wallum Sedgefrog
- Wallum Froglet
- Wallum Rocket Frog.

Management of the Wallum Sedgefrog is to occur in accordance with the approved *Caloundra South Wallum Sedge Frog Management Plan*. Some Sedgefrog habitat areas within the development footprint will be removed and compensatory Sedgefrog habitat areas recreated within the Aura development site (typically within frog zones and buffers as per Section 2.5).

The Wallum Froglet and Wallum Rocket Frog will be managed in accordance with the *Caloundra South Acid Frog Management Plan*, the requirements of which are very similar to the Wallum Sedgefrog outlined above.

2.5 Waterway and frog buffers

To preserve and enhance the riparian function of Bells Creek and meet the requirements of the *Caloundra South Wallum Sedge Frog Management Plan* and *Caloundra South Acid Frog Management Plan*, the development edges in Precincts 11-12 (Part) are required to incorporate the following:

- 25m wide riparian buffers from top of waterway banks (for preservation and rehabilitation of riparian vegetation)
- 50m width Frog Zone (for creation of Wallum Frog habitat)
- 50m Frog Buffer (buffer to the Frog Zone and additional space for creation of Wallum Frog Habitat).

The Frog Buffer can incorporate some stormwater management as per *Caloundra South Wallum Sedge Frog Management Plan* and details of permitted encroachment into the frog buffer is described in Section 6.3.1.

3 Stormwater Treatment Objectives

There are several fundamental drivers for managing stormwater quality from Aura.

The adjacent sections of Pumicestone Passage which receive runoff from the site have been defined as having High Ecological Value (HEV) status in the *Environmental Protection Policy (EPP) – Water* (2009). Water quality objectives that accompany HEV status are of the nature of 'no worsening', but more specifically are quantified as maintaining existing water quality (20th, 50th and 80th percentiles) in the receiving waterway (Department of Environment and Heritage Protection).

Pumicestone Passage and the estuarine sections of Bells Creek have also been defined as having Ramsar wetland status. The associated significance criteria which accompany this designation include:

- Areas of the wetland being destroyed or substantially modified
- A substantial and measurable change in the hydrological regime of the wetland (e.g. volume, timing, duration and frequency of surface and groundwater flows)
- The habitat or lifecycle of native species being seriously affected
- A substantial and measurable change in the water quality of the wetland that may adversely impact on biodiversity, ecological integrity, social amenity or human health
- An invasive species that is harmful to the ecological character of the wetland becoming established, or an existing invasive species spreading.

With such significant high value environmental areas downstream of Aura, considerable investigation and planning has gone into protecting these areas from the impacts of urbanisation as outlined in a range of previous reports (not reproduced here). These reports have attempted to establish load base stormwater quality design objectives which will ensure the 'no worsening' receiving water quality requirement is achieved.

Objectives that are applied to Precincts 11-12 are the same as the recently approved objectives for the urban areas of Application 4 (i.e. Precincts 6 – 10 & 16) and Precinct 2. Stormwater load based reduction targets are presented in Table 1. These exceed *State Planning Policy* requirements, reflecting the significance of the receiving waters.

Table 1: Stormwater quality design objectives for Precincts 11-12 (Part)

Pollutant	Objective - Minimum reduction in mean annual load from unmitigated development
Total Suspended Solids	95%
Total Phosphorus	90%
Total Nitrogen	70%
Gross Pollutants	90%

These objectives are consistent with those applied to Precincts 1-10 & 16. They have been established for the development areas of Aura and relate to achieving no-worsening of condition for Bells Creek and Pumicestone Passage. The objectives were developed with regard to site wide modelling and assessing ecological impacts on Bells Creek and Pumicestone Passage.

4 Stormwater Quality Management Strategy

This section provides an overview of the stormwater design philosophy and describes the treatment systems proposed for Precincts 11-12 (Part).

4.1 Design principles

To develop a robust stormwater treatment strategy, a number of principles were applied for managing stormwater quality. These include:

1. Flexibility – The stormwater treatment strategy will have flexibility and redundancy to allow adjustment in response to site constraints and issues identified as part of future design. This allows the design to be modified during detailed design if an unforeseen constraint is identified.
2. Avoid double treating – As much as practically possible, stormwater that has been "treated" in a wetland or bioretention system should not flow into a downstream treatment, but rather be discharged to the receiving waterway.
3. Identify end-of-line treatment opportunities – Explore all "end-of-pipe" treatment systems initially. Treatment systems are located along the southern perimeter of the development and need to work within the constraints of areas for frog habitat, buffer and existing Bells Creek North levels. This approach reduces the number of treatment devices needing maintenance and increases opportunities for adaptive management.
4. At-source treatments – At-source biopods (bioretention) are proposed for residential streets. These systems are proposed to provide stormwater treatment, improve street greening and also to provide a barrier for any spillages along the roads.
5. Frogs – Ensure the requirements of the *Caloundra South Wallum Sedge Frog Management Plan* and *Caloundra South Acid Frog Management Plan* are achieved.
6. Match catchments, levels and drainage to end-of line treatments– Consideration of slopes, drainage and earthworks requirements to ensure the correct catchment areas were drained to spaces that allowed suitably sited treatment system and also drainage can occur to these system to allow proper drainage into the creek or waterway following treatment.

4.2 Stormwater treatment strategy

A concept layout for the stormwater treatment strategy for the site is presented in Figure 5. It shows how stormwater is directed to the two receiving waters (Bells Creek North and Bells Creek South) and the interactions of tanks, biopods, wetlands, bioretention and swales with flows, overflows and treated water.

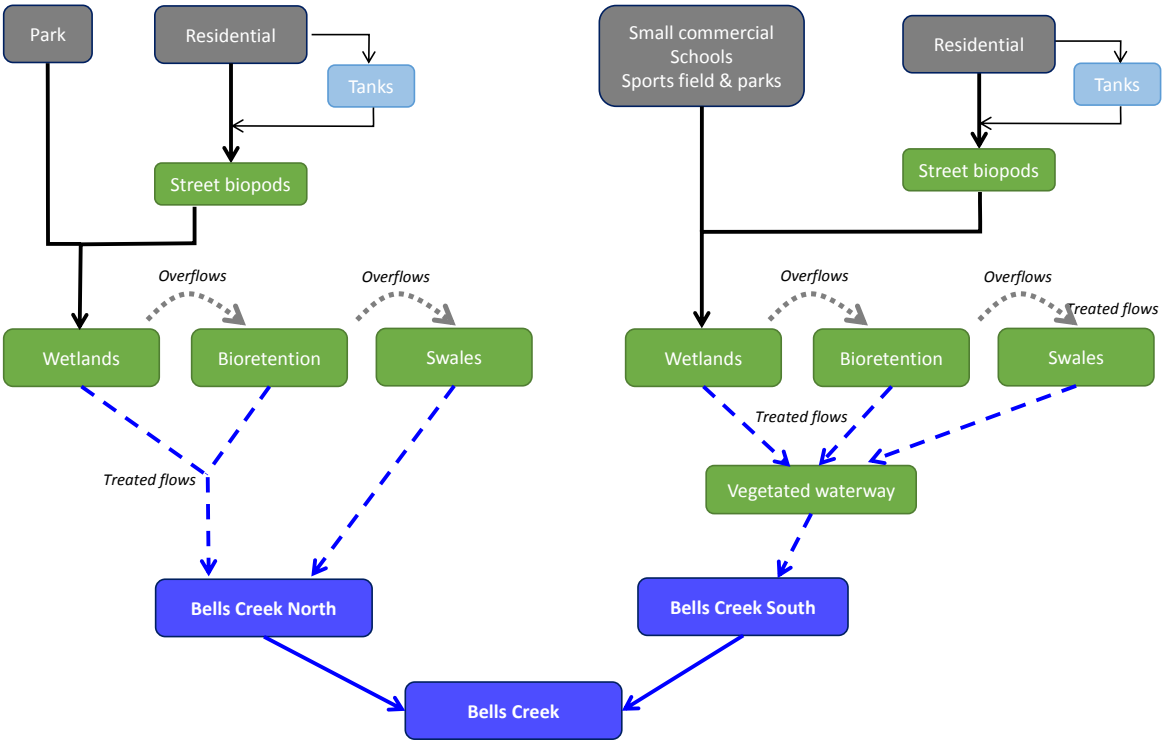

Figure 5 Stormwater treatment train flow diagram

The strategy adopts a similar approach to that taken in previous precincts of Aura. The same suite of stormwater treatment measures are used (i.e. rainwater tanks, biopods, end-of-line bioretention and wetland systems and vegetated swales in various forms). For Precincts 11-12 treatment measures have been applied responding to proposed land uses and the constraints of the site while providing flexibility to achieve the stormwater quality objectives.

Important aspects of the treatment strategy are:

1. Tanks are included in the strategy and will provide a water conservation function. The tanks are to be placed on residential lots and plumbed for toilets and outdoor uses. These also contribute to Aura's water conservation initiatives.
2. Biopods (for residential roads) will treat flows in the streets and will be installed to treat at least 30% of the residential areas. They are sized to be 1.0 % of their contributing catchment areas.
3. End-of-line treatment systems (i.e. combined wetlands and bioretention systems) have been sized to achieve the stormwater quality objectives in combination with upstream treatments. Based on concept layouts (Section 5) there is suitable space having given consideration to other land requirements (e.g. frog zones).

4. A vegetated waterway will collect and convey flows from the area of the site flow south and convey water to Bells Creek South.

Figure 6 presents the proposed catchment areas draining to the treatments and Figure 7 shows a summary of the overall treatment strategy, including the location and sizes of the end-of line treatment systems. The exact location for biopods (for allotments and roads) will be developed in further design. Design principles for biopods are described in Section 5.

Table 2Error! Reference source not found. presents catchment and treatment size details for the proposed end of line treatment systems.

Note the sizes nominated in Table 2Error! Reference source not found. for treatment areas are the wet areas of wetlands (i.e. normal water level) and the filter area surfaces of biopods and bioretention basins. They do not include land for required batters, access tracks etc. Total land requirements have been considered carefully when developing the concept layouts and are included in those diagrams (Section 6.4).

Table 2 Stormwater catchments and treatment system areas for Precincts 11 & 12

Catchment ID	Area	Inlet Pond		Wetland	Bioretention
	ha	Volume (m3)	Area (m2)*	Area (m2)	Area (m2)
N1	25.07	650	650	5500	4800
N2	10.69	550	550	-	2900
N3	8.21	300	300	-	2200
C1	4.93	350	350	-	1300
C2	5.33	350	350	-	1375
C3	29.64	650	650	4000	6200
C4	29.03	650	650	4000	6200
C5	15.28	600	600	-	3850
Total	**128.2**				

NORTH
MGA-55

LEGEND:
- CATCHMENT BOUNDARY
- DRAIN
- CULVERTS
- DRAINAGE DIRECTION
- PRECINCT 11 & 12 BOUNDARY
- RESIDENTIAL
- SCHOOL
- PARK

BELLS CREEK NORTH

N2 = 10.69ha

N1 = 25.07ha

N3 = 1.89ha

FUTURE CATCHMENT = 6.32ha

C5 = 15.28ha

C4 = 29.03ha

PRECINCT 10

C3 = 29.64ha

FUTURE DRAINAGE WATERWAY

C2 = 5.33ha

C1 = 4.93ha

BELLS CREEK SOUTH

1:7,500

0 150 300 450m

REVISION	DESCRIPTION	DRAFTED INITS	DRAFTED DATE	APPROVED INITS	APPROVED DATE
A	PRELIMINARY ISSUE	SBY	14.12.17	SL	14.12.17

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DRAWN: SBY — DATE: 14.12.17

DESIGNED: SL — DATE: 14.12.17

SCALE: A3

PROJECT: AURA PRECINCTS 11 & 12 SWQMP

DRAWING TITLE: **CONCEPTUAL STORMWATER CATCHMENTS FOR PRECINCT 11 AND 12**

PROJECT No: 4344 — DRAWING No: FIGURE 6 — REVISION: A

XREF:
FILE: C:\PROJECTS\DF - 4344 AURA PRECINCTS 11 & 12\4344_SWQMP FIGURE 6.DWG

NORTH
MGA-55

LEGEND:
- CATCHMENT BOUNDARY
- DRAIN
- CULVERTS
- DRAINAGE DIRECTION
- PRECINCT 11 & 12 BOUNDARY
- INLET POND (SEDIMENT BASIN)
- WETLAND
- BIO RETENTION BASIN

BELLS CREEK NORTH

N2 = 10.69ha

N1 = 25.07ha

N3 = 1.89ha

FUTURE CATCHMENT = 6.32ha

C5 = 15.28ha

C4 = 29.03ha

C3 = 29.64ha

DRAINS TO PRECINCT 6-10 TREATMENT

FUTURE DRAINAGE WATERWAY

C2 = 5.33ha

C1 = 4.93ha

BELLS CREEK SOUTH

1:7,500

0 150 300 450m

REVISION	DESCRIPTION	DRAFTED INITS	DRAFTED DATE	APPROVED INITS	APPROVED DATE
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DATE	14.12.17
DESIGNED	SL
DATE	14.12.17
SCALE	A3
PROJECT	AURA PRECINCTS 11 & 12 SWQMP
DRAWING TITLE	CONCEPTUAL STORMWATER TREATMENT STRATEGY FOR PRECINCT 11 AND 12
PROJECT No	4344
DRAWING No	FIGURE 7
REVISION	A

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4.3 Summary of proposed stormwater treatment measures

The table below briefly describes the stormwater treatments measures adopted for Precincts 11-12. Many have been applied to other precincts of the Aura development.

Table 3 Summary of Stormwater Treatment Measures for Precincts 11 & 12

Measure	Description
Education and Awareness	Education of stormwater management approaches at Aura will be built into community communication through signs, kerb messages and other media. While education can play a role in reducing pollutants reaching waterways, the benefits of education on reduced pollutant loads have not been included in the MUSIC modelling assessment.
Rainwater Tanks	As part of Stockland's water conservation policy rainwater tanks accepting runoff from at least 50% of roof areas are proposed for all properties. Water from the tanks is to be plumbed to indoor non-potable and outdoor uses. While the tanks serve an important water conservation role they also contribute to reducing stormwater pollutant export.
Biopods (Streetscape raingardens)	Biopods (referred to as streetscape raingardens in previous stormwater strategies) have formed an important part of the stormwater strategy for the Aura site and have been implemented as part of earlier Precincts including Bells Reach and Precinct 2. The systems work by receiving runoff from the kerb in set down areas in the road verge. Stormwater then percolates through a vegetated soil matrix that promotes fine filtration and biological uptake of pollutants. Treated water is collected at the base and discharged in to the stormwater system. The street biopods are proposed to cover 30% of the residential catchment areas. They are assumed to have an average 100-200mm ponding depth. Biopods are proposed for the roads in the residential area, they have not been included in the MUSIC modelling assessment of treatment performance (Section 7) because it is not known exactly where they will be located. They will essentially provide additional treatment to what is propose din this strategy.
Constructed Wetlands	Constructed wetlands are proposed at perimeter of Precincts 11-12. The wetlands will receive flows from the drainage network hold water for treatment for approximately 2 days with overflows being transferred to adjacent bioretention basins. Constructed wetland systems are shallow extensively vegetated water bodies that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events (by up to 350mm) and outlets are configured to slowly release flows, typically over two to three days, back to dry weather water levels. Wetlands consist of an inlet zone (sediment basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and facilitate the uptake of soluble pollutants) and a high flow bypass (to protect the macrophyte zone). The proposed operation of the wetlands and interaction with the subsequent bioretention basins is described in Section 5. Treated flows from the wetlands will be discharged to either Bells Creek North or South. Overflows from the wetland will enter bioretention basins located immediately around the wetland perimeter to receive further treatment. During large events, overflows from the inlet pond will drain via overflow swales. The wetlands will all be designed in accordance with the WSUD Technical Design Guidelines for SEQ (Water by Design).

Measure	Description
Bioretention Basins	Bioretention basins are proposed to receive stormwater that overflows from the wetlands as part of the end-of-line treatment systems. There are a number of advantages in considering the bioretention systems in this manner: • bioretention systems accept untreated stormwater thus avoiding double treating stormwater • bioretention systems do not receive regular "trickle' flows (that can cause algal growth and block their surface) • allows the bioretention basins to be positioned higher than the wetland normal water level. This approach minimises the head required to operate the wetland and bioretention treatment combination and thus reduces the level the development pad is required to be lifted to enable free draining to and from the treatment systems. Treated flow that collects in the underdrainage pipes will combine with treated water from the wetlands and discharge into Bells Creek North or the waterway leading to Bells Creek South. Design of the bioretention systems will occur in accordance with Bioretention Technical Design Guideline (Water by Design).
Overflow Swales	Overflows (i.e. high flow bypass flows) from the wetland and bioretention systems will be directed to wide shallow vegetated areas that will convey flows downstream. The areas will act to filter the overflows and slow flows down before entering the creek. The systems will essentially act like occasional flowing wide swales.

5 Biopod Design Principles

Biopods are to be used in approximately 30% fo the residential areas across Precincts 11 & 12. The biopods will be located within the residential streets, receive water flowing along kerns and be set down in the verges. They are size to be typically 1% of their contributing catchment area and have 100-200mm ponding depths.

The detailed design for each biopod will be developed during further stages of design. Stockland has extensive experience on other Precincts of Aura in delivering biopods in different locations. While the particular aspects of the biopods will differ between the locations the operating principles are all similar and council's requirements will be accommodated.

Important design considerations will include:

- Biopod filter media set back a minimum of 1m from the back of kerb.
- Biopod filter media minimum width of 1.5m
- Batters of 1 in 2 or flatter
- Avoid safety fencing and pedestrian trip hazards
- No conflict with services other than sewer which may pass under a biopod, with correct protection.
- Consider one-way cross-fall pavement for streets
- Locate biopods to avoid driveways and parking areas
- Ensure sufficient traffic barriers to prevent vehicle entry into biopods
- Moving pedestrian pathways and non-compatible services to the opposite verge from the biopod to create space where required.

There are many variations of biopod designs but the proposal for Precincts 11-12 (Part) will be to create systems similar to other areas of Aura so that maintenance can be streamlined. An example biopod is provided in the photo below.

Photo: Example of biopod with one-way cross fall and narrowed pavement (Bells Reach)

6 Wetland and Bioretention System Concept Designs

Concept designs for the end-of-line treatment systems (i.e. constructed wetlands, bioretention basins and overflow swales) involved a number of steps:

1. Resolving the function of the treatment systems (i.e. how they interact hydraulically to maximize treatment performance)
2. Identifying available space for treatment adjacent to Bells Creek North and accommodating the required buffers and finding sufficient space within the propsoed waterway flowing to the south
3. Ensuring there is sufficient space for the contributing catchments
4. Completing MUSIC modelling to confirm treatment performance
5. Completing survey of creek levels (top of bank and standing water level)
6. Defining operating levels in the wetlands and bioretention systems (using discharge levels into the creek)
7. Optimising the drainage levels and associated earthworks in the development.

The following sections summarise the considerations and findings of this process.

6.1 Treatment system operation

The wetland and bioretention treatment systems receive flows from drainage pipes throughout the development (Figure 7). As flow enters the treatment systems it follows the sequence below (refer to Figure 8):

- Inlet pond - Flows from pipes enter an inlet pond where coarse sediment will settle out and low flows will pass via a pit/pipe system to the wetland.
- Wetland - Flows enter the macrophyte zone of a wetland for treatment. The wetland will treat base flows and small storm events with treated flows discharging directly downstream to Bells Creek North or the constructed waterway. Wetlands will typically have a 48hr notional detention time and a maximum depth of 350mm above normal water level (when bioretention is engaged as well).
- Bioretention – During rainfall events, the wetlands begin to fill and as water levels increase by more than 50mm they will overtop weirs into adjacent bioretention basins. As flow increases water ponds over the bioretention by up to 300mm. The ponded water is combined with that over the wetland. As a storm ends, water then flows through the bioretention media (the majority) and through the wetland outlet. Treated flows from the bioretention basins will be discharged to Bells Creek North or the constructed waterway in the south. Bioretention basins are divided into "cells" to provide management flexibility, promote better flow spreading and allow easier construction and maintenance.
- Overflow swales – The vast majority of stormwater will pass through the wetland and bioretention system to achieve the performance objectives listed in Section 3. Large storm events will overflow a weir in the inlet pond and pass through an overflow swale which will be vegetated. The swale will promote sedimentation and filtration of sediment and particulate phosphorus and discharge large flow events to the creek.

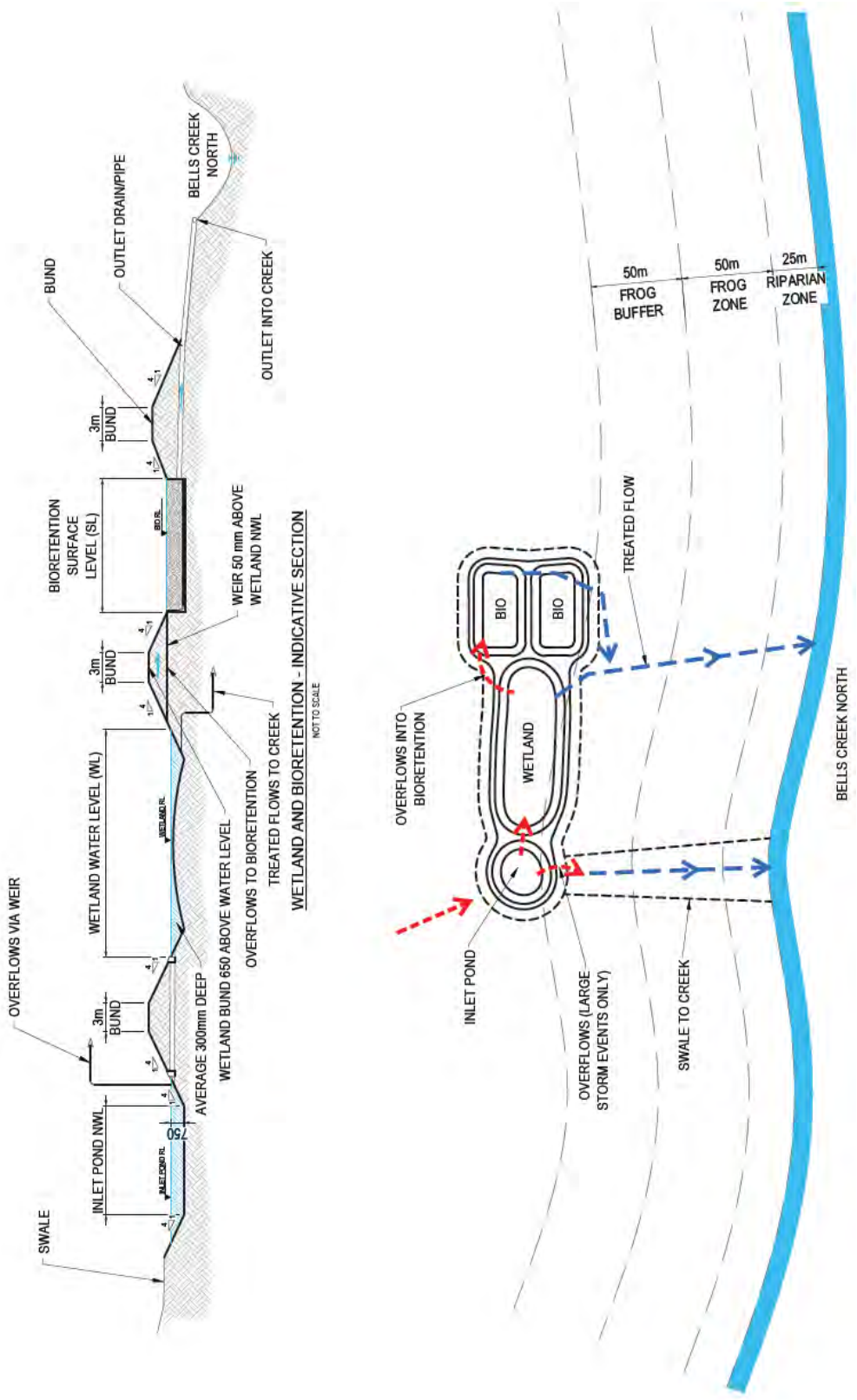

Figure 8 Function and operating levels wetland and bioretention treatment systems

6.2 Operating levels

A critical consideration of the end-of-line treatment systems is the operating levels and how the systems will discharge into Bells Creek. Figure 8 provides a conceptual cross section through the wetlands and bioretention systems to illustrate how water will move through the systems and drain freely into the adjacent creek.

It shows there is 1-2-1.5m between the outfall levels in the creek to the swale invert entering the wetlands. Survey of the creek standing water level and top of bank was completed as part of the conceptual design to define outfall levels, which have been set above the standing water and low flow levels in the creek.

6.3 Location and size

The end-of-line wetlands and bioretention systems have been carefully located considering the constraints including:

- Existing Wallum Sedgefrog habitat (no stormwater management allowed)
- Riparian buffer of 25m (no stormwater management allowed)
- Frog zone of 50m (no stormwater management allowed)
- Frog buffer of 50m (stormwater management allowed) following appropriate criteria (Section 6.3.1)
- Existing vegetation
- Existing drainage
- Parkland, following appropriate criteria (Section 6.3.2)
- Suitable discharge points for treated stormwater.

Sufficient space for the treatment areas as well as batters and access tracks etc. have been provided. In addition, consideration of flood levels of Bells Creek North and requirements for pedestrian paths have influenced their proposed locations.

6.3.1 Frog buffer considerations

Stormwater treatment systems are located in parts of the frog buffer ensuring the following criteria are met (developed in consultation with Australian Wetlands Consulting):

1. No more than 40% of the Frog Buffer can be used for stormwater management devices, including drainage channels. Stormwater management devices must be placed uniformly along the length of the Frog Buffer to ensure no restriction to the overall connectivity of Wallum Sedgefrog (WSF) habitat within the Frog Zone and Frog Buffer.
2. Where stormwater management is located within the Frog Buffer, an average minimum set back of 20m is required between all the edges of each stormwater management measure and the Frog Zone boundary. This set back distance does not apply to stormwater outlet drainage channels.
3. The final locations of the stormwater management devices will be determined during detailed design. The location will consider the proposed WSF breeding ponds,

foraging habitat and overall habitat connectivity to ensure compliance with Key Performance Criteria 5, listed in Table 6.2a within the *Wallum Sedgefrog Management Plan* and Table 8.2a within the *Acid Frog Management Plan*.

6.3.2 Parklands considerations

Stormwater treatment systems have been placed in parklands in accordance with the *Caloundra South Infrastructure Agreement*:

1. Land provided for stormwater treatment facilities for the park are to have a minimal impact on the park's functionality.
2. Max. 5% of total park area for stormwater treatment
3. Where possible, stormwater treatment facilities are to be integrated with planting areas and form part of the overall vegetated area.
4. 30% of the parkland area can be below the 5yr ARI
5. Max grade 1:4, 1:6 preferred for maintenance requirements.

6.4 End-of-line concept designs

Proposed sizes, shapes and configurations for wetland and bioretention systems were resolved by considering available areas for the treatment systems, catchments, required treatment areas and surveyed outfall levels. The operational principles as shown in Figure 8 were applied to develop the concepts.

Concept designs have been developed for the systems discharging directly into Bells Creek North. Designs for the systems draining to the south will be developed further in parallel with the design for the waterway that will convey flows to Bells Creek South.

Figure 9 (north-east) and Figure 10 (north-west) show the concepts for the two end-of-line systems that discharge directly into Bells Creek North. They show sizes, shapes, conceptual earthworks and levels for each system. They demonstrate how the proposed system can feasibly fit within the available space and operate hydraulically with the levels of the area and Bells Creek North. Similar concepts will be developed for the other end-of line systems as the design or the drainage channels develop.

It is possible that during design development, the designs may 'evolve' in response to catchment changes or other constraints. There is sufficient redundancy and flexibility in the proposed designs to accommodate minor changes. On the basis of these concept designs, there is a high level of certainty that the proposed treatment strategy is feasible and can be implemented without changing the development layout.

NORTH

HIGH FLOW BYPASS

BELLS CREEK NORTH

WATERWAY BUFFER

FROG ZONE

BYPASS WEIR

FROG PONDS

SEDIMENT BASIN
650 m² @ RL 7.80

FROG BUFFER

AVERAGE MINIMUM SETBACK = 20m

CREEK WET SEASON
WL = 6.07

NEW CHANNEL

20m

BIORETENTION
1600m² @ RL 7.80

R.L.6.80

WETLAND
5500 m² @ RL 7.80

BIORETENTION
1600m² @ RL 7.80

BIORETENTION
1600m² @ RL 7.80

PARK

SCALE 1:500 @ A1
(1:1000 @ A3)

0 10 20 30 40 50m

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DRAWING TITLE	END OF LINE TREATMENT SYSTEM N1 CONCEPT
PROJECT No	4344
DRAWING No	FIGURE 9
REVISION	A

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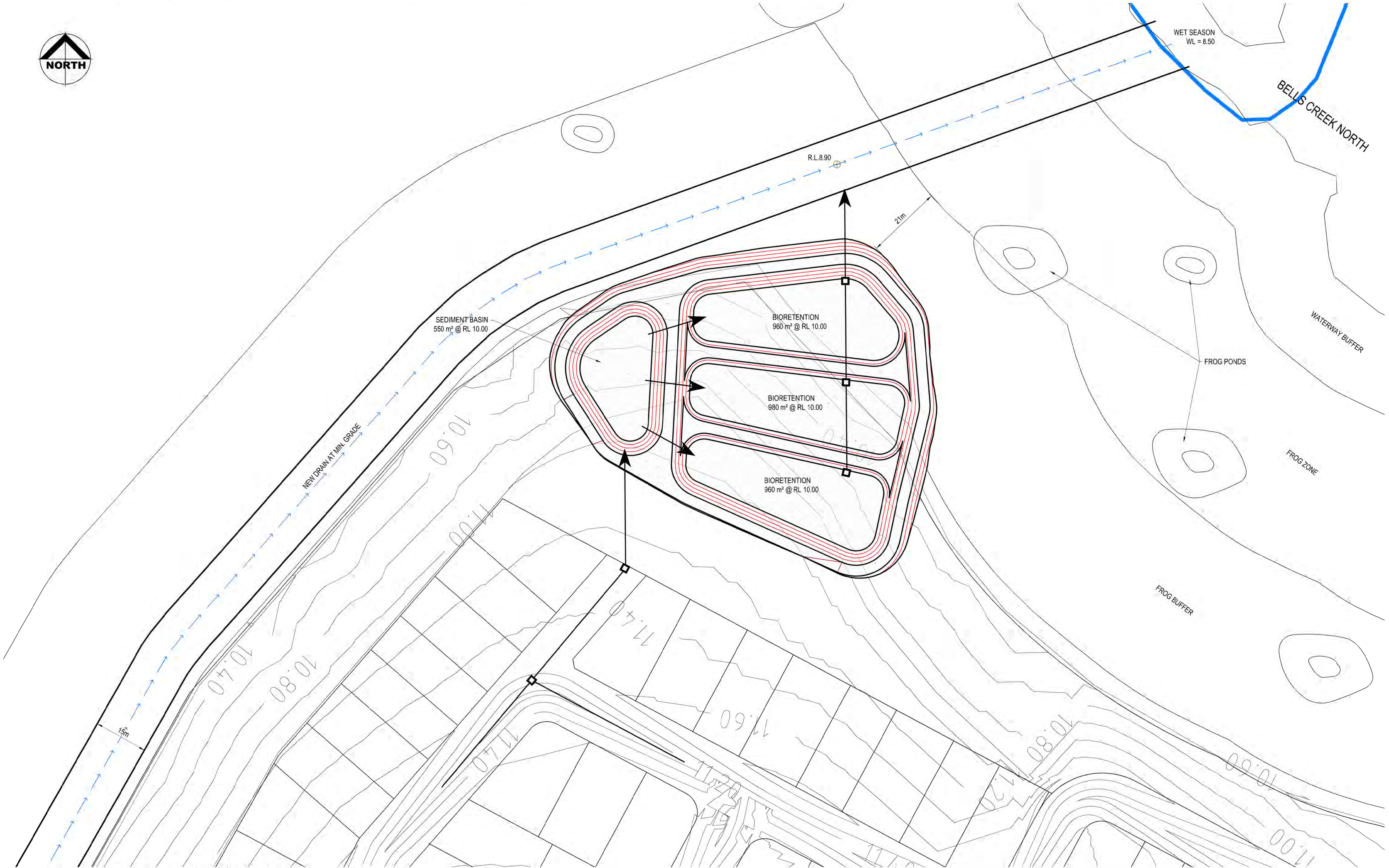
FILE: C:\PROJECTS\DF - 4344 AURA PRECINCTS 11 & 12\ACAD\4344 SWQMP FIGURES 9 & 10.DWG



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PROJECT	AURA PRECINCTS 11 & 12 SWQMP
DRAWING TITLE	END OF LINE TREATMENT SYSTEM N2 CONCEPT
PROJECT No.	4344
DRAWING No.	FIGURE 10
REVISION	A

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7 Performance Assessment (MUSIC modelling)

7.1 MUSIC modelling approach

MUSIC modelling was undertaken to quantitatively assess the performance of the proposed stormwater strategy. MUSIC version 6.3 was used for the assessment and the parameters have been established in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2010).

7.1.1 Model structure

The Precincts 11-12 (Part) MUSIC model layout is shown in Figure 11. Details of the modelling assumptions, parameters and results are provided below.

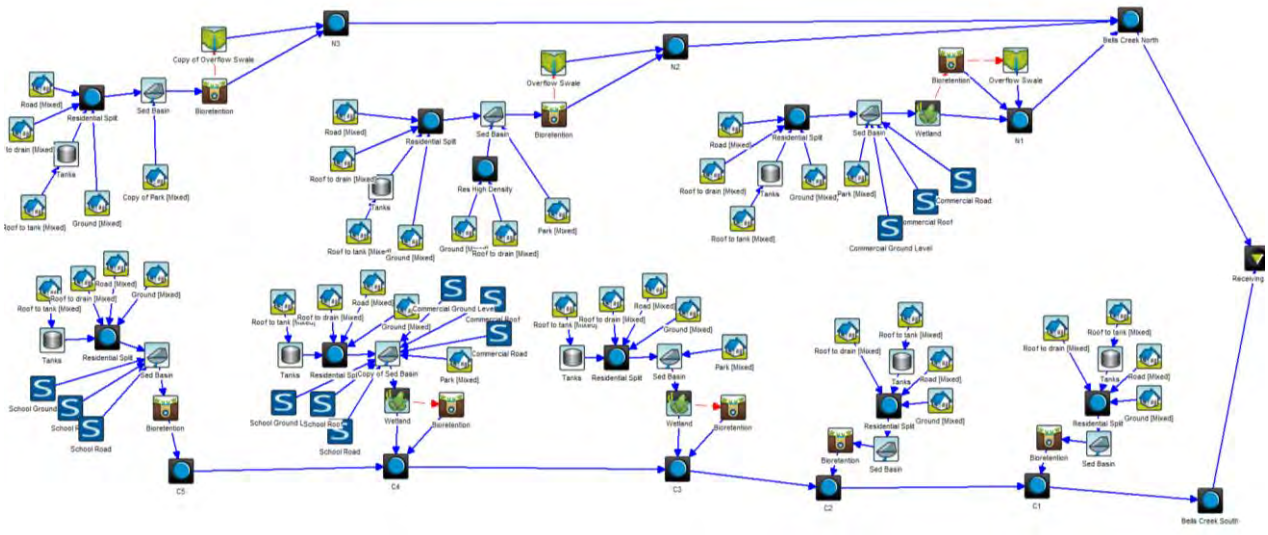

Figure 11 Precincts 11-12 (Part) MUSIC model layout

Table 4 provides a summary of the meteorological data on which the model is based.

Table 4 Meteorological and rainfall runoff data

Input	Data used in modelling
Rainfall station	40496 Caloundra
Time step	6 minute
Modelling period	1997 – 2007
Mean annual rainfall	1,348 mm (for the period used)
Mean annual evapotranspiration	1,628 mm
Rainfall runoff parameters	Per SEQ MUSIC Guidelines
Pollutant export parameters	Per SEQ MUSIC Guidelines

7.1.2 Catchments

The stormwater catchments presented in Figure 6 were used and the various land uses (residential, commercial or parkland) within these catchments were measured. The model uses split land uses, so that particular areas could be directed to treatment while others may bypass (for example, roof runoff can be directed to tanks).

The overall catchment areas and land use types are presented in **Error! Reference source not found.** and details of the split catchments are shown in **Table 5**.

Table 5 Catchment land use area details

Catchment ID	Residential Split				Residential High Density		Commercial			School			Park	Total
	Roof to tank (ha)	Roof to drain (ha)	Road (ha)	Ground (ha)	Roof to drain (ha)	Ground (ha)	Roof to drain (ha)	Ground (ha)	Road/Parkng (ha)	Roof to drain (ha)	Ground (ha)	Road/Parking (ha)	(ha)	(ha)
N1	4.094	4.094	5.84925	7.232			0.115	0.046	0.069				3.57	**25.07**
N2	1.401	1.401	2.002	2.475	0.125	0.125							3.16	**10.69**
N3 + Future	1.107	1.107	1.58125	1.955									2.46	**8.21**
C1	0.949	0.949	1.35575	1.676										**4.93**
C2	1.026	1.026	1.46575	1.812										**5.33**
C3	3.931	3.931	5.6155	6.943									9.22	**29.64**
C4	2.861	2.861	4.0865	5.052			0.57	0.228	0.342	2.85	5.225	1.425	3.53	**29.03**
C5	2.622	2.622	3.7455	4.631	0.34	0.34				0.294	0.539	0.147		**15.28**
Total														**128.18**

7.2 Treatment systems

A summary of the treatment system sizes is shown in **Error! Reference source not found.** and the characteristics for MUSIC modelling purposes of each treatment system are summarised below.

7.2.1 Wetland systems

Wetlands were modelled in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2010). The inlet pond volume was typically set at approximately 10% of the macrophyte zone area and with a notional depth of 1.5m. Weir and bypass flows were directed to the bioretention basins and treated pipe flows bypass the bioretention.

7.2.2 Bioretention basins

The bioretention basins were modelled to only receive overflows from the wetlands with the adopted parameters in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2010). The only variation from the *MUSIC Modelling Guidelines* (Water by Design, 2010) is the bioretention media specifications Ortho-P of 20mg/kg and TN of 400mg/kg which have been justified previously by BMT WBM and previously accepted by EDQ reviewers.

The extended detention depth above the bioretention basins is configured to include the ponding depth above the wetlands once the wetlands spill into the bioretention basins. This is because the two systems will 'share' this ponded water and the bioretention basins will draw down much faster than the wetland systems, hence the vast majority of ponded water will filter through the bioretention media.

7.2.3 Overflow swales

The swales that take untreated overflows from the end-of-line treatments and the swales have the following characteristics:

- Length = 50m
- 0.2% bed slope
- Base width = varies
- Top width = varies
- Depth = 500-800mm
- Vegetation height = 250mm
- Exfiltration = 0 mm/hour

7.3 Results

The results of the MUSIC modelling for flow entering Bells Creek from Precincts 11-12 using the proposed strategy are shown in Table 6. The results in Table 6 include loads from development areas and parkland area (not buffers). This model has assumed although the streetscape biopods are actually installed in accordance with the strategy, the stormwater objectives will be achieved by the end of line treatment systems thus allow flexibility in the design of the streetscape systems (coverage, location). The streetscape systems will result in additional load removal above that presented in the table below.

The results demonstrate that the proposed stormwater strategy achieves the stormwater quality load reduction objectives as outlined in Section 3.

Table 6 MUSIC modelling results

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1100	918	16.2%
TSS (kg/yr)	175000	7760	95.6%
TP (kg/yr)	377	36.8	90.2%
TN (kg/yr)	2380	708	70.2%
Gross Pollutants (kg/yr)	24000	0	100%

7.4 Sensitivity Test

The table below shows the treatment performance with streetscape biopods included in the MUSIC model for the residential areas of Precinct 11 and 12 in accordance with the proposed strategy:

- Biopod area = 1% of catchment
- Coverage = 30% coverage of the residential
- Extended detention 200mm

The results indicate there is a small increase in treatment performance predicted by MUSIC as a result of including streetscape bioretention basins in the model. This confirms the vast majority of the treatment is occurring within the end of line systems.

Table 7 MUSIC modelling results – Streetscape Biopods

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1100	912	16.7%
TSS (kg/yr)	175000	7410	95.8%
TP (kg/yr)	377	35.6	90.5%
TN (kg/yr)	2380	695	70.7%
Gross Pollutants (kg/yr)	24000	0	100%

8 Conclusions

This report describes a Stormwater Quality Management Plan for 128ha of Precincts 11 & 12 of Aura. It comes as a results of thorough assessments of constraints to stormwater treatment measures.

Precincts 11 & 12 drain to two catchments, Bells Creek North (1/3 of the area) and Bells Creek South (2/3 of the area). Both receiving waters have the same discharge requirements and are stringent stormwater quality improvement because of the sensitive receiving environment of Bells Creek and Pumicestone Passage.

The strategy provides a comprehensive stormwater treatment proposal in reflection of the high valued receiving waters. It includes using rainwater tanks, at source biopods (for residential streets), an innovative combination of precinct wetland and bioretention basins and a vegetated conveyance waterway.

Principles of the strategy focus on not treating already treated water and providing flexibility in the treatment train to adjust the design in response to constraints and other design requirements.

The proposal takes advantage of available areas at the northern perimeter of the site adjacent to Bells Creek North and along a planned major constructed water along the southern edge of the precincts. All the concept designs gives careful consideration of the existing levels within the creek given the mild grades of the area.

The treatment strategy meets the requirements for stormwater quality improvement for the Bells Creek receiving waterway.

The measures proposed here will help to ensure there are no adverse impacts on Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by 95% for suspended solids, 90% for total phosphorus and 70% for total nitrogen from the site.

The load of stormwater pollutants will be further reduced should a regional stormwater harvesting scheme for the site be implemented (that is currently being investigated).

9 References

Corrs Chambers McGrath (2015) *Caloundra South Infrastructure Agreement*

Stockland (2017) *Caloundra South Wallum Sedge Frog Management Plan*

Stockland (2017) *Caloundra South Acid Frog Management Plan*

Water by Design (2009), *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*, SEQ Healthy Waterways Partnership. Brisbane, Queensland.

Water by Design (2006), *Water Sensitive Urban Design Technical Design Guidelines for South East Queensland Version 1.* Moreton Bay and Waterways Catchments Partnership. Brisbane, Queensland.

Water by Design (2014), *Bioretention Chapter Technical Design Guidelines for South East Queensland.*

Water by Design (2010), *MUSIC Modelling Guidelines*. Water by Design - SEQ Healthy Waterways Partnership. Brisbane, Queensland.