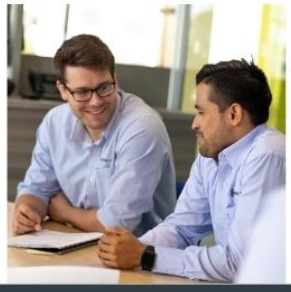
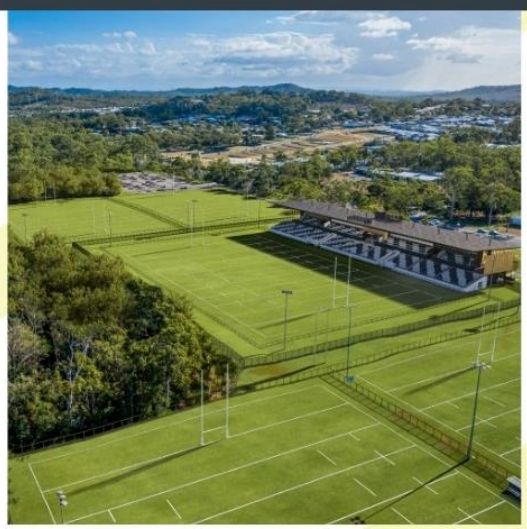
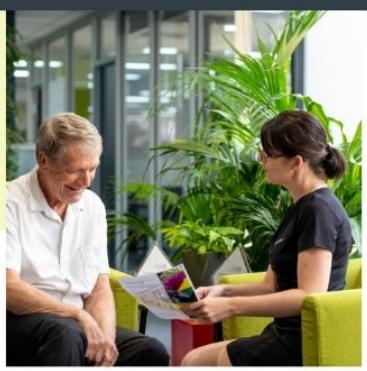
BURCHILLS
ENGINEERING SOLUTIONS



The experience **you deserve**





Boomerang Cove – 16 Tea Tree Road, Forster
Water Sensitive Design Strategy

Client:	Palm Lake Works Pty Ltd
Project Number:	BE190213
Document Number:	BE190213-02-RP-WSDS-02
Date of Issue:	11 December 2024

Document Control Record

Prepared by:	Toby Bennett
Position:	Senior Civil & Water Engineer
Signed:	
Date:	11 December 2024

Approved by:	Michael Harvey
Position:	Civil Engineer
Signed:	
Date:	11 December 2024

Version No.	Description	Date	Prepared	Approved
00	Initial Issue	8/11/2019	SH	TB
01	RFI Response	27/11/2019	SH	TB
02	MOD2024/0144 RFI	11/12/2024	TB	MH

Recipients are responsible for eliminating all superseded documents in their possession.

Coote Burchills Engineering Pty Ltd ACN: 166 942 365

GOLD COAST – Level 2, 26 Marine Parade Southport QLD 4215 - PO Box 3766, Australia Fair Southport QLD 4215
BRISBANE – Level 25, 215 Adelaide Street Brisbane QLD 4000 – GPO Box 3083, Brisbane QLD 4001
TOOWOOMBA – Unit 4, 462 Ruthven Street Toowoomba QLD 4350 - PO Box 1439, Toowoomba QLD 4350

MORETON BAY I SUNSHINE COAST I IPSWICH I BANGALOW

Executive Summary

This Water Sensitive Design Strategy (WSDS) report has been prepared in accordance with the Great Lakes Development Control Plan and is to accompany a modification to the development application for the proposed tourist development. The WSDS has referenced relevant guidelines relating to stormwater management to form the basis of the stormwater plan.

Runoff from the subject site will be conveyed to the proposed treatment devices before discharging via pipe drainage and overland flow. The LPD at the subject site is defined as the outlet to Dunns Creek.

As the subject site discharges directly to a tidal waters, no stormwater detention is proposed as part of this WSDS. Allowing runoff to discharge unmitigated to the tidal water way will not cause adverse hydrological impacts to surface or ground water systems

To achieve the requirements of the Great Lakes DCP it is proposed to incorporate rainwater tanks to allow for rainwater reuse where possible. Rainwater tanks will double as a treatment measure with overflow being directed to bioretention raingarden systems. Filtered runoff will then discharge directly to Dunns Creek.

Table of Contents

Tables

Figures

Appendices

1. Introduction

1.1 Background

This Water Sensitive Design Strategy (WSDS) has been prepared for Palm Lake Works Pty Ltd, the proponent of this Application. The proponent is seeking an application modification for a legacy development consent from 1992 (D/A 4973 and D/A 4974) which has secured the establishment of a tourist development over 16 Tea Tree Road, Forster properly described as Lot 3 DP 548504 (the subject site).

The subject site is situated within the Midcoast Council Local Government Area (LGA) and is zoned by the Great Lakes Development Control Plan as 'Tourist' and *'Medium Density Residential'*.

1.2 Regulatory Requirements

The strategies proposed in this WSDS have been developed to address the requirements of the Great Lakes Development Control Plan (DCP) and the Great Lakes Local Environmental Plan (LEP). With reference to these documents, a WSDS is required for large scale and high density developments that are considered to have a significant impact on waterway health.

The WSDS objectives for the proposed development are based on the integrated Water Cycle Management Objectives and stormwater quality targets in Section 11 of Great Lakes DCP, aimed at incorporating Water Sensitive Urban Design (WSUD) into proposed developments. The development site has an area greater than 2000 m² and is considered 'other' development for the purposes of applying Section 11.4.4 of the DCP.

1.3 Purpose

The main objectives of this WSDS have been established from the criteria set out in the Great Lakes Local Environmental Plan and the Development Control Plan and are summarised as follows:

- To safeguard the environment by maintaining or improving the quality of stormwater run-off.
- To protect and restore aquatic, estuarine or riparian ecosystems and bushland areas.
- To harvest rainwater and urban stormwater runoff for use where appropriate.
- To control the hydrological impacts of development on receiving surface and ground water systems by controlling the frequency, magnitude and duration of flows to preserve, as far as practicable, predevelopment groundwater and surface water regimes and interactions.
- To control the impacts of development on channel bed and bank erosion by controlling the magnitude, nature and duration of sediment-transporting flows.
- To promote disconnection of impervious areas to the drainage system by introducing appropriate measures to minimise the rate, frequency and volume of urban runoff events in order to improve WSD performance.

1.4 Scope

To achieve the above mentioned objectives, this WSDS details the following:

- Site assessment including:
  - Existing land use;
  - Topography;
  - Soils and vegetation; and
  - Receiving environment.
- Proposed development details including:
  - Proposed land uses;
  - Development staging;
  - Constraints and opportunities; and
  - Best planning practices.

- Construction phase soil and water management including:
    - Soil and water management plan for the construction phase of the development prepared in accordance with Blue Book Volume 1 (Landcom, 2004) and Blue Book Volume 2 (DECC, 2008).
- Stormwater management including:
    - Water quality targets;
    - Proposed stormwater treatment measures;
    - Stormwater quality modelling used MUSIC;
    - Integration with urban design; and
    - Operational maintenance and management plan.

To minimise the impact of the proposed development on the external environment and to avoid significant and / or sustained deterioration in downstream water quality the proponent shall implement this WSDS. This WSDS may be amended as required, in response to a monitoring and maintenance program.

2. Site Details

2.1 Location and Zoning

The subject site is located at 16 Tea Tree Road, Forster which is properly described as Lot 3 DP54804 and has a total site area of 4.07 ha. The site is identified by the Local Environmental Plan (LEP) as having dual zoning comprising of Tourist area and Medium Density Residential. Figure 2.1 below identifies the location of the subject site.

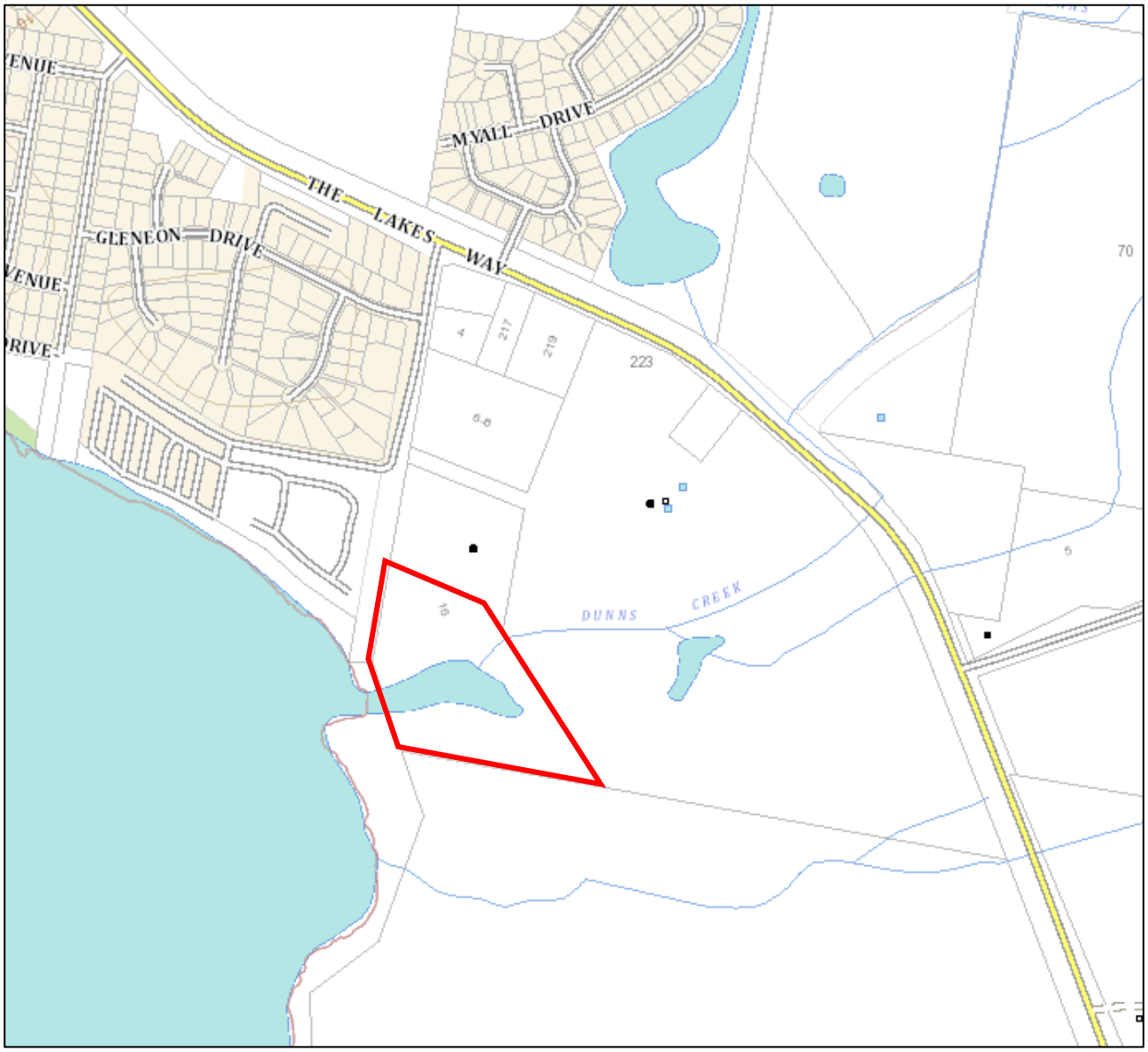


Figure 2.1 Site Locality Plan (Midcoast Council, 2019)

2.2 Land Uses and Vegetation

Prior to the bulk earthworks being completed, the site was entirely vacant with a large waterbody forming the outlet for Dunns Creek. Sparse vegetation existed around the waterbody and on the site's eastern boundary. An aerial image of the site in its pre-development condition circa 2019 is provided as Figure 2.2.

Figure 2.2 Aerial Imagery (Nearmap, 2019)

2.3 Topography

Site survey was used to delineate catchments at the site and determine the pre-development site grading. The site generally grades toward the existing water body in the centre of the site. For further detail regarding catchment delineation please refer to Drawing N200 included within Appendix C.

The site has an RL ranging from 1.9 – 0.5 m AHD. With an average RL of 1.1 m AHD.

2.4 Soils

In its undeveloped condition (prior to any bulk earthworks), the site contained mostly soils of hydrological Group D which have high runoff potential and very slow infiltration (Mid Coast Council, 2019). These soils are likely to contain highly dispersible sodic and magnesic clay particles which will need to be closely managed during construction activities.

2.5 Downstream Environment

Stormwater discharges from the site at the existing waterbody in the centre of the site. This waterbody forms the outlet of Dunns Creek which discharges runoff into the Pipers Bay and Wallis Lake systems.

3. Proposed Development

3.1 Proposed Land Use

The proposed development is to provide tourist holiday accommodation and is named Boomerang Cove. The proposed development is located around the outlet of Dunns Creek and comprises the following components:

- Internal driveway and parking area;
- Serviced apartments
- Apartment buildings;
- A reception centre;
- Tennis courts; and
- Communal gardens.

3.2 Constraints and Opportunities

3.2.1 Flooding

The site is constrained by flooding where an elevated water level in the Wallis Lake system caused by regional flooding and/or abnormally high tides results in inundation of the site up to the flood planning level of 3.2 m AHD.

3.2.2 Drainage

The site is very flat but grades gently towards the existing outlet to Dunns Creek. Runoff from the site will be collected by a proposed pit and pipe system that will be conveyed through the treatment train. The stormwater infrastructure will be required to not drain through the proposed revetment wall, so all drainage will need to be conveyed around the boundary of the site to Dunns Creek. It is proposed to implement catch drains (swales) along the site's boundaries to achieve this. This grade constraint makes at source stormwater treatment difficult to achieve due to the head loss through such systems.

3.2.3 Stormwater Treatment

The subject site has a highly sensitive receiving environment in Pipers Bay and the greater Wallis Lake system. Although this presents as a constraint to the development, it is also an opportunity to ensure the construction and operation of the development result in the long term improvement and protection of the ecology of this system. Neutral or Beneficial Effect (NorBE) water quality objectives have been adopted for the subject site.

3.3 Best Planning Practices

Capturing roof water within rainwater tanks is considered a viable option for this development and will reduce ongoing utilities costs as well as not burdening the local water supply network. It is proposed to incorporate rainwater tanks where possible on the site for this reason.

The most cost-effective option for stormwater treatment at this site is the use of bioretention devices. The proposed bioretention devices can be built into the development landscaping adjacent to carparks and driveways.

All runoff from the development will be conveyed towards the central body of water within the site (Dunns Creek Outlet). Conveying runoff away from the sensitive wetlands to the south of the development is considered best planning as it avoids the creation of nuisance flows that have potential to cause erosion and scour.

4. Stormwater Quantity Management

4.1 Overview

As the subject site discharges directly to a tidal waterway, no stormwater detention is proposed as part of this WSDS. Allowing runoff to discharge unmitigated to the tidal waterway will not cause adverse hydrological impacts to surface and ground water systems for the following reasons:

- There is no downstream infrastructure that will be compromised as a result of increased peak flows;
- Surface water systems downstream of the site are tidally influenced and the effects of changed hydrological conditions at the site will not alter water surface level or inundation frequency; and
- Ground water at the site is characterised by the adjacent tidal waters within Dunns Creek, not by site conditions.

4.2 Drainage Catchment Parameters

Drainage catchments have been delineated using site survey, aerial imagery and development plans in the post developed scenario. Catchment parameters are summarised in Table 4.1.

Table 4.1 Catchment Parameters

Scenario	Catchment ID	Total Area (ha)	Impervious %	Catchment Slope (%)
Pre-developed	A1	1.292	0	1
	A2	1.666	0	1
Post-developed	A1	1.292	65	1
	A2	1.666	65	1

4.3 Conveyance of Site Flows

Runoff from the site will be conveyed as sheet flow to proposed drainage infrastructure in the form of pit and pipe systems. Depending on where the runoff is produced, it will be conveyed to proposed stormwater treatment facilities as discussed in Section 5.3. All treated runoff will be conveyed via the site's drainage infrastructure to the outlet of Dunns Creek.

Rainwater collected by the proposed tanks will be stored for reuse or will overflow through the high-flow tank pipe. High-flows from the rainwater tank will be conveyed from underground drainage pipes to the proposed rain garden areas.

4.4 Lawful Point of Stormwater Discharge

The Lawful Point of Discharge (LPD) is defined as the water body that exists in the centre of the site. This water body within the subject site is known as the outlet to Dunns Creek.

5. Stormwater Quality Management

5.1 Integrated Water Cycle Management

It is proposed that stormwater treatment devices be located within the development and be made up of rainwater tanks and bioretention 'raingardens'. The strategy for stormwater management incorporates the following main principles:

- Capture of roof rainwater for reuse purposes. Additional captured flow that exceeds the volume of the rainwater tank is to be conveyed to bioretentions systems for treatment.
- Collection of runoff from impervious areas, such as driveways within bioretention systems. Runoff is to be filtered through the bioretention system and discharged to the adjacent tidal water way.
- Small disconnected impervious areas, such as footpaths to be discharged directly to landscaped areas.

5.2 Water Quality Objective (WQO)

In accordance with Section 11.4.2.1 of the Great Lakes Development Control Plan, the total effect of permanent water quality control measures employed by the development are at minimum the following:

- 90% load reduction for Gross Pollutants (GP) (>5mm);
- Neutral or Beneficial Effect (NorBE) for Total Suspended solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN).

5.3 MUSIC Modelling

The quality of stormwater discharging from the subject site in its predevelopment condition was modelled in MUSIC using a 'rural' node for the cleared portion of the site and a 'forest' node for the vegetated areas of the site as directed by Council. The base flow and storm flow concentration parameters for these 'large areas of interest' were taken from Table 5-6 and Table 5-7 of the NSW MUSIC Modelling Guidelines (BMT WBM Pty Ltd, 2015) while the impervious areas were estimated from aerial imagery and development plans.

5.3.1 Treatment Train

To ensure the above WQOs can be met at the site's LPD, a treatment train was proposed for the developed site and modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software. All input parameters for the MUSIC model can be found within Appendix B.

It is proposed to capture all runoff that is produced on the development's roof area within rainwater tanks. Captured runoff will be used for reuse purposes, such as gardening, laundry and bathroom purposes. Captured runoff that exceeds the capacity of the tanks will overflow and be conveyed to bioretention systems.

Bioretention 'raingardens' are proposed to treat stormwater that is produced over the development. Runoff produced on the development driveways, carparks and other impervious surfaces will be conveyed to the bioretention system along with the above-mentioned tank overflow. The bioretention systems will act as pollutant filtration, removing pollutants through natural process before discharging treated runoff to the tidal waterway.

Conceptualisation of the treatment train strategy within MUSIC has been included in Figure 5.1 below. The location of the proposed treatment train elements is included in the Operational Control Plan within Appendix C.

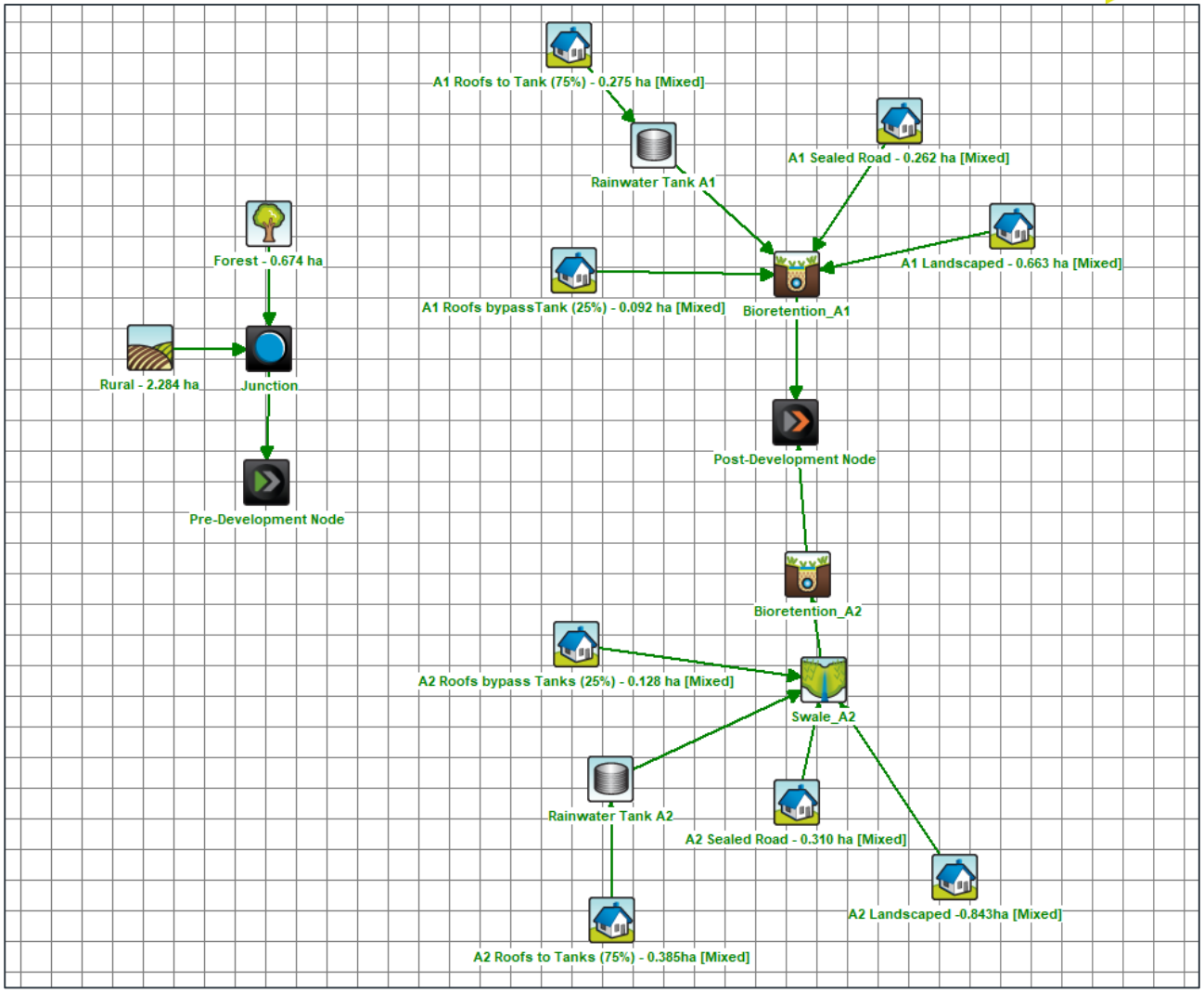


Figure 5.1 Treatment Train Conceptualisation

5.3.2 Rainwater Tanks

All development roof areas will drain to rainwater tanks where captured water will be used for reuse and overflow will be conveyed to bioretention 'raingardens'. All rainwater tanks have been assumed to be minimum storage size of 5 kL and have been reflected within the MUSIC modelling using a lumped catchment approach. Details of MUSIC input parameters with refence to rainwater tanks can be found within Appendix B. It is assumed that 75% of roof area drains to the rainwater tanks.

Table 6.2 of the NSW MUSIC Modelling Guidelines (WBM BMT, 2015) suggests the following re-use demand for a multi residential dwelling with an average of 2.35 occupants:

- Daily internal use – 370L
- Daily external use – 88L

The reuse demands utilized in the model have assumed external use only and have been scaled back by 30% to better reflect the reuse rates from tourist developments.

It is proposed to incorporate a rainwater tanks for each building as follows:

Northern Precinct:

- Serviced Apartments – 3 x 5kL tanks
- Recreation Centre – 3 x 5kL tanks

Southern Precinct:

- Building Type A – 5 x 5kL tank
- Building Type B – 5 x 5kL tanks

5.4 Bioretention System – Raingardens

Bioretention systems are proposed in the form of rain gardens and are to be utilised to treat runoff from the entire development through natural process. Treated runoff will discharge to the adjacent tidal waterbody.

The typical parameters of the proposed bioretention raingardens are presented in Table 5.1, and further detail of the input parameters used within MUSIC are included in Appendix B.

Typical sections of a bioretention raingarden have been included in Figure 5.2. The bioretention systems shall be designed and constructed in accordance with the Midcoast Council Water Sensitive Design Standard Plans.

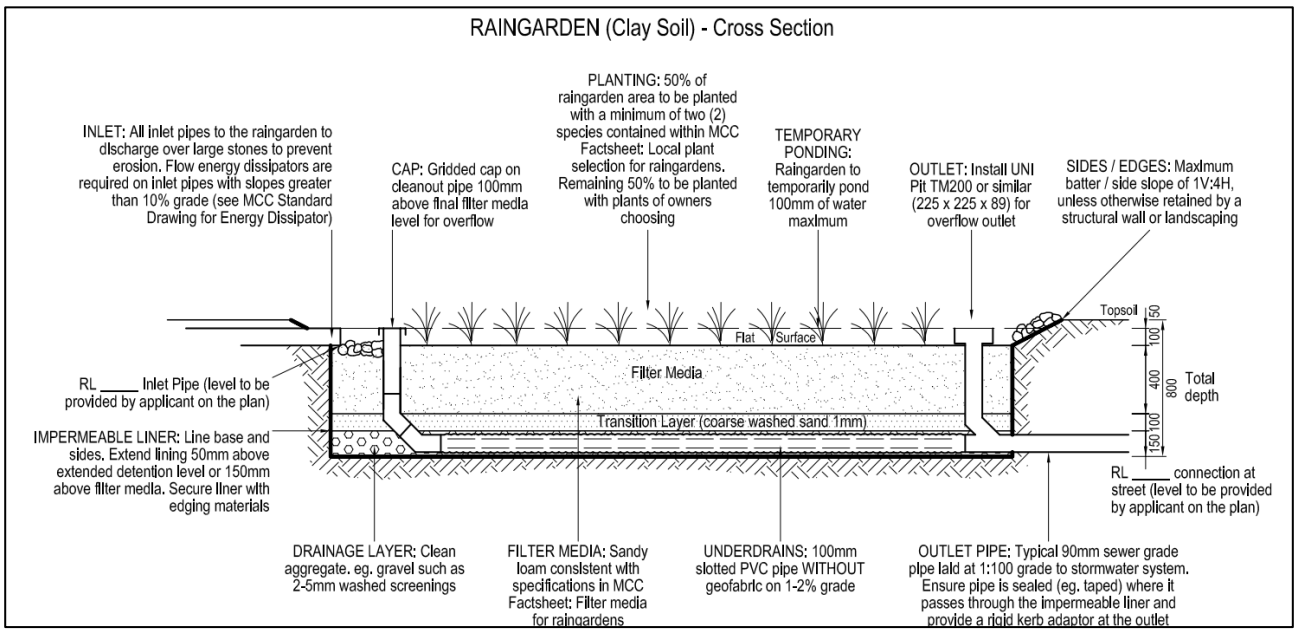


Figure 5.2 Typical Bioretention Basin (Midcoast Council, 2018)

Table 5.1 Typical Bio-retention Basin Parameters

Parameter	Value
Extended Detention Depth	300mm
Filter Media Depth	400mm
Transition Layer	100mm
Drainage Layer	150mm
Total Filter Media Area	**350 m²**

5.5 MUSIC Results

Results of the MUSIC modelling for the treatment train effectiveness are summarised in Table 5.2. The results indicate the 90% reduction target gross pollutants and the NorBE target for TSS, TP, TN are achieved for the rainfall data set simulated.

Table 5.2 Treatment Train Effectiveness

Pollutant	Pre-Development	Post Development		Pollutant Load Reduction Achieved (%)	Pre-Post Pollutant Load Outflow Change (%)	Water Quality Objective (%)
	Outflows (kg/yr)	Inflows (kg/yr)	Outflows (kg/yr)			
TSS	1380	4000	436	89.1	68	NorBE
TP	2.98	7.99	2.25	71.8	25	NorBE
TN	26.4	57.3	23.3	59.3	12	NorBE
GP	54.9	621	0	100	100	90%

NOTE: All simulations have been run with pollutant export estimation set to “stochastic generation”.

6. Operation and Maintenance

6.1 Construction Sequencing

Construction of the proposed bioretention systems is to be undertaken in three separate phases as follows:

- Civil construction phase – The civil construction phase will see the earthworks for the bioretention systems completed and the under drainage and filtration media installed.
- Building works phase – The filter media surface shall be protected with turf until at least 80% of the contributing catchment has been developed including building works.
- Operational phase – Once the development is operational then the turf can be removed and the bioretention systems planted with appropriate species.

6.2 Management Responsibility

The responsibility for proper operation and maintenance of the proposed bioretention systems will be transferred to Palm Lake Resort following the completion of construction. Palm Lake Resort will own and maintain the entire site in perpetuity including the drainage system and bioretention systems. The property owner and operator shall be equally responsible for the maintenance of the systems required to ensure they continue to function as designed for the life of the development.

6.3 Maintenance Procedures

Once the systems have been established, operation is mostly passive and requires little operator intervention. The appointed maintenance operator must be observant, take appropriate action when problems develop, and conduct the required monitoring as necessary. The typical maintenance issues for bioretention systems are discussed below.

For further information, please refer to the Water by Design *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1*.

6.3.1 Plant Replacement

Regular, long-term maintenance of plants within basins is essential to ensure that the system functions as designed. During operation phase, plant health and coverage should be monitored on a bi-monthly basis as part of the 'routine inspection'. Discolouration or wilted leaves indicate poor plant health and could be caused by inadequate watering, disease, or lack of nutrients. Plants that have not grown since being planted or showing signs of discolouration in the leaves may require the application of fertilisers. Replanting may need to be carried out if:

- Survival rates are below 90%;
- An obvious channel in a plant stand allows water to bypass treatment (this is also known as short circuiting); or
- Plants have been destroyed (e.g. by birds) or displaced by storm events.

When replanting, ensure that plant species are installed at the appropriate depth. To ensure successful plant establishment, install large nursery plant stock or transplant clumps of well-established plants from within the basin. Plant species selection for replacement plants should be informed by observations of site conditions which will provide an indication of which species are likely to respond well and prosper long-term.

6.3.2 Weed Management

After the bioretention basins are well established, bi-monthly inspections should be sufficient to monitor weed invasions, and quarterly maintenance will be sufficient unless significant replanting or re-establishment works are undertaken. Once the vegetated areas are established, fortnightly inspections may still be required over

the summer months if a particular infestation is being controlled and monitored. Weed infestations are undesirable in and around the system as they compete with and displace native species and contribute to the decline in system health.

6.3.3 Inlet and Outlet Points

Inflow / inlet systems and overflow pits/outlets require careful monitoring as they can be prone to scour and litter build up. Debris can block inlets and outlets, compromising the function of the system, and can be unsightly, particularly in highly visible areas.

There are bi-monthly routine inspections and quarterly routine maintenance planned during which sediment and rubbish at the inlet areas will be monitored and removed.

The outlet pit will also be inspected for damage, accumulated debris and working order at the routine inspection.

6.3.4 Rubbish Removal

Litter and debris which washes into basins can be unsightly and dangerous for wildlife. Plastic containers and other accumulated rubbish also provide ideal breeding habitat for mosquitoes. Rubbish should be removed after storm events and/or during the routine maintenance.

Rubbish should be separated and recycled where possible. The approximate quantity and type of rubbish should be recorded, as this can assist in understanding where the rubbish may originate and help to devise appropriate source control measures.

6.3.5 Managing Extreme Events

In the event of an extended period of drought, established plants may die or retreat below ground (enter 'senescence') but will re-grow when water is supplied. Mature plants should survive extended periods of drought with no standing water by penetrating their roots deep into the soil profile. In prolonged periods of drought, management should:

- Monitor plant health;
- Prevent soil desiccation by using sprinkler irrigation, particularly in areas containing unhealthy looking plants;
- Consider flood irrigation; and
- The basin outlets could be modified (blocked) to retain water in extreme circumstances.

The impact of drought can be reduced through:

- Selection of drought tolerant species;
- Mulching of terrestrial areas; and
- Deep watering that encourages deep-rooted plants.

Following a flood or significant storm event, basins should be assessed for scouring, vegetation loss and general damage. If necessary, repair or replanting should be undertaken to emulate pre-flood conditions and prevent further damage.

Extreme flood events may also introduce noxious weed species. Post-flood management should therefore place high priority on monitoring for, and vigilantly removing, noxious weed and undesirable species. After floods there is commonly an accumulation of rubbish and debris. Resources will need to be allocated for the collection of this rubbish.

6.3.6 Resetting of Systems

Regular maintenance, management and water quality testing may identify that stormwater treatment infrastructure is not achieving prescribed water quality objectives. In order to address this non-compliance, the relevant party shall be required to determine whether the performance can be improved through increased maintenance, or whether rectification works (reset of the system) will be required.

The underperformance of a stormwater treatment device can be attributed to a number of different factors, including (but not limited to):

- A flaw in the design of the treatment device (incorrectly sized outlet structure, miscalculation of hydraulic regime etc.);
- Poor construction (bioretention components installed incorrectly);
- A lack of maintenance;
- The collapse of the hydraulic structure;
- Unforeseen / unusual events (unusually high amounts of sediment, pollution or weeds entering an asset); or
- Mass plant failure within a planted system.

For further details regarding the rectification of a bioretention system, please refer to the Water by Design: Rectifying Vegetated Stormwater Assets document, available at the Healthy Land and Water website: http://hlw.org.au/initiatives/waterbydesign

6.4 Maintenance Schedule

Inspection and maintenance activities during the plant establishment period (first two years) are likely to be more frequent when more regular weed removal and replanting may be required. Inspections should also be performed after large rainfall events to check for scour damage or significant pollutant accumulation. Maintenance should only occur after a reasonably rain free period (preferably 5 days) when the soil in the basin is dry.

The proposed inspection and maintenance schedule for the bioretention systems is presented in Table 6.1.

Table 6.1 Bioretention Maintenance Schedule

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine Inspection	6/year	✓		✓		✓		✓		✓		✓	
Routine Maintenance	4/year	✓			✓			✓			✓		
Annual Inspection	1/year					✓							

Table 6.2 outlines the recommended procedures for the routine inspection, annual inspection, and routine maintenance. An example inspection checklist is presented in Table 6.3.

Table 6.2 Bioretention Inspection and Maintenance Procedures

BIO-RETENTION BASIN INSPECTION	
1	**Routine Inspection**
1.1	Routine inspection should be carried out on a bi-monthly basis. The purpose of the inspection is to check for: - weed invasion; - litter accumulation; - vegetation health; and - any damage/vandalism. The above tasks could be undertaken in conjunction with the trash rack routine maintenance which has a higher frequency.
1.3	The basin (including inflow points, overflow pits, under-drains and vegetation) should be checked for litter accumulation.
1.4	Identify areas of obvious sediment deposition (i.e. around the inlet area) or damage.
1.5	Identify areas of erosion, including scouring from storm flows and rill erosion of the batters from lateral inflows. Assess any damage to bund walls.
1.6	Any structures such as maintenance accesses, weirs, pits, piping and access restrictions (eg. lock-rails, fencing) should be inspected for damage and/or vandalism.
1.7	The attached maintenance form (or copy) should be completed and or kept on file to be supplied to the relevant agency upon request.
1.8	Check for any safety hazards such as broken pipes, holes etc and cordon off and rectify as soon as possible.
2.	**Annual Reporting**
2.1	Once per year, a report shall be prepared detailing the condition and performance (water quality) of the bio-retention structures. Any damage or problems should be noted within the report prior to the reports submission to the relevant maintenance agency.
BIORETENTION BASIN ROUTINE MAINTENANCE (QUARTERLY)	
3	**Purpose**
3.1	Routine maintenance of the basin involves weed control and the collection of any litter and minor remedial works if required.
4	**Weed Management**
4.1	If weeds have been observed within the basin during routine inspection, these weeds should be removed by hand. If herbicides are to be used, ensure a qualified and experienced applicator.
4.2	Where physical removal has been specified, the aim is to remove the weed including the roots when the weeds are less than 3 months old.
4.3	The weeds should be disposed of offsite at an appropriate waste management facility.
4.4	Replant plant species as necessary in areas that have been extensively weed infested or in areas that have been identified as lacking appropriate vegetation cover during the routine or annual inspections.
4.5	In general, the planted species should not be harvested. Harvesting plants has little, if any, benefit for treatment performance.
5	**Litter Management**
5.1	Remove and dispose of any accumulated litter/debris within the basin.
6	**Sediment Removal**
6.1	Remove sediment where it is smothering the basin vegetation, particularly likely at the inlet areas. Remove accumulated sediment by surface scraping (if it does not damage the vegetation).
7	**Remedial Works**

7.1	Routine inspection may detect minor damage to the basin after storms that should be repaired. This may include erosion of the bio-retention system or scouring at the inlet and/or outlet or replanting of vegetation. This damage should be repaired as part of the routine maintenance. Measures to reduce future damage (e.g. erosion) from occurring should also be investigated and, if possible, implemented.
8	**Rectification Works / Resetting of System**
8.1	Should routine inspections and monitoring determined that the bio-retention system is underperforming (not achieving water quality objectives) or failing, it may be necessary to undertake rectification works or reset the vegetated stormwater asset.
8.2	If rectification works are required, then works should be undertaken in accordance with the stamped approved plans prepared at the Operational Works stage of the development. Reference should also be made to the approved species palette provided by the landscape architect for the bio-retention basins.
8.3	If the resetting of the system is required, then resetting should be undertaken in accordance with the stamped approved plans prepared at the Operational Works stage of the development. Reference should also be made to the approved species palette provided by the landscape architect for the bio-retention basins.
8.4	If it is determined that structural damage has been caused as a result of poor design, then the advice of a specialist stormwater engineer should be sort prior to the reinstatement of the system occurring.

Table 6.3 Bioretention System Inspection Notes

Basin Maintenance Checklist				
Asset I.D.				
Inspection Frequency:	1 to 6 months	Date of Visit:		
Location:				
Description:				
Site Visit by:				
Inspection Items			Y	N	Action Required (details)
Sediment accumulation at inflow points & filter area? (record depth, remove if > 50%)				
Litter within inlet or filter zones?				
Erosion at inlet or other key structures?				
Traffic damage present?				
Evidence of dumping (building waste)?				
Vegetation condition satisfactory (density, weeds etc)? - Density > 90% coverage of macrophyte zone - >1 species in filter zone - ≥5 plants/m^2 - No weeds				
Watering of vegetation required?				
Weed removal required?				
Harvesting required?				
Removal of dead or diseased vegetation required?				
Replanting required?				
Damage/vandalism to structures present?				
Evidence of ponding?				
Evidence of scour and/or preferential flow path through basin floor?				
Are outlet structures free from silt or debris? Is cleaning required?				
Evidence of under-drain blockages? Is cleaning required?				
Resetting of system required?				
Comments				

7. Conclusion

This Water Sensitive Design Strategy (WSDS) has been prepared in accordance with the Midcoast Council Local Environmental Plan and the Great Lakes Development Control Plan and is to accompany the modification of the development application for the approved tourist development. The WSDS has referenced relevant guidelines relating to stormwater management to form the basis of the overall stormwater strategy to be implemented at the subject site.

The proposal shall incorporate a treatment train of rainwater tanks to capture at least 75% of all roof runoff and bio-retention raingardens across the northern and southern precincts with a total filter area of 350 m² to achieve the prescribed water quality objectives.

Through the implementation of the proposed stormwater treatment measures, the proposed development shall comply with the requirements set out in the Great Lakes Development Control Plan and the Local Environmental Plan with respect to stormwater runoff.

8. References

Great Lakes Development Control Plan (Midcoast Council, 2019)

Great Lakes Local Environmental Plan (New South Wales State Government, 2019)

Water Sensitive Design Strategy Guidelines (Midcoast Council, 2019)

Queensland Urban Drainage Manual (QUDM) Fourth Edition (IPWEAQ, 2017);

Australian Rainfall & Runoff: A Guide to Flood Estimation (Ball J, 2016);

Australian Government – Bureau of Meteorology (Bureau of Meteorology, n.d.);

NSW MUSIC Modelling Guidelines (WBM BMT, 2015)

Concept Design Guidelines for Water Sensitive Urban Design - Version 1 (Water By Design, 2009);

Soils and Construction Volume 1, 4th Edition 'Blue Book' (Landcom, 2004)

Best Practice Erosion and Sediment Control (IECA, 2008).

Best Practice Erosion and Sediment Control Appendix B - Draft Document Revision December 2016 (IECA, 2016)

Appendix A – Proposed Plans of Development

MGA SCIMS

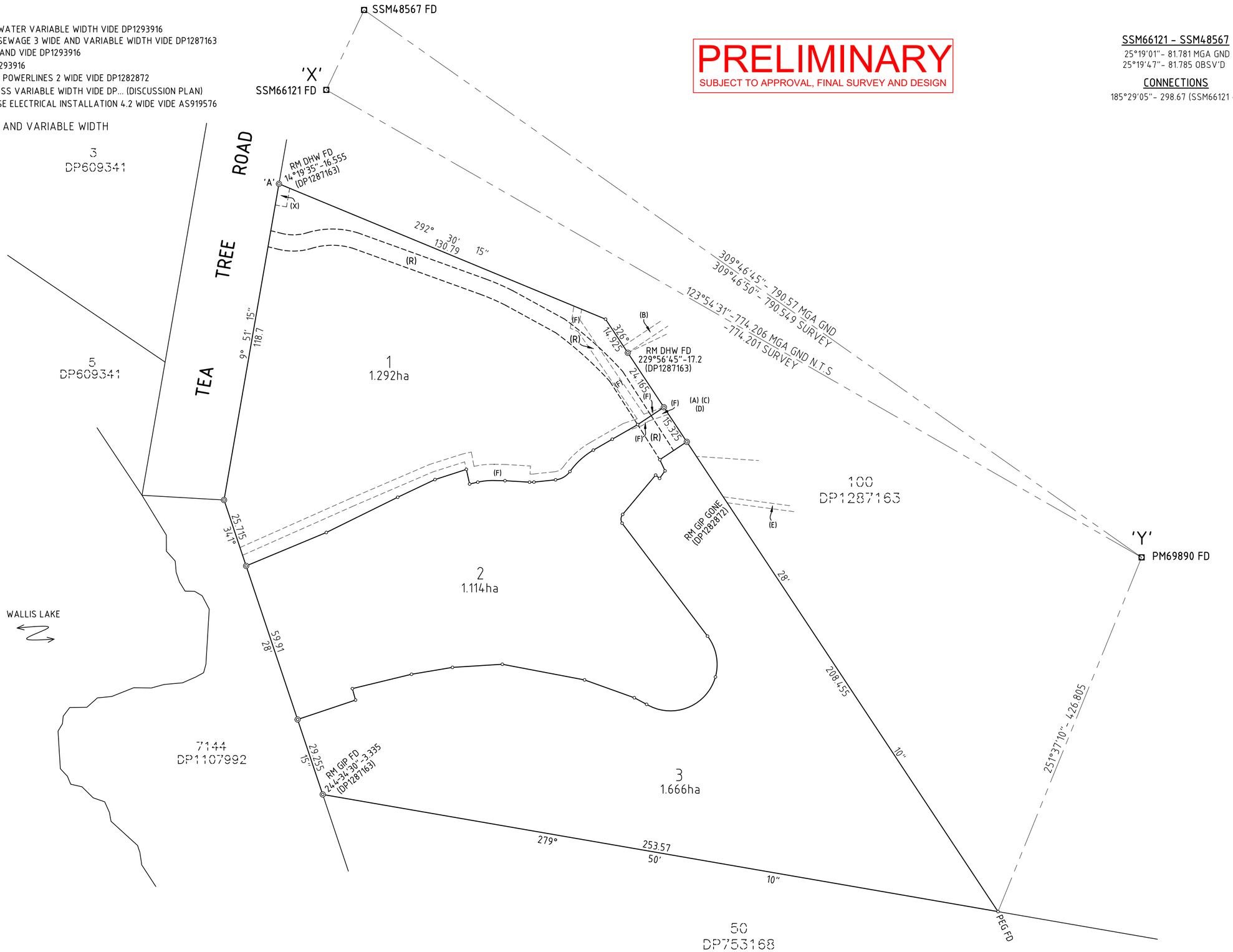
(A) EASEMENT FOR DRAINAGE OF WATER VARIABLE WIDTH VIDE DP1293916
(B) EASEMENT FOR DRAINAGE OF SEWAGE 3 WIDE AND VARIABLE WIDTH VIDE DP1287163
(C) RESTRICTION ON THE USE OF LAND VIDE DP1293916
(D) POSITIVE COVENANT VIDE DP1293916
(E) EASEMENT FOR UNDERGROUND POWERLINES 2 WIDE VIDE DP1282872
(F) EASEMENT FOR RIGHT OF ACCESS VARIABLE WIDTH VIDE DP... (DISCUSSION PLAN)
(X) EASEMENT FOR MULTI-PURPOSE ELECTRICAL INSTALLATION 4.2 WIDE VIDE AS919576

(R) RIGHT OF ACCESS 6 WIDE AND VARIABLE WIDTH

PRELIMINARY
SUBJECT TO APPROVAL, FINAL SURVEY AND DESIGN

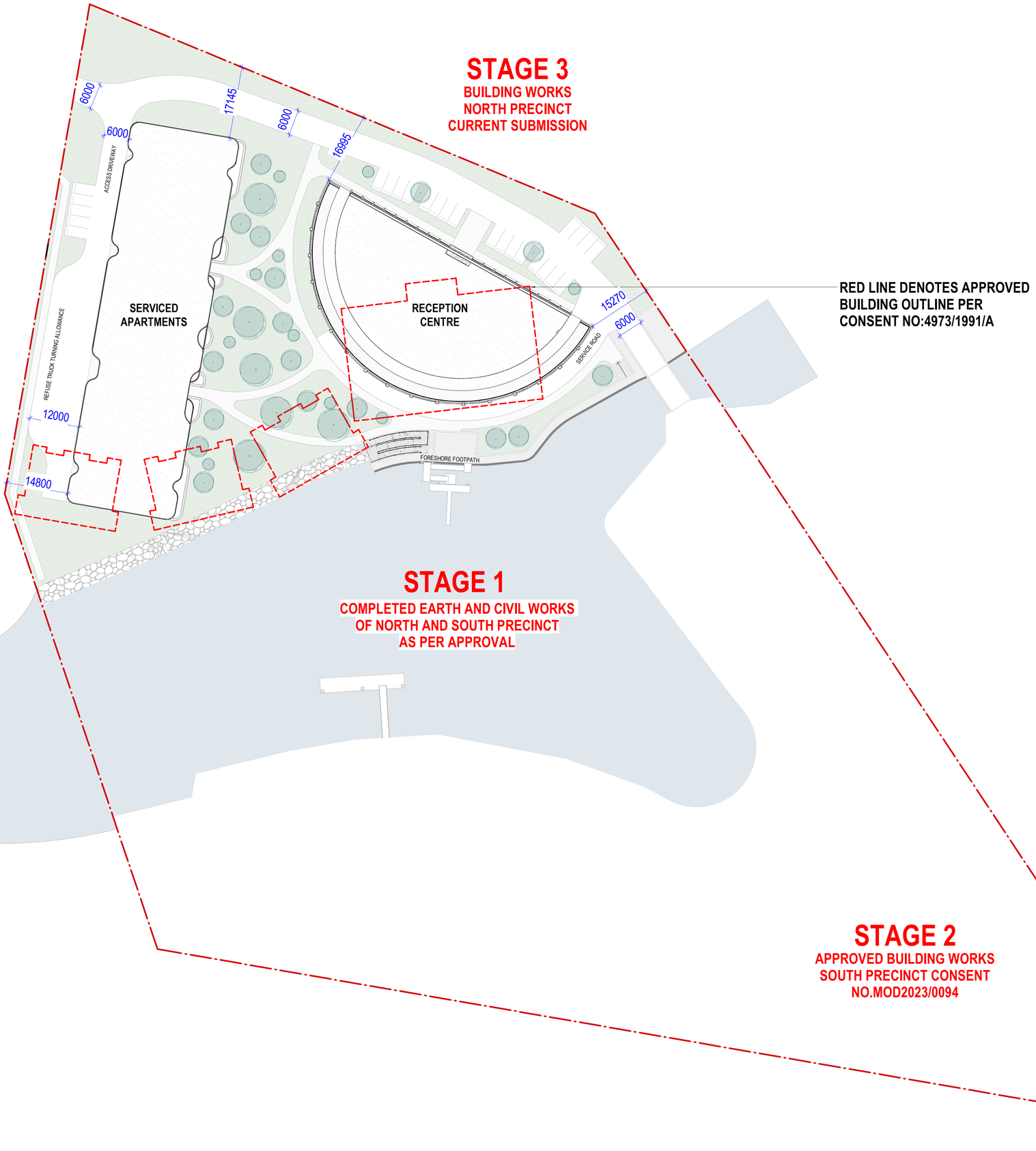
SSM66121 – SSM48567
25°19'01"– 81.781 MGA GND
25°19'47"– 81.785 OBSV'D

CONNECTIONS
185°29'05"– 298.67 (SSM66121 –'A')



COORDINATE SCHEDULE						
MARK	M.G.A. CO-ORDINATES		CLASS	PU	METHOD	STATE
	EASTING	NORTHING				
SSM48567	456015.240	6435031.650	B	0.02	FROM SCIMS	FOUND
PM69890	456622.573	6434526.012	B	0.03	FROM SCIMS	FOUND
SSM66121	455980.282	6434957.752	B	0.02	FROM SCIMS	FOUND
DATE OF SCIMS CO-ORDINATES: 3rd April. 2024 MGA ZONE: 56 MGA DATUM: GDA2020 COMBINED SCALE FACTOR 0.999618						

SURVEYOR Name: Reagan J. Lidbury Date: 23/08/2024 Reference: 2704BC	PLAN OF SUBDIVISION OF LOT 3 DP548504	L.G.A.: MID-COAST Locality: FORSTER Reduction Ratio: 1:1000 Lengths are in metres	REGISTERED	DP DRAFT



Certified System ISO 9001

Certified System AS 4801

TIMESTAMP: 31/05/2024 9:43:51 AM
PROJECT REC:\Users\MLevic\Documents\FORSTER PALM LAKE - BOOMERANG COVE_DA_R23_mlevicKH62R.rvt

REV	DESCRIPTION	DATE	BY
A	FOR INFORMATION + CLIENT REVIEW	20/03/2024	ML
B	FOR INFORMATION	08/05/2024	ML
C	FOR INFORMATION	09/05/2024	ML
D	DA MODIFICATION SUBMISSION	28/05/2024	ML

DEVELOPMENT SUMMARY
NORTH PRECINCT COMPARISON (STAGE 3)

OVERALL AREAS	APPROVED	PROPOSED
SERVICED APARTMENTS (m2)	1,656	2,485
RECEPTION CENTRE (m2)	1,211	2,065
PAVILION (m2)	81	-
TENNIS COURTS (m2)	1,364	-
ROADS (m2)	3,547	2,552
TOTAL	**7,859**	**7,102**

MOTEL / SERVICED APARTMENTS	APPROVED	PROPOSED
1-BED SERVICED	-	4
2-BED SERVICED	-	16
3-BED SERVICED	-	4
MOTEL ROOM	24	-
TOTAL	**24**	**24**

PARKING	APPROVED	PROPOSED
MOTEL / SERVICED APARTMENTS	24	44
VISITOR	5	5
RECEPTION CENTRE	20	20
TOTAL	**49**	**69**

LANDSCAPING	APPROVED	PROPOSED
GREENSPACE + PEDESTRIAN PATHS	5,283	6,040
TOTAL	**5,283**	**6,040**

FLOOR SPACE RATIO (FSR) NORTH PRECINCT	
GROSS FLOOR AREA (m2)	5,182
NORTH PRECINCT AREA (m2)	13,142
FSR (GFA/TOTAL)	**0.39**

FLOOR SPACE RATIO (FSR) TOTAL SITE	
GROSS FLOOR AREA (m2)	12,955
TOTAL SITE AREA (m2)	40,686
FSR (GFA/TOTAL)	**0.32**

NOTE:
THE CALCULATION OF GFA IS MEASURED TO THE INTERNAL SURFACE OF EXTERNAL WALL. EXCLUDING LIFT, STAIRS, BALCONY, STORAGE, ROOF TERRACE AND CAR PARKING.
**(BOAT STORAGE DEFINED AS PARKING THEREFORE EXCLUDED FROM GFA CALCULATION)

0 5m 10m 20m 30m
Scale 1: 500

STATUS DA MODIFICATION SUBMISSION

PROJECT
BOOMERANG COVE

CLIENT
PALM LAKE GROUP

ADDRESS
LOT 3 PP548504
16 TEA TREE ROAD, FORSTER

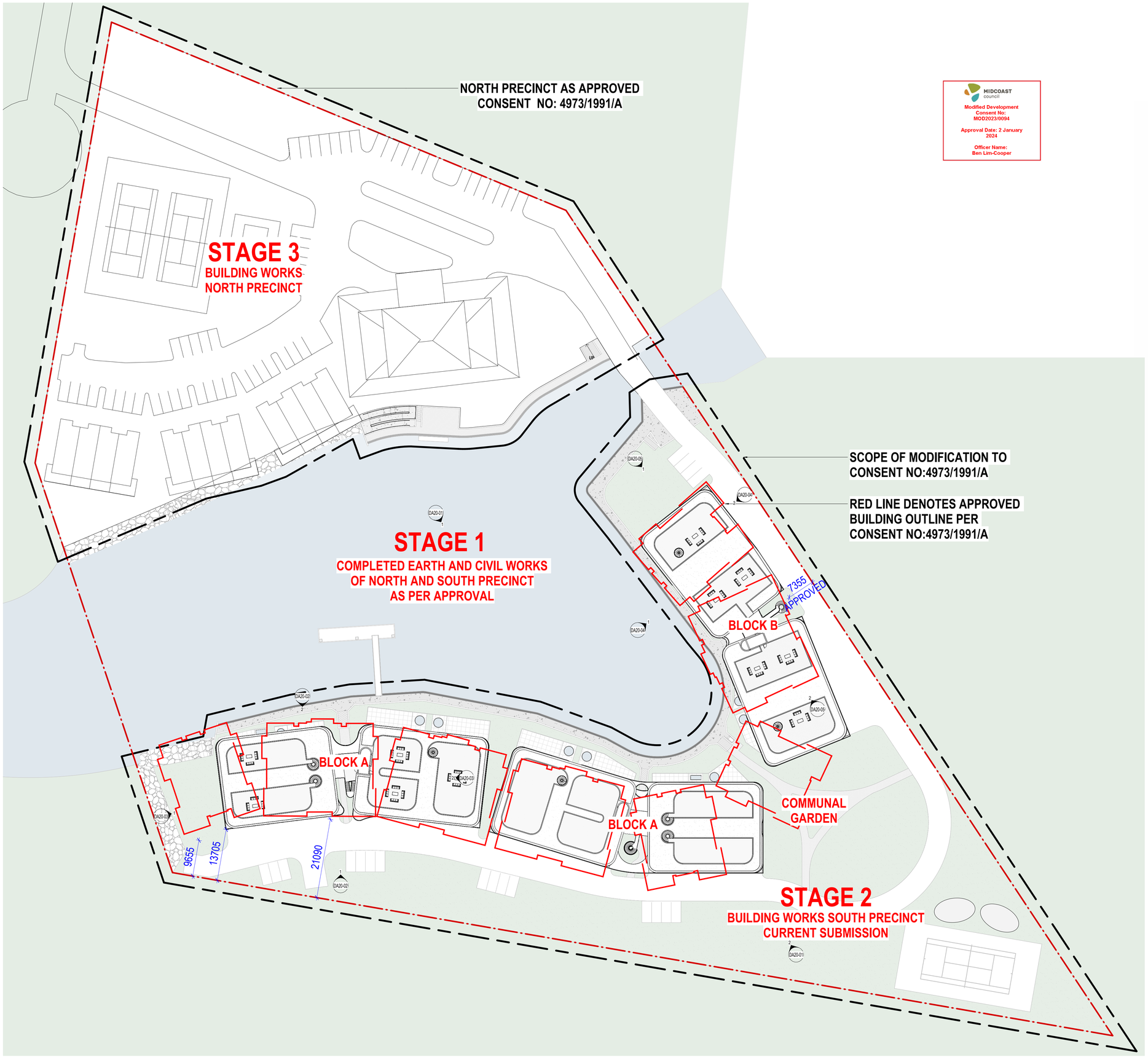
DRAWING TITLE
SITE PLAN - CURRENT SUBMISSION

NORTH

DRW	CHK	SCALE (@A1)
ML	GH	1 : 500

PROJECT No.	DRAWING No.	REV
2210008	DA00-001	D

V / A ARCHITECTS
LEVEL 3, 377 LONSDALE STREET. MELBOURNE VIC 3000
+61 3 8678 3300 / viaarchitects.com.au /



1 DA00-01 SITE PLAN MODIFIED
1 : 500

MIDCOAST council

Modified Development Consent No: MOD2023/0094

Approval Date: 2 January 2024

Officer Name: Ben Lim-Cooper

Certified System ISO 9001 Health & Safety AS 4801

TIMESTAMP: 20/06/2023 12:35:37 PM
PROJECT REF C:\Users\yzhang\Documents\FORSTER PALM LAKE - BOOMERANG COVE_DA_R23_detached_yzhang6BEYU.rvt

REV	DESCRIPTION	DATE	BY
A	DA MODIFICATION	13/04/2023	YZ
B	DA FURTHER INFORMATION	20/06/2023	YZ

DEVELOPMENT SUMMARY
SOUTH PRECINCT COMPARISON

	APPROVED	PROPOSED
BUILDING COVERAGE (m2)	4,952	4,947
ROAD (m2)	2,898	2,865
TOTAL	**7,850**	**7,812**
APARTMENT		
2 BED	16	10
3 BED	36	42
TOTAL	**52**	**52**
PARKING		
GARAGE	40	104
ON GRADE	56	19
TOTAL	**96**	**123**

FLOOR SPACE RATIO (FSR)

GROSS FLOOR AREA (m2)	9,037
SOUTH PRECINCT AREA (m2)	16,667
FSR	0.54

NOTE:
THE CALCULATION OF GFA IS MEASURED TO THE INTERNAL SURFACE OF EXTERNAL WALL.
EXCLUDE LIFT, BALCONY, ROOF TERRACE AND CAR PARKING.

0 5m 10m 20m 30m
Scale 1: 500

STATUS DA MODIFICATION

PROJECT
BOOMERANG COVE
CLIENT
PALM LAKE GROUP
ADDRESS
LOT 3 PP548504
16 TEA TREE ROAD, FORSTER
DRAWING TITLE
SITE PLAN

DRW	CHK	SCALE (@A1)
YZ	MA	1 : 500

NORTH

PROJECT No.	DRAWING No.	REV
2210008	DA00-01	F

V/A ARCHITECTS
LEVEL 3, 377 LONSDALE STREET. MELBOURNE VIC 3000
+61 3 8678 3300 / viaarchitects.com.au /

Appendix B – MUSIC Input Parameters

Rainfall and Evapotranspiration Parameters

MUSIC modelling was based on 6-minute interval data obtained from the Bureau of Meteorology (BOM) for rainfall station at Zones 1 and 2 within the Great Lakes Area, as summarised in Table B.1.

Table B.1 Meteorological and Rainfall Runoff Data Reporting Table

Input	Data Used in Modelling
Rainfall station	Zones 1 and 2
Time step	6 minute
Modelling period	1/01/1969 to 31/12/1978 (10 years)
Mean annual rainfall (mm)	1234
Evapotranspiration	1,367

Catchment Parameters

Based on the proposed land uses within the development, the subject site has been modelled as commercial land use as detailed in Table B.2.

Table B.2 Land Use Parameters

Catchment ID	Area (ha)	Land use	Total Impervious (%)
Pre – Forest	0.674	Forest	0
Pre – Rural	2.284	Rural	5
A1 – Landscaped	0.663	Mixed	30
A1 – Sealed Road	0.262	Mixed	100
A1 – Roofs to Tank (75%)	0.275	Mixed	100
A1 – Roofs bypass Tanks (25%)	0.092	Mixed	100
A2 – Landscaped	0.843	Mixed	30
A2 – Sealed Road	0.310	Mixed	100
A2 – Roofs to Tanks (75%)	0.385	Mixed	100
A2 Roof bypass Tanks (25%)	0.128	Mixed	100

The pollutant loads and runoff parameters for each source node have been based on the data from the NSW MUSIC Modelling Guidelines (BMT WBM, 2015), as summarised in Table B.3 and Table B.4.

Table B.3 Rainfall Runoff Parameters

Landuse	Forest/Rural	Landscaped/Sealed Road/Roof
Rainfall threshold (mm)	1.50	1.50
Soil storage capacity (mm)	90	105
Initial storage (% capacity)	25	25
Field capacity (mm)	65	75
Infiltration capacity coefficient a	135	250
Infiltration capacity exponent b	4	1.3
Initial depth (mm)	10	10
Daily recharge rate (%)	10	60
Daily baseflow rate (%)	10	45
Daily deep seepage rate (%)	0	0

Table B.4 Pollutant Load Parameters

Land Use	Flow Type	Total Suspended Solids (log mg/L)		Total Phosphorous (log mg/L)		Total Nitrogen (log mg/L)	
		Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Forest	Storm Flow Concentration	1.600	0.200	-1.100	0.220	-0.050	0.240
	Base Flow Concentration	0.780	0.130	-1.220	0.130	-0.520	0.130
Rural	Storm Flow Concentration	1.950	0.320	-0.660	0.250	0.300	0.190
	Base Flow Concentration	1.150	0.170	-1.220	0.190	-0.050	0.120
Urban Landscaped	Storm Flow Concentration	2.150	0.320	-0.600	0.250	0.300	0.190
	Base Flow Concentration	1.120	0.170	-0.850	0.190	0.110	0.120
Landscaped	Storm Flow Concentration	2.150	0.320	-0.600	0.250	0.300	0.190
	Base Flow Concentration	1.200	0.170	-0.850	0.190	0.110	0.120
Sealed Road	Storm Flow Concentration	2.430	0.320	-0.300	0.250	0.340	0.190
	Base Flow Concentration	1.200	0.170	-0.850	0.190	0.110	0.120
Roof	Storm Flow Concentration	1.300	0.320	-0.890	0.250	0.300	0.190
	Base Flow Concentration	0	0	0	0	0	0

Treatment Node Parameters

The following sections describe the modelling parameters applied to MUSIC for each of the treatment nodes included as part of the water quality assessment.

Bioretention Systems

The input parameters for the bioretention system are summarised in Table B.5.

Table B.5 Bioretention Parameters

ID	A1	A2
Surface area (m^2)	150	200
Extended detention depth (m)	0.3	0.3
Filter area (m^2)	150	200
Unlined filter media perimeter (m)	0.01	0.01
Saturated hydraulic conductivity (mm/hour)	100	100
Filter depth (m)	0.4	0.4
TN content of filter media (mg/kg)	400	400
Orthophosphate content of filter media (mg/kg)	40	40
Is the base lined? (Y/N)	Yes	Yes
Effectiveness of plant TN removal	Effective	Effective
Overflow weir width (m)	20	25
Exfiltration rate (mm/hr)	0.00	0.00
Underdrain present? (Y/N)	Yes	Yes
Submerged zone with carbon present?	No	No
Confirmation that K and C* remain default? (Y/N)	Yes	Yes

Rainwater Tanks

The input parameters for the Rainwater Tanks are summarised in Table B.6.

Table B.6 Rainwater Tank Parameters

ID	A1	A2a
Low Flow Bypass (m^3/s)	0	0
High Flow Bypass (m^3/s)	0.005	0.005
Number of Tanks	6	15
Volume below overflow pipe	30	75
Depth above overflow (kL)	0.20	0.2
Surface Area (m^2)	15.0	37.5
Initial Volume (kL)	30	75
Overflow pipe diameter	367	581
Use stored water for irrigation or other purposes	Enabled	Enabled
Max drawdown height (m)	2	2
Annual Demand (kL/yr)	2725	3465

Appendix C – Stormwater Management Plan Drawings

PROJECT No.:	DRAWING No. :	VERSION:
BE190213	N000	A

DATE : 27.11.19

LOT 3 in DP548504, 16 TEA TREE ROAD FORSTER, NSW

STORMWATER MANAGEMENT DRAWINGS

LOCALITY PLAN

SCHEDULE OF DRAWINGS	
Drawing No.	Drawing Title
N000	LOCALITY AND DRAWING INDEX PLAN
N202	PRE-DEVELOPMENT MUSIC CATCHMENT PLAN
N203	POST-DEVELOPMENT MUSIC CATCHMENT PLAN
N400	OPERATIONAL CONTROL PLAN
N401	OPERATIONAL CONTROL PLAN - TYPICAL CROSS SECTION

PREPARED FOR

Palm Lake Works

PREPARED BY

BURCHILLS ENGINEERING SOLUTIONS

Level 2, The Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

STORMWATER QUALITY

AT
LOT 3 in DP548504,
16 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		27.11.19

REVISIONS

BURCHILLS ENGINEERING SOLUTIONS

Level 2, The Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

DRAWING TITLE :

PRE-DEVELOPMENT MUSIC CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 27.11.19
PROJECT LEADER : JC	
DESIGNER : SH/TP	
DRAFTSPERSON : TP / KP	
CHECKED : SH	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365 RPEQ No. :	
SCALE : 1:1200	DATUM : / FULL SIZE : A3
PROJECT No.: BE-190213	DRAWING No. : N202 / VERSION: A

N

CATCHMENT A1:
FOREST: 0.122 ha
RURAL: 1.170 ha
TOTAL AREA: 1.292 ha

A1
(1.292ha)

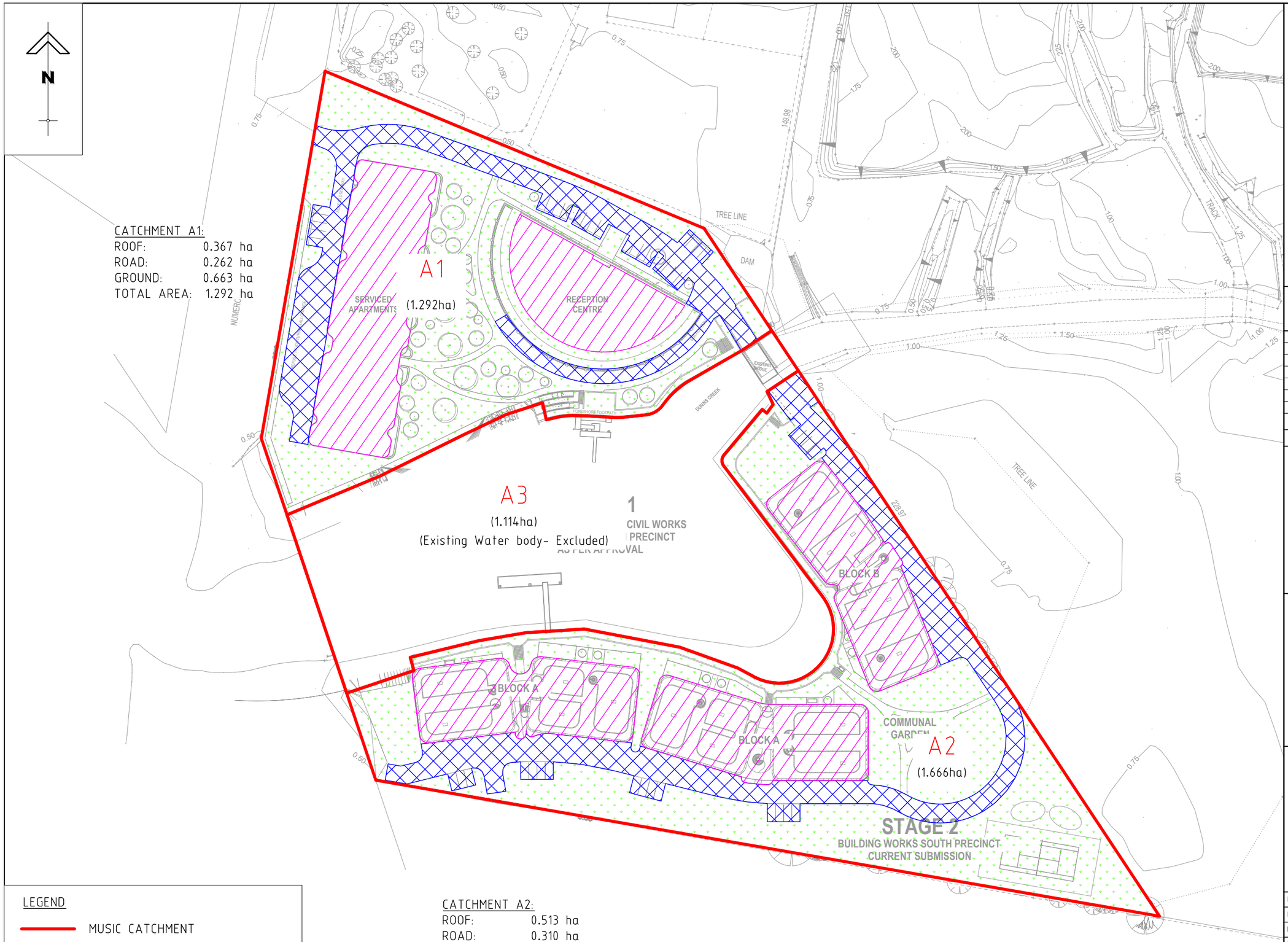
A3
(1.114ha)
(Existing Water body- Excluded)

A2
(1.666ha)

CATCHMENT A2:
FOREST: 0.552 ha
RURAL: 1.114 ha
TOTAL AREA: 1.666 ha

LEGEND
- MUSIC CATCHMENT
- FOREST
- RURAL

SCALE 12.0 0 12.0 24.0 36.0 48.0 60.0 (metres)
1 : 1200 (FULL SIZE)



STORMWATER QUALITY

AT
LOT 3 in DP548504,
16 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		27.11.19

REVISIONS

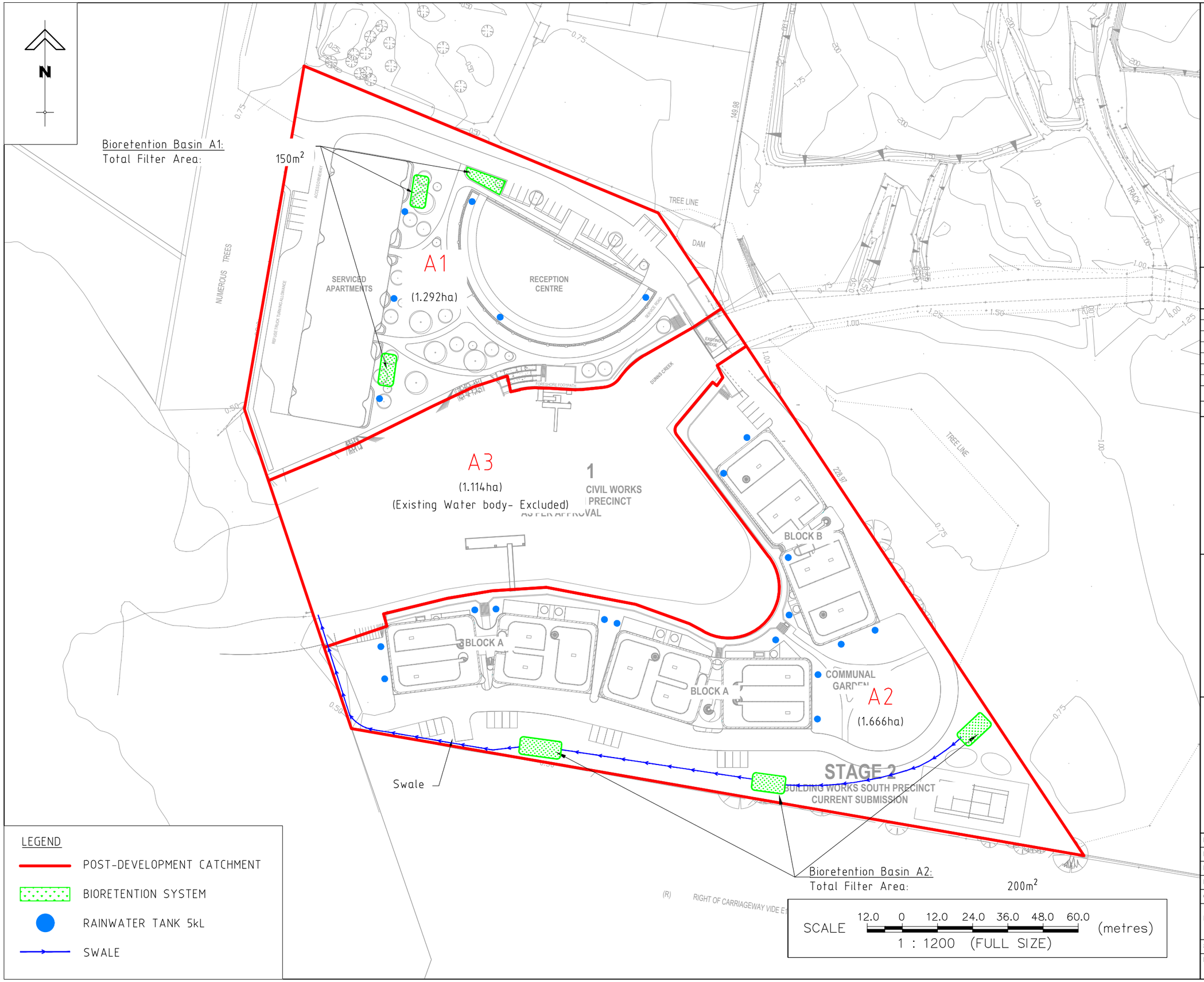
BURCHILLS ENGINEERING SOLUTIONS

Level 2, The Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

DRAWING TITLE :

POST-DEVELOPMENT MUSIC CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 27.11.19
PROJECT LEADER : JC	
DESIGNER : SH/TP	
DRAFTSPERSON : TP / KP	
CHECKED : SH	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365 RPEQ No. :	
SCALE : 1:1200	DATUM : FULL SIZE : A3
PROJECT No.: BE-190213	DRAWING No. : N203 VERSION: A



STORMWATER QUALITY

AT
LOT 3 in DP548504,
16 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		27.11.19

REVISIONS

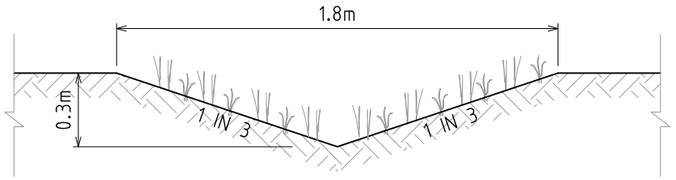
BURCHILLS ENGINEERING SOLUTIONS

Level 2, The Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

DRAWING TITLE :

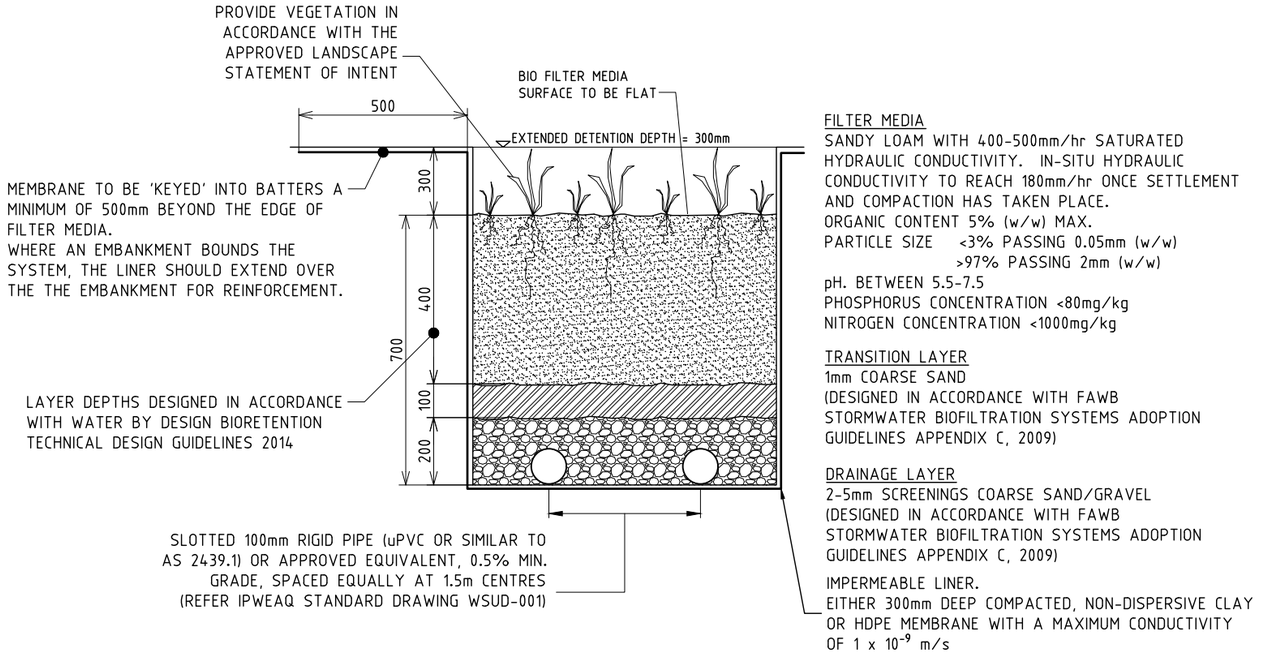
OPERATIONAL CONTROL PLAN

DEVEL. APPLIC. No. :	DATE : 27.11.19
PROJECT LEADER : JC	
DESIGNER : SH/TP	
DRAFTSPERSON : TP / KP	
CHECKED : SH	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365 RPEQ No. :	
SCALE : 1:1200	DATUM : / FULL SIZE : A3
PROJECT No.: BE-190213	DRAWING No. : N400 / VERSION: A



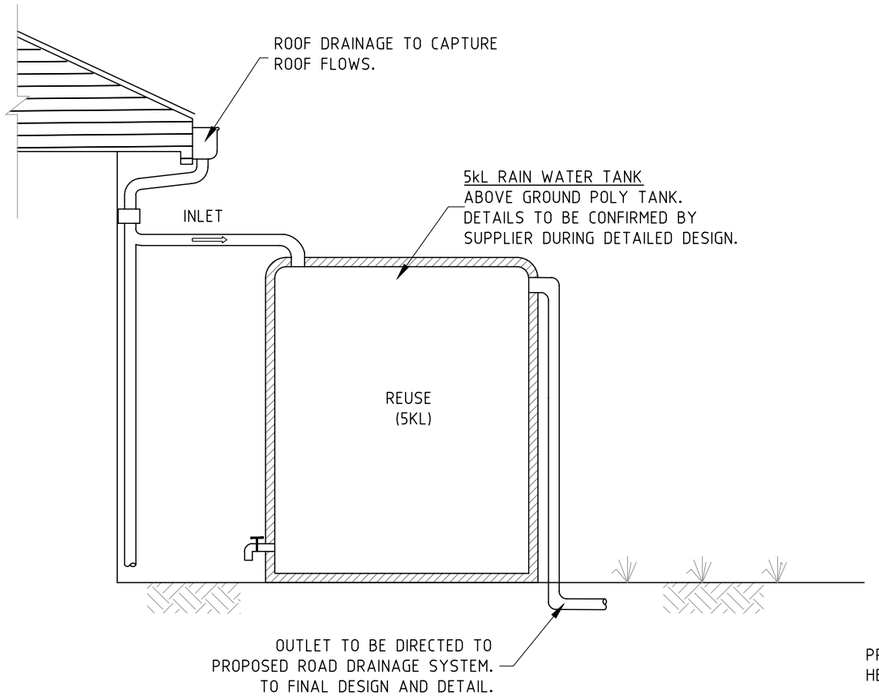
SWALE TYPICAL CROSS SECTION

N.T.S



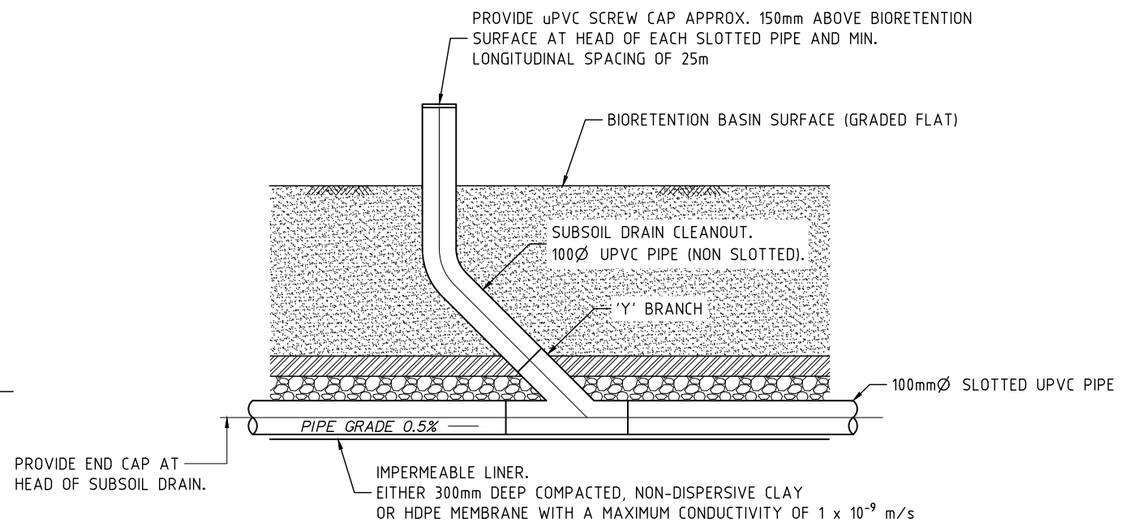
TYPICAL BIO-RETENTION MEDIA CROSS SECTION

N.T.S



RAINWATER TANK SCHEMATIC

N.T.S



TYPICAL BIO-RETENTION BASIN SUBSOIL DRAIN CLEANOUT

N.T.S

STORMWATER QUALITY

AT
LOT 3 in DP548504,
16 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		27.11.19

REVISIONS

BURCHILLS ENGINEERING SOLUTIONS

Level 2, The Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

DRAWING TITLE :

OPERATIONAL CONTROL PLAN TYPICAL CROSS SECTION

DEVEL. APPLIC. No. :		DATE : 27.11.19
PROJECT LEADER : JC		
DESIGNER : SH/TP		
DRAFTSPERSON : TP / KP		
CHECKED : SH		
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365		
	RPEQ No. :	
SCALE : N.T.S	DATUM :	FULL SIZE : A3
PROJECT No.: BE-190213	DRAWING No. : N401	VERSION: A