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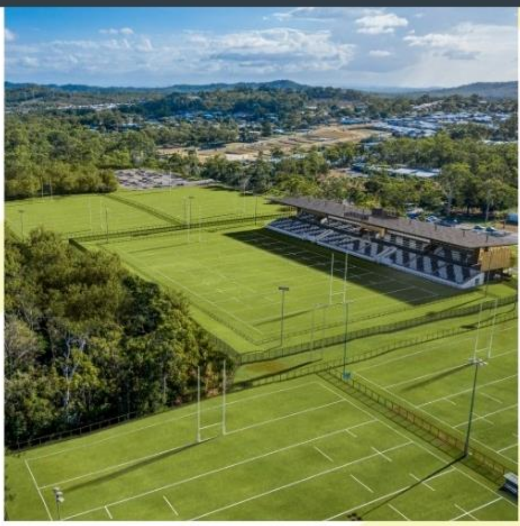

223 The Lakes Way, Forster – Aged Care
Water Sensitive Design Strategy

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MORETON BAY I SUNSHINE COAST I IPSWICH I BANGALOW

Table of Contents

Tables

Figures

Appendices

1. Introduction

1.1 Background

This Water Sensitive Design Strategy (WSDS) report has been prepared for Palm Lake Works Pty Ltd to support a development application at 2 Tea Tree Road, 4 Tea Tree Road, 217 The Lakes Way, and 219 The Lakes Way, Forster (the subject site).

The subject site is situated within the MidCoast Council Local Government Area (LGA) and is zoned by the Great Lakes Local Environmental Plan as 'Low 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 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 2,500 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 report 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 report details the following:

- Site assessment including:
  - Existing land use;
  - Topography;
  - Soils and vegetation; and
  - Receiving environment.
- Proposed development details including:
  - Proposed land uses;
  - Constraints and opportunities; and
  - Best planning practices.
- Construction phase soil and water management including:

    - Conceptual soil and water management plan for the bulk earthworks 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 report. This WSDS report 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 2 Tea Tree Road, 4 Tea Tree Road, 217 The Lakes Way and 219 The Lakes Way, Forster, New South Wales. The application relates to the parcels properly described as Lots 21, 22, 23, and 24 on DP838699 with the proposed development covering all of Lot 22 and parts of Lots 21, 23, and 24.

The proposed development site has a total area of 1.576 ha and is zoned as Low Density Residential under the Great Lakes Local Environmental Plan (LEP). The location of the subject site is presented in Figure 2.1.

Figure 2.1 Site Locality Plan (Google Maps, 2022)

2.2 Land Use and Vegetation

The site currently encompasses four (4) vacant lots which have been recently cleared of development and vegetation. An aerial image of the subject site pre-demolition and clearing is presented in Figure 2.2.

Figure 2.2 Aerial Imagery (Metromap, 2022)

2.3 Topography

The subject site grades somewhat uniformly towards the south-eastern boundary at approximately 1% with a vertical crossfall of 3.4 m.

2.4 Soils

The site appears to contain 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 runoff from the subject site is ultimately conveyed to Pipers Bay, which is part of the Wallis Lake system. Council have advised that this area is highly sensitive to changes in the catchment and that proper management of site runoff is critical to ensuring the ecological values in Wallis Lake are maintained.

2.6 Flooding

The subject site is not affected by regional flooding from the Wallis Lake system as described in the *223 The Lakes Way and 6-16 Tea Tree Road, Forster Flood Study Report* prepared by Burchills Engineering Solutions (Burchills, 2019).

3. Proposed Development

3.1 Proposed Land Use

The proposed development includes a Residential Care Facility (Seniors Housing) and includes the following elements:

- One (1) Residential Care Facility (Seniors Housing);
- Driveways and parking
- Internal drainage system; and
- Services (water, sewer, power, communications).

The proposed plan of development is presented in Appendix A.

3.2 Constraints and Opportunities

3.3 Topography and Drainage

The site currently grades gently away from Tea Tree Road, towards Dunns Creek. The proposal includes changes to the ground level to redirect site flows to Tea Tree Road in all storm events in accordance with Council's master drainage strategy for the area. The grade constraints on this site make at source stormwater treatment difficult to achieve due to the head loss that occurs through such systems. As such, an end of pipe system is proposed.

Runoff from major storm events, where the capacity of the minor drainage system is exceeded, will be directed as piped and overland flow to Tea Tree Road.

3.4 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 important system for the benefit of the community and environment.

3.5 Best Planning Practices

The concept proposed in this WSDS has been developed in consultation with the project architect and planner to ensure sufficient space is available for the required stormwater management infrastructure within the site. The proposed development layout was established through an iterative process to ensure the stormwater drainage (piped and overland flow) and bioretention treatment systems were incorporated seamlessly into the built form. The proposed stormwater management infrastructure requires minimal maintenance and the prominence of the bioretention system at the entrance to the site incentivizes the site manager to maintain the function and aesthetics of the system.

4. Stormwater Quantity Management

4.1 Overview

It is proposed to regrade the subject site towards the existing stormwater infrastructure in Tea Tree Road. It is understood that existing infrastructure has been designed to cater for the proposed development. As such, no stormwater detention is proposed for the site and in any case would not provide any benefit for the following reasons:

- There is no downstream infrastructure that will be compromised as a result of increased peak flows (Tea Tree Road minor and major drainage system has adequate capacity); and
- 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.

To confirm that the existing drainage system in Tea Tree Road has sufficient capacity to convey the increased site runoff, a simplified, 1D model of the drainage catchment and system was modelled in XPSWMM.

4.2 Conveyance of Flows

Currently, site stormwater runoff is conveyed overland to the south-eastern corner, towards Dunns Creek. In the post-development scenario, runoff from the subject site will be conveyed by the internal stormwater drainage infrastructure to the proposed on-site bioretention basin. Treated runoff will then be directed to the existing stormwater infrastructure within Tea Tree Road.

4.3 Lawful Point of Stormwater Discharge

The existing Lawful Point of Discharge (LPD) is defined as Dunns Creek located approximately 400m east of the subject site. The adjacent development of Palm Lake Resort no longer allows discharge to the south east.

The proposed LPD is the existing stormwater infrastructure located in Tea Tree Road, which ultimately discharges to Wallis Lake.

4.4 Drainage Catchment Parameters

Drainage catchments were delineated using Aerial Laser Survey, detailed site survey, and development plans. The drainage catchments were also verified against the road and drainage design drawings for the Tea Tree Road construction as prepared by Tattersall Lander (reference: 21900139 dated 11/7/2019). Only the catchments contributing to the drainage system on the eastern side of Tea Tree Road were considered in the modelling as shown in Figure 4.1.

It should be noted that the subject site (Residential Care Facility) and the parcel immediately south of the site (Stage 12 – 6-8 Tea Tree Rd, Forster) drain naturally to the south-east however, discharge from these lots has been catered for in the design of the stormwater infrastructure within Tea Tree Road.

Hydrology modelling was completed in accordance with ARR 2019 methodology including pre-burst, storm losses, and temporal variations. The key catchment parameters are summarised in Table 4.1.

Table 4.1 Catchment Parameters

Catchment ID	Total Area (ha)	Impervious %	Catchment Slope (%)
Gleneon Dr	1.751	70	2.3
Tea Tree Rd	0.185	90	2.9
Aged Care (subject site)	1.576	70	1.8
Stage 12	2.772	85	1.8
Stage 11 West	1.426	85	1.8

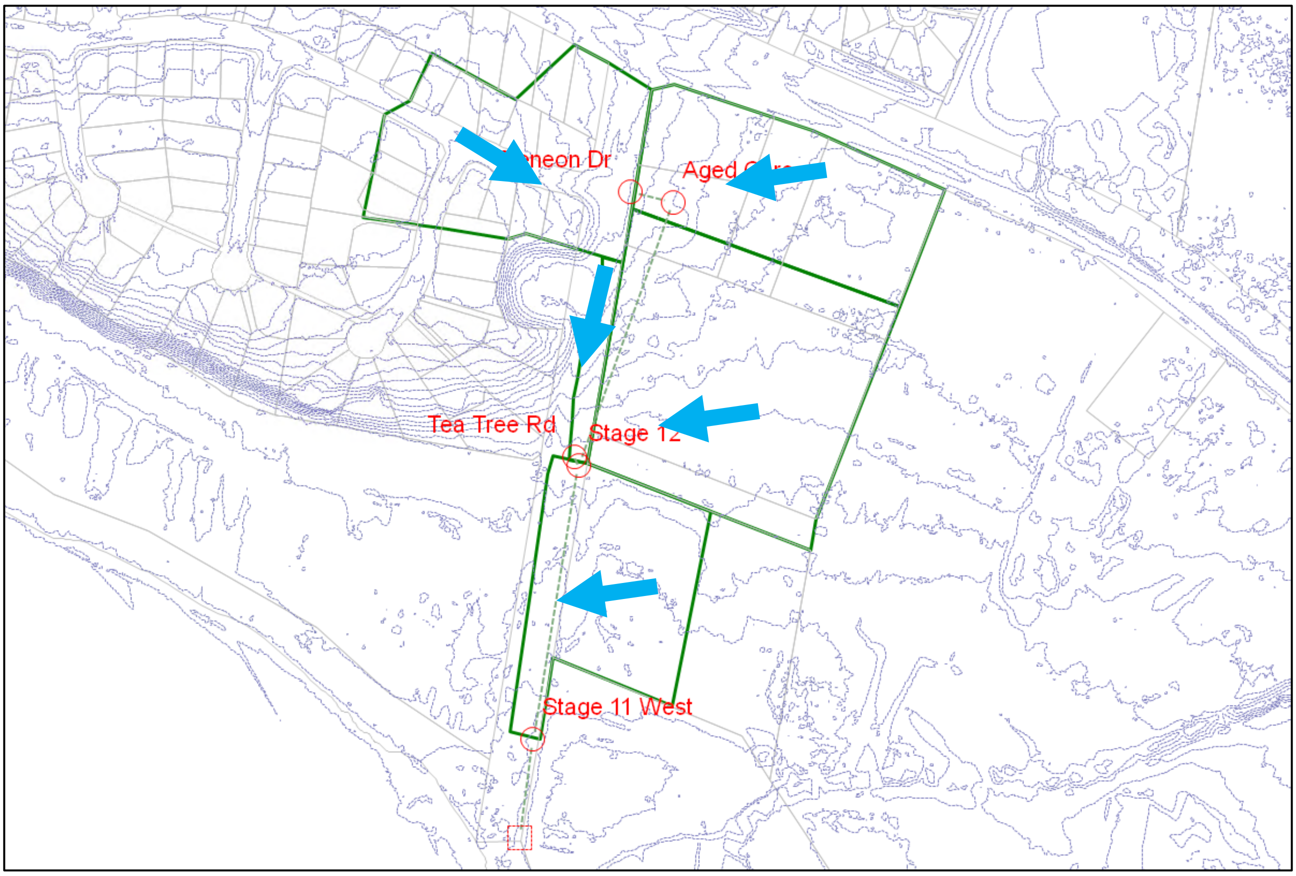

Figure 4.1 XPSWMM Catchments

Table 4.2 XPSWMM Peak Runoff Hydrology

Catchment ID	0.2 EY Peak Discharge (m³/s)	0.2 EY Critical Storm	1% AEP Peak Discharge (m³/s)	1% AEP Critical Storm
Gleneon Dr	0.55	10 min TP 5	1.17	10 min TP 6
Tea Tree Rd	0.08	10 min TP 6	0.16	10 min TP 6
Aged Care	0.49	15 min TP 9	1.02	10 min TP 6
Stage 12	1.04	15 min TP 2	2.12	10 min TP 6
Stage 11 West	0.57	15 min TP 9	1.19	10 min TP 6

4.5 Tea Tree Road Peak Discharge

According to the referenced Tea Tree Road Construction design drawings prepared by Tattersall Lander, the pipe drainage in Tea Tree Road (2 x Ø675 RCP) was designed based on a 5 year ARI (0.2 EY) peak discharge of 1,057 L/s, increasing to 1,146 L/s at the outlet to Wallis Lake.

The bioretention swale located in the eastern verge of Tea Tree Road has an estimated capacity of 3.9 m^3/s based on the profile provided in the referenced design drawings (2.2 m base width, 1 in 3 side slopes, 822 mm depth and, 0.3% grade).

One-dimensional hydraulic modelling of the existing drainage system downstream of the subject site has been carried out in XPSWMM based on the referenced design drawings to confirm the infrastructure has sufficient capacity to convey the design flows from a fully developed catchment.

The results of the modelling are summarised in Table 4.3. Based on these results, the pipe drainage is flowing full in events exceeding and including the 0.2 EY, while the bioretention swale reaches a peak flow depth of approximately 500 mm in the 1% AEP design event.

Table 4.3 XPSWMM Peak Discharges

Reporting Location	0.2 EY Peak Discharge (m^3/s)	0.2 EY Critical Storm	1% AEP Peak Discharge (m^3/s)	1% AEP Critical Storm
2 x Ø675 RCP Under bio-swale	0.93	10 min TP 2	0.93	10 min TP 8
Tea Tree Road XS including bio-swale	0.86	10 min TP 8	2.45	10 min TP 1
0.6 x 1.2 RCBC Outlet to Wallis Lake	1.57	10 min TP 8	1.84	10 min TP 1
Overland Flow Outlet to Wallis Lake	0.60	10 min TP 8	2.41	10 min TP 1

Based on this hydrological and hydraulic assessment of the drainage network, stormwater detention is not required for the proposed development provided the catchment characteristics remain generally in accordance with the stated assumptions in this report.

5. Soil and Water Management

5.1 Best Management Practice

Construction phase soil and water management for the proposed development shall be carried out in accordance with Managing Urban Stormwater: Soils and Construction (4th Edition, March 2004) – also known as the "Blue Book Volume 1" (Landcom, 2004).

Land disturbance activities should be minimised or avoided where possible through best planning practices. However, where land disturbance is necessary, drainage, erosion, and sediment control Best Management Practices (BMPs) should be adopted in accordance with Best Practice Erosion and Sediment Control (IECA, 2008).

5.2 Bulk Earthworks

Clearing, grubbing, and stripping of topsoil shall be carried out immediately prior to the commencement of work. Once earthworks for a particular phase is completed, and if no further construction work is to be carried out within six (6) weeks, that area should be redressed with topsoil and revegetated with a fast-growing ground cover such as millet or oats.

Detailed erosion and sediment control drawings and management strategies shall be prepared for any subsequent Construction Certificate applications, such as those required for civil works, to ensure an appropriate level of detail is provided for each specific stage.

5.3 Land Disturbance

The total duration of disturbance for any lands from initial clearing to revegetation should not exceed six (6) months. Areas of disturbance should be limited to a workable size and exclusion zones should be established with physical barriers to restrict access in accordance with the recommendations from Table 4.1 of the Blue Book (Landcom, 2004).

5.4 Soil Loss Estimate

The potential volume of soil loss from disturbed areas for the bulk earthworks has been estimated using the Revised Universal Soil Loss Equation (RUSLE). RUSLE calculates annual soil loss rates based on:

$$A = R. K. LS. C. P$$

Where:

A = annual soil loss due to erosion (t/ha/yr)

R = rainfall erosivity factor (Appendix B Map 9 (Landcom, 2004))

K = soil erodibility factor

LS = topographic factor derived from slope length and slope gradient (assumed 80 m maximum)

C = cover and management factor

P = erosion control practice factor

The input parameters for the RUSLE calculation have been developed in accordance with the Blue Book. In the absence of more detailed information, the K factor has been assumed as 0.025 to represent soil erodibility for clayey sand. The calculation inputs and estimated soil loss rates and volumes for each phase are presented in Table 5.1.

Table 5.1 Potential Sediment Loss (RUSLE)

ID	Area (ha)	Soil Type*	Slope length (m)	Slope Grade (%)	Intensity $^{6}I_{2}$ (mm/hr)	R	K	LS	C	P	A (t/ha/yr)	Yield (m^3/yr)
A	1.58	Sandy Clay	80	1.6	12.1	3157	0.025	0.322	1	1.3	33.0	40.1

*Note soil testing will need to be carried out to confirm soil type.

5.5 Erosion Control Standard

The estimated soil loss rate is 33.0 tonnes per hectare per year which equates to Soil Loss Class 1 (very low) from Table 4.2 of the Blue Book (Landcom, 2004). However, due to the location of the site adjacent to highly sensitive receiving waters, the Soil Loss Class is automatically elevated to 6 (very high).

In this case, construction activities shall be scheduled to occur during periods when rainfall erosivity is low (June to mid-November) as identified in Table 4.3 of the Blue Book (Landcom, 2004). Where scheduling of activities to occur during these periods is not possible or is impractical, a management plan should be established to ensure stabilisation of exposed areas can be achieved within 24 hours should any rainfall be likely.

The best practice erosion control measures for high risk development as detailed in Best Practice Erosion and Sediment Control (IECA, 2008) include the following:

- All reasonable and practical steps to be taken to apply best practice erosion control measures to completed earthworks, or otherwise stabilise such works, prior to anticipated rainfall - including existing unstable, undisturbed, soil surfaces under the management or control of the building/construction works;
- Land clearing limited to maximum 4 weeks work;
- Disturbed soil surfaces stabilised with minimum 75% cover within 10 days of completion of works within any area of a work site;
- Staged construction and stabilisation of earth batters; and
- Soil stockpiles and unfinished earthworks are suitably stabilised (covered) if disturbance is expected to be suspended for a period exceeding 10 days.

5.6 Waste Control

Waste materials such as paints, concrete slurry, chemicals, wastewater, cleared vegetation, and general litter shall be appropriately managed and disposed of by the contractor.

5.7 Sediment Control Standard

Section 6.3.2 of the Blue Book (Landcom, 2004) states that if the average annual soil loss from a disturbed area is less than 150m^3/year, the building of a sediment retention basin can be considered unnecessary.

Table 4.5.1 of Best Practice Erosion and Sediment Control (IECA, 2008) provides a method for determining the sediment control standard for construction activities based on the estimated soil loss rate. Based on the estimated soil loss rates being less than 75 t/ha/year in each phase, Type 3 sediment controls will be required for this site as a minimum.

A list of Type 3 and supplementary sediment control techniques is provided in Table 5.2 based on Table 4.5.3 and Table 4.5.4 of Best Practice Erosion and Sediment Control (IECA, 2008).

Table 5.2 Sediment Control Techniques

	Type 3	Supplementary
Sheet Flow Treatment Techniques	• Buffer zone • Excavated drop inlet protection • Fabric drop inlet protection • Fabric wrap field inlet sediment trap • Filter fence • Modular sediment trap • Straw bale barrier • Sediment fence	• Grass filter strips • Fibre rolls • stiff grass barrier
Concentrated Flow Treatment Techniques	• Coarse sediment trap • Modular sediment trap • U-shaped sediment trap	• Check dam sediment traps • Kerb inlet sediment traps • Straw bale barrier

5.8 Pre-Construction Procedures

Prior to the commencement of works, the following physical and management measures will be implemented at the site:

- All subcontractors to be informed of their responsibilities in reducing the potential for soil erosion and pollution to downstream waters;
- Establish site offices and stabilised vehicle parking areas;
- Ensure appropriate waste management and collection services are implemented for the site;
- Identify any areas that are not to be disturbed by construction activities and cordon off from vehicle traffic to prevent erosion; and
- Site personnel complete an environmental induction covering the erosion and sediment control strategy.

5.9 During Construction

At the commencement of and during construction works, the following physical and management measures will be implemented at the site:

- Install woven fabric sediment fences (Standard Drawing SD 6-8 (Landcom, 2004)) along the downstream boundaries of disturbed areas;
- Establish a stabilised site access point in accordance with Standard Drawing SD 6-14 (Landcom, 2004);
- Topsoil to be stripped and stockpiled as shown on Standard Drawing SD 4-1 (Landcom, 2004) and later replaced as shown on Standard Drawing SD 4-2 (Landcom, 2004);
- Install diversion mounds in accordance with Standard Drawing SD 5-5 (Landcom, 2004) to reduce the length of sheet flow across disturbed areas to a maximum of 80 metres;
- Conduct regular inspections of control devices as soon as practicable after storm events to check and maintain controls;
- Sediment to be removed from fences when controls are 40% full and at the completion of construction. All material to be re-used or stored on-site in a controlled manner or taken off-site for re-use or disposal at a licensed waste disposal facility;
- Monitoring of water quality to determine the effectiveness of the sediment and erosion control management practices. De-watering of sediment control devices shall meet the discharge requirements of 50 mg/L TSS; and
- Disturbed soil surfaces stabilised with minimum 75% cover within 10 days of completion of works within any area of a work site.

5.10 Monitoring Program

Prior to construction, it is recommended the developer undertake a series of data collection exercises to define the existing stormwater runoff quality. This will comprise the collection of water samples after the following rainfall events:

- 3 storm events of greater than 25 mm; and
- 3 smaller rainfall events.

Samples will be analysed for total suspended solids (TSS), pH, dissolved oxygen (DO) and hydrocarbons with the results being used as water quality indicators for construction phase monitoring. Monitoring during the construction phase will be conducted in accordance with the following procedures:

- Monitoring sites: At the site discharge points.
- Parameters: TSS, pH, DO and hydrocarbons.
- Frequency: Following single rain events in excess of 5 mm in 24 hours during the construction phase.
- Monitoring Procedures: Sampling by the proponent in accordance with procedures set out in the Environmental Protection Authority's Water Quality Sampling Manual. A NATA registered laboratory will be used to perform the analysis of collected samples.
- Corrective Actions:
    - TSS – Apply gypsum per manufacturers specifications to achieve maximum 50 mg/L TSS.
    - pH – Addition of hydrated lime to raise the pH to an acceptable level (6.5 to 8.5).
    - DO – Mechanical aeration until DO reaches a minimum of 6mg/L.
    - Hydrocarbons – Locate source of hydrocarbons to prevent further contamination. Licensed waste contractor to be used to remove contaminated water. If the source cannot be located, a floating boom may be required to contain any future spills.
- Reporting: An inspection report shall be prepared by a suitably qualified and experienced scientist/engineer following each water quality monitoring event.

6. Stormwater Quality Management

6.1 Integrated Water Cycle Management

The strategy for stormwater management incorporates the following main principles:

- Collection of runoff from impervious areas, such as driveways, within the bioretention system. Runoff is to be filtered through the bioretention system and discharged to the adjacent tidal water way; and,
- Small disconnected impervious areas, such as footpaths are to be discharged directly to landscaped areas.

6.2 Water Quality Targets

In accordance with the Great Lakes Development Control Plan, permanent water quality control measures employed by the development are to achieve 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).

This will ensure the environmental values of the downstream receiving waters are maintained and have been adopted as the water quality targets for the development.

6.3 MUSIC Modelling

To demonstrate compliance with the water quality targets, stormwater quality modelling for the pre- and post-development conditions was carried out using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software. MUSIC modelling was carried out in accordance with Council's Water Sensitive Design Strategy Guidelines (Alluvium & MidCoast Council, 2019) and the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). Details of the input parameters used in the modelling are presented in Appendix B of this report.

6.3.1 Pre-Development Scenario

The quality of stormwater discharging from the subject site in its predevelopment condition was modelled in MUSIC using a 'rural' node to represent the site in its current state. 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, 2015) while the impervious areas were estimated from aerial imagery.

The mean annual pollutant loads discharging from the site in the pre-development condition as determined by MUSIC are presented in Table 6.1.

Table 6.1 Mean Annual Pollutant Loads (Pre-development)

TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
867.4	1.764	11.06	66.49

6.3.2 Post Development Scenario

The developed site was modelled in MUSIC using the split catchment approach with development areas broken down into 'roofs', 'roads', and 'landscaped' areas. The base flow and storm flow concentration parameters for these 'small areas of interest' were taken from Table 5-6 and Table 5-7 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015) while the impervious areas were estimated from the proposed plan of development.

The mean annual pollutant loads discharging from the site in the post-development condition as determined by MUSIC are presented in Table 6.2.

Table 6.2 Mean Annual Pollutant Loads (Post-development – untreated)

TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
1018	2.56	23.38	249.9

6.3.3 Proposed Treatment Systems

A bioretention system is proposed to treat stormwater runoff from the developed site in order to achieve the prescribed water quality targets. Bioretention systems are designed to remove pollutants through water retention and evapotranspiration, physical filtration, nutrient absorption and adsorption by plants and microorganisms, and through the natural denitrification process. Treated water is collected through the underdrainage system and discharged into the receiving waterway.

Details of the proposed bioretention system modelling parameters are included in Appendix B. The mean annual pollutant loads discharging from the site in the post-development condition with the proposed bioretention systems are presented in Table 6.3.

Table 6.3 Mean Annual Pollutant Loads (Post-development – treated)

TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
158.1	0.94	9.75	3.37

The MUSIC model layout and results for treatment train effectiveness comparing pre- and post-development mean annual pollutant load export are presented in Figure 6.1 and Table 6.4.

The results demonstrate that the proposed bioretention treatment systems achieve the NorBE water quality targets for TSS, TP, and TN, and the 90% reduction target for gross pollutants.

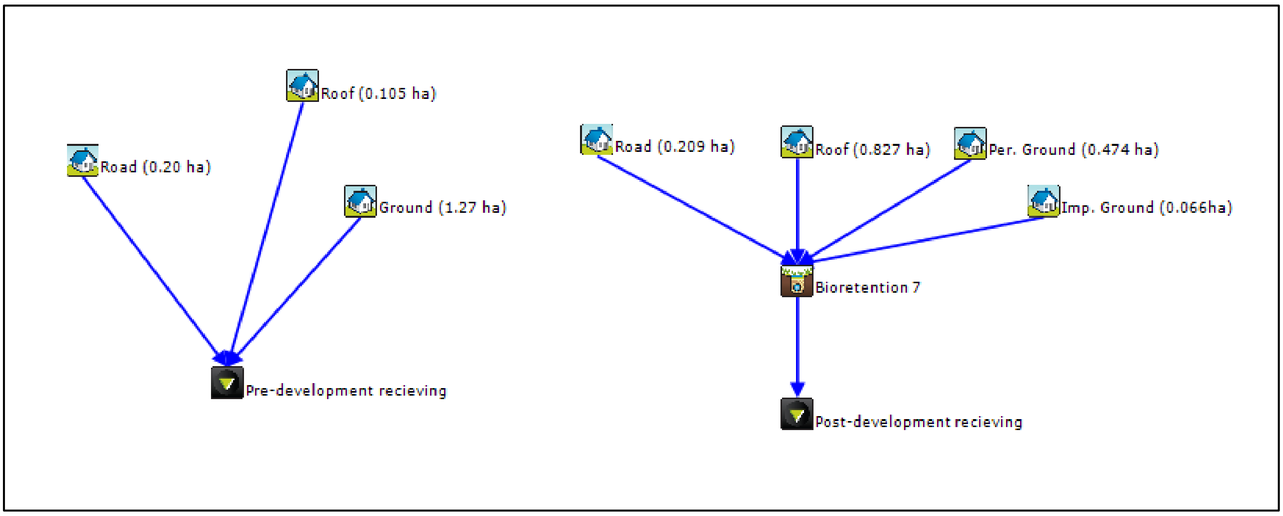

Figure 6.1 MUSIC Model Layout

Table 6.4 Treatment Train Effectiveness

Pollutant	Pre-Development	Post Development		Pollutant Load Reduction (%)	Pollutant Load Reduction (kg/yr)	Water Quality Objective
	Outflows (kg/yr)	Inflows (kg/yr)	Outflows (kg/yr)			
TSS	867.4	1018.0	158.1	84.5	709.3	NorBE
TP	1.76	2.56	0.94	63.3	0.82	NorBE
TN	11.06	23.38	9.75	58.3	1.3	NorBE
GP	66.5	249.9	3.4	98.7	63.1	90% Reduction

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

The proposed location and configuration of the bioretention system is shown on the Operational Control Plan within Appendix C. The bioretention system shall be designed and constructed in accordance with the Midcoast Council Water Sensitive Design Standard Plans.

7. Operation and Maintenance

7.1 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.

7.2 Management Responsibility

The responsibility for proper operation and maintenance of the proposed on-site bioretention system 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 system. The property owner and operator shall be equally responsible for the maintenance of the system required to ensure they continue to function as designed for the life of the development.

The existing bioretention system in Tea Tree Road will be owned and maintained by Mid Coast Council.

7.3 Maintenance Procedures

Once the system has 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.*

7.3.1 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.

7.3.2 Weed Management

After the bioretention basin is 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.

7.3.3 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.

7.3.4 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.

7.3.5 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.

7.3.6 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

7.4 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 system is presented in Table 7.1.

Table 7.1 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 7.2 outlines the recommended procedures for the routine inspection, annual inspection, and routine maintenance. An example inspection checklist is presented in Table 7.3.

Table 7.2 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 7.3 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

8. Conclusion

This WSDS report has been prepared in accordance with Chapter 11 – Water Sensitive Design of the Great Lakes Development Control Plan. The report has addressed the construction phase soil and water management and operational phase stormwater management strategies required to ensure the long-term protection of the downstream receiving waters.

Based on this study, the following conclusions have been drawn:

- The subject site is located immediately upstream of Pipers Bay and the Wallis Lake system which has been identified by Council as a highly sensitive receiving environment.
- The proposed construction phase erosion and sediment control physical and management measures have been developed in accordance with the Blue Book Volume 1 (Landcom, 2004) and Best Practice Erosion and Sediment Control (IECA, 2008).
- Construction phasing, timing, and duration of works are the critical components in the minimisation of erosion during construction.
- The potential soil loss rate for the site has been estimated at 33 tonnes per hectare per year which demonstrates a low erosion risk.
- Due to the sensitive receiving environment, the site requires “high risk” erosion control practices and “Type 3” sediment controls to be implemented during construction (IECA, 2008).
- Stormwater runoff quality in the operational phase of the development will be managed through the inclusion of a bioretention system sized to ensure compliance with Council’s water quality targets.
- The development site will drain to the proposed bioretention system on lot which has a total filter area of 150 m^2.
- All stormwater runoff produced over the subject site will be discharged to Tea Tree Road.

Provided the stormwater management strategy described in this report is fully implemented, the proposed development shall not cause any adverse impacts on the downstream environment.

It is prudent that the design of the stormwater management system proposed herein be revisited and modelling updated during the detailed design and operational works phase of the development.

9. References

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IECA, 2008. *Best Practice Erosion and Sediment Control.* s.l.:IECA.

Landcom, 2004. *Managing Urban Stormwater: Soils and Construction.* 4th ed. Sydney: New South Wales Government.

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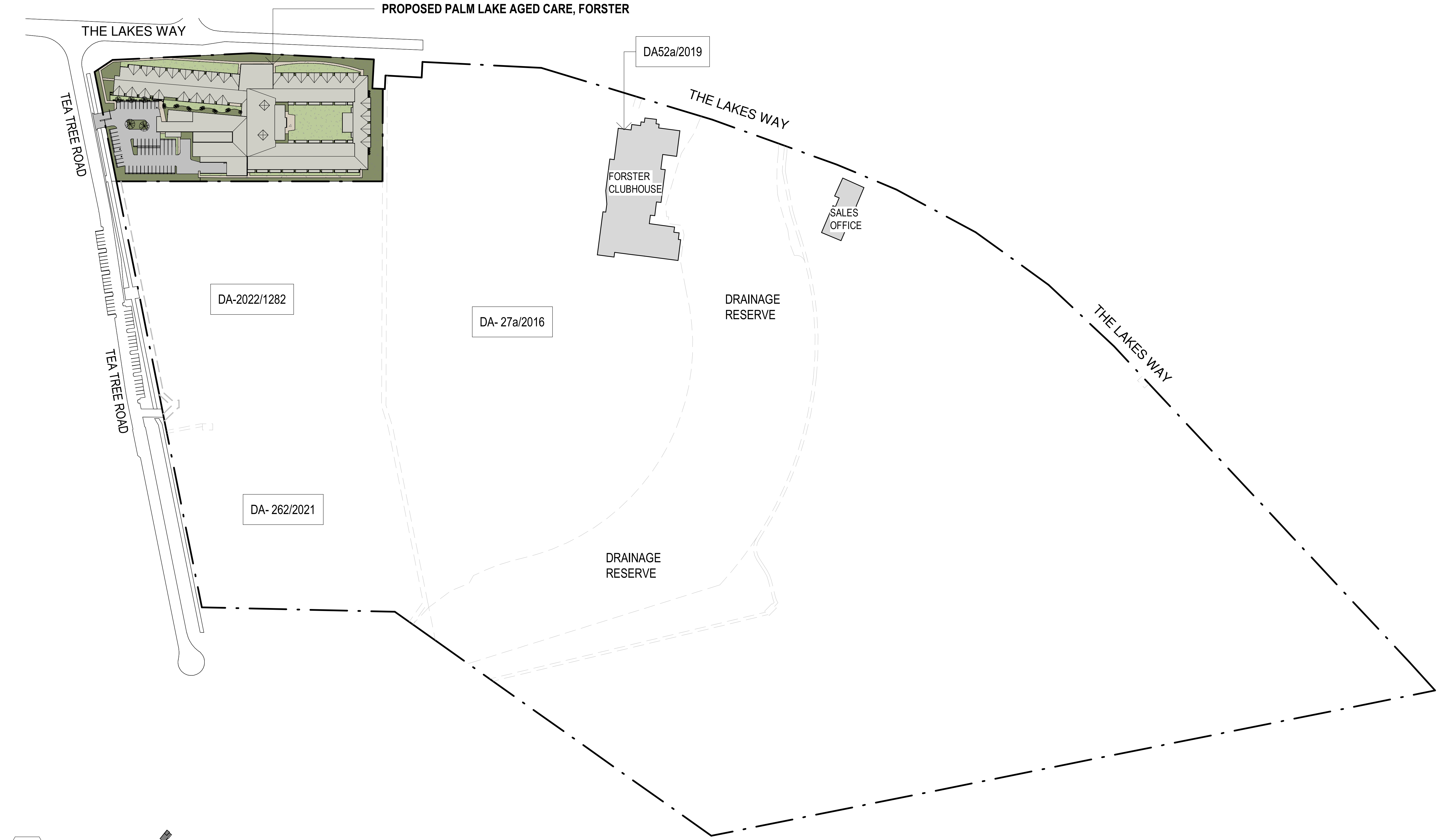
Appendix A – Proposed Plans of Development



1 SITE PLAN - Locality Plan
1 : 2500

LOCALITY SITE PLAN

PALM LAKE CARE - FORSTER

PALM LAKE WORKS 20230024 SD 001 6

06/09/2024

0

Suite 1A, 76 Commercial Road, Teneriffe QLD 4005 T: 07 3252 1711 E: brisbane@pwarch.com.au
Unit 11, 58-60 Torquay Road, Pialba Q 4655 T: 07 4124 5088 E: herveybay@pwarch.com.au

PARUPS WARING ARCHITECTURE

1 SITE PLAN.

1 : 1000

AREA CALCULATIONS:

SITE AREA:	15766.6m^2
GFA AREA:	6690.5m^2
SITE COVER:	42.5%
IMPERVIOUS SERFACES:	
- Outdoor Roofed Area	1369.1m^2
- Parking and Footpaths	2838.5m^2

SITE PLAN

PALM LAKE CARE - FORSTER

PALM LAKE WORKS

20230024 SD 002 7

06/09/2024

0

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PARUPS WARING ARCHITECTURE

GROUND FLOOR PLAN

PALM LAKE CARE - FORSTER

PALM LAKE WORKS 20230024 SD101 9

06/09/2024

PARUPS WARING ARCHITECTURE
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Appendix B – MUSIC Input Parameters

Rainfall and Evapotranspiration

MUSIC modelling was based on 6-minute rainfall and monthly Potential Evapotranspiration (PET) data supplied by Mid Coast Council as summarised below.

Rainfall and Evapotranspiration Data

Input	Data Used in Modelling
Rainfall station	60030 – Taree (Robertson St)
Time step	6 minute
Modelling period	18/06/1995 to 31/05/2005 (10 years)

Rainfall Runoff

The rainfall runoff parameters for each source node have been based on the data from the MUSIC Modelling Guidelines (Healthy Land and Water, 2018) as summarised below.

Rainfall Runoff Parameters

Landuse	Rural Residential	Urban Residential
Rainfall threshold (mm)	1	1
Soil storage capacity (mm)	98	500
Initial storage (% capacity)	10	10
Field capacity (mm)	80	200
Infiltration capacity coefficient a	84	211
Infiltration capacity exponent b	3.3	5
Initial depth (mm)	50	50
Daily recharge rate (%)	100	28
Daily baseflow rate (%)	22	27
Daily deep seepage rate (%)	0	0

Pollutant Load Generation

The base flow and storm flow pollutant load generation parameters for each land use type were based on the data from the MUSIC Modelling Guidelines (Healthy Land and Water, 2018) as summarised below.

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.
Rural	Base Flow Concentration		1.15	0.17	-1.22	0.19	-0.05	0.12
	Storm Flow Concentration		1.95	0.32	-0.66	0.25	0.3	0.19
Urban	Base Flow Concentration	Roof	N/A	N/A	N/A	N/A	N/A	N/A
		Roads	1.2	0.17	-0.85	0.19	0.11	0.12
		Landscape	1.2	0.17	-0.85	0.19	0.11	0.12
	Storm Flow Concentration	Roof	1.3	0.32	-0.89	0.25	0.3	0.19
		Roads	2.43	0.32	-0.3	0.25	0.34	0.19
		Landscape	2.15	0.32	-0.6	0.25	0.3	0.19

Pollutant Sources

Details of the pollutant source node parameters for the pre- and post-development scenarios are presented below.

Land Use Parameters

Catchment ID	Area (ha)	Land use	Total Impervious (%)
Pre - Roof	0.105	Urban	100
Pre – Road	0.20	Urban	100
Pre - Ground	1.27	Urban	0
Post - Roof	0.872	Urban	100
Post - Road	0.209	Urban	100
Post – Pervious Ground	0.474	Urban	0
Post – Impervious Ground	0.066	Urban	100

Bioretention System Parameters

Bioretention Parameters

Surface area (m^2)	150
Extended detention depth (m)	0.3
Filter area (m^2)	150
Unlined filter media perimeter (m)	0.01
Saturated hydraulic conductivity (mm/hour)	200
Filter depth (m)	0.5
TN content of filter media (mg/kg)	400
Orthophosphate content of filter media (mg/kg)	40
Is the base lined? (Y/N)	Yes
Effectiveness of plant TN removal (effective/ineffective/unvegetated)	Effective
Overflow weir width (m)	2
Exfiltration rate (mm/hr)	0.00
Underdrain present? (Y/N)	Yes
Submerged zone with carbon present?	No
Confirmation that K and C* remain default? (Y/N)	Yes

Appendix C – Conceptual Stormwater Management Plans

PROPOSED DEVELOPMENT

LOT 22-24 ON DP838699,
4 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		16.11.22

REVISIONS

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Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

DRAWING TITLE :

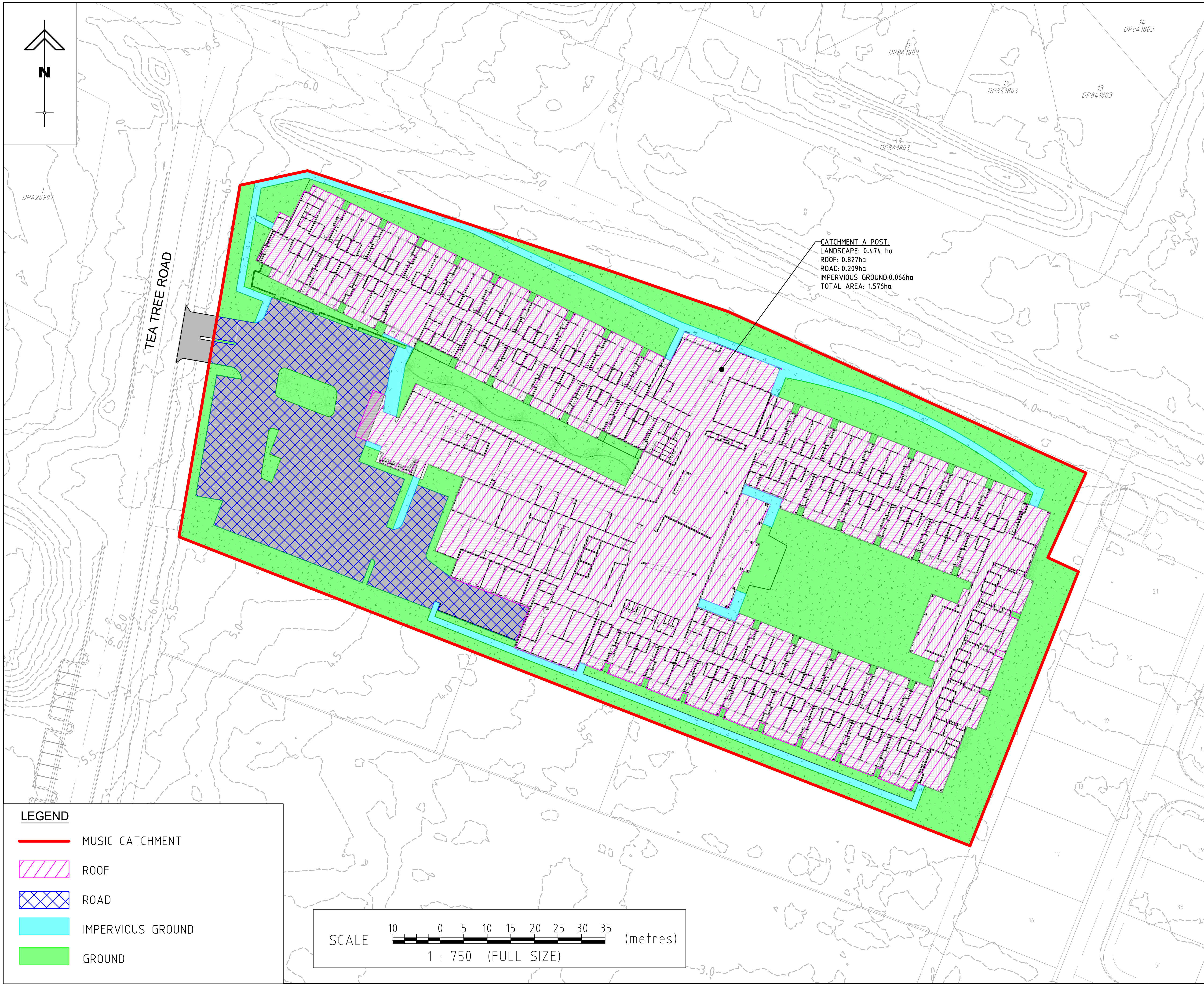
PRE-DEVELOPMENT MUSIC CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 25.10.22
PROJECT LEADER : JC	
DESIGNER : MN	
DRAFTSPERSON : MN	
CHECKED : HL	

APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365

RPEQ No. :

SCALE : AS SHOWN	DATUM :	FULL SIZE : A3
PROJECT No.: BE-190213-10	DRAWING No. : N202	VERSION: A



PROPOSED DEVELOPMENT

LOT 22-24 ON DP838699,
4 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

A	ORIGINAL ISSUE		16.11.22
VER.	DESCRIPTION	APPR.	DATE

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DRAWING TITLE :

POST-DEVELOPMENT MUSIC CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 25.10.22
PROJECT LEADER : JC	
DESIGNER : MN	
DRAFTSPERSON : MN	
CHECKED : HL	

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RPEQ No. :

SCALE : AS SHOWN	DATUM :	FULL SIZE : A3
PROJECT No.: BE-190213-10	DRAWING No. : N203	VERSION: A

LEGEND

—	BIO OUTLET PIPE
--SW--	EXITING (STAGE 12) SW PIPE
● LPD	LEGAL POINT OF DISCHARGE
▬	BIORETENTION BASIN

SCALE 10 0 5 10 15 20 25 30 35 (metres)

1 : 750 (FULL SIZE)

PROPOSED DEVELOPMENT

LOT 22-24 ON DP838699,
4 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

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A	ORIGINAL ISSUE		16.11.22

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OPERATIONAL CONTROL PLAN

DEVEL. APPLIC. No. :	DATE : 25.10.22
PROJECT LEADER : JC	
DESIGNER : MN	
DRAFTSPERSON : MN	
CHECKED : HL	

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RPEQ No. :

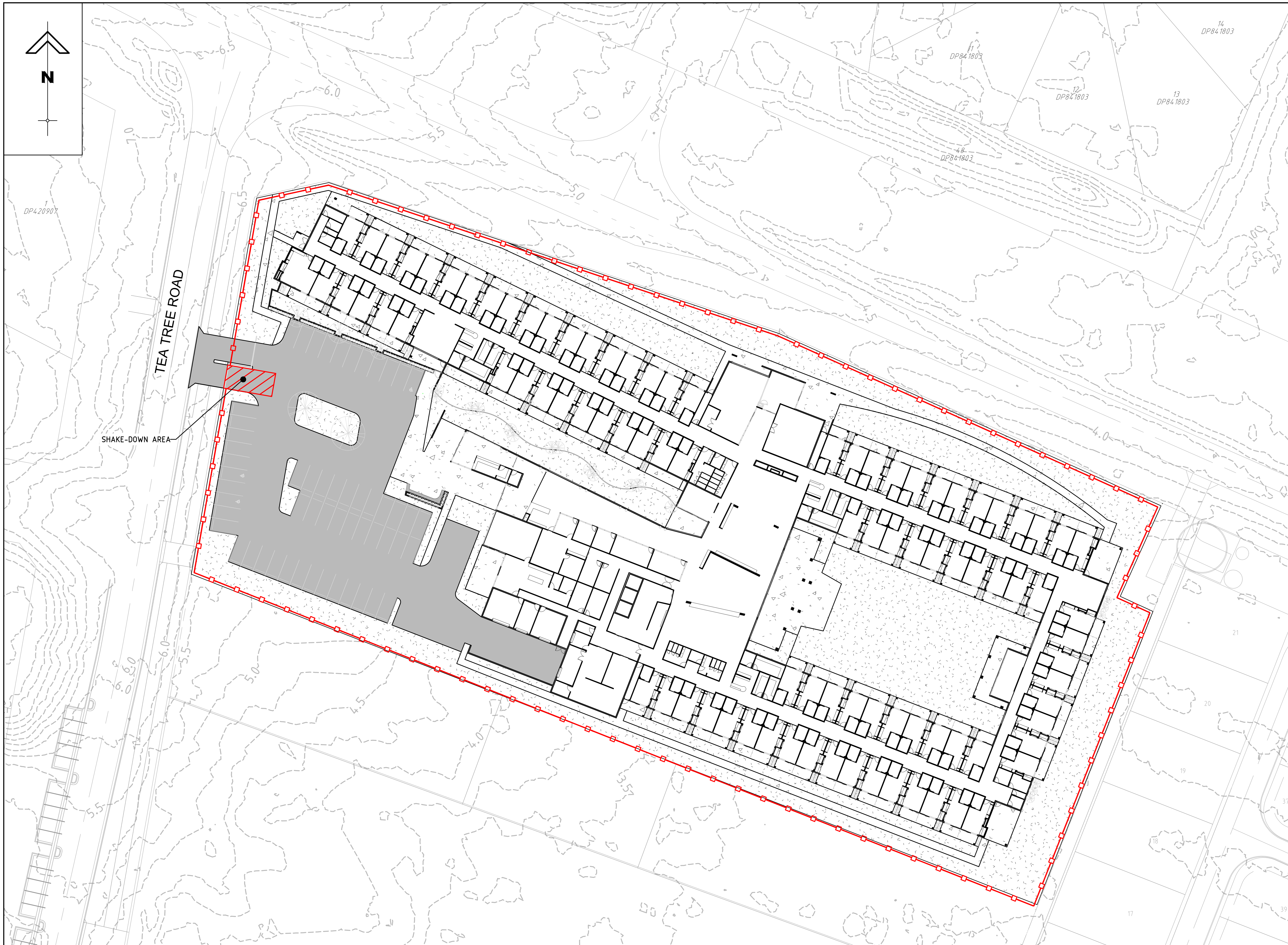
SCALE : AS SHOWN	DATUM :	FULL SIZE : A3
PROJECT No.: BE-190213-10	DRAWING No. : N300	VERSION: A

PROPOSED DEVELOPMENT

LOT 22-24 ON DP838699,
4 TEA TREE ROAD
FORSTER, NSW

FOR

Palm Lake Works



LEGEND

- PROPOSED SEDIMENT FENCE
- SHAKE-DOWN AREA

SCALE 10 0 5 10 15 20 25 30 35 (metres)
1 : 750 (FULL SIZE)

ORIGINAL SCALE BEFORE REDUCTION
A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		16.11.22

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PROJECT No.: BE-190213-10	DRAWING No. : N400	VERSION: A