Conceptual Stormwater Management Strategy

Planning Proposal at 196 Old Main Road, 263, 269, 271, 273, 293 & 321 Gan Gan Road, Anna Bay, NSW

Final Report

P2208888JR16V02

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Prepared for AB Rise Pty Ltd C/- Mecone Group Pty Ltd

environmental science & engineering

Project Details

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Contents

Tables

1 Introduction

1.1 Overview

Martens & Associates Pty Ltd (**MA**) have prepared this Concept Stormwater Management Strategy (**SMS**) to support a Planning Proposal (**PP**) for the rezoning of land located at 196 Old Main Road, 263, 269, 271, 273, 293 and 321 Gan Gan Road, Anna Bay, NSW (the **Site**) to enable a future residential development of the Site. The Site is located within the Port Stephens Council (**Council**) Local Government Area (**LGA**).

The Site comprises a group of contiguous lots along the northern side of Gan Gan Road. The Site is shown on the Maps in Appendix A. We note that there is an area in the southern portion of 293 and 321 Gan Gan Road which is subject to a recent Development Application (**DA**) approval (the **DA Site**). This small portion of the Site is currently zoned residential and is not included as part of this PP.

1.2 Study Objectives

The objectives of this study are to:

1. Identify the policies and guidelines applicable to similar developments in the area and their stormwater management requirements.
2. Prepare a conceptual SMS to inform likely future stormwater management solution for the PP masterplan of the Site.

1.3 Planning Proposal Overview

The Planning Proposal seeks to rezone the Site to R2 Low Density Residential and C3 Environmental Management, with portions designated as RE1 Public Recreation, facilitating future residential development as outlined in relevant rezoning and masterplan layout plans by BKA Architecture provided in Appendix B. The proposed masterplan includes:

1. Residential lots of varying sizes.
2. The internal access road network.
3. The upgraded canal and the associated riparian zone in the middle of the Site.
4. Stormwater management basins in accordance with this SMS.
5. Indicative stormwater pipes and culverts.
6. New public reserves comprising areas of existing bushland, rehabilitated and reforested areas.

2 Policies and Guidelines

2.1 State Government Environmental Planning Policies

The site is not within any regulated catchments under Chapter 6 of the *State Environmental Planning Policy Biodiversity Conservation (2021)* (**SEPP BC**), so the specific requirements and provisions under Chapter 6 of SEPP BC do not apply to the site.

2.2 Council Local Environmental Plan

The Port Stephens Local Environmental Plan (2013) (**LEP**) does not explicitly outline objectives specific to stormwater management.

2.3 Council Development Control Plan

The Port Stephens Council Development Control Plan (2024) (**DCP**) was taken into consideration and will mainly contribute to developing a SMS for the PP. DCP Section B4 applies to developments similar to the Site. The following objectives from this chapter have been adapted to develop this SMS.

2.3.1 Stormwater Drainage Objectives

The following objectives have been adapted from DCP Section B4.A:

1. To ensure a stormwater drainage plan is submitted when development either increases impervious surfaces or drains to the public drainage system.
2. To ensure the stormwater drainage plan details a legal and physical point of discharge to minimise impacts on water balance, surface water and groundwater flow and volume regimes and flooding.
3. To implement sustainable mitigation systems that can be maintained using resources available to the maintainer.

2.3.2 Stormwater Quantity Objectives

The following objective has been adapted from DCP Section B4.B:

1. To regulate the impacts on the capacity of the public drainage system.

2.3.3 Stormwater Quality Objectives

The following objectives have been adapted from DCP Section B4.C:

1. To ensure development does not detrimentally impact on water quality through the use of water quality modelling, such as small scale stormwater water quality model (**SSSQM**) or model for urban stormwater improvement conceptualisation (**MUSIC**), and subsequent water sensitive urban design (**WSUD**) measures.
2. To safeguard the environment by improving the quality of stormwater run-off.

3. To ensure water quality is protected and maintained during the construction phase through the conditioning of appropriate measures.

4. To provide further guidance to clauses in the local environmental plan relating to water quality for development in drinking water catchments.

2.4 Council Design Guidelines

The Council's Stormwater Drainage Design Specifications (2022) (**Design Guidelines**) outline specific drainage requirements relevant to this SMS. Any future development on the PP Site may be designed to comply with these specifications and standards.

2.5 NSW MUSIC Modelling Guideline

The NSW MUSIC modelling guidelines (2015) prepared by BMT WBM provide details of default stormwater quality modelling values for determining the effectiveness of stormwater quality management measures. These guidelines specifically provide:

1. Recommended values for hydrological and hydraulic modelling inputs.

2. Default pollution generation parameters by catchment type.

3. Default stormwater treatment node modelling parameters.

4. Guidelines on pollution reduction / retention targets.

5. Calibration of modelling parameters.

6. Recommendations on reporting of modelling results and their use in development of stormwater management strategies at local and regional scales.

Any future development of the PP Site may be recommended to comply with these guidelines.

3 Local Environmental Setting

3.1 Site Description

An overview of the Site is provided in Table 1.

Table 1: Site overview.

Parameter	Description
Local Government Area	Port Stephens Council
Lots	Lot 963 in DP 731955 (196 Old Main Road, Anna Bay) Lot 21 in DP 590387 (263 Gan Gan Road, Anna Bay) Lot 23 in DP 590387 (269 Gan Gan Road, Anna Bay) Lot 1 in DP 536752 (271 Gan Gan Road, Anna Bay) Lot 901 in DP436550 (273 Gan Gan Road, Anna Bay) Lot 902 in DP 634550 (293 Gan Gan Road, Anna Bay) Lot 1 in DP 503876 (321 Gan Gan Road, Anna Bay)
Total Study Area	118.7 ha approximately
Current Zoning	RU2 – Rural Landscape R2 – Low Density Residential C3 – Environmental Management

Existing land zoning plan by BKA Architecture is provided in Appendix B.

3.2 Topography

Site topography is characterised by three primary morphological units:

1. **Sand Dune** – A long near linear Sand Dune, approximately 100 m wide, is located near the southern Site boundary. This reaches elevations of around 20-23 m.
2. **Low Lying Land** – The majority of the Site north of the Sand Dune is generally low lying and relatively flat, with elevations ranging between 1-2 m AHD.
3. **Canal** – The Anna Bay Main Drain is an approximately 7.5 m wide canal that flows from east to west across the middle of the Site. The invert levels of the canal ranges from -2.3 to -1.4 m AHD with a depth between 2.5-3.0 m.
4. **Valley Area** – A narrow strip of land, approximately 100 m wide, ranging in elevation between say 5-7 mAHD, located south of the Sand Dune and north of Gan Gan Road.

3.3 Existing Drainage Conditions

From a stormwater management perspective, the Site is divided into three areas: north of the sand dune (**Area 1**), southeast of the sand dune (**Area 2**), and southwest of the sand dune (**Area 3**). Descriptions and details of each area are provided in Table 2 below. The approximate extents of each area are shown in Appendix A Map 02.

Table 2: Existing conditions of the Site Areas.

Area	Description	Existing Drainage
Area 1	Located north of the Sand Dune, this area comprises a network of drainage channels, bushland areas, and some cleared grassed sections.	The majority of this area drains through a network of manmade channels into the east west aligned Anna Bay Main Drain, while a smaller portion drains to an unnamed drain just north of the Site. Both drainage paths ultimately discharge into Tilligerry Creek.
Area 2	Situated southeast of the Sand Dune, this area includes existing residential dwellings, associated ancillary infrastructure, and a substantial area of cleared land.	This area drains via overland flow to a trapped low point at 293 Gan Gan Road. However, as part of the approved DA, these overland flows will be collected and discharged north of the dune via proposed twin pipes through the Sand Dune. This SMS assumes the DA as approved and implemented.
Area 3	Located southwest of the Sand Dune, this area contains a residential dwelling, an access driveway, several trees, and a significant portion of cleared land.	This area primarily drains via overland flow to a trapped low point at 196 Old Main Road.

4 Stormwater Management Principles

4.1 Overview

This SMS endorses stormwater management objectives of Council's DCP as outlined in Section 2.3. To achieve these objectives, this SMS incorporates most of the development controls from the Council's DCP and Design Guidelines and proposes some Site specific development controls detailed in the following sections. This SMS advocates the future Site design should aim to achieve these controls to demonstrate compliance with the above endorsed DCP objectives.

4.2 Adopted Stormwater Conveyance Controls

The adopted stormwater drainage controls are designed to achieve the endorsed objectives outlined in Section 2.3 and align with the controls specified in Council's DCP and Design Guidelines. These controls include:

1. Stormwater conveyance must be via minor and major systems, designed in accordance with Council's Design Guidelines, Australian Rainfall and Runoff (**ARR**), and relevant Australian Standards.
2. Design storm annual exceedance probabilities (**AEPs**) for both major and minor drainage systems should be determined in accordance with the Council's Drainage Guidelines, as outlined in Table 3 below, to ensure compliance with the specified requirements.
3. Each lot must be designed to allow gravity drainage into the public drainage system.
4. Inter allotment drainage may be required for subdivisions where lots are unable to drain directly to the road kerb.

Table 3: Major and minor systems design AEP.

Design System	Design AEP (%)
Major	1
Minor	10

4.3 Adopted Stormwater Quantity Controls

The stormwater quantity controls are designed to meet the endorsed stormwater quantity objectives outlined in Section 2.3. The adopted controls include:

1. The increased peak flows from the development must not adversely impact the capacity of public drainage system and receiving waters or cause nuisance to adjoining land owners.
2. Where the existing public drainage system or receiving waters are undersized to convey the increased peak flows from the development in accordance with the

minor and major system, the developer must upgrade them or provide alternative solutions to Council's satisfaction.

3. To safeguard the receiving environments against potential erosion damage from the increased peak runoff flows, the maximum Stream Erosion Index (**SEI**) of 3.5 should be aimed for the clay soil catchments and 2.0 for the sandy soil catchments.

4. All Site stormwater discharge points to overland flow paths and all road crossings should be optimised and provided with permanent sediment and erosion control, energy dissipation and revegetation works to maximise protection of bed and banks against erosion from concentrated and/or increased flows. Where feasible, such works should be integrated into Site earthworks and landscaping in order to enhance natural riparian landforms and Site aesthetics.

4.4 Adopted Stormwater Quality Controls

The adopted stormwater quality controls are derived from Section B4.C of the DCP. For lots with an area equal to or greater than 2,500 m² and located outside drinking water catchment, stormwater quality targets outlined in Table 4 below must be achieved.

MUSIC modelling should be used to demonstrate how these water quality targets are met.

Table 4: Pollutant reduction targets.

Stormwater Pollutant Parameters	Reduction Targets
Total Suspended Solids (**TSS**)	90% reduction in the post development mean annual load
Total Phosphorus (**TP**)	60% reduction in the post development mean annual load
Total Nitrogen (**TN**)	45% reduction in the post development mean annual load
Gross Pollutants (**GP**)	90% reduction in the post development mean annual load

5 Concept Stormwater Conveyance Strategy

5.1 Overview

This SMS is designed to outline the stormwater management strategy of the Site masterplan. The strategy takes into account the Site's masterplan, grading, existing drainage characteristics, and stormwater management requirements to meet the specific objectives outlined in Section 2.3. It aims to provide a comprehensive framework for managing stormwater on Site, ensuring that the development adheres to WSUD principles and regulatory requirements. The strategy incorporates the following key WSUD principles:

1. Safe collection and conveyance of stormwater.
2. Treatment of stormwater to meet water quality standards.
3. Management of flows to prevent flooding and erosion.
4. Reuse of stormwater for non potable purposes.
5. Integration of stormwater systems with Site layout and design.

Considering the existing conditions of the three Site Areas as outlined in Section 3.3, the SMS provides different stormwater management strategies for each of those Areas. The catchments associated with each Area are provided in Table 5 below, with extents shown in Appendix A Map 02. Catchment names are consistent with the Section names in the masterplan (Appendix B).

Table 5: Site Areas and associated catchments.

Area	Location	Catchment(s)
Area 1	North of the Sand Dune	G, H, I, L, M, N
Area 2	Southeast of the Sand Dune	E
Area 3	Southwest of the Sand Dune	F

The following sections outline the stormwater conveyance strategy for each Area of the Site, indicating the conveyance systems, flow management, and proposed treatment measures for effective stormwater management.

5.2 Area 1 – North of the Sand Dune

In Area 1, the stormwater conveyance system will consist of a minor/major stormwater network. The piped drainage system will handle flows from minor events (up to the 10% AEP), collecting and conveying runoff from the roof, hardstand, and landscaped areas. For major events (up to the 1% AEP), stormwater will be conveyed through a combination of the pit and pipe network and overland flow paths, with the kerb and gutter network directing runoff into the system. The collected stormwater will be directed to stormwater quality treatment basins for detention and treatment, with a controlled outlet structure regulating discharge to nearby receiving waters. This approach minimises the Site fill or

land raising, reducing earthworks while integrating engineered and natural systems for effective stormwater management.

Flows from Catchment N will discharge to a swale for treatment and conveyance to the existing watercourse located further northwest of the catchment. The same swale will also be used to convey flows from the pipes through the sand dune to the existing watercourse, as shown in the Maps in Appendix A.

Area 1 also includes several culverts/pipes incorporated into the preliminary masterplan design to maintain the continuity of existing flow patterns and mitigate potential flow obstructions caused by the future residential development in the area. The potential locations of these culverts and pipes are illustrated in the Maps in Appendix A.

5.3 Area 2 – Southeast of the Sand Dune

The stormwater conveyance system in Area 2 will follow a similar approach to Area 1, utilising a minor/major network to manage flows. A swale is planned along the western boundary of Area 2 to capture upstream flows and a portion of runoff from within Area 2. The swale will extend along the southern boundary adjacent to Gan Gan Road to intercept additional Site generated flows. Collected runoff will be conveyed via pipe through Area 2 to the culvert at the northeastern boundary, discharging into the approved DA stormwater system. Indicative swale and pipe locations are shown in Appendix A.

Treatable flows from Area 2 will be diverted to the bioretention infiltration basin associated with the approved DA Site. This basin should be designed to handle additional flows from Area 2, providing sufficient capacity and ensuring effective treatment of stormwater. Thus, is recommended to be revisited at detailed design stage to ensure it accommodates the flows from the development in Area 2, in addition to the DA Site.

For non treatable flows, the conveyance strategy relies on the approved DA pipe to be bored through the Sand Dune discharging runoff to north. The culvert pipe should be adequately sized to handle the flow from the developed Area 2 catchment.

5.4 Area 3 – Southwest of the Sand Dune

In Area 3, the stormwater conveyance system will comprise a minor and major network designed to collect and manage all flows within the Area. Runoff will be directed to the low point in the southwestern corner of the Site, where it will discharge to the stormwater quality treatment basin. Flows collected from the upstream catchment by the diversion swale along the western boundary will also be conveyed to this basin. From the basin, flows will be directed to the proposed pipe network in Area 2 via a new public pipe system along Gan Gan Road, which will connect to the Area 2 network and ultimately discharge into the approved DA approved stormwater system.

6 Concept Stormwater Quantity Strategy

6.1 Overview

The stormwater quantity management strategy for the Site is designed to ensure compliance with the objective of regulating impacts on the capacity of the public drainage system. The strategy adopts a holistic approach that integrates infrastructure upgrades, natural features, and flood modelling to achieve the adopted objectives.

6.2 Area 1 – North of the Sand Dune

In alignment with the stormwater quantity principles (Section 4), the stormwater quantity management strategy consists of the following measures to be implemented on Site to achieve the stormwater quantity objective outlined in Section 2.3:

1. The Anna Bay Main Drain will be upgraded to enhance its capacity and stability in order to manage the increased stormwater flows from the future development by widening the canal to handle higher flows, stabilising the banks to limit scouring and erosion and maintain slope stability, and incorporating vegetation improvements to promote ecological resilience. These enhancements will ensure the canal can effectively convey stormwater discharge during both minor and major storm events, increasing the overall capacity of the public drainage system.

2. Stormwater from the Site will be conveyed by a pipe network through constructed wetlands and discharge into a tidal receiving environment, leveraging its natural capacity to manage varying water levels and flows. Discharging into a tidal system helps regulate stormwater impacts, thus aligning with the stormwater quantity objectives outlined in Section 2.3.

3. Constructed wetlands will be integrated into the stormwater management plan to provide treatment and detention functions. Multiple discharge outlets will be employed to distribute flows along the receiving environments, minimising the burden on individual drainage points and promoting gradual, controlled discharge into receiving waters. The constructed wetlands will also contribute to harvesting and infiltration of stormwater. This approach leverages the ecological, detention, and infiltration benefits of wetlands, regulating the impact on public drainage system.

4. A TUFLOW hydraulic model, included in the detailed flood assessment by MA, evaluated pre and post development flooding during the 1% AEP flood and probably maximum flood (**PMF**) events with and without climate change. The results indicate acceptable impacts on public drainage capacity. For further details, refer to the MA Flood Impact and Risk Assessment Report (**FIRA**, REF: P2208888JR19V01). This assessment confirms compliance with the stormwater quantity objective, demonstrating that the stormwater management strategy results in the Site development having no unacceptable adverse impacts on public drainage system.

6.3 Area 2 – Southeast of the Sand Dune

Stormwater flows from this area will connect to the approved DA Site's stormwater system, which discharges north of the Sand Dune. The FIRA evaluated flooding in this region and concluded that the impacts on the capacity of the public drainage system are acceptable, meeting the adopted controls and objectives. For detailed modelling results, refer to the MA FIRA.

6.4 Area 3 – Southwest of the Sand Dune

Stormwater from this area will connect to the Area 2 pipe system, which then discharges into the approved DA Site's stormwater system and ultimately flows north of the Sand Dune. The FIRA determined that the impacts on the capacity of the public drainage system are acceptable and comply with the adopted controls and objectives. Detailed modelling results are provided in the MA FIRA.

7 Concept Stormwater Quality Strategy

7.1 Overview

The planning proposal and concept masterplan have been designed to align with stormwater management objectives (Section 2.3) through the application of Water Sensitive Urban Design. The stormwater treatment strategy for the Site combines both 'at source' and 'end of line' controls to ensure the objectives are satisfied.

To guide the design, preliminary water quality models were developed for the future developments in Areas 1 and 3. These models help determine the likely extent and requirements for future stormwater treatment systems in these areas, providing a general specification for water quality structures. These specifications will be refined during the detailed design stages.

7.2 Water Sensitive Urban Design

WSUD is a philosophy that combines elements of the natural environment into urban design to achieve water management objectives. WSUD aims to ensure protection of downstream receiving environments (terrestrial and aquatic) by minimising the adverse impacts of development on the natural water cycle. To achieve this, WSUD requires an integrated approach to managing water supply, groundwater, stormwater, wastewater, flood controls and riparian management elements of a development. Of note for protecting downstream receiving environments at the Site are the management of stormwater quantity and quality control, maintenance as best as possible of existing groundwater conditions and integration of any riparian corridors and vegetation into Site solutions.

7.3 Treatment Systems

WSUD treatment may include a combination of systems including:

1. **Rainwater Tanks:** Each dwelling should have a suitably sized rainwater tank to capture and store part of roof runoff for reuse. Rainwater tanks should overflow to Site road reserves / drainage systems.

2. **Vegetated Swales:** Swales should be integrated into the Site's surface drainage system to convey runoff while providing treatment. These swales offer primary treatment by filtering coarse matter and litter from stormwater.

3. **Bioretention Swales:** Bioretention swales are gently sloped channels with bioretention filter media, and nutrient removal vegetation designed to manage and treat stormwater runoff. They filter pollutants through vegetation, soil, and microbial activity, helping to remove sediments, nutrients, and other contaminants. Bioretention swales should be integrated into the Site layout to provide effective treatment while also conveying surface water.

4. **Gross Pollutant Traps:** GPTs are to be located to capture stormwater runoff from lots and road reserves. These may be proprietary systems or specifically designed

to suit individual catchments. Discharge from the GPTs should be directed to constructed wetland and / or piped drainage.

5. **Bioretention Basins:** Located at the lower end of Site catchments as an end of line treatment, bioretention basins provide tertiary treatment, removing pollutants via filtration, adsorption and biological uptake.

6. **Constructed Wetland:** Located at the lower end of Site catchments as an end of line treatment, collecting and treating the proposed development and upstream catchments. These systems would incorporate a mixture of inlet / bypass zone, extended detention, and nutrient removing vegetation to reduce catchment pollutant loads and discharge volumes. The wetland provides treatment through sedimentation, infiltration and absorption by vegetation to remove fine sediments, nutrients, and other pollutants.

7.4 Irrigation Reuse / Harvesting

Stormwater retention and reuse should ideally be undertaken through a combination of one or more of the following WSUD measures:

1. Roofwater runoff capture and storage: All residential dwellings should capture roofwater runoff for storage. The collected water can be used for non potable demands such as toilet flushing and irrigation of landscaped areas, reducing potable water requirements for the development.

2. Wetland water reuse for recreational areas: Water from some of the constructed wetlands should be captured for reuse in irrigating recreational and landscaped areas, where practical. After natural filtration in the wetland, the treated water can preferably be directed to passive gravity fed irrigation systems, such as wicking networks, to support vegetation in parks and green spaces, reducing potable water demands and promoting sustainable landscaping practices.

7.5 Preliminary Stormwater Quality Modelling

7.5.1 Overview

Separate water quality models were developed for the catchments within Areas 1 and 3 of the Site to assess the likely extent and requirements for future stormwater treatment systems. It allows for a general specification of water quality structures and will require refinement at the detailed design stages.

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.3), developed by the CRC for Catchment Hydrology, was used to evaluate for the modelling exercise. The preliminary MUSIC model layouts are shown in Figure 1 and Figure 2 below.

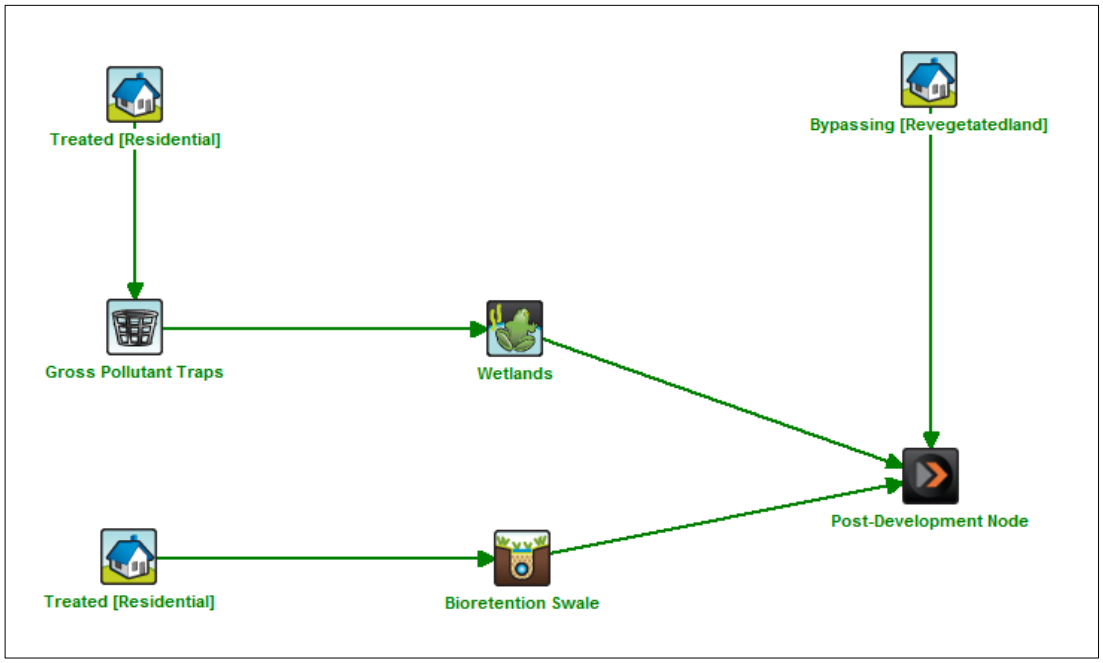


Figure 1: MUSIC modelling layout for Area 1.

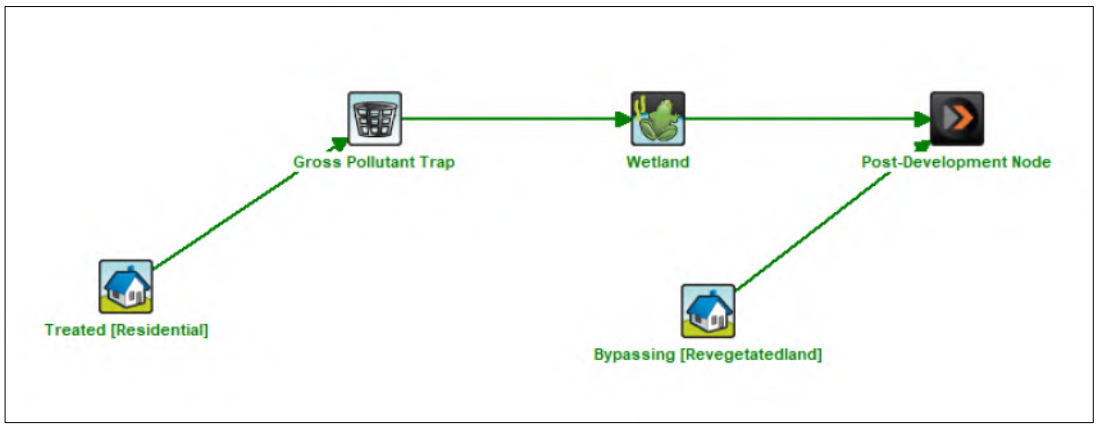


Figure 2: MUSIC modelling layout for Area 3.

7.5.2 Model Scenarios

The following modelling scenarios were considered as part of the preliminary modelling exercise:

- **Post development (untreated):** Future Site condition modelled without any water quality treatment devices.
- **Post development (treated):** Future Site condition modelled with water quality treatment devices to achieve adopted objectives for nutrients and gross pollutants.

An iterative approach was used for post development modelling to determine appropriate types, sizes and locations of stormwater treatment devices for modelling scenarios to achieve water quality objectives.

7.5.3 Model Setup

The treatment train devices selected are intended to estimate the necessary land area for effective stormwater management. Alternative devices, such as swales, bio swales and buffer strips may also be considered for implementation.

7.5.3.1 Area 1 – North of the Sand Dune

The MUSIC model utilised the following assumptions and data:

1. Council's Sensitive Catchment Clay Soils MLB file from MUSIC link, which incorporates rainfall climate data from the Williamtown RAF (Zone A), was used for modelling.
2. Catchments delineated based on MA concept grading strategy, developed for the masterplan layout by BKA Architecture (Appendix B). Refer to Appendix A for catchment plan and Table 6 for summary of assumed catchment characteristics.
3. Default pollutant generation rates and treatment inputs, including pollutant retention capabilities, were adopted in accordance with the NSW MUSIC Modelling Guidelines (2015).
4. The future residential development area was modelled using residential and revegetated land source nodes, with details provided in Table 6 below. Rainfall runoff parameters for silty clay soil were applied in accordance with the NSW MUSIC Modelling Guidelines (2015), based on the geotechnical investigation by MA (2024, REF: P228888JR07V01).
5. The MUSIC model incorporates a treatment train consisting of bioretention swale, GPTs and constructed wetland areas. While BASIX compliant rainwater tanks are recommended for inclusion in future modelling, they have been excluded from the current analysis to focus on determining the required land take for stormwater treatment.
6. Constructed wetlands are modelled with input parameters as detailed in Table 7 below and are in accordance with the NSW MUSIC Modelling Guidelines (2015). Although stormwater reuse and harvesting from the wetlands forms part of the strategy, it was conservatively not considered in the modelling.
7. Bioretention swale is modelled with input parameters as detailed in Table 8 below and are in accordance with the NSW MUSIC Modelling Guidelines (2015).
8. Constructed wetlands and bioretention swale are sized to achieve the stormwater quality targets (Section 4.4) for the overall Area 1.

Table 6: Summary of assumed MUSIC modelling catchment characteristics for Area 1.

Catchment Name	Source Node	Area (ha)	Impervious (%)	Assumptions and Notes
Treated	Residential	32.9	70	Consists of the future residential development draining to wetlands, assuming 70% imperviousness for R2 zoned lots.
Bypassing	Revegetated Land	3.5	0	Consists of future batters planned to be revegetated, assuming 0% imperviousness.

Table 7: Wetlands modelling parameters for Area 1.

Parameters	Inputs
Surface Area (m^2)	20,390
Extended Detention Depth (m)	0.50
Permanent Pool Volume (m^3)	6,797
Exfiltration Rate (mm/hour)	0
Evaporative Loss (% of PET)	125.0
Equivalent Pipe Diameter (mm)	189
Overflow Weir Width (m)	2.0
Notional Detention Time (hours)	48.1

Table 8: Bioretention swale modelling parameters for Area 1.

Parameters	Inputs
Extended Detention Depth (m)	0.15
Surface Area (m^2)	170
Filter Area (m^2)	170
Based Lined	Yes
Exfiltration Rate (mm/hour)	0
Overflow Weir Width (m)	2.0
Underdrain Present	Yes
Submerged Zone Present	No

7.5.3.2 Area 3 – Southwest of the Sand Dune

The MUSIC model utilised the following assumptions and data:

1. Council's Sensitive Catchment Sandy Soils MLB file from MUSIC link, which incorporates rainfall climate data from the Williamtown RAF (Zone A), was used for modelling.

2. Catchments delineated based on masterplan layout by BKA Architecture (Appendix B). Refer to Appendix A for catchment plan and Table 9 for summary for assumed catchment characteristics.

3. Default pollutant generation rates and treatment inputs, including pollutant retention capabilities, were adopted in accordance with the NSW MUSIC Modelling Guidelines (2015).

4. The future residential development area was modelled using residential source node, with details provided in Table 9 below. Rainfall runoff parameters for sandy soil were applied in accordance with the NSW MUSIC Modelling Guidelines (2015), based on the geotechnical investigation by MA (2024, REF: P228888JR07V01).

5. The MUSIC model incorporates a treatment train consisting of a GPT and constructed wetland. While BASIX compliant rainwater tanks are recommended for inclusion in future modelling, they have been excluded from the current analysis to focus on determining the required land take for stormwater treatment.

6. Constructed wetland is modelled with input parameters as detailed in Table 10 below and is in accordance with the NSW MUSIC Modelling Guidelines (2015). Although stormwater reuse and harvesting from the constructed wetlands forms part of the strategy, it was conservatively not considered in the modelling.

7. Constructed wetland is sized to achieve the stormwater quality targets (Section 4.4) for Area 3.

Table 9: Summary of assumed MUSIC modelling catchment characteristics for Area 3.

Catchment Name	Source Node	Area (ha)	Impervious (%)	Assumptions and Notes
Treated	Residential	1.22	70	Consists of the future residential development draining wetlands, assuming 70% imperviousness for R2 zoned lots.
Bypassing	Revegetated Land	0.05	0	Consists of future batters planned to be revegetated, assuming 0% imperviousness.

Table 10: Wetland modelling parameters for Area 3.

Parameters	Inputs
Surface Area (m^2)	685
Extended Detention Depth (m)	0.50
Permanent Pool Volume (m^3)	228
Exfiltration Rate (mm/hour)	0
Evaporative Loss (% of PET)	125.0
Equivalent Pipe Diameter (mm)	34
Overflow Weir Width (m)	2.0
Notional Detention Time (hours)	50

7.6 Stormwater Quality Results

7.6.1 Area 1 – North of the Sand Dune

MUSIC Modelling results for Area 1 are provided in Table 11. A total of 6.2% of the future residential development areas that are treated by the wetlands was modelled as wetland, along with the parameters detailed in Table 7. Also, for the development area treated by bioretention swale (Catchment N), the model included a bioretention swale with an area equivalent to 1% of the total catchment area, along with the parameters detailed in Table 8. The results demonstrate that these proportions are sufficient to achieve the adopted stormwater quality objectives overall for Area 1.

Therefore, where constructed wetland is opted as the treatment option for any future development in Area 1 of the Site, minimum 6.2% of the overall developed catchment area may be allocated for this purpose. Where bioretention swale is opted as the treatment, minimum 1% or the overall development may be required.

However, the areas should be refined at the design stage to ensure it complies with the stormwater quality objectives and controls.

Table 11: MUSIC modelling results for Area 1 (P2208888MUS02V03).

Parameter	Source Load	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	46400	4340	91%	90%	Yes
TP (kg/year)	76.7	24.5	68%	60%	Yes
TN (kg/year)	568	312	45%	45%	Yes
GP (kg/year)	7290	0	100%	90%	Yes

7.6.2 Area 3 – Southwest of the Sand Dune

MUSIC Modelling results for Area 3 are provided in Table 12. A total of 5.7% of the future residential development area was modelled as constructed wetland, along with the parameters detailed in Table 10. The results demonstrate that this proportion is sufficient to achieve the adopted stormwater quality objectives. Therefore, if constructed wetland is selected as the treatment option for any future development in Area 3 of the Site, a minimum of 5.7% of the developed catchment area should be designated for this purpose.

Table 12: MUSIC modelling results for Area 3 (P2208888MUS03V02).

Parameter	Source Load	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	1460	109	93%	90%	Yes
TP (kg/year)	2.5	0.8	68%	60%	Yes
TN (kg/year)	18.4	10.4	43%	45%	Yes
GP (kg/year)	251	0	100%	90%	Yes

7.7 WSUD Sizing

7.7.1 Area 1 – North of the Sand Dune

For Area 1, north of the sand dune, the locations of wetlands, referenced as stormwater treatments on the Maps in Appendix A, are identified for different catchments where wetlands will be used as a treatment device. Table 13 summarises the wetland areas for each catchment. Preliminary MUSIC modelling indicates that the wetland area required for future residential development should cover at least 6.2% of the catchment area. As such, the masterplan has allocated 6.2% of the total catchment area for wetland treatment. This approach ensures that the development in these catchments will meet the adopted stormwater quality targets.

For Catchment N, the stormwater quality strategy incorporates bioretention swale located in the northern part of the catchment. This swale will convey flows from the Site to the existing watercourse in the northwest of the catchment, as shown on the Maps provided in Appendix A. The sizing of this bioretention swale will be finalised during the detailed design stages.

Table 13: Summary of wetlands sizing for Area 1.

Catchment	Catchment Area (ha)	Stormwater Treatment	Distributed Stormwater treatment Area (m^2)
G	4.5	G1	2,500
H	6.2	H1	2,040
		H2	1,440
I	11.1	I1	1,670
		I2	2,580
		I3	2,290
L	3.8	L1	770
M	7.3	M1	2,300
		M2	4,800
Total catchment area	32.9	**Total treatment area**	20,390
		Percentage of catchment area	6.2%

7.7.2 Area 2 – Southeast of the Sand Dune

For Area 2, southeast of the Sand Dune, no stormwater water quality treatments are included in the preliminary masterplan. Instead, the bioretention basin of the approved DA Site will be utilised for stormwater quality treatment. The DA bioretention is recommended to be sized at detailed design stage of the DA Site or to be modified to treat Area 2.

7.7.3 Area 3 – Southwest of the Sand Dune

For Area 3, southwest of the sand dune, the location of the constructed wetland is shown on the Maps in Appendix A, and Table 14 summarises the constructed wetland sizing for the catchment. Preliminary MUSIC modelling results for Area 3 indicate that 5.7% of the development area is required for constructed wetland to meet the adopted water quality objectives. Consequently, the masterplan has allocated 5.7% of the total catchment area for constructed wetland, which exceeds the required amount and ensures that the adopted stormwater quality targets are met.

Table 14: Summary of wetland sizing for Area 3.

Catchment	Catchment Area (ha)	Stormwater Treatment	Distributed Stormwater Treatment Area (m^2)	Percentage of Catchment Area
F	1.22	F1	685	5.7%

8 Ownership and Maintenance

Anticipated ownership and maintenance of the water cycle management scheme for the future development is expected to be as follows:

1. **Rainwater tanks:** Dwelling / building owner to obtain approvals, construct and maintain.
2. **GPTs**: After provided and installed by the developer, the ownership and maintenance obligations transferred to Council following construction and operational certification.
3. **Stormwater treatment basins**: Ownership and maintenance obligations transferred to Council following construction, establishment and a period of operational maintenance to confirm performance. Anticipated basin maintenance requirements are broadly summarised in Table 15.

Table 15: Likely stormwater treatment basins ongoing maintenance requirements.

Type	Frequency	Element(s)
Routine inspections	3 monthly / after heavy rainfall	• Inlet system • Outlet system • Basin and batter vegetation • Embankment condition • Signs of surface erosion
Annual management	12 monthly	• Manage weeds • Maintain vegetation as necessary • Replace any degraded materials which would lead to a significant reduction in performance
Long term management	5+ year cycle	• Clean / remove accumulated sediment as required • Trim larger woody vegetation where necessary • Check water quality performance

9 Conclusions

This conceptual Stormwater Management Strategy has been prepared by MA to support a Planning Proposal for the rezoning of land located at Old Main Road and Gan Gan Road, Anna Bay, NSW to enable a future residential subdivision within the Site. In summary:

1. **Water Sensitive Urban Design:** The principles of WSUD are well suited for the development of the Site, with no significant constraints identified for their implementation.

2. **Stormwater Drainage:** The stormwater drainage system for the site will be designed to align with the Council's Design Guidelines, incorporating both minor and major stormwater networks. Flows from minor storm events will be conveyed through a piped drainage system, while major storm events will be managed using a combination of pit and pipe networks and overland flow paths. All collected stormwater will be directed to a water quality treatment device before being discharged into the receiving waters. This strategy also includes the use of swales to convey development flows to the treatment devices, from the treatment device to the receiving environment, and to divert upstream flows. Several culvert crossings have been included in the strategy to maintain the existing flow patterns and address the obstruction of flow from the future residential development on the Site.

3. **Stormwater Quantity:** The stormwater quantity management strategy integrates infrastructure upgrades, natural features, and controlled outlet structures with multiple discharge locations across different catchments to mitigate potential impacts on the public drainage system. Key measures include upgrading the Anna Bay Main Drain, discharging stormwater into a tidal system, and incorporating basins with controlled discharge structures to manage flows to the public drainage system. Flood assessments confirm the strategy's effectiveness, ensuring compliance with stormwater quantity objectives with no unacceptable adverse impacts on public drainage capacity.

4. **Stormwater Quality:** Preliminary MUSIC modelling indicates that water quality objectives can be achieved for the Site through the implementation of various WSUD treatment systems, with a specified minimum percentage of the catchment area allocated for these treatment devices. As part of this strategy, various potential locations for treatment devices, such as constructed wetlands, bioretention systems, and swales, have been integrated into the preliminary master plan. However, it is recommended that during the future detailed design stages, a suitable treatment train incorporating both at source and end of line treatment systems be utilised to achieve the adopted water quality objectives.

Overall, we conclude that the provision of appropriate stormwater management infrastructure will not likely impede the orderly development of the Site and that the stormwater drainage, quantity and quality objectives can be met.

10 References

BMT WBM (2015), *NSW MUSIC Modelling Guidelines*, August 2015.

Engineers Australia (2006), *Australian Runoff Quality: A Guide to Water Sensitive Urban Design*.

Institution of Engineers, Australia (2019), *Australian Rainfall and Runoff*.

Martens and Associates (December 2024), *Geotechnical and Acid Sulfate Soil Assessment (P2208888JR07V01)*

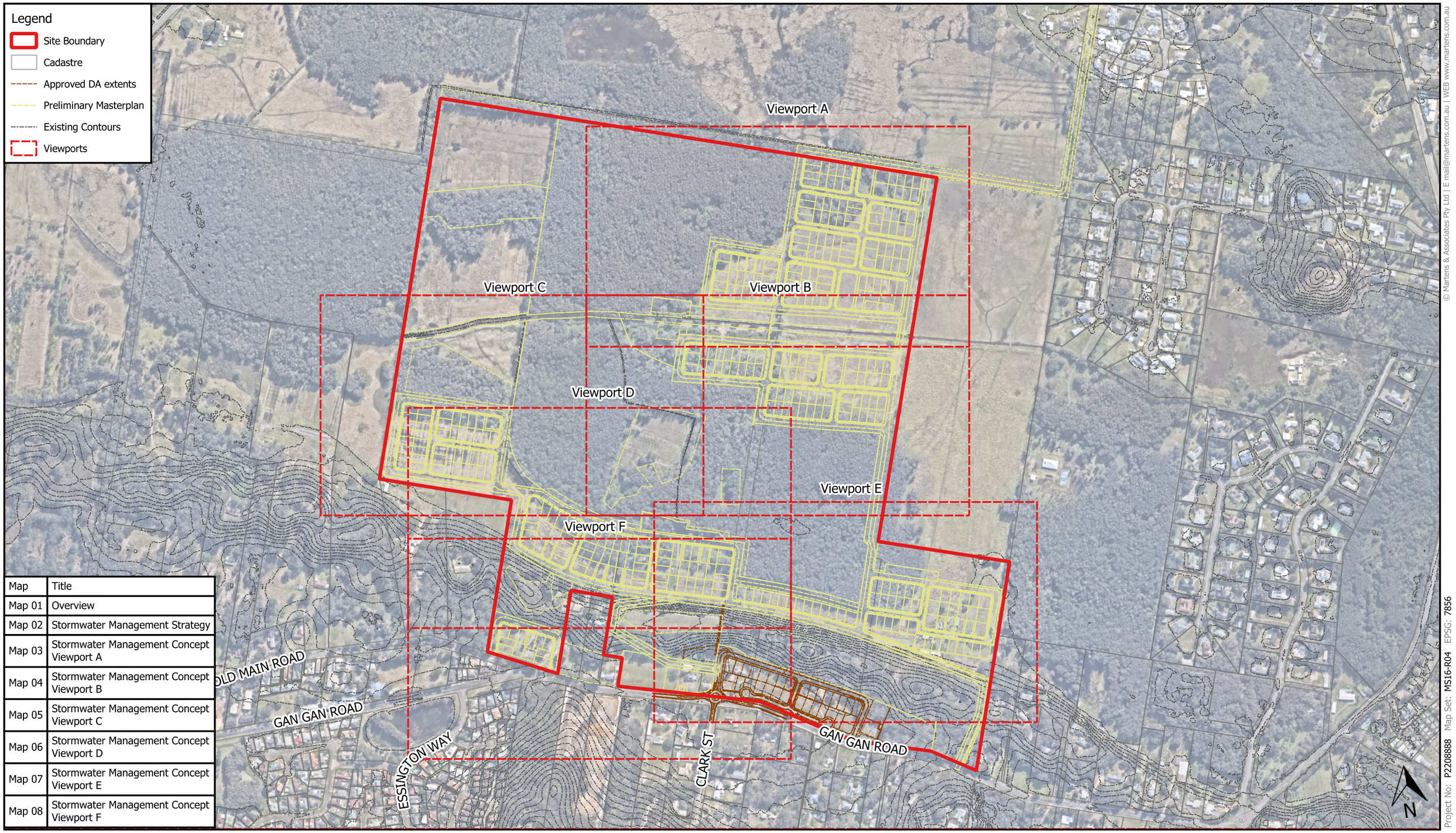
Martens and Associates (August 2025), *Flood Impact and Risk Assessment (P2208888JR19V01).*

Port Stephens Council (2013), *Port Stephens Local Environmental Plan (LEP).*

Port Stephens Council (2022), *0074 Stormwater Drainage (Design) – Development Design Specification.*

Port Stephens Council (2024), *Development Control Plan (DCP).*

Appendix A Maps



Map	Title
Map 01	Overview
Map 02	Stormwater Management Strategy
Map 03	Stormwater Management Concept Viewport A
Map 04	Stormwater Management Concept Viewport B
Map 05	Stormwater Management Concept Viewport C
Map 06	Stormwater Management Concept Viewport D
Map 07	Stormwater Management Concept Viewport E
Map 08	Stormwater Management Concept Viewport F

0 90 180 270 360 450 m

1:7500 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).

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Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Map Title / Figure:
Overview

Map 01	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Legend

- Site Boundary
- Cadastre
- Approved DA extents
- Preliminary Masterplan
- Retained Watercourses
- Stormwater Treatment
- Bypassing Catchment
- Treated Catchment
- Area 1
- Area 2
- Area 3

Future road to be constructed above PMF levels

I1
Catchment I
I2
I3
H2
H1
Catchment H
L1
Catchment L
M1
M2
Catchment M
N1
Catchment N
G1
Catchment G
Catchment F
F1
Catchment E

N

0 90 180 270 360 450 m

1:7500 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).
- Catchment areas and basin locations are indicative only.

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Map Title / Figure:

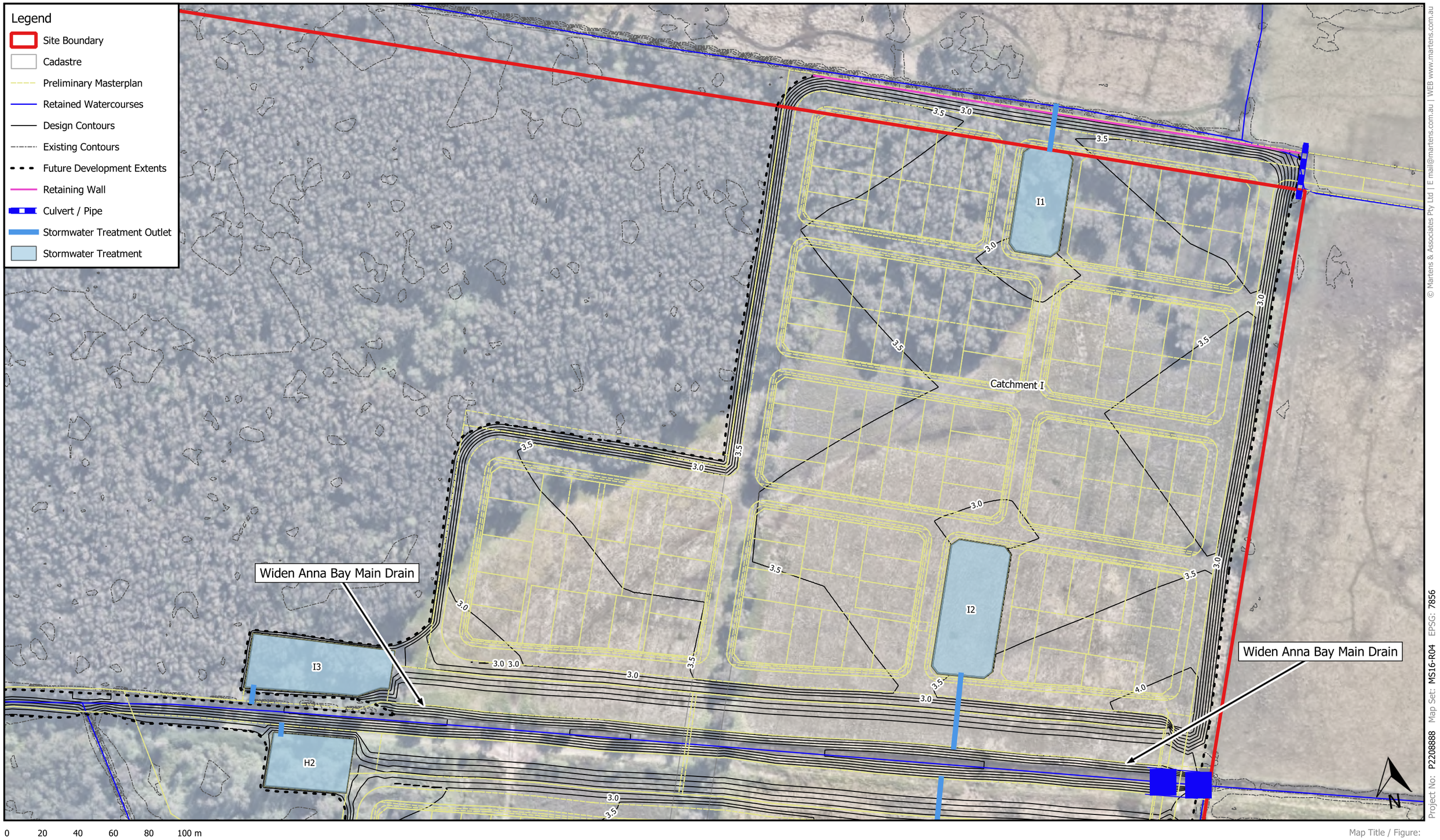
Stormwater Management Strategy

Map 02	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Legend

- Site Boundary
- Cadastre
- Preliminary Masterplan
- Retained Watercourses
- Design Contours
- Existing Contours
- Future Development Extents
- Retaining Wall
- Culvert / Pipe
- Stormwater Treatment Outlet
- Stormwater Treatment



0 20 40 60 80 100 m

1:2000 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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Map Title / Figure:

Stormwater Management Concept Viewport A

Map 03	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Legend

- Site Boundary
- Cadastre
- Preliminary Masterplan
- Retained Watercourses
- Design Contours
- Existing Contours
- Future Development Extents
- Retaining Wall
- Culvert / Pipe
- Stormwater Treatment Outlet
- Stormwater Treatment

I3 I2 H2 H1 M2 Catchment H

3.0 3.5 4.0

0 20 40 60 80 100 m

1:2000 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

N

Map Title / Figure:

Stormwater Management Concept Viewport B

Map 04	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Legend

- Site Boundary
- Cadastre
- Preliminary Masterplan
- Retained Watercourses
- Design Contours
- Existing Contours
- Future Development Extents
- Swale
- Culvert / Pipe
- Stormwater Treatment Outlet
- Stormwater Treatment

0 20 40 60 80 100 m

1:2000 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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Map Title / Figure:

Stormwater Management Concept Viewport C

Map 05	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Legend

- Site Boundary
- Cadastre
- Approved DA extents
- Preliminary Masterplan
- Retained Watercourses
- Design Contours
- Existing Contours
- Future Development Extents
- Retaining Wall
- Swale
- Culvert / Pipe
- Stormwater Treatment Outlet
- Stormwater Treatment

L1 M1 M2 N1

Catchment M

Catchment N

0 20 40 60 80 100 m

1:2000 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Map Title / Figure:

Stormwater Management Concept Viewport D

Map 06	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Legend

- Site Boundary
- Cadastre
- Approved DA extents
- Preliminary Masterplan
- Retained Watercourses
- Design Contours
- Existing Contours
- Future Development Extents
- Retaining Wall
- Swale
- Culvert / Pipe
- Stormwater Treatment Outlet
- Stormwater Treatment

N1

G1

Catchment N

Catchment G

Catchment E

Approved DA twin pipes through sand dune

Extend proposed DA twin pipes to drain into the swale

Approved DA stormwater treatment

Culvert to convey stormwater flows from Catchment E and Catchment F to approved DA stormwater management system

GAN GAN ROAD

CLARK ST

N

0 20 40 60 80 100 m

1:2000 @ A3

Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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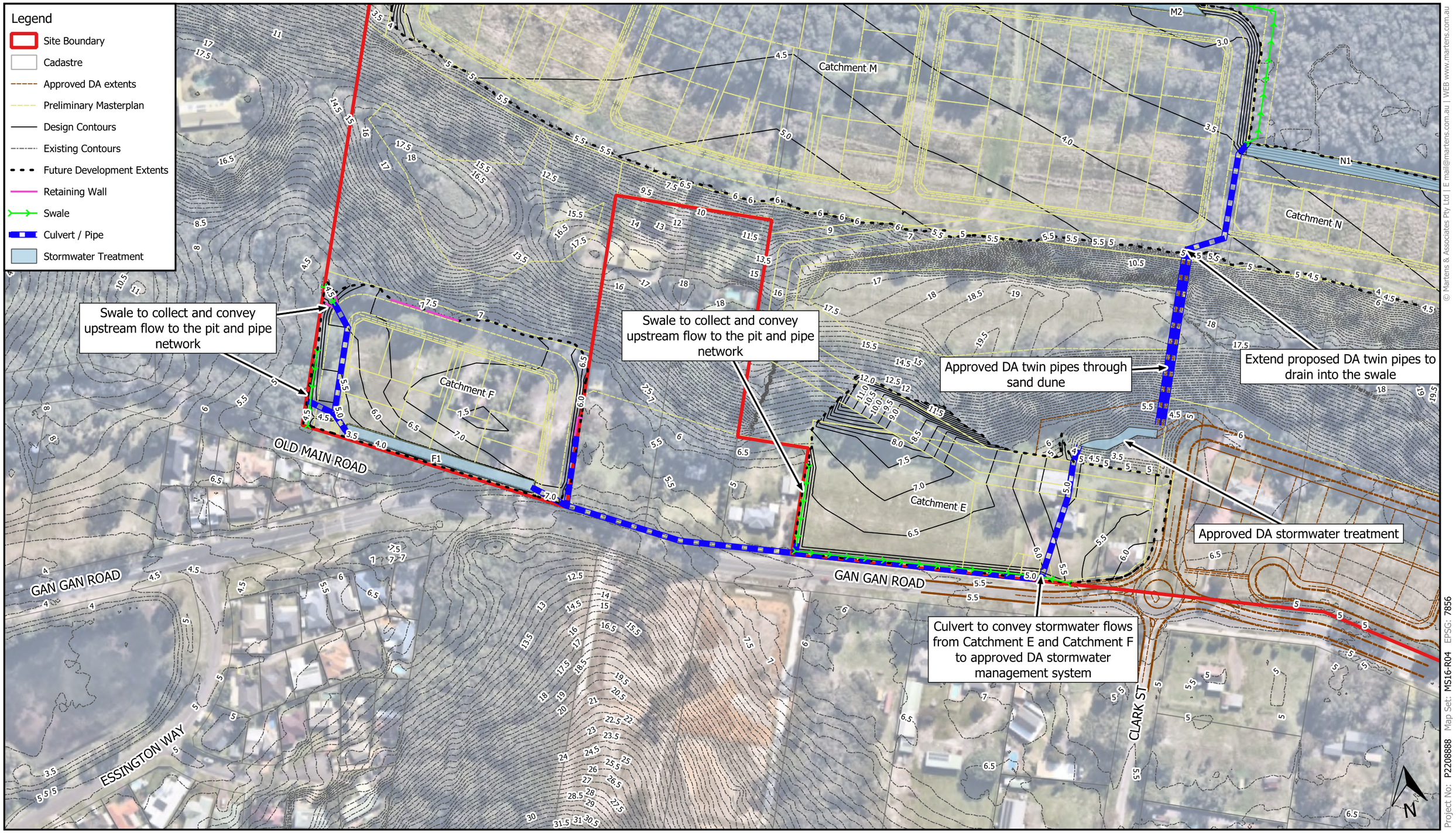
Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

Map Title / Figure:

Stormwater Management Concept Viewport E

Map 07	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date



Project No: P2208888 Map Set: MS16-R04 EPSG: 7856

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Viewport

Note:
- Aerial from Nearmap (2024).
- Cadastre from NSW Spatial Services Clip and Ship (2023).
- Preliminary masterplan from BKA Architecture (2025).
- Retained watercourses are based on MA Riparian Management Study (2024).

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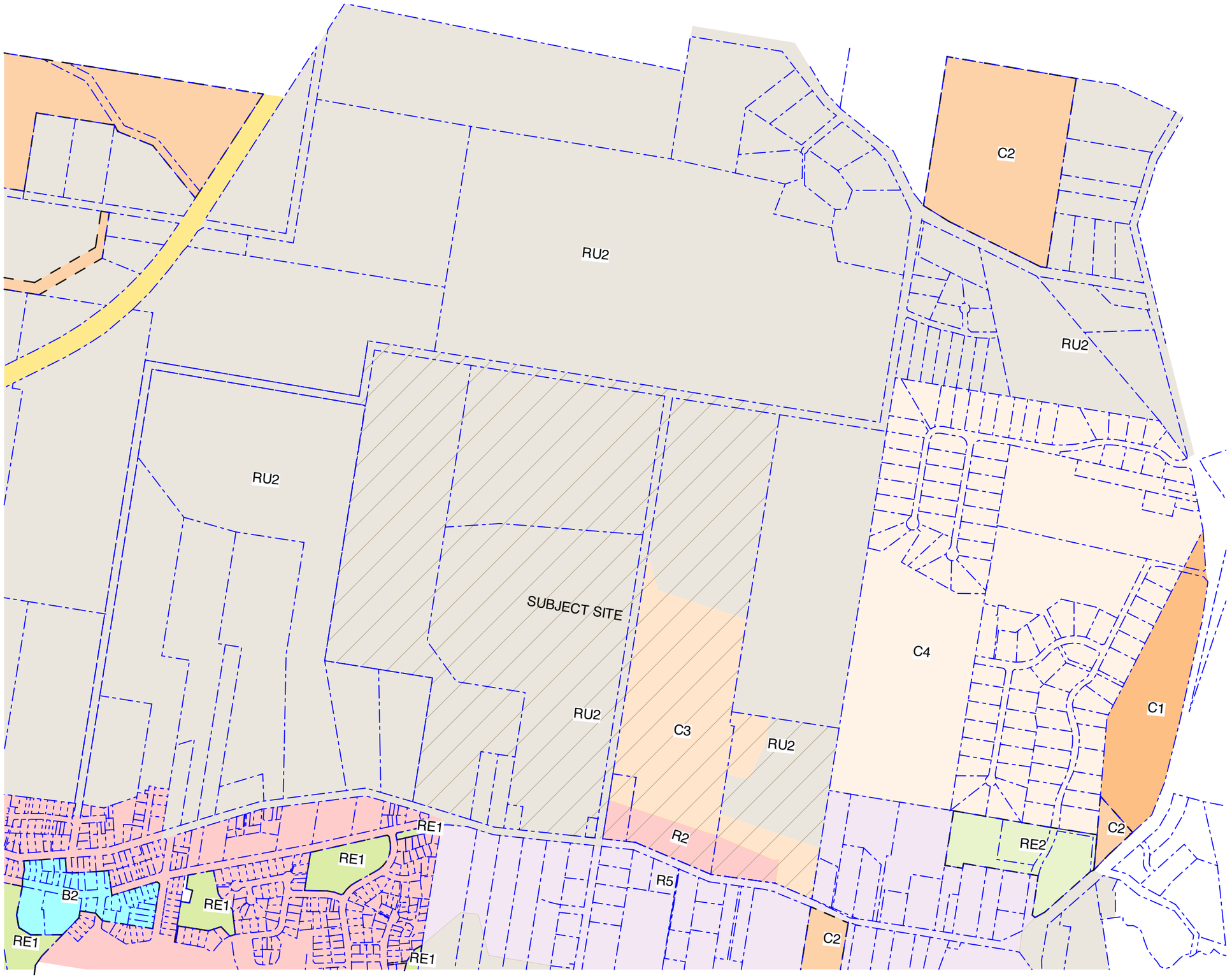
Map Title / Figure:

Stormwater Management Concept Viewport F

Map 08	Map
Gan Gan Rd & Old Main Rd, Anna Bay, NSW	Site
Proposed Land Rezoning	Project
Conceptual Stormwater Management Strategy	Sub-Project
AB Rise Pty Ltd	Client
27/08/2025	Date

Appendix B Masterplan



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Nominated Architects (NSW) - John Baker 3552, John Kavanagh 5999

Rev	Date	Issue
A	4/3/2024	Preliminary Issue to Council
B	22/3/2024	Issue for Scoping Report
C	3/12/2024	Issue for Planning Proposal

LEGEND:
Zone
- SP2 INFRASTRUCTURE
- RU2 RURAL LANDSCAPE
- R2 LOW DENSITY RESIDENTIAL
- R5 LARGE LOT RESIDENTIAL
- RE1 PUBLIC RECREATION
- RE2 PRIVATE RECREATION
- B2 LOCAL CENTRE
- C1 NATIONAL PARKS & NATURE RESERVES
- C2 ENVIRONMENTAL CONSERVATION
- C3 ENVIRONMENTAL MANAGEMENT
- C4 ENVIRONMENTAL LIVING
- SUBJECT SITE

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North

Scale at A3
1:10000

Status
Not for Construction

Drawn
VK, JG

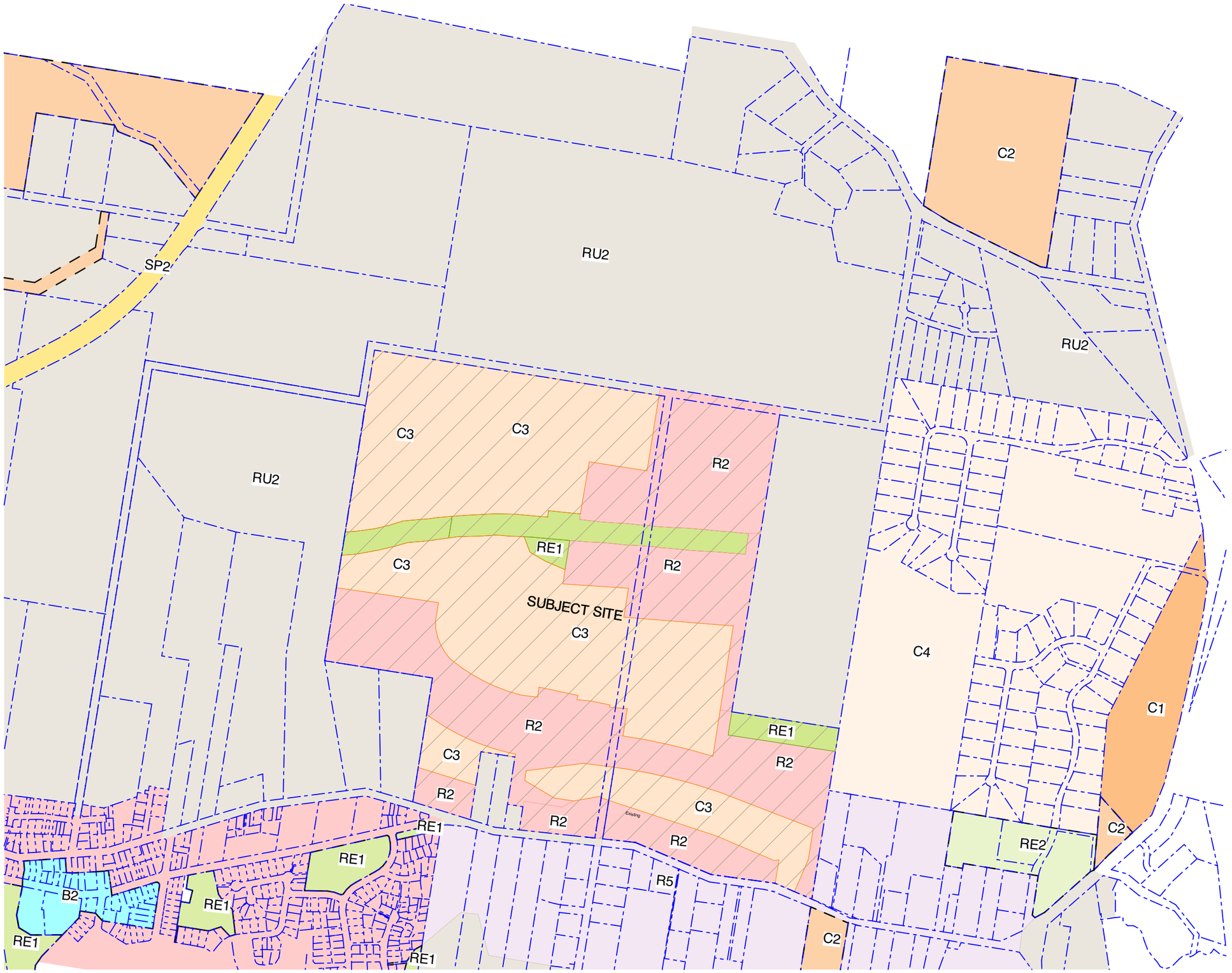
Date
3/12/2024

Checked
JG

Project Address
Gan Gan Road, Anna Bay

Drawing
Existing Land Zoning Map

Project No.	Revision	Drawing No.
22011	C	A003



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Rev	Date	Issue
B	22/3/2024	Issue for Scoping Report
C	3/12/2024	Issue for Planning Proposal
D	19/6/2025	Issue for Rezoning Panel

LEGEND:
Zone
- SP2 INFRASTRUCTURE
- RU2 RURAL LANDSCAPE
- R2 LOW DENSITY RESIDENTIAL
- R5 LARGE LOT RESIDENTIAL
- RE1 PUBLIC RECREATION
- RE2 PRIVATE RECREATION
- B2 LOCAL CENTRE
- C1 NATIONAL PARKS & NATURE RESERVES
- C2 ENVIRONMENTAL CONSERVATION
- C3 ENVIRONMENTAL MANAGEMENT
- C4 ENVIRONMENTAL LIVING
- SUBJECT SITE

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North

Scale at A3
1:10000

Status
Not for Construction

Drawn
VK, JG

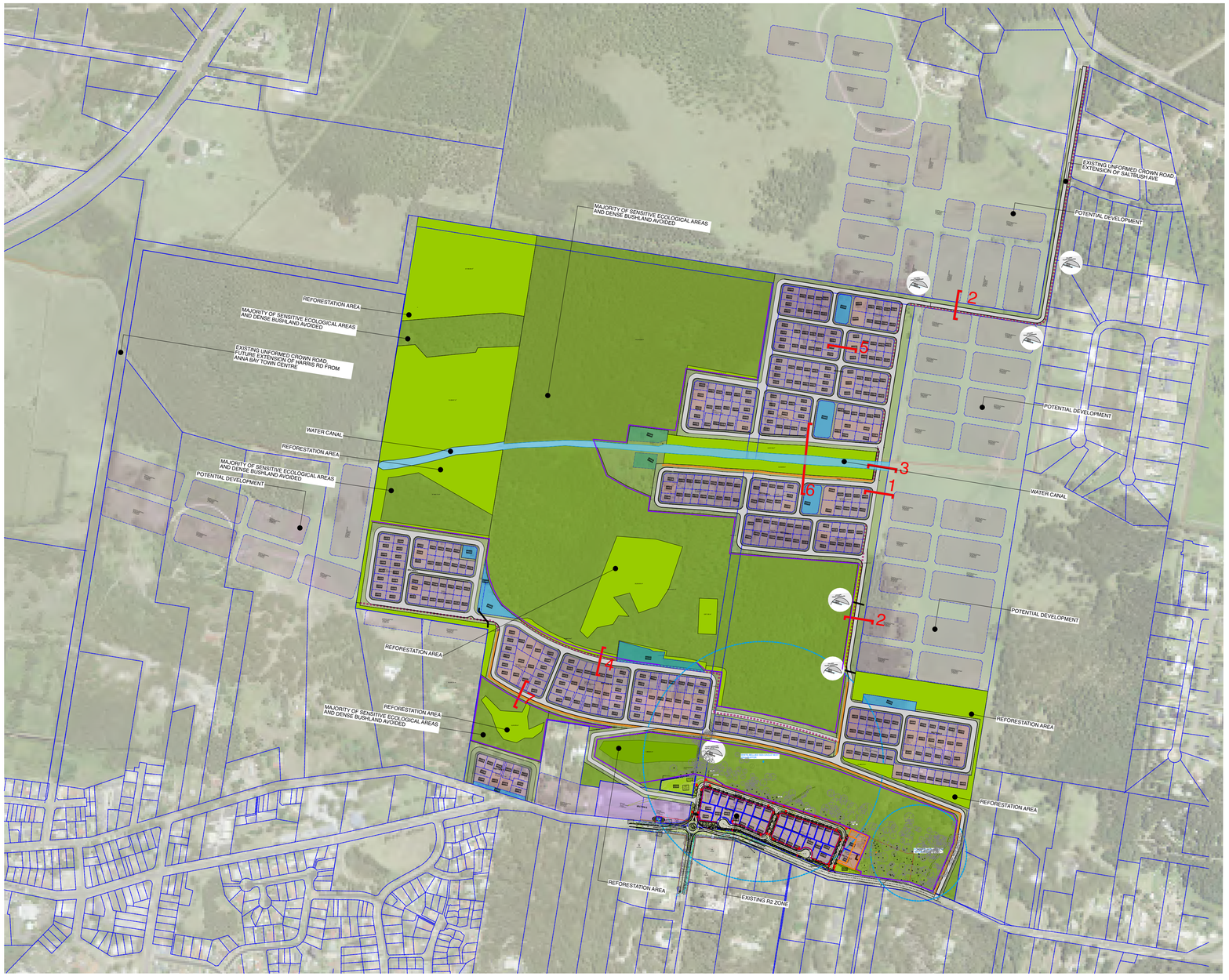
Date
19/6/2025

Checked
JG

Project Address
Gan Gan Road, Anna Bay

Drawing
Proposed Land Zoning Map

Project No.	Revision	Drawing No.
22011	D	A013



1 Proposed Masterplan
1:5000

BKA Architecture
22011 Gan Gan Rd, Anna Bay

Calculations

Site Area **Gan Gan Rd** **1,186,830 m2** **approx**

Stage	Section	Residential Area m2	Standard Blocks # 500m2 16.7m x 30m R2	Dual Occupation # 600m2 20m x 30m R2	Dwellings # R2
Stage 1	A	8,138	16		16
	B	8,153	16		16
	C	2,854	2	0	2
Stage 2	EA	6,337			25
	EB	4,328			25
	FA	7,422	10	2	14
Stage 3	GA	6,385	10	2	14
	GB	7,944	12	3	18
	GC	11,270	8	10	28
Stage 4	HA	8,083	16		16
	HB	5,724	10	1	12
	HC	8,097	8	2	12
	HD	5,743	10	1	12
	HE	9,766	18	1	20
Stage 5	IA	12,127	18	3	24
	IB	7,957	14	1	16
	IC	9,783	8	4	16
	ID	5,728	10	1	12
	IE	5,728	10	1	12
	IF	7,728	8	2	12
	IG	6,068	12		12
	IH	8,073	16		16
	IJ	8,071	16		16
Stage 6	NA	7,212	12	1	14
Stage 7	MA	11,622	12	7	26
	MB	15,050	24	3	30
	MC	15,858	16	11	38
Stage 8	LA	8,071	16		16
	LB	7,644	14	1	16
	LC	7,712	14	1	16
TOTAL		**225,530.66**	**322**	**58**	**488**

TOTAL Dwellings	**488**	
TOTAL Lots	**380**	plus 2 Multi Dwelling Housing Lots
NOTE: Excludes current R2 zoning (DA)		

General Notes

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39-41 Main St,
Clunes,
NSW 2480
T: +61 2 6687 2712

Scale at A1 1:5000
North
Project Address Gan Gan Road, Anna Bay
Date 3/12/2024
Drawn VK, JG
Checked JG
Status Not for Construction

Drawing **Proposed Masterplan and Yield**
Project No. **22011**
Revision **C**
Drawing No. **A100**