Capital Engineering Consultants

SUPPLEMENTARY WATER MANAGEMENT REPORT

Client — Warriewood Developers Pty Ltd
Project Title — Proposed Residential Development
Project No. — SW24353
Date Issued — 08/11/2024

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Revision	Issue	Status	Release Date	Approved by:
A	CC Approval	Final	08.11.2024	**Paul El-Bayeh**

Limitations

The sole purpose of this report and the associated services performed by Capital Engineering Consultants Pty Ltd is to provide an assessment of the water quality measures at the subject site in accordance with the scope of services set out in the contract / quotation between Capital Engineering Consultants Pty Ltd and Warriewood Developers Pty Ltd. That scope of works and services were defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

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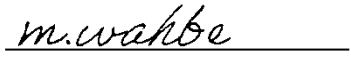
Prepared By:



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1. Introduction

1.1 Overview

A development application has been approved under **DA2021/2600** for a proposed Subdivision of Land into twelve (12) lots, supporting civil engineering works, biodiversity management of riparian/wetlands areas and the construction of two residential flat buildings at **43-45 & 49 Warriewood Road, Warriewood NSW**.

In order to satisfy Condition 1A of the Deferred Commencement, Council has indicated that the site will require an Updated Water Management Report which includes:

- Include the results of an adequate, but not more than 12 months, amount of baseline water quality and sediment quality data. This is a minimum of at least one dry weather sample collection and one wet weather sample collection from Narrabeen Creek as well as macroinvertebrate sampling on at least one occasion and accompanied by a signed checklist;
- a detailed a Maintenance Plan and Schedule for all water management facilities (including the gross pollutant traps, bioretention/OSD system and outlet works).

Capital Engineering Consultants (CEC) have been commissioned to assess Council's requirements and prepare an updated Water Management Plan in compliance with all Council codes, policies and established industry best practices.

1.2 Project Objectives and Scope of Works

CEC have been engaged by the client, to carry out the following scope and objectives to support the proposed construction certificate:

1. Review supplied water quality and sediment quality data reports;
2. Address the requirements of Council's relevant guidelines and DCP; and
3. Propose water quality/quantity Maintenance and Management Procedures for implementation

2. Background Information & Site Description

2.1 Background

Water quality design is the integration of planning & management practices for the sustainable management of the urban water cycle. Water quality design is concerned with the design of urban environments to be more "sustainable" by limiting the negative impacts of urban development on the total urban water cycle by:

- Trying to more closely match the pre-development stormwater runoff regime, in both quality and quantity;
- Reducing the amount of water transported between catchment, both in water supply import and wastewater export; and
- Optimising the use of rainwater that falls on the urban areas.

Many characteristics of urban development, such as increases in land cover, have the potential to impact the natural water-cycle and increase pollutant loads in run-off. Water quality design aims to mitigate the negative effects of urban development by:

- Improving the quality of stormwater runoff draining from urban developments.
- Integrating stormwater treatment into the landscape by using stormwater treatment systems in the landscape that incorporate multiple uses providing various benefits such as water quality treatment, wildlife habitat, public open space, recreational and visual amenity for the community.
- Reducing runoff peak flows from developments by on-site temporary storage measures (with potential for reuse) and minimise impervious areas.
- Reducing potable water demand by using stormwater as a resource through capture and reuse for non-potable purposes.

To avoid any adverse impact on the downstream drainage systems, the site stormwater system is required to be planned correctly to ensure safe conveyance of flows through the site and within the capacity of the downstream trunk drainage systems.

2.2 Site Description and Location

Refer to Table 1 and Figure 1 below for the existing site description summary:

Table 1: Site Description Summary

Summary	Site Description
Address	43-45 & 49 Warriewood Road, Warriewood NSW
Lot/DP	Lot 2 in DP972209, Lot 2 in DP349085 and Lot 1 in DP349085
Catchment Area	Narrabeen Creek

Figure 1: Site Locality Plan

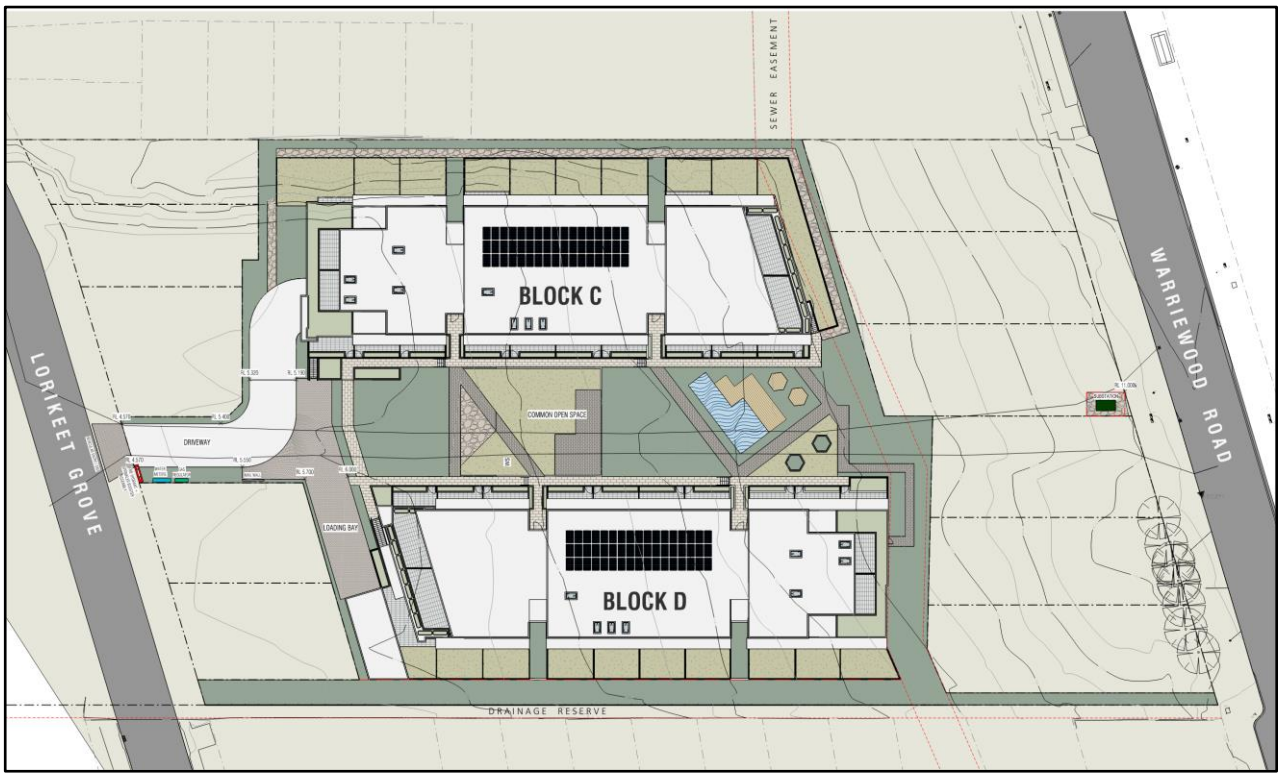
Source: Mecone Mosaic (2024)

2.3 Proposed Development

The architectural plans provided by Architex indicate the following design intent as part of the development application:

- Subdivision of Land into twelve (12) lots;
- Supporting civil engineering works, biodiversity management of riparian/wetlands areas; and
- Construction of two Residential Flat Buildings

Figure 2: Proposed Site Plan Layout



Source: Archtiex (2024)

3. Water Quality Management Measures

3.1 Introduction

Changes in urbanisation, particularly population growth and increasing urban density, have created a dramatic increase in the area of impervious surfaces within a typical urbanised catchment. The high proportion of sealed areas greatly affects both the quality and quantity of water infiltrating the soil and, as most of this rainfall is converted into run-off it is then directed into our urban waterways.

Run-off carries a range of pollutants into waterways and, although concentrations may be diluted during a run-off event, the total loads can affect the environmental quality of downstream aquatic habitats. The types of pollutants that can be found in stormwater runoff are sediments, nutrients, oxygen-demanding substances, pH (acidity), micro-organisms, toxic organics, heavy metals, litter, soil and increased water temperature.

As organic waste breaks down in a waterway a number of natural compounds such as nitrogen and phosphorus, which are essential to plant and animal life, are released. In their natural state, Australian soils and waterways are generally low in nutrient content, and consequently, the organisms living in Australian waterways have adapted to low nutrient conditions. Fertilisers such as blood and bone, superphosphate, seaweed and animal manure are used widely on private gardens and on the many parks and golf courses that are close to waterways which drain to the stormwater systems within a Council. Stormwater runoff from these areas contributes phosphorus and nitrogen to our waterways.

As such in order to limit the amount of nutrients that run-off from the sites it is important to intercept these nutrients. This section of the report addresses the long term impacts of the development on water quality and quantity. For short term effects (i.e. during the construction phase) water quality control is achieved by implementing the Sedimentation & Erosion Control measures in accordance with the submitted drawings.

3.2 Water Quality Devices/Measures

The Approved Civil Engineering Plans prepared by **ACOR Consultants** Drawings No(s) **C1.00 – C4.03** Revision **'C'** Dated **6th March 2024** detail the following Water Quality Management Treatment measures which will require appropriate Maintenance and Management Measures:

- Bio-retention basin No.1 comprising an area of 474 m2 for the treatment of proposed Lots 6-11 and the RFB site.
- Bio-retention basin No.2 comprising an area of 300 m2 for the treatment of proposed Lots 1-5 and Lorikeet Grove.
- Below ground Gross Pollutant Traps (GPTs) (one (1) for each bio-retention basin).
- 5kL rainwater re-use tanks on each torrents title lot and a 50kL rainwater re-use tank common to the RFB buildings.

It is noted that no alterations to the approved Water Quality and Quantity Measures are proposed. The Approved Water Management Plan prepared by **ACOR Consultants** Revision **'B'** dated **6th March 2024** demonstrating compliance with the relevant WSUD Controls is provided in **Appendix 1**.

4. Baseline Water Quality Monitoring

4.1 Introduction

Baseline water quality monitoring is a fundamental component of environmental management and conservation. It involves the systematic collection of data on various water quality parameters at specific locations over time.

Establishing a baseline provides a reference point against which future water quality can be compared, helping to identify trends, detect pollution sources, and assess the effectiveness of management interventions.

4.2 Council's Requirements

In order to satisfy Condition 1A of the Deferred Commencement, Council has requested additional Baseline Water Quality Monitoring, specifically:

- the results of an adequate, but not more than 12 months, amount of baseline water quality and sediment quality data. This is a minimum of at least one dry weather sample collection and one wet weather sample collection from Narrabeen Creek as well as macroinvertebrate sampling on at least one occasion and accompanied by a signed checklist;

4.3 Additional Water Quality Monitoring

H2O Consulting Group were engaged to prepare the additional Baseline Monitoring and Water Quality Assessment Report which addresses the requirements of Condition 1A of the Deferred Commencement.

A copy of the supplementary Pre-Development Baseline Monitoring and Water Quality Assessment Reporting addressing Council's requirements is provided in **Appendix 2:**

- **Appendix 2A:** Pre-Development Water Quality Assessment Report – Quarter 1 (dated **5th June 2024**) prepared by H2O Consulting Group
- **Appendix 2B:** Pre-Development Water Quality Assessment Report – Quarter 2 (dated **4th September 2024**) prepared by H2O Consulting Group

5. Treatment Device Maintenance & Management Plan

5.1 Introduction

Appropriate maintenance is essential for the short and long-term viability and effectiveness of the Water Quality Treatment devices to be installed. Experienced personnel should be used to ensure that the system is safely maintained.

Most components of the system should be checked for blockages after each significant storm to ensure that they continue to function effectively. The build-up of sludge and debris depends on the individual site and more frequent maintenance may be required where there are many trees, especially after windy conditions.

5.2 Post Construction Maintenance Actions

Immediately following the construction period and following significant rainfall, an inspection of the commissioned treatment devices shall be undertaken to ensure that builders rubble and heavy sedimentation from the construction works has not excessively contaminated the devices. Any builders rubble or heavy sedimentation shall be removed immediately if found during the initial inspection.

The duration of post construction maintenance for the proposed system is expected to be approximately **6 Months**. This period will ensure that all landscaping throughout the site is well established and if necessary, any sediment accumulation from post construction run-off from the site is removed as required.

5.3 Post-Occupation Maintenance Schedule

The following schedule provides a guide to the timing of typical maintenance actions for all Water Quality and Quantity Management Devices. It is recommended that all maintenance actions are carried out by an appropriately experienced Contractor (with the exception of the 5kL Rainwater Tanks on each Torrens Title Block which may be inspected and maintained by the future land-owners).

Bio-retention Basins 1 & 2

Short Term Maintenance:-	Removal of Litter and Debris from Basin every **3 Months and following major rainfall events.**
	Visual Inspection for Erosion and appropriate rectifications to prevent short-circuiting of flows and/or damage to the bio-retention structure **every 6 Months and following major rainfall events.**

Visual inspection of plant heath & coverage and necessary rectifications every **6 Months (or if Plant Coverage falls below 50%).**

Removal of Weeds and Invasive Species every **6 Months (or if Weed Coverage exceeds 20%).**

Long Term Maintenance:- Visual inspection of all pits and removal of accumulated sediment/sludge every **6 Months.**

Visual inspection of inlet/outlet structures (outfall, check-valve and surrounding swale/rip-rap) and removal of blockages/replacement of damaged components every **6 Months.**

Confirm permeability of Basin Surface (water poured on surface should completely infiltrate with a few minutes) every **12 Months**.

Below Ground Gross Pollutant Traps (GPTs)

Short Term Maintenance:- Visual inspection of inlet aperture, Removal of large floatable pollutants and Measuring of sediment depth every **6 Months**

Long Term Maintenance:- Removal of accumulated sediment and gross pollutants via vacuum truck (or similar) every **12 Months**.

Inspection and Cleaning of Screening Element every **24 Months.**

50 kL Rainwater Re-Use Tank (Common to the RFB Buildings)

Short Term Maintenance:- Visual inspection of inlet aperture, gutters downpipes, mosquito screens, etc. every **6 Months**

Visual Inspection and emptying of First Flush Unit and Tank Overflow confirming no blockages every **6 Months**

Long Term Maintenance:- Visual inspection of Pumps, Valves and Filters (allow for replacement of any filters if deemed necessary) every **12 Months**.

Visual Inspection of Tank Base, Body and Integrity (allow for rectifications as necessary) **60 Months.**

Visual Inspection and Removal of excess Sediment/Sludge (if necessary) from Tank base every **60 Months.**

5 kL Rainwater Re-Use Tanks (on each Torrens Title Lot)

Short Term Maintenance:-

Visual inspection of inlet aperture, gutters downpipes, mosquito screens, etc. every **6 Months**

Visual Inspection and emptying of First Flush Unit and Tank Overflow confirming no blockages every **6 Months**

Long Term Maintenance:-

Visual inspection of Pumps, Valves and Filters (allow for replacement of any filters if deemed necessary) every **12 Months**.

Visual Inspection of Tank Base, Body and Integrity (allow for rectifications as necessary) **24 Months.**

Visual Inspection and Removal of excess Sediment/Sludge (if necessary) from Tank base every **60 Months.**

6. Conclusion

Should no action be taken in providing a satisfactory level of water quality management on newly developed sites, our natural creeks and waterways will be inundated with the growth of algae which can become a major factor in destroying the existing native and aquatic life that currently exists. For this reason, it is important to ensure that satisfactory reductions are achieved.

Therefore, the key strategies proposed are to be adopted for this development include the following:

- Bio-retention basin No.1 comprising an area of 474 m2 for the treatment of proposed Lots 6-11 and the RFB site.
- Bio-retention basin No.2 comprising an area of 300 m2 for the treatment of proposed Lots 1-5 and Lorikeet Grove.
- Below ground Gross Pollutant Traps (GPTs) (one (1) for each bio-retention basin).
- 5kL rainwater re-use tanks on each torrents title lot and a 50kL rainwater re-use tank common to the RFB buildings.
- A comprehensive Maintenance and Management Plan for all Water Quality Installations to ensure on-going operation in accordance with the approved design intent.

Appendix 1

Supplementary Water Management Plan
(Revision 'B' dated 6th March 2024)

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INFRASTRUCTURE
PLANNERS

DEVELOPMENT
CONSULTANTS

Supplementary Water Management Report

& Response to Contentions

For a Proposed Residential Development

Prepared for: **Warriewood Developers Pty Ltd**

Project address: **Lots 1 & 2 in DP 349085 (No. 45-49) and Lot 2 in DP 972209 (No.43) Warriewood Road, Warriewood**

Document No.: **CC230177_WMP**

Version No.: **B**

Dated: **6 March 2024**

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VERSION HISTORY

Version	Date	Purpose	Prepared By	Approved By
A	15/12/2023	Supplementary Water Management Report	Nathan Broadbent	
B	6/03/2024	Revised Supplementary Water Management Report	Nathan Broadbent	

Review Panel	
Division/Office	**Name**

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Annexures

Annexure A	ACOR Consultants (CC) Pty Ltd Civil Engineering Plans, reference CC230177, sheets C1.00 to C4.03 (26 sheets), Revision C dated 6 March 2024.

1 Introduction

This report has been prepared as a supplementary report to the Engineering Report prepared by C & M Consulting Engineers, Report No. R2192, Revision C, dated 4 June 2021 and seeks to address the relevant design short falls outlined in the Statement of Facts and Contentions (SOFCAS) reference No. 2023/00096634. This report also incorporates engineering concepts discussed with Northern Beaches Council and their representatives during the preparation of this report.

During the preparation of this report, information was sourced from various documents. These included, but are not limited to the following:

- Addendum Flood Impact Assessment prepared by BMT.
- Civil Engineering Works prepared by C & M for the subject site, drawing No.'s 02192-100 to 02192 (14 sheets), revision 4, dated 26 July 2023.
- Detailed Site Investigation report prepares by Sydney Environmental Group, Report No. 2148-DSI-01-280723.v1f, dated 28 July 2023.
- Engineering Report prepared by C & M, reference R02192, Revision C, dated 4 June 2021.
- Northern Beaches Council Pittwater Development Control Plan (DCP) 21
- Northern Beaches Council Warriewood Valley Water Management Specification 2001
- Northern Beaches Council Water Management for Development Policy.
- Statement of Facts and Contentions (SOFCAS) reference No. 2023/00096634 filed 18 May 2023.

2 Site overview

The subject site is known as Lots 1 & 2 in DP 349085 (No. 45-49) and Lot 2 in DP 972209 (No.43) Warriewood Road, Warriewood.

The site is bound by Warriewood Road to the north, Narrabeen Creek to the south and residential development to the east and west.

Current structures on the site includes two dilapidated former dwellings and several ancillary minor structures. Prior to partial clearing of the site in 2020, the site contained approximately 20 rows of greenhouses, the purpose of which was not known at the time of preparation of this report.

The locality of the site in relation to Narrabeen Creek and surrounding development is depicted in Figure 1.

Figure 1. Site locality plan

The site comprises an area of approximately 2.157 ha. This includes a developable area of approximately 1.37 ha including road and drainage works.

2.1 Proposed development

The proposed development consists of two Residential Flat Buildings and a Torrens Title Subdivision creating 11 new residential allotments.

The primary details of the proposed development are depicted on Site Plan prepared by Archidrome, Drawing No.A03, Revision 12, dated 6 March 2024 and generally comprises the following:

- Two (2) Residential Flat Buildings (RFBs) with a basement.
- Creation of eleven (11) Torrens Title residential lots.
- Extension of the Lorikeet Grove corridor through the site including drainage works.
- Road upgrade works within Warriewood Road including drainage infrastructure and additional roadside parking.

- Construction of a stormwater culvert within the existing drainage easement positioned along the site's eastern boundary.
- Construction of two bioretention basins within the Narrabeen Creek wetland.
- Construction of a suspended walkway through the wetland.

We note that works assessed under as part of a future application to Council required under Section 138 of the Roads Act are not discussed in detail in this report.

2.2 Topography

The site falls generally towards Narrabeen Creek from northeast to southwest. Ground surface elevations on the site are generally within the range of RL 12.5 m AHD near northwest corner of the stie to RL 2.4 m AHD within the drainage channel along the eastern boundary.

2.3 Existing geotechnical conditions

A detailed description of the site can be found in the in Detailed Site Investigation report prepares by Sydney Environmental Group (SEG), Report No. 2148-DSI-01-280723.v1f, dated 28 July 2023.

The SEG report identifies 23 test pits were installed in various locations across the developable site using a combination of hand augering and mechanical excavation with a 5t excavator.

The bore logs indicate most of the subsurface conditions within the developable parts of the site consist of clayey fill underlain by natural clay to various depths of up to 1.5 metres bgs.

3 Water Cycle Assessment

A water balance was prepared for the site under existing and proposed conditions and considers three years independent years of daily rainfall data obtained for the Mona Vale rainfall gauge and average monthly evapotranspiration data for the area. Rainfall years were selected to allow assessment of existing and proposed conditions for a typical dry year, average year, and wet year. The selected years and associated rainfall depths are as follows:

- 2002 (dry year) with a rainfall total of 865 mm.
- 1984 (average year) with a rainfall total of 1068 mm.
- 1998 (wet year) with a rainfall total of 1650 mm.

A water balance was prepared for each year under existing and proposed conditions to determine following design constraints and parameters.

- Proposed surface runoff volume check against predevelopment conditions modelling (refer Section 3)
- Anticipated reuse demand based on varying rainfall totals for each year assessed.

3.1 Water balance – existing conditions

A water balance was conducted for the developable site area under existing conditions. The parameters adopted for the water balance assessment is outlined in Table 1.

Table 1 - Water balance for existing conditions

Existing case		
Areas	Value	Unit
total area	13,470	m^2
pervious area	12,123	m^2
impervious area	1,347	m^2
Reuse		
no reuse provided for existing conditions		
Losses		
pervious area loss (mm)	5	mm
impervious area loss (mm)	1	mm
Statistics		
number of runoff days	71	days
number of runoff days	76	days
number of runoff days	98	days
Annual runoff total		
dry year	6.27	ML
average year	8.41	ML
wet year	15.23	ML

The results of the site water balance for the existing case were used to assess the potential for a variation in post-development stormwater runoff from the site. We note the first principles approach used in this assessment does not account infiltration. Subsequently, the results from MUSIC will ultimately be relied upon and this water balance will inform re-use rates for MUSIC modelling and also provide a check for stormwater quantities.

3.2 Post-development water balance methodology

The post-development water balance was prepared to for each of the three years described above (wet, dry, and average rainfall). The flow of the water balance calculations is depicted below in Figure 2.

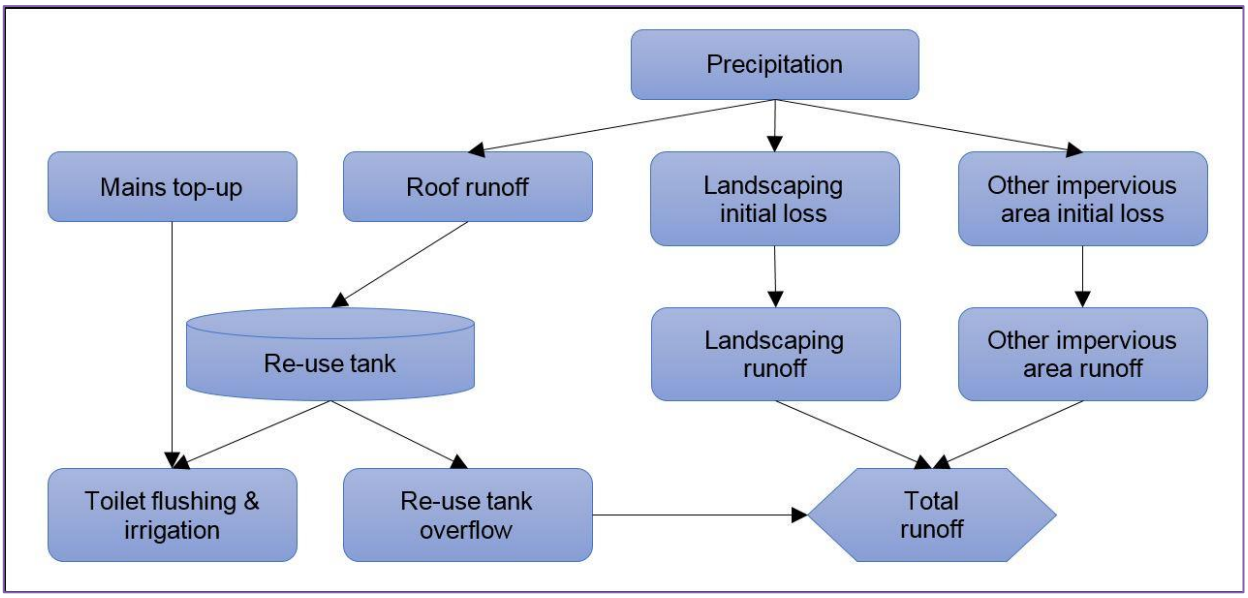

Figure 2. Water balance flow

3.2.1 Pervious area treatment

The pervious area initial loss for areas of proposed deep soil was increased to reflect a sandy loam topsoil as opposed to silty clay which is present under existing conditions.

3.2.2 Rainwater re-use calculations

Re-use was determined specifically for each year based on moisture deficit. The moisture deficit was calculated daily by subtracting the daily evapotranspiration from the daily rainfall. Only on days where the moisture deficit is equal to or greater than 10 mm was a re-use event triggered.

Based on the above methodology, the annual re-use demand varied for each year depending on the rainfall trend. i.e. for drier years, the demand for irrigation is higher than it is for wet years. This is captured in this methodology and the results are presented in Section 3.3.

3.3 Water balance – proposed conditions

A water balance was conducted for the developable site area under proposed conditions for each of the assessed years. The results are presented in Table 2 for the dry year, Table 3 for the average rainfall year and Table 4 for the wet year.

Table 2. Post-development water balance (dry year)

Post-development site (dry year)		
Areas		
total area	13,470	m^2
impervious area draining to re-use	2,800	m^2
pervious area	4,700	m^2
impervious area graded to landscaping	0	m^2
impervious area bypassing reuse & landscaping	5970	m^2
Reuse		
total reuse tank volume	105	m^3
initial fraction full of reuse tanks	100	%
irrigation use per event (pervious areas only)	0.015	m
deficit before irrigation	10	mm
Losses		
pervious area loss (mm)	10	mm
impervious area loss (mm)	1	mm
area to re-use loss (mm)	0.5	mm
Statistics		
number of tank spill days	6	
number of irrigation days	80	
annual irrigation volume	4.79	ML
Annual runoff total		
number of runoff days	71	days
total runoff volume (dry year)	6.40	ML

Table 3. Post-development water balance (average rainfall year)

Post-development site (average year)		
Areas		
total area	13,470	m^2
impervious area draining to re-use	2,800	m^2
pervious area	4,700	m^2
impervious area graded to landscaping	0	m^2
impervious area bypassing reuse & landscaping	5970	m^2
Reuse		
total reuse tank volume	105	m^3
initial fraction full of reuse tanks	100	%
irrigation use per event (pervious areas only)	0.015	m
deficit before irrigation	10	mm
Losses		

pervious area loss (mm)*	10	mm
impervious area loss (mm)	1	mm
area to re-use loss (mm)	0.5	mm
Statistics		
number of tank spill days	30	
number of irrigation days	75	
annual irrigation volume	4.49	ML
Annual runoff total		
number of runoff days	76	days
total runoff volume (average rainfall year)	9.26	ML

Table 4. Post-development water balance (wet year)

Post-development site (wet year)		
Areas		
total area	13,470	m^2
impervious area draining to re-use	2,800	m^2
pervious area	4,700	m^2
impervious area graded to landscaping	0	m^2
impervious area bypassing reuse & landscaping	5970	m^2
Reuse		
total reuse tank volume	105	m^3
initial fraction full of reuse tanks	100	%
irrigation use per event (pervious areas only)	0.015	m
deficit before irrigation	10	mm
Losses		
pervious area loss (mm)*	10	mm
impervious area loss (mm)	1	mm
area to re-use loss (mm)	0.5	mm
Statistics		
number of tank spill days	44	
number of irrigation days	72	
annual irrigation volume	4.31	ML
Annual runoff total		
number of runoff days	99	days
total runoff volume (wet year)	16.38	ML

Based on the foregoing, it has been determined that under proposed conditions, post development flows are +-10% of pre-development conditions. Additionally, the number of runoff days under proposed conditions are the same as pre-development conditions except for the wet year which reports one additional runoff generating event per year when compared to existing conditions.

4 Water Quality Assessment

4.1 Water quality monitoring plan

A water quality monitoring plan has been prepared by H2O Consulting Group. We understand the water monitoring plan will be used to set baseline water quality parameters for the site and will also define minimum testing requirements.

4.2 Water quality monitoring data

Water quality testing is being undertaken by H2O Consulting Group.

5 Water Quality Management

5.1 Erosion and sediment control during construction

During construction, an erosion and sediment control plan to be prepared prior to issue of construction certificate will be designed and implemented in accordance with Council requirements and the requirements of NSW DPE document '*Managing Urban Stormwater: Soils and Construction*' 2008.

We note an erosion and sediment control plan is not required at Development Application stage in accordance with the Warriewood Water Management Specification checklist included under Annexure xx.

5.2 Proposed stormwater quality measures – post-development

Stormwater runoff quality from the development has been assessed under pre- and post-development conditions using MUSIC software which considers the treatment train depicted in Figure 1. The water quality treatment systems for the site consist of the following:

- Bio-retention basin No.1 comprising an area of 474 m^2 for the treatment of proposed Lots 6-11 and the RFB site.
- Bio-retention basin No.2 comprising an area of 300 m^2 for the treatment of proposed Lots 1-5 and Lorikeet Grove.
- Below ground Gross Pollutant Traps (GPTs) (one (1) for each bio-retention basin).
- 5kL rainwater re-use tanks on each torrents title lot and a 50kL rainwater re-use tank common to the RFB buildings. Total proposed rainwater re-use tank volume is 105 kL for the development.

5.3 MUSIC modelling

MUSIC modelling software is a commonly utilised and accepted software for modelling the effectiveness of stormwater quality treatment devices.

The following scenarios were assessed for the three years described in Section 3.

- Existing site conditions (pre-development)
- Proposed development (post-development) with proposed water quality treatment measures.

The MUSIC model schematic is presented in Figure 3, and a summary of inputs and results are presented thereafter.

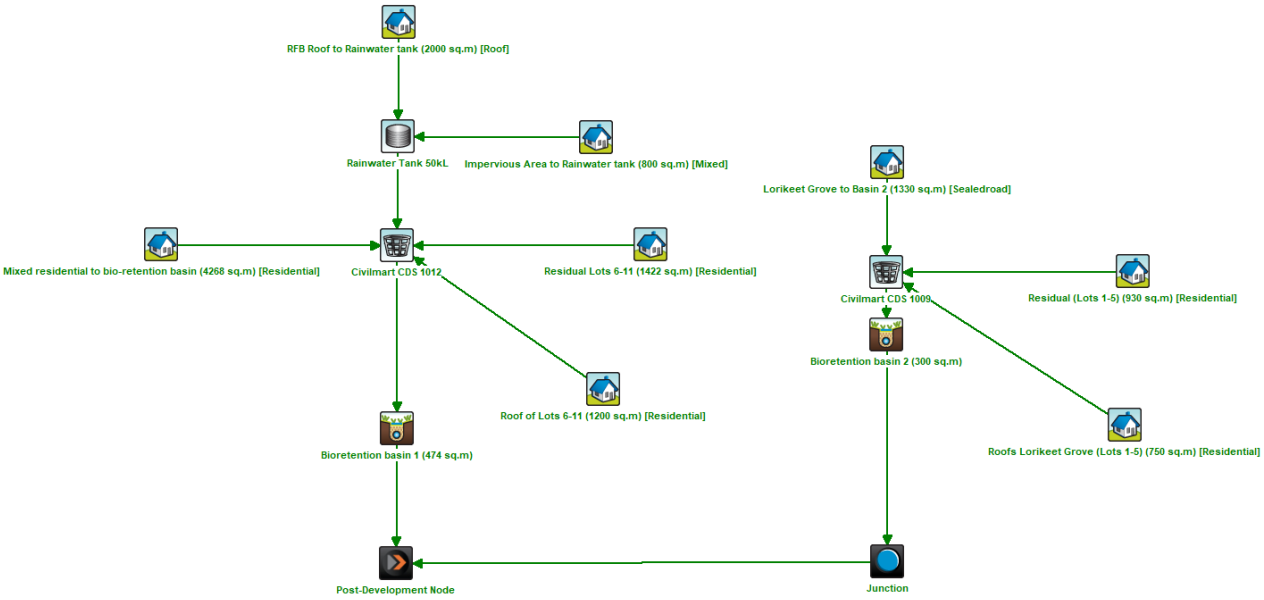

Figure 3. MUSIC model schematic

5.3.1 Catchment areas

The pre- and post-development catchments considered are presented in Table 5 below.

Table 5. MUSIC catchment summary

Catchment	Area (ha)	Impervious Fraction (%)
Existing site	1.347	10
RFB roof to rainwater tank	0.2	100
RFB (residential) to bio-retention basin 1	0.426	47
Impervious RFB area to rainwater tank (refer to BASIX)	0.08	100
Roof of lots 6-11	0.12	100
Residual area for lots 6-11	0.142	30
Basin 1 area	0.047	0
Lorikeet Grove to basin 2	0.133	85
Roof of lots 1-5	0.072	10
Residual area for lots 1-5	0.09	100
Basin 2	0.03	0

5.3.2 Source of rainfall and evapotranspiration data

Rainfall data was sourced from the Bureau of Meteorology via the website.

The data was sourced as daily rainfall data and average monthly evapotranspiration for the Mona Vale golf course (gauge 066141) as described in Section 3.

5.3.3 Pollutant loads

The Event Mean Concentrations for pollutants loading was defined in the MUSIC model in accordance with the parameters required by Council WMS. These EMCs are presented in Table 6 below.

Table 6. Pollutant loads

Land use	Total Suspended Solids (TSS) (mg/L)	Total Phosphorus (TP) (mg/L)	Total Nitrogen (TN) (mg/L)
Rural residential (existing site conditions)	35	0.1	1
Urban (proposed site)	100	0.3	1.5

5.3.4 Pollutant capture targets

The proposed treatment system was tested against two pollutant targets. Firstly, against the general requirements of Northern Beaches Council's Water Management for Development Policy (WMDP). Secondly, against the requirements of Council WMS. The targets outlined in the WMDP are presented in Table 7 and the WMS requires post-development pollutants to be less than or equal to pre-development conditions.

Table 7. Pollutants capture targets.

Pollutant	Target
Total suspended solids (TSS)	80% capture
Total phosphorus (TP)	65% capture
Total nitrogen (TN)	45% capture
Gross pollutants (GP)	90% capture

5.3.5 Bio-retention basin features

The features of the bio-retention basins are presented below in Table 8.

Table 8. Bio-retention basin properties.

Basin	Basin Area (m^2)	Extended detention depth (m)	Saturated hydraulic conductivity (mm/hr)	Underdrain (yes/no)	Basin lined (yes/no)
Basin 1	474	0.3	100	yes	yes
Basin 2	300	0.2	100	yes	yes

5.3.6 Gross pollutants traps

The pollutants traps proposed for the site include the following:

- Basin 1 – CDS unit 1012
- Basin 2 – CDS unit 1009

The CDS units are based on preliminary sizing from Civil Mart to cater for flows up to the 1 year ARI flows. An approved equal may be appropriately designed at construction certificate stage if the above is not desirable.

5.3.7 Music modelling results

Based on the foregoing, the outputs from the pre-development MUSIC model were compared to post-development outputs. The results are presented in Table 9, Table 10, and Table 11 for each year assessed.

Table 9. MUSC results (dry year).

	Parameter	Existing case	Post-dev pollutant load (without treatment)	Post-dev (with treatment)	Post-dev reduction (%)	Pre-dev vs Pos-dev reduction (%)
Dry (2002)	Flow (ML/yr)	3.91	7.42	4.2	43.5%	-7.4%
	TSS (kg/yr)	203	1110	11.8	98.9%	94.2%
	TP (kg/yr)	0.411	2.24	0.273	87.8%	33.6%
	TN (kg/yr)	4.82	14	2.67	80.9%	44.6%
	GP (kg/yr)	50.3	212	0	100.0%	100.0%

Table 10. MUSIC results (average year).

	Parameter	Existing case	Post-dev pollutant load (without treatment)	Post-dev (with treatment)	Post-dev reduction (%)	Pre-dev vs Pos-dev reduction (%)
Ave (1984)	Flow (ML/yr)	5.7	9.97	5.88	41.0%	-3.16%
	TSS (kg/yr)	218	1450	15.7	98.9%	92.80%
	TP (kg/yr)	0.679	3.38	0.372	89.0%	45.21%
	TN (kg/yr)	5.04	18	3.72	79.4%	26.19%
	GP (kg/yr)	77.7	281	0	100.0%	100.00%

Table 11. MUSIC results (wet year).

	Parameter	Existing case	Post-dev pollutant load (without treatment)	Post-dev (with treatment)	Post-dev reduction (%)	Pre-dev vs Pos-dev reduction (%)
Wet (1998)	Flow (ML/yr)	13.7	17	12.9	23.8%	5.84%
	TSS (kg/yr)	576	2120	33.2	98.4%	94.24%
	TP (kg/yr)	1.61	5.41	0.8	85.2%	50.31%
	TN (kg/yr)	14.4	32.3	7.87	75.6%	45.35%
	GP (kg/yr)	98.9	323	0	100.0%	100.00%

Based on the foregoing, the proposed water quality management system meets the water quality targets prescribed by Council Water Management for Development Policy and the Warriewood Water Management Specification. Additionally, we note that the annual flow has generally been maintained from pre-development to post-development within acceptable tolerances (+-10% of pre-development flows). Subsequently, no additional flow control such as pumping is required to maintain existing flow behaviour on the site.

6 Stormwater Quantity Management

Stormwater runoff rate and quantity is managed by the provision od detention storage in the bio-retention basins. The storage volume for quantity management has been provided above the extended detention depths report in Section 5.3.5.

A DRAINS model was prepared to assess pre- and post-development stormwater runoff from the site.

The catchment considered in the DRAINS model for each basin is depicted in Civil Engineering Plans prepared by ACOR Consultants Pty Ltd, Reference CC230177, Sheet C1.01, Revision C, dated 6 March 2024 (copy enclosed under Annexure A).

The DRAINS model configuration represents the stormwater management on-site detention basins depicted on in Civil Engineering Plans prepared by ACOR Consultants Pty Ltd, Reference CC230177, Sheets C3.05 & C3.06, Revision C, dated 6 March 2024 (copy enclosed under Annexure A).

A copy of the DRAINS model files has been forwarded to Council for assessment.

6.1 DRAINS catchment parameters.

A summary of the DRAINS catchment parameters for both pre- and post-development conditions are presented below in Table 12.

Table 12. DRAINS parameters.

Parameters	Existing conditions basin 1	Existing conditions basin 2	Proposed conditions basin 1	Proposed conditions basin 2
Catchment area (ha)	0.931	0.286	0.931	0.286
Impervious fraction (%)	0	0	70	90
Time of concentration	Pervious - 8 mins	Pervious - 8 mins	Pervious - 8 mins Impervious - 5 mins	Pervious - 8 mins Impervious - 5 mins

6.2 On-site detention results

The pre- and post-development results for basin 1 and basin 2 catchments are presented in Table 13 and Table 14 respectively.

Table 13. On-site detention results basin 1.

Basin 1 catchment			
Storm event	Pre-development flow (m^3/s)	Post-development flow (m^3/s)	Detention volume utilised (m^3)
1yr ARI +CC	0.219	0.152	125
5yr ARI +CC	0.418	0.227	235
10yr ARI +CC	0.481	0.248	260
20yr ARI +CC	0.565	0.275	330
100yr ARI +CC	0.687	0.567	400

Table 14. On-site detention results basin 2.

Basin 2 catchment			
Storm event	Pre-development flow (m^3/s)	Post-development flow (m^3/s)	Detention volume utilised (m^3)
1yr ARI +CC	0.067	0.024	85
5yr ARI +CC	0.128	0.061	115
10yr ARI +CC	0.148	0.085	118
20yr ARI +CC	0.173	0.093	142
100yr ARI +CC	0.211	0.127	170

Based on the foregoing, the proposed detention basins attenuate flows for all storms up to and including the 100 Year ARI storm event with consideration of climate change (30% increase in rainfall).

6.3 Distribution of outflows from the detention basins

Both proposed detention basins discharge into a specifically designed energy dissipation and level spreader system. The detail of the system is depicted on Civil Engineering Plans prepared by ACOR Consultants Pty Ltd, Reference CC230177, Sheets C3.05 & C3.06, Revision C, dated 6 March 2024 (copy enclosed under Annexure A) and generally comprises 2 m wide rock lined swale designed to dissipate flows at the existing natural surface level downstream of the basins.

6.4 Distribution of outflows from the proposed culvert

A 2.1 m wide 0.6 m high culvert is proposed within the 3.5 m wide proposed easement along the site's eastern boundary. The culvert has been designed to convey the full 100 year ARI flows from the upstream catchment. Details of the culvert are depicted on ACOR Consultants Pty Ltd, Reference CC230177, Sheet C3.14, Revision C, dated 6 March 2024 (copy enclosed under Annexure A).

The outlet of the proposed culvert comprises an energy dissipation area including a low flow weir to ensure pre-developed flows are conveyed to Narrabeen Creek via an existing channel during all storm events up to and including the 1 year ARI storm event. When the 1 year ARI flows are exceeded, stormwater will overflow via a weir into the proposed level spreader system and distributed at natural surface levels into the wetland.

7 Watercourse and Corridor Preservation

Based on the foregoing, the proposed water quality systems and on-site detention systems ensure that the proposed development does not result in adverse impacts relating to water quantity and water quality on the downstream wetlands which support a variety of endangered ecological communities.

8 Flood Protection

The following consideration have been made in relation to the management of flood risk on the site:

- All proposed new lots are proposed to be constructed to levels above the applicable Flood Planning Level of RL 4.71 m AHD and allow for the construction of future dwellings with habitable floor levels at or above the Probable Maximum Flood (PMF) level of RL 4.88 m AHD.
- Construction of the overland flow path along the proposed 3.5 m wide drainage easement has been designed to ensure PMF flows are H1 or H2 hazard (not hazardous to people).

Refer to Flood Impact Assessment prepared by BMT for additional information relating to flood impacts and flood risk management.

9 Stormwater Drainage Concept Plan

The stormwater drainage concept plan is depicted on Civil Engineering Plans prepared by ACOR Consultants Pty Ltd, Reference CC230177, Sheet C1, Revision C, dated 6 March 2024 (copy enclosed under Annexure A). The plans incorporate all of the details covered in this report which have been prepared in line with current industry standards and applicable Council requirements.

9.1 Sydney water sewer pipe

There is an 1800mm dia. Sydney Water sewer pipe traversing the site within a 5 m wide easement. The details of the sewer have been confirmed on site by a qualified contractor considered in the preparation of the stormwater management concept for the site. The proposed stormwater system interacts with the 5 m wide sewer easement in the following locations:

- Minor stormwater pipes must cross **over** the sewer in three locations. The locations are depicted on ACOR Consultants Pty Ltd, Reference CC230177, Sheet C2.01, Revision C, dated 6 March 2024 (copy enclosed under Annexure A).
- The proposed 2.1 m wide, 0.6 m high culvert must cross **below** the sewer pipe. We note the culvert proposes a 450 mm vertical clearance to the underside of the sewer pipe.

Notwithstanding, the above will form part of an out of scope application to Sydney Water prepared by a suitably qualified Water Services Coordinator during construction certificate stage.

10 Contentions

To address the contentions raised by Council, supplementary civil engineering plans have been prepared. In this regard, we refer to our document reference CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 (copies enclosed under Annexure A). The DRAINS modelling and MUSIC modelling which forms the basis for our revised design can be forwarded to Council and their representatives for review. A description of the DRAINS modelling parameters are outlined in Addendum Flood Impact Assessment prepared by BMT.

The relevant contentions and associated responses are included in Table 15.

Table 15. Contentions and responses.

No.	Contention	Response
3.a.i	The proposal seeks to discharge stormwater into the wetlands at the rear of the site. The Applicant has not addressed the impacts of the outlet flow upon the wetlands, which contain a groundwater dependent EEC.	We refer to our document CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 and note that an updated BDAR has been prepared based on these plans. We confirm our revised engineering plans provide an outcome that accommodates the maintenance of base flows currently servicing the EEC.
3.a.ii	The proposal seeks to construct a 900mm RCP stormwater line within the existing drainage reserve (43 Warriewood Road) to cater for the 1 in 100-year AEP upper catchment flow from upslope of the site. Although this approach is supported in principle, the Applicant has not demonstrated how the flow of water from upslope is to be suitably captured/directed into the proposed pipeline	A DRAINS model has been prepared based on our revised civil engineering plans. The model demonstrates that the revised stormwater system is able to capture all of the 100 Year ARI +CC30 flows from Warriewood Road and convey them via the proposed culvert to Narrabeen Creek. The DRAINS modelling includes a 20% blockage applied to all on-grade pits and a 50% blockage to all sag pits.
3.a.iii	The proposed 900mm RCP stormwater line within the existing drainage reserve (43 Warriewood Road) is required to be included in the TUFLOW model, inclusive of all existing and proposed drainage systems in the catchment in order to demonstrate that there are no adverse impacts associated with the proposal up to the PMF Event. The assessment needs to assess the worst-case scenario where there is a coincidental local catchment and Narrabeen Creek event up to the PMF event.	Refer to supplementary information prepared by BMT. We note the proposed overland flow path coveys PMF floodwater falling within the H1-H2 hazard classification which is non-hazardous to people.
3.a.iv	The Applicant has not provided sufficient detail with respect to the design of the overland flow path over the proposed stormwater line within the existing drainage reserve. Cross sections are required along the overland flow path to detail the 1& AEP Top Water Levels and to ensure that all habitable areas are a minimum of 500mm above these levels.	We refer to our response to contention 3.a.ii and note that a revised design and associated DRAINS model has been prepared which demonstrates the system depicted on our revised civil engineering plans can sufficiently capture and convey 100 Year ARI + CC30 flows through the site.

No.	Contention	Response
3.a.v	The overland flow path dissects Lot 1 and limits the available footprint for future development.	We refer to Site Plan prepared by Archidrome, Drawing No.A03, Revision 12, dated 6 March 2024 and note the revised overland flow path does not encroach on the proposed new Lot 1
3.a.vi	The Applicant does not adequately demonstrate suitable infrastructure upgrades on Warriewood Road, with a new 375mm RCP pipe and pit/s required.	We refer to our revised civil engineering plans and note that a revised stormwater drainage system for Warriewood Road has been documented.
3.a.vii	The development application is not supported by sufficient long sections of stormwater lines, required to detail surface levels, the location of the pipe, the hydraulic grade line, velocities, and flows.	We refer to our revised civil engineering plans and note that a revised stormwater drainage long section has been document. The long section includes a hydraulic grade line analysis for the 100 Year ARI flows plus Climate Change.
3.a.viii	It is unclear whether the Overland Flow Study was undertaken in accordance with Australian Rainfall and Runoff 2019 and Book 9 A Guide to Flood Estimation in Urban Areas, or whether climate change was incorporated into the modelling. Further, the modelling needs to be undertaken by an Engineer that is registered under the NSW Design and Building Practitioners Act and Regulation.	We refer to Addendum Flood Impact Assessment prepared by BMT, reference L.N20951.007_Warriewood_Rd_FloodingRFI.docx, dated 8 July 2022. In this regard, we have reviewed the adopted methodology and confirm that climate change has been considered. Additionally, we are of the view that the view the adopted flood modelling is appropriate to allow for an assessment of flood impacts and flood risk associated with the development.
3.a.ix	The development application is not accompanied by a completed/signed Documentation Checklist – Development Application, as required by the Water Management Specification.	We refer to our revised civil engineering plans and note that some of the measures included in our assessment result from an engineering assessment. Whilst these concepts have been discussed with Council's representatives, a merit-based assessment is required which falls outside the items defined within the checklist.
3.a.x	The Applicant has not demonstrated that flood free evacuation from all lots is possible in the PMF event.	We refer to our response to contention 3.a.iii and note supplementary modelling has been undertaken. In this regard, we refer to the revised PMF assessment prepared by BMT.
3.a.xi	The Applicant has failed to consider potential impacts upon the water table, or the groundwater dependent EEC.	We refer to our document CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 and note that an updated BDAR has been prepared based on these plans. We confirm our revised engineering plans provide an outcome that accommodates the maintenance of base flows currently servicing the EEC.
3.a.xii	The Applicant has not adequately address water quality, with over simplified and generalised statements that are not specific to the unique circumstances of the site.	A detailed MUSIC model has been prepared as part of our revised assessment. The MUSIC model can be provided to Council's representative for assessment. We can confirm that the MUSIC modelling was undertaken in accordance with Council's DCP requirements, and the pollutant reduction targets of Council's Water Management for Development Specification have been met for scenarios representing a dry, wet, and average rainfall year.
3.a.xiii	Insufficient information has been provided in relation to the proposed infiltration basin, with	We refer to our document CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 and

No.	Contention	Response
	concern that large volumes of runoff will not be treated. A bioretention basin is considered to be more suitable in this instance.	note that two basins have been documented to manage stormwater flows and to provide a compliant water quality outcome. The details of the basin are depicted on our revised documents.
3.a.xiv	The proposed infiltration basin has a weir to control the outflow. The Applicant has not demonstrated that this is an appropriate outlet method in light of the groundwater dependent EEC along the creek line.	We refer to our document CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 and note that weir overflows are proposed to an energy dissipation swale. This method has been discussed with Council's representatives in concept and are documented on our revised civil engineering plans. We understand this is a satisfactory outcome resulting in minimal impact to the EEC.
3.a.xv	The proposed use of litter baskets is not a practical outcome, with a gross pollutant trap is more appropriate.	We refer to our document CC230177, sheets C1.00 to C4.03 (26 sheets), revision C, dated 6 March 2024 and note two GPTs have been proposed. We acknowledge the limited fall available to provide a large GTP due to the Lorikeet Grove Road surface levels required to tie in with existing road levels. Notwithstanding, we have been liaising with manufacturers who have advised custom solutions are available to suit.
3.a.xvi	The MUSIC Model is to be prepared in accordance with Council's guidelines and is to be supplied to Council as a model file (.sqz).	We can provide our MUSIC model for assessment.
3.a.xvii	The Engineering Report (C&M Consulting Engineers, 4 June 2021) relies upon rainwater tanks on each of the 11 residential lots that are not proposed as part of the proposal, and the assumed rainwater reuse is inconsistent with the submitted BASIX Certificate.	We confirm our revised assessment includes both the ultimate scenario described in the C & M report dated 4 June 2021. We note it is common practice for new dwellings to require reasonably sized rainwater tanks and which will be a requirement of future BASIX for the new lots.
3.a.xviii	The Engineering Report (C&M Consulting Engineers, 4 June 2021) makes assumptions regarding the developed conditions of Catchment 3, being the proposed Torrens Title lots fronting Lorikeet Drive and the access driveway for the residential flat buildings. It is unclear how these assumed calculations have been derived or how the consent authority can ensure consistency with these assumptions in the long term.	We refer to drawing C1.01 which depicts the catchments draining to each of the proposed basins. A DRAINS model has been prepared to size the OSD basins to ensure post-development flows do not exceed pre-developed conditions for a range of storm events from the 1 Year ARI to 100 Year ARI flood event plus climate change.
3.a.xviii	For the purpose of assessing water management and flooding, is it unclear whether the relevant technical consultants have relied upon the architectural plans or the civil plans, which significantly differ with respect to the earthworks proposed and resultant ground levels.	We confirm our revised documents are consistent with the details depicted on Site Plan prepared by Archidrome, Drawing No.A03, Revision 12, dated 6 March 2024.
3.b	Clause C6.1 (Integrated Water Cycle Management) of P21 DCP and the Water Management Specification require a cohesive,	

No.	Contention	Response
	site specific solution for water management across a development site.	We confirm our revised documents are consistent with the details depicted on Site Plan prepared by Archidrome, Drawing No.A03, Revision 12, dated 6 March 2024
3.c	Although individual technical reports have been provided, they are internally inconsistent, and with each other, and do not satisfactorily demonstrate how the water cycle is cohesively managed on the site.	
3.e	Without consistency with the Water Management Specification or adequate consideration of impacts associated with the proposal, it is also inconsistent with the requirements and objectives of cl.5.21 (Flood planning) of PLEP 2014.	
3.d	Without consistency with the Water Management Specification or adequate consideration of impacts associated with the proposal, it is also inconsistent with the requirements and objectives of cl.6.1(3) of PLEP 2014.	

11 Conclusion

Based on the foregoing, we are of the view that the current list of civil engineering contentions before the court can be satisfactorily addressed based on the contents of our revised documents.

Yours faithfully,
ACOR Consultants (CC) Pty Ltd

Nathan Broadbent
BEng(Civil) CPEng NER

Annexure A **ACOR Consultants (CC) Pty Ltd Civil Engineering Plans, reference CC230177, sheets C1.00 to C4.03 (26 sheets), Revision C dated 6 March 2024.**

PROPOSED DEVELOPMENT
(No.43-49) WARRIEWOOD ROAD, WARRIEWOOD
CIVIL ENGINEERING PLANS

GENERAL NOTES

1. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL AND OTHER CONSULTANTS DRAWINGS AND SPECIFICATIONS AND WITH SUCH OTHER WRITTEN INSTRUCTIONS AS MAY BE ISSUED.
2. ALL DIMENSIONS RELEVANT TO SETTING OUT AND OFF-SITE WORK SHALL BE VERIFIED BY THE CONTRACTOR BEFORE CONSTRUCTION
3. DIMENSIONS SHALL NOT BE OBTAINED BY SCALING THE DRAWINGS.
4. ALL DIMENSIONS ON DETAILS ARE IN MILLIMETRES UNLESS STATED OTHERWISE. ALL PLANS AND LEVELS ARE EXPRESSED IN METRES.
5. DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STRUCTURAL STABILITY OF THE WORKS AND ENSURE NO PARTS BE OVER STRESSED UNDER CONSTRUCTION ACTIVITIES.
6. WORKMANSHIP AND MATERIALS ARE TO BE IN ACCORDANCE WITH THE RELEVANT CURRENT S.A.A. CODES INCLUDING ALL AMENDMENTS, AND THE LOCAL STATUTORY AUTHORITIES, EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.
7. THE APPROVAL OF A SUBSTITUTION SHALL BE SOUGHT FROM THE ENGINEER BUT IS NOT AN AUTHORISATION FOR A VARIATION. ANY VARIATIONS INVOLVED MUST BE TAKEN UP WITH THE ARCHITECT OR PROJECT MANAGER BEFORE THE WORK COMMENCES.
8. ANY DISCREPANCIES OR OMISSIONS SHALL BE REFERRED TO THE ENGINEER FOR A DECISION BEFORE PROCEEDING WITH THE WORK.
9. THE BUILDER SHALL GIVE 48 HOURS NOTICE FOR ALL ENGINEERING INSPECTIONS.
10. BUILDING FROM THESE DRAWINGS IS NOT TO COMMENCE UNTIL APPROVED BY THE LOCAL AUTHORITIES
11. THE WORD 'ENGINEER' USED IN THESE NOTES REFER TO AN EMPLOYEE OR NOMINATED REPRESENTATIVE OF **ACOR CONSULTANTS PTY.LTD.**

ROADWORKS NOTES

1. ALL BASECOURSE AND SUB-BASECOURSE MATERIALS SHALL CONFORM WITH AUSTRALIAN STANDARDS.
2. ALL BASECOURSE AND SUB-BASE MATERIALS SHALL BE COMPACTED TO ACHIEVE A MINIMUM OF 100% STANDARD MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT OF +OR- 2% IN ACCORDANCE WITH AS1289 E1.1.
3. ALL WEARING SURFACES SHALL BE ASPHALTIC CONCRETE LAID TO THE THICKNESS SPECIFIED AND IN ACCORDANCE WITH THE SPECIFICATION.
4. CONCRETE FOR KERB SHALL HAVE A CONCRETE STRENGTH OF 20MPa AT 28 DAYS, MINIMUM SLUMP OF 60mm AND MAXIMUM AGGREGATE SIZE OF 40mm.

EXISTING SERVICES AND FEATURES

1. THE CONTRACTOR SHALL ALLOW FOR THE CAPPING OFF, EXCAVATION, REMOVAL AND DISPOSAL IF REQUIRED OF ALL EXISTING SERVICES IN AREAS AFFECTED BY WORKS WITHIN THE CONTRACT AREA, AS SHOWN ON THE DRAWINGS UNLESS DIRECTED OTHERWISE BY THE SUPERINTENDENT.
2. THE CONTRACTOR IS TO CONDUCT A THOROUGH UNDERGROUND SERVICES INVESTIGATION TO LOCATE ALL SERVICES WITHIN THE AREA OF WORKS PRIOR TO ANY DEMOLITION WORKS COMMENCING
3. THE CONTRACTOR SHALL ENSURE THAT AT ALL TIMES SERVICES TO ALL BUILDINGS NOT AFFECTED BY THE WORKS ARE NOT DISRUPTED.
4. PRIOR TO COMMENCEMENT OF ANY WORKS THE CONTRACTOR SHALL GAIN WRITTEN APPROVAL OF HIS PROGRAMME FOR THE RELOCATION/CONSTRUCTION OF TEMPORARY SERVICES.
5. EXISTING BUILDINGS, EXTERNAL STRUCTURES, AND TREES SHOWN ON THESE DRAWINGS ARE FEATURES EXISTING PRIOR TO ANY DEMOLITION WORKS.
6. CONTRACTOR SHALL CONSTRUCT TEMPORARY SERVICES TO MAINTAIN EXISTING SUPPLY TO BUILDINGS REMAINING IN OPERATION DURING WORKS TO THE SATISFACTION AND APPROVAL OF THE SUPERINTENDENT. ONCE DIVERSION IS IS COMPLETE AND COMMISSIONED THE CONTRACTOR SHALL REMOVE ALL SUCH TEMPORARY SERVICES AND MAKE GOOD TO THE SATISFACTION OF THE SUPERINTENDENT.
7. INTERRUPTION TO SUPPLY OF EXISTING SERVICES SHALL BE DONE SO AS NOT TO CAUSE ANY INCONVENIENCE TO THE PRINCIPAL. CONTRACTOR TO GAIN APPROVAL OF SUPERINTENDENT FOR TIME OF INTERRUPTION.

SITEWORKS NOTES

1. ORIGIN OF LEVELS :- AUSTRALIAN HEIGHT DATUM (A.H.D.)
2. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND EXISTING LEVELS ON SITE PRIOR TO COMMENCEMENT OF WORK.
3. ALL WORK IS TO BE UNDERTAKEN IN ACCORDANCE WITH THE DETAILS SHOWN ON THE DRAWINGS, THE SPECIFICATIONS AND THE DIRECTIONS OF THE PRINCIPAL'S REPRESENTATIVE.
4. EXISTING SERVICES HAVE BEEN PLOTTED FROM SUPPLIED DATA AND AS SUCH THEIR ACCURACY CANNOT BE GUARANTEED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ESTABLISH THE LOCATION AND LEVEL OF ALL EXISTING SERVICES PRIOR TO THE COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE PRINCIPAL'S REPRESENTATIVE. CLEARANCES SHALL BE OBTAINED FROM THE RELEVANT SERVICE AUTHORITY.
5. WHERE NEW WORKS ABUT EXISTING THE CONTRACTOR SHALL ENSURE THAT A SMOOTH EVEN PROFILE, FREE FROM ABRUPT CHANGES IS OBTAINED.
6. THE CONTRACTOR SHALL ARRANGE ALL SURVEY SETOUT TO BE CARRIED OUT BY A REGISTERED SURVEYOR.
7. CARE IS TO BE TAKEN WHEN EXCAVATING NEAR EXISTING SERVICES. NO MECHANICAL EXCAVATIONS ARE TO BE UNDERTAKEN OVER COMMUNICATIONS OR ELECTRICAL SERVICES. HAND EXCAVATE IN THESE AREAS.
8. ALL SERVICE TRENCHES UNDER VEHICULAR PAVEMENTS SHALL BE BACKFILLED WITH AN APPROVED NON-NATURAL GRANULAR MATERIAL AND COMPACTED TO 98% STANDARD MAXIMUM DRY DENSITY IN ACCORDANCE WITH AS.1289.5.1.1.
9. ALL TRENCH BACKFILL MATERIAL SHALL BE COMPACTED TO THE SAME DENSITY AS THE ADJACENT MATERIAL.
10. ON COMPLETION OF PIPE INSTALLATION ALL DISTURBED AREAS MUST BE RESTORED TO ORIGINAL, INCLUDING KERBS, FOOTPATHS, CONCRETE AREAS, GRAVEL AND GRASSED AREAS AND ROAD PAVEMENTS.
11. PROVIDE 12mm WIDE EXPANDING CORK JOINTS BETWEEN CONCRETE PAVEMENTS AND ALL BUILDINGS , WALLS, FOOTINGS, COLUMNS, KERBS, DISH DRAINS, GRATED DRAINS, BOLLARD FOOTINGS ETC
12. CONTRACTOR TO OBTAIN ALL AUTHORITY APPROVALS.
13. ALL BATTERS TO BE GRASSED LINED WITH MINIMUM 100 TOPSOIL AND APPROVED COUCH LAID AS TURF.
14. MAKE SMOOTH TRANSITION TO EXISTING SERVICES AND MAKE GOOD.
15. THE CONTRACTOR SHALL PROVIDE ALL TEMPORARY DIVERSION DRAINS AND MOUNDS TO ENSURE THAT AT ALL TIMES EXPOSED SURFACES ARE FREE DRAINING AND WHERE NECESSARY EXCAVATE SUMPS AND PROVIDE PUMPING EQUIPMENT TO DRAIN EXPOSED AREAS.
16. THESE PLANS SHALL BE READ IN CONJUNCTION WITH APPROVED ARCHITECTURAL, STRUCTURAL, HYDRAULIC AND MECHANICAL DRAWINGS AND SPECIFICATIONS.
17. TRENCHES THROUGH EXISTING ROAD AND CONCRETE PAVEMENTS SHALL BE SAWCUT TO FULL DEPTH OF CONCRETE AND A MIN 50mm IN BITUMINOUS PAVING.
18. ALL BRANCH GAS AND WATER SERVICES UNDER DRIVEWAYS AND BRICK PAVING SHALL BE LOCATED IN Ø80 uPVC SEWER GRADE CONDUITS EXTENDING A MIN OF 500mm PAST PAVING.
19. ON COMPLETION OF WORKS ALL DISTURBED AREAS MUST BE RESTORED TO ORIGINAL INCLUDING, BUT NOT LIMITED TO, KERBS, FOOTPATHS, CONCRETE AREAS, GRASS AND LANDSCAPED AREAS.

COMPACTION NOTES

1. ALL SOFT, WET OR UNSUITABLE MATERIAL TO BE REMOVED AS DIRECTED BY THE SUPERINTENDENT AND REPLACED WITH APPROVED MATERIAL SATISFYING THE REQUIREMENTS LISTED BELOW.
2. ALL FILL MATERIAL SHALL BE FROM A SOURCE APPROVED BY THE SUPERINTENDENT AND SHALL COMPLY WITH THE FOLLOWING :
   a. FREE FROM ORGANIC, PERISHABLE AND CONTAMINATED MATTER
   b. MAXIMUM PARTICLE SIZE 75MM
   c. PLASTICITY INDEX BETWEEN 2% AND 15%
3. THE CONTRACTOR SHALL PROGRAM THE EARTHWORKS OPERATION SO THAT THE WORKING AREAS ARE ADEQUATELY DRAINED DURING THE PERIOD OF CONSTRUCTION. THE SURFACE SHALL BE GRADED AND SEALED OFF TO REMOVE DEPRESSIONS AND SIMILAR WHICH WOULD ALLOW WATER TO POND AND PENETRATE THE UNDERLYING MATERIAL. ANY DAMAGE RESULTING FROM THE CONTRACTOR NOT OBSERVING THESE REQUIREMENTS SHALL BE RECTIFIED BY THE CONTRACTOR AT THEIR COST.
4. TESTING OF THE SUBGRADE SHALL BE CARRIED OUT BY AN APPROVED NATA REGISTERED LABORATORY AT THE CONTRACTORS EXPENSE.

STORMWATER NOTES

1. ALL 225 DIA. DRAINAGE PIPES AND LARGER SHALL BE CLASS "2" APPROVED SPIGOT AND SOCKET FRC OR RCP PIPES WITH RUBBER RING JOINTS. (U.N.O.) ALL DOWNPIPE DRAINAGE LINES SHALL BE SEWER GRADE uPVC WITH SOLVENT WELD JOINTS. (U.N.O.)
2. EQUIVALENT STRENGTH REINFORCED CONCRETE PIPES MAY BE USED.
3. ALL PIPE JUNCTIONS UP TO AND INCLUDING 450 DIA. AND TAPERS SHALL BE VIA PURPOSE MADE FITTINGS.
4. MINIMUM GRADE TO STORMWATER LINES TO BE 1%. (U.N.O.)
5. CONTRACTOR TO SUPPLY AND INSTALL ALL FITTINGS AND SPECIALS INCLUDING VARIOUS PIPE ADAPTORS TO ENSURE PROPER CONNECTION BETWEEN DISSIMILAR PIPEWORK.
6. ALL CONNECTIONS TO EXISTING DRAINAGE PITS SHALL BE MADE IN A TRADESMAN-LIKE MANNER AND THE INTERNAL WALL OF THE PIT AT THE POINT OF ENTRY SHALL BE CEMENT RENDERED TO ENSURE A SMOOTH FINISH.
7. PRECAST PITS SHALL NOT BE USED UNLESS WRITTEN APPROVAL IS OBTAINED FROM THE SUPERINTENDENT.
8. WHERE TRENCHES ARE IN ROCK, THE PIPE SHALL BE BEDDED ON A MIN. 50MM CONCRETE BED (OR 75MM THICK BED OF 12MM BLUE METAL) UNDER THE BARREL OF THE PIPE. THE PIPE COLLAR AT NO POINT SHALL BEAR ON THE ROCK. IN OTHER THAN ROCK, PIPES SHALL BE LAID ON A 75MM THICK SAND BED. IN ALL CASES BACKFILL THE TRENCH WITH SAND TO 200MM ABOVE THE PIPE. WHERE THE PIPE IS UNDER PAVEMENTS BACKFILL REMAINDER OF TRENCH WITH SAND OR APPROVED GRANULAR BACKFILL COMPACTED IN 150MM LAYERS TO 98% STANDARD MAX. DRY DENSITY.
9. BEDDING SHALL BE (U.N.O.) TYPE H1, IN ACCORDANCE WITH CURRENT RELEVANT AUSTRALIAN STANDARDS.
10. WHERE STORMWATER LINES PASS UNDER FLOOR SLABS SEWER GRADE RUBBER RING JOINTS ARE TO BE USED.
11. WHERE SUBSOIL DRAINAGE LINES PASS UNDER FLOOR SLABS AND VEHICULAR PAVEMENTS UNSLOTTED UPVC SEWER GRADE PIPE SHALL BE USED.
12. PROVIDE 3.0M LENGTH OF 100 DIA. SUBSOIL DRAINAGE PIPE WRAPPED IN FABRIC SOCK, AT UPSTREAM END OF EACH PIT.

CONCRETE PAVEMENT NOTES

1. CONCRETE MIX PARAMETERS ;
   - MAXIMUM AGGREGATE SIZE 20mm
   - FLEXURAL STRENGTH AT 28 DAYS = 3.5MPa
   - FLEXURAL STRENGTH AT 90 DAYS = 3.85 MPa
   - MAXIMUM WATER / CEMENT RATIO = 0.55
   - MAXIMUM SHRINKAGE LIMIT = 650 MICRON STRAINS (AS 1012 Pt 13)
   - MINIMUM CEMENT CONTENT = 300kg/m3
   - CEMENT TO BE TYPE "A" (NORMAL CEMENT) TO AS.1315
   - SLUMP = 50mm
2. JOINT TO BE SAWN AS SOON AS CONCRETE HAS HARDENED SUFFICIENTLY THAT IT WILL NOT BE DAMAGED BY SAWING. IF AN UNPLANNED CRACK OCCURS THE CONTRACTOR SHALL REPLACE WHOLE SLABS EITHER SIDE OF THE UNPLANNED CRACK, UNLESS DIRECTED OTHERWISE.
3. CONSTRUCT JOINTS AS DETAILED
4. CONSTRUCTION JOINTS WHERE REQUIRED BUT NOT SHOWN, SHALL BE LOCATED TO THE APPROVAL OF THE ENGINEER AND CONSTRUCTED AT THE CONTRACTORS EXPENSE.
5. ALL LONGITUDINAL CONSTRUCTION JOINTS SHALL BE FORMED AND INCLUDE DOWEL BARS AS SPECIFIED. ALL TRANSVERSE CONSTRUCTION JOINTS SHALL BE FORMED AND INCLUDE DOWEL BARS AS SPECIFIED.
6. BOND BREAKER TO BE TWO (2) UNIFORM COATS OF BITUMEN EMULSION ALL OVER THE EXPOSED SURFACE AND ON END.
7. DOWELS AND TIE BARS TO MEET STRENGTH REQUIREMENTS OF STRUCTURAL GRADE STEEL IN ACCORDANCE AS. 1302. DOWELS AND TIE BARS SHALL BE ;-
   - STRAIGHT
   - TO LENGTH SPECIFIED
   - CLEAN AND FREE FROM MILL SCALE, RUST AND OIL.
   - SAWN TO LENGTH NOT CROPPED.
8. DIMENSIONS OF SEALANT RESERVOIR DEPENDANT ON THE SEALANT TYPE ADOPTED. ENGINEERS APPROVAL TO BE OBTAINED FOR SEALANT AND RESERVOIR DIMENSIONS AND DETAIL PROPOSED BY THE CONTRACTOR. REFER DETAIL "B" FOR TYPICAL ARRANGEMENT AND SEALANT.
9. PRIOR TO THE PLACEMENT OF CONCRETE IN THE ADJACENT SLAB, SELF EXPANDING CORK FILLER SHALL BE ADHERED TO THE ALREADY CAST AND CLEANED CONCRETE FACE USING AN APPROVED WATERPROOF ADHESIVE. ADHESIVE SHALL BE LIBERALLY APPLIED TO THE FULL FACE OF THE CONCRETE SLAB TO BE COVERED BY THE FILLER, AND ON THE FULL FACE OF THE FILLER TO BE ADHERED.
10. REFER TO COMPACTION NOTES FOR PREPARATION OF SUB-BASE AND SUB-GRADE.
11. ALL WORK TO BE BROOM FINISH.

ASPHALTIC CONCRETE NOTES

1. GENERAL
   a) MINERAL AGGREGATES TO COMPLY WITH AUSTRALIAN STANDARDS
   b) MINERAL FILLER TO COMPLY WITH AS.2357 MINERAL FILLERS OR ASPHALT.
   c) BITUMEN BINDER SHALL COMPLY WITH AS 2008
2. MIX PROPORTIONS
   a) JOB MIX - 10mm NOMINAL SIZE AGGREGATE. MINIMUM BITUMEN CONTENT BY MASS OF TOTAL MASS - 5.1%
   b) MIX STABILITY - BETWEEN 16kN AND 36kN AS DETERMINED BY AS 2891
   c) AIR VOIDS IN COMPACTED MIX - BETWEEN 4% AND 7% OF THE VOLUME OF THE MIX.
   d) VOIDS FILLED IN BINDER - 65-80% OF AIR VOIDS IN THE TOTAL MINERAL AGGREGATE FILLED BY BINDER IN ACCORDANCE WITH AUSTRALIAN STANDARDS
3. PAVEMENT PREPARATION
   a) THE EXISTING SURFACE TO BE SEALED SHALL BE DRY AND BROOMED BEFORE COMMENCEMENT OF WORK TO ENSURE COMPLETE REMOVAL OF ALL SUPERFICIAL FOREIGN MATTER.
   b) ALL DEPRESSIONS OR UNEVEN AREAS ARE TO BE TACK-COATED AND BROUGHT UP TO GENERAL LEVEL OF PAVEMENT WITH ASPHALTIC CONCRETE BEFORE LAYING OF MAIN COURSE.
4. TACK COAT
   a) THE WHOLE OF THE AREA TO BE SHEETED WITH ASPHALTIC CONCRETE SHALL BE LIGHTLY AND EVENLY COATED WITH RAPID SETTING BITUMEN COMPLYING WITH AUSTRALIAN STANDARDS. APPLICATION RATE FOR RESIDUAL BITUMEN SHALL BE 0.15 TO 0.30 LITRES/SQUARE METRE. APPLICATION SHALL BE BY MEANS OF A MECHANICAL SPRAYER WITH SPRAY BAR.
5. SPREADING
   a) ALL ASPHALTIC CONCRETE SHALL BE SPREAD WITH A SELF PROPELLED PAVING MACHINE.
   b) THE ASPHALTIC CONCRETE SHALL BE LAID AT A MIX TEMPERATURE AS SHOWN BELOW;

ROAD SURFACE TEMPERATURE IN SHADE (°C)	MIX TEMPERATURES (°C)
5 - 10	NOT PERMITTED
10 - 15	150
15 - 25	145
OVER 25	140

   c) ASPHALTIC CONCRETE SHALL NOT BE LAID WHEN THE ROAD SURFACE IS WET OR WHEN COLD WINDS CHILL THE MIX ADVERSELY AFFECT SPREADING AND COMPACTION.
   d) THE MINIMUM COMPACTED THICKNESS IS 30mm OVER EXISTING SEALED PAVEMENTS AND 50mm OVER NEW PAVEMENTS
6. JOINTS
   a) THE NUMBER OF JOINTS BOTH LONGITUDINAL AND TRANSVERSE SHALL BE KEPT TO A MINIMUM.
   b) THE DENSITY AND SURFACE FINISH AT JOINTS SHALL BE SIMILAR TO THOSE OF THE REMAINDER OF THE LAYER.
7. COMPACTION
   a) ALL COMPACTION SHALL BE UNDERTAKEN USING SELF PROPELLED ROLLERS.
   b) INITIAL ROLLING SHALL BE COMPLETE BEFORE THE MIX TEMPERATURE FALLS BELOW 105°C
   c) SECONDARY ROLLING SHALL BE COMPLETED BEFORE THE MIX TEMPERATURE FALLS BELOW 60°C
   d) MINIMUM CHARACTERISTICS VALUE OF RELATIVE COMPACTION OF A LOT WHEN TESTED IN ACCORDANCE WITH AS2150
8. FINISHED PAVEMENT PROPERTIES
   a) FINISHED SURFACES SHALL BE SMOOTH, DENSE AND TRUE TO SHAPE AND SHALL NOT VARY MORE THAN 10mm FROM THE SPECIFIED PLAN LEVEL AT ANY POINT AND SHALL NOT DEVIATE FROM THE BOTTOM OF A 3m STRAIGHT EDGE LAID IN ANY DIRECTION BY MORE THAN 5mm.

DIAL BEFORE YOU DIG

DIAL BEFORE YOU DIG www.1100.com.au

IMPORTANT: THE CONTRACTOR IS TO MAINTAIN A CURRENT SET OF "DIAL BEFORE YOU DIG" DRAWINGS ON SITE AT ALL TIMES.

SHEET INDEX

DRAWINGS MUST BE PRINTED IN COLOUR

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

1cm at full size

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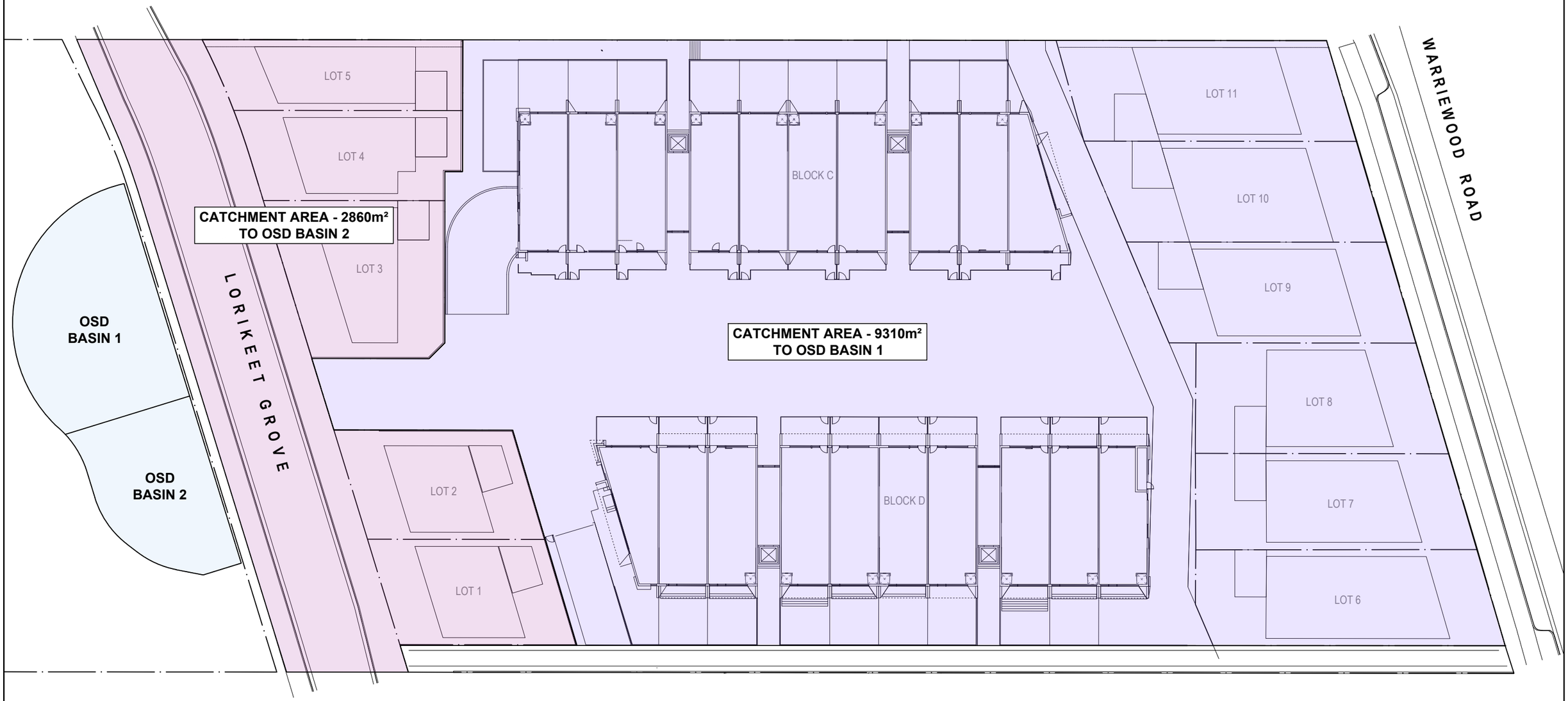
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title				
COVER SHEET & NOTES				
Drawn: RH	Date: SEPT 23	Scale A1: AS NOTED	Q.A. Check: -	Date: -
Designed: BK	Project No.: CC230177	Dwg. No.: C1.00	Issue: C	



DRAINAGE CATCHMENT PLAN

SCALE - 1:250/A1, 1:500/A3

0 2.5 5 10 15 20 25m

Issue	Description	Date	Drawn	Approved
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

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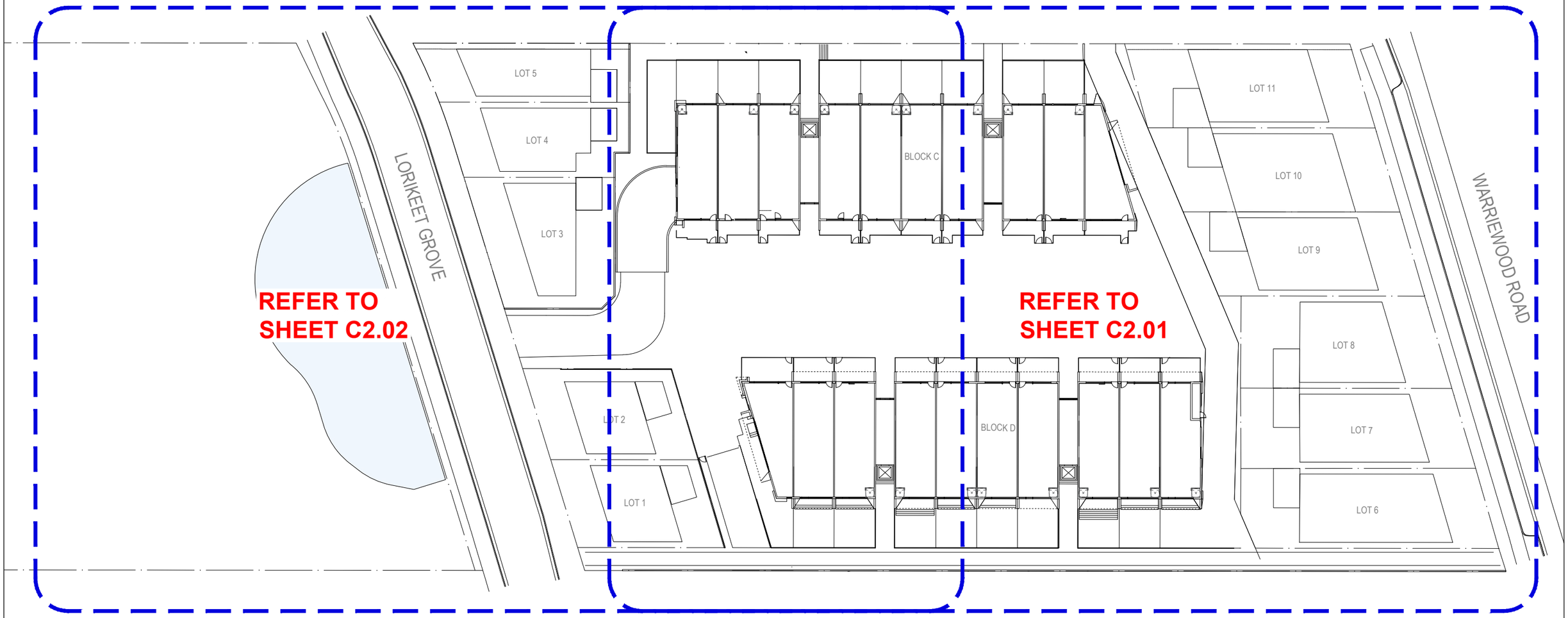
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: DRAINAGE CATCHMENT PLAN

Drawn	Date	Scale A1	Q.A. Check	Date
LW	SEPT 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C1.01	C



KEY PLAN
SCALE - 1:300/A1, 1:600/A3
0 2 4 8 12 16 20m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
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Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
KEY PLAN - SITE STORMWATER MANAGEMENT

Drawn	Date	Scale A1	Q.A. Check	Date
RH	SEPT 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C2.00	C

FOR CONTINUATION REFER DRAWING SHEET C2.02

BLOCK C

BLOCK D

C1 C4 C5 C6 C8 C9 C10

D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

FUTURE 150 DIA MIN. CAPPED TIE IN POINT FOR CONNECTION BY THE HYDRAULIC SERVICES CONSULTANT CONVEYING SURFACE STORMWATER FROM TERRACES / BALCONIES WITHIN THE BULDING ENVELOPE TYP UNO

FUTURE 225 DIA MIN. CAPPED TIE IN POINT FOR CONNECTION BY THE HYDRAULIC SERVICES CONSULTANT / AERIAL PIPE SYSTEM CONVEYING SURFACE STORMWATER FROM TERRACES / BALCONIES WITHIN THE BULDING ENVELOPE

DENOTES FULLY SEALED ROOF WATER ONLY DRAINAGE. CONNECT ROOF WATER DOWNPIPES TO THIS SYSTEM & CONVEY TO THE RAINWATER TANK. PIPE ALIGNMENT WITHIN THE BUILDING ENVELOPE TO BE DETAILED AND COORDINATED BY THE HYDRAULIC SERVICES CONSULTANT TYP UNO

DENOTES ROOF WATER ONLY DRAINAGE. CONNECT ROOF WATER DOWNPIPES TO THIS SYSTEM & CONVEY TO THE RAINWATER TANK. PIPE ALIGNMENT WITHIN THE BUILDING ENVELOPE TO BE DETAILED AND COORDINATED BY THE HYDRAULIC SERVICES CONSULTANT TYP UNO

ALLOW TO GRADE LANDSCAPE AREA TO STORMWATER PITS WITH A MIN. 1% FALL TYP UNO

PROVIDE ATLANTIS DRAINAGE CELL TO PLANTERS OVER SUSPENDED SLAB COMPLETE WITH PLANTER DRAIN OUTLETS (PDO) TYP UNO

300W x 200D GRATED DRAIN WITH HEAVY DUTY GRATE & FRAME

DROP PIPE TO IL 5.70 NOM 2.2m NOM AFFL

2 x 300 DIA RWT OVERFLOW PIPE/S

SWIMMING POOL

FIRE ESCAPE STAIRS 2

FIRE ESCAPE STAIRS 4

EASEMENT

3.5m WIDE DRAINAGE EASEMENT REFER TO SHEET C3.02 - C3.04 FOR DETAILS

2 DP 972209 DRAINAGE RESERVE

WARRIEWOOD ROAD

B6 (LOT 11) 440.5 m²

B5 (LOT 10) 435.34 m²

B4 (LOT 9) 414.21 m²

B3 (LOT 8) 423.90 m²

B2 (LOT 7) 416.35 m²

B1 (LOT 6) 453.15 m²

A1 (LOT 1) 302.34 m² RL 4.85 +

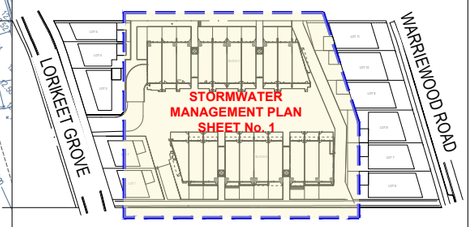
A2 (LOT 2) 315 m² RL 4.85 +

No.4 PHEASANT PL.
No.6 PHEASANT PL.
No.8 PHEASANT PL.
No.10 PHEASANT PL.
No.12 PHEASANT PL.
No.14 PHEASANT PL.
No.85 WARRIEWOOD RD.
No.65 WARRIEWOOD RD.
No.20 BUBALO ST.
No.18 BUBALO ST.
No.16 BUBALO ST.
No.14 BUBALO ST.
No.12 BUBALO ST.
No.10 BUBALO ST.
No.8 BUBALO ST.
No.4 BUBALO ST.

RAINWATER RE-USE TANK (OSR)

PROVIDE RAINWATER RE-USE TANK WITH:
STORAGE VOLUME: 50m³
(IN ACCORDANCE WITH THE BASIX REQUIREMENT)
INTERNAL FOOTPRINT: 57m² x 1.14m DEEP

LOCALITY PLAN



STORMWATER LEGEND

- DENOTES ON-SITE DETENTION BASIN
- DENOTES ON-SITE RETENTION TANK (50m³)
- STORMWATER PIT - SOLID COVER
- STORMWATER PIT - GRATED INLET
- 150 SW — DENOTES STORMWATER / SURFACE WATER PIPE & DIA. @ 1% MIN GRADE
- 150 RW — DENOTES RAINWATER PIPE COLLECTING ROOFWATER ONLY & DIA. @ 1% MIN. GRADE
- W/RM — DENOTES WATER RISING MAIN FROM BASEMENT PUMPOUT - BY OTHERS

NOTES:

1. ALL SERVICES INDICATED ARE TO BE USED AS A GUIDE ONLY. EXACT LOCATIONS AND INVERTS OF PIPEWORK TO BE DETERMINED ON SITE. CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCEMENT OF ANY WORK.
2. GRATED DRAINS TO BE AS SPECIFIED. WHERE GRATED DRAINS ARE LOCATED IN A PEDESTRIAN AREA AND NOT SUBJECT TO VEHICULAR LOADING, CONSTRUCT USING A HEELPROOF GRATE & FRAME.
3. ALL PLANTER BEDS OVER SLABS TO BE CONSTRUCTED WITH ATLANTIS DRAINAGE CELL COMPLETE WITH PLANTER DRAIN OUTLET. PLANTER BED SLABS TO FALL TO OUTLETS WITH A MIN. 1% FALL.

STORMWATER MANAGEMENT PLAN

SCALE - 1:200/A1, 1:400/A3

0 2 4 8 12 16 20m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
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1cm at full size

North

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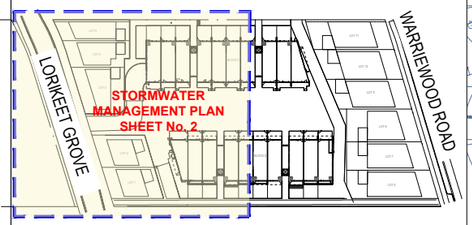
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title				
STORMWATER MANAGEMENT PLAN - SHEET 1 OF 2				
Drawn	Date	Scale A1	Q.A. Check	Date
RH	SEPT 2023	AS NOTED	-	-
Designed	Project No.	Dwg. No.		Issue
BK	CC230177	C2.01		C

LOCALITY PLAN



STORMWATER LEGEND

	DENOTES ON-SITE DETENTION BASIN
	DENOTES ON-SITE RETENTION TANK (50m³)
	STORMWATER PIT - SOLID COVER
	STORMWATER PIT - GRATED INLET
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HATCHING DENOTES EXTENT OF WORK DETAILED ON SHEETS C3.04 & C3.05. REFER TO THESE PLANS FOR SITE DISCHARGE

LORIKEET GROVE

BLOCK C

BLOCK D

FOR CONTINUATION REFER DRAWING SHEET C2.01

RAINWATER RE-USE TANK (OSR)

PROVIDE RAINWATER RE-USE TANK WITH:
STORAGE VOLUME: 50m³
(IN ACCORDANCE WITH THE BASIX REQUIREMENT)
INTERNAL FOOTPRINT: 57m² x 1.14m DEEP

STORMWATER MANAGEMENT PLAN

SCALE - 1:200/A1, 1:400/A3

0 2 4 8 12 16 20m

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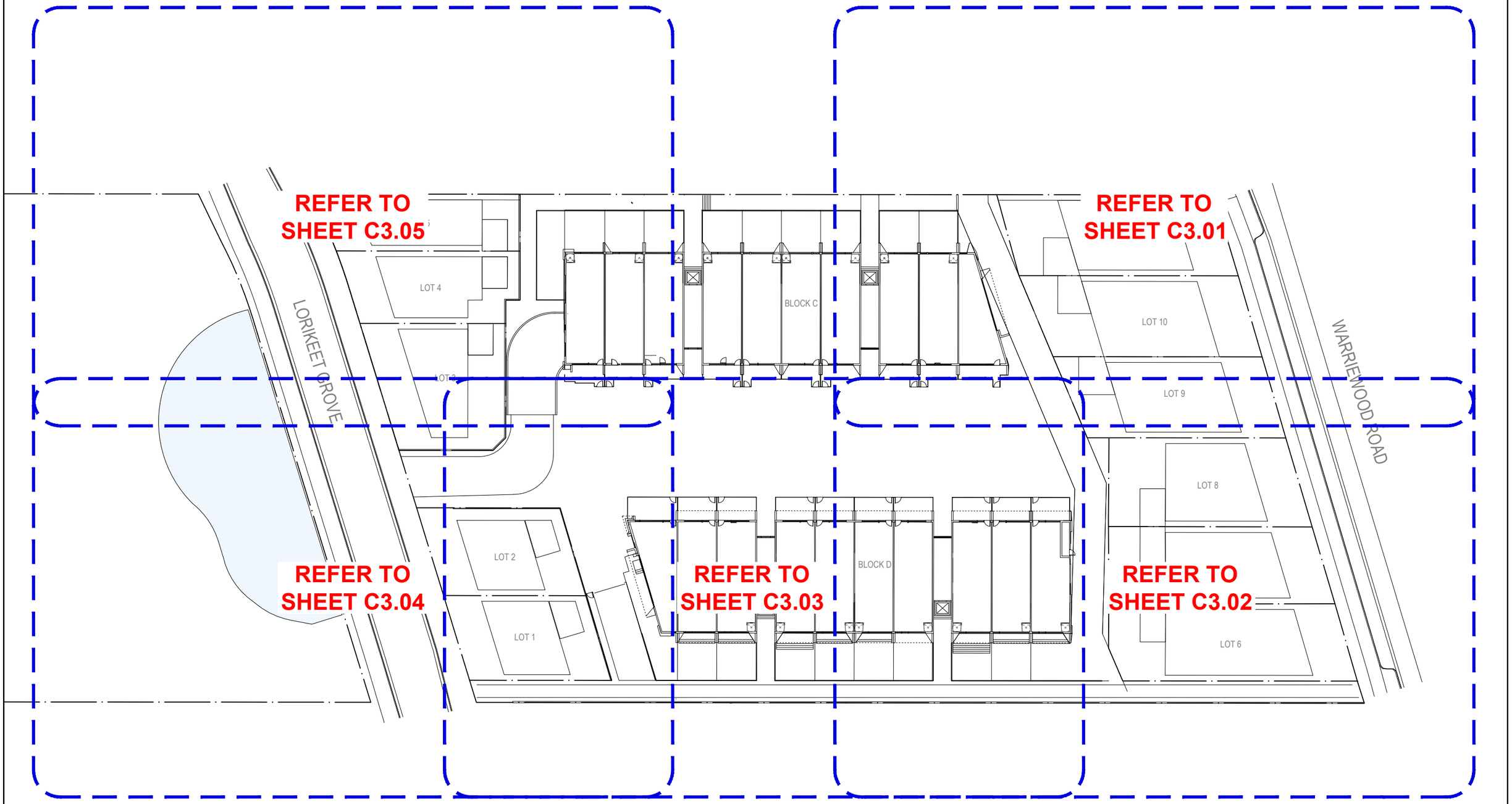
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: STORMWATER MANAGEMENT PLAN SHEET 2 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
RH	SEPT 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C2.02	C



KEY PLAN
SCALE - 1:300/A1, 1:600/A3
0 2 4 8 12 16 20m

Issue	Description	Date	Drawn	Approved
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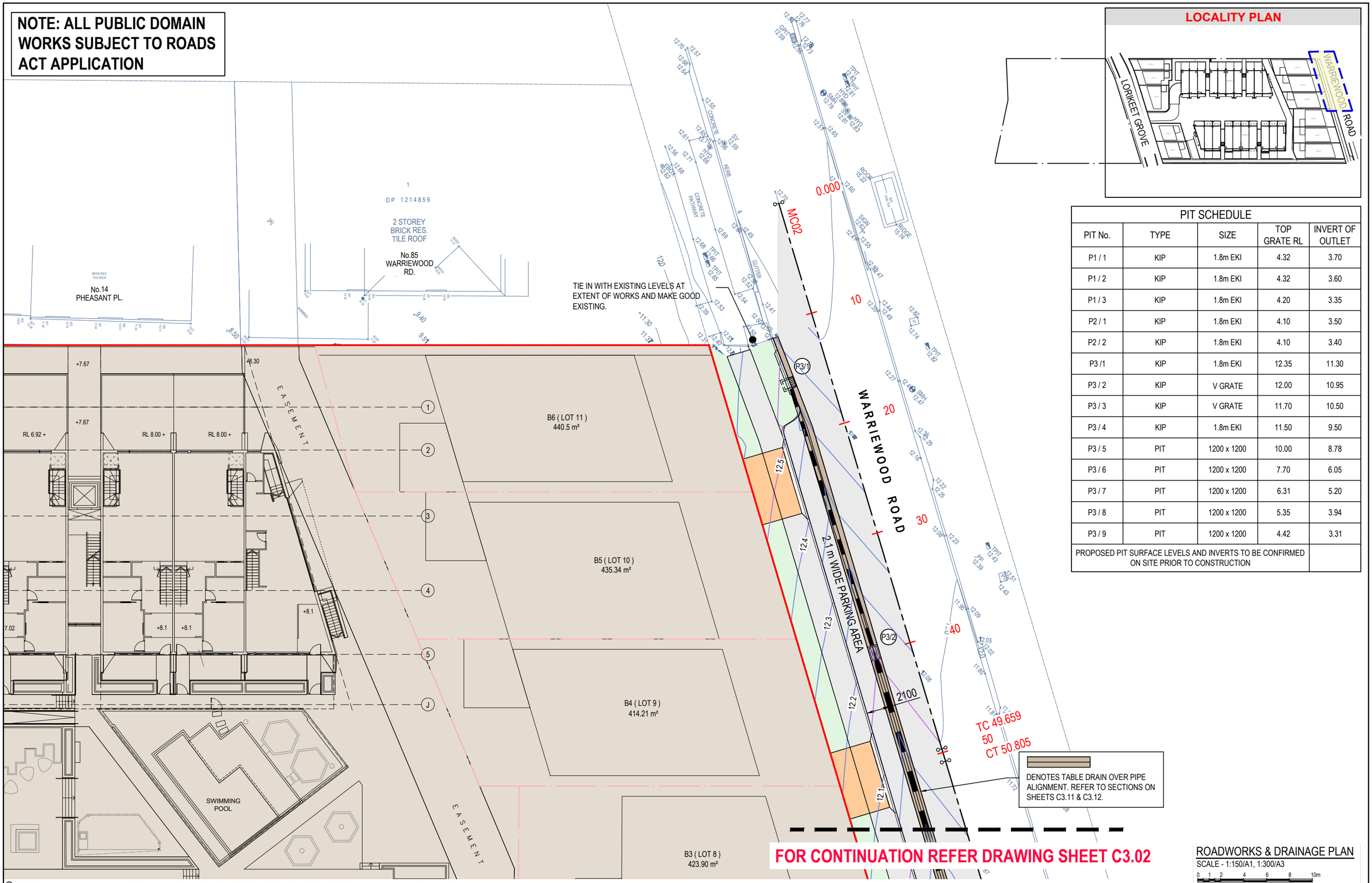
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
KEY PLAN - ROADWORKS & DRAINAGE GENERAL ARRANGEMENT

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.00	C

NOTE: ALL PUBLIC DOMAIN WORKS SUBJECT TO ROADS ACT APPLICATION



FOR CONTINUATION REFER DRAWING SHEET C3.02

LOCALITY PLAN

PIT SCHEDULE

PIT No.	TYPE	SIZE	TOP GRATE RL	INVERT OF OUTLET
P1 / 1	KIP	1.8m EKI	4.32	3.70
P1 / 2	KIP	1.8m EKI	4.32	3.60
P1 / 3	KIP	1.8m EKI	4.20	3.35
P2 / 1	KIP	1.8m EKI	4.10	3.50
P2 / 2	KIP	1.8m EKI	4.10	3.40
P3 /1	KIP	1.8m EKI	12.35	11.30
P3 / 2	KIP	V GRATE	12.00	10.95
P3 / 3	KIP	V GRATE	11.70	10.50
P3 / 4	KIP	1.8m EKI	11.50	9.50
P3 / 5	PIT	1200 x 1200	10.00	8.78
P3 / 6	PIT	1200 x 1200	7.70	6.05
P3 / 7	PIT	1200 x 1200	6.31	5.20
P3 / 8	PIT	1200 x 1200	5.35	3.94
P3 / 9	PIT	1200 x 1200	4.42	3.31
PROPOSED PIT SURFACE LEVELS AND INVERTS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION				

ROADWORKS & DRAINAGE PLAN
SCALE - 1:150/A1, 1:300/A3
0 1 2 4 6 8 10m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size 10cm

North

Client
WARRIEWOOD DEVELOPERS PTY LTD

Architect

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
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ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD WORKS & DRAINAGE PLAN SHEET 1 OF 5

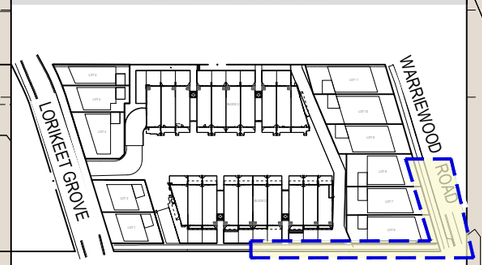
Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.	Dwg. No.	Issue	
BK	CC230177	C3.01	C	

PIT SCHEDULE

PIT No.	TYPE	SIZE	TOP GRATE RL	INVERT OF OUTLET
P1 / 1	KIP	1.8m EKI	4.32	3.70
P1 / 2	KIP	1.8m EKI	4.32	3.60
P1 / 3	KIP	1.8m EKI	4.20	3.35
P2 / 1	KIP	1.8m EKI	4.10	3.50
P2 / 2	KIP	1.8m EKI	4.10	3.40
P3 /1	KIP	1.8m EKI	12.35	11.30
P3 / 2	KIP	V GRATE	12.00	10.95
P3 / 3	KIP	V GRATE	11.70	10.50
P3 / 4	KIP	1.8m EKI	11.50	9.50
P3 / 5	PIT	1200 x 1200	10.00	8.78
P3 / 6	PIT	1200 x 1200	7.70	6.05
P3 / 7	PIT	1200 x 1200	6.31	5.20
P3 / 8	PIT	1200 x 1200	5.35	3.94
P3 / 9	PIT	1200 x 1200	4.42	3.31

PROPOSED PIT SURFACE LEVELS AND INVERTS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION

LOCALITY PLAN



NOTE: ALL PUBLIC DOMAIN WORKS SUBJECT TO ROADS ACT APPLICATION

FOR CONTINUATION REFER DRAWING SHEET C3.03

FOR CONTINUATION REFER DRAWING SHEET C3.01

B4 (LOT 9)
414.21 m²

B3 (LOT 8)
423.90 m²

B2 (LOT 7)
416.35 m²

B1 (LOT 6)
453.15 m²
TOW PROVIDES 250mm FREEBOARD MIN. TO INVERT OF FLOW PATH

EASEMENT

3.5m WIDE DRAINAGE EASEMENT AND CULVERT

TOW PROVIDES 250mm FREEBOARD MIN. TO INVERT OF FLOW PATH BUT DOES NOT EXCEED 350 mm IN HEIGHT ADJACENT TO THE BLOCK D. THERFORE SAFETY FENCING NOT REQUIRED.

DENOTES TABLE DRAIN OVER PIPE ALIGNMENT. REFER TO SECTIONS ON SHEETS C3.11 & C3.12.

FOOTPATH 2.1 WIDE

WARRIEWOOD ROAD

CENTRE LINE OF ROAD

TC 49.659
50
CT 50.805

P3/3 P3/4 P3/5 P3/6 P3/7 P3/8 P3/9

DR01

30 DP 271139 2 STOREY BRICK & W/BOARD RES. TILE ROOF No.20 BUBALO ST.

29 DP 271139 2 STOREY W/BOARD RES. METAL ROOF No.18 BUBALO ST.

28 DP 271139 2 STOREY BRICK & W/BOARD RES. METAL ROOF No.16 BUBALO ST.

27 DP 271139 2 STOREY BRICK & W/BOARD RES. TILE ROOF No.14 BUBALO ST.

26 DP 271139 2 STOREY BRICK & W/BOARD RES. METAL ROOF No.12 BUBALO ST.

25 DP 271139 2 STOREY REND. RES. TILE ROOF No.10 BUBALO ST.

24 DP 271139 2 STOREY BRICK & W/BOARD RES. TILE ROOF No.8 BUBALO ST.

23 DP 271139 2 STOREY BRICK & W/BOARD RES. METAL ROOF No.8 BUBALO ST.

22 DP 271139 2 STOREY BRICK RES. TILE ROOF No.4 BUBALO ST.

2 STOREY BRICK RES. TILE ROOF No.65 WARRIEWOOD RD.

21 DP 271139

SAFETY FENCING TO BE PROVIDED AROUND PIT P3 /5 TO PREVENT ACCESS

ROADWORKS & DRAINAGE PLAN

SCALE - 1:150/A1, 1:300/A3

0 1 2 4 6 8 10m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1 0 1cm at full size 10cm

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

Architect:

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Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: ROAD WORKS & DRAINAGE PLAN SHEET 2 OF 5

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C3.02	C

NOTE: ALL PUBLIC DOMAIN WORKS SUBJECT TO ROADS ACT APPLICATION

PIT SCHEDULE				
PIT No.	TYPE	SIZE	TOP GRATE RL	INVERT OF OUTLET
P1 / 1	KIP	1.8m EKI	4.32	3.70
P1 / 2	KIP	1.8m EKI	4.32	3.60
P1 / 3	KIP	1.8m EKI	4.20	3.35
P2 / 1	KIP	1.8m EKI	4.10	3.50
P2 / 2	KIP	1.8m EKI	4.10	3.40
P3 /1	KIP	1.8m EKI	12.35	11.30
P3 / 2	KIP	V GRATE	12.00	10.95
P3 / 3	KIP	V GRATE	11.70	10.50
P3 / 4	KIP	1.8m EKI	11.50	9.50
P3 / 5	PIT	1200 x 1200	10.00	8.78
P3 / 6	PIT	1200 x 1200	7.70	6.05
P3 / 7	PIT	1200 x 1200	6.31	5.20
P3 / 8	PIT	1200 x 1200	5.35	3.94
P3 / 9	PIT	1200 x 1200	4.42	3.31
PROPOSED PIT SURFACE LEVELS AND INVERTS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION				

FOR CONTINUATION REFER DRAWING SHEET C3.04

FOR CONTINUATION REFER DRAWING SHEET C3.02

900 x 900 BOUNDARY SWP RL 4.68 IL 3.70

600 SW

C2.02

REFER TO SHEET C2.02 FOR CONTINUATION OF STORMWATER PIPE FOR SUBJECT SITE

RL 5.47 RL 5.41

ESH 30mm TOP COVER

A2 (LOT 2) 315 m² RL 4.85 +

A1 (LOT 1) 302.34 m² RL 4.85 +

BIN COLLECTION

BULKY GOODS AREA

LIFT

BIN AREA RL 5.70+

RL 6.32 +

RL 5.92 +

3.5m WIDE DRAINAGE EASEMENT AND CULVERT

TOW PROVIDES 250mm FREEBOARD MIN. TO INVERT OF FLOW PATH BUT DOES NOT EXCEED 350 mm IN HEIGHT ADJACENT TO THE BLOCK D. THERFORE SAFETY FENCING NOT REQUIRED.

+RL 6.20

RL 6.45 +

RL 7.72 +

+ RL 7.72

+ RL 7.22

RL 6.72 +

+ RL 6.72

+ RL 6.32

P3/9 P3/8 P3/7 P3/6

PROVIDE SMOOTH TRANSITION WITH EXISTING FOOTPATH

140.701

2 STOREY BRICK & W/BOARD RES. TILE ROOF No.53 LORIKEET GR.

2 DP 271139

2 STOREY BRICK & W/BOARD RES. TILE ROOF No.20 BUBALO ST.

30 DP 271139

2 STOREY W/BOARD RES. METAL ROOF No.18 BUBALO ST.

29 DP 271139

2 STOREY BRICK & W/BOARD RES. METAL ROOF No.16 BUBALO ST.

28 DP 271139

2 STOREY BRICK & W/BOARD RES. TILE ROOF No.14 BUBALO ST.

27 DP 271139

2 STOREY BRICK & W/BOARD RES. METAL ROOF No.12 BUBALO ST.

26 DP 271139

2 STOREY REND. RES. TILE ROOF No.10 BUBALO ST.

25 DP 271139

2 STOREY BRICK & W/BOARD RES. METAL ROOF No.8 BUBALO ST.

24 DP 271139

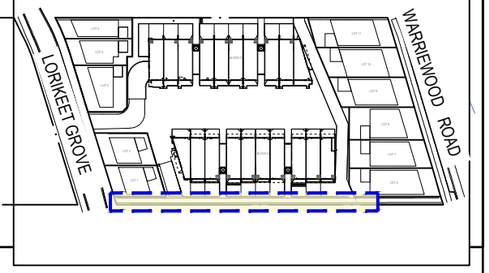
2 STOREY BRICK & W/BOARD RES. METAL ROOF No.8 BUBALO ST.

23 DP 271139

3 DP 271139

[A]

LOCALITY PLAN



ROADWORKS & DRAINAGE PLAN

SCALE - 1:150/A1, 1:300/A3

0 1 2 4 6 8 10m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

Architect

ACOR CONSULTANTS
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ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT (No. 43 - 49) WARRIEWOOD ROAD WARRIEWOOD

Drawing Title: ROAD WORKS & DRAINAGE PLAN SHEET 3 OF 5

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C3.03	C

FOR CONTINUATION REFER DRAWING SHEET C3.05

ON-SITE DETENTION/ BIORETENTION BASIN 1

ABOVE GROUND STORAGE AREA (SHOWN SHADED)
BASIN STORAGE VOLUME = 474 m³
EXTENDED DETENTION VOLUME = 142 m³
TOP STORED WSL = RL 4.60
BASIN INVERT RL 3.35 NOM.
MAX STORED OSD WATER DEPTH - 1.0m NOM
MAX STORED WATER DEPTH - 1.3m NOM
CONSTRUCT 474m² OF BASIN SURFACE AREA
NOTE: CONSTRUCT 12m LONG OVERLFOW WEIR TOP OF WEIR RL 4.52
NOTE: PROVIDE BASIN WITH IMPERMEABLE LINER TYP.

ON-SITE DETENTION/ BIORETENTION BASIN 2

ABOVE GROUND STORAGE AREA (SHOWN SHADED)
BASIN STORAGE VOLUME = 180 m³
EXTENDED DETENTION VOLUME = 90 m³
TOP STORED WSL = RL 4.20
BASIN INVERT RL 3.35 NOM.
MAX STORED OSD WATER DEPTH - 0.60m NOM
MAX STORED TOTAL WATER DEPTH - 0.9m NOM
CONSTRUCT 300m² OF BASIN SURFACE AREA
NOTE: PROVIDE BASIN WITH IMPERMEABLE LINER TYP.

12m NOM. WEIR. RL 4.52
GPT CDS 1012 CUSTOM UNIT.
+FSL 3.30
900 SQUARE PIT. REFER TO DETAIL AND 300 DIA. OUTLET. REFER TO DETAIL
FSL 3.40 +
TOW RL 4.9 MIN AND VARIES
FOOPATH 2.5 WIDE
TOW RL 4.60
TOW RL 4.8 MIN.
IL 3.50
FSL 3.40 +
TOW RL 4.65 NOM.
BOW RL 3.30
EDGE OF SWALE TO MATCH EXISTING SURFACE LEVEL
DENOTES 100mm Ø PERFORATED PIPE WRAPPED IN GEOTEXTILE AT 0.5% LONGITUDINAL GRADE TOWARDS OVERFLOW PIT
TOW RL 4.20
3m NOM. WEIR. RL 4.15
FSL 3.35 +
+FSL 3.30
2m NOM. WEIR. RL 3.15
900 SQUARE PIT. REFER TO DETAIL AND 300 DIA. OUTLET. REFER TO DETAIL
TOW 3.2
GPT CDS 1009 CUSTOM UNIT.
ENERGY DISSIPATION ZONE
1000
4000
TOW 3.2
4m NOM. WEIR. RL 3.00
DENOTES SANDSTONE WALL. WEIR LOCATION (IN RED) TO BE SAW-CUT AT THE WEIR TO REQUIRED LEVEL TO CONVEY UP TO THE 1YEAR ARI FLOW
6400m NOM.
CONCRETE HEADWALL
CONSTRUCT ROCK ARMOUR PROTECTION AND DIRECT TOWARDS LEVEL SPREADER/OVERFLOW ENERGY DISSIPATION. INVERT LEVEL OF OUTLET RL2.70 m AHD. REFER TO DETAIL ON SHEET C3.15
PROVIDE SMOOTH TRANSITION WITH EXISTING FOOTPATH
DENOTES EXTENT OF FOOTPATH TO BE DESIGNED FOR MAINTENANCE VEHICLE LOADING. 150mm THICK N32 CONCRETE WITH SL82 MESH 30mm TOP COVER
900 x 900 BOUNDARY SWP RL 4.68 IL 3.70
600
C2.02
REFER TO SHEET C2.02 FOR CONTINUATION OF STORMWATER PIPE FOR SUBJECT SITE
PROVIDE SMOOTH TRANSITION WITH EXISTING FOOTPATH
LORIKEET AVE
A3 (LOT 3) 400.27 m² RL 4.85 +
A2 (LO 315 RL 4.
A1 (LOT 1) 302.34 m² RL 4.85 +
BULKY GOODS AREA
BIN COLLECTION
LIFT
BIN AREA RL 5.70+
2 STOREY BRICK & W/BOARD RES. TILE ROOF No.53 LORIKEET GR.
DP 2
3 DP 271139
GPT
P1/1
P1/2
P1/3
P2/1
P2/2
P3/8
P3/9

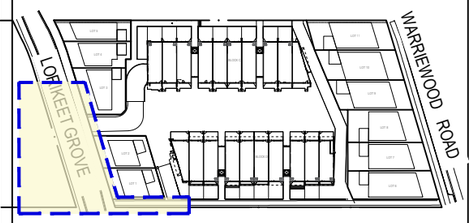
PIT SCHEDULE

PIT No.	TYPE	SIZE	TOP GRATE RL	INVERT OF OUTLET
P1 / 1	KIP	1.8m EKI	4.32	3.70
P1 / 2	KIP	1.8m EKI	4.32	3.60
P1 / 3	KIP	1.8m EKI	4.20	3.35
P2 / 1	KIP	1.8m EKI	4.10	3.50
P2 / 2	KIP	1.8m EKI	4.10	3.40
P3 /1	KIP	1.8m EKI	12.35	11.30
P3 / 2	KIP	V GRATE	12.00	10.95
P3 / 3	KIP	V GRATE	11.70	10.50
P3 / 4	KIP	1.8m EKI	11.50	9.50
P3 / 5	PIT	1200 x 1200	10.00	8.78
P3 / 6	PIT	1200 x 1200	7.70	6.05
P3 / 7	PIT	1200 x 1200	6.31	5.20
P3 / 8	PIT	1200 x 1200	5.35	3.94
P3 / 9	PIT	1200 x 1200	4.42	3.31

PROPOSED PIT SURFACE LEVELS AND INVERTS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION

NOTE: ALL PUBLIC DOMAIN WORKS SUBJECT TO ROADS ACT APPLICATION

LOCALITY PLAN



FOR CONTINUATION REFER DRAWING SHEET C3.03

ROADWORKS & DRAINAGE PLAN

SCALE - 1:150/A1, 1:300/A3
0 1 2 4 6 8 10m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

Architect:

ACOR Consultants (CC) Pty Ltd
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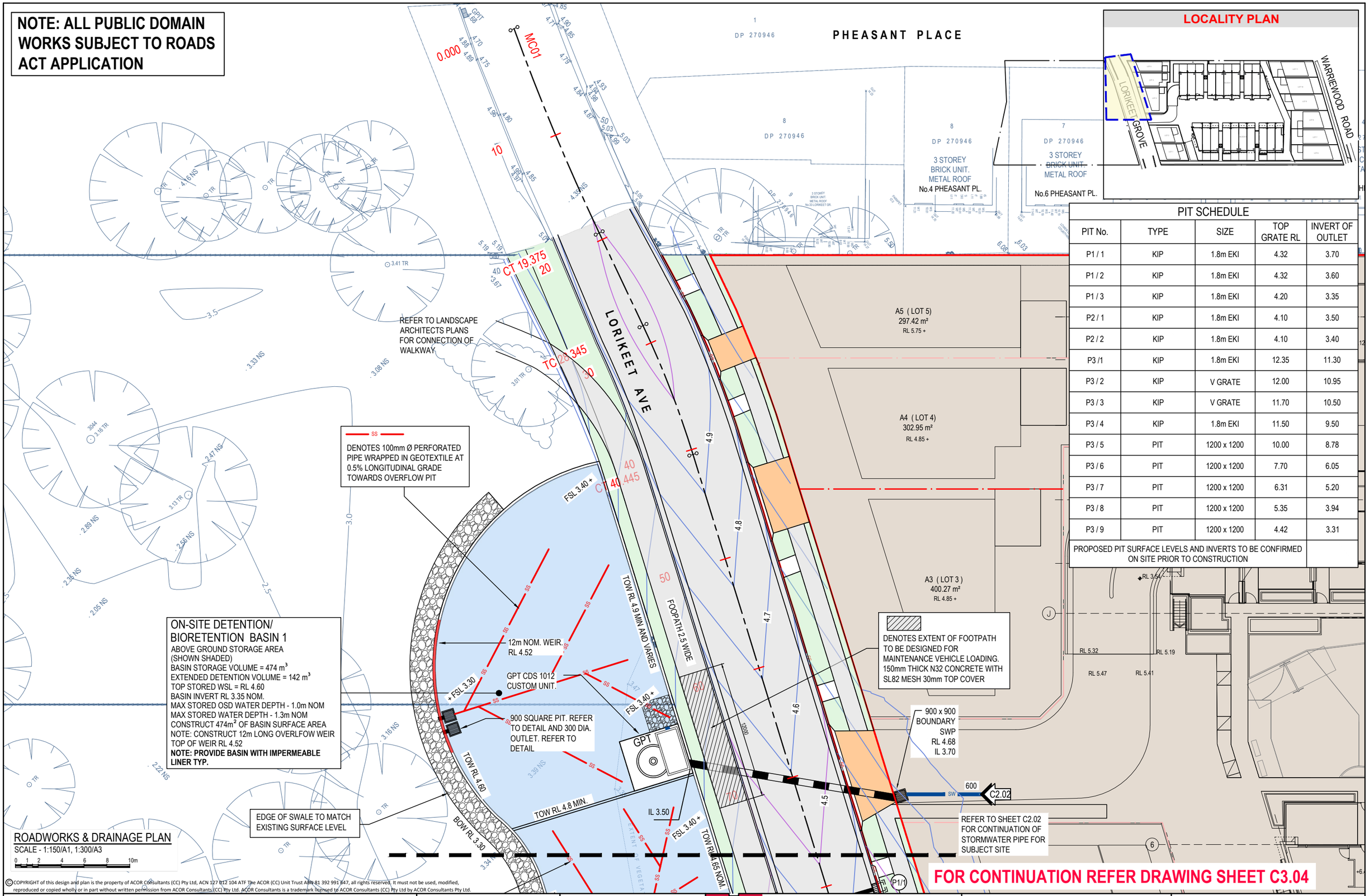
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: ROAD WORKS & DRAINAGE PLAN SHEET 4 OF 5

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.	Dwg. No.	Issue	
BK	CC230177	C3.04	C	

NOTE: ALL PUBLIC DOMAIN WORKS SUBJECT TO ROADS ACT APPLICATION



LOCALITY PLAN

PIT SCHEDULE

PIT No.	TYPE	SIZE	TOP GRATE RL	INVERT OF OUTLET
P1 / 1	KIP	1.8m EKI	4.32	3.70
P1 / 2	KIP	1.8m EKI	4.32	3.60
P1 / 3	KIP	1.8m EKI	4.20	3.35
P2 / 1	KIP	1.8m EKI	4.10	3.50
P2 / 2	KIP	1.8m EKI	4.10	3.40
P3 /1	KIP	1.8m EKI	12.35	11.30
P3 / 2	KIP	V GRATE	12.00	10.95
P3 / 3	KIP	V GRATE	11.70	10.50
P3 / 4	KIP	1.8m EKI	11.50	9.50
P3 / 5	PIT	1200 x 1200	10.00	8.78
P3 / 6	PIT	1200 x 1200	7.70	6.05
P3 / 7	PIT	1200 x 1200	6.31	5.20
P3 / 8	PIT	1200 x 1200	5.35	3.94
P3 / 9	PIT	1200 x 1200	4.42	3.31
PROPOSED PIT SURFACE LEVELS AND INVERTS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION				

ROADWORKS & DRAINAGE PLAN

SCALE - 1:150/A1, 1:300/A3

0 1 2 4 6 8 10m

FOR CONTINUATION REFER DRAWING SHEET C3.04

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

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Architect:

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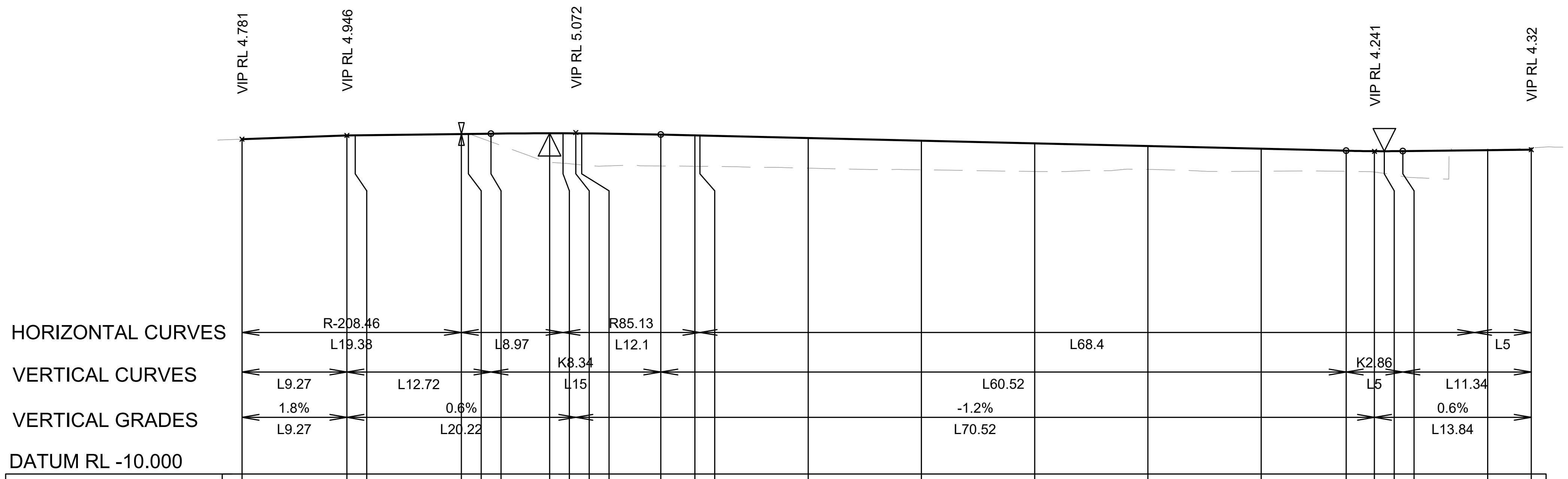
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: ROAD WORKS & DRAINAGE PLAN SHEET 5 OF 5

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.	Dwg. No.	Issue	
BK	CC230177	C3.05	C	



CHAINAGE	DESIGN	SURVEY	CUT/FILL
0	4.781	4.781	0.000
9.266	4.946	4.946	0.001
10	4.951	4.950	0.000
19.375	5.009	5.006	0.003
20	5.013	5.009	0.004
21.985	5.025	4.667	0.358
27.162	5.041	3.765	1.276
28.345	5.040	3.719	1.321
29.485	5.038	3.672	1.366
30	5.036	3.650	1.386
36.985	4.983	3.598	1.386
40	4.948	3.585	1.363
40.445	4.942	3.583	1.359
50	4.830	3.503	1.327
60	4.712	3.429	1.283
70	4.594	3.355	1.239
80	4.477	3.448	1.029
90	4.359	3.368	0.991
97.509	4.271	3.362	0.908
100	4.252	3.328	0.924
100.878	4.251	3.270	0.981
102.509	4.255	3.135	1.121
110	4.298	4.327	-0.029
113.847	4.320	4.394	-0.074

MC01 - LONGITUDINAL SECTION
HORZ SCALE 1:500
VERT SCALE 1:250

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

Architect

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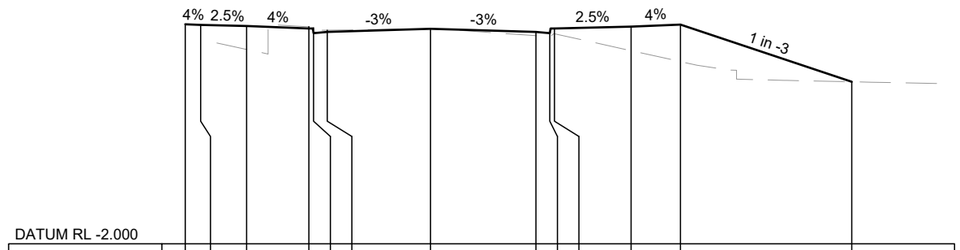
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: ROAD LONGITUDINAL SECTION (MC01) - LORIKEET GROVE

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

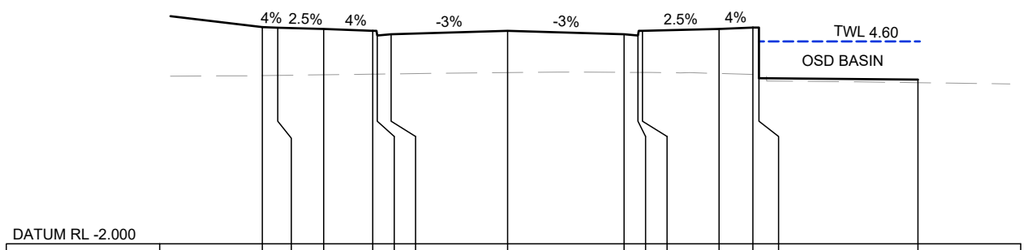
Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.06	C



DATUM RL -2.000

DESIGN	5.160	5.140	5.103	5.022	4.872	4.912	5.013	4.909	4.869	5.019	5.082	5.146	3.283	
SURVEY	4.712	4.680	4.340	5.083	5.046	4.967	5.009	4.789	4.759	4.850	4.299	3.943	3.283	
OFFSET	-8.000	-7.500	-6.000	-3.968	-3.818	-3.368	0.000	3.440	3.890	4.040	6.540	8.152	13.741	

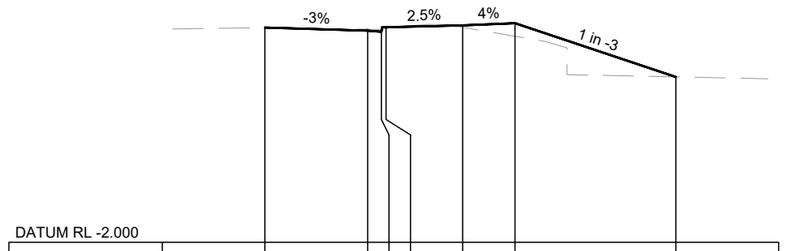
CH 20



DATUM RL -2.000

DESIGN	5.065	5.045	5.008	4.944	4.794	4.834	4.948	4.834	4.794	4.944	5.006	5.050	5.050	3.400	3.370	
SURVEY	3.485	3.493	3.512	3.532	3.534	3.540	3.585	3.591	3.589	3.589	3.554	3.523	3.520		3.255	
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200		13.384	

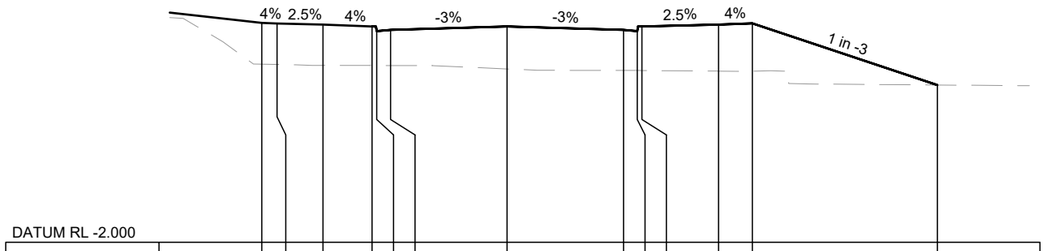
CH 40



DATUM RL -2.000

DESIGN	5.000	4.900	4.860	5.010	5.072	5.140	3.391	
SURVEY	4.998	4.943	4.938	4.961	5.008	4.716	3.391	
OFFSET	0.000	3.350	3.800	3.950	6.450	8.156	13.405	

CH 18



DATUM RL -2.000

DESIGN	5.154	5.134	5.096	5.032	4.882	4.922	5.036	4.922	4.882	5.032	5.095	5.139	3.127	
SURVEY	3.806	3.795	3.764	3.762	3.762	3.762	3.650	3.602	3.601	3.599	3.579	3.576	3.127	
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	14.037	

CH 30

HORZ SCALE 1:200
VERT SCALE 1:400

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

Client
WARRIEWOOD DEVELOPERS PTY LTD

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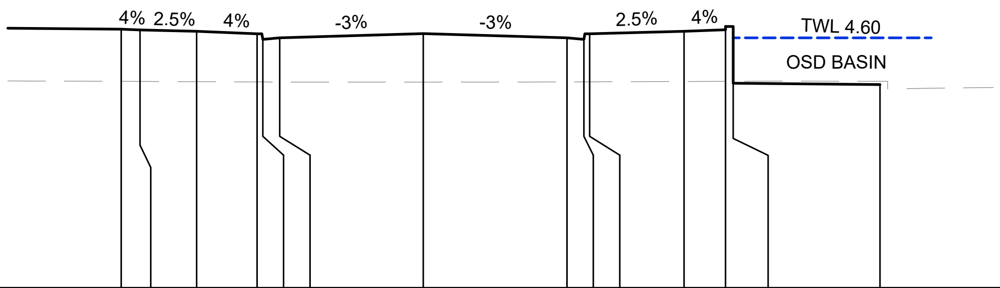
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD CROSS SECTIONS (MC01)
LORIKEET GROVE SHEET 1 OF 3

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

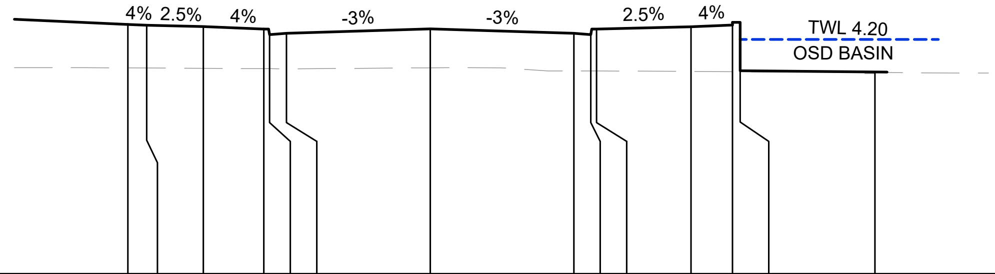
Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.07	C



DATUM RL -2.000

DESIGN	4.830	4.810	4.772	4.708	4.558	4.598	4.712	4.598	4.558	4.708	4.771	4.815	4.900 3.400	3.365
SURVEY	3.449	3.447	3.441	3.434	3.434	3.432	3.429	3.436	3.437	3.438	3.446	3.450	3.448	3.453
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200	12.086

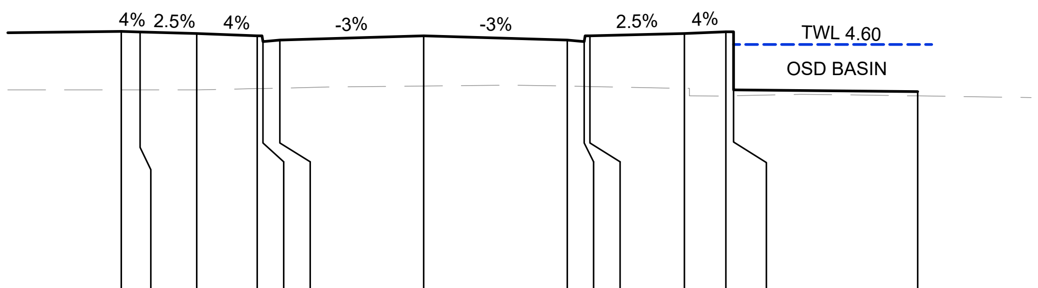
CH 60



DATUM RL -2.000

DESIGN	4.594	4.574	4.537	4.473	4.323	4.363	4.477	4.363	4.323	4.473	4.535	4.579	4.650 3.370	3.50
SURVEY	3.445	3.442	3.434	3.424	3.423	3.421	3.448	3.366	3.365	3.365	3.351	3.344	3.344	3.323
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200	11.768

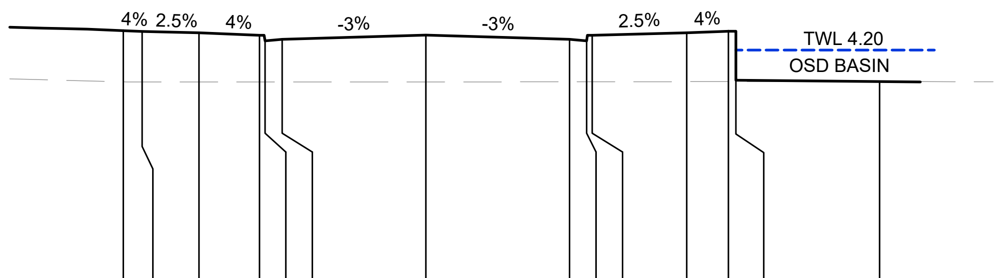
CH 80



DATUM RL -2.000

DESIGN	4.947	4.927	4.890	4.826	4.676	4.716	4.830	4.716	4.676	4.826	4.888	4.932	4.932	3.356
SURVEY	3.400	3.400	3.399	3.434	3.437	3.447	3.503	3.500	3.491	3.488	3.441	3.244	3.242	3.241
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200	13.074

CH 50



DATUM RL -2.000

DESIGN	4.712	4.692	4.654	4.590	4.440	4.480	4.594	4.480	4.440	4.590	4.653	4.697	4.697 3.400	3.364
SURVEY	3.359	3.357	3.356	3.356	3.356	3.356	3.355	3.359	3.360	3.360	3.363	3.364	3.363	3.364
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200	11.999

CH 70

HORZ SCALE 1:200
VERT SCALE 1:400

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

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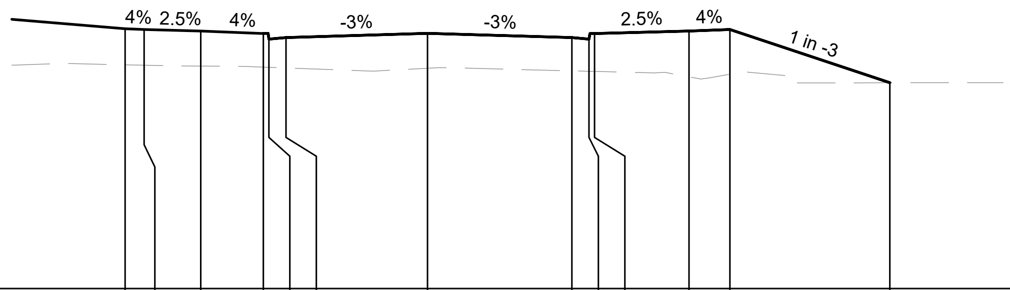
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD CROSS SECTIONS (MC01)
LORIKEET GROVE SHEET 2 OF 3

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

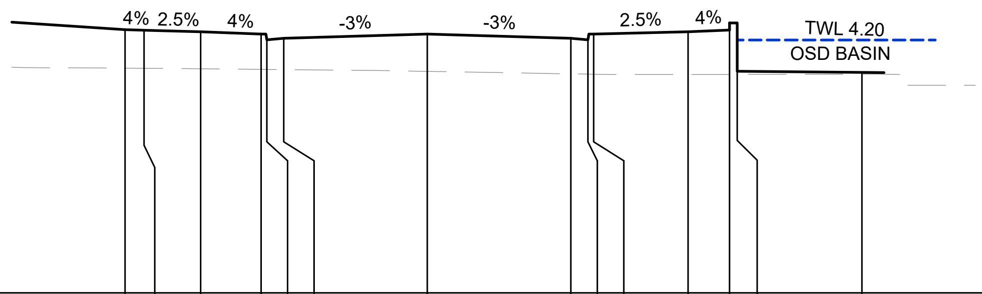
Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.08	C



DATUM RL -2.500

DESIGN	4.371	4.351	4.314	4.250	4.100	4.140	4.252	4.137	4.097	4.247	4.310	4.353	2.944
SURVEY	3.419	3.407	3.386	3.358	3.353	3.336	3.328	3.259	3.248	3.244	3.099	3.169	2.944
OFFSET	-8.000	-7.500	-6.000	-4.345	-4.195	-3.745	0.000	3.819	4.269	4.419	6.919	8.000	12.229

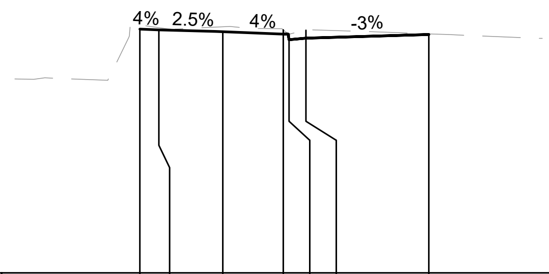
CH 100



DATUM RL -2.500

DESIGN	4.476	4.456	4.419	4.355	4.205	4.245	4.359	4.245	4.205	4.355	4.417	4.461	4.650 / 3.350	3.335
SURVEY	3.453	3.450	3.437	3.421	3.420	3.415	3.368	3.302	3.294	3.291	3.286	3.287	3.287	3.293
OFFSET	-8.000	-7.500	-6.000	-4.400	-4.250	-3.800	0.000	3.800	4.250	4.400	6.900	8.000	8.200	11.505

CH 90



DATUM RL -2.000

DESIGN	3.934	3.914	3.869	4.305	4.155	4.195	4.292
SURVEY	3.989	3.976	4.006	4.415	4.306	4.406	4.310
OFFSET	-7.644	-7.500	-6.000	-3.850	-3.700	-3.250	0.000

CH 109

HORZ SCALE 1:200
VERT SCALE 1:400

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

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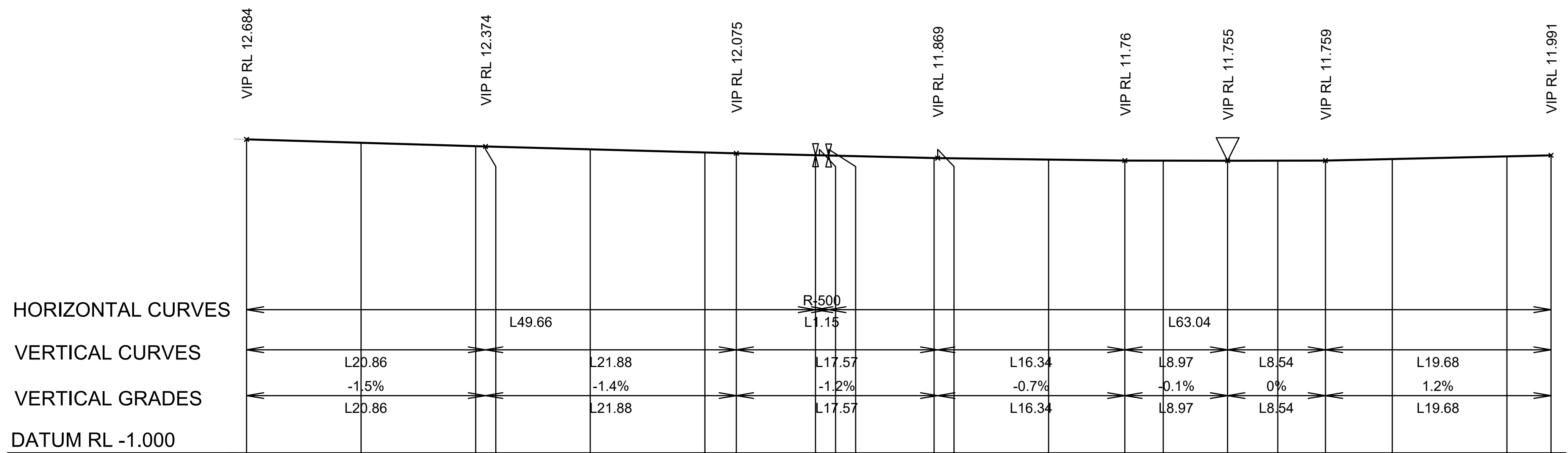
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: ROAD CROSS SECTIONS (MC01) LORIKEET GROVE SHEET 3 OF 3

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.09	C



DESIGN	12.684	12.536	12.387	12.374	12.249	12.112	12.075	11.994	11.990	11.980	11.873	11.869	11.805	11.760	11.758	11.755	11.758	11.759	11.828	11.946	11.991
SURVEY	12.684	12.536	12.387	12.374	12.249	12.113	12.075	11.994	11.990	11.981	11.873	11.869	11.805	11.760	11.757	11.755	11.757	11.759	11.828	11.946	11.991
CUT/FILL	0.000	0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
CHAINAGE	0	10	20	20.86	30	40	42.744	49.659	50	50.805	60	60.318	70	76.658	80	85.624	90	94.16	100	110	113.844

MC02 - LONGITUDINAL SECTION

HORZ SCALE 1:500
VERT SCALE 1:250

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

Client
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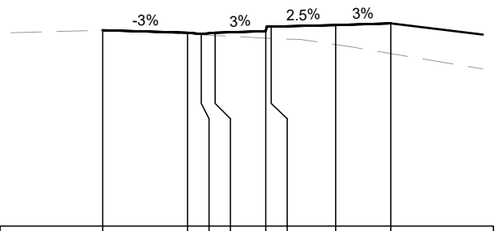
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD LONGITUDINAL SECTION (MC02) - WARRIEWOOD ROAD

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

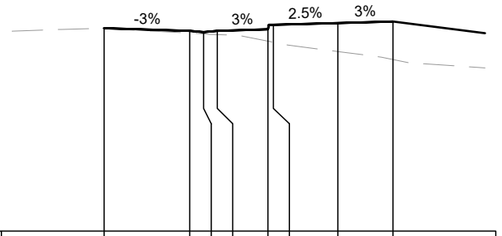
Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.10	C



DATUM RL 6.000

DESIGN	12.387	12.304	12.264	12.304	12.354	12.504	12.556	12.610	
SURVEY	12.387	12.258	12.237	12.214	12.128	12.119	11.919	11.626	
OFFSET	0.000	2.766	3.216	3.666	5.316	5.496	7.596	9.396	

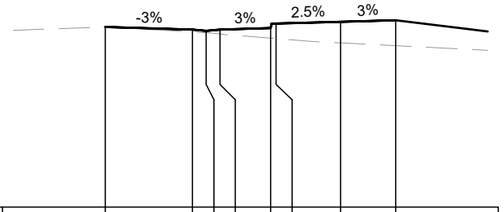
CH 20



DATUM RL 5.500

DESIGN	12.112	12.029	11.989	12.029	12.078	12.228	12.281	12.335	
SURVEY	12.113	11.957	11.930	11.904	11.694	11.658	11.355	11.094	
OFFSET	0.000	2.794	3.244	3.694	5.344	5.524	7.624	9.424	

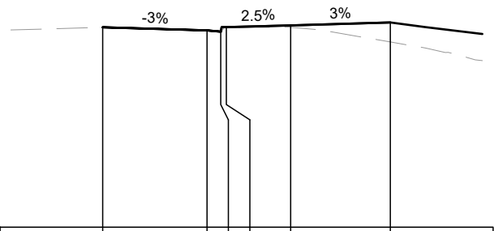
CH 40



DATUM RL 6.000

DESIGN	11.873	11.787	11.747	11.787	11.837	11.987	12.039	12.093	
SURVEY	11.873	11.710	11.684	11.644	11.509	11.494	11.353	11.262	
OFFSET	0.000	2.844	3.294	3.744	5.394	5.574	7.674	9.474	

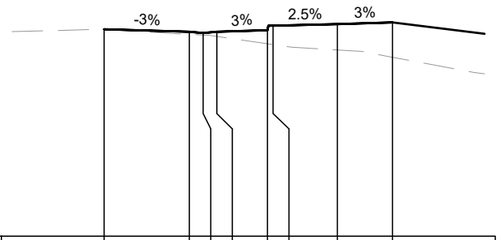
CH 60



DATUM RL 6.000

DESIGN	12.519	12.417	12.377	12.527	12.580	12.677		
SURVEY	12.519	12.408	12.375	12.509	12.522	12.040		
OFFSET	0.000	3.400	3.850	4.030	6.130	9.383		

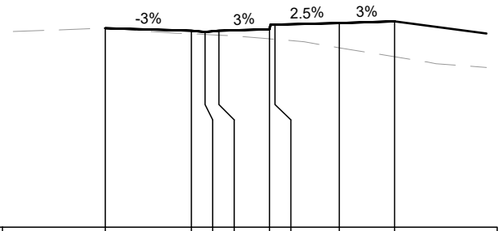
CH 11.122



DATUM RL 5.500

DESIGN	12.249	12.166	12.126	12.166	12.215	12.365	12.418	12.472
SURVEY	12.249	12.079	12.059	12.015	11.777	11.751	11.573	11.336
	0.000	2.780	3.230	3.680	5.330	5.510	7.610	9.410

CH 30



DATUM RL 5.500

DESIGN	11.990	11.906	11.866	11.906	11.955	12.105	12.158	12.212
SURVEY	11.990	11.808	11.785	11.763	11.644	11.629	11.350	11.059
OFFSET	0.000	2.808	3.258	3.708	5.358	5.538	7.638	9.438

CH 50

HORZ SCALE 1:200
VERT SCALE 1:400

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

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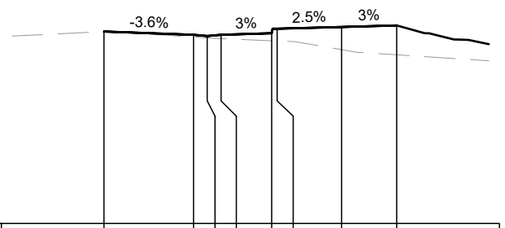
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD CROSS SECTIONS (MC02)
WARRIEWOOD ROAD SHEET 1 OF 2

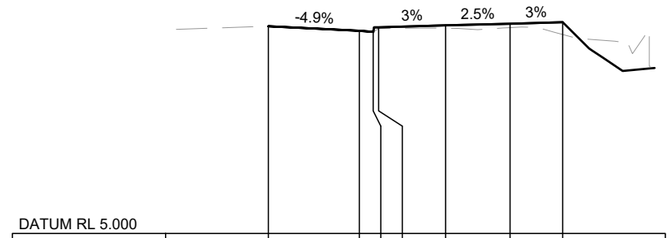
Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C3.11	C



DATUM RL 5.500

DESIGN	11.758	11.653	11.613	11.653	11.703	11.853	11.905	11.959		
SURVEY	11.757	11.582	11.552	11.529	11.458	11.451	11.169	11.001		
OFFSET	0.000	2.918	3.368	3.818	5.468	5.648	7.748	9.548		

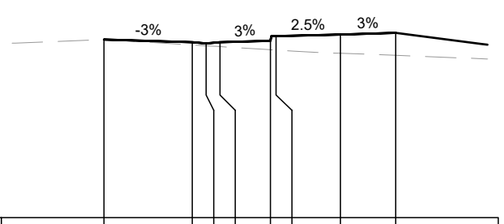
CH 80



DATUM RL 5.000

DESIGN	11.759	11.613	11.573	11.723	11.788		11.841	11.892		
SURVEY	11.758	11.613	11.592	11.678	11.700		11.713	11.489		
OFFSET	0.000	2.968	3.418	3.598	5.782		7.882	9.599		

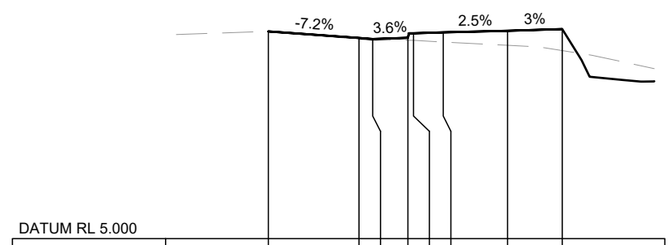
CH 93.576



DATUM RL 6.000

DESIGN	11.805	11.718	11.678	11.718	11.768	11.918	11.970	12.024		
SURVEY	11.805	11.629	11.603	11.577	11.475	11.464	11.360	11.293		
OFFSET	0.000	2.881	3.331	3.781	5.431	5.611	7.711	9.511		

CH 70



DATUM RL 5.000

DESIGN	11.758	11.546	11.506	11.548	11.698	11.727	11.779	11.833		
SURVEY	11.757	11.502	11.468	11.470	11.466	11.411	11.305	11.132		
OFFSET	0.000	2.955	3.405	4.553	4.733	5.704	7.804	9.585		

CH 90

HORZ SCALE 1:200
VERT SCALE 1:400

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

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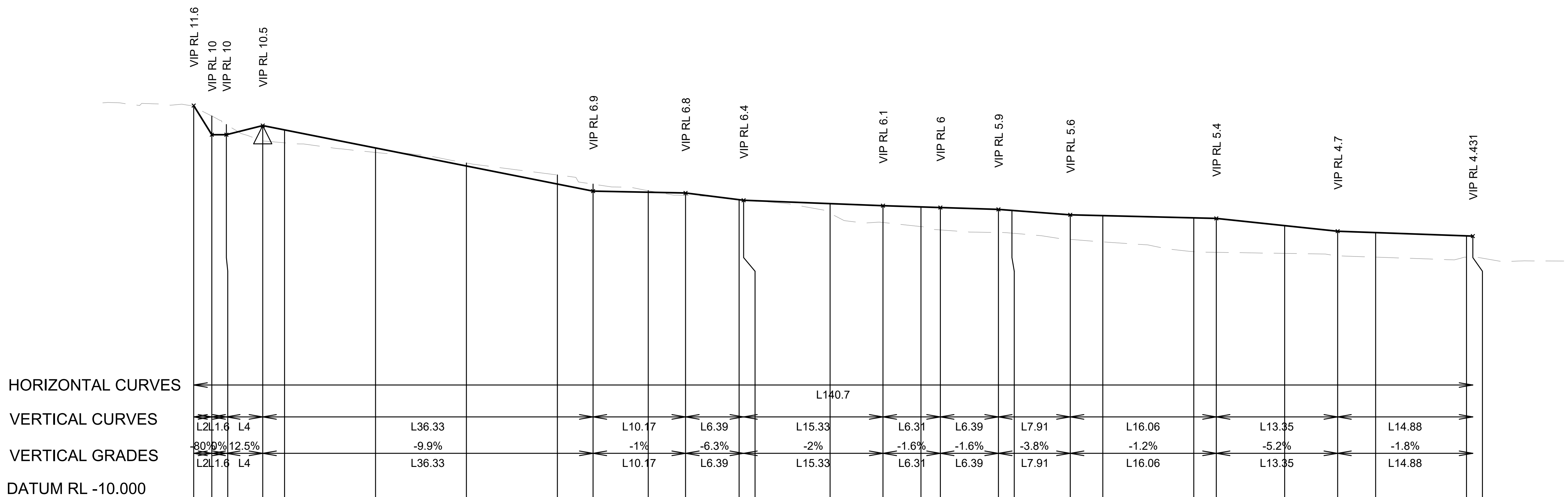
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
ROAD CROSS SECTIONS (MC02)
WARRIEWOOD ROAD SHEET 2 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C3.12	C



DESIGN	11.600	10.000	10.000	10.500	10.262	9.271	8.281	7.290	6.900	6.840	6.800	6.430	6.400	6.214	6.100	6.034	6.000	5.900	5.844	5.600	5.555	5.431	5.400	5.005	4.700	4.624	4.444	4.431
SURVEY	11.534	11.025	10.557	9.657	9.556	9.027	8.443	7.788	7.285	6.926	6.663	6.434	6.411	5.680	5.176	4.955	4.772	4.628	4.592	4.251	4.111	3.573	3.540	3.481	3.345	3.274	3.271	3.264
CUT/FILL	0.066	-1.025	-0.557	0.843	0.706	0.244	-0.163	-0.498	-0.385	-0.085	0.137	-0.004	-0.011	0.534	0.924	1.078	1.228	1.272	1.251	1.349	1.444	1.858	1.860	1.525	1.355	1.351	1.173	1.167
CHAINAGE	0	2	3.6	7.6	10	20	30	40	43.934	50	54.099	60	60.486	70	75.816	80	82.125	88.512	90	96.417	100	110	112.477	120	125.825	130	140	140.701

DR01 - LONGITUDINAL SECTION
HORZ SCALE 1:500
VERT SCALE 1:250

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

North

Client
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Architect

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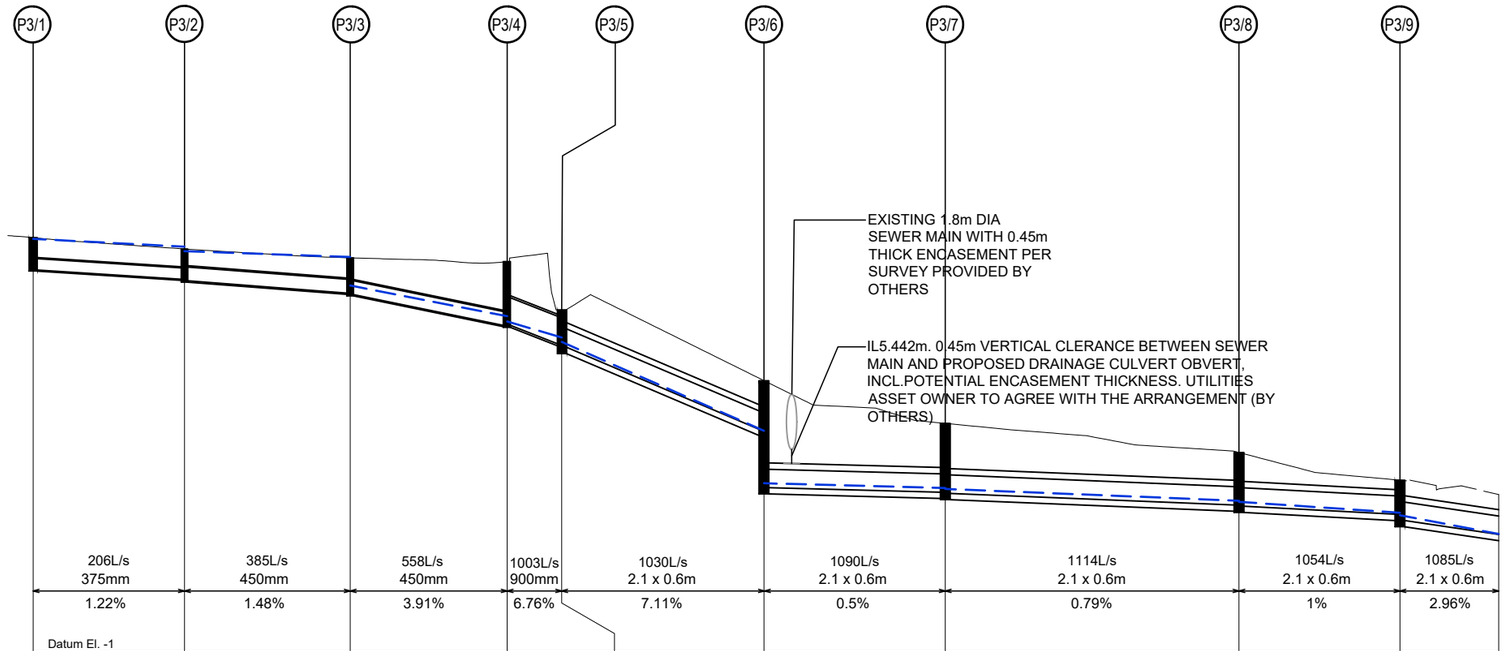
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
DRAINAGE EASEMENT LONGITUDINAL SECTION (DR01)

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.13	C



	206L/s 375mm	385L/s 450mm	558L/s 450mm	1003L/s 900mm	1030L/s 2.1 x 0.6m	1090L/s 2.1 x 0.6m	1114L/s 2.1 x 0.6m	1054L/s 2.1 x 0.6m	1085L/s 2.1 x 0.6m
	1.22%	1.48%	3.91%	6.76%	7.11%	0.5%	0.79%	1%	2.96%
Datum El. -1									
HGL	12.473 / 12.214	12.070 / 11.879	11.210 / 10.283	9.779 / 9.253	9.110 / 6.211	4.503 / 4.347	4.317 / 3.932	3.897 / 3.540	3.460 / 2.859
Surface Level	12.36	11.99	11.7	11.58	10.0	7.70	6.30	5.35	4.45 / 4
Invert Level	11.300 / 11.000	10.950 / 10.550	10.500	9.500 / 8.900	8.780 / 6.110	4.210 / 4.060	4.020 / 3.640	3.600 / 3.340	3.310 / 2.700
Chainage	0	24.66	51.70	77.30	86.18	119.19	148.74	196.64	222.91 / 239.02

LONG SECTION (100YR ARI + CC)
DRAINAGE LINE 3

HORIZONTAL SCALE - 1:500/A1, 1:1000/A3

0 5 10 20 30 40 50m

VERTICAL SCALE - 1:100/A1, 1:200/A3

0 0.5 1 2 3 4 5m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

Client: WARRIEWOOD DEVELOPERS PTY LTD

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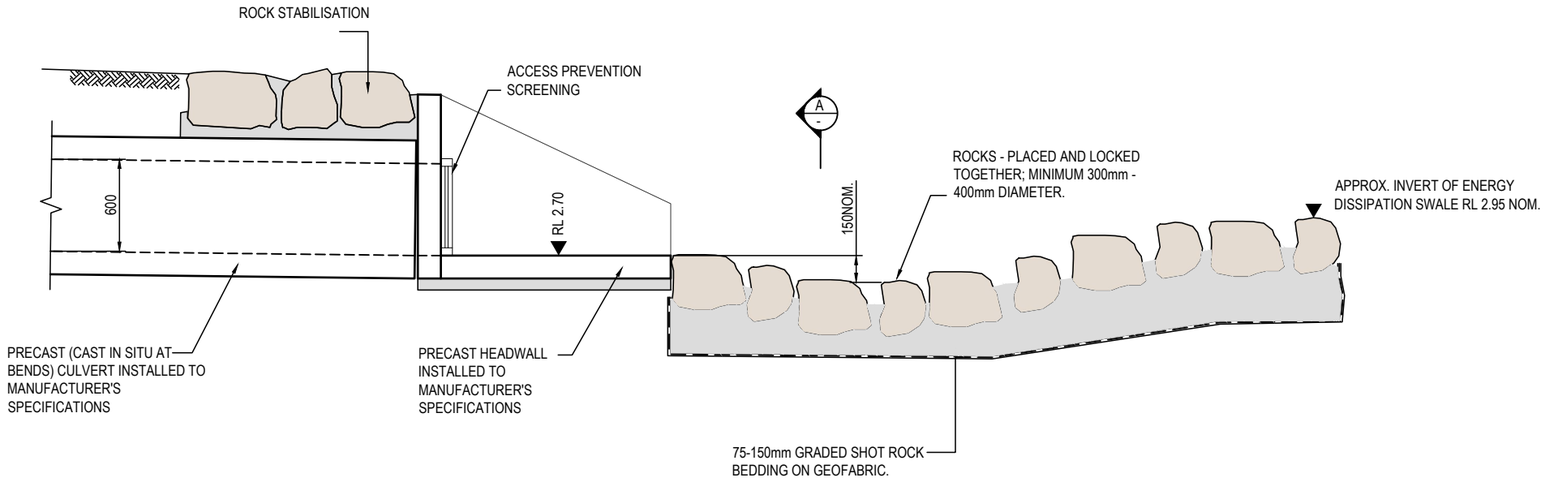
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

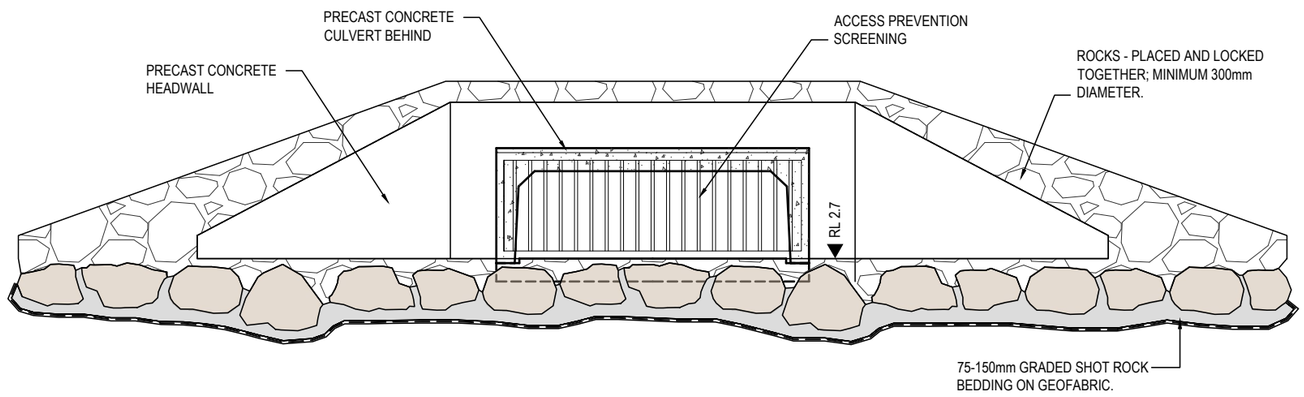
Drawing Title: DRAINAGE PIT & PIPE LONGITUDINAL SECTION

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.	Dwg. No.	Issue	
BK	CC230177	C3.14	C	



CULVERT HEADWALL SECTION

SCALE - 1:20/A1, 1:40/A3



SECTION A -

SCALE: 1:20/A1, 1:40/A3

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1 0 1cm at full size 10cm

North

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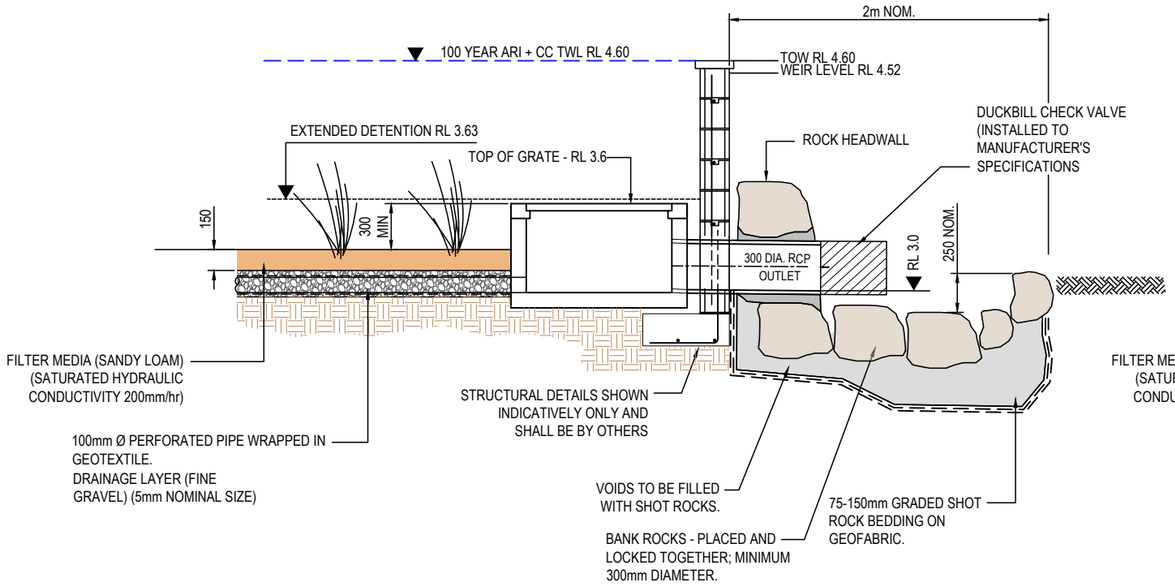
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: TYPICAL DETAIL SHEET 1 OF 2

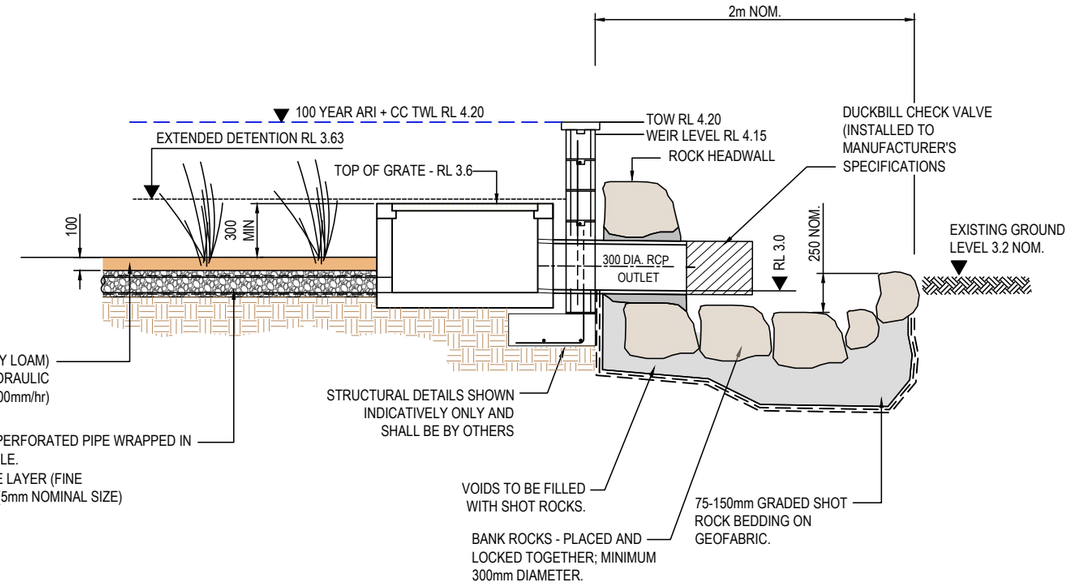
Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C3.15	C



NOTE: 2 OFF PIT AND PIPE DISCHARGE AT THIS LOCATION ONLY (ONLY ONE SHOWN IN DETAIL FOR CLARITY)

OUTLET AND ENERGY DISSIPATION SWALE - BASIN 1
NOT TO SCALE



OUTLET AND ENERGY DISSIPATION SWALE - BASIN 2
NOT TO SCALE

Issue	Description	Date	Drawn	Approved
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B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size

North

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(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: TYPICAL DETAIL SHEET 2 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
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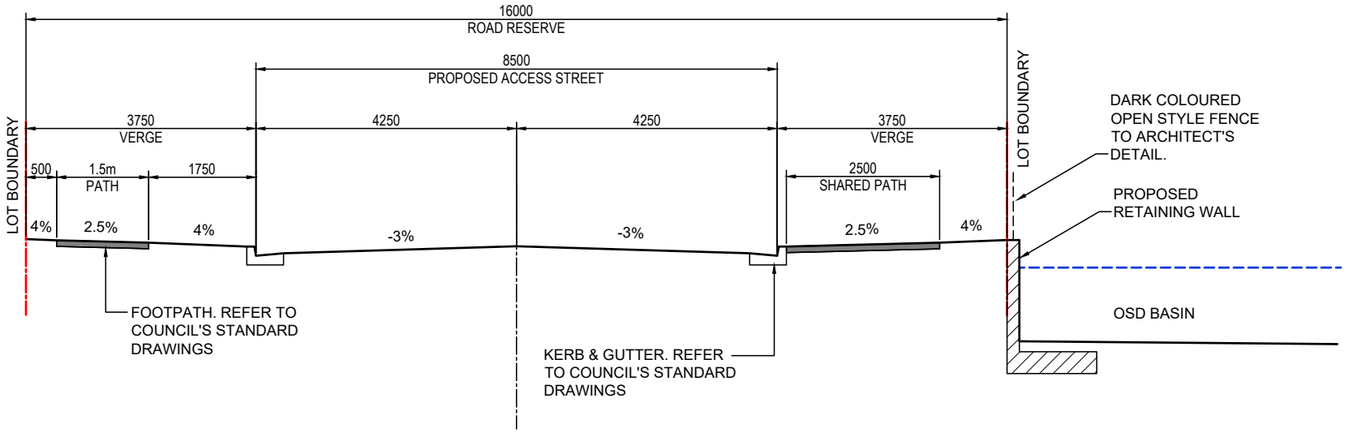
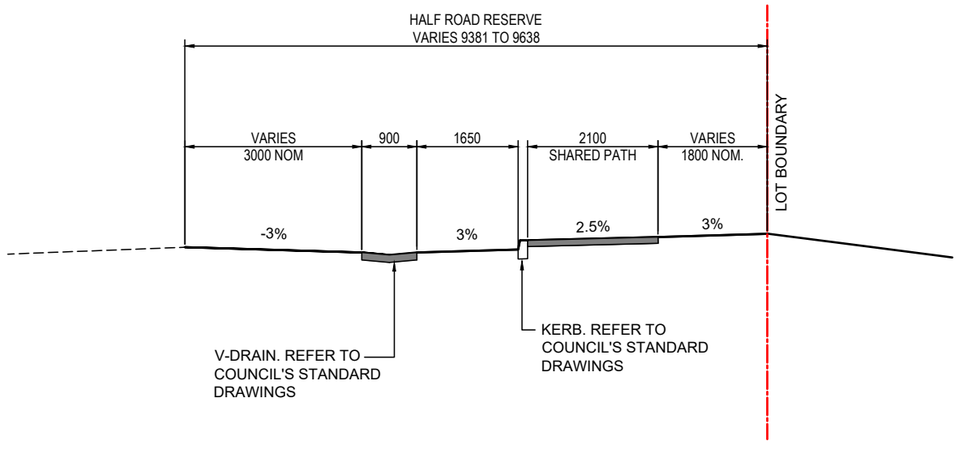


TYPICAL ROAD SECTION - LORIKEET GROVE EXTENSION

SCALE - 1:50/A1, 1:100/A3



Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	28.02.24	SJ	BK
A	ISSUED FOR APPROVAL	15.12.23	RH	BK

1cm at full size 10cm

North

Client
WARRIEWOOD DEVELOPERS
PTY LTD

Architect

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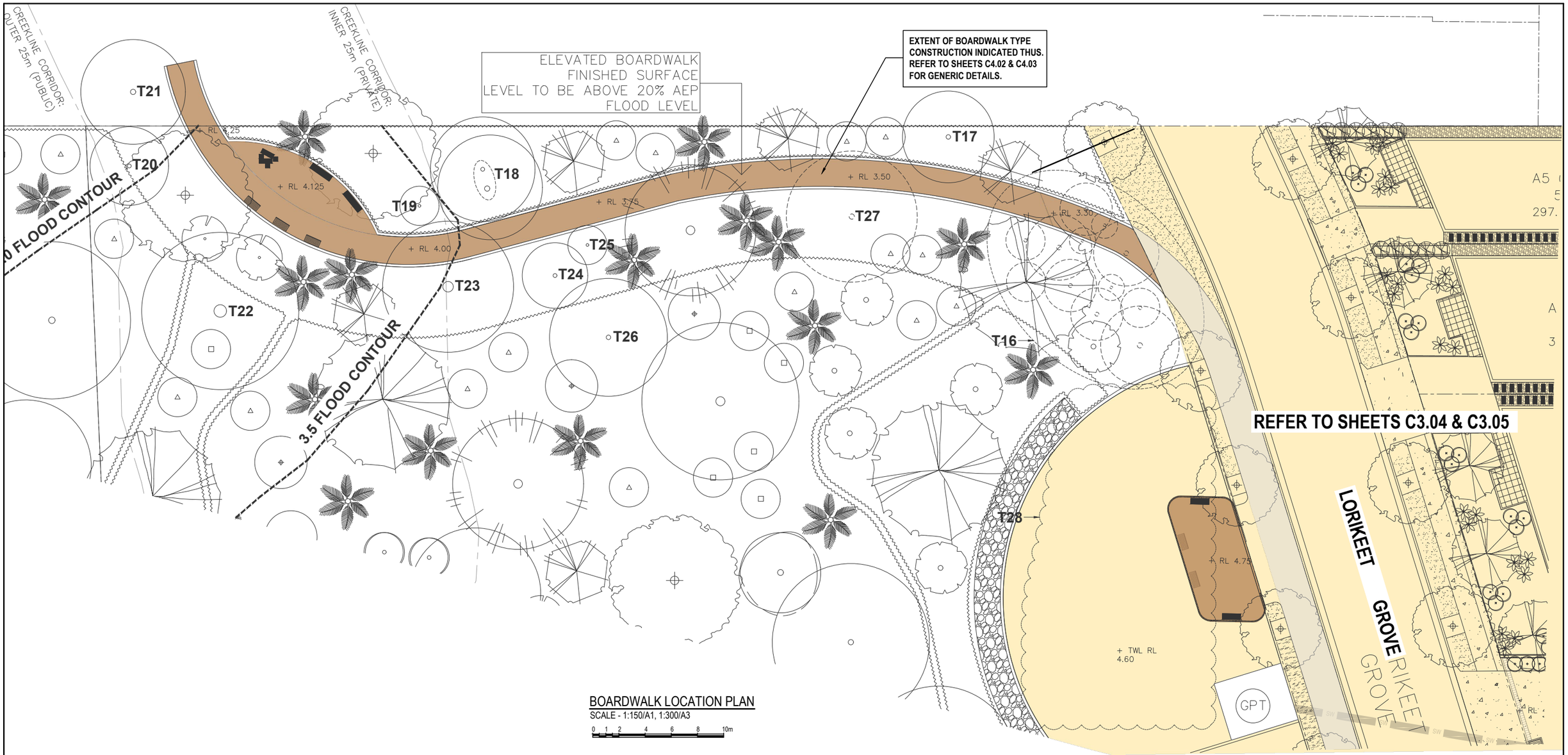
Project
PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title
TYPICAL ROAD SECTIONS

Drawn	Date	Scale A1	Q.A. Check	Date
LW	DEC 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C3.17	C



BOARDWALK LOCATION PLAN

SCALE - 1:150/A1, 1:300/A3

0 1 2 4 6 8 10m

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	29.02.24	SJ	BK
A	ISSUED FOR REVIEW & COMMENT	26.02.24	SJ	BK

1 0 1cm at full size 10cm

North

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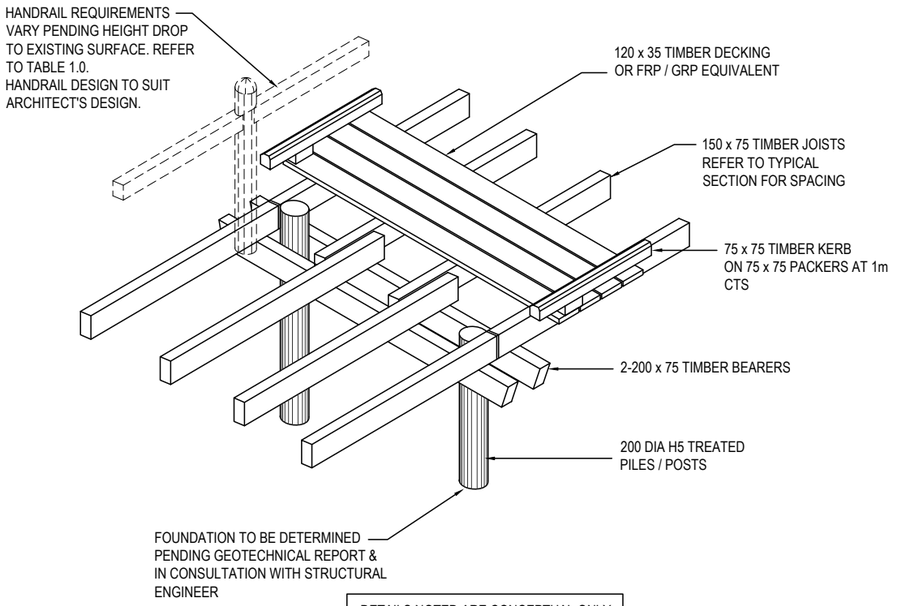
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: BOARDWALK LOCATION PLAN

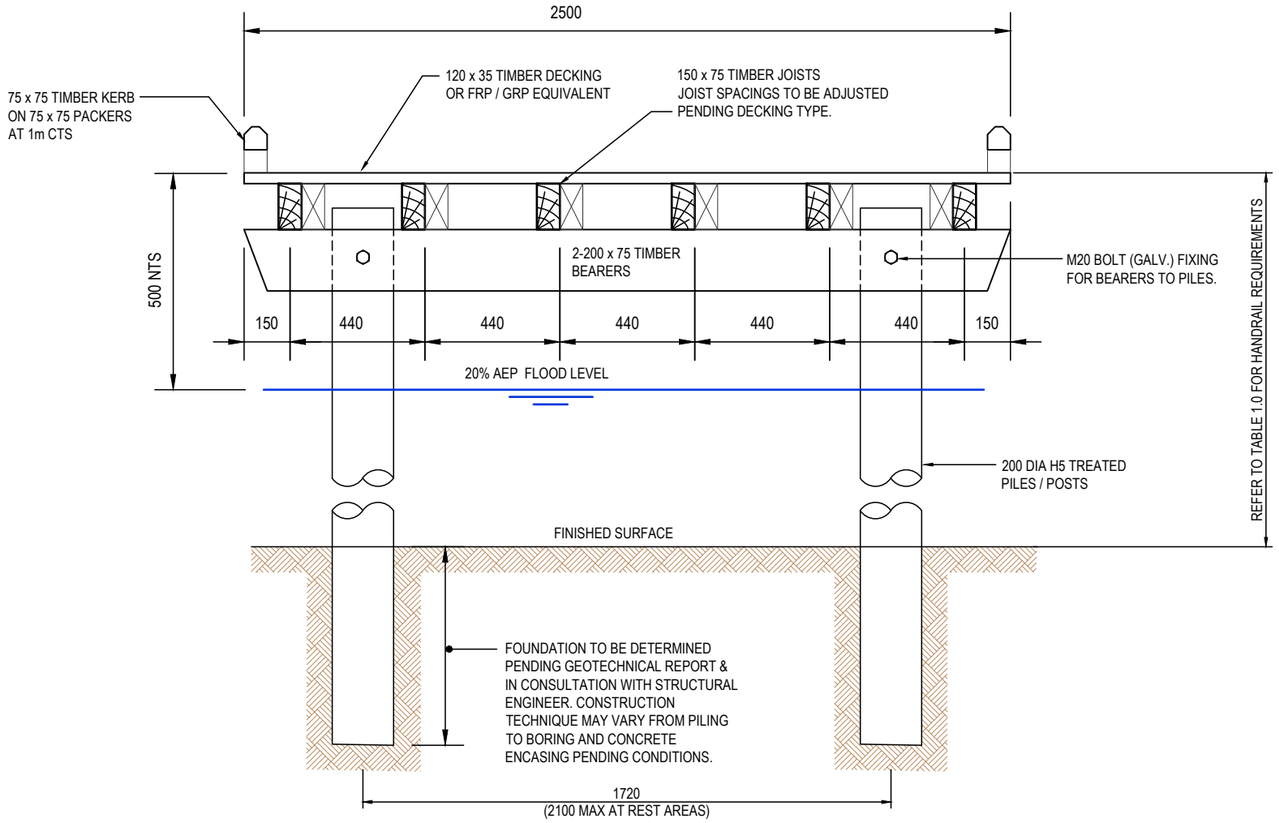
Drawn	Date	Scale A1	Q.A. Check	Date
SJ	FEB 2023	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	CC230177		C4.01	C



DETAILS NOTED ARE CONCEPTUAL ONLY. FINAL DESIGN TO BE DETERMINED AT CC STAGE DOCUMENTATION

BOARDWALK GENERAL ARRANGEMENT

SCALE - 1:10/A3, 1:20/A1



TYPICAL BOARDWALK SECTION

SCALE - 1:10/A3, 1:20/A1

GEOMETRIC REQUIREMENTS

LONGITUDINAL GRADES

3% MAX. GRADE GENERALLY

7% GRADE RAMPS CONNECTING DIFFERENCES IN LEVEL OF LESS THAN 0.63m (IE RAMPS NO LONGER THAN 9m.

HORIZONTAL CURVES

	AustRoads - Bicycles	
	Radius	Approx angle change in 3m chords (degrees)
Minimum	5m	35
Preferred	8m	22

OVERHEAD VERTICAL CLEARANCE

	BCA		AustRoads			
	Rooms	Doorways & Stairs	Pedestrians	Bicycles	Bridge Design	
					Pedestrians	Bicycles
Minimum	2.1m	2.0m	2.0m	2.4m	2.0m	2.4m
Preferred	2.4m		2.4m	2.7m	2.4m	2.7m

TABLE 1.0 HANDRAIL HEIGHTS

Bridge Design Code - AustRoads	Min rail height	Preferred rail height
Pedestrian Barrier	1.1m	1.1m
Cyclist Barrier	1.3m	1.3m
AS 1428.2 Design for Access & Mobility	Min rail height	Preferred rail height
Handrails at walkways ramps & landings	0.87 m	1.0 m
Building Code of Australia	Min rail height	Preferred rail height
for balconies between 1 & 3 m above ground. (125 mm max gap)	1.0 m	
for balconies less than 1m	no rail required	

Issue	Description	Date	Drawn	Approved
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A	ISSUED FOR REVIEW & COMMENT	26.02.24	SJ	BK

1cm at full size

North

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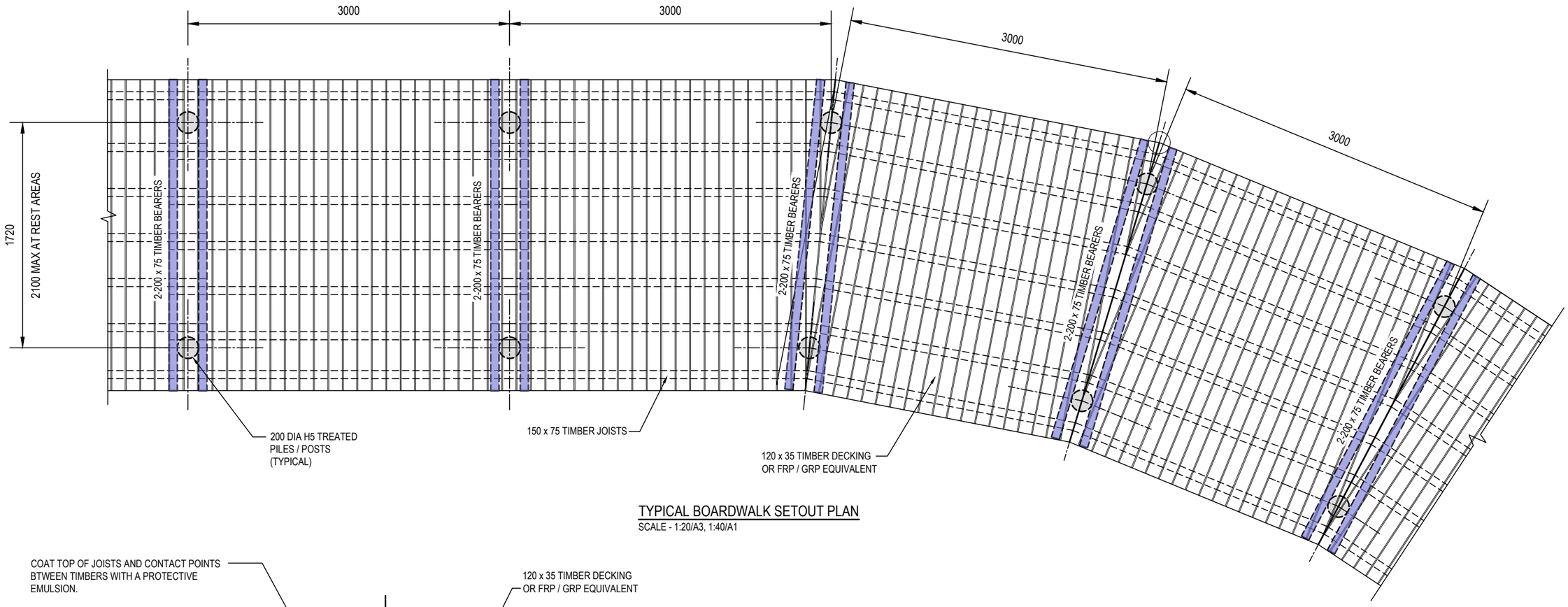
Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

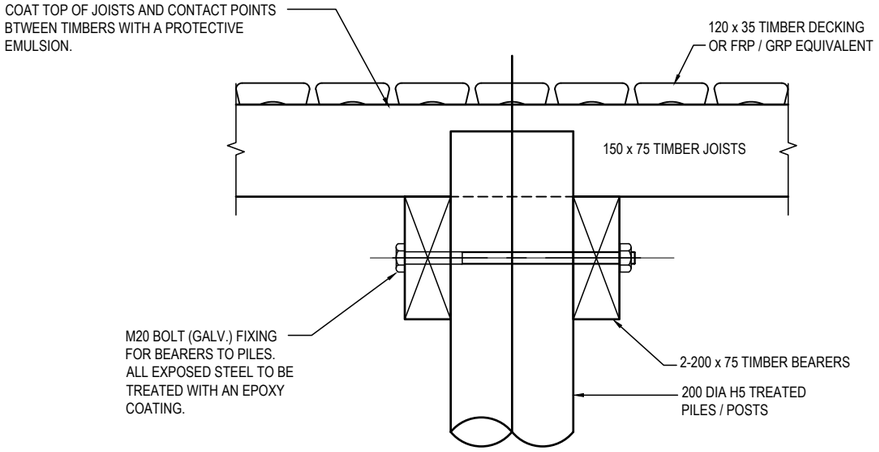
Drawing Title: BOARDWALK GENERIC DETAILS SHEET 1 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	FEB 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C4.02	C

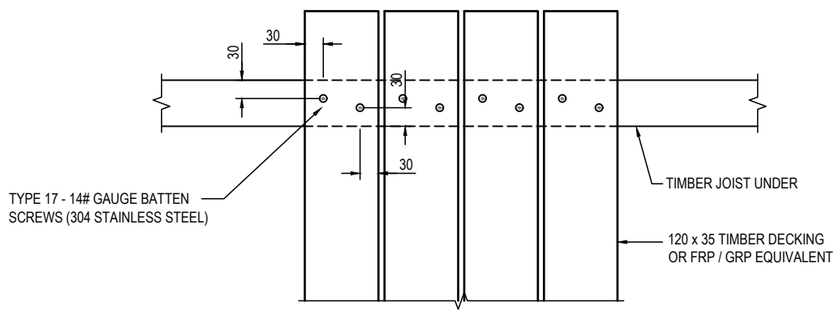


TYPICAL BOARDWALK SETOUT PLAN
SCALE - 1:20/A3, 1:40/A1

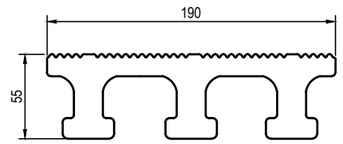


COAT ALL CUT SURFACES , END GRAINS OF JOISTS, BEARERS, POSTS & KERBS WITH A PROTECTIVE EMULSION.

TYPICAL POST TO BEARERS CONNECTION DETAIL
SCALE - 1:5/A3, 1:10/A1



TYPICAL DECK FIXING DETAIL
SCALE - 1:5/A3, 1:10/A1



"EVERTUFF" DECKING BOARDS MANUFACTURED BY "INTEGRATED RECYCLING" SHOWN . FIXING TO JOISTS AS PER MANUFACTURER'S SPECIFICATIONS.

NOTE: JOIST SPACING TO BE ADJUSTED TO SUIT ALTERNATIVE DECKING TYPE.

ALTERNATIVE DECKING TYPE
SCALE - 1:2/A3, 1:4/A1

Issue	Description	Date	Drawn	Approved
C	ISSUED FOR APPROVAL	06.03.24	NB	BK
B	ISSUED FOR APPROVAL	29.02.24	SJ	BK
A	ISSUED FOR REVIEW & COMMENT	26.02.24	SJ	BK

North

1cm at full size

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Project: PROPOSED RESIDENTIAL DEVELOPMENT
(No. 43 - 49)
WARRIEWOOD ROAD
WARRIEWOOD

Drawing Title: BOARDWALK GENERIC DETAILS SHEET 2 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	FEB 2023	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	CC230177	C4.03	C

Appendix 2A

Pre-Development Water Quality Assessment Report (Quarter 1 dated 04th June 2024)

H2O Consulting Group

Pre-Development Water Quality Assessment Report – Quarter 1

43-49 Warriewood Road, Warriewood

Prepared For: Warriewood Developers Pty Ltd

Report Date: 05 June 2024

H2O Consulting Group Pty Ltd

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H2O Consulting Group Pty Ltd

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Document Details	
Report Title	Pre-Development Water Quality Assessment Report – Quarter 1
Project Title	Water Quality Monitoring– 43-49 Warriewood Rd, Warriewood
Prepared For	Warriewood Developers Pty Ltd
Report Date	05 June 2024
Job Number	2357
Project Team	Dr David Cummings, Alex Swanson, Simon Kirgis, Ari Saunders

Document Control				
Version	Author	Reviewer	Approved by	Date
R0	Alex Swanson BMarBiol Simon Kirgis BEnvScMgmt	Dr David Cummings	Dr David Cummings	05/06/2024

Disclaimer:

The information provided in this document is based on knowledge, understanding and field observations at the time of review of associated materials and/or site survey. The report should be read and considered in its entirety including consideration of the limitations described in the report.

H2O Consulting Group Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation. H2O Consulting Group Pty Ltd accepts no liability or responsibility for contents of this report in respect of any use of, or reliance upon, by any third party or for any use other than the purposes for which it was commissioned. Unauthorised use of this document is prohibited.

Table of Contents

1 Introduction

1.1 Overview

H2O Consulting Group were engaged by Warriewood Developers Pty Ltd (the Applicant) to undertake a Water Quality Assessment (WQA) for Development Application (DA) No. DA2021/2600., which includes the subdivision of land into twelve (12) lots, creek line works and the construction of two (2) high density residential buildings at 43, 45 and 49 Warriewood Road, Warriewood (the Project). To adhere to the requirements of the Warriewood Valley Urban Land Release Water Management Specification (WVWMS), the following activities are required to be undertaken as part of this WQA:

- Undertake baseline monitoring over a period of at least 12 months prior to construction.
- Provision of a Water Quality Assessment Report for the baseline period (preconstruction) which will form a section of the Water Management Report.

This document presents the results of the initial Quarter 1 Dry Survey and Event 1 Wet Survey commencing the twelve (12) months of monitoring prior to construction.

1.2 Scope of Monitoring Program

The scope of this Program is designed specifically to establish the water quality and ecological characteristics of the riparian watercourses in the sector. This Program includes the following assessments to assess water quality, sediment quality and ecological health:

- Water Quality Monitoring (discrete sampling),
- Rapid Biological Assessment; and
- Sediment Toxicant Monitoring.

1.3 Objectives of Monitoring Program

The objectives of the water quality monitoring program are to:

- To ensure early detection of any significant risk to the health of the waterway and the public through pollution and habitat change during the development phase (Pittwater Council 2001).
- To establish a broad range baseline dataset of standard parameters by which the impacts of the development can then be measured (Pittwater Council 2001).

1.4 Locality and Site

1.4.1 Catchment Description

The Warriewood Valley Catchment is located on the southern boundary of the Pittwater Council Local Government Area (LGA) on Sydney's northern beaches. The catchment has a total area of 9.04 km^2 and includes the Warriewood Wetlands and three major creeks. These include Mullet Creek which drains an area of 3.5 km^2, Narrabeen Creek which drains an area of 3.2 km^2 and Fern Creek which drains an area of 0.73 km^2 (Lawson and Treloar 2005). Land use within the catchment is mixed and has undergone significant urban development, with approximately 32% of the catchment residential, 31% open pasture and 37% natural wetlands and bush (Lawson and Treloar 2005). As part of the Warriewood Valley Flood Study (Lawson and Treloar 2005), a 60% imperviousness was assumed for urban areas, 10% for rural areas and

5% for forested areas. Additional previous flood study modelling in the locality conducted by BMT WBM (2013) delineated the wider Warriewood and Narrabeen catchment into smaller sub-catchments, with the sub-catchment NL19 including the Project site and encompassing an area of 34.32 ha and overall 36.4% impervious area.

1.4.2 Site Description

The site of development includes 43, 45 and 49 Warriewood Road, Warriewood, identified as Lot 2, DP 972209, Lot 2, DP 349085 and Lot 1, DP 349085 respectively, with a combined area of ~22,187 m^2 (CPS 2023). These Lots will be referred to throughout this program as the 'Project Area'. The site is located within the Northern Beaches LGA, in the Warriewood Valley locality as per Section A4.16 of the Pittwater 21 Development Control Plan (PDCP 2014) and comprises the sectors Buffer Area 1F and 1G. The site within 43 Warriewood Rd is predominantly undeveloped and comprises an open drainage channel, whilst the front (northeastern) halves of 45 and 49 Warriewood Rd each comprise of a detached dwelling house and associated residential structures. The rear (southwestern) halves of the latter two properties are predominantly undeveloped and consist of vegetated areas along the Narrabeen Creek riparian corridor, with the southern boundary extending ~81.4 m along the creek line (CPS 2023).

Narrabeen Creek is approximately 4 km in length, with its headwaters located in the Healesville Estate section of the Ingleside escarpment, in the most northern section of the Ingleside Nature Reserve. The creek flows southwest parallel to Fern Creek, which joins Narrabeen Creek before the confluence with Mullet Creek on the southern side of the Warriewood Wetlands. Mullet Creek then flows into Narrabeen Lagoon approximately 750 m downstream.

Sites were selected along Narrabeen Creek near the upstream and downstream ends of each sector, and one within the sectors, with consideration to avoid upstream point sources of pollution, to ensure generally well mixed flow conditions and to avoid presence of physical structures that may influence water quality. Additional sites may be required at later stages of construction/development, including any water quality control ponds, sediment control basin or GPTs. Additional sites would be addressed in subsequent reports. Baseline monitoring sites are detailed in Table 1 and shown in Figure 1. The creek and surrounding creek banks surveyed as part of this monitoring program is referred to throughout this report as the 'Study Area'.

Table 1: Monitoring sites

Site	Creek location	Approximate GPS Coordinates	Location Type
1	Approximately 20 m upstream of upstream sector edge of Buffer Area 1F.	151.296467 °E 33.687697 °S	Upstream
2	Instream at intersection of Buffer Areas 1F and 1G.	151.296862°E 33.688046°S	In-sector
3	Approximately 20 m downstream of downstream sector edge of Buffer Area 1G.	151.2972660°E 33.6884624°S	Downstream

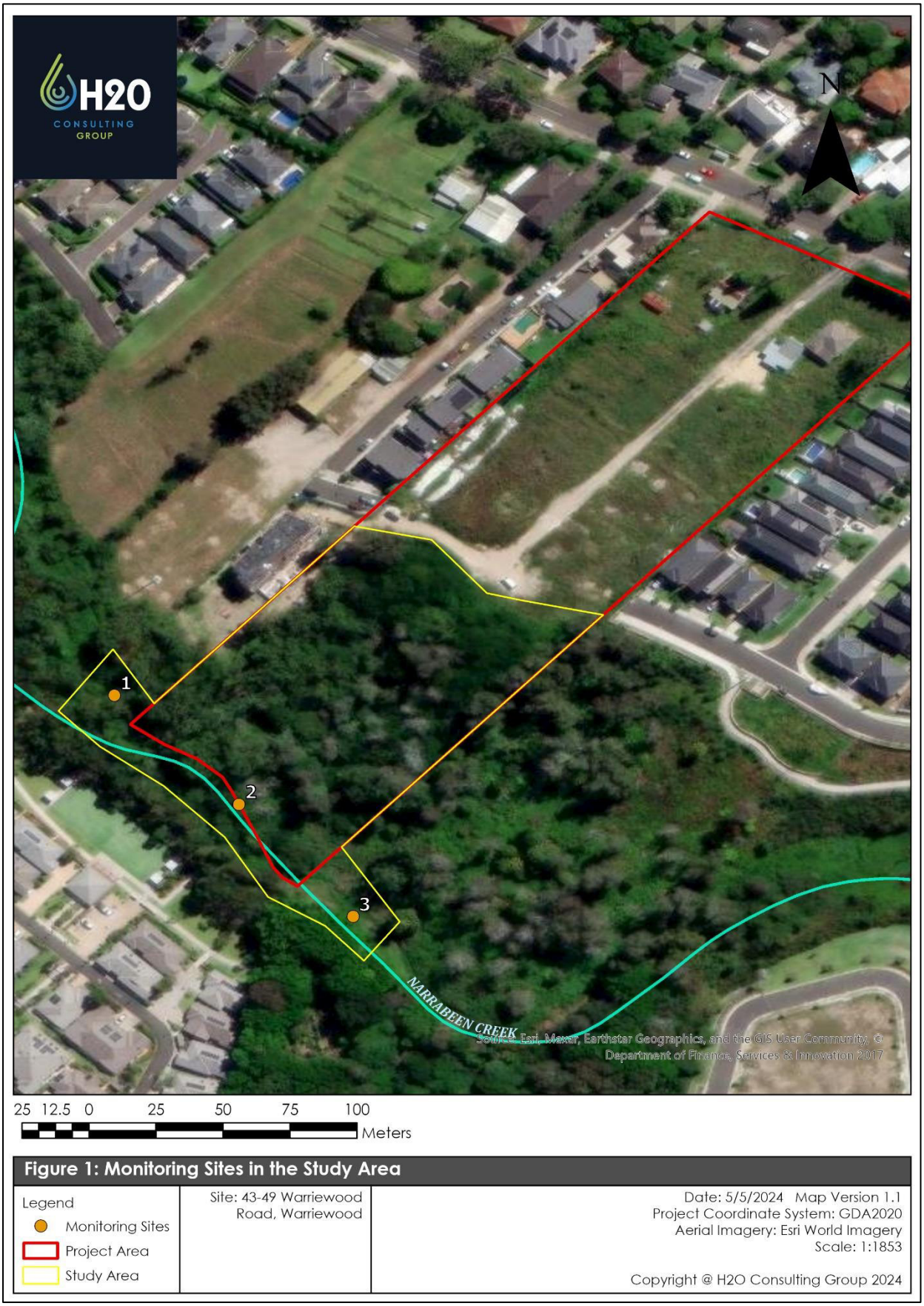

Figure 1: Monitoring sites along Narrabeen Creek

1.5 Limitations of Monitoring Program

Habitat based assessment, observations and physio-chemical measures of water attributes were taken on one occasion for dry and wet weather at each site. These measures provide only a snapshot of these site attributes at the time of survey and may not be reflective of spatial and temporal variability of these attributes. Further surveys will provide a more reflective spatial and temporal representation of the sites over the 12 months of baseline monitoring.

Total suspended solids for each site and nitrite, nitrate, NOx and reactive phosphorous at Site 2 were missed during the first dry weather survey. An additional site visit was made within 4 weeks of the initial survey under similar weather conditions.

2 Methodology

2.1 Survey Methodology

Detailed methodologies of the below sections may be found in the associated Water Quality Monitoring Plan (H2O Consulting Group 2024) associated with this project. The Event 1 Wet Survey was triggered by a predicted rainfall greater than 20 mm within 24 hours.

2.1.1 Visual Condition

Visual monitoring of habitat and water quality was undertaken at each site and recorded based on the average predominant characteristic along a 30 m reach. Monitoring surveys were conducted within the same 30 m reach of channel (±5 m), using the GPS coordinates recorded at the initial site surveys for reference. Visual water quality parameters were used to detail site condition.

2.1.2 Water Quality Sampling

In-situ measurements are recorded for field parameters at each site using a calibrated water quality meter. These parameters include pH, temperature (°C), specific electrical conductivity (µs/cm), dissolved oxygen (% saturation) and turbidity (NTU). Three replicate readings are conducted at each monitoring site, within 5 m of the GPS position of the monitoring site and include the date and time of day.

Surface water samples were collected for physical and chemical parameters at each site. The surface water sampling was undertaken via hand grab, with personnel wearing disposable nitrile gloves. One surface water sample was taken at each site, for each parameter. The collection of each sample occurred within 5 m of the GPS position of the monitoring site.

Sample bottles with the lid on were completely immersed in water to a depth of 10-15 cm (where depth allowed). Once rinsed, the lid was then removed with the bottle opening directed into the water flow (facing upstream), and the sampler's hand positioned downstream to avoid contamination. The bottles were filled to capacity. Sample bottles were uniquely labelled for each parameter and site, stored on ice in a dark Esky with appropriate preservatives where applicable, and provided to the laboratory within 6-8 hours of collection.

2.1.3 Sediment Sampling

Sediment samples were collected using a stainless-steel trowel, with personnel wearing nitrile disposable gloves. At each site, three replicate sediment samples were taken, of approximately 200 g of sediment within 5 m of the GPS position of the monitoring site. Where sufficient sediment for laboratory analysis was not successfully collected in a single grab, a composite sample to achieve sufficient volume of material was collected from the same location. A subsample was then sieved through a stainless-steel sieve to retain the fraction less than 2mm for analysis, following ANZG (2018) guidance. This subsample was transferred to its corresponding sample jar using decontaminated equipment. All equipment used to collect sediment samples, including the stainless-steel trowel, sieve and transfer equipment, was decontaminated in between samples in a dilute Liquinox solution, with potable water rinse then distilled water rinse. Sample jars were filled to capacity. Sample jars were uniquely labelled for each parameter and site, stored on ice in a dark Esky, and provided to the laboratory within 6-8 hours of collection. An additional subsample of the sampled sediment was measured for pH and redox potential using a calibrated water quality meter.

2.1.4 Rapid Biological Assessment

The following method to sample macroinvertebrates was derived from the *NSW AUSRIVAS Sampling and Processing Manual (2004*) and is conducted in autumn and spring.

A large 250 µm mesh net with triangular opening and a large tray were used to sample macroinvertebrates. Equipment was cleaned/washed of biota and sediment using water prior to and in between samples. Sampling included a representative selection of potential habitat at the site, including aquatic vegetation/macrophytes, areas with bare bank, tree roots, trailing vegetation, snags, submerged rocks and organic deposits and rocky formations creating runs. The net was moved in short, strong, sweeping movements facing upstream at a right angle to the bank to dislodge macroinvertebrates and then swept through the suspended material. Benthic material was also disturbed in areas of cobble and pebble bed substrate, by the sampler shuffling and shifting their feet. Surface dwelling animals were also collected. This was repeated along a number of segments, for a total sampled length of 10 m within the 50 m reach of habitat.

The contents of the net were emptied onto a clean, white tray for picking, as soon as possible after collection. Sampling personnel live picked each sample for 40 minutes, placing macroinvertebrates into a labelled specimen jar with 70% ethanol.

2.2 Lab Analysis

The laboratory used to analyse samples was accredited by the National Association of Testing Authorities, Australia (NATA). Analyses performed by the laboratory were to conducted using standardised methods and undertaken by appropriately qualified and experienced personnel. The laboratory provided a quality assurance program with analysis of internal spikes, duplicates and method blanks, and reported results at sufficiently low limits of reporting (LOR) to allow comparison with adopted sediment quality guidelines. Laboratory certificates are included in the appendix of this report (Appendix 1).

2.3 QA/QC Procedures

The team involved in field sampling for water quality, sediment quality and ecological monitoring surveys comprised of suitably qualified and experienced environmental scientists and included at least one personnel with the following experience:

- Previous experience conducting visual riparian, channel and aquatic ecological assessments, water quality assessments and sediment assessments.
- Previous training or experience in macroinvertebrate sampling methods and live field picking; and
- Tertiary qualifications in environmental science, biology, or chemistry.

2.4 Data Analysis

Water quality and sediment quality parameters were assessed against the Australian and New Zealand Fresh and Marine Water Quality Guidelines (ANZG) (2018), and the ANZECC & ARMCANZ (2000) Guidelines where applicable. Water quality data was screened against stressor values for South-east Australian lowland rivers (ANZECC 2000) and toxicant trigger values for ecosystem species protection of 95% (ANZG 2018). For Mercury and a number of organochlorine pesticides and PAH toxicants, the 99% species protection level was used to account for the bioaccumulating nature of toxicants.

SIGNAL Index for each site was calculated by averaging the SIGNAL Grade numbers of all aquatic macroinvertebrate taxa collected in that sample. Taxa that did not have a specific SIGNAL Grade were omitted from the calculation. EPT Richness was calculated for each site as a count of the individual families that belong the orders Ephemeroptera, Plecoptera and Trichoptera. Percent sensitive taxa for each sample was calculated as the percentage of the total taxa with a SIGNAL Grade possessing a SIGNAL Grade ≥ 8, whilst percent tolerant taxa was calculated as the percentage with a SIGNAL Grade ≤ 3.

3 Results and Findings

3.1 Weather Patterns

3.1.1 Dry Survey 1 – March 2024

The dry survey was conducted on the 21st of March, 2024. A total of 0.8 mm of rain was recorded in the 24 hours prior to the survey. A high of 20.8 °C and a low of 11.8 °C was recorded on the day of the survey, with generally sunny and warm conditions.

3.1.2 Wet Survey 1 – April 2024

The wet survey was conducted on the 5th of April, 2024. A total of 68.2 mm of rain was recorded in the 24 hours prior to the survey. A high of 19.5 °C and a low of 17 °C was recorded on the day of the survey, with wet weather conditions.

3.2 Visual Condition

3.2.1 Dry Survey 1 – March 2024

The creek at Site 1 measured 1.5 – 8 m in width with an approximate stream depth of 1.5 m, and no evidence of erosion along the banks during the dry survey. Water level was moderate (25-50%) with little water flow, potentially being restricted by dense vegetation upstream. Water was turbid with a slight odour and surface foams evident. Macrophytes were absent, however, turfing benthic algae was observed. Dense fringing vegetation surrounded the stream, including Morning Glory (*Ipomoea indica)* and Harsh Ground Fern (*Hypolepis meulleri)*, whilst the invasive Trad (*Tradescantia fluminensis*) was a common ground cover. Some plastic debris was observed in the area.

The creek at Site 2 measured 3 – 15 m in width and 0.5 – 1 m depth during the dry survey. Water level was moderate (25 – 50%) with low flow. Water was tannin coloured, with no evident odour and some organic surface scum. No erosion of banks was evident, with a small amount of finer sandy sediments accumulated on the creek bed. Fringing vegetation was primarily composed of rushes and weeds, with some small ornamental, toxic Arum Lily (*Zantedeschia aethiopica*) and Cherry Laurel (*Prunus laurocerasus*). Some plastic debris was observed at the time of the survey.

The creek at Site 3 measured 3 – 7 m in width and 1 m in depth during the dry survey. Water level was moderate (25 – 50%) with low flow. Water was turbid, with no evident surface scums or odours. Macrophytes were present, consisting largely of Parrot's Feather (*Myriophyllum aquaticum*) and mixed aquatic weeds, with some benthic algae. Fringing vegetation was dense and primarily composed of rushes and weeds, with common species including Saw Sedge (*Gahnia* sp.), *I. indica* and extensive ground cover assemblages of *T. fluminensis* and Weeping Rice Grass (*Microleana stipoides*). Some debris was observed at the time of the survey. No evidence of erosion was observed.

3.2.2 Wet Survey 1 – April 2024

The creek at Site 1 measured approximately 8 m in width with an approximate depth of 1.8 m during the wet survey. Water level was high (>75%) with a moderate flow, whilst no erosion of the creek banks was

evident and sedimentation was low. Water was turbid but did not present any odour or surface scums. Vegetation was consistent with dry surveys.

The creek at Site 2 had flooded surrounding land, ranging from 15 – 18 m width, with an approximate depth of 1.5 m during the wet survey. Water level was high (>75%) with a moderate flow, with a small amount erosion and sedimentation of the sandy banks and bed evident. Water was turbid but did not present any odour or surface scums. Vegetation was consistent with dry surveys.

The creek at Site 3 had formed an additional channel, with an average width of 7 – 8 m and an approximate depth of 1.2 m during the wet survey. Water level was high (>75%) with a high rate of flow, however, no erosion of the banks was evident and sedimentation was low. Water was turbid but did not present any odour or surface scums. Vegetation was consistent with dry surveys.

3.3 Physical-Chemical Water Quality

The average physical-chemical water quality measurements for each site during the Quarter 1 Dry Survey were compared against the ANZECC Guidelines (2000) for lowland rivers in south-east Australia. Average electrical conductivity (EC) was within the guideline values at each site and presented just above the typical range in NSW coastal rivers of 200-300 μScm^{-1}. Average pH was within the Guideline (2000) values at each site, however, bordered on the accepted lower limit of 6.5. Dissolved oxygen (DO) saturation (%) was substantially below the Guideline (2000) lower limit of 85%, with sites recording averages between 10.67 – 16.67%. Turbidity was also below the Guideline (2000) lower limit of 6, however, was consistent with expected low values in well vegetated catchments and at times of low flow. The average physical-chemical water quality values for each site are detailed in Table 2.

Chemical analysis of water samples from each site during the Quarter 1 Dry Survey were compared against ANZECC Guidelines (2000) for lowland rivers in south-east Australia and toxicant trigger values for ecosystem species protection of 95% (ANZG 2018), where applicable. Total nitrogen, ammonia and total nitrates and nitrites as NOx were slightly above specified Guideline (2000) values at every site (Table 2). A calcium hardness of 65 mg/L at Site 1 and 72 mg/L at Site 3 was considered a moderate hardness (ANZECC 2000) and used to create site-specific trigger values for metals. Metals were typically below site-specific Default Guideline Values (DGVs), with the exception of Zinc which greatly exceeded the DGV at Site 1 and slightly exceeded at Site 3, and Copper which exceeded Guidelines at Site 3 (Table 2). Phenolic compounds, organochlorine and organophosphorus pesticides and PAHs were reported below the Limit of Reporting (LOR) for both Sites 1 and 3.

Table 2: Average physical-chemical water quality values for each site during the Quarter 1 Dry Survey.

Parameter	ANZECC Guidelines	Q1 Dry Survey		
		Site 1 (U)	Site 2 (I)	Site 3 (D)
Physical				
Electrical Conductivity ($\mu S\ cm^{-1}$)	125-2200	356.77	382.90	343.20
pH	6.5-8.0	6.61	6.55	6.56
Temperature (ºC)	N/A	19.4	19.7	20.1
Dissolved Oxygen (%)	85-110	**10.67***	**16.67***	**14.67***

Turbidity (NTU)	6-50	**3.26***	**5.47***	**4.55***
Suspended Solids (mg/L)	N/A	13	9	8
Chemical				
Total Nitrogen (mg/L)	0.5	**0.7***	**0.6***	**0.6***
Ammonia Nitrogen (mg/L)	0.02	**0.08***	**0.09***	**0.09***
Total Kjeldahl Nitrogen (mg/L)	-	0.6	0.6	0.6
Nitrates (mg/L)	-	0.06	0.24	0.05
Nitrites (mg/L)	-	<0.01	<0.01	<0.01
Total Nitrates & Nitrites (mg/L)	0.04	**0.06***	**0.05***	**0.05***
Total Phosphorus (mg/L)	0.05	0.05	0.04	0.05
Orthophosphate (mg/L)	0.02	0.01	<0.01	0.01
Non-Filterable Phosphorous (mg/L)	0.05	0.05	0.04	0.05
Calcium Hardness (CaCO3) (mg/L)	-	65	-	72
Oil and Grease (H.E.M) (mg/L)		<5	-	<5
Arsenic (µg/L)	24	<1	-	<1
Chromium (µg/L)	8.25**	<1	-	<1
Copper (µg/L)	3.5**	1	-	**6***
Lead (µg/L)	13.6**	<1	-	<1
Zinc (µg/L)	20**	**47***	-	**25***
Mercury (µg/L)	0.06	<0.1	-	<0.1
Phenolic Compounds (µg/L)	320	Below LOR	-	Below LOR
Organochlorine Pesticides (OC) (µg/L)	0.001-0.5	Below LOR	-	Below LOR
Organophosphorus Pesticides (OP) (µg/L)	-	Below LOR	-	Below LOR
Polynuclear Aromatic Hydrocarbons (PAH) (µg/L)	0.01-16	Below LOR	-	Below LOR

*** Outside of applicable ANZECC water quality Guidelines (ANZECC 2000)**

**Site-specific trigger values considering moderate water hardness (ANZECC 2000)

The average physical-chemical water quality measurements for each site during the Event 1 Wet Survey were compared against the ANZECC Guidelines (2000) for lowland rivers in south-east Australia. The average EC was just above the lower limit of Guideline (2000) values, typical at times of increased flow. Average pH was well within Guidelines (2000), whilst DO saturation was also recorded at acceptable levels between 87-92%. Turbidity was within Guideline (2000) values. The average physical-chemical water quality values for each site are detailed in Table 3.

Chemical analysis of water sample for each site during the Event 1 Wet Survey were compared against ANZECC Guidelines (2000) for lowland rivers in south-east Australia where applicable. Total nitrogen, total phosphorous, orthophosphate (reactive phosphate) and non-filterable phosphorous were above Guideline (2000) values at every site, whilst ammonia nitrogen exceeded the Guideline value at Site 3 and total nitrates and nitrites as NOx exceeded the Guideline value at Site 1 (Table 3).

Table 3: Average physical-chemical water quality values for each site during the Event 1 Wet Survey.

Parameter	ANZECC Guidelines	E1 Wet Survey		
		Site 1 (U)	Site 2 (I)	Site 3 (D)
Physical				
Electrical Conductivity (µS cm^{-1})	125-2200	147.43	137.53	133.43
pH	6.5-8.0	6.94	6.88	6.94
Temperature (ºC)	N/A	19.9	19.9	19.9
Dissolved Oxygen (%)	85-110	88.67	87.00	91.67
Turbidity (NTU)	6-50	23.77	25.95	21.69
Suspended Solids (mg/L)	N/A	10	12	9
Chemical				
Total Nitrogen (mg/L)	0.5	**1.3***	**0.9***	**0.6***
Ammonia Nitrogen (mg/L)	0.02	0.02	0.01	**0.03***
Total Kjeldahl Nitrogen (mg/L)	-	0.6	0.6	0.3
Nitrates (mg/L)	-	0.67	0.3	0.32
Nitrites (mg/L)	-	<0.01	<0.01	<0.01
Total Nitrates & Nitrites (mg/L)	0.04	**0.67***	0.3	0.32
Total Phosphorus (mg/L)	0.05	**0.13***	**0.12***	**0.08***
Orthophosphate (mg/L)	0.02	**0.06***	**0.05***	**0.04***
Non-Filterable Phosphorous (mg/L)	0.05	**0.13***	**0.12***	**0.08***

*** Outside of applicable ANZECC water quality Guidelines (ANZECC 2000)**

3.4 Sediment Quality

Chemical analysis of sediment samples for each site during Quarter 1 Dry Survey were compared against toxicant trigger values for ecosystem species protection of 95% (ANZG 2018), where applicable. Metals were below DGVs for sediment quality, whilst phenolic compounds, organochlorine and organophosphorus pesticides and PAHs were reported below the LOR for both Sites 1 and 3 (Table 4).

Table 4: Average chemical sediment quality values for each site during the Quarter 1 Dry Survey.

Parameter	ANZECC Guidelines	Q1 Dry Survey	
		Site 1 (U)	Site 3 (D)
Moisture Content (Dried at 105-110ºC) (%)	-	19.6	26
Arsenic (mg/kg)	20	0.9	0.3
Chromium (mg/kg)	80	4.2	1.7
Copper (mg/kg)	65	6.9	2.2
Lead (mg/kg)	50	10.5	3.6
Zinc (mg/kg)	200	36.0	17.5
Mercury (mg/kg)	0.15	<0.1	<0.1
Organochlorine Pesticides (OC) (mg/kg)		Below LOR	Below LOR
Phenolic Compounds (PC) (mg/kg)	95	Below LOR	Below LOR
Polynuclear Aromatic Hydrocarbons (PAH) (µg/kg dry weight)	10,000	-	-
Benzo(a)pyrene TEQ (half LOR) (µg/kg)		600	600
Benzo(a)pyrene TEQ (LOR) (µg/kg)		1200	1200
Combined remaining parameters (µg/kg)		Below LOR	Below LOR

Note that OC, PC, and PAH (excluding Benzo(a)pyrene TEQ (half LOR), and Benzo(a)pyrene TEQ (LOR)) were below the Limit of Reporting (LOR) i.e. below recordable levels. Note, when the individual TEQ PAH component concentration is reported as less than the LOR, then the Toxicity Equivalence Factors (TEF's) are multiplied by half the LOR, which results in a positive result.

3.5 Rapid Biological Assessment

Biological testing of each site during the Quarter 1 Dry Survey identified between 480 – 3400 coliform organisms/100 mL, the highest recorded at Site 3, downstream (Table 5). Contrastingly, between 6600 – 9100 coliform organisms/100 mL were recorded during the Event 1 Wet Survey, the highest being at Site 2, instream (Table 6). Total algal counts collected during the dry survey identified a total of 2280 algae at Site 1 and 1450 at Site 3 (Table 5). Cyanophytes (blue-green algae) comprised the highest proportion of the population collected upstream, whilst Chlorophytes (green algae) dominated downstream. Potentially toxic cyanophytes were less than 5 counts at both sites.

Table 5: Biological water quality parameters for each site during Quarter 1 Dry Survey.

Parameter	Q1 Dry Survey		
	Site 1 (U)	Site 2 (I)	Site 3 (D)
Coliforms & *E. coli*			
Thermotolerant Coliforms (CFU/100ml)	540	480	3400
Bacillariophytes (Diatoms)			
Navicula spp.	25	-	20
Nitzschia spp.	5	-	-
Total	30	-	20
Chlorophytes (Green Algae)			
Chlamydomonas spp.	75	-	-
Dictyosphaerium spp.	300	-	150
Kirchneriella spp.	-	-	50
Oocystis spp.	50	-	25
Other green cells	300	-	250
Scenedesmus spp.	125	-	325
Total	850	-	800
Cyanophytes (Blue Green Algae)			
Leptolyngbya spp.	540	-	400
Pseudanabaena spp.	800	-	100
Cf. Synechococcus spp.	-	-	50
Total	1340	-	550
Total Potentially Toxic Cyanophytes	<5	-	<5

Flagellates – Euglenophytes			
Euglena spp.	50	-	5
Trachelomonas spp.	15	-	75
Total	64	-	80

Table 6: Biological water quality parameters for each site during the Event 1 Wet Survey.

Parameter	E1 Wet Survey		
	Site 1 (U)	Site 2 (I)	Site 3 (D)
Coliforms & E.coli			
Thermotolerant Coliforms (CFU/100ml)	8000	9100	6600

Rapid Biological Assessment surveys also included the collection of macroinvertebrate samples. Taxa collected at Site 1 included organisms from Planorbidae (Gastropods), Chironominae (Diptera) and Hebridae (Hemiptera), with a total abundance of five macroinvertebrates. Taxa collected at Site 3 included organisms from Oligochaeta, Acarina, Libellulidae (Odonata) and Chironominae (Diptera), with a total abundance of four macroinvertebrates. SIGNAL indexes at Sites 1 and 3 of 2.75 and 3.75, respectively, indicates a severely impaired habitat that is likely to possess very poor water quality (Table 7). The absence of Ephemeroptera, Plecoptera and Tricoptera (EPT) taxa and other sensitive taxa also indicate a highly disturbed aquatic habitat (Table 7).

Table 7: SIGNAL Indices for each site during the Quarter 1 Dry Survey.

SIGNAL Indices	Q1 Dry Survey	
	Site 1 (U)	Site 3 (D)
SIGNAL Index	2.75	3.75
EPT Richness	0	0
Sensitive taxa (%)	0	0
Tolerant taxa (%)	100	50

During the dry monitoring event, a native fish (likely Gudgeon sp.) was observed at Site 1, whilst a Long-necked freshwater turtle (*Chelodina longicollis*) was observed at Site 3. During the wet sampling event, an Eastern Water dragon (*Intellagama lesueurii*) was observed at Site 2.

4 Discussion and Trends

4.1.1 Trends and the Influence of Seasons and Flow Conditions

Physio-chemical water quality presented measurements typically expected considering the environmental conditions at each survey. During the dry survey, turbidity and DO saturation were low, likely reflective of the low flow conditions present in Narrabeen Creek at the time of survey (ANZECC 2000). Low DO levels may also be attributed to decaying organic matter from plants or animals and the benthic turfing algae observed across sites. Contrastingly, during wet surveys turbidity and DO saturation increased, whilst EC levels decreased, typical of lowland rivers at times of increased flow (ANZECC 2000).

Total nitrogen, ammonia and NOx were slightly above ANZECC Guidelines at each site during the dry survey, whilst nitrogen and phosphorous measures were above Guidelines during the wet survey. Nutrient loading, seen by increases in both nitrogen and phosphorous at all sites during the wet survey, can be attributed to flushing and scouring of upstream areas of the catchment including areas of urban development, which may have resulted in increases in toxicants and nutrients (WQA 2013). An increase in the limiting factors of nitrogen and phosphorous as turbidity and flow decreases after a flow event may result in eutrophication of the waterway. Slight differences in these limiting factors between sites may also be responsible for a higher total algal count at Site 1.

Heavy metals were generally below DGVs for a 95% level of ecosystem species protection (Table 2) at upstream and downstream sites in water and all below DGVs for sediment. However, Zinc was above the DGV for water quality at both sites and Copper was above the DGV at Site 3. Heavy metal toxicity can be influenced by physical water quality parameters, including pH, hardness, DO, temperature, turbidity and alkalinity (ANZECC 2000). While zinc is an essential trace element required by most organisms for their growth and development, it may become extremely toxic for aquatic animals as its concentration increases (Pourkhabbaz, et al 2015). Typically, below pH 8, the toxicity of Zinc decreases with decreasing pH until pH 4, where increased acidity may increase toxicity (ANZECC 2000). Additionally, the toxicity of zinc to aquatic organisms generally decreases with increasing water hardness (ANZECC 2000). Considering the pH range across both surveys was between 6.55 – 6.94, with a moderate water hardness recorded during dry surveys, the levels of zinc recorded are not likely to be currently toxic to aquatic animals in Narrabeen Creek.

The use of thermotolerant coliforms is no longer recommended as a primary indicator of faecal contamination by the Australian Drinking Water Guidelines (2022). Some members of thermotolerant coliform families are present in faeces but may also occur naturally in soil and water. Coliforms were generally low at Sites 1 and 2 during the dry survey, but were significantly higher at Site 3, which may indicate point disturbance in the downstream section of the site. Coliforms greatly increased at all sites during the wet survey, likely from flushing of the surrounding developed catchment or sewer infrastructure overflows. Typically, secondary contact recreation levels of thermotolerant coliforms should be <1000 coliforms/100 mL (ANZECC 2000), however, during wet surveys coliforms were in excess of 6600/ 100 mL. This is reflective of catchment runoff and may become an issue in downstream areas where secondary contact occurs during and after rainfall.

The baseline water quality and consideration of low SIGNAL scores for macroinvertebrates indicates that Narrabeen Creek within the Study Area is moderately disturbed. It should be noted that the study area is

located within a highly developed and degraded reach along Narrabeen Creek in Warriewood, with multiple residential and industrial developments adjacent to the creek that may influence baseline data.

4.1.2 Water Quality Objectives

The objective of this Program is to report on the water quality, biota assessment, and sediment quality within the Study Area. This report has been developed to meet requirements of the development consent and assess results against guideline values. Results obtained in this monitoring report and subsequent surveys over the 12 months of baseline monitoring will be used to develop baseline and guideline values for the construction phase.

5 Conclusion

The Quarter 1 Dry Survey and Event 1 Wet Survey were conducted in March and April 2024 respectively, commencing the 12 months baseline monitoring of the Study Area. Results from water quality, sediment quality and the rapid biological assessment indicated that the habitat of Narrabeen Creek within the Study Area is moderately disturbed, with both physical and chemical water properties and thermotolerant coliforms evidently influenced by flow events at the site.

Whilst some parameters exceeded the accepted ANZECC Guidelines or DGVs, these increased levels are not currently expected to result in toxicity to aquatic organisms inhabiting the Study Area. Data from these initial surveys, along with subsequent monitoring surveys within the 12 month pre-construction phase will be used to develop baseline data and acceptance criteria (Appendix 3) for later phases of the project.

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Plates

	Upstream	Downstream
Dry		
Wet		

Plate 1. Site 1 photos upstream and downstream during dry (21/03/2024) and wet (05/04/2024) surveys

	Upstream	Downstream
Dry		
Wet		

Plate 2. Site 2 photos upstream and downstream during dry (21/03/2024) and wet (05/04/2024) surveys

	Upstream	Downstream
Dry		
Wet		

Plate 3. Site 3 photos upstream and downstream during dry (21/03/2024) and wet (05/04/2024) surveys

Appendix 1 – Laboratory Certificates

CERTIFICATE OF ANALYSIS

Work Order	: **ES2409395**	Page	: 1 of 13
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
Contact	: Alex Swanson	Contact	: Customer Services ES
Address	: 307A Avoca Dr Green Point NSW	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 21-Mar-2024 17:30
Order number	: ----	Date Analysis Commenced	: 22-Mar-2024
C-O-C number	: ----	Issue Date	: 10-Apr-2024 11:02
Sampler	: Alex Swanson		
Site	: ----		
Quote number	: ES24H2OCONS0001		
No. of samples received	: 5		
No. of samples analysed	: 5		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW
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General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MW024: Results apply to sample(s) as submitted.
- MF = membrane filtration
- CFU = colony forming unit
- EP075: Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP068: Where reported, Total OCP is the sum of the reported concentrations of all Organochlorine Pesticides at or above LOR.
- MW006 is ALS's internal code and is equivalent to AS4276.5.
- MW024: KEY: PTP = Potential Toxin Producers; cf. = comparable form.
- MW024: Samples were preserved with Lugols Iodine solution.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- MW024: Algal enumeration values of <5 cells/mL will not be reported.
- MW024: Under microscopic observation, debris present in sample #01 and #04
- EP075: Where reported, 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero, for 'TEQ 1/2LOR' are treated as half the reported LOR, and for 'TEQ LOR' are treated as being equal to the reported LOR. Note: TEQ 1/2LOR and TEQ LOR will calculate as 0.6mg/Kg and 1.2mg/Kg respectively for samples with non-detects for all of the eight TEQ PAHs.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	WW01	WW03	----	----	----
			Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2409395-002	ES2409395-005	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**19.6**	**26.0**	----	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**0.9**	**0.3**	----	----	----
Chromium	7440-47-3	0.1	mg/kg	**4.2**	**1.7**	----	----	----
Copper	7440-50-8	0.1	mg/kg	**6.9**	**2.2**	----	----	----
Lead	7439-92-1	0.1	mg/kg	**10.5**	**3.6**	----	----	----
Zinc	7440-66-6	0.5	mg/kg	**36.0**	**17.5**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	----	----	----
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	----	----	----
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	----	----	----
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	----	----	----
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	----	----	----
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	----	----	----
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	----	----	----
^ Total Chlordane (sum)	----	0.05	mg/kg	<0.05	<0.05	----	----	----
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	----	----	----
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	----	----	----
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	----	----	----
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	----	----	----
4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	----	----	----
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	----	----	----
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	----	----	----
^ Endosulfan (sum)	115-29-7	0.05	mg/kg	<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	WW01	WW03	----	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2409395-002	ES2409395-005	--------	--------	--------
					Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
4.4`-DDD	72-54-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Endrin aldehyde	7421-93-4	0.05	mg/kg		<0.05	<0.05	----	----	----
Endosulfan sulfate	1031-07-8	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDT	50-29-3	0.2	mg/kg		<0.2	<0.2	----	----	----
Endrin ketone	53494-70-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Methoxychlor	72-43-5	0.2	mg/kg		<0.2	<0.2	----	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.05	mg/kg		<0.05	<0.05	----	----	----
^ **Sum of DDD + DDE + DDT**	72-54-8/72-55-9/50-2	0.05	mg/kg		<0.05	<0.05	----	----	----
EP075A: Phenolic Compounds									
Phenol	108-95-2	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Chlorophenol	95-57-8	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Methylphenol	95-48-7	0.5	mg/kg		<0.5	<0.5	----	----	----
3- & 4-Methylphenol	1319-77-3	1.0	mg/kg		<1.0	<1.0	----	----	----
2-Nitrophenol	88-75-5	0.5	mg/kg		<0.5	<0.5	----	----	----
2.4-Dimethylphenol	105-67-9	0.5	mg/kg		<0.5	<0.5	----	----	----
2.4-Dichlorophenol	120-83-2	0.5	mg/kg		<0.5	<0.5	----	----	----
2.6-Dichlorophenol	87-65-0	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg		<0.5	<0.5	----	----	----
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg		<0.5	<0.5	----	----	----
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Pentachlorophenol	87-86-5	1	mg/kg		<1	<1	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Methylnaphthalene	91-57-6	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Chloronaphthalene	91-58-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Acenaphthylene	208-96-8	0.5	mg/kg		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	WW01	WW03	----	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2409395-002	ES2409395-005	--------	--------	--------
					Result	Result	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
Acenaphthene	83-32-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Fluorene	86-73-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Phenanthrene	85-01-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Anthracene	120-12-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Fluoranthene	206-44-0	0.5	mg/kg		<0.5	<0.5	----	----	----
Pyrene	129-00-0	0.5	mg/kg		<0.5	<0.5	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Benz(a)anthracene	56-55-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Chrysene	218-01-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg		<1	<1	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg		<0.5	<0.5	----	----	----
3-Methylcholanthrene	56-49-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg		<0.5	<0.5	----	----	----
^ Sum of PAHs	----	0.5	mg/kg		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (half LOR)	----	0.5	mg/kg		**0.6**	**0.6**	----	----	----
^ Benzo(a)pyrene TEQ (LOR)	----	0.5	mg/kg		**1.2**	**1.2**	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.05	%		**106**	**89.8**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.05	%		**98.0**	**79.5**	----	----	----
EP075S: Acid Extractable Surrogates									
2-Fluorophenol	367-12-4	0.5	%		**96.4**	**98.8**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	WW01	WW03	----	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2409395-002	ES2409395-005	--------	--------	--------
					Result	Result	----	----	----
EP075S: Acid Extractable Surrogates - Continued									
Phenol-d6	13127-88-3	0.5	%		**98.4**	**99.4**	**----**	**----**	**----**
2-Chlorophenol-D4	93951-73-6	0.5	%		**101**	**97.3**	**----**	**----**	**----**
2.4.6-Tribromophenol	118-79-6	0.5	%		**80.4**	**73.0**	**----**	**----**	**----**
EP075T: Base/Neutral Extractable Surrogates									
Nitrobenzene-D5	4165-60-0	0.5	%		**94.0**	**97.8**	**----**	**----**	**----**
1.2-Dichlorobenzene-D4	2199-69-1	0.5	%		**90.1**	**92.4**	**----**	**----**	**----**
2-Fluorobiphenyl	321-60-8	0.5	%		**91.6**	**95.3**	**----**	**----**	**----**
Anthracene-d10	1719-06-8	0.5	%		**88.6**	**91.2**	**----**	**----**	**----**
4-Terphenyl-d14	1718-51-0	0.5	%		**83.2**	**90.2**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WW01	WW02	WW03	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
					Result	Result	Result	----	----
ED093F: SAR and Hardness Calculations									
Calcium Hardness as CaCO3	----	1	mg/L		**65**	----	**72**	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	<0.001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	----	**0.006**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.047**	----	**0.025**	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.08**	**0.09**	**0.09**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.06**	----	**0.05**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.06**	**0.05**	**0.05**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.6**	**0.6**	**0.6**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**0.6**	**0.6**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.05**	**0.04**	**0.05**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.01**	----	**0.01**	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	----	<5	----	----
EP068A: Organochlorine Pesticides (OC)									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WW01	WW02	WW03	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
					Result	Result	Result	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	----	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	----	<0.5	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	----	<0.5	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	----	<0.5	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	----	<0.5	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	----	<0.5	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	----	<0.5	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	----	<0.5	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	----	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	----	<0.5	----	----
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	----	<0.5	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	----	<0.5	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	----	<0.5	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	----	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	----	<0.5	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	----	<0.5	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	----	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	----	<0.5	----	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	----	<2.0	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	----	<0.5	----	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	----	<2.0	----	----
^ **Total Chlordane (sum)**	----	0.5	µg/L		<0.5	----	<0.5	----	----
^ **Sum of DDD + DDE + DDT**	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	----	<0.5	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L		<0.5	----	<0.5	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	----	<0.5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WW01	WW02	WW03	----	----
			Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit	ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
				Result	Result	Result	----	----
EP068B: Organophosphorus Pesticides (OP) - Continued								
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	----	<0.5	----	----
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	----	<2.0	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	----	<0.5	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	----	<0.5	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	----	<0.5	----	----
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	----	<2.0	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	----	<0.5	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	----	<0.5	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	----	<0.5	----	----
Parathion	56-38-2	2.0	µg/L	<2.0	----	<2.0	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	----	<0.5	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	----	<0.5	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	----	<0.5	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	----	<0.5	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	----	<0.5	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	----	<0.5	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	----	<0.5	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	----	<0.5	----	----
EP075A: Phenolic Compounds								
Phenol	108-95-2	2	µg/L	<2	----	<2	----	----
2-Chlorophenol	95-57-8	2	µg/L	<2	----	<2	----	----
2-Methylphenol	95-48-7	2	µg/L	<2	----	<2	----	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2	----	<2	----	----
2-Nitrophenol	88-75-5	2	µg/L	<2	----	<2	----	----
2.4-Dimethylphenol	105-67-9	2	µg/L	<2	----	<2	----	----
2.4-Dichlorophenol	120-83-2	2	µg/L	<2	----	<2	----	----
2.6-Dichlorophenol	87-65-0	2	µg/L	<2	----	<2	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WW01	WW02	WW03	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
					Result	Result	Result	----	----
EP075A: Phenolic Compounds - Continued									
4-Chloro-3-methylphenol	59-50-7	2	µg/L		<2	----	<2	----	----
2.4.6-Trichlorophenol	88-06-2	2	µg/L		<2	----	<2	----	----
2.4.5-Trichlorophenol	95-95-4	2	µg/L		<2	----	<2	----	----
Pentachlorophenol	87-86-5	4	µg/L		<4	----	<4	----	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	2	µg/L		<2	----	<2	----	----
2-Methylnaphthalene	91-57-6	2	µg/L		<2	----	<2	----	----
2-Chloronaphthalene	91-58-7	2	µg/L		<2	----	<2	----	----
Acenaphthylene	208-96-8	2	µg/L		<2	----	<2	----	----
Acenaphthene	83-32-9	2	µg/L		<2	----	<2	----	----
Fluorene	86-73-7	2	µg/L		<2	----	<2	----	----
Phenanthrene	85-01-8	2	µg/L		<2	----	<2	----	----
Anthracene	120-12-7	2	µg/L		<2	----	<2	----	----
Fluoranthene	206-44-0	2	µg/L		<2	----	<2	----	----
Pyrene	129-00-0	2	µg/L		<2	----	<2	----	----
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L		<2	----	<2	----	----
Benz(a)anthracene	56-55-3	2	µg/L		<2	----	<2	----	----
Chrysene	218-01-9	2	µg/L		<2	----	<2	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L		<4	----	<4	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L		<2	----	<2	----	----
Benzo(a)pyrene	50-32-8	2	µg/L		<2	----	<2	----	----
3-Methylcholanthrene	56-49-5	2	µg/L		<2	----	<2	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L		<2	----	<2	----	----
Dibenz(a.h)anthracene	53-70-3	2	µg/L		<2	----	<2	----	----
Benzo(g.h.i)perylene	191-24-2	2	µg/L		<2	----	<2	----	----
^ Sum of PAHs	----	2	µg/L		<2	----	<2	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WW01	WW02	WW03	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
					Result	Result	Result	----	----
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L		<2	----	<2	----	----
MW006: Thermotolerant Coliforms & E.coli by MF									
Thermotolerant Coliforms	----	1	CFU/100mL		540	480	3400	----	----
MW024: Bacillariophytes (Diatoms) - Pennales									
Navicula spp.	----	5	cells/ml		25	----	20	----	----
Nitzschia spp.	----	5	cells/ml		5	----	----	----	----
MW024: Bacillariophytes (Diatoms) - TOTAL BACILLARIOPHYTES									
Total Bacillariophytes	----	5	cells/ml		30	----	20	----	----
MW024: Chlorophytes (Green Algae)									
Chlamydomonas spp.	----	5	cells/ml		75	----	----	----	----
Dictyosphaerium spp.	----	5	cells/ml		300	----	150	----	----
Kirchneriella spp.	----	5	cells/ml		----	----	50	----	----
Oocystis spp.	----	5	cells/ml		50	----	25	----	----
Other green cells	----	5	cells/ml		300	----	250	----	----
Scenedesmus spp.	----	5	cells/ml		125	----	325	----	----
MW024: Chlorophytes (Green Algae) - TOTAL CHLOROPHYTES									
Total Chlorophytes	----	5	cells/ml		850	----	800	----	----
MW024: Cyanophytes (Blue Green Algae)									
cf. Synechococcus spp.	----	5	cells/ml		----	----	50	----	----
Leptolyngbya spp.	----	5	cells/ml		540	----	400	----	----
Pseudanabaena spp.	----	5	cells/ml		800	----	100	----	----
MW024: Cyanophytes (Blue Green Algae) - TOTAL CYANOPHYTES									
Total Cyanophytes	----	5	cells/ml		1340	----	550	----	----
MW024: Cyanophytes (Blue Green Algae) - TOTAL POTENTIALLY TOXIC CYANOPHYTES									
Total Potentially Toxic Cyanophytes	----	5	cells/ml		<5	----	<5	----	----
MW024: Flagellates - Euglenophytes									
Euglena spp.	----	5	cells/ml		50	----	5	----	----
Trachelomonas spp.	----	5	cells/ml		15	----	75	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WW01	WW02	WW03	----	----
				Sampling date / time	21-Mar-2024 11:00	21-Mar-2024 11:00	21-Mar-2024 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2409395-001	ES2409395-003	ES2409395-004	--------	--------
					Result	Result	Result	----	----
MW024: Flagellates - TOTAL FLAGELLATES									
Total Flagellates	----	5	cells/ml		**65**	**----**	**80**	**----**	**----**
MW024T: TOTAL ALGAE									
Total Algae Count	----	5	cells/ml		**2280**	**----**	**1450**	**----**	**----**
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**101**	**----**	**92.7**	**----**	**----**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**111**	**----**	**102**	**----**	**----**
EP075S: Acid Extractable Surrogates									
2-Fluorophenol	367-12-4	2	%		**44.8**	**----**	**49.7**	**----**	**----**
Phenol-d6	13127-88-3	2	%		**32.8**	**----**	**33.7**	**----**	**----**
2-Chlorophenol-D4	93951-73-6	2	%		**69.1**	**----**	**71.6**	**----**	**----**
2.4.6-Tribromophenol	118-79-6	2	%		**75.2**	**----**	**75.7**	**----**	**----**
EP075T: Base/Neutral Extractable Surrogates									
Nitrobenzene-D5	4165-60-0	2	%		**74.0**	**----**	**75.5**	**----**	**----**
1.2-Dichlorobenzene-D4	2199-69-1	2	%		**61.5**	**----**	**66.8**	**----**	**----**
2-Fluorobiphenyl	321-60-8	2	%		**76.3**	**----**	**82.0**	**----**	**----**
Anthracene-d10	1719-06-8	2	%		**90.1**	**----**	**94.1**	**----**	**----**
4-Terphenyl-d14	1718-51-0	2	%		**90.2**	**----**	**96.0**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: SOIL		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	147
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	35	143
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	29	149
Phenol-d6	13127-88-3	32	128
2-Chlorophenol-D4	93951-73-6	32	128
2.4.6-Tribromophenol	118-79-6	13	121
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	33	125
1.2-Dichlorobenzene-D4	2199-69-1	34	108
2-Fluorobiphenyl	321-60-8	35	121
Anthracene-d10	1719-06-8	35	123
4-Terphenyl-d14	1718-51-0	33	125

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	50	150
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	50	150
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	10	117
Phenol-d6	13127-88-3	10	69
2-Chlorophenol-D4	93951-73-6	21	130
2.4.6-Tribromophenol	118-79-6	10	151
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	29	142
1.2-Dichlorobenzene-D4	2199-69-1	24	121
2-Fluorobiphenyl	321-60-8	27	135
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	21	123

CERTIFICATE OF ANALYSIS

Work Order	: **ES2411844**	Page	: 1 of 2
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
Contact	: Alex Swanson	Contact	: Customer Services ES
Address	: 307A Avoca Dr Green Point NSW	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 12-Apr-2024 13:05
Order number	: ----	Date Analysis Commenced	: 13-Apr-2024
C-O-C number	: ----	Issue Date	: 18-Apr-2024 11:46
Sampler	: Alex Swanson		
Site	: ----		
Quote number	: ES24H2OCONS0001		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WW01	WW02	WW03	----	----
			Sampling date / time	12-Apr-2024 11:23	12-Apr-2024 11:27	12-Apr-2024 11:32	----	----
Compound	CAS Number	LOR	Unit	ES2411844-001	ES2411844-002	ES2411844-003	--------	--------
				Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**13**	**9**	**8**	**----**	**----**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**----**	<0.01	**----**	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**----**	**0.24**	**----**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**----**	**0.24**	**----**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**----**	<0.01	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **ES2410969**	Page	: 1 of 3
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
Contact	: Alex Swanson	Contact	: Customer Services ES
Address	: 307A Avoca Dr Green Point NSW	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 05-Apr-2024 16:05
Order number	: ----	Date Analysis Commenced	: 05-Apr-2024
C-O-C number	: ----	Issue Date	: 12-Apr-2024 13:10
Sampler	: Alex Swanson		
Site	: ----		
Quote number	: ES24H2OCONS0001		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- MW006 is ALS's internal code and is equivalent to AS4276.5.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WW01	WW02	WW03	----	----
			Sampling date / time	05-Apr-2024 13:20	05-Apr-2024 13:40	05-Apr-2024 14:10	----	----
Compound	CAS Number	LOR	Unit	ES2410969-001	ES2410969-002	ES2410969-003	--------	--------
				Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**10**	**12**	**9**	**----**	**----**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.01**	**0.03**	**----**	**----**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.67**	**0.30**	**0.32**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.67**	**0.30**	**0.32**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**0.6**	**0.3**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.3**	**0.9**	**0.6**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.13**	**0.12**	**0.08**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.06**	**0.05**	**0.04**	**----**	**----**
MW006: Thermotolerant Coliforms & E.coli by MF								
Thermotolerant Coliforms	----	1	CFU/100mL	**8000**	**9100**	**6600**	**----**	**----**

Appendix 2 – Monitoring schedule

Table 1: Physical and chemical parameters to be monitored at each site, including location and timing.

State	Parameter	Pre-Construction Phase		Construction Phase		Post-Construction Phase	
		Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather
Physical	Visual*	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Electrical Conductivity/Salinity (field)	U/D	U/D	U/D	U/D	U/D	U/D
	pH (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Temperature (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Dissolved Oxygen (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Turbidity (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Suspended Solids	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Volume Gross Pollutants Removed				SQID		SQID
Chemical	Total Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Ammonia-Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Total Kjeldahl Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Nitrates and Nitrites	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Total Phosphorous	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Ortho-Phosphate	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Non-Filterable Phosphorous	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Hardness (CaCO3)		U/D		U/D		U/D
	Chromium		U/D		U/D		U/D
	Lead		U/D		U/D		U/D
	Zinc		U/D		U/D		U/D
	Arsenic		U/D		U/D		U/D
	Mercury		U/D		U/D		U/D
	Copper		U/D		U/D		U/D
	Phenolic Compounds		U/D		U/D		U/D
	OC/OP Pesticides		U/D		U/D		U/D
	Oil and grease (H.E.M)		U/D		U/D		U/D
	PAH		U/D		U/D		U/D
	Chlorophyll-a						U/D

Biological	Algal Identification and Count		U/D		U/D/I		U/D
	Faecal Coliform Count	U/D/I	U/D/I	U/D/I	U/D	U/D/I/SQID	U/D/I
	Biotic Index (SIGNAL)		U/D		U/D		U/D
Chemical	Chromium	U/D		U/D		U/D	
	Lead	U/D		U/D		U/D	
	Zinc	U/D		U/D		U/D	
	Arsenic	U/D		U/D		U/D	
	Mercury	U/D		U/D		U/D	
	Copper	U/D		U/D		U/D	
	Phenolic Compounds	U/D		U/D		U/D	
	Organochlorine Pesticides	U/D		U/D		U/D	
	PAHs	U/D		U/D		U/D	

U = upstream, D = downstream, I = in-sector, ESC = sediment control basins, visual inspection of other erosion and sediment control measures, SQID = GPTs, water quality control ponds and constructed wetlands (inflow and outflow locations). NA = not applicable. Visual* = parameters as described in Section 3.3.2.

Key for Table 10:

	Three monthly
	Annual Sampling including at least one sampling at the Rezoning stage and one sampling at the Handover stage
	Three Times Each Year, One Sample on Rising Limb and One Sample on the Falling Limb of the Hydrograph at Each Site

Appendix 3 – Monitoring Acceptance Criteria

Table 2 Summary of Acceptance Criteria – Site Discharge and Creeks (Pittwater Council 2001)

Media	State	Variable	Units	During Construction Site Discharges/In sector	Post Construction Site Discharges	Instream Short Term (Status Quo)	In-stream Medium Term	In-stream Long Term
Water	Physical	Visual	-	No litter	No litter	No litter	No litter	No litter
		Salinity (TDS)	mg/L	NA	NA	1000	1000	1000
		pH (Field)	-	NA	NA	6.6 - 8	6.6 - 8	6.6 - 8
		Temperature (Field)	ºC	NA	NA	Status quo	Status quo	Status quo
		Dissolved Oxygen (Field)	%Sat	NA	NA	Status quo	90	90
		Turbidity (Field)	NTU	NA	NA	Status quo	50	20
		Suspended Solids	mg/L	100	50	Status quo	20	6
		Volume Gross Pollutants Removed	Tonne	NA	NA	NA	NA	NA
	Chemical	Total Nitrogen	mg/L	1.6	1.6	Status quo	1.6	1.0
		Ammonia-Nitrogen	mg/L	See Key	See Key	See Key	See Key	See Key
		Total Kjeldahl Nitrogen	mg/L	-	-	-	-	-
		Nitrates and Nitrites	mg/L	-	-	-	-	-
		Total Phosphorous	mg/L	0.1	0.05	Status quo	0.1	0.04
		Ortho-Phosphate	mg/L	-	-	-	-	-
		Non-Filterable Phosphorous	mg/L	-	-	-	-	-
		Hardness (CaCO3)	mg/L	NA	NA	-	-	-

		Chromium	µg/L	NA	NA	Status quo	50% status quo	10
		Lead	µg/L	NA	NA	Status quo	50% status quo	1
		Zinc	µg/L	NA	NA	Status quo	50% status quo	50
		Arsenic	µg/L	NA	NA	Status quo	50% status quo	50
		Mercury	µg/L	NA	NA	Status quo	50% status quo	0.1
		Copper	µg/L	NA	NA	Status quo	50% status quo	2
		Phenolic Compounds	µg/L	NA	NA	Status quo	50% status quo	Note
		OC/OP Pesticides	ng/L	NA	NA	Status quo	50% status quo	Note
		Oil and grease (H.E.M)	mg/L	NA	NA	50	20	5
		PAH	µg/L	NA	NA	Status quo	50% status quo	3
		Chlorophyll-a	mg/m^3	NA	NA	15	15	10
	Biological	Algal identification and count	-	NA	NA	Status quo	No algal bloom	No algal bloom
		Faecal Coliform Count	Cfu/100mL	150	150	1000	150	150
		Biotic Index (SIGNAL)	-	NA	NA	Status quo	> 5	> 6
Sediment	Chemical	Chromium	mg/kg	NA	NA	Status quo	50% status quo	80
		Lead	mg/kg	NA	NA	Status quo	50% status quo	50

		Zinc	mg/kg	NA	NA	Status quo	50% status quo	200
		Arsenic	mg/kg	NA	NA	Status quo	50% status quo	20
		Mercury	mg/kg	NA	NA	Status quo	50% status quo	0.15
		Copper	mg/kg	NA	NA	Status quo	50% status quo	65
		Phenolic Compounds	mg/kg	NA	NA	Status quo	50% status quo	Note
		Organochlorine Pesticides	mg/kg	NA	NA	Status quo	50% status quo	Note
		PAH	mg/kg	NA	NA	Status quo	50% status quo	4000

'Short-term' relates to the period during and just after development (up to 'Handover'). 'Medium-term' is the period of one year after completion of all water quality controls associated with the fully developed area. Due to the likely fragmented nature of development, permanent water quality controls may not be fully functional for some years. 'Long-term' is defined as the period after control measures are introduced for all pollutant sources in the valley (Pittwater Council 2001).

NOTES and KEY for Table C2:

- 'Status Quo' means the median value is within the range of the 10%ile and 90%ile from the pre development condition data
- 50% Status Quo means the median value is within the range of 50% of the 10%ile and 50% of the 90%ile from the pre-development condition data
- Sediment guidelines are dry weight from ANZECC, 1999 General values have been adopted with consideration of ANZECC 1999, ANZECC, 1992, Brisbane City Council, 2000, Lawson & Treloar, 1997 and Laxton, 1993
- TDS values are appropriate for non-tidal sections of the creeks only Water Hardness required to assist with interpretation of ANZECC, 1999 trigger guidelines for metal concentrations
- For the purposes of comparing the results with ANZECC, 1999 guidelines, the creeks can generally be defined as 'lowland rivers'
- If the existing level is lower than the medium or long-term guideline provided, the existing level is not to be exceeded Note - ANZECC 1999 guidelines for each compound to be used
- Ammonia - Details for the assessment of ammonia are described in Section C3. Comparison required with ANZECC (1999) guidelines for all samples.

Appendix 4 – Raw Data

Physical water quality raw data

Table 5: Physical water quality parameters at Site 1 (upstream) from dry and wet surveys

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm^{-1})	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Dry (1) 21 March 2024	1	349.4	6.68	19.4	12	2.75
	2	374.5	6.6	19.4	9	3.52
	3	346.4	6.55	19.4	11	3.5
Wet (1) 5 April 2024	1	151.9	6.97	19.9	88	23.77
	2	145.1	6.94	19.9	89	22.32
	3	145.3	6.92	19.9	89	24.13

Table 6: Physical water quality parameters at Site 2 (instream) from dry and wet surveys

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm^{-1})	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Dry (2) 21 March 2024	1	383.2	6.56	19.7	13	5.59
	2	383.2	6.52	19.7	12	4.42
	3	382.3	6.57	19.7	25	6.39
Wet (2) 5 April 2024	1	137.7	6.92	19.9	88	20.5
	2	137.5	6.87	19.9	87	22.34
	3	137.4	6.86	19.9	86	35

Table 7: Physical water quality parameters at Site 3 (downstream) from dry and wet surveys

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm^{-1})	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Dry (3) 21 March 2024	1	343.9	6.56	20.1	14	4.7
	2	343.0	6.56	20.2	15	4.37
	3	342.7	6.55	20.1	15	4.57
Wet (3) 5 April 2024	1	133.4	6.95	19.9	92	21.6
	2	133.3	6.94	19.9	92	21.7
	3	133.6	6.93	19.9	91	21.75

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Appendix 2B

Pre-Development Water Quality Assessment Report (Quarter 2 dated 04th September 2024)

H2O Consulting Group

Pre-Development Water Quality Assessment Report – Quarter 2

43-49 Warriewood Road, Warriewood

Prepared For: Warriewood Developers Pty Ltd

Report Date: 04 September 2024

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Document Details	
Report Title	Pre-Development Water Quality Assessment Report – Quarter 2 (Dry)
Project Title	Water Quality Monitoring– 43-49 Warriewood Rd, Warriewood
Prepared For	Warriewood Developers Pty Ltd
Report Date	04 September 2024
Job Number	2357
Project Team	Dr David Cummings, Alex Swanson, Simon Kirgis,

Document Control				
Version	Author	Reviewer	Approved by	Date
R0	Alex Swanson BMarBiol Simon Kirgis BEnvScMgmt	Alex Swanson BMarBiol	Dr David Cummings	04/09/2024

Disclaimer:

The information provided in this document is based on knowledge, understanding and field observations at the time of review of associated materials and/or site survey. The report should be read and considered in its entirety including consideration of the limitations described in the report.

H2O Consulting Group Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation. H2O Consulting Group Pty Ltd accepts no liability or responsibility for contents of this report in respect of any use of, or reliance upon, by any third party or for any use other than the purposes for which it was commissioned. Unauthorised use of this document is prohibited.

Table of Contents

1 Introduction

1.1 Overview

H2O Consulting Group were engaged by Warriewood Developers Pty Ltd (the Applicant) to undertake a Water Quality Assessment (WQA) for Development Application (DA) No. DA2021/2600., which includes the subdivision of land into twelve (12) lots, creek line works and the construction of two (2) high density residential buildings at 43, 45 and 49 Warriewood Road, Warriewood (the Project). To adhere to the requirements of the Warriewood Valley Urban Land Release Water Management Specification (WVWMS), the following activities are required to be undertaken as part of this WQA:

- Undertake baseline monitoring over a period of at least 12 months prior to construction.
- Provision of a Water Quality Assessment Report for the baseline period (preconstruction) which will form a section of the Water Management Report.

This document presents the results of the Quarter 2 Dry Survey which is included in the twelve (12) months of monitoring prior to construction.

1.2 Scope of Monitoring Program

The scope of this Program is designed specifically to establish the water quality and ecological characteristics of the riparian watercourses in the sector. This Program includes the following assessments to assess water quality, sediment quality and ecological health:

- Water Quality Monitoring (discrete sampling),
- Rapid Biological Assessment; and
- Sediment Toxicant Monitoring.

1.3 Objectives of Monitoring Program

The objectives of the water quality monitoring program are to:

- To ensure early detection of any significant risk to the health of the waterway and the public through pollution and habitat change during the development phase (Pittwater Council 2001).
- To establish a broad range baseline dataset of standard parameters by which the impacts of the development can then be measured (Pittwater Council 2001).

1.4 Locality and Site

1.4.1 Catchment Description

The Warriewood Valley Catchment is located on the southern boundary of the Pittwater Council Local Government Area (LGA) on Sydney's northern beaches. The catchment has a total area of 9.04 km^2 and includes the Warriewood Wetlands and three major creeks. These include Mullet Creek which drains an area of 3.5 km^2, Narrabeen Creek which drains an area of 3.2 km^2 and Fern Creek which drains an area of 0.73 km^2 (Lawson and Treloar 2005). Land use within the catchment is mixed and has undergone significant urban development, with approximately 32% of the catchment residential, 31% open pasture and 37% natural wetlands and bush (Lawson and Treloar 2005). As part of the Warriewood Valley Flood Study (Lawson and Treloar 2005), a 60% imperviousness was assumed for urban areas, 10% for rural areas and 5% for forested

areas. Additional previous flood study modelling in the locality conducted by BMT WBM (2013) delineated the wider Warriewood and Narrabeen catchment into smaller sub-catchments, with the sub-catchment NL19 including the Project site and encompassing an area of 34.32 ha and overall 36.4% impervious area.

1.4.2 Site Description

The site of development includes 43, 45 and 49 Warriewood Road, Warriewood, identified as Lot 2, DP 972209, Lot 2, DP 349085 and Lot 1, DP 349085 respectively, with a combined area of ~22,187 m^2 (CPS 2023). These Lots will be referred to throughout this program as the 'Project Area'. The site is located within the Northern Beaches LGA, in the Warriewood Valley locality as per Section A4.16 of the Pittwater 21 Development Control Plan (PDCP 2014) and comprises the sectors Buffer Area 1F and 1G. The site within 43 Warriewood Rd is predominantly undeveloped and comprises an open drainage channel, whilst the front (northeastern) halves of 45 and 49 Warriewood Rd each comprise of a detached dwelling house and associated residential structures. The rear (southwestern) halves of the latter two properties are predominantly undeveloped and consist of vegetated areas along the Narrabeen Creek riparian corridor, with the southern boundary extending ~81.4 m along the creek line (CPS 2023).

Narrabeen Creek is approximately 4 km in length, with its headwaters located in the Healesville Estate section of the Ingleside escarpment, in the most northern section of the Ingleside Nature Reserve. The creek flows southwest parallel to Fern Creek, which joins Narrabeen Creek before the confluence with Mullet Creek on the southern side of the Warriewood Wetlands. Mullet Creek then flows into Narrabeen Lagoon approximately 750 m downstream.

Sites were selected along Narrabeen Creek near the upstream and downstream ends of each sector, and one within the sectors, with consideration to avoid upstream point sources of pollution, to ensure generally well mixed flow conditions and to avoid presence of physical structures that may influence water quality. Additional sites may be required at later stages of construction/development, including any water quality control ponds, sediment control basin or GPTs. Additional sites would be addressed in subsequent reports. Baseline monitoring sites are detailed in Table 1 and shown in Figure 1. The creek and surrounding creek banks surveyed as part of this monitoring program is referred to throughout this report as the 'Study Area'.

Table 1: Monitoring sites

Site	Creek location	Approximate GPS Coordinates	Location Type
1	Approximately 20 m upstream of upstream sector edge of Buffer Area 1F.	151.296467 °E 33.687697 °S	Upstream
2	Instream at intersection of Buffer Areas 1F and 1G.	151.296862°E 33.688046°S	In-sector
3	Approximately 20 m downstream of downstream sector edge of Buffer Area 1G.	151.2972660°E 33.6884624°S	Downstream

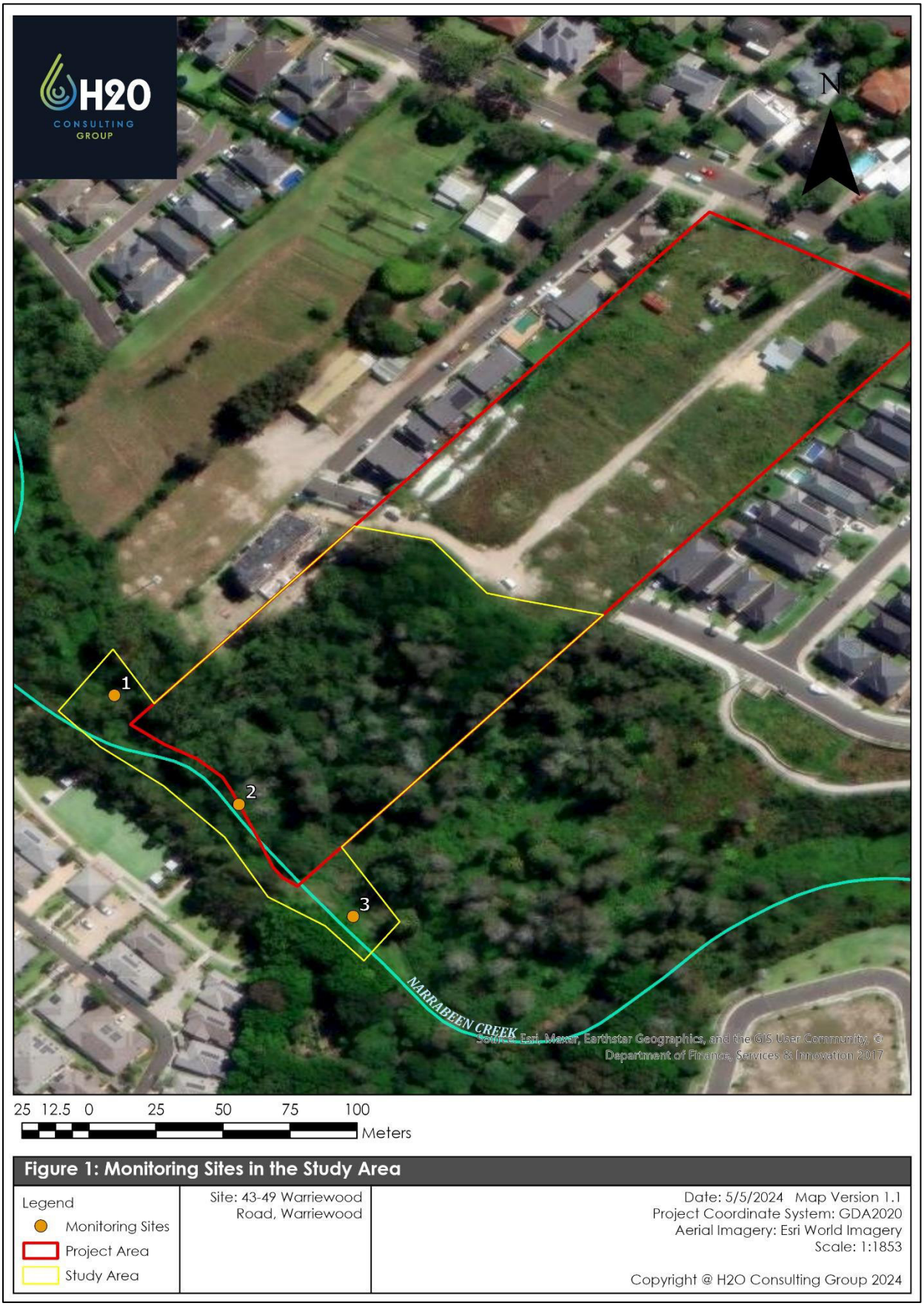

Figure 1: Monitoring sites along Narrabeen Creek

1.5 Limitations of Monitoring Program

Habitat based assessment, observations and physio-chemical measures of water attributes were taken on one occasion for dry weather at each site. These measures provide only a snapshot of these site attributes at the time of survey and may not be reflective of spatial and temporal variability of these attributes. Further surveys will provide a more reflective spatial and temporal representation of the sites over the 12 months of baseline monitoring.

2 Methodology

2.1 Survey Methodology

Detailed methodologies of the below sections may be found in the Water Quality Monitoring Plan (H2O Consulting Group 2024) associated with this project.

2.1.1 Visual Condition

Visual monitoring of habitat and water quality was undertaken at each site and recorded based on the average predominant characteristic along a 30 m reach. Monitoring surveys were conducted within the same 30 m reach of channel (±5 m), using the GPS coordinates recorded at the initial site surveys for reference. Visual water quality parameters were used to detail site condition.

2.1.2 Water Quality Sampling

In-situ measurements are recorded for field parameters at each site using a calibrated water quality meter. These parameters include pH, temperature (°C), specific electrical conductivity (µs/cm), dissolved oxygen (% saturation) and turbidity (NTU). Three replicate readings are conducted at each monitoring site, within 5 m of the GPS position of the monitoring site and include the date and time of day.

Surface water samples were collected for physical and chemical parameters at each site. The surface water sampling was undertaken via hand grab, with personnel wearing disposable nitrile gloves. One surface water sample was taken at each site, for each parameter. The collection of each sample occurred within 5 m of the GPS position of the monitoring site.

Sample bottles with the lid on were completely immersed in water to a depth of 10-15 cm (where depth allowed). Once rinsed, the lid was then removed with the bottle opening directed into the water flow (facing upstream), and the sampler's hand positioned downstream to avoid contamination. The bottles were filled to capacity. Sample bottles were uniquely labelled for each parameter and site, stored on ice in a dark Ice Cooler with appropriate preservatives where applicable, and provided to the laboratory within 6-8 hours of collection.

2.2 Lab Analysis

The laboratory used to analyse samples was accredited by the National Association of Testing Authorities, Australia (NATA). Analyses performed by the laboratory were conducted using standardised methods and undertaken by appropriately qualified and experienced personnel. The laboratory provided a quality assurance program with analysis of internal spikes, duplicates and method blanks, and reported results at sufficiently low limits of reporting (LOR) to allow comparison with adopted sediment quality guidelines. Laboratory certificates are included in the appendix of this report (Appendix 1).

2.3 QA/QC Procedures

The team involved in field sampling for visual condition surveys and water quality sampling comprised of suitably qualified and experienced environmental scientists and included at least one personnel with the following experience:

- Previous experience conducting visual riparian, channel and aquatic ecological assessments and water quality assessments
- Tertiary qualifications in environmental science, biology, or chemistry.

2.4 Data Analysis

Water quality parameters were assessed against the Australian and New Zealand Fresh and Marine Water Quality Guidelines (ANZG) (2018), and the ANZECC & ARMCANZ (2000) Guidelines where applicable. Water quality data was screened against stressor values for South-east Australian lowland rivers (ANZECC 2000) and toxicant trigger values for ecosystem species protection of 95% (ANZG 2018).

3 Results and Findings

The Quarter 2 Dry survey includes Physical-Chemical water quality and Rapid Biological Assessment (Faecal Coliforms), as per the WVWMS (2001).

3.1 Weather Patterns

3.1.1 Dry Survey 2 – July 2024

The dry survey was conducted on the 5 July 2024. A total of 8.6 mm of rain was recorded in the 24 hours prior to the survey at Terry Hills BOM AWS (Station 066059), 5 km from the Project Site. A high of 15°C and a low of 10.9 °C was recorded on the day of the survey, with generally light showers, overcast and cool conditions observed.

3.2 Visual Condition

3.2.1 Dry Survey 2 – July 2024

- Site 1

The creek at Site 1 measured 2 – 10 m in width with an approximate stream depth of 1.5 m, and some minor undercutting of erosion along the banks evident during the dry survey. Water level was high (50-75%) with moderate water flow, potentially being restricted by dense vegetation upstream. Water was turbid with no odour or surface foams. Macrophytes were absent, while dense fringing vegetation surrounded the stream, including Morning Glory (*Ipomoea indica)* and Harsh Ground Fern (*Hypolepis meulleri)*, whilst the invasive Trad (*Tradescantia fluminensis*) was a common ground cover. Mixed plastic debris, and other urban debris was observed in the area.

- Site 2

The creek at Site 2 measured 2 – 15 m in width and 0.5 – 1 m depth during the dry survey. Water level was high (>75%) with moderate flow. Water was coloured, with no evident odour or organic surface scum. Minor erosion of banks was evident in the form of undercutting, while a small amount of finer sandy sediments accumulated on the creek banks. Macrophytes were absent, while fringing vegetation was primarily composed of rushes and weeds, including the invasive Trad (*T. fluminensis*) with some small ornamental, toxic Arum Lily (*Zantedeschia aethiopica*) and Cherry Laurel (*Prunus laurocerasus*). Mixed plastic debris was observed at the time of the survey.

- Site 3

The creek at Site 3 measured 1 – 5 m in width and 1 m in depth during the dry survey. Water level was moderate (25 – 50%) with high flow. Water was turbid, with no evident surface scums or odours. Macrophytes were present, consisting largely of Parrot's Feather (*Myriophyllum aquaticum*), Slender Knotweed (*Periscaria decipiens*) and Rush (*Juncus sp.)* along with mixed aquatic weeds. Fringing vegetation was dense and primarily composed of rushes and weeds, with common species including Saw Sedge (*Gahnia* sp.), and extensive ground cover assemblages of *T. fluminensis* and Weeping Rice Grass (*Microleana stipoides*). Mixed debris was observed at the time of the survey. No evidence of erosion was observed.

3.3 Physical-Chemical Water Quality

Dry Sample Event

The average physical-chemical water quality measurements for each site during the Quarter 2 Dry Survey were compared against the ANZECC Guidelines (2000) for lowland rivers in south-east Australia. Average electrical conductivity (EC) was within the guideline values at each site and presented within the typical range in NSW coastal rivers of 200-300 μScm^{-1}. Average pH was within the Guideline (2000) values at each site, however, and Dissolved oxygen saturation (DO%) was slightly below the Guideline (2000) lower limit of 85%, with sites recording averages between 77-83%. Turbidity was within the Guideline (2000) with ranges from 17-38 NTU recorded. The average physical-chemical water quality values for each site are detailed in Table 2.

Chemical analysis of water samples from each site during the Quarter 2 Dry Survey were compared against ANZECC Guidelines (2000) for lowland rivers in south-east Australia. Total nitrogen, ammonia and total nitrates and nitrites as NOx were slightly above specified Guideline (2000) values at every site (**Table 2**).

Table 2: Average physical-chemical water quality values for each site during the Quarter 1 Dry Survey.

Parameter	ANZECC Guidelines	Q2 Dry Survey		
		Site 1 (U)	Site 2 (I)	Site 3 (D)
Physical				
Electrical Conductivity ($\mu S\ cm^{-1}$)	125-2200	249	251	264
pH	6.5-8.0	7.33	7.18	7.26
Temperature (ºC)	N/A	14.04	13.84	13.74
Dissolved Oxygen (%)	85-110	77.13	82.20	83.33
Turbidity (NTU)	6-50	24.67	38.13	17.86
Suspended Solids (mg/L)	N/A	6	5	5
Chemical				
Total Nitrogen (mg/L)	0.5	**0.9**	**0.8**	**0.7**
Ammonia Nitrogen (mg/L)	0.02	**0.04**	**0.04**	**0.03**
Total Kjeldahl Nitrogen (mg/L)	-	0.6	0.5	0.5
Nitrates (mg/L)	-	0.26	0.29	0.24
Nitrites (mg/L)	-	<0.01	<0.01	<0.01
Total Nitrates & Nitrites (mg/L)	0.04	**0.26**	**0.29**	**0.24**
Total Phosphorus (mg/L)	0.05	**0.08**	0.04	0.05
Orthophosphate (mg/L)	0.02	0.01	0.01	0.01
Non-Filterable Phosphorous (mg/L)	0.05	**0.08**	0.04	0.05

Outside of applicable ANZECC water quality Guidelines (ANZECC 2000)

3.4 Rapid Biological Assessment

Biological testing of each site during the Quarter 2 Dry Survey identified between 320 – 510 coliform organisms/100 mL, with the highest recorded at Site 2, instream (Table 3).

Table 3: Biological water quality parameters for each site during Quarter 2 Dry Survey.

Parameter	Q2 Dry Survey		
	Site 1 (U)	Site 2 (I)	Site 3 (D)
Coliforms & *E. coli*			
Thermotolerant Coliforms (CFU/100ml)	500	510	320

All sites during the dry survey were below the secondary contact recreation levels of thermotolerant coliforms <1000 coliforms/100 mL (ANZECC 2000).

4 Discussion and Trends

4.1.1 Trends between Dry Surveys

Physical Water Quality

A slight decrease in EC was recorded between Q1 and Q2 Dry events, with Q1 Dry recording an average of 350 µS cm^{-1} while Q2 Dry recorded an average of 255 µS cm^{-1} across sites. This slight decrease may be linked to the increase in flow recorded, whilst temperature decreases in cooler months may also lower EC levels, with water temperatures during Q1 Dry recording an average of 19.5 ºC across sites, while Q2 Dry recorded an average of 14ºC. A slight rise in average pH levels across sites may also be attributable to lower water temperatures over cooler months.

When compared to the Q1 Dry sample, Dissolved Oxygen % (DO) recorded significant increases from an average of 15% across sites, to an average of 80% in Q2 data. This is likely attributed to better flow conditions recorded during site inspections, which allows for increased oxygenation of the water. Additionally, in the week prior to survey, Terry Hills AWS recorded 8 mm of rain, which may have also contributed to the increased oxygen levels within waterways.

Turbidity recorded in Q1 Dry was ~4 NTU, while Q2 Dry ~25 NTU. This slight increase in turbidity is likely linked to the increased flow recorded during site inspections, resulting in slightly elevated disturbances of the stream bed and bank sediments. The increase in turbidity recorded is within guidelines and would likely dissipate with reduced flows.

Chemical Water Quality

Total nitrogen, ammonia and NOx were slightly above ANZECC Guidelines at each site during the survey. This observation was also recorded in Q1 Dry sampling event and may be indicative of wider environmental conditions in the catchment. Nutrient loading, seen by increases in both nitrogen and phosphorous levels, may be attributed to flushing and scouring of upstream areas of the catchment including areas of urban development, which may have resulted in increases in toxicants and nutrients (WQA 2013). An increase in the limiting factors of nitrogen and phosphorous may occur, as turbidity and flow decreases after a flow event which may result in eutrophication of the waterway.

Thermotolerant Coliforms

A significant change in coliform concentrations was recorded between the Q1 dry and Q2 dry surveys at Site 3. Coliforms at Site 3 decreased from 3400 CFU/100ml to 320 CFU/100ml from the Q1 dry to Q2 dry survey, which may indicate that a point disturbance may have occurred between Sites 2 and 3 at the time of Q1 dry survey. Sites 1 and 2 both recorded consistent concentrations.

4.1.2 Influence of Seasons and Flow Conditions

Seasonal changes are known to affect water quality, with cooler waters known to reduce EC levels by 2-3% per 1ºC cooler (Dewangan 2023), whilst pH and DO are also affected by water temperature. Additionally, water appearance, DO, and pH may also change with increases in detritus, which may occur as a result of deciduous trees during cooler months.

The increased flows that were recorded during the Q2 dry survey are expected to have also impacted water quality, with flowing waters often having no or low odour, increased DO levels, and increased short term turbidity as opposed to still waters. Additionally, stormwater runoff from the surrounding catchment may also result in increased minerals being present in waterways, which can impact pH, nitrogen and phosphorous levels.

4.1.3 Water Quality Objectives

The objective of this Program is to report on the water quality within the Study Area. This report has been developed to meet requirements of the development consent and assess results against guideline values. Results obtained in this monitoring report and subsequent surveys over the 12 months of baseline monitoring will be used to develop baseline and guideline values for the construction phase.

5 Conclusion

The Quarter 2 Dry Survey was conducted in July 2024, as part of the 12 months baseline monitoring of the Study Area. Physical and chemical monitoring results from Quarter 2 water quality samples indicate that the habitat of Narrabeen Creek within the Study Area is disturbed. In comparison, the previous Quarter 1 water quality, sediment quality and the rapid biological assessment, indicated that the creek within the Study Area is moderately disturbed. This change in disturbance may be linked to seasonal or flow conditions recorded. Subsequent monitoring through the 12-month pre-construction period will likely lead to emerging treads, and provide more accurate baseline data of the greater Narrabeen Creek.

Whilst some parameters exceeded the accepted ANZECC Guidelines or DGVs, these increased levels are not currently expected to result in toxicity to aquatic organisms inhabiting the Study Area. Data from these surveys, along with subsequent monitoring surveys within the 12-month pre-construction phase will be used to develop baseline data and acceptance criteria (Appendix 3) for later phases of the project.

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Plate – Dry Survey

Dry	Upstream	Downstream
Site 1		
Site 2		
Site 3		

Plate 1 – Upstream and downstream at Site 1, 2, and 3.

Appendix 1 – Laboratory Certificates

CERTIFICATE OF ANALYSIS

Work Order	: **ES2422281**	Page	: 1 of 3
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
Contact	: SIMON KIRGIS	Contact	: Customer Services ES
Address	: PO Box 3257, Erina NSW 2250	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 05-Jul-2024 15:23
Order number	: ----	Date Analysis Commenced	: 05-Jul-2024
C-O-C number	: ----	Issue Date	: 12-Jul-2024 14:46
Sampler	: SIMON KIRGIS		
Site	: ----		
Quote number	: ES24H2OCONS0001		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- MW006 is ALS's internal code and is equivalent to AS4276.5.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WW01	WW02	WW03	----	----
			Sampling date / time	05-Jul-2024 12:12	05-Jul-2024 12:27	05-Jul-2024 12:39	----	----
Compound	CAS Number	LOR	Unit	ES2422281-001	ES2422281-002	ES2422281-003	--------	--------
				Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**6**	**5**	**5**	**----**	**----**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.04**	**0.03**	**----**	**----**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.26**	**0.29**	**0.24**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.26**	**0.29**	**0.24**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**0.5**	**0.5**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.9**	**0.8**	**0.7**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.08**	**0.04**	**0.05**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.01**	**0.01**	**0.01**	**----**	**----**
MW006: Thermotolerant Coliforms & E.coli by MF								
Thermotolerant Coliforms	----	1	CFU/100mL	**500**	**510**	**320**	**----**	**----**

QUALITY CONTROL REPORT

Work Order	: **ES2422281**	Page	: 1 of 5
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
Contact	: SIMON KIRGIS	Contact	: Customer Services ES
Address	: PO Box 3257, Erina NSW 2250	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 05-Jul-2024
Order number	: ----	Date Analysis Commenced	: 05-Jul-2024
C-O-C number	: ----	Issue Date	: 12-Jul-2024
Sampler	: SIMON KIRGIS		
Site	: ----		
Quote number	: ES24H2OCONS0001		
No. of samples received	: 3		
No. of samples analysed	: 3		

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This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW

General Comments

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Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC
* = The final LOR has been raised due to dilution or other sample specific cause; adjusted LOR is shown in brackets. The duplicate ranges for Acceptable RPD% are applied to the final LOR where applicable.

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 5916497)									
ES2422231-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	568	586	3.1	0% - 20%
ES2422310-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	5090	4460	13.1	0% - 20%
ES2422368-004	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.0	No Limit
ES2422486-005	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	1750	1770	1.1	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 5915084)									
ES2422264-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	88.2	86.4	2.0	0% - 20%
ES2422596-003	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.02	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5906564)									
ES2422203-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	0.0	No Limit
ES2422233-009	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5915085)									
ES2422264-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01 (0.10)*	mg/L	<0.10	<0.10	0.0	No Limit
ES2422596-003	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5915083)									
ES2422264-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1 (2.0)*	mg/L	131	134	1.7	0% - 20%
ES2422596-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5915082)									
ES2422264-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01 (0.20)*	mg/L	6.40	6.57	2.6	0% - 20%
ES2422596-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5906563)									

QUALITY CONTROL REPORT

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Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 2357 Warriewood Management Plan	Date Samples Received	: 05-Jul-2024
Order number	: ----	Date Analysis Commenced	: 05-Jul-2024
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Site	: ----		
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- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW

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Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 5916497)									
ES2422231-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	568	586	3.1	0% - 20%
ES2422310-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	5090	4460	13.1	0% - 20%
ES2422368-004	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.0	No Limit
ES2422486-005	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	1750	1770	1.1	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 5915084)									
ES2422264-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	88.2	86.4	2.0	0% - 20%
ES2422596-003	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.02	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5906564)									
ES2422203-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	0.0	No Limit
ES2422233-009	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5915085)									
ES2422264-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01 (0.10)*	mg/L	<0.10	<0.10	0.0	No Limit
ES2422596-003	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5915083)									
ES2422264-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1 (2.0)*	mg/L	131	134	1.7	0% - 20%
ES2422596-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5915082)									
ES2422264-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01 (0.20)*	mg/L	6.40	6.57	2.6	0% - 20%
ES2422596-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5906563)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 5906563) - continued									
ES2422203-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	<0.01	0.0	No Limit
EW2403151-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.05	0.05	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 5916497)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	94.7	83.0	129
				<5	1000 mg/L	98.8	82.0	110
				<5	928 mg/L	97.5	83.0	118
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5915084)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	99.9	90.0	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5906564)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	107	82.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5915085)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91.0	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5915083)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	97.1	69.0	123
				<0.1	1 mg/L	110	70.0	123
				<0.1	5 mg/L	101	70.0	123
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5915082)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	99.3	71.3	126
				<0.01	0.442 mg/L	108	71.3	126
				<0.01	1 mg/L	107	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5906563)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	102	85.0	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5915084)							
ES2422264-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	# Not Determined	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5906564)							
ES2422203-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	106	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5915085)							
ES2422264-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	5 mg/L	103	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5915083)							
ES2422264-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5915082)							
ES2422264-002	Anonymous	EK067G: Total Phosphorus as P	----	10 mg/L	100	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 5906563)							
ES2422203-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	96.1	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2422281**	Page	: 1 of 5
Client	: **H2O CONSULTING GROUP**	Laboratory	: Environmental Division Sydney
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Site	: ----	Issue Date	: 12-Jul-2024
Sampler	: SIMON KIRGIS	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, where applicable to the methodology, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK055G: Ammonia as N by Discrete Analyser	ES2422264--001	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser	ES2422264--002	Anonymous	**Total Kjeldahl Nitrogen as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	**----**	**11-Jul-2024**	12-Jul-2024	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	**----**	**11-Jul-2024**	02-Aug-2024	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	**----**	**05-Jul-2024**	07-Jul-2024	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	**----**	**11-Jul-2024**	02-Aug-2024	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
WW01, WW02, WW03	**05-Jul-2024**	**10-Jul-2024**	02-Aug-2024	✓	**10-Jul-2024**	02-Aug-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
WW01, WW02, WW03	**05-Jul-2024**	**10-Jul-2024**	02-Aug-2024	✓	**10-Jul-2024**	02-Aug-2024	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	----	**05-Jul-2024**	07-Jul-2024	✓
MW006: Thermotolerant Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006)							
WW01, WW02, WW03	**05-Jul-2024**	**----**	----	----	**05-Jul-2024**	06-Jul-2024	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	5	39	**12.82**	**12.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	17	**17.65**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	17	**17.65**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	AS 4276.7

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

Appendix 2 – Monitoring schedule

Table 1: Physical and chemical parameters to be monitored at each site, including location and timing.

State	Parameter	Pre-Construction Phase		Construction Phase		Post-Construction Phase	
		Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather
Physical	Visual*	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Electrical Conductivity/Salinity (field)	U/D	U/D	U/D	U/D	U/D	U/D
	pH (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Temperature (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Dissolved Oxygen (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Turbidity (field)	U/D	U/D	U/D	U/D	U/D	U/D
	Suspended Solids	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Volume Gross Pollutants Removed				SQID		SQID
Chemical	Total Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Ammonia-Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Total Kjeldahl Nitrogen	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Nitrates and Nitrites	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Total Phosphorous	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Ortho-Phosphate	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Non-Filterable Phosphorous	U/D/I	U/D/I	U/D/I/ESC	U/D/I	U/D/I/SQID	U/D/I
	Hardness (CaCO3)		U/D		U/D		U/D
	Chromium		U/D		U/D		U/D
	Lead		U/D		U/D		U/D
	Zinc		U/D		U/D		U/D
	Arsenic		U/D		U/D		U/D
	Mercury		U/D		U/D		U/D
	Copper		U/D		U/D		U/D
	Phenolic Compounds		U/D		U/D		U/D
	OC/OP Pesticides		U/D		U/D		U/D
	Oil and grease (H.E.M)		U/D		U/D		U/D
	PAH		U/D		U/D		U/D
	Chlorophyll-a						U/D

Biological	Algal Identification and Count		U/D		U/D/I		U/D
	Faecal Coliform Count	U/D/I	U/D/I	U/D/I	U/D	U/D/I/SQID	U/D/I
	Biotic Index (SIGNAL)		U/D		U/D		U/D
Chemical	Chromium	U/D		U/D		U/D	
	Lead	U/D		U/D		U/D	
	Zinc	U/D		U/D		U/D	
	Arsenic	U/D		U/D		U/D	
	Mercury	U/D		U/D		U/D	
	Copper	U/D		U/D		U/D	
	Phenolic Compounds	U/D		U/D		U/D	
	Organochlorine Pesticides	U/D		U/D		U/D	
	PAHs	U/D		U/D		U/D	

U = upstream, D = downstream, I = in-sector, ESC = sediment control basins, visual inspection of other erosion and sediment control measures, SQID = GPTs, water quality control ponds and constructed wetlands (inflow and outflow locations). NA = not applicable. Visual* = parameters as described in Section 3.3.2.

Key for Table 10:

	Three monthly
	Annual Sampling including at least one sampling at the Rezoning stage and one sampling at the Handover stage
	Three Times Each Year, One Sample on Rising Limb and One Sample on the Falling Limb of the Hydrograph at Each Site

Appendix 3 – Monitoring Acceptance Criteria

Table 1 Summary of Acceptance Criteria – Site Discharge and Creeks (Pittwater Council 2001)

Media	State	Variable	Units	During Construction Site Discharges/In sector	Post Construction Site Discharges	Instream Short Term (Status Quo)	In-stream Medium Term	In-stream Long Term
Water	Physical	Visual	-	No litter	No litter	No litter	No litter	No litter
		Salinity (TDS)	mg/L	NA	NA	1000	1000	1000
		pH (Field)	-	NA	NA	6.6 - 8	6.6 - 8	6.6 - 8
		Temperature (Field)	ºC	NA	NA	Status quo	Status quo	Status quo
		Dissolved Oxygen (Field)	%Sat	NA	NA	Status quo	90	90
		Turbidity (Field)	NTU	NA	NA	Status quo	50	20
		Suspended Solids	mg/L	100	50	Status quo	20	6
		Volume Gross Pollutants Removed	Tonne	NA	NA	NA	NA	NA
	Chemical	Total Nitrogen	mg/L	1.6	1.6	Status quo	1.6	1.0
		Ammonia-Nitrogen	mg/L	See Key	See Key	See Key	See Key	See Key
		Total Kjeldahl Nitrogen	mg/L	-	-	-	-	-
		Nitrates and Nitrites	mg/L	-	-	-	-	-
		Total Phosphorous	mg/L	0.1	0.05	Status quo	0.1	0.04
		Ortho-Phosphate	mg/L	-	-	-	-	-
		Non-Filterable Phosphorous	mg/L	-	-	-	-	-
		Hardness (CaCO3)	mg/L	NA	NA	-	-	-

		Chromium	µg/L	NA	NA	Status quo	50% status quo	10
		Lead	µg/L	NA	NA	Status quo	50% status quo	1
		Zinc	µg/L	NA	NA	Status quo	50% status quo	50
		Arsenic	µg/L	NA	NA	Status quo	50% status quo	50
		Mercury	µg/L	NA	NA	Status quo	50% status quo	0.1
		Copper	µg/L	NA	NA	Status quo	50% status quo	2
		Phenolic Compounds	µg/L	NA	NA	Status quo	50% status quo	Note
		OC/OP Pesticides	ng/L	NA	NA	Status quo	50% status quo	Note
		Oil and grease (H.E.M)	mg/L	NA	NA	50	20	5
		PAH	µg/L	NA	NA	Status quo	50% status quo	3
		Chlorophyll-a	mg/m^3	NA	NA	15	15	10
	Biological	Algal identification and count	-	NA	NA	Status quo	No algal bloom	No algal bloom
		Faecal Coliform Count	Cfu/100mL	150	150	1000	150	150
		Biotic Index (SIGNAL)	-	NA	NA	Status quo	> 5	> 6
Sediment	Chemical	Chromium	mg/kg	NA	NA	Status quo	50% status quo	80
		Lead	mg/kg	NA	NA	Status quo	50% status quo	50

		Zinc	mg/kg	NA	NA	Status quo	50% status quo	200
		Arsenic	mg/kg	NA	NA	Status quo	50% status quo	20
		Mercury	mg/kg	NA	NA	Status quo	50% status quo	0.15
		Copper	mg/kg	NA	NA	Status quo	50% status quo	65
		Phenolic Compounds	mg/kg	NA	NA	Status quo	50% status quo	Note
		Organochlorine Pesticides	mg/kg	NA	NA	Status quo	50% status quo	Note
		PAH	mg/kg	NA	NA	Status quo	50% status quo	4000

'Short-term' relates to the period during and just after development (up to 'Handover'). 'Medium-term' is the period of one year after completion of all water quality controls associated with the fully developed area. Due to the likely fragmented nature of development, permanent water quality controls may not be fully functional for some years. 'Long-term' is defined as the period after control measures are introduced for all pollutant sources in the valley (Pittwater Council 2001).

NOTES and KEY for Table C2:

- 'Status Quo' means the median value is within the range of the 10%ile and 90%ile from the pre development condition data
- 50% Status Quo means the median value is within the range of 50% of the 10%ile and 50% of the 90%ile from the pre-development condition data
- Sediment guidelines are dry weight from ANZECC, 1999 General values have been adopted with consideration of ANZECC 1999, ANZECC, 1992, Brisbane City Council, 2000, Lawson & Treloar, 1997 and Laxton, 1993
- TDS values are appropriate for non-tidal sections of the creeks only Water Hardness required to assist with interpretation of ANZECC, 1999 trigger guidelines for metal concentrations
- For the purposes of comparing the results with ANZECC, 1999 guidelines, the creeks can generally be defined as 'lowland rivers'
- If the existing level is lower than the medium or long-term guideline provided, the existing level is not to be exceeded Note - ANZECC 1999 guidelines for each compound to be used
- Ammonia - Details for the assessment of ammonia are described in Section C3. Comparison required with ANZECC (1999) guidelines for all samples.

Appendix 4 – Raw Data (Dry Survey)

Physical water quality raw data

Table 1: Physical water quality parameters at Site 1 (upstream)

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm-1)	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Site 1 5 July 2024	1	231	7.61	14.28	82.6	14.9
	2	262	7.18	13.86	74.7	17
	3	255	7.21	13.95	74.1	16.5

Table 2: Physical water quality parameters at Site 2 (instream)

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm^{-1})	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Site 2 5 July 2024	1	25	7.24	13.92	78	36.2
	2	247	7.16	13.83	91.5	49.7
	3	257	7.15	13.76	77.1	28.5

Table 3: Physical water quality parameters at Site 3 (downstream)

Survey	Physical Water Quality Parameters					
	Replicate	Electrical Conductivity (µS cm^{-1})	pH	Temperature (ºC)	Dissolved Oxygen (%)	Turbidity (NTU)
Site 3 5 July 2024	1	259	7.2	13.75	80	17.5
	2	248	7.17	13.73	75.5	19.7
	3	285	7.43	13.74	94.5	16.4

DOCUMENTATION CHECKLIST - CONSTRUCTION CERTIFICATE

(Detach and include with submissions)

Section	Item	Requirement	Check (√)
4.1	Water Cycle Assessment - Water Balance Modelling Pre & Post Development		
4.1.1	Stream Gauging, infiltration testing and use of local rainfall data for modelling		
4.2.1	Water Quality Monitoring Plan	♦♦♦♦♦♦♦♦	A.S
4.2.1	Water Quality Monitoring Sites Shown on Plan (at least three)	♦♦♦♦♦♦♦♦	A.S
4.2.1, 2, C	Water Quality Monitoring Data	♦♦♦♦♦♦♦♦	A.S
4.2.1, 2, C	Assessment and interpretation of water quality monitoring data	♦♦♦♦♦♦♦♦	A.S
4.2.1, 2, C	Assessment and interpretation of water quality monitoring data from SQID's		
4.3	Water Quality Management Assessment - Load Modelling Pre and Post Development		
4.3.1, 3	Justification of assumptions for Event Mean Concentrations		
4.3.2	Identification of and details for Stormwater quality facilities	++++++++++	
4.3.2, 4.4.5	Mosquito Risk Assessment for both Watercourse and Water Quality/Quantity features Text	++++++++++	
4.3.6, 4.6.5	Inspection and Cleaning Reports for SQID's and OSD		
4.3.6	Management Plan for Stormwater Quality Improvement Devices	++++++++++	
4.3.5	Environmental Management Plan (Soil and Water Aspects)	++++++++++	
4.3.4	Erosion and Sediment Control Plan	++++++++++	
4.4.3, 4, 5	Existing and Proposed Creek Corridor in plan with cross/long sections with flood levels	+++Note 1+++	
4.4.4	Proposed Creek Corridor Planting Schedule	+++Note 1+++	
4.4.5	Creek Corridor Vegetation Monitoring and Management Plan	♦♦Note 1♦♦	
4.4.5	Vegetation and Creek Maintenance and Monitoring Reports		
4.5	Flood Analysis – existing design conditions	♦♦♦♦♦♦♦♦	
4.5.2	Compliance of structures and creek corridor with flood planning levels	++++++++++	
4.5.4	Details of Interim Flood Protection Works	++++++++++	
4.6.3	Design Storm Hydrological Modelling of Site - Pre and Post Development	♦♦♦♦♦♦♦♦	
4.6.3	On-Site Detention Facilities	++++++++++	
4.6.4	Stormwater Retention Facilities	++++++++++	
4.7	Stormwater Concept Drainage Plan		

KEY:

	Preliminary Calculations/Assessment Required		*Work as Executed Plans*
	Concept Design Required	♦♦♦♦♦♦	*Required/Reviewed/Updated*
+++++++	*Detailed Assessment/Calculations/Design*		*Not required*

Note 1 Even if the works are not to be constructed by the Applicant on the land to be transferred to Council under the Material Public Benefit Option in the Section 94 Plan, preliminary investigation for Rezoning and concept design at DA stage is required

~~*Completed by Principal Certifier:*~~

Name: ..... Alex Swanson For applicable items 4.2.1 and 4.2.1, 2, C
Title: ..... Experienced Aquatic Ecologist
Organisation: ..... H2O Consulting Group Pty Ltd

Signature: .....
Date: ..... 10 December 2024

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