



**ENGINEERING REPORT
FOR
PROPOSED RESIDENTIAL DEVELOPMENT
AT
45-49 WARRIEWOOD RD, WARRIEWOOD**

**REPORT NO. R02192
Revision C**

4 June 2021

PROJECT DETAILS

Property Address: 45-49 Warriewood Rd, Warriewood

Development Proposal: Residential Development

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1. INTRODUCTION

1.1 General

This engineering report has been prepared to support the proposed Development Application to Northern Beaches Council (Council) for a residential development at 45-49 Warriewood Road, Warriewood.

The proposed infrastructure works include roads (both new and upgrade of an existing), stormwater drainage, bulk earthworks, site accesses, retaining walls, on-site detention, water quality measures, and other associated works. These will be designed to comply with the principles outlined in Council's DCPs and Standards.

This report should be read in conjunction with the accompanying Engineering Drawings, PN02292 and other planning reports and drawings. Reduced scale of engineering drawings are included in Appendix A.

The following issues have been addressed in this report:

- General engineering issues,
- Access and car parking,
- Stormwater management and,
- Utility services.

The following information and documents were used for this report:

- Northern Beaches Council – Pittwater 21 DCP, 2018
- Northern Beaches Council – Warriewood Valley Roads Masterplan, 2018
- Northern Beaches Council – Warriewood Valley Water Management Specification, 2001
- Northern Beaches Council – Pre-lodgement Notes, PLM2019/0109
- Engineers Australia - Australian Runoff Quality – A Guide to Water Sensitive Urban Design”, (2006),
- Engineers Australia - Australian Rainfall & Runoff, 1987
- Sydney Water HYDRA Diagram;
- Agility Gas Diagram;
- Energy Australia Electrical Infrastructure Plans / Diagrams;
- Telstra Service Diagrams.

1.2 Engineering Objectives and Targets

The engineering objectives are to create a well linked and highly accessible layout to provide a development that responds to the topography and site constraints, and to provide a safe and environmentally friendly development.

From the planning, policy and legislation, the following principles will guide the development in relation to engineering works:

- Provision of roads system that meets Council's Warriewood Valley Roads Masterplan,
- Provision of water sensitive urban design principles and improve stormwater runoff quality discharging from the site to Narrabeen Creek
- Provision of a safe access links to the adjoining neighborhood by well linked cycleways and paths,
- Respond to the existing drainage system in Warriewood Road,
- Sympathetic to the terrain and landform and responsive to the existing environmental constraints,
- Develop a high quality infrastructure that integrates well with landform and drainage system
- Meet triple bottom line benchmarks encompassing social, ecological, and economic factors.

Site specific design objectives and targets have been established on the basis of the review of relevant policy, legislation and guidelines.

Issue	Site-Applicable Target or Management Objective
Site Works	<ul style="list-style-type: none"> - Sympathetic to the existing landform and surrounding built-form. - Minimise excessive cut or fill. - Responsive to the existing environmental constraints-Narrabeen Creek.
Accesses and Carpark	<ul style="list-style-type: none"> - Provide simple and efficient layout for public safety. - Provide safe and functional access system without compromising streetscape qualities. - Provide enough car parking spaces for the demand.
Mainstream Flooding	<ul style="list-style-type: none"> - Ensure the development has adequate freeboard from Narrabeen Creek flooding. - Incorporate Flood Risk Management.
Overland Flow	<ul style="list-style-type: none"> - Provide safe conveyancing of stormwater through the site.
Flow management	<ul style="list-style-type: none"> - Provide OSD system to the requirement of Council to control stormwater runoff and minimise discharge impacts on adjoining properties and into the natural drainage system before, during and after construction. - Minimise alteration to natural flow paths and discharge points. - Closely match pre-development frequency of runoff events. - To provide for the disposal of stormwater from the site in an efficient, equitable and environmentally sensible way.
Stormwater Quality	<ul style="list-style-type: none"> - Manage stormwater to remove as much total Phosphorus and Nitrogen, at least 80% of Total Suspended Solids and 70% of Litter and 90% of hydrocarbons from runoff.
Water conservation	<ul style="list-style-type: none"> - Provide efficient sized rainwater tank for both irrigation of landscape areas and toilet flushing.
Services	<ul style="list-style-type: none"> - Provide site with essential services.

Table 1 – Engineering Objectives and Targets

1.3 SITE

The site is located at 45-49 Warriewood, Warriewood. It comprises an area of 2.154 hectares by Title consisting two (2) separate allotments: Lot 1 & 2 in DP 349085. It is located on the southern side of Warriewood Road and bounded by Narrabeen Creek to the south.

The site has a gently rolling slope in a southerly direction from Warriewood Road (gradients are generally 5-7%) then flattens towards the creek.

Areal view of the existing site is shown in Figure 1 below.



Figure 1 – Areal View of the site

There is 1.822m wide drainage reserve (Lot 2 in DP972209) along the eastern boundary of Lot 2 with an open channel. On the upstream of the channel in Warriewood Road, there is an existing 525mm diameter stormwater pipe with a headwall.

2. GENERAL ENGINEERING ISSUES

2.1 Site Earth Works

The proposed development includes subdivision of 3 individual lots (Lots 1 & 2 in DP 349085 and Lot 2 in DP972209) into 14 lots comprising:

- 11 Torrens Title lots,
- 1 Superlot with Strata development,
- 1 lot for Road Reserve, and
- 1 Residue Lot (Drainage Reserve along Narrabeen Creek).

The site is affected by the 1 in 100 year ARI flooding of Narrabeen Creek. As per BMT's¹ recommendation the site is proposed to fill to the planning level.

It is inevitable that construction of a residential development on a sloping land requires excavation and filling of the site. To minimise the excessive alteration of the existing topography and sympathetic to its surrounding built form, the buildings have been stepped. The average alteration of the final levels, therefore, would be less than 1m.

Drawing 02192_231 shows the extent of cut and fill.

The earthworks will be done under strict supervision of a geotechnical engineer to meet AS3798.

¹ Reference 4

3. ROADS, SITE ACCESS AND PARKING

3.1 Road Planning

A separate Traffic report prepared by TEF Consulting is included in the Development Application. Issues relating to traffic should refer to the report.

This Section addresses issues relating to road works in the aspects of civil engineering works either identified in the traffic report or are deemed necessary relate to this type of development.

Proposed extension of Lorikeet Grove is classified as Local Street and the existing Warriewood Rd is classified as Collector Street in accordance with Warriewood Valley Roads Masterplan². Tables 2 below summarises composition of Local Streets and Collector Streets.

Local Streets	
Traffic Volume	2000 vehicles per day – approximate upper limit.
Maximum Number of Dwellings	200
Design Speed	40km/h
Speed Limit	50km/h
Traffic Lane Width	Total 7.5m carriageway to cater for traffic, parking, cyclists.
Cycle Lane Width	Share roadway with vehicles.
Parking Lane Width	No parking lane marked, park adjacent to kerb.
Bus Bay Width	N/A
Verge Width	4.25m on both sides of carriageway to cater for street tree planting.
Footpath Width	1.5m footpath one side of carriageway.
Total Road Reserve Width	16.0m minimum
Collector Streets	
Traffic Volume	5,000 vehicles per day – approximate upper limit.
Design Speed	50km/h
Speed Limit	50km/h
Traffic Lane Width	3.7m
Cycle Lane Width	Share roadway with vehicles.
Indented Parking Lane Width	2.1m
Indented Bus Bay Width	3.0m
Shared Path Width	2.1m shared path on both sides of the carriageway.
Total Road Reserve Width	20m minimum

Table 2 – Road System

The existing Warriewood Road fronting the site requires a half road ² Reference 1

3.1 Lorikeet Grove Construction

Lorikeet Grove is a Local Street under Warriewood Valley Roads Masterplan. This formation is reflected in the existing road to the west of the site. However, the width of the existing carriageway to the east of the site that has been recently constructed under DA N0491/16 is 8m. It is understood that 8m carriage width was a Rural Fire requirement as this road is a perimeter road.

We have maintained 8m carriage width for the full length of the road except for the last 10m where width varies from 8m to 7.5m.

3.2 Warriewood Road Reconstruction

The existing Warriewood Road fronting the site requires a half road reconstruction to reflect Collector Street.

The new kerbline is set 10.9m from the existing kerb on the northern side with the centreline of the road located at 5.1m from the northern side kerb. The proposed reconstruction includes 3.7m wide carriageway and 2.1m indented car parking bays totalling 5.8m wide reconstruction.

The proposed work is shown on Drawings 02192_201 and 02192_401.

3.3 Internal Accesses and Off Street Parking

The proposed new access points to the site will be from Lorikeet Grove to the requirements of the AS2890.1 and 2.

The basement access, parking, isle widths, and turning provisions have been designed in accordance with AS2890.1 - Off Street Car parking.

4. STORMWATER MANAGEMENT

4.1 Introduction

4.1.1 Background

The objective is to provide stormwater management, which ensure that the proposed development is safe from the mainstream flooding; local overland flows and does not adversely impact on the stormwater flows and water quality of waterways within, adjacent and downstream of the site.

Conceptual design of the drainage system has been included in the Engineering Drawings in Appendix A. Detailed design will be provided as part of the Construction Certificate application.

4.1.2 Key Issues

The key issues and the mitigating measures to be employed within the proposed development site are:

- **Mainstream Flooding** – *The site is affected by flooding of Narrabeen Creek located to the south of the site. To avoid impacting on the development, the site has been filled to the flood planning level without affecting the flood levels in the creek. The flood planning level is described in Section 4.2.*
- **Local Overland Flows** – *In urbanised situation, the excess runoff from the major storm events is conveyed by roads, overland flow paths and channels. The site contains overland flow path in a form of open channel that drains the upstream properties. To limit impact on the site, we have proposed to pipe for the 1 in 100 year storm events with overland flow provision. The design and operation of the proposed system is described in Section 4.3.*
- **Stormwater Flow** - *Increased impervious surfaces (such as roads, roofs, carparks, etc) have the potential to increase the stormwater flows from the site during storm events. To avoid impacting on the downstream drainage system, the site stormwater system has been designed to safely convey the flows through the site and within the capacity of the downstream system. The design and operation of the proposed system is described in Section 4.4.*
- **Water Quality** - *Urban developments have the potential to increase gross pollutants, sediments and nutrient concentrations in stormwater runoff. To limit impact on the downstream water quality, water quality control devices will be provided prior to discharging to the downstream waterways. The design and operation of the proposed system is described in Section 4.5*

4.2 Mainstream Flooding

4.2.1 Narrabeen Creek

BMT Pty Ltd has prepared Narrabeen Creek Flood Risk Management Plan³ for the development and submitted as part of the current DA submission. The report is submitted under a separate cover.

The BMT's flood report (Report) indicates that the site is classified as Flood Category 1 – High Hazard. This is due to that the southern portion of the site is inundated by the 1 in 100 year ARI flood.

The Report estimates the 1 in 100 year flood level within the site and recommends Flood Planning Levels for the development as well as levels for Lorikeet Grove.

Table 3 below summarises the findings and recommendations:

Design Event (AEP)	Peak Flood Level (m AHD)	
	Existing	Developed
20%	3.90	3.89 (+0.01)
10%	3.96	3.96 (0.0)
5%	4.03	4.03 (0.0)
2%	4.09	4.09 (0.0)
1%	4.13	4.13 (0.0)
1% + Climate Change	4.21	4.21 (0.0)
PMF	4.89	4.89 (0.0)

Table 3 – Narrabeen Creek Flood Levels

Note: Bracketed value is change in peak flood level from the existing conditions

The Flood Planning Level (FPL) for the site was calculated by adding a 0.5m freeboard allowance to the simulated 1% AEP+CC existing peak flood level. The FPL for the site is 4.71 m AHD (4.21 m AHD + 0.5 m freeboard).

All habitable floor areas will be at or above the FPL. The proposed Lorikeet Grove will be above the 1% AEP+CC.

³ Appendix D

4.3 Overland Flow Flooding

As mentioned in Section 1.3 above, the development associated with the existing drainage reserve located to the east of the site. Its upstream catchment is drained by the existing 525mm diameter pipe discharging to the open channel in the drainage reserve. The catchment of this pipe is approximately 4.5 hectares. With 65% imperviousness and using XPRAFTS, the estimated peaks for the 1 in 5 year ARI and 1 in 100 year ARI are 1.95m³/s and 3.36m³/s respectively. External catchment is shown in Figure 2 below.



Figure 2 – Upstream Catchment

The proposed pipe in the drainage reserve is 900mm pipe which has a capacity of 3.4m³/s at an effective hydraulic grade of 2.5%. This is approximate peak flows of the 1 in 100 year ARI.

Given that the proposed 900mm pipe is conveying the major storm events, and the street drainage system only carries the minor storm events, there would always be surface flows during the major storm events.

In order to control the surface flows, we have proposed large inlet structures including an extra large gully pit in the sag point in Warriewood Road and three (3) large letter box pits within the site.

These structures will capture estimated surface flows during the major storm event. Further, we have proposed overland flow path over the proposed 900mm pipe which will carry the full surface flows.

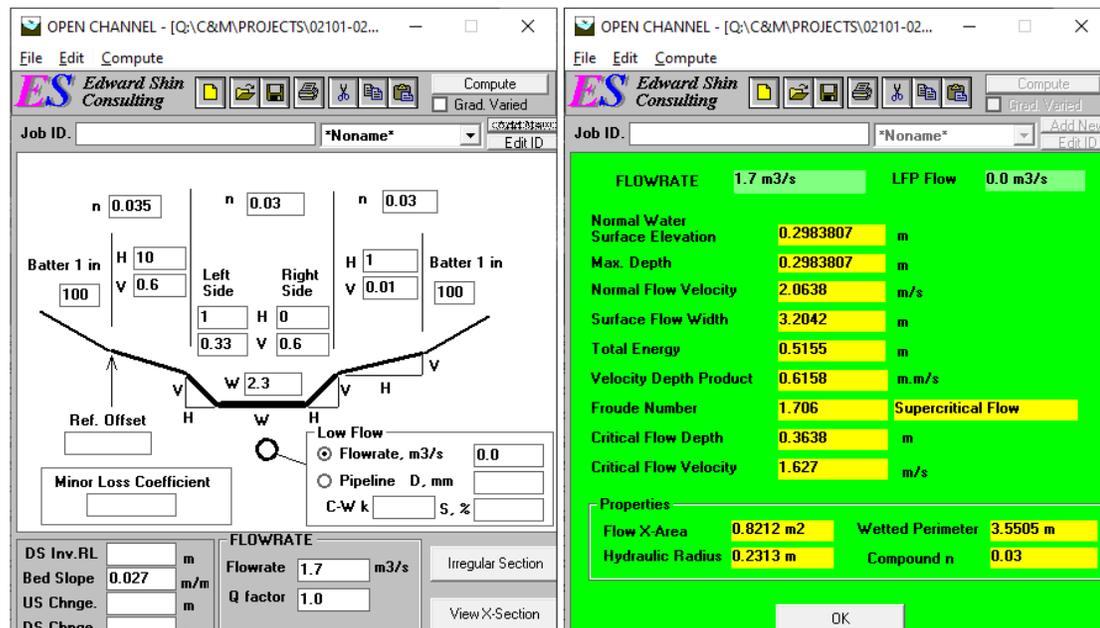
The inlet capacities of gully pit and the special pits have been calculated using HEC22 calculation.

STRUCTURE	PONDING DEPTH (m)	INLET CAPACITY (m3/s)
3.6m Gully pit with 3 grates	0.16	0.75
3 x 2.4m x 1.2m 'letter box' surface inlet pit	0.3	1.16 x 3 = 3.48
TOTAL		4.23

Table 4 – Inlet Capacities

Assuming 50% blockage, the total capture capacity is 2.1m3/s. This is greater than the surface flow of 1.41m3/s (3.36 – 1.95 = 1.41).

In addition to these inlet structures, we have also proposed an overland flow channel over the proposed 900mm pipe to carry the surface flow of 1.7m3/s being 50% of the 1 in 100 year storm. Calculation is done using CoSMoS program.



Amended engineering plans show the proposal. XPRAFTS hydrology model is included in the DA submission.

4.4 Stormwater Quantity Control

4.4.1 Design Guidelines

The site based stormwater management and planning elements are to be designed and constructed in accordance with the following:

Guidelines: Warriewood Valley Water Management Specification 2001⁴

The proposed development increases the total impervious area of the existing site and therefore may increase the discharge rate to the downstream waterways. The main objective is to achieve a natural water balance which seeks to approximate the pre-development site conditions to maintain existing conditions as well as controlling erosion and sediment removal.

The site is located within Sector 2 in the Guideline, where the RAFTS model was based on 50% imperviousness ratio over the whole site. Council however recommended using 65% imperviousness ratio for the development portion of the site⁵.

4.4.2 Proposed Drainage System

The drainage system for the development will be designed to collect all surface runoff flows from impermeable surfaces such as roads, buildings and hard surface areas to the designated conveyancing system to the downstream drainage system in a safe manner.

The drainage system proposed for the development includes:

- A piped system to collect minor storm events from the developed areas;
- Diversion pipe for the upstream external catchment;
- Overland flow path to direct the major storm safely through the site;
- Gross pollutant traps at each inlet pits;
- On-site detention (OSD) tank to attenuate developed flows to mimic existing flows;
- Stormwater quality control measures to reduce nutrient runoff to pre-development levels.

The development of the above infrastructure has been conceptually designed and presented in the Engineering Drawings in Appendix A.

⁴ Reference 2

⁵ Pre-lodgement Notes, PLM2019/0109

4.4.3 Sizing of the OSD Tank

Since the imperviousness ratio has changed for the site the OSD calculations have been performed using the hydrologic model, XP-RAFTS for the Permissible Site Discharge (PSD) and Site Storage Requirements (SSR) for the 2 year ARI to 100 year ARI.

The parameters used in the RAFTS model are same as used in the Warriewood Valley Water Management Specification for Sector 2. The parameters are re-produced in Table 4 below.

Base Condition Parameters								Developed Condition Parameters							
Area (ha) #1	Area (ha) #2	%Im #1	%Im #2	Slp % #1	Slp % #2	Pern #1	Pern #2	Area (ha) #1	Area (ha) #2	%Im #1	%Im #2	Slp % #1	Slp % #2	Pern #1	Pern #2
4.3	0.001	5	100	4.4	4.4	0.07	0.015	2.14	2.14	5	100	4.4	4.4	0.025	0.015

Table 5 – RAFTS Parameters used in the model

Table 6 below shows catchment configuration for the developed condition.

Catchment	Area (Ha)		
	Total	Impervious	Pervious
SITE	0.93	0.744	0.186
BYPASS (Developed)	0.178	0.1	0.078
LORIKEET Gr ⁽¹⁾	0.133	0.1	0.033
ENVIROMENTAL AREA ⁽²⁾	0.91	0	0.91
DRAINAGE RESERVE ⁽²⁾	0.053	0	0.053
TOTAL	2.204	0.944	1.260

Table 6– Developed Catchments

NOTE 1 – Lorikeet Gr road area is included as bypass since it is located below the OSD.

NOTE 2 – Environmental Area and Drainage Reserve have not been included as they have no additional impervious area and bypassing the OSD.

From the modelling, a 260m² x 1.8m deep underground tank is required to detain developed flows to mimic the existing. Discharge is controlled by a 230mm diameter orifice and a 200mm wide internal weir.

The weir is the main flow controlling structure which set above the flood level of Narrabeen Creek. This will eliminate backwater effects of the outflows.

Full details of the OSD system are shown on Drawing 02192_621.

Table 7 below shows the performance of the proposed OSD system.

ARI	Ex Q	De Q	WITH OSD		
			Q	Stage	Storage
2	0.182	0.401	0.18		
5	0.275	0.532	0.247		
10	0.337	0.616	0.313		
20	0.418	0.721	0.405		
50	0.497	0.798	0.487		
100	0.577	0.896	0.575	5.136	365

Table 7– PSD and OSD Performance – RAFTS

The results show that there would be up to 120% increase in peak flows due to the development. With the proposed drainage system it can achieve its main function of safely conveying stormwater through the site without any adverse impact both on site and downstream of the site.

XPRAFTS hydrology model is included in the DA submission.
Print out of hydrographs is in Appendix C.

4.5 Stormwater Quality Control

4.5.1 Design Guidelines

The site based stormwater management and planning elements are to be designed and constructed in accordance with the following:

Guidelines: Warriewood Valley Water Management Specification 2001

The main objective for stormwater quality is to detail the pollutant load modelling for the existing (pre) and post development conditions and the proposed measures to reduce pollutant loads. As a minimum, a 'no worsening' of existing runoff quality is required. Consideration of three scenarios is to be made:

- A wet year (90%ile rainfall),
- An average year (50%ile rainfall) and
- A dry year (10%ile rainfall)

4.5.2 Water Quality Control Measures

There are a number of measures that can reduce pollutant loadings, varying in effectiveness depending on land use type, topography and the control target.

As recommended by Warriewood Valley Water Management Specification, we are proposing infiltration system within the residue lot south of proposed Lorikeet Gr. This method will replenish groundwater where the endangered ecological community (EEC) that is present on site will greatly benefit.

In addition to infiltration system, all stormwater pits will be installed with 'Oceanguard' filter basket to control gross pollutants and suspended solids.

The measures proposed for the redevelopment are summarised in Table 8.

Measures	Descriptions
Infiltration Basin	<ul style="list-style-type: none"> ▪ An infiltration basin is a vertical filtration system that filters stormwater through a prescribed media (e.g. sandy loam) and recharges groundwater. ▪ The standard infiltration basin in this study has a detention depth of 0.3m and the filter media depth of 0.3m.
Gross Pollutant Traps	<ul style="list-style-type: none"> ▪ An Oceanguard (<i>Enviropod</i>) is a catch basin insert installed inside inlet pits. It is effective in removing trash, debris and other pollutants from runoff. ▪ Oceanguards proposed for the project utilise a 200 micron filter system. <p>These filter baskets will be installed in the most surface inlet pits for the proposed development including each Torrens titled lots fronting Lorikeet Grove.</p>
Rainwater Tank	<ul style="list-style-type: none"> ▪ Rainwater tanks are effective in the removal of pollutant loads at source. The pollutant removal process occurs by harvesting runoff for reuse, thereby limiting the nutrients that are discharged into the waterways. ▪ It is proposed to provide a rainwater reuse tank system with a minimum effective volume of 72kL. This is made up with 50KL for the units and 2kl/lot for Torrens titled lots. These will be plumbed for landscape irrigation and toilet flushing. ▪ Rainwater re-use rate for irrigation used is 1.0kL/year/m² of landscape area as PET-Rain. For Torrens titles lots 25kL/year/lot as PET-Rain. For toilet flushing, a nominal rate of 0.1kL/day/dwelling is used. Above rates are industrial standard rates used in Australia.

Table 8– Description of Stormwater Quality Improvement Devices (SQID)

4.5.3 Strategy Effectiveness

The effectiveness of the proposed water quality measures has been assessed using numerical modelling. The results were assessed against the established Council requirements to determine the effectiveness of the proposed strategy.

4.5.4 MUSIC Program

The water quality model adopted for this project is the MUSIC (Model for Urban Stormwater Improvement Conceptualisation version 6) water quality numerical model developed by the MUSIC Development Team of the Cooperative Research Centre for Catchment Hydrology (CRCCH). MUSIC is an event basis model, and will simulate the performance of a group of stormwater management measures, configured in series or in parallel to form a “treatment train”.

As per the Warriewood Valley Water Management Specification 2001, the models have adopted a daily timestep. The specification requires the consideration of three scenarios to be made:

- A wet year (90%ile rainfall),
- An average year (50%ile rainfall) and
- A dry year (10%ile rainfall)

A separate MUSIC model was done for each of the 3 scenarios to compare the pre-development with the post-development pollutant load rates and to ensure no increases in the post-developed state. The base models were acquired from Council and have used the specific council source nodes. The first model is for the year of 1984 which was a ‘wet year’, the second was for the year of 1998 which was an ‘average year’ and the final model was for the year of 2002 which was a ‘dry year’

Catchment characteristics were defined using a combination of roof areas and non-roof catchments with varying imperviousness ratios to replicate the catchment for the development condition. The respective catchment areas are shown in Table 8.

The MUSIC model layout are shown in Appendix B of this report.

4.5.5 Event Mean Concentration

MUSIC uses different event mean concentrations (EMC) to determine the pollutant loads generated by different land uses. The standard EMCs adopted within MUSIC were based on research undertaken by Duncan (1999) through the CRCCH and the results are reproduced in Australian Runoff Quality – A Guide to Water Sensitive Urban Design (ARQ). Table 8 summarises the parameters used for the development site.

Land Use	Mean Base Flow Concentration Parameters Log ₁₀ (mg/L)			Mean Storm Flow Concentration Parameters Log ₁₀ (mg/L)		
	TSS	TP	TN	TSS	TP	TN
Roof Areas	Not Applicable ^{*Note 1}			1.300	-0.890	0.300
Impervious Areas	1.200	-0.850	0.110	2.150	-0.600	0.300
Pervious Areas	1.200	-0.850	0.110	2.150	-0.600	0.300

Table 9– EMC Parameters used in MUSIC

*Note 1 – Roof areas consists of 100% impervious area so there is no base flow generated from this area.

4.5.6 Configuration

Tables 10 and 11 provide the treatment configurations used in the MUSIC model:

Land Use	Developed Conditions	
	Area (m ²)	Imperviousness (%)
Catchment 1		
Roof	1300	100
Ground	4300	55
Catchment 2		
Roof	970	100
Ground	2750	55
Catchment 3		
Roof	700	100
Ground	1090	45
Catchment 4 – Lorikeet Gr		
Road	1330	85

Table 10– MUSIC Catchment Areas

Since Council requirement is no increase from the existing the catchments south of Lorikeet Gr where no development proposed has been excluded in the modelling.

Stormwater Quality Improvement Device (SQID)	Quantity Of SQID
Infiltration Basin	350m ² with 300m ² filter area
Oceanguards	40 x 200micron
Rainwater Tanks	50kL and 11x2kL for lots

Table 11 - Stormwater Quality Improvement Devices (SQID)

4.5.7 Results

The results of the MUSIC modelling are shown in Table 12 below. The total pollutant loads from the development are expressed in kilograms per year.

Parameters	Pre	Post	Change
YEAR 1984 - Wet Year			
Flow (ML/yr)	4.3	5.67	
Total Suspended Solids (kg/yr)	416	218	-198
Total Phosphorus (kg/yr)	1.83	0.942	-0.888
Total Nitrogen (kg/yr)	10.9	10.1	-0.8
Gross Pollutants (kg/yr)	55.2	0	-55.2
YEAR 1998 - Average Year			
Flow (ML/yr)	12.3	12.3	
Total Suspended Solids (kg/yr)	2.29E+03	722	-1568
Total Phosphorus (kg/yr)	6.39	3.26	-3.13
Total Nitrogen (kg/yr)	33.1	25.8	-7.3
Gross Pollutants (kg/yr)	63.1	0	-63.1
YEAR 2002 - Dry Year			
Flow (ML/yr)	3.03	3.82	
Total Suspended Solids (kg/yr)	390	212	-178
Total Phosphorus (kg/yr)	1.25	0.808	-0.442
Total Nitrogen (kg/yr)	8.67	7	-1.67
Gross Pollutants (kg/yr)	39.2	0	-39.2

Table 12 – Results of MUSIC Modelling

The above results show that in all instances, the post development pollutant loads were less than the pre-developed pollutant loads. Therefore, by implementing the proposed treatment train measures within the proposed development there will be no detrimental effect on the quality of stormwater discharging to Narrabeen Creek.

5. UTILITY SERVICES

5.1 Water Supply

There is a DN100 C/CL watermain in Warriewood Road and a DN100 oPVC in Lorikeet Grove which will be extended as part of the development.

Therefore water does not pose any implication on the development.

5.2 Sewerage

The site contains a DN1800 trunk sewermain but is unlikely that connection is made to this main.

There is however a DN400 RC pipe near Narrabeen Creek. We expect that there should be sufficient sewer capacity available to service the site.

The sewer reticulation for the development will be done to the requirement of Sydney Water by a Water Servicing Coordinator.

5.3 Gas

There is a DN32 medium pressure gas main (300kPa) in Warriewood Road and Lorikeet Grove. Both mains are available for the development.

5.4 Electricity and Telecommunication

Electricity and telecommunications services are readily available from Warriewood Rd and Lorikeet Grove and we expect that these have sufficient capacity to adequately service the proposed development. These should not present any restrictions to the proposed development.

6. CONCLUSION

This engineering report has been prepared to support the proposed Development Application to Northern Beaches Council for a Residential Development at 45-49 Warriewood Rd, Warriewood.

The development as proposed, in the aspects of engineering, is functionally effective, safe, and environmentally sustainable. This high standard has been achieved by implementing Council DCP and various Planning Instruments and Standards including the WSUD principles in the planning and design of the development.

Whilst it is inevitable that development will have an impact of the existing stormwater runoff characteristics of a site due to changes in impervious areas and changes in landform, adequate stormwater management practices can be implemented that minimise the impact of development on the existing stormwater system.

The results provided in this report indicate that the condition of the downstream stormwater system will be improved by implementation of OSD and water quality measures in accordance with Council's requirements.

The stormwater and WSUD system provided for the development can only operate adequately if the system is regularly maintained during the operational life of the system. The Operation and Maintenance Schedule is included in Appendix E.

It should be noted that the results shown in this report are limited to use for Development Application purposes only. During the detailed design stages, a further refinement of the modelling based on the detail design of the development will be necessary.

It is recommended that the proposal of this report be adopted as the proposals in the report are in accordance with Council's DCPs and also to the requirements of a various Australian Standards.

REFERENCES

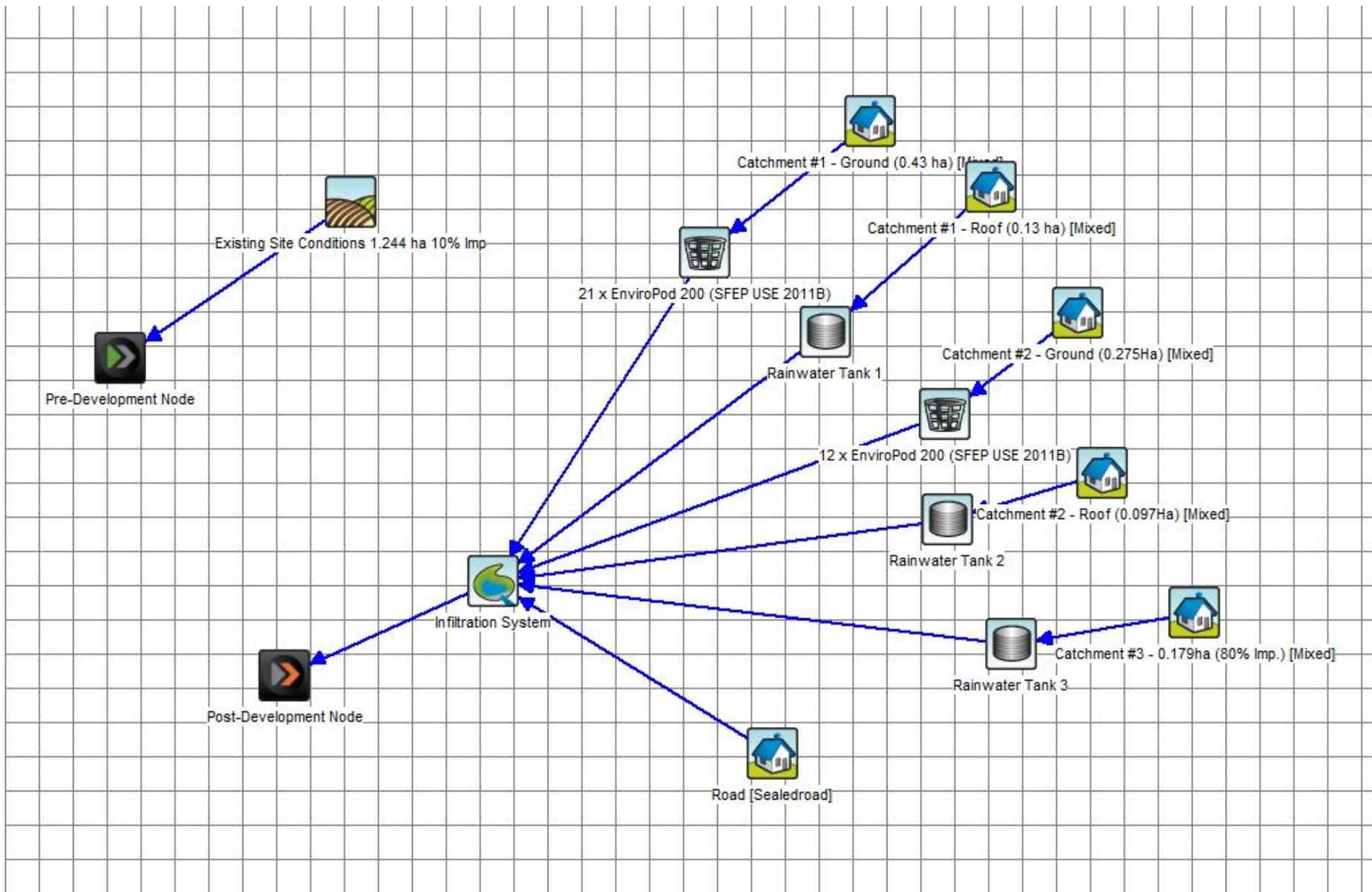
1. Northern Beaches Council – Warriewood Valley Roads Masterplan, 2018
2. Northern Beaches Council – Warriewood Valley Water Management Specification, 2001
3. Northern Beaches Council – Pittwater 21 DCP, 2018
4. BMT – 45 Warriewood Road, Warriewood Flood Impact Assessment
5. Archidrome – Architectural Drawings for 45-49 Warriewood Rd, Warriewood
6. CPS – Landscape Plan of 45-49 Warriewood Rd, Warriewood
7. Institution Of Engineers, Australia - "Australian Rainfall and Runoff", 1987, 3rd Edition
8. Engineers Australia - Australian Runoff Quality – A Guide to Water Sensitive Urban Design, 2006
9. Austroads – Guide to Road Design
10. AS 2890.1 - Off Street Car Parking

APPENDIX A

ENGINEERING DRAWINGS

APPENDIX B

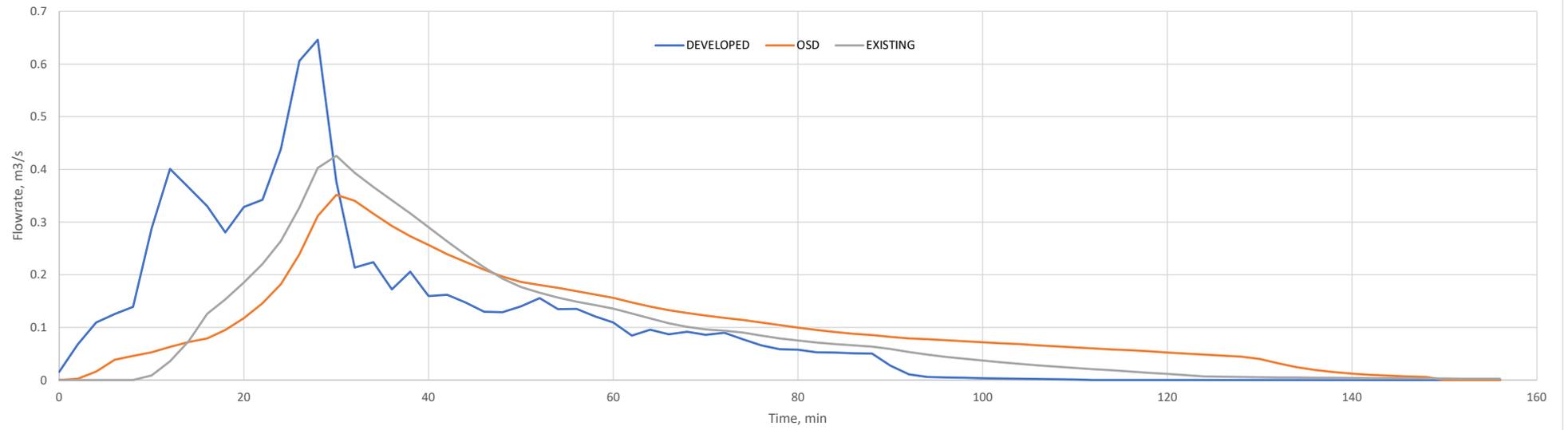
MUSIC LAYOUT



APPENDIX C

HYDROGRAPHS

HYDROGRAPHS AT OSD



APPENDIX D

PRELODGE MENT NOTES



PRELODGE MENT NOTES

Application No: PLM2019/0109

Meeting Date: 6/06/2019

Property Address: 45-49 Warriewood Road WARRIEWOOD
(Buffer Areas 1F and 1G)

Proposal: Subdivision of the site into 44 residential lots

Attendees for Council: Claire Ryan (Principal Planner – Development Assessment)
Rebecca Englund (Principal Planner – Development Assessment)
Rob Barbuto (Principal Engineer – Major Developments)
Lea Lennon (Senior Urban Designer)
Joseph Tramonte (Senior Landscape Architect)
Ruby Ardren (Project Leader – Water Management)
Valerie Tulk (Special Floodplain Engineer)
Dean McNatty (Team Leader – Stormwater)

Apologies: Matthew Edmonds (Manager – Development Assessment)
Patrick Bastawrous (Traffic Engineer)
Brendan Smith (Team Leader – Biodiversity)

Attendees for applicant: Sanjeev Loura (Owner)
Tarun Chadha (Architect)
Ben Tesoriero (Town Planner)
Tyson Ek-Moller (Town Planner)

General comments/limitations of these notes

These notes have been prepared by Council on the basis of information provided by the applicant and a consultation meeting with Council staff. Council provides this service for guidance purposes only. These notes are an account of the specific issues discussed and conclusions reached at the pre-lodgement meeting. These notes are not a complete set of planning and related comments for the proposed development. Matters discussed and comments offered by Council will in no way fetter Council's discretion as the Consent Authority. A determination can only be made following the lodgement and full assessment of the development application.

In addition to the comments made within these notes, it is a requirement of the applicant to address ALL relevant pieces of legislation including (but not limited to) any SEPP and any applicable clauses of Pittwater Local Environment Plan 2014 and Pittwater 21 Development Control Plan within the supporting documentation of a development application including the Statement of Environmental Effects.

You are advised to carefully review these notes. If there is an area of concern or non-compliance that cannot be supported by Council, you are strongly advised to review and reconsider the appropriateness of the design of your development for your site and the adverse impacts that may arise as a result of your development prior to the lodgement of any development application.



SPECIFIC ISSUES RAISED BY APPLICANT FOR DISCUSSION

Issues Raised	Council Response
<p>Road layout</p> <p>Feedback is sought in relation to the internal road layout</p>	<p>Council is concerned with what is perceived as an unnecessary duplication of roadways, noting that the internal central road serves little to no purpose in the overall subdivision pattern.</p> <p>Council considers that a better result could be achieved with the deletion of the internal central road (and the associated cul-de-sac), with total reliance upon the perimeter loop road. Adjustments would then be required to ensure that the design of the loop road meets the provisions of the <i>Warriewood Valley Roads Masterplan</i> and Council's <i>Waste Management Policy</i> with regard to access for garbage vehicles.</p>
<p>Dwelling design</p> <p>Feedback is sought in relation to the design of the proposed dwellings</p>	<p><u>Warriewood Road</u></p> <p>The proposed dwellings fronting Warriewood Road do not appropriately mimic the scale of the low density development on the high side of Warriewood Road, resulting in inconsistency with the requirements of clause C6.10 of P21 DCP. You are encouraged to explore semi-detached housing, with clear and meaningful breaks between every two dwellings.</p> <p>The setbacks to Warriewood Road are also inconsistent with the requirements of D16.6 of P21 DCP, noting that two dwellings are well forward of the 6.5m minimum setback and that the width of the proposed articulation zones exceeds 25% of the width of the frontage of the dwelling.</p> <p>The utilisation of the loop road and the removal of the cul-de-sac should also remove reliance upon the secondary access driveway that is proposed to service the dwellings fronting Warriewood Road, providing for greater setbacks between the secondary frontage of the dwelling and the internal road. The 1m setback to the 3 storey unarticulated façade currently proposed is unacceptable.</p> <p>The dwellings/lots marked 7 and 8 should be removed to facilitate a direct connection between all lots fronting Warriewood Road and the internal loop road.</p>



	<p><u>Internal Road</u> Council is supportive of the single garage design and tandem parking arrangement currently proposed. However, there is insufficient spatial separation between the attached dwellings, inconsistent with the provisions of C6.8 of P21 DCP which require a clear and meaningful break between buildings.</p> <p>The deletion of the internal central road will also facilitate more usable areas of private open space at the rear of each dwelling, rather than requiring private open space fronting roadways. This will also enable the removal of high front fences currently proposed, to achieve a streetscape more in keeping with the remainder of the land release area.</p> <p>The design of the northern dwellings, which vary in height and number of storeys, is preferred when compared to the southern dwellings, which have a continual 3 storey presentation along the length of the site.</p> <p>The garbage and tree enclosures located with a nil setback to the street are not supported.</p> <p><u>Lorikeet Grove</u> Concern is raised in regards to the bulk of the proposed semi-detached houses fronting Lorikeet Grove. Whilst access from the internal road is supported, further refinement is required to the facades presenting to Lorikeet Grove to reduce the massing and apparent size of the 3 storey structures proposed.</p>
<p>43 Warriewood Road</p> <p>Advice is sought in relation to Council's intentions for the development of 43 Warriewood Road.</p>	<p>To ensure orderly development and connectivity through Buffer Area 1a to 1m, Council requires 43 Warriewood Road (Buffer Area 1H) to be incorporated into the development of the subject site. This land is critical to the proposal to facilitate access from Lorikeet Grove.</p> <p>Please contact Council's Property Team for further advise in this regard.</p>



PITTWATER LOCAL ENVIRONMENTAL PLAN 2014 (PLEP 2014)

Note: PLEP 2014 can be viewed at the [NSW Government Legislation Website](http://www.nsw.gov.au/legislation/online/default.asp?name=2&link=6)

Zoning and Permissibility	
Definition of proposed development:	Subdivision and Dwelling Houses
Zone:	R3 Medium Density Residential
Permissibility:	Permitted with consent

Part 4 – Principal development standards
4.3 Height of buildings
Comment: It is assumed that each of the proposed new dwellings will comply with the building height development standard prescribed by subclause 2F of clause 4.3 of PLEP 2014.

Part 6 – Urban release areas
6.1 Warriewood Valley Release Area
With 44 dwellings, the proposal is consistent with the dwelling yield prescribed for Buffer Areas 1F, 1G and 1H (being 31-45 dwellings).
As currently proposed, the development presents as an overdevelopment of the site. You are strongly encouraged to remove the dwellings/lots marked 7 and 8, with further refinement of the maximum yield likely as a result of the design changes required to achieve consistency with the provisions of P21 DCP and the recommendations contained within these notes.

Part 7 - Additional local provisions
7.1 Acid sulphate soils
A preliminary acid sulphate soil assessment and an acid sulphate soils management plan is required to accompany any future application, particularly noting the likely presence of acid sulphate soils within the creekline corridor.
7.3 Flood planning
The site is subject to flooding in both the FPL and PMF event. Any future application will be required to address the provisions of this clause, in addition to the specific requirements of clause C6.1 of P21 DCP and the Water Management Specification. See further comments from Council's Flood Team, further in this report.
7.6 Biodiversity
The site contains areas of Swamp Sclerophyll Coastal Forest Endangered Ecological Community, and is subject to the provisions of this clause. See further comments from Council's Biodiversity and Riparian Teams, further in this report.
7.7 Geotechnical hazards
Given the extent of earthworks required, the application is to be supported by a geotechnical risk management report identifying consistency with this clause and clause B8.1 of P21 DCP.



Furthermore, the geotechnical risk management report could be used to provide information of ground water levels on the site, specifically in and around the EEC.

7.10 Essential services

The application is to demonstrate that each lot has adequate access to all essential services, being the supply of water and electricity, the disposal and management of sewerage, stormwater drainage and suitable vehicular access. Concern is raised with regard to vehicle access, noting that without the incorporation of 43 Warriewood Road, it is unlikely that access can be legally obtained in the short-medium term.

PITTWATER 21 DEVELOPMENT CONTROL PLAN (P21 DCP)

Note: P21 DCP can be accessed via Council's website: www.northernbeaches.nsw.gov.au

Section C6: Design criteria for Warriewood Valley Release Area

C6.1 Integrated Water Cycle Management

The prelodgement application was not supported by any information relating to the proposed water management solution for the site. The relevant teams have provided general commentary further in the report.

C6.2 Natural Environment and Landscape

Given the presence of the EEC in the vicinity of the creekline, some of the provisions of clause C6.2 of P21 DCP will not be relevant. The application should ensure that the impacts upon the EEC are avoided or minimised, and the cleared areas within the EEC should be revegetated to compensate for impacts elsewhere on the site.

C6.4 The Road System and Pedestrian and Cyclist Network

The proposal is to demonstrate consistency with the provisions of clause C6.4 of P21 DCP, the *Warriewood Valley Roads Masterplan* and the *Warriewood Valley Landscape Masterplan*.

Internal Road:

The internal loop road should be designed as a 'Local Street'; however the 'Access Street' requirements may be accepted subject to adequate landscaping and appropriate setbacks to dwellings. Visitor parking should be evenly distributed throughout the site, and a one-way loop system is not supported.

Warriewood Road:

The design of the half road reconstruction of Warriewood Road is to align with the roads works approved in relation to both adjoining properties and comply with the Warriewood Valley Roads Masterplan. Council would prefer if all properties fronting Warriewood Road obtained vehicular access from the internal road. It is noted that this could be readily achieved if the dwellings/lots marked 7 and 8 were removed.

Lorikeet Grove:

Lorikeet Grove is to align with the location of those sections of Lorikeet Grove approved on adjoining sites, and is to be designed in accordance with the Roads Masterplan. The proposed indented parking bay along Lorikeet Grove is not supported.

Shared Path:

The location of the shared path on both adjoining sites has now been confirmed and approved. Details of the design and levels of these connections are viewable on Council's website via the Application Tracking service. When passing through the EEC, the cycle pathway should be



elevated on piers and should be sited to avoid impacts upon vegetation of waterbodies. The location of the cycle path should be reviewed by the project ecologist.

C6.5 Utilities, Services and Infrastructure Provision

Services:

Services should be located within the road verge, in a common trench below the footpath, to minimise impacts upon canopy trees.

Subdivision:

The application is silent with respect to the type of subdivision proposed. Council strongly advises that the proposed subdivision should be in the form of a Community Title subdivision.

C6.7 Landscape Area (Sector, Buffer Area or Development Site)

A minimum of 35% of the total site is to be landscaped area. Please be advised that 'landscaped area' differs from impervious area, as considered in the *Warriewood Valley Water Management Specification*. Furthermore, all roads and pathways (even those proposed to be dedicated to Council) are to be considered as part of this calculation.

C6.8 Residential Development Subdivision Principles

Concern is raised in relation to the design of the proposed dwellings and inconsistency with the provisions of this clause. See further comments above.

C6.10 Additional Specifications for Development of Buffer Area 1a to 1m

The proposed lack of inclusion of 43 Warriewood Road is inconsistent with the provisions and outcomes of this development control:

- Development occurs in an orderly manner,
- Continuation of the multifunctional creekline corridor, including cyclist and pedestrian access,
- To ensure that lots with a width of less than 60m are amalgamated to facilitate orderly planning and development outcomes and the efficient use of land, and
- To ensure consistency with the 'Indicative Layout Plan'.

Furthermore, as above, the design of the development fronting Warriewood Road is inconsistent with the requirement for built form to reflect the streetscape of Warriewood Road.

Section D16: Warriewood Valley Release Area

D16.1 Character as viewed from a public place

Concern is raised in relation to the presentation proposed dwellings, specifically:

- The housing typology fronting Warriewood Road is not considered to appropriately respond to the housing typology on the other side of the street,
- Insufficient spatial separation between dwellings, with no landscaping between buildings,
- The dwellings are generally unarticulated, with 3 storey blank facades presenting to the higher order streets.

D16.5 Landscaped Area for Newly Created Individual Allotments

Each lot is to strictly comply with the minimum landscaped area requirements of this control. Furthermore, the application should demonstrate how each lot can achieve consistency with the landscaping requirements (ie: the provision of canopy trees) prescribed.



D16.6 Front Building Line
A number of dwellings do not conform to the minimum setback requirements prescribed by this development control.
D16.7 Side and Rear Building Line
A number of dwellings do not conform to the minimum setback requirements prescribed by this development control.
D16.9 Solar Access
The application is required to demonstrate that each proposed dwelling will receive a minimum of 2 hours of direct sunlight to areas of private open space and windows of living areas between 9am and 3pm in midwinter.
D16.11 Form of construction including retaining walls, terracing and undercroft areas
The application does not demonstrate the extent of cut and fill required to facilitate the proposed development, and the design appears to assume that the site is flat. Further detail is required in this regard, particularly where retaining walls are required along common boundaries and in the vicinity of existing and proposed canopy trees.

Specialist Advice	
Referral Body	Comments
Natural Environment - Biodiversity	<p>The applicant should ensure that required bushfire asset protection zones are maintained outside of the retained vegetation (an Endangered Ecological Community) in the south-west of the property. Any proposed flood storage and or water management infrastructure should be installed outside of the retained vegetation.</p> <p>In accordance with the Biodiversity Conservation Act 2016, a Biodiversity Development Assessment Report (BDAR) (formerly a Flora and Fauna Assessment) must be prepared to address any proposed impacts upon native vegetation within the site. The BDAR report must account for any direct and potential indirect impacts (e.g. changes in hydrology, weed invasion) upon native vegetation and habitats resulting from the proposal. The BDAR should include assessments of significance (5 part test) for threatened species matters occurring or with potential to occur on the site.</p> <p>A vegetation management plan must be prepared to guide weed removal and management within areas of retained vegetation including the riparian zone. Existing cleared and disturbed patches within the retained areas (including trails) must be revegetated the local native species guided by the Vegetation Management Plan.</p>



Specialist Advice	
Flooding	<p>The property at 45 – 49 Warriewood Rd, Warriewood is affected by the low, medium and high flood risk precincts, as well as Flood Life Hazard Categories H1-H5, as shown on the attached maps.</p> <p>The 1% AEP flood level including climate change predicted by the Narrabeen Lagoon Flood Study (2013) is 3.90m AHD*, and the Probable Maximum Flood level is 4.88m AHD.</p> <p>Freeboard is 0.5m, so the Flood Planning Level (FPL) is 0.5m above the 1% AEP flood level.</p> <p>*Note: The FPL has marginally increased in the time since the last advice was provided.</p> <p>It is understood that all of the portion of the property east of Lorikeet Grove is to be filled to above the FPL, which would modify the Flood Life Hazard Category and flood levels quoted above. If the proposed ground levels in the area where homes are proposed are above the post-development FPL, then the homes themselves would not be affected by flood related development controls, and a shelter in place refuge above the PMF would not be required. Flooding and evacuation would still need to be addressed though.</p> <p>The development needs to satisfy requirements set out in the <i>Warriewood Valley Urban Land Release Water Management Specification</i>, as well as the relevant provisions of PLEP 2014 and P21 DCP.</p> <p>Flood modelling would need to be undertaken to assess the pre- and post-development scenarios (including any basins and/or compensatory Works), and the Flood Management Report would need to identify any impact on this property as well as surrounding properties.</p> <p>Floods models are to include the PMF, 1% AEP, 20% AEP and 50% AEP events.</p> <p>Flood levels and velocities are to be shown to 2 decimal places.</p> <p>Flood impact mapping is to be presented.</p> <p>Calculations for pre- and post-development storage are to be presented.</p> <p>The DCP requirements include:</p> <ol style="list-style-type: none">There is no net loss of flood storage below the 1% AEP flood level;



Specialist Advice	
	<ul style="list-style-type: none"> b. There are no adverse changes in flood levels and velocities caused by alterations to the flood conveyance; c. There are no adverse effects on surrounding properties; and d. It is sited to minimise exposure to flood hazard.
Water Management	<p>Water Management Report A thorough Water Management Report will be necessary. The requirements are detailed in the <i>Warriewood Valley Water Management Specification</i>; some key points that are often missed or misinterpreted are outlined below:</p> <ol style="list-style-type: none"> 1. All water management facilities must be located outside the inner 25m riparian creek corridor. If they are located in the private buffer (outer 25m creek corridor), they must be situated above the 20%AEP. Flood maps should be provided that demonstrate this. 2. Assessment of existing conditions. There is a gauge at Mona Vale managed by Manly Hydraulics Lab and I believe there is a suitable five year period of data in the 1990's. There may be a more recent and longer period of suitable data available now. Please do not use data from Terrey Hills, as rainfall events there differ significantly from Warriewood. 3. An assessment of existing water quality in Narrabeen Creek (this is required for DA). 4. A water quality monitoring strategy covering the period prior to (if unable to obtain data on existing conditions), during and following construction up until issue of the occupation certificate. Major SQIDs should be monitored for one year following commissioning. 5. Proprietary devices such as filtration cartridges cannot be used in place of infiltration. Infiltration is necessary to replenish groundwater, a significant source of water for the Endangered Ecological Community on the site. 6. Water quality management. To demonstrate compliance with the relevant stormwater performance requirements, a model (preferably MUSIC) or an equivalent, widely accepted model or methodology must be provided. Should MUSIC be used, modelling shall be undertaken in accordance with draft NSW



Specialist Advice	
	<p>Water Sensitive Urban Design Guidelines unless alternative modelling parameters are justified on the basis of local studies. Model data files should be submitted with a summary of the elements, parameters and assumptions used in the model.</p> <ol style="list-style-type: none">7. A maintenance plan is required for all water quality infrastructure (and OSDs).8. Division of responsibility for the maintenance of water management systems should be equitable.9. All facilities should be accessible by maintenance vehicles and equipment.10. Outlets to the creek should be designed so that flow enters the creek in a direction similar to the flow of the creek (no more than 30 degrees is recommended).11. Impervious area. OSD calculations are based on 50% of the <i>total</i> site being impervious, including the riparian corridor. There are different requirements for landscaped area. The developed dwelling lots must be a maximum of 65% impervious. The inner creekline corridor (25m from creek centreline) must be vegetated. The outer creekline corridor (private buffer) from 25-50m from the creek centreline may be up to 25% impervious surfaces including roads and pedestrian/cycle ways. Water management facilities may also be in the private buffer.12. A catchment plan should be provided that shows the areas contributing flows to each OSD. Please ensure impervious vs pervious finishes are clearly differentiated eg. do not describe an area as 'courtyard' when this could include a combination of deep soil and paved areas.13. Rainwater tanks cannot be oversized to provide OSD storage.14. Due to the EEC the creek invert level should not be changed (overbank flows should not be altered). The creek currently consists of a pool, riffle and then another pool. The riffle should be maintained. Rehabilitation of the aquatic and riparian habitat is to be undertaken. The roadway should be removed and compaction of the soil reduced. Weeds are to be removed (including all Coral trees) and creek banks stabilised where required as a result of the weed removal. It is recommended that



Specialist Advice

rocks are placed to blend with the current stacked rock on the creek bank towards the boundary with 53C. Any outlets must have substantial rip rap surrounding them to prevent erosion of the creek. Significant vegetation in the riparian area (inner 25m creekline corridor) must be retained and indicated in the Flora and Fauna report and Biodiversity/ Vegetation Management Plan.

Issues specific to this site

1. The EEC on 45-49 Warriewood Road relies on overbank flows from the creek. Due to the reliance of the EEC on overbank flows there are significant constraints on cutting into the creek for flood storage, as this will change the creek invert level.
2. The EEC is groundwater dependent vegetation. It is believed that groundwater flows originate from 53A Warriewood Road and generally flow on a diagonal path from the north-western corner of that property across to the EEC on 45-49 and 41 Warriewood Road.

A groundwater monitoring plan will be required to determine the level and area of groundwater and establish the quantity and patterns of flow. The key will be determining whether proposed construction work and development will impact groundwater flows in the short and/or long term and what impact this might have on the EEC.

Please note: Water level monitoring should be undertaken on a regular basis for a period of six months from monitoring bores installed at the site upslope of the EEC. Monitoring results should include a rainfall hyetograph to indicate the sensitivity of groundwater levels to periods of rainfall. A minimum of three bores should be installed to allow triangulation of water levels, determination of the hydraulic gradient and interpretation of flow direction.

3. Due to past use of the site for market gardening, particularly 49 Warriewood Road where there are large numbers of greenhouses, a groundwater contamination assessment is required. If contaminants are found above ANZECC guidelines, a groundwater management plan should be prepared.



Specialist Advice	
Engineering	<ol style="list-style-type: none"> 1. The applicant we need to prepare an upstream overland flow study using the DRAINS program. It has been identified that there are significant overland flow heading from the west towards the site. As there is a sag pit that fronts the site a large volume of stormwater will enter the site. The applicant is advised that as the overland flow may inhibit development potential of the site that a stormwater drainage line be installed in the current location of the open swale (eastern side boundary). The pipe is to be designed to cater for the 1 in 20 year ARI flows that are generated from the upstream catchment(s) and Warriewood Road with an overland flow path /swale provided above the line to cater for flows up to the 1 in 100 year ARI storm event. The discharge point of this line is to be designed to have minimal impact on the adjoining riparian area. 2. On site stormwater detention is to be provided in accordance with Councils <i>Warriewood Valley Urban Land Release Water Management Specification</i>, in particular Appendix A "On site detention requirements" 3. The subdivision layout is to allow for the continuation of the adjoining shared pedestrian pathways in accordance with Councils <i>Warriewood Valley Roads Masterplan</i>. The road and footpath design is also to be in accordance with this document.
Traffic	<p><u>Warriewood Road</u></p> <ul style="list-style-type: none"> - The frontage to Warriewood Road requires a half road construction. - Kerb and Guttering (vertical faced kerb only will be permitted) with the face of the kerb located 10.9m from face of existing kerb on the northern side. - Plans need to show a cross-section where the centreline of the road is located 5.1m from the existing kerb on the northern side, as well as a proposed 3.7m traffic lane, and 2.1m indented parking bay. - As the traffic lane is 3.7m which is reduced from the required 4.2m for a sub-arterial road, the shared path is to be increased to 2.5m shared path and is to be located directly adjacent to kerb and fully within the



Specialist Advice	
	<p>Public Road Reserve where practicable. If the shared path of the adjacent sites is less than 2.5m then a transition is to be provided increasing to the full path width.</p> <ul style="list-style-type: none"> - Where otherwise available, access to properties fronting Warriewood Road should be accessed internally. <p><u>Lorikeet Grove</u> To be designed as a Local Road in accordance with the <i>Warriewood Valley Roads Masterplan</i>, to align with existing/proposed connections on adjoining sites.</p> <p><u>Central Road</u> Proposed 6.2m wide central road is not acceptable, as road needs to be designed as a Local Road or Access Road in accordance with the WVRMP, minimum 7.5m carriageway with parking permitted on both sides of the road, and 1.5m wide footpath on one side of the road.</p> <p><u>Laneways</u> Laneway (for rear vehicular access only) may be considered if designed in accordance with the WVRMP. No parking is permitted in the laneway. Laneway must be constructed as a Shared Zone in accordance with the RMS standards. One way traffic laneway cannot be considered as length exceeds 40m and 6 number of dwellings.</p> <p><u>Access driveway</u> Access driveway off turning circle for rear parking to dwellings fronting Warriewood Road too close to vehicle path and must be setback further from the roadway.</p> <p><u>Waste Vehicle Access</u> The turning area in Central Road must be designed to cater for safe movements by a waste collection vehicle minimum 9.7m in length, to accommodate the existing vehicle type for all turning movements. May need to check with Waste Services regarding type of vehicles they will be using in the future and the minimum length required.</p>
Urban Design	<p>The deletion of the central road to allow for internal courtyard common open space should provide a variety of places for adequate circulation, rest and play. Areas of large shaded trees (possibly deciduous) are encouraged to allow for shade in</p>



Specialist Advice	
	<p>summer and solar gain in winter and the change of seasons.</p> <p>The 1 metre wide allocation for the boundary deep soil zone for mature plantings will be insufficient. A minimum 2 metres should be allowed for to encourage not only mature planting but low to mid-range height landscaping response.</p> <p>The bin receptacles provided to the front landscaped area are not a preferred solution for the bin storage areas. Bin storage should be internal to the site and not be part of the front landscaped area of the apartments. The preference is for minimised built form additional to the entrances and facades to the units. As cars and hardstand driveway and pedestrian paths will dominate this forecourt area, strategies that provide a green landscaped response that complements the hardstand will be required in future applications.</p> <p>Overall the development has maximised the yield to achieve 44 dwellings The minimum requirement is 31 and it is suggested a more reasonable and less intense development could be achieved by the reduction of the number of dwellings proposed. The separation requirements outlined above will see the loss of several of the building blocks to allow for this pattern of built form across the site.</p>
<p>Landscape Architect</p>	<p>The subdivision proposal does not satisfy all the road verge requirements contained collectively in the <i>Warriewood Valley Roads Masterplan</i> and <i>Warriewood Valley Landscape Masterplan</i>.</p> <p>Sharepath and Footpath requirements:</p> <p>To satisfy the Warriewood Valley Landscape Masterplan and Design Guidelines, the following pedestrian and sharepath network are required:</p> <p><i>Warriewood Rd</i> A 2.1m wide footpath is required along Warriewood Rd and shall be shown on subdivision plans, and shall be co-ordinated to align with the proposed 2.1m footpath for the adjoining properties. Where appropriate, the footpath should be aligned to abut the kerb to increase deep soil area for street tree planting.</p> <p><i>Lorikeet Grove</i></p>



Specialist Advice	
	<p>A 1.5m wide footpath is required to one side of Lorikeet Grove and shall be shown on subdivision plans, and shall be co-ordinated to align with the proposed 1.5m footpath for the adjoining properties.</p> <p><i>Creepline Corridor</i> A 2.5m wide sharepath is required within the outer creepline corridor, and shall be shown on subdivision plans, and shall be co-ordinated to align with the proposed footpath for the adjoining properties.</p> <p>Within the creepline corridor, the proposal must demonstrate the location and connectivity of a 2.5m width sharepath above the 20% AEP flood level.</p> <p>Landscaping</p> <p>Planting within the existing or proposed public road reserve is to be in accordance with the <i>Warriewood Valley Landscape Masterplan and Design Guidelines (Public Domain)</i>.</p> <p>Landscape Plans are required to demonstrate the proposal for extensive landscaping within the 50 metre creepline riparian corridor.</p> <p>The 50 metre corridor consists of an inner 25 metre public creepline corridor that is solely comprised of a native flora/fauna vegetation corridor adjoining the creepline, and an outer 25 metre private landscaped buffer setback.</p> <p>The Creepline Corridor landscape plans for the inner creepline corridor must be prepared illustrating the following: extensive stands of <i>Casuarina glauca</i>, and groves of <i>Eucalyptus robusta</i> with other native feature trees and indigenous understorey and ground covers are to comprise a minimum of 75 % of the total creepline corridor area. In areas of low use, native groundcovers should be used as an alternative to lawn.</p>
<p>Stormwater</p>	<p>Council's records indicate that the subject site is burdened by a public open drainage system which conveys runoff from Warriewood Road.</p> <p>it is recommended that the following details are submitted with any application.</p>



Specialist Advice	
	<ul style="list-style-type: none"> - Accurately locate and confirm dimensions of this drainage system and plot to scale on the DA site plans that outline the proposal. The locating should be carried out by a registered surveyor. - All structures are to be located clear of this drainage system. - Overland flow management – Refer to Development Engineering comments. <p>The following details should be submitted with the application should the applicant propose to modify, relocate, upgrade or remove the public drainage system:</p> <ul style="list-style-type: none"> - Hydraulic design & construction plans and an accompanying report detailing the Council drainage system upgrade are to be prepared by a Civil Engineer registered on the NPER. Hydrological and Hydraulic technical guidelines as specified in Council's Engineering Design Specification -AUSPEC ONE are to be used in the preparation of the Hydraulic design plans and report.
<p>Waste</p>	<p><u>Road Design</u></p> <ul style="list-style-type: none"> - The pavement width of the outer loop road does not comply with the requirements of the Waste DCP. <i>Minimum pavement width for roads to be accessed by waste collection vehicles is 6.0metres.</i> - Minimum footpath/naturestrip width (the distance between the property boundary and the kerb) to be 1.5 metres. <i>This is to allow residents to present bins and other wastes at the kerbside for collection without blocking the footpath.</i> <p><u>Access for waste collection vehicles.</u></p> <ul style="list-style-type: none"> - Public road access required to provide waste collection services to this community association. <i>Completion of access via Lorikeet Grove required prior to waste services being provided.</i> <p><u>General Information</u></p> <ul style="list-style-type: none"> - Compliance with all aspects of Waste DCP required. - Residents will be required to place bins and other wastes at the kerbside for collection.



Specialist Advice	
	<ul style="list-style-type: none"> - Positive covenant to be placed on community lot for access by waste collection vehicle. Wording will be provided by Council. - Waste collection clauses to be placed in Community Management Statement. Wording will be provided by Council.

Documentation to accompany the Development Application	
	<ul style="list-style-type: none"> • Completed Application Form and payment of fees • Electronic copies (USB) • Statement of Environmental Effects • Cost of works estimate/ Quote • Site Plan • Floor Plan • Elevations and sections • A4 Notification Plans (excluding internal layouts) • Survey Plan • Demolition Plan • Excavation and fill Plan • Waste Management Plan (Construction & Demolition & Ongoing) • Certified Shadow Diagrams • BASIX Certificates • Schedule of colours and materials • Landscape Plan and Landscape Design Statement • Arboricultural Impact Assessment Report • Subdivision Plans • Road Design Plan • Erosion and Sediment Control Plan / Soil and Water Management Plan • Stormwater Management Plan / Stormwater Plans and On-site Stormwater Detention (OSD) Checklist • Water Management Report and signed Water Management Specification Checklist • Operation and Maintenance Manual for water management infrastructure • Stormwater Drainage Assets Plan • Geotechnical Report • Bushfire Report • Acid Sulfate Soil Report • Flood Risk Assessment Report • Water Table Report • Overland Flows Study • Biodiversity Development Assessment Report • Vegetation Management Plan • Traffic and Parking Report • Construction Traffic Management Plan • Integrated Development Fees • Preliminary Contaminated Land Report • Landscaped area and impervious area calculation diagrams <p><i>Please refer to Development Application Checklist for further detail.</i></p>



Concluding Comments

These notes are in response to a prelodgement meeting held on 6 June 2019 to discuss the development of 45-49 Warriewood Road, Warriewood. These notes are based on discussions at the prelodgement meeting and the following information provided to Council:

- A01 to A20, prepared by Archidrome, dated 23 May 2019.

Council has reviewed the information presented and acknowledges the additional justification provided during the prelodgement meeting. However, at this stage, Council is not in a position to support the proposal, largely due to:

- Duplication of internal roads and inconsistency with the *Warriewood Valley Roads Masterplan* with regard to the width of the road pavement and the road verges,
- Unsuitable dwelling design, and
- Insufficient landscaped treatment.

Generally, the proposal presents as an overdevelopment of the site, hitting the maximum dwelling yield without the incorporation of a residential flat building, being the housing typology anticipated with the higher yield.

Council also maintains concerns regarding the lack of information regarding the water management solution for the site, and the potential impacts upon the EEC. The size and design of the water management infrastructure will dictate the development potential/capacity of the site, and as such, the water management solution should be resolved as soon as possible.

APPENDIX E

STORMWATER MAINTENANCE SCHEDULE



MAINTENANCE SCHEDULE

FOR

**STORMWATER DRAINAGE, ON-SITE
STORMWATER DETENTION SYSTEMS AND
STORMWATER TREATMENT DEVICE**

45-49 WARRIEWOOD RD, WARRIEWOOD

REVISION B

MARCH 2020

PROPERTY DETAILS

Property Address: 45-49 Warriewood Rd, Warriewood

Development: Residential Development

DOCUMENT CERTIFICATION

Document prepared by:



EDWARD SHIN
Civil Engineer – Director
B.E.(Civil) , MIEAust, CPEng,
RPEQ, NER (Civil)

DISCLAIMER

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DOCUMENT CONTROL

REVISION	ISSUE DATE	ISSUED TO	ISSUED FOR
A	March 2020	Northern Beaches Council	DA Application

**MAINTENANCE SCHEDULE FOR STORMWATER DRAINAGE, ON-SITE
STORMWATER DETENTION SYSTEMS AND STORMWATER
TREATMENT DEVICE AT:**

45-49 WARRIEWOOD RD, WARRIEWOOD

INTRODUCTION

The following Maintenance Schedule has been prepared to provide advice to the owners, occupiers and strata manager of 45-49 Warriewood Rd, Warriewood, to assist them with maintaining the Stormwater Drainage, On-site Stormwater Detention System and Stormwater Treatment Device installed at this property to ensure the systems operates properly for a long term.

**DESCRIPTION OF STORMWATER DRAINAGE AND
ON-SITE STORMWATER DETENTION SYSTEM AT THIS SITE**

Stormwater at the site is collected by a system of roof drains, downpipes, grated drains and pits which direct stormwater away from the site.

The roof is drained via roof drains and downpipes. The ground/site areas are drained by a conventional drainage system consisting of a series of pits, pipes and subsoil drains.

All the pits have installed with 'Oceanguard'. Oceanguards will trap silt and debris that enter the stormwater system.

The drainage systems are connected to common on-site stormwater detention (OSD) system in a form of underground tank located under the main entry road.

The OSD system then discharge to an infiltration basin located on the southern side of Lorikeet Grove, where secondary treatment of runoff occurs before discharging to Narrabeen Creek. The system has been designed to remove the majority of the suspended sediments, nutrients and oils and hydrocarbons that may be present in the stormwater.

ROUTINE MAINTENANCE REQUIRED

To ensure the long-term working order of the stormwater drainage, on-site detention systems and water quality control devices, it is important that the systems are regularly inspected approximately every six (6) months AND after any heavy rainfall. If something looks extraordinary, you are not sure if it has been damaged or is working properly, then we recommend that you contact a Licensed Plumber to inspect the drainage system.

Important – The on-site stormwater detention tank and the pits are classified as a “Confined Space” in accordance with the Work Cover Authority of NSW Occupational Health & Safety Regulation 2001. Entry to the confined space must be conducted strictly in accordance with the requirements of “Division 9 – Working in Confined Spaces” of the Work Cover Authority of NSW Occupational Health & Safety Regulation 2001.

The checklist in Appendix C should be used for each maintenance. A copy of the completed checklist should be kept as a record of the maintenance work carried out.

APPENDIX A

CIVIL ENGINEERING DRAWINGS (WORK AS CONSTRUCTED)

(TO BE PROVIDED AFTER CONSTRUCTION)

APPENDIX B

OCEANGUARD OPERATIONS AND MAINTENANCE



OCEAN
P R O T E C T

OceanGuard™

Operations & Maintenance Manual

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Introduction

The primary purpose of stormwater treatment devices is to capture and prevent pollutants from entering waterways, maintenance is a critical component of ensuring the ongoing effectiveness of this process. The specific requirements and frequency for maintenance depends on the treatment device and pollutant load characteristics of each site. This manual has been designed to provide details on the cleaning and maintenance processes as recommended by the manufacturer.

The OceanGuard technology is a gully pit basket designed to fit within new and existing gully pits to remove pollution from stormwater runoff. The system has a choice of Filtration liners, designed to remove gross pollutants, total suspended solids and attached pollutants as either a standalone technology or as part of a treatment train with our StormFilter or Jellyfish Filtration products. OceanGuard pit baskets are highly effective, easy to install and simple to maintain.

Why do I need to perform maintenance?

Adhering to the maintenance schedule of each stormwater treatment device is essential to ensuring that it functions properly throughout its design life.

During each inspection and clean, details of the mass, volume and type of material that has been collected by the device should be recorded. This data will assist with the revision of future management plans and help determine maintenance interval frequency. It is also essential that qualified and experienced personnel carry out all maintenance (including inspections, recording and reporting) in a systematic manner.

Maintenance of your stormwater management system is essential to ensuring ongoing at-source control of stormwater pollution. Maintenance also helps prevent structural failures (e.g. prevents blocked outlets) and aesthetic failures (e.g. debris build up), but most of all ensures the long term effective operation of the OceanGuard.

Health and Safety

Access to pits containing an OceanGuard typically requires removing (heavy) access covers/grates, but typically it is not necessary to enter into a confined space. Pollutants collected by the OceanGuard will vary depending on the nature of your site. There is potential for these materials to be harmful. For example, sediments may contain heavy metals, carcinogenic substances or sharp objects such as broken glass and syringes. For these reasons, there should be no primary contact with the waste collect and all aspects of maintaining and cleaning your OceanGuard require careful adherence to Occupational Health and Safety (OH&S) guidelines.

It is important to note that the same level of care needs to be taken to ensure the safety of non-work personnel, as a result it may be necessary to employ traffic/pedestrian control measures when the device is situated in, or near areas with high vehicular/pedestrian activity.

Personnel health and safety

Whilst performing maintenance on the OceanGuard pit insert, precautions should be taken in order to minimise (or when possible prevent) contact with sediment and other captured pollutants by maintenance personnel. In order to achieve this the following personal protective equipment (PPE) is recommended:

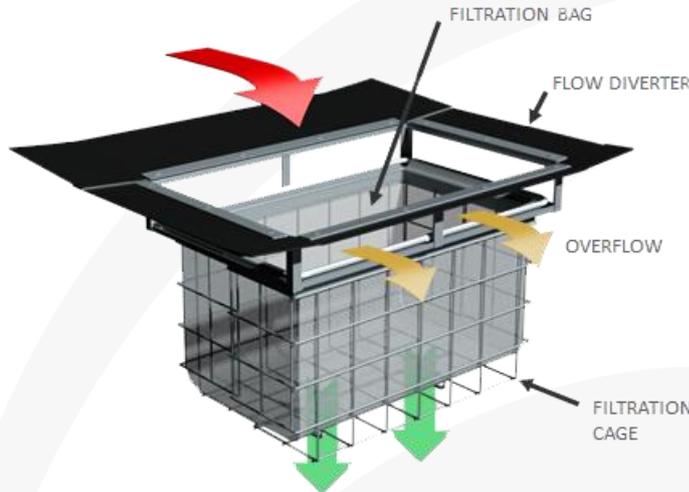
- Puncture resistant gloves
- Steel capped safety boots,
- Long sleeve clothing, overalls or similar skin protection
- Eye protection
- High visibility clothing or vest

During maintenance activities it may be necessary to implement traffic control measures. Ocean Protect recommend that a separate site specific traffic control plan is implemented as required to meet the relevant governing authority guidelines.

The OceanGuard pit insert is designed to be maintained from surface level, without the need to enter the pit. However depending on the installation configuration, location and site specific maintenance requirements it may be necessary to enter a confined space occasionally. It is recommended that all maintenance personnel evaluate their own needs for confined space entry and compliance with relevant industry regulations and guidelines. Ocean Protect maintenance personnel are fully trained and carry certification for confined space entry.

How does it Work?

OceanGuard is designed to intercept stormwater as it enters the stormwater pits throughout a site. The OceanGuard has diversion panels that sit flush with the pit walls, this ensures that as stormwater enters at the top of the pit it is directed to the middle of the insert where the Filtration bag is situated. The filtration bag allows for screening to occur removing 100% of pollutants greater than the opening of the filtration material (200micron, 1600micron bags available).



During larger rain events the large flows overflow slots in the flow diverter of the OceanGuard ensure that the conveyance of stormwater is not impeded thus eliminating the potential for surface flooding. As the flow subsides, the captured pollutants are held in the OceanGuard Filtration bag dry. The waste then starts to dry which reduces the magnitude of organic material decomposition transitioning between maintenance intervals.

Maintenance Procedures

To ensure that each OceanGuard pit insert achieves optimal performance, it is advisable that regular maintenance is performed. Typically the OceanGuard requires 2-4 minor services annually, pending the outcome of these inspections additional maintenance servicing may be required.

Primary Types of Maintenance

The table below outlines the primary types of maintenance activities that typically take place as part of an ongoing maintenance schedule for the OceanGuard.

	Description of Typical Activities	Frequency
Minor Service	Filter bag inspection and evaluation Removal of capture pollutants Disposal of material	2-4 Times Annually
Major Service	Filter Bag Replacement Support frame rectification	As required

Maintenance requirements and frequencies are dependent on the pollutant load characteristics of each site. The frequencies provided in this document represent what the manufacturer considers to be best practice to ensure the continuing operation of the device is in line with the original design specification.

Minor Service

This service is designed to return the OceanGuard device back to optimal operating performance. This type of service can be undertaken either by hand or with the assistance of a Vacuum unit.

Hand Maintenance

1. Establish a safe working area around the pit insert
2. Remove access cover/grate
3. Use two lifting hooks to remove the filtration bag
4. Empty the contents of the filtration bag into a disposal container
5. Inspect and evaluate the filtration bag
6. Inspect and evaluate remaining OceanGuard components (i.e. flow diverter, filtration cage and supporting frame)
7. Rejuvenate filtration bag by removing pollutant build up with a stiff brush, additionally the filtration bag can be washed using high pressure water
8. Re-install filtration bag and replace access cover/grate

Vacuum Maintenance

1. Establish a safe working area around the pit insert
2. Remove access cover/grate
3. Vacuum captured pollutants from the filtration bag
4. Remove filtration bag
5. Inspect and evaluate the filtration bag
6. Inspect and evaluate remaining OceanGuard components (i.e. flow diverter, filtration cage and supporting frame)
7. Rejuvenate filtration bag by removing pollutant build up with a stiff brush, additionally the filtration bag can be washed using high pressure water
8. Re-install filtration bag and replace access cover/grate

Major Service (Filter Bag Replacement)

For the OceanGuard system, a major service is a reactionary process based on the outcomes from the minor service.

Trigger Event from Minor Service	Maintenance Action
Filtration bag inspection reveals damage	Replace the filtration bag ^[1]
Component inspection reveals damage	Perform rectification works and if necessary replace components ^[1]

[1] Replacement filtration bags and components are available for purchase from Ocean Protect.

Additional Reasons of Maintenance

Occasionally, events on site can make it necessary to perform additional maintenance to ensure the continuing performance of the device.

Hazardous Material Spill

If there is a spill event on site, all OceanGuard pits that potentially received flow should be inspected and cleaned. Specifically all captured pollutants from within the filtration bag should be removed and disposed in accordance with any additional requirements that may relate to the type of spill event. All filtration bags should be rejuvenated (replaced if required) and re-installed.

Blockages

The OceanGuards internal high flow bypass functionality is designed to minimise the potential of blockages/flooding. In the unlikely event that flooding occurs around the stormwater pit the following steps should be undertaken to assist in diagnosing the issue and implementing the appropriate response.

1. Inspect the OceanGuard flow diverter, ensuring that they are free of debris and pollutants
2. Perform a minor service on the OceanGuard
3. Remove the OceanGuard insert to access the pit and inspect both the inlet and outlet pipes, ensuring they are free of debris and pollutants

Major Storms and Flooding

In addition to the scheduled activities, it is important to inspect the condition of the OceanGuard pit insert after a major storm event. The inspection should focus on checking for damage and higher than normal sediment accumulation that may result from localised erosion. Where necessary damaged components should be replaced and accumulated pollutants disposed.

Disposal of Waste Materials

The accumulated pollutants found in the OceanGuard must be handled and disposed of in a manner that is in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. If the filtration bag has been contaminated with any unusual substance, there may be additional special handling and disposal methods required to comply with relevant government/authority/industry regulations.

Maintenance Services

With over a decade and a half of maintenance experience Ocean Protect has developed a systematic approach to inspecting, cleaning and maintaining a wide variety of stormwater treatment devices. Our fully trained and professional staff are familiar with the characteristics of each type of system, and the processes required to ensure its optimal performance.

Ocean Protect has several stormwater maintenance service options available to help ensure that your stormwater device functions properly throughout its design life. In the case of our OceanGuard system we offer long term pay-as-you-go contracts, pre-paid once off servicing and replacement filter bags.

For more information please visit www.OceanProtect.com.au

APPENDIX C

STORMWATER DRAINAGE MAINTENANCE CHECKLIST

STORMWATER DRAINAGE MAINTENANCE CHECKLIST
(COPY AND COMPLETE THIS CHECKLIST FOR EVERY MAINTENANCE CHECK –
KEEP A COPY OF THE COMPLETED CHECKLIST ON FILE AS A RECORD OF MAINTENANCE)

Location: 45-49 Warriewood Rd, Warriewood

Inspected By: _____

Date of Visit: _____

Estimated Time Since Last Inspection: _____ (Months)

Weather Conditions: _____

INSPECTION ITEM	Frequency	Responsibility	ACTION REQUIRED			ACTION COMPLETED BY	
			Y	N	DETAILS	SIGNATURE	DATE
<u>Stormwater Pits</u>							
Is litter or debris present within the pit?	6 Monthly or after a major storm	Owner / Maintenance Contractor			Remove litter and debris and dispose of lawfully		
Is the grate/cover fixed correctly to the stormwater pit?	6 Monthly or after a major storm	Owner / Maintenance Contractor			Repair fixings		
Is the grate/cover damaged?	6 Monthly or after a major storm	Owner / Maintenance Contractor			Replace or repair grate/cover		

INSPECTION ITEM	Frequency	Responsibility	ACTION REQUIRED			ACTION COMPLETED BY	
			Y	N	DETAILS	SIGNATURE	DATE
<u>On-site Stormwater Detention System(s)</u>							
Check that all detention areas and/or structures are clear of any debris and leaf litter.	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean as required		
Check that all grates are clear of any debris and leaf litter	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean as required		
Remove screen over the outlet and ensure that there is no blockage or damage to the steel orifice plate	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean and repair as required		
Remove screen over the outlet and ensure that the orifice plate is mounted securely	6 Monthly or after a major storm	Owner / Maintenance Contractor			Tighten fixings and seal any gaps as required		
Inspect screen for damage and corrosion or rusting, clean screen and re-install ensuring that the screen is correctly positioned and secure	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean, repair and replace screen as required		

INSPECTION ITEM	Frequency	Responsibility	ACTION REQUIRED			ACTION COMPLETED BY	
			Y	N	DETAILS	SIGNATURE	DATE
Inspect the weir ensure that it is clear of any debris and leaf litter	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean as required		
Inspect the discharge control pit walls for any cracking or spalling	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean and repair as required		
Inspect the outlet pipe from the discharge control pit (behind the orifice plate)	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean and remove any blockage as required		
Inspect step irons for corrosion or rusting	6 Monthly or after a major storm	Owner / Maintenance Contractor			Repair and replace as required		
Inspect step irons to see if fixings are secure	6 Monthly or after a major storm	Owner / Maintenance Contractor			Repair and replace as required		
Inspect the return pit or storage walls for any cracking or spalling and sediment or sludge build-up	6 Monthly or after a major storm	Owner / Maintenance Contractor			Clean and repair as required		
Inspect storages for subsidence (especially near pits or grates)	6 Monthly or after a major storm	Owner / Maintenance Contractor			Repair as required		
Inspect and test pumps in rainwater holding component of the tank to ensure they are working correctly and service as required	6 Monthly or after a major storm	Owner / Maintenance Contractor			Remove any silt, litter or debris from around the pump inlet		

INSPECTION ITEM	Frequency	Responsibility	ACTION REQUIRED			ACTION COMPLETED BY	
			Y	N	DETAILS	SIGNATURE	DATE
<u>Infiltration System</u>							
Inspect headwall (at the basin inlets) for litter and debris	6 Monthly or after a major storm	Maintenance Contractor			Remove litter and debris and dispose of lawfully		
Inspect rock rip-rap and scour protection at headwalls to ensure that rocks have not been displaced	6 Monthly or after a major storm	Maintenance Contractor			Replace and reset rocks as required		
Inspect infiltration basin spillway to ensure that the rocks have not been displaced	6 Monthly or after a major storm	Maintenance Contractor			Replace and reset rocks as required		
Inspect for sediment build up on the surface of the basin that may be preventing filtration or plant growth	6 Monthly or after a major storm	Maintenance Contractor			Remove the sediment as required and dispose of lawfully		
Inspect for erosion of the basin surface	6 Monthly or after a major storm	Maintenance Contractor			Replace eroded material and replant as required		
Inspect for damaged or dead plants	6 Monthly or after a major storm	Maintenance Contractor			Remove and replant as required		

INSPECTION ITEM	Frequency	Responsibility	ACTION REQUIRED			ACTION COMPLETED BY	
			Y	N	DETAILS	SIGNATURE	DATE
Inspect for weeds	6 Monthly or after a major storm	Maintenance Contractor			Remove as required		
Inspect for overgrown vegetation that may tend to clog the filter media,	6 Monthly or after a major storm	Maintenance Contractor			Mow or slash grass and vegetation as required		
<u>Comments or Recommendations</u>							