12 April 2019

Qasabian Family Investments Pty Ltd
63 Dareen Street
Frenchs Forest NSW 2086

c/o schotty81@y7mail.com

Project Reference: **19043**
Project Location: **312 Warringah Road, Frenchs Forest**
Project Details: **Proposed 1 into 5 lot subdivision**

Stormwater management plan for the proposed 1 into 5 lot subdivision

1.0 Executive Summary

GZ Engineers was engaged to assess the proposed new 1 into 5 lot subdivision development at 312 Warringah Road, Frenchs Forest in reference to stormwater quantity and quality.

The stormwater development works propose:

- Construction of 15kL litres of underground rainwater storage (3kL per lot).
- Creation and construction of a proposed easement to drain water in favour of the proposed development through 61 Dareen Street discharging into Council's sub-surface stormwater system.
- Surface drainage for each lot (each containing a 3kL underground rainwater tank) all connected to a single on-site detention (OSD) system located at the rear of the site within the boundary of proposed Lot 3.
- Construction of an 80kL on-site detention (OSD) system with a high early discharge (HED) arrangement, and associated stormwater quality improvement devices (OCEAN PROTECT Stormfilter cartridges and pit baskets).

Stormwater Quantity and Conveyance

The development is serviced by a series of pits and pipes connected to a combined OSD system located at the rear of the site within the boundaries of proposed Lot 3. The OSD discharge is piped to council's stormwater system in Dareen Street below through a proposed easement to drain water over 61 Dareen Street. An overflow weir is provided within the OSD allowing for a safe overflow into the piped drainage which is sized to convey a 1% annual exceedance period (AEP) event for the sites.

The proposed development's stormwater system and disposal philosophy is consistent with Northern Beaches Council (formerly Warringah Council) – *"On-site Stormwater Technical Specification, s4.2.3 Full Computational Method".* In this regard, the post-development peak stormwater discharge:

- flow does not exceed the pre-development peak discharge for events to the 0.5 EY event,
- piped flow is restricted to the 0.2 EY event state of nature case for flows up to the 1% AEP event, and;
- piped and overland flow is restricted to the pre-developed state of nature case for events up to the 1% AEP event.

Stormwater Quality

The following stormwater quality improvement devices (SQIDs) are proposed for the development

- 4 off OCEAN PROTECT 690mm PSorb cartridges located within the OSD system
- 5 off OCEAN PROTECT Enviropod pit baskets located in the boundary pit for each lot

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- Five 3kL rainwater tanks (one per lot) each connected to toilets for flushing, cold clothes machine washers and one outdoor tap (min) in accordance with BASIX commitments.

The proposed stormwater quality improvement strategy was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software package and has been prepared in accordance with the following documents:

- Northern Beaches Council (Warringah) PL 850 WATER – *"Water Management Policy (2017)"*
- Northern Beaches Council – *"WSUD & MUSIC Modelling Guidelines"*

The proposed stormwater management plan as described in this report and the attached plans (Appendix B) is recommended as a safe a practical stormwater solution to support the proposed development.

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2.0 Introduction

GZ Engineers was engaged to assess the proposed new 1 into 5 lot subdivision development at 312 Warringah Road, Frenchs Forest in reference to stormwater quantity and quality.

The purpose of this report and supporting drawings is to provide a summary of the proposed stormwater systems and show feasibility of the proposed development with regard to on-site stormwater management. The design is not intended as a detailed construction document.

3.0 Existing Development

Lot 100, DP 592389 known as 312 Warringah Road consists of a single 3,218.2 m^2 trapezoidal lot. Current development on the lot consists of sediment and erosion control measures with no existing buildings.

4.0 Proposed Development

The proposed works are shown in the architectural drawings prepared by Alvaro Architects, (refer Appendix A).

The development proposes subdivision of the land (1 into 5), construction of five residential dwellings (one per lot) and associated driveway access from Warringah Road.

5.0 Stormwater Management Plan

5.1 Performance Criteria

The proposed development's stormwater system and disposal philosophy is consistent with Northern Beaches Council (formerly Warringah Council) – *"On-site Stormwater Technical Specification, s4.2.3 Full Computational Method" PL850 Table 4 (Hydrology)*. In this regard:

- the post-development peak discharge flow must not exceed the pre-development peak discharge for flows up to the 0.5 EY rain event,
- peak piped stormwater flows from the development are restricted to the 0.2 EY rain event state of nature case for all storms up to and including the 1% AEP rain event, and;
- peak stormwater discharge from the site (piped and overland) is restricted to the pre-developed state of nature case for all storms up to and including the 1% AEP rain event.

Drainage components for the site have been sized and designed in accordance with Table 1.

Table 1 - Design rain event for drainage components

Drainage Component	Design Rain Event
Roof drainage system	Not part of this design
On-site detention (OSD) system	1% AEP
Pits and pipes draining to the OSD	1% AEP
Channels, culverts and overflow paths	1% AEP

5.2 Existing Stormwater System

No existing stormwater infrastructure was observed during a site visit. This site has been cleared with minor erosion and sedimentation measures in place supporting the clearing of the land.

5.3 Proposed stormwater system

The stormwater development works propose:

- Construction of a 15kL underground rainwater storage (3kL per lot).
- Creation and construction of a proposed easement to drain water in favour of the proposed development through 61 Dareen Street discharging into Council's sub-surface stormwater system in Dareen Street.
- Surface drainage for each lot and driveway access, connected to a single on-site detention (OSD) system located at the rear of the site within the boundaries of proposed Lot 3.

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- Construction of an 80kL on-site detention (OSD) system with a high early discharge (HED) arrangement, and associated stormwater quality improvement devices (OCEAN PROTECT Stormfilter cartridges)

The proposed stormwater management plan is attached in Appendix B.

5.4 OSD Design and Modelling

The proposed stormwater system was designed using DRAINS Hydrologic and Hydraulic Urban Catchment modelling. Rainfall data was derived from BOM IFD based on latitude/longitude for the site. The following design parameters were adopted:

- soil type = 2.5
- antecedent moisture content, AMC = 3
- infiltration rates: initial paved = 1 mm, grassed = 5 mm
- hardstand areas retardance coefficient 'n': 0.012
- pervious areas retardance coefficient 'n': 0.15 (sparse vegetation)

The design process undertaken for this project within DRAINS is outlined below:

1. Determine pre-development peak flows for 20% and 1%AEP rain events
2. Match pre and post development 20% and 1%AEP peak flows by adjusting the OSD arrangement
3. Check 5%AEP rainfall events to ensure compliance
4. Check piped flow from the OSD < 20%AEP pre-developed peak flow for the site
5. Check post-development peak discharge is less than or equal to pre-development peak discharge for flows up to the 50% AEP.

Development Catchment Area

Refer to DR-101 (Appendix B) for a post-development catchment plan catchment. The catchment areas are summarised below.

"State of Nature"

- The state of nature case for the site was modelled as:
    a. Bushland 3,217m^2 (100% pervious)
- Catchment slopes and flow path lengths were determined from survey data

Pre-Development

- Existing land has been cleared, modelled as "State of Nature"

Post-Development

- The post-development case was modelled as:
    a. OSD bypass 264m^2 (100% pervious)
    b. Development to OSD 2952m2 (66% impervious)
- Catchment slopes and flow path lengths were determined from architectural plans and survey data

5.5 Results

The properties of the final OSD system modelled that met the performance criteria outlined in s5.1 is shown in Figure 1 below. The storage vs. elevation graph for the system is shown in Figure 2.

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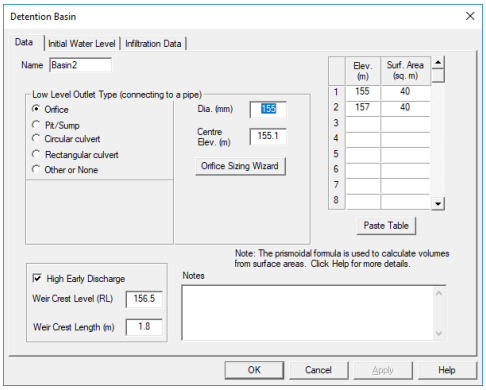

Figure 1 – OSD modelling properties (DRAINS)

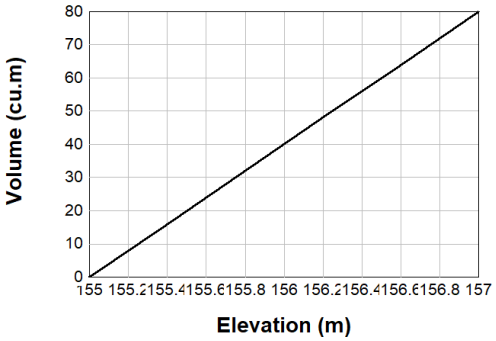

Figure 2 – Storage vs. elevation for the proposed OSD

The runoff from the site after development will not exceed the runoff from the total site prior to the development, for the modelled durations during 0.2 EY, 5% AEP and 1% AEP storm events as described in Table 2.

Table 2 – State of nature and post-development peak flows

RAIN EVENT	STATE OF NATURE	POST-DEVELOPMENT		
	100% PERVIOUS (l/s)	IMPERVIOUS FROM OSD - PIPED (l/s)	BYPASS - PIPED (l/s)	TOTAL (l/s)
0.2 EY	87	61	7	68
5% AEP	140	62	12	74
1% AEP	186	63	15	78

Additionally, post-development peak discharge was checked for the 0.5 EY storm event in accordance the hydrology requirement of NBC PL 850 – Table 4 - General Stormwater Quality Requirements. Table 3 demonstrates that during the 0.5 EY stormwater the post-development peak discharge does not exceed the pre-development peak discharge.

Table 3 – Pre-development and post-development peak flow check for water quality (0.5EY rain event)

RAIN EVENT	PRE-DEVELOPMENT	POST-DEVELOPMENT		
	100% PERVIOUS (l/s)	OSD - PIPED (l/s)	BYPASS - PIPED (l/s)	TOTAL (l/s)
0.5 EY	66	61	5	66

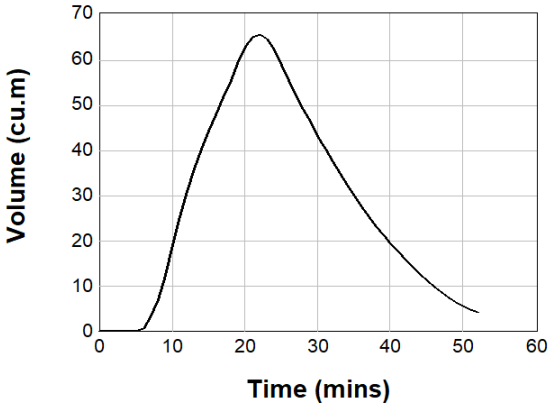

Figure 3 – Storage Volume, 1% AEP, 20min burst, Storm 2

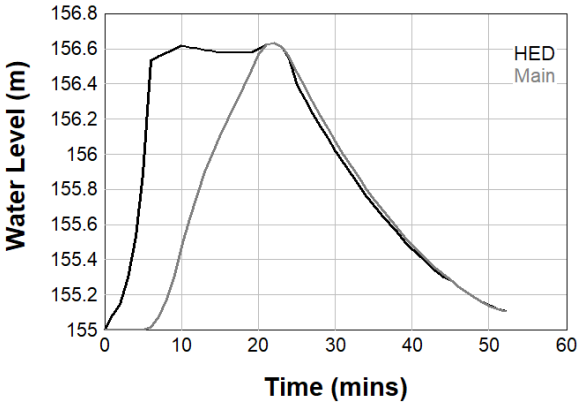

Figure 4 – Water Level, 1% AEP, 20min burst, Storm 2

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Figure 3 and Figure 4 above show the peak storage volume and water level during the 1% AEP critical storm event. Additionally, these figures demonstrate that the proposed OSD system is sufficiently sized so as not to overflow during the 1% AEP critical storm event.

The proposed OSD system meets the performance criteria outlined in s5.1 and is described in the stormwater drawings, refer Appendix B.

6.0 Stormwater Quality

6.1 Performance Criteria

The proposed Water Quality Management Strategy has been designed in accordance with Northern Beaches Council (Warringah) PL 850 WATER – Water Management Policy (2017) including:

- 90% reduction in the post development mean annual load of Gross Pollutants
- 85% reduction in the post development mean annual load of Total Suspended Solids (TSS)
- 65% reduction in the post development mean annual load of Total Phosphorus (TP)
- 45% reduction in the post development mean annual load of Total Nitrogen (TN)

7.0 Proposed development and WSUD Measures

Details of the proposed development are outlined above in **Error! Reference source not found.**.

The following stormwater quality improvement devices (SQIDs) are proposed and located within the OSD system:

- 4 off OCEAN PROTECT 690mm PSorb cartridges
- 5 off OCEAN PROTECT Enviropod pit baskets (1 per lot)
- 15kL rainwater storage (3kL per lot)

7.1 Performance of Proposed Strategy

Conceptual water quality modelling using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6.3.0 was undertaken to estimate the effectiveness of the proposed stormwater management strategy at removing pollutants, particularly sediment, phosphorous and nitrogen, over the long term.

The procedures and assumptions outlined Northern Beaches Council (NBC) *"WSUD & MUSIC Modelling Guidelines"* have been followed in the preparation of MUSIC modelling for this site including the use of the following:

- Continuous rainfall data (6 minute) from Sydney Rainfall Station (Bureau of Meteorology station no. 66062)
- Recommended settings by NBC "*WSUD & MUSIC Modelling Guidelines"* for:
    a. Average Monthly Potential Evapotranspiration (PET)
    b. Rainfall-Runoff Parameters and Pollutant Generation Parameters
    c. MUSIC source nodes

7.2 Model Configuration

Figure 5 shows the setup and layout of the MUSIC model for the proposed stormwater treatment measures.

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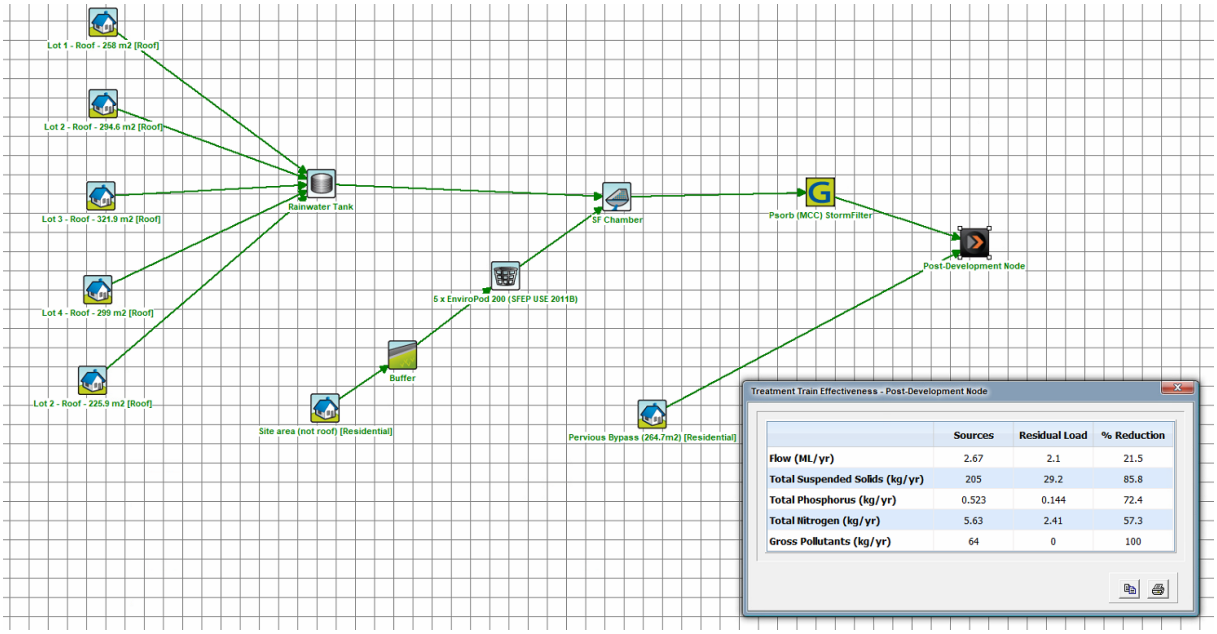

Figure 5 - MUSIC model configuration

7.3 Results

The MUSIC model results showed that the proposed Water Quality Management Strategy provides a reduction in post development loads of Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants by 85.8%, 72.4%, 57.3% and 100% respectively (see Table 4).

This exceeds Council's pollution reduction targets outlined in NBC PL850 Water.

Table 4 - Effectiveness of Proposed Water Quality Management Scheme

Pollutant	Generated by development	Residual load	Reduction (%)
Total Suspended Solids (kg/yr)	205	29.2	85.8
Total Phosphorus (kg/yr)	0.523	0.144	72.4
Total Nitrogen (kg/yr)	5.63	2.41	57.3
Gross Pollutants (kg/yr)	64	0	100

7.4 Operation and Maintenance Plan

Refer to Appendix C.

7.5 Findings and Recommendations

MUSIC modelling was used to assess the performance of the Water Quality Management Strategy for the proposed development at 312 Warringah Road

The proposed scheme includes Ocean Protect Enviropods (pit baskets) located in each lots boundary pit, PSorb Stormfilter cartridges located in the OSD system and 15,000 litres rainwater storage (total).

The MUSIC model results showed that the proposed Water Quality Management Strategy can achieve Council's pollution reduction targets.

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8.0 Conclusion

Stormwater Quantity and Conveyance

The proposed development's stormwater system and disposal philosophy is consistent with Northern Beaches Council (formerly Warringah Council) – *"On-site Stormwater Technical Specification, s4.2.3 Full Computational Method".* In this regard the post-development peak stormwater discharge:

- does not exceed the pre-development peak discharge for flows up to the 0.5 EY rain event,
- piped flow is restricted to the 0.2 EY rain event state of nature case for flows up to the 1% AEP rain event, and;
- piped and overland flow is restricted to the pre-developed state of nature case for flows up to the 1% AEP rain event.

Stormwater Quality

The proposed stormwater quality improvement strategy was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software package and has been prepared in accordance with the following documents:

- Northern Beaches Council (Warringah) PL 850 WATER – *"Water Management Policy (2017)"*
- Northern Beaches Council – *"WSUD & MUSIC Modelling Guidelines"*

The proposed Water Quality Management Strategy provides a reduction in post development loads of Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants by 85.8%, 72.4%, 57.3% and 100% respectively when compared to no treatment measures. The MUSIC model results showed that the proposed stormwater quality improvements measures can achieve Council's pollution reduction targets outlined in PL850.

The proposed stormwater management plan as described in this report and the attached plans (Appendix B) is recommended as a safe a practical stormwater solution to support the proposed development.

Please contact me if you have any questions regarding this report.

Kind regards,

Author	**Reviewed**
Logan English-Smith **Engineer**	Ian Warren **Principal Engineer (NER 3705882)**

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REFERENCES

Northern Beaches Council (formerly Warringah Council) – *"On-site Stormwater Technical Specification"*

Northern Beaches Council (formerly Warringah Council) – *"PL-850 Water Management Policy"*

Northern Beaches Council (formerly Warringah Council) – *"WSUD & MUSIC Modelling Guidelines"*

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Appendix A

Architectural Plans
by Alvaro Architects

Drg #	Title	Rev	Date
000	COVER SHEET & STREET ELEVATION	H	-
100	SITE ANALYSIS	A	-
101	SITE PLAN	G	-
301	ELEVATIONS	A	-
302	INTERNAL ELEVATIONS & DRIVEWAY SECTION	A	-
401	22 JUNE SHADOW DIAGRAMS	B	-
SUB101	DRAFT SUBDIVISION PLAN	C	-

Table 5 - Architectural Plans

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Appendix B

Stormwater Management Plan
by GZ Engineers

Drg #	Title	Rev	Date
DR-000	LEGEND	0	12.04.2019
DR-001	PIPE LAYOUT – WARRINGAH ROAD	0	12.04.2019
DR-002	PIPE LAYOUT – DEREEN STREET	0	12.04.2019
DR-100	OSD DETAILS	0	12.04.2019
DR-101	CATCHMENT PLAN & OSD DETAILS	0	12.04.2019

Table 6 – Stormwater Management Plans

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Appendix C

WSUD Operation and Maintenance Plan

Site description

312 Warringah Road, Frenchs Forest

Subdivision of the land (1 into 5) and construction of 5 residential dwellings and associated site access.

Site access description

Access from Warringah Road

Likely pollutant types, sources and estimated loads

Stormwater contains both particulate and dissolved or liquid pollutants. Particulate pollutants include litter, debris, and sediment or soil particles. Dissolved and liquid pollutants include oils, nutrients, toxic chemicals such as pesticides and heavy metals. To remove these pollutants a “treatment train” is used. This requires:

- Particulate pollutants to be removed by interception and sedimentation (i.e. pit baskets, gross pollutant trap, OCEAN PROTECT Stormfilter media.)
- Dissolved particulates to be removed through chemical and biological processes (i.e. SW 360 Stormfilter media)

Locations, types and descriptions of measures proposed:

Refer to attached stormwater management plan (Appendix B)

Operation and maintenance responsibility (council, developer or owner)

At this stage it is envisaged that on-site WSUD measures would be maintained by the Developer and/or Owner

Inspection methods

Visual inspection – both routine and inspection after large rain events to check for blockages.

Maintenance Schedule

Refer schedule below and in addition, inspection of system elements will also be required after large rain events to check for blockages.

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Item	Maintenance	
	Description	Frequency
OSD	Inspect and clean inlet screen	1/six months
	Inspect base of tank and remove sediment/sludge	1/annum
	Inspect and test pumps	1/six months
SW 360 Enviropod (pit baskets)	Inspect for blockages	1/quarter
	Clean out enviropods	1/six months
StormFilters (maintenance by Stormwater 360 or equivalent Contractor)	Inspect for blockages	1/quarter
	Clean and replace cartridges	1/annum
Rainwater Tanks + First Flush Diverter	Inspect and clean inlet screens	1/six months
	Inspect base of tank and remove sediment/sludge	1/annum

Table 7: Maintenance schedule for proposed WSUD measures.

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