CRAIG& RHODES

TAKE THE LEAD

Overland Flow Impact Assessment

Proposed Residential Subdivision
53A Warriewood Rd, Warriewood

Prepared for: PVD No.21 PTY LTD

Date: July 2021

Our Reference: 434-20

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Contents

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1 Background

Craig & Rhodes has been engaged by PVD No.21 Pty Ltd to undertake a Flood Impact Assessment to accompany the Development Application for the proposed development of Lot 2 DP1115877 at 53A Warriewood Rd, Warriewood (the subject Site).

The Flood Impact Assessment includes determination of the peak flood levels and overland flood behaviour for the 50%, 20%, 1%, 1% with climate change and PMF Annual Exceedance Probability (AEP) design events. Flood impacts associated with the proposed subdivision are identified and assessed in accordance with Council's flood policies.

This report provides a summary of the analysis and results. A full set of concept engineering drawings prepared by Craig & Rhodes is included with this report and DA submission.

2 Study Area

The locality of the Site is shown in Figure 1. The Site is located north of Sydney within the Local Government Area (LGA) of Northern Beaches Council. The proposed development is located within the Narrabeen Creek catchment on one allotment, totalling approximately 0.93 ha in size. The proposed development involves the demolition of existing Site structures, subdivision into a total of 22 community residential lots and accessway, extension of new public road, provision for one temporary on-site detentions (OSD), and associated cut and fill to create developable residential lots.

Figure 1 – 53A Warriewood Rd, Warriewood LOCALITY

3 Methodology

Existing “Ingleside, Elanora and Warriewood Overland Flow Flood Study” report and models were obtained from the Northern Beach Council which is the most up-to-date flood study in the area. The model is based on separate Hydrologic model (DRAINS) and Hydraulic model (TUFLOW). Australian Rainfall and Runoff (AR&R) 1987 was used for the above modelling study.

In the study for the following report, the obtained models were first trimmed for the Narrabeen catchment to include the Site and respective upstream and downstream sub-catchments. Then the models were updated in accordance with AR&R 2019. The models then were used to simulate both existing and proposed development scenarios. The details of hydrologic and hydraulic models are explained in the next sections.

4 Hydrological Model

4.1 Existing Conditions

The existing DRAINS model was trimmed for the Narrabeen catchment and then was updated based on AR&R 2019. The trimmed model covers an area of 254.4 ha. Five AEPs were modelled including 50%, 20%, 1%, 1% with climate change and PMF. For the climate change scenario, 30% was added to the 1% AEP rainfalls. Generalised Short Duration Method (GSDM) was used for developing the PMP rainfalls. A range of durations from 20 minutes to 270 minutes were modelled. For each AEP, excluding PMF, ten temporal patterns were modelled. The flow rates (runoffs) were generated from the model as TS1 files for inputs into the hydraulic model.

4.2 Proposed Development Scenario

The catchment properties were updated based on the proposed developed scenario for the Site catchment in the DRAINS model. The model was then run for all the modelled AEPs, durations and the temporal patterns. The flow rates were generated for the hydraulic model.

5 Hydraulic Model

5.1 Model Development

The trimmed TUFLOW model covers an effective area of approximately 254.4 ha, similar to the Hydrologic model. The boundary of the hydraulic model is presented in Figure 2. The catchment contributing to overland flow for the Site has an area of approximately 208 ha. The flow boundary conditions generated by the DRAINS model were specified. The downstream boundary was defined as a HQ (height-discharge) series with a 0.002 slope. All 1D networks from the existing TUFLOW model within the trimmed area were retained.

The TUFLOW with a 4 m grid was run to identify the critical storm duration and temporal pattern for the modelled AEP events at the Site. The summary of the results including the critical duration and temporal pattern are presented in Table 1 and Figures 3 to 7.

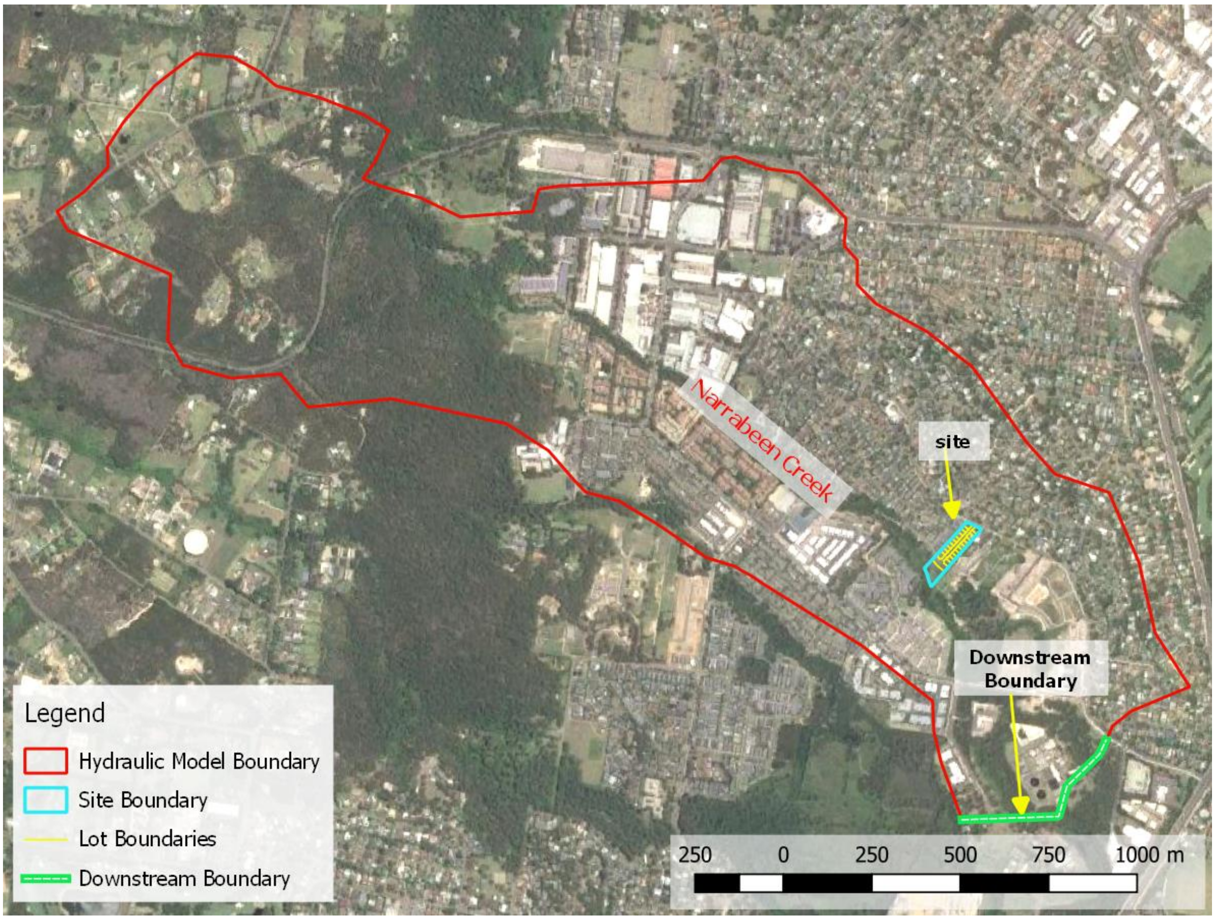

Figure 2 – Hydraulic Model Boundary

Table 1: Modelled AEPs and durations and selected durations and temporal patterns

AEP	Durations Modelled (minutes)	Critical Duration (minutes)	Median Temporal Pattern
50%	20, 30, 45, 60, 90, 120, 180, 270	60	6
20%	20, 30, 45, 60, 90, 120, 180, 270	45	8
1%	20, 30, 45, 60, 90, 120, 180	45	2
1% with Climate Change	20, 30, 45, 60, 90, 120, 180	45	8
PMF	20, 30, 45, 60, 90, 120, 180	45	-

Two scenarios were modelled to compare the flood behaviour under existing and proposed development conditions. For each AEP, the critical duration identified in this section (Table 1) were modelled. The details of the existing and proposed condition are presented in the following sections.

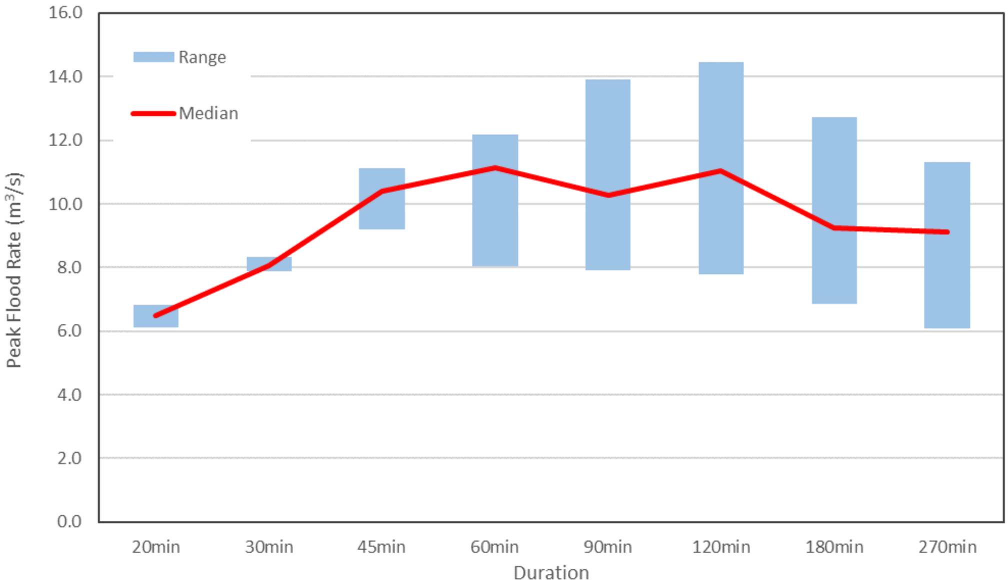

Figure 3: Peak flood rate at Site for various duration and temporal patterns (50% AEP)

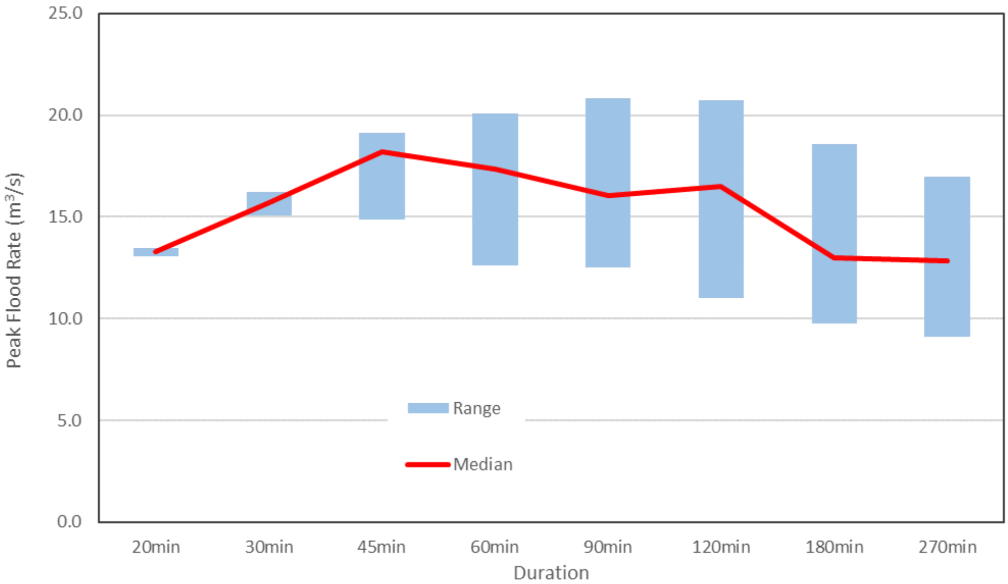

Figure 4: Peak flood rate at Site for various duration and temporal patterns (20% AEP)

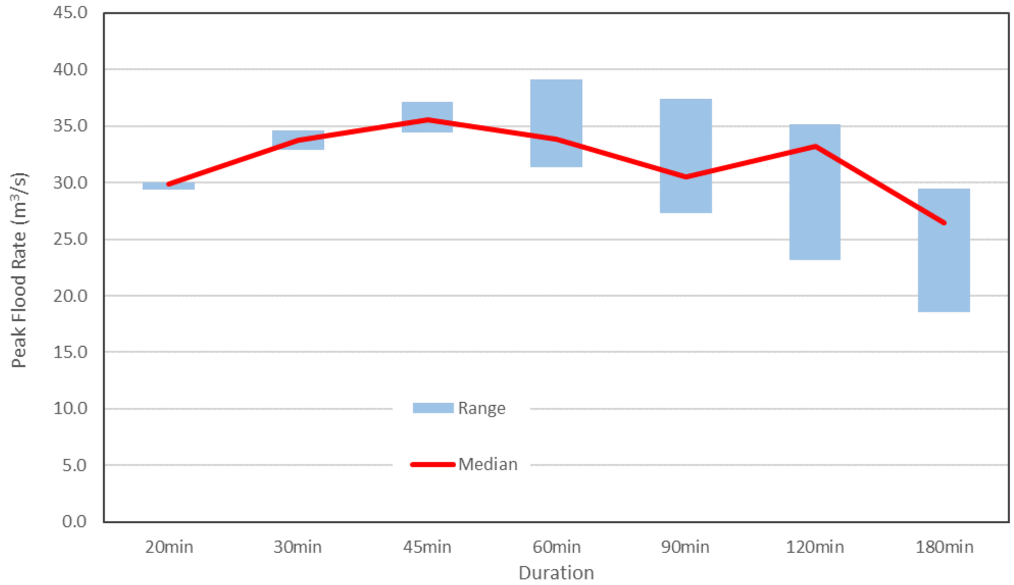

Figure 5: Peak flood rate at Site for various duration and temporal patterns (1% AEP)

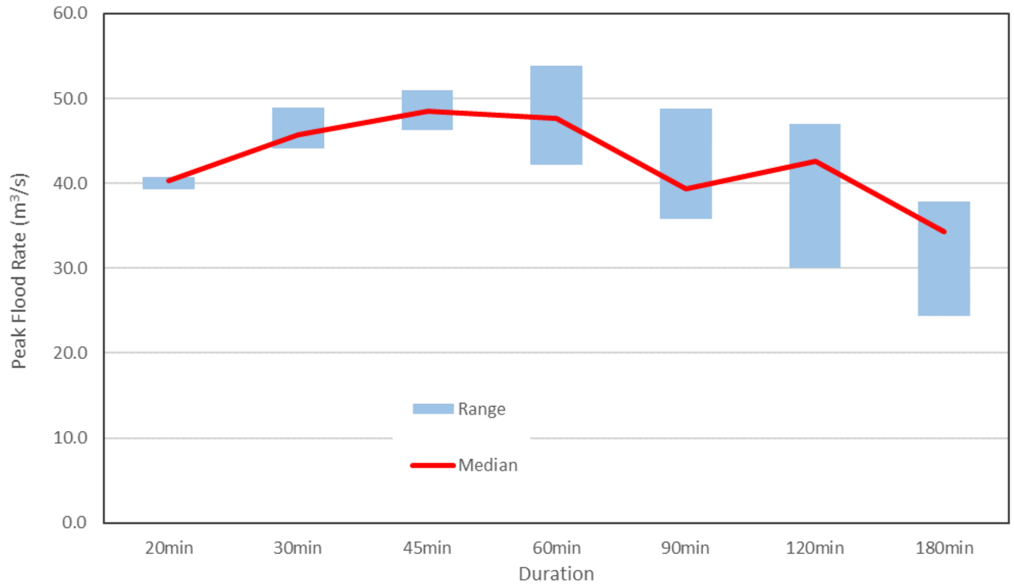

Figure 6: Peak flood rate at Site for various duration and temporal patterns (1% AEP with climate change)

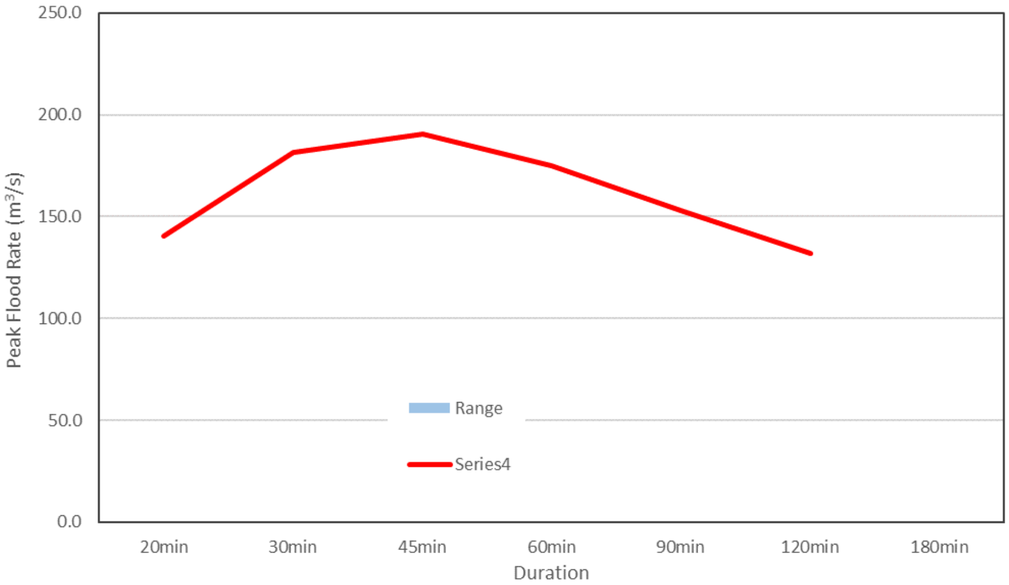

Figure 7: Peak flood rate at Site for various durations (PMF)

5.2 Existing Conditions

To better represent the existing conditions at the proposed development Site, the surveyed Digital Elevation Model (DEM) of the proposed Site and the neighbouring Site located at the south-east side of the Site were added to the model. Manning's n values were also specified to include various land use types in the modelling area. The n values used in the existing council TUFLOW model were adopted. The adopted Manning's n values are shown in Table 2. Additional details, including the final DEM for the existing Site, are included in Appendix Figure A1.

Table 2: Adopted hydraulic roughness coefficients.

Material	Manning's n values
Default	0.05
Roads/Pavements	0.025
Light Vegetation/Grass/Field	0.04
Medium Vegetation/Light	0.07
Heavy Vegetation/Light	0.1
Residential low density	0.05
Residential high density	0.05
Industrial/Commercial	0.03
Lake or estuary/ocean	0.03
Concrete-lined channel	0.02
Waterway/channels minimal vegetation	0.03
Waterway/channels vegetated	0.07

5.3 Proposed Development Scenario

The TUFLOW DEM at the development Site was modified to represent the proposed development conditions. This was specified using the design ground surfaces for the proposed subdivision (file reference: *434-20 Design DEM 100mm Cells updated 01 07 2021*) prepared by Craig and Rhodes (2021).

The proposed subdivision includes provision of a stormwater drainage network. The drainage network will be connected to the proposed detention and water quality basin. Details of the stormwater drainage network incorporated in the TUFLOW model for the interim phase are represented in Figure 8.

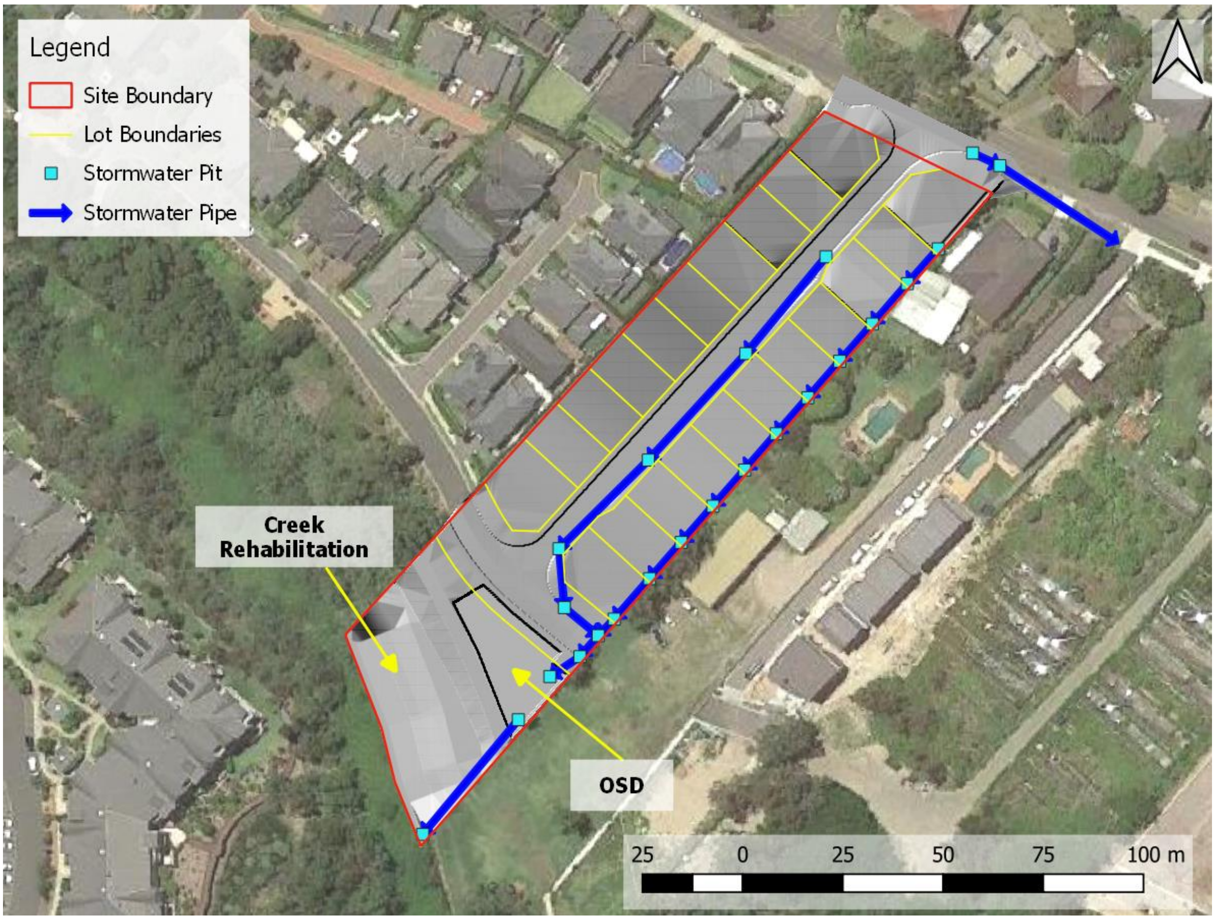

Figure 8: Flood Mitigation Elements

6 Findings

The Site DEM for existing and proposed condition is presented in the Appendix A (Figure A1). The elevation change is calculated from the existing and proposed DEMs and presented in the same figure.

Detailed flood mapping results, including peak flood depths, velocities, hazard, and flood afflux for the modelled AEP events are included in Appendix B to E.

6.1 Flood Depths

It can be observed in Figures B1 to B5 that, under existing conditions, the flow depth in the Narrabeen Creek and the Site location and in the south-west part of the Site ranges from about 1000 mm for the 50% AEP to about 1500 mm for 1% AEP with climate change. This increases to about 2500 mm for PMF.

Under the proposed development conditions (Figures B6 to B9), it can be seen that the flows are captured by a temporary swale in the south-east border of the Site, the road systems and the rehabilitated section of the Creek. The remainder of the Site flow is captured by the pit and pipe system and is stored temporarily in the OSD and then is discharged at the Creek at the south-west of the OSD. The overland flow for the developed Site is limited to the future roads and the proposed temporary swale. The flood depth in all areas, except the OSD, is limited to the existing condition depths. Figure B10 shows that the flood depth in the lot located at the south-east of the Site reaches 800 mm for the PMF.

Based on the maps the flood depths along the proposed roads and accessways are found to be safely conveyed and to be less than 200 mm for 1% AEP with climate change.

6.2 Flood Velocities

Figures C1 and C10 compare the peak flood velocities under existing and proposed conditions. As for the flood depths, the post development velocities throughout the modelled area are found to be generally either maintained or improved. The only exception is within the roads and the temporary swale. It is considered that this localised impact is negligible.

6.3 Flood Hazard

A comparison of the flood hazard is provided in Figures D1 and D10. The results indicate that the flood hazard within the proposed sub-division either remains the same as that under existing conditions or is improved. For the proposed condition this corresponds to a H1 category, which represents “Relatively benign flow condition” (AEM 2014, ARR 2019). This is the case within the project Site and the surrounding area except for the OSD where the hazard categories are H4 (Unsafe for people and vehicles) for 1% AEP with climate change. This impact is considered negligible as no vehicles or persons are expected within the OSD area.

6.4 Flood Afflux

Comparison of the flood depths in Figures E1 to E4 as flood afflux indicates that the flood depths on adjacent lands under proposed development conditions are generally maintained or reduced.

There is a minor local afflux up to 110 mm in the Warriewood Road (1% AEP with climate change). As the flood depth is safely convey and limited to 110 mm in this area, the impact of this afflux is considered negligible.

There are two areas of local afflux (1% AEP) which are located in the creek upstream of the Site and towards south-west of the Site. These are less than 40 mm and as they are in the existing floodway, they will have no impact to the neighbouring lots. In 1% AEP with climate change this becomes one area of local afflux at the upstream of the Site with maximum flood level change of 60 mm. These minor impacts are partly due to the conveyance limitations in the creek design profile that has been approved for adjacent developments as well as the location of the Lorikeet Grove public road extension.

Lastly, the afflux within the proposed temporary swale is less than 100mm. This swale is temporary and will be decommissioned in the future once the adjacent lot upgrades the Warriewood Road frontage. This system contributes to elimination of afflux in the neighbouring lot.

7 Conclusions

The results of this flood study indicate that flood behaviour in the vicinity of the Site in the lots and roads area is improved due to the stormwater management measures (i.e. pit and pipe network, temporary swale, creek rehabilitation, and OSD) provided as part of the proposed development. This includes flood depths, velocities, and flood hazard, which are improved or maintained.

It is concluded that the proposed subdivision, with the stormwater management measures in place, will have no adverse impact on the existing flood behaviour in the surrounding areas.

8 References

- Ingleside, Elanora and Warriewood Overland Flow Flood Study, WMA Water, 2019.
- Pilgrim, D.H. (1987) *Australian Rainfall and Runoff – A Guide to Flood Estimation,* Canberra: The Institution of Engineers, Australia
- *TUFLOW User Manual* - 2016-03-AE, BMT WBM, February 2017

9 Appendices

Appendix A – Digital Elevation Model (Figure A1)

Appendix B – Peak Flood Depth (Figures B1 to B10)

Appendix C – Peak Flood Velocity (Figures C1 to C10)

Appendix D – Peak Flood Hazard (Figures D1 to D10)

Appendix E – Flood Afflux (Figure E1 to E4)