APPENDIX K

Flood Study

Lots 100 & 101 DP1157883 Downes Place, Jamberoo

W.G. & M.E. Downes

Flood Study

15144 - September 2015

siteplus

planning . engineering . landscape . design . management

FLOOD STUDY

LOTS 100 & 101 DP1157883 DOWNES PLACE, JAMBEROO

PREPARED FOR

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EXECUTIVE SUMMARY

On behalf of W.G. & M.E. Downes, Site Plus has prepared a flood study for the Proposed Rezoning of Land on Lots 100 & Lots 101 DP1157883 Downes Place, Jamberoo.

This report assesses the hydrological and hydraulic characteristics of the catchment and addresses the current 100yr and Probable Maximum Flood (PMF) flooding for the site.

The site is currently cleared agricultural land, with one large main dam near the proposed development of 0.35Ha. The flood waters exit the site to the North across the unformed Duralla road continuing onto more agricultural land.

The development proposal has also been assessed to obtain both flood levels and extents for the existing site.

The extents of flooding thus determined are illustrated on the Siteplus Drawings 15144.DA.C01-C02 attached in Appendix C of this report.

All results are detailed in the following report.

1. INTRODUCTION

1.1. Preliminary

1.1.1. Siteplus Engagement

On behalf of W.G. & M.E. Downes, Site Plus has prepared a flood study for the Proposed Residential Subdivision on Lots 100 & Lots 101 DP1157883 Downes Place, Jamberoo.

1.1.2. Scope of Work

Siteplus determined the following investigations were required to complete a thorough flood study of the site:

- Construct a Hydrological model to determine the flow rates for both the 100yr and Probable Maximum Flood (PMF);
- Develop a Hydraulic model to calculate the 100yr and Probable Maximum Flood levels for the site.
- Prepare a brief report summarising the findings of the analysis.

1.2. Subject Land

The subject site lies on the Western edge of Jamberoo. See *figure 1* for details.

The site consists of mainly cleared, agricultural land with one existing building in the North Eastern corner fronting Downes place. The site slopes considerably, with grades in the range of 12 to 15% across the site. The site survey plan is located in *Appendix A.*

Flood waters pass through the site from the upstream 24.74Ha catchment through a natural, grass lined channel that enters the large dam to the west of the proposed developments. They are then discharged from the dam, into a small water hole and then leave the site through the unformed Drualla Road.

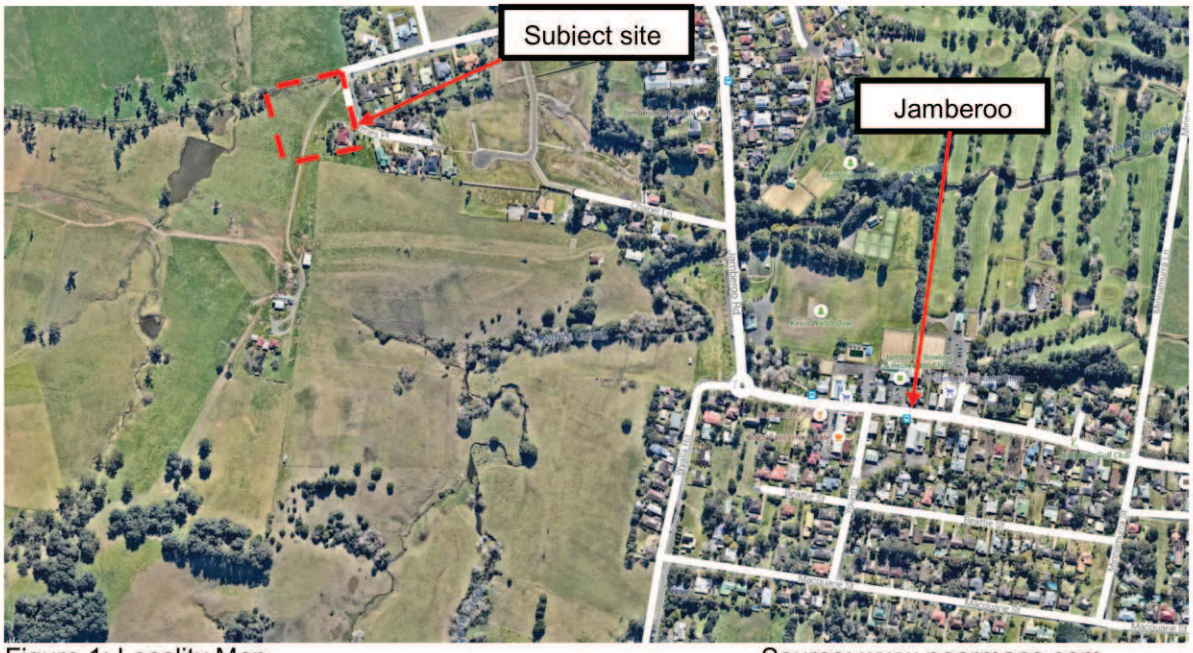

Figure 1: Locality Map Source: www.nearmaps.com

2. HYDROLOGICAL MODELLING

2.1. Selection of Hydrological Model

The Watershed Bounded Network Model (WBNM) – 2007 - has been adopted for the hydrological analyses in this study. WBNM has been used extensively in NSW and is accepted by Kiama Municipal Council.

There is no stream gauging data available for the local tributary and as a result of the catchments characteristics the WBNM is an ideal model for prediction of catchment flows. WBNM is a highly regarded model that has local validation with local government authorities. The main variable in the program, the lag parameter, approximates a conservative value of 1.7 and has been accepted by Council as basis for modelling.

2.2. Procedure

The procedure adopted in the study was as follows:

Step 1 Determine the values to be adopted for the model.

Step 2 Model the existing catchment and determine the critical storm duration for the 1 in 100 year flood event.

Step 3 From Step 2 extract the maximum peak flow for each ARI modelled.

The design rainfall intensities and temporal patterns were determined in accordance with procedures set out by Australian Rainfall and Runoff, and as derived by WBNM 2007.

2.3. Model Calibration

As mentioned earlier, WBNM has been used extensively in the Illawarra area.

The adopted findings of past studies indicate that a lag parameter value of 1.3 is appropriate for the Illawarra area.

The loss model used in the study is

Initial Loss + Constant Loss Rate

The constant loss rate has been adopted from the Cordery-Webb study of Flood Estimation in Eastern NSW, 1974 in which a figure of approximately 1.0mm/hr is recommended.

Therefore, in summary, the adopted parameters are:

Lag parameter (C)	1.3
Initial loss (IL)	2.0 mm
Continual loss (CL)	1.0 mm/hr

2.4. Catchment

The upstream catchment is made of 9 major sub-catchments with a total catchment area of 24.75ha. The sub catchments are illustrated in Appendix C.

In order to identify the catchment boundaries, the New South Wales State Governments SIX Maps, online mapping was used. The topographic data was used to determine catchments and overland flow paths.

2.5. Results of Hydrological Modelling

2.5.1. 1% AEP Results

The 1% AEP event is the critical storm event when determining the developable area of the site, and the future floor levels for proposed dwellings.

A range of storm events were modelled, commencing with the 1hour event through to the 3 hour event. The results are as follows for the flow in the channel exiting the site to the north.

Table 1 1% AEP Results

Storm event Time (min)	Flowrate (m^3/s)
60	11.86
90	11.83
120	12.19
180	9.91

Figure 2 illustrates the resulting 1% AEP outflow hydrograph from the catchment during the critical storm event.

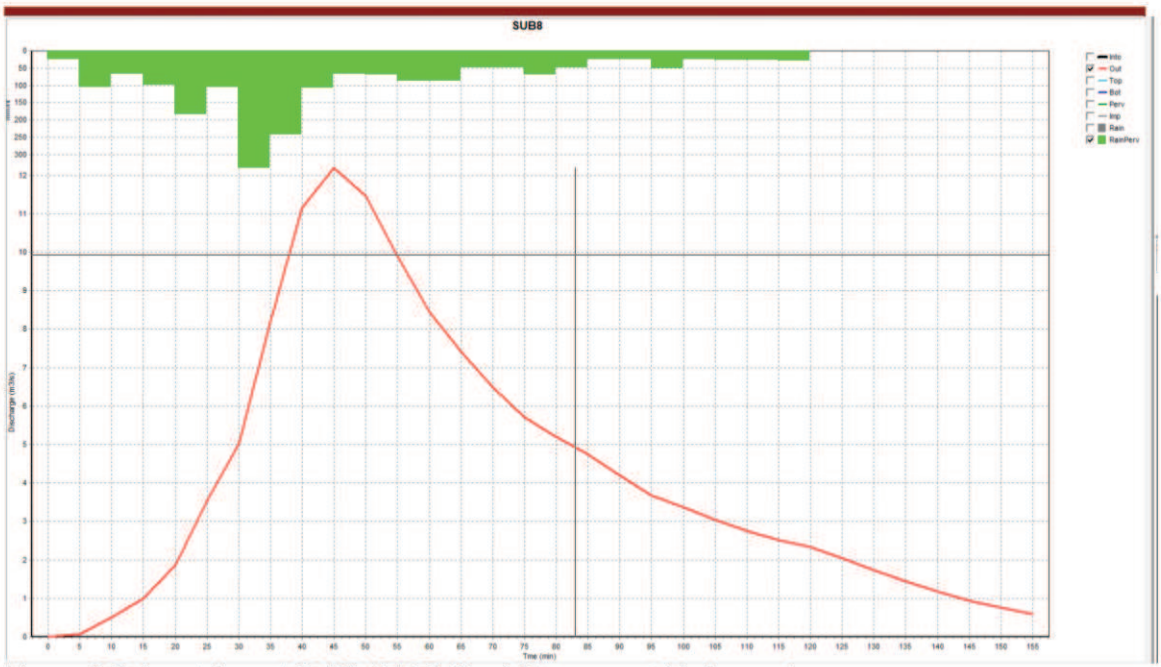

Figure 2 Sub-catchment 8 1% AEP Critical Storm event Hydrograph

2.5.2. PMF Results

Bulletin 53 methodology was used to calculate the PMF (probable maximum flood) flow rate. The WBNM the results are summarised for each sub-catchment below.

Table 2 PMF Results

Storm event Time (min)	Flowrate (m^3/s)
60	29.154

Figure 2 illustrates the resulting PMF outflow hydrograph from the catchment during the critical storm event.

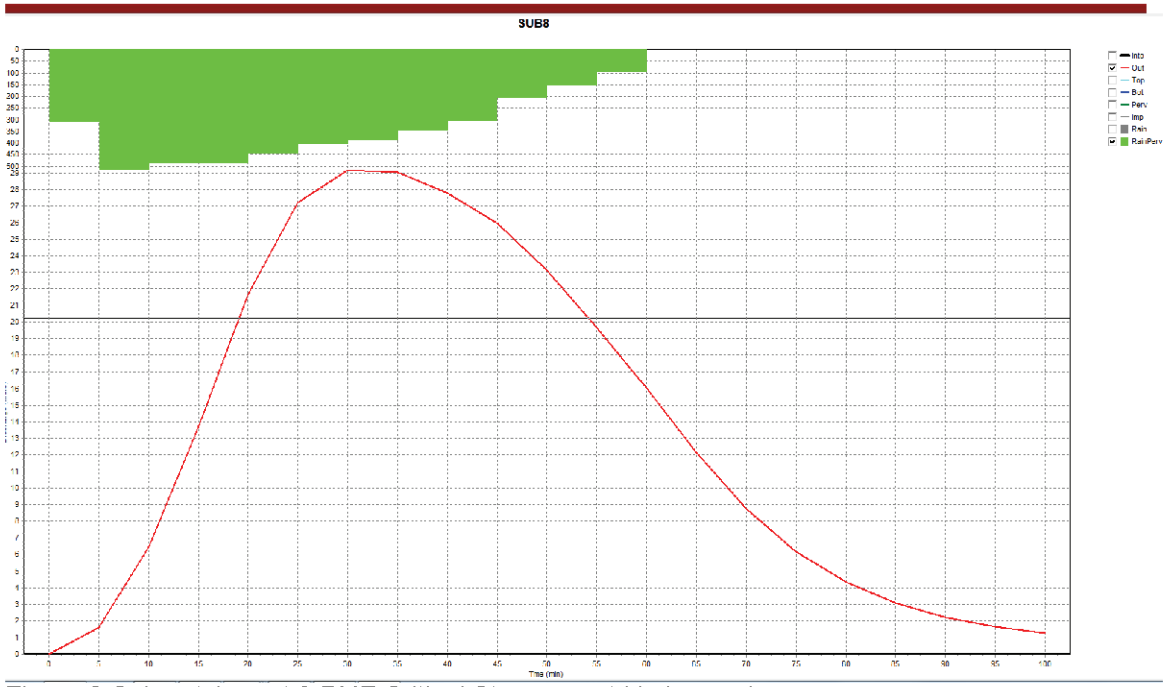

Figure 3 Sub-catchment 8 PMF Critical Storm event Hydrograph

3. HYDRAULIC MODELING

3.1. Site Survey

A site survey was carried out in November 2010 by D. Yates Surveyors. The survey provides details of the site including Dams, waterhole and overland flow route. The survey includes spot levels of the site. The survey plan is attached in appendix A.

3.2. Discussion of Hydraulic Controls

The flow path past site is one that is generally considered trapezoidal. For modelling of the existing Dam and waterhole, they are considered to be full at the time of the storm event. For the sections CH60, CH70 & CH80, a levee situation was modelled in HEC-RAS as that the water will flow down the overflow channel and then upon capacity spill to the water hole, rather than HEC-RAS adopting the lower ground level of the waterhole as the flow route. This has resulted in conservative values for the water level on the western side of the waterhole but accurate on the eastern side, proposed for rezoning.

As the water leaves the site and continues downstream, there are no immediate constrictions or variations in the channel that will affect the level of water on the site.

3.3. Hydraulic Flow Calculations

The long-sections, cross-sections and obstructions of the existing channel were entered into HEC-RAS Version 4.1.0 for modelling. The following Manning's values were used for the subject site model. The overland flow path consists of vegetated channel and banks that were clear of any large obstructions.

Table 3 Manning Values

Left Bank Manning 'n'	Channel Manning 'n'	Right Bank Manning 'n'
0.05	0.05	0.05

HEC-RAS was used to calculate the depth and velocity of flow within the site and downstream of the subject site. This was achieved using steady flow analysis with the calculated flow rates from Section 2 of this report.

3.4. Hydraulic Site Results

The results attained in Appendix B and C indicate that both the 1% AEP and PMF events are predominantly contained within the banks of the existing dam and flow path as shown in Siteplus Drawings 15144.DA.C01-C03. There is small encroachment into the area proposed for rezoning in the North West corner. This is of low hydraulic hazard with depths less then 0.25m and lies wholly within half width of the proposed road reserve.

Velocities within the site are shown in appendix B, where the maximum velocity in the site is 1.18m/s in the 1% AEP and 1.41m/s in the PMF.

4. KIAMA COUNCIL DCP 29 REQUIREMENTS

4.1. Floor Level

Any new building should maintain a floor level that is equal or above the 1% AEP plus 0.5m freeboard. The absolute minimum habitable floor level for the site must be RL.32.527m, increasing up the stream beside the flow path as shown in the cross section in appendix B.

4.2. Flood Evacuation

As there is no inundation of the proposed rezoned land by the floodwaters, the overland flow path causes no need for an evacuation procedure for the site.

5. CONCLUSION

W.G. and M.E. Downes are proposing a rezoning of land on Lots 100 & Lots 101, DP1157883 Downes Place, Jamberoo.

The existing site contains a small vegetated channel that runs into a dam to the west of the proposed rezoning. Overflow from this dam then leaves the site to the North.

The Siteplus Drawings in Appendix C, show that in both the 1% AEP and the PMF storm events, the flood waters only marginally effect the proposed land. Only inundating what would be half width of the proposed perimeter road with a low hydraulic hazard.

In the event of development of the site, freeboard of 0.5m must be maintained to all finished floor levels from the surface level of the 1% AEP event.