DEVCORE PROPERTY GROUP

ROWAN VILLAGE
MODEL UPDATE AND FLOOD CONSTRAINTS ASSESSMENT

FINAL



APRIL 2026

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Project Rowan Village Model Update and Flood Constraints Assessment	**Project Number** **122013**
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LIST OF ACRONYMS

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ALS	Airborne Laser Scanning
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
DECC	Department of Environment and Climate Change (now OEH)
DNR	Department of Natural Resources (now OEH)
DRM	Direct Rainfall Method
DTM	Digital Terrain Model
GIS	Geographic Information System
GPS	Global Positioning System
IFD	Intensity, Frequency and Duration (Rainfall)
mAHD	meters above Australian Height Datum
OEH	Office of Environment and Heritage
PMF	Probable Maximum Flood
SRMT	Shuttle Radar Mission Topography
TUFLOW	one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software (hydraulic model)
WBNM	Watershed Bounded Network Model (hydrologic model)

ADOPTED TERMINOLOGY

Australian Rainfall and Runoff (ARR, ed Ball et al, 2016) recommends terminology that is not misleading to the public and stakeholders. Therefore the use of terms such as “recurrence interval” and “return period” are no longer recommended as they imply that a given event magnitude is only exceeded at regular intervals such as every 100 years. However, rare events may occur in clusters. For example there are several instances of an event with a 1% chance of occurring within a short period, for example the 1949 and 1950 events at Kempsey. Historically the term Average Recurrence Interval (ARI) has been used.

ARR 2016 recommends the use of Annual Exceedance Probability (AEP). Annual Exceedance Probability (AEP) is the probability of an event being equalled or exceeded within a year. AEP may be expressed as either a percentage (%) or 1 in X. Floodplain management typically uses the percentage form of terminology. Therefore a 1% AEP event or 1 in 100 AEP has a 1% chance of being equalled or exceeded in any year.

ARI and AEP are often mistaken as being interchangeable for events equal to or more frequent than 10% AEP. The table below describes how they are subtly different.

For events more frequent than 50% AEP, expressing frequency in terms of Annual Exceedance Probability is not meaningful and misleading particularly in areas with strong seasonality. Therefore the term Exceedances per Year (EY) is recommended. Statistically a 0.5 EY event is not the same as a 50% AEP event, and likewise an event with a 20% AEP is not the same as a 0.2 EY event. For example an event of 0.5 EY is an event which would, on average, occur every two years. A 2 EY event is equivalent to a design event with a 6 month Average Recurrence Interval where there is no seasonality, or an event that is likely to occur twice in one year.

The Probable Maximum Flood is the largest flood that could possibly occur on a catchment. It is related to the Probable Maximum Precipitation (PMP). The PMP has an approximate probability. Due to the conservativeness applied to other factors influencing flooding a PMP does not translate to a PMF of the same AEP. Therefore an AEP is not assigned to the PMF.

This report has adopted the approach recommended by ARR and uses % AEP for all events rarer than the 50 % AEP and EY for all events more frequent than this.

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	19.5
	0.02	2	50	49.5
	0.01	1	100	99.5
Very Rare	0.005	0.5	200	199.5
	0.002	0.2	500	499.5
	0.001	0.1	1000	999.5
	0.0005	0.05	2000	1999.5
Extreme	0.0002	0.02	5000	4999.5
			↓	
			PMP/ PMP Flood	

1. INTRODUCTION

A subdivision is planned for a 225.02 ha parcel of land located at 7066 Holbrook Road, Rowan NSW 2650 (the Site). The Site sits at the boundary of the southern development area in Wagga Wagga, providing a key link to the broader region. The subdivision will provide over 2,200 homes, a village centre and land set aside for a school, senior living, restored riparian corridor and outdoor recreation purposes. The Site is currently zoned RU1 Primary Production and requires rezoning. The rezoning Planning Proposal was developed in 2022 and has received Gateway Determination. The Rowan Site is being progressed through the planning process in parallel to the adjacent Sunnyside Estate site. Since the Gateway Determination small refinements have been made to the proposed masterplan.

The 2022 Planning Proposal was supported by a Site Stormwater Management Strategy which included an assessment of broader flooding constraints. The Wagga Wagga Major Overland Flow Floodplain Risk Management Study (MOFFRMS; WMAwater, 2021) (Reference 8), defines existing design overland flood behaviour at the site. The information derived from that study is the most up to date representation of the broad catchment flood behaviour available (based on around 2018/2019 conditions). The modelling is based on a 5 m resolution grid and is considered suitable as a starting base for the assessment of flood behaviour. The models established as part of Reference 1 were refined for a site specific assessment as part of the 2022 work.

Given the refinements to the proposed masterplan and the time since the original models in Reference 8 were developed, there is an opportunity to develop a further refined localised site based assessment. As such Wagga Wagga City Council has requested that the underlying topographic information be updated and refined, and to consider current guidance in relation to the assessment of climate change (as documented in Australian Rainfall and Runoff 2019 Version 4.2). The outcomes of this update are documented in this report and the resulting flood constraints considered in the context of the updated proposed masterplan.

Updates to the Stormwater Management aspects have been undertaken separately.

2. BACKGROUND

The land parcels, known as Rowan Village, with a total area of 225 hectares, are being investigated for rezoning and development options with average lot sizes of 540 m^2, 900 m^2 and 8,000 m^2, and an indicative dwelling yield in excess of 2,200, including land set aside for a school, senior living, restored riparian corridor and outdoor recreation purposes.

The site is currently vacant cropping and grazing land, and is legally described as:

- Lot 18 in DP 1054800
- Lots 24, 26, 43, 65, 66 in DP 757246
- Lot 23 in DP 1063399
- Lots 1 and 2 DP 1171894

2.1. Planning Proposal

The Planning Proposal seeks to rezone the site from RU1 Primary Production and R5 Large Lot Residential to the following mix of land use zones:

- R1 General Residential
- R3 Medium Density Residential
- R5 Large Lot Residential
- E1 Local Centre
- C2 Environmental Conservation
- SP2 Infrastructure
- RE1 Public Recreation

Based on a dwelling yield of 10 dwellings per hectare, the Planning Proposal masterplan will enable the delivery of in excess of 2,200 dwellings across a 225-hectare site area, which importantly will encompass the delivery of a diverse mix of low density residential housing typologies described as follows:

- **Rural transition residential lots** – These residential lots will be located along the southern boundary of the site and will be the largest residential lot typology. This lot typology will importantly provide an appropriate transition between the site and the adjacent rural context to the south of Rowan Road.

- **Neighbourhood residential lots** – A range of suitable low density residential lots will be accommodated within close proximity to open space provision and the riparian corridor network. This lot typology will provide the appropriate transition between the village residential lots and the rural transition lots. A diversity of lot sizes will be delivered through the neighbourhood residential lot typology.

- **Village residential lots** – These residential lots will leverage off the close proximity to the local centre and its associated amenities and offerings. Fundamentally, these residential lots will still uphold the low-density residential housing charter that the site will deliver, whilst ensuring that an appropriate diversity of housing choice is delivered.

The Planning Proposal will enable the creation of a new amenity-led neighbourhood providing an opportunity for a variety of housing options through a range of residential lot sizes, supported by the timely delivery of resilient utilities and infrastructure that supports and promotes the future growth of Wagga Wagga in an orderly and sustainable way. The delivery of a mix of low-density housing choices will be crucial to attracting a wide range of demographics to the area.

Future development on the site would be facilitated by a highly connected, and permeable network with convenient access to public transport, public spaces, facilities, and amenities. Cycleways and footpaths will connect across the site to promote a walkable community.

The Planning Proposal will also ensure that the environmental values of the site are preserved through the dedicated retention, and where required rehabilitation, of significant trees and riparian corridors.

2.2. Study Site

The site is located in Rowan, on the southern fringe of Wagga Wagga. The site is bounded by Lloyd Road (north), Holbrook Road (west), Rowan Road (south) and the proposed Sunnyside Estate (east).

The site and surrounding areas are subject to inundation from overland flow, which is typically shallower than mainstream flooding. The area sits within the Lake Albert catchment, which moves in a generally northerly direction from the site, towards the Murrumbidgee River.

Elevations across the site vary from approximately 255 mAHD at the south western corner of the site (the intersection of Holbrook and Rowan Road), falling to approximately 223 mAHD at the north eastern corner of the site. This represents an elevation change of 20m from west to east and 10 – 15 m, south to north. The topography creates four (4) distinct sub catchments and points of discharge –

- A creek line which enters at the southwest corner and discharges to the east side of the northern boundary and is a tributary to Stringybark Creek.
- A small north west portion of the site draining via the northern boundary into properties fronting Lloyds Road.
- The southern portion of the site draining across the east boundary towards the Sunnyside Estate, and
- The north east portion of the site draining via the north and east boundary into properties fronting Lloyds Road and the adjacent Sunnyside Estate, and ultimately into Stringybark Creek.

The location of the Site is shown on **Error! Reference source not found.**.

2.3. Previous Studies

There have been a number of regional and local flood investigations in this area, including the following recent studies:

- Planning Proposal – Rowan Village, 7066 Holbrook Road Rowan – Stormwater Management Strategy (SSMP) – WMAwater, 2022 (Reference 5)
- Sunnyside Estate Wagga Wagga Precinct Stormwater Drainage Strategy – WMAwater 2021 (Reference 6)
- Sunnyside Estate Wagga Wagga Site Stormwater Management Plan (SSMP) – WMAwater 2020 (Reference 7)
- Wagga Wagga Major Overland Flow Floodplain Risk Management Study (MOFFRMS) – Public Exhibition Version, WMAwater, 2020 (Reference 8)
- Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan, WMAwater, 2018 (Reference 9)
- Wagga Wagga Detailed Flood Model Revisions, WMAwater, 2014 (Reference 10)
- Wagga Wagga LGA Murrumbidgee River Flood Modelling, WMAwater, 2012 (Reference 11)
- Wagga Wagga Major Overland Flow Flood Study (MOFFS), 2011 (Reference 12)

The MOFFRMS defines existing design overland flood behaviour at the site using a hydrologic (WBNM) and hydraulic (TUFLOW) model. The information derived from that study is the most up to date representation of the broad catchment flood behaviour available (based on around 2018/2019 conditions). The modelling is based on a 5 m resolution grid and is considered suitable as a starting base for the assessment of flood behaviour. The 2022 Rowan Village SSMP refined the models from MOFFRMS to develop a site specific assessment. This work did not update the topographic information or grid resolution.

3. HYDROLOGIC AND HYDRAULIC MODEL UPDATE

3.1. Overview

The Wagga Wagga Major Overland Flow Floodplain Risk Management Study (MOFFRMS; WMAwater, 2021), provides the most up to date definition of the broad catchment design flood behaviour at the site.

MOFFRMS utilised a TUFLOW hydraulic model coupled with a WBNM hydrologic model to define overland flooding within the model domain. The study does not consider flooding impacts resulting from the Murrumbidgee River, however the Murrumbidgee River inundation does not extend to the Lake Albert model domain.

The topography within the MOFFRMS TUFLOW model generally represents catchment conditions around 2018/2019, however was derived from a base LiDAR dataset captured in 2009. The model topography was represented by a 5m grid resolution, this was considered appropriate for the representation of catchment scale overland flow inundation.

MOFFRMS applied the data and methodologies outlined in Australian Rainfall and Runoff 2019 (ARR 2019), this included the selection of representative storms, which were considered appropriate at a catchment scale.

As the current investigation is a localised site based assessment, Wagga Wagga City Council has requested that the underlying topographic information be refined and updated to more recent data and that the catchment wide assumptions, around representative storm events are reviewed in relation to the localised flood behaviour at the site.

The following sections outline the model refinement and its associated outcomes. All other modelling assumptions remain unchanged from those documented in MOFFRMS; WMAwater, 2021.

3.2. Available Data

3.2.1. LiDAR

Light Detection and Ranging (LiDAR) topographic survey of the study area and its immediate surroundings was provided for the impact assessment by NSW Government Spatial Services, freely available from Geosciences Australia (ELVIS). LiDAR is aerial survey data that provides a detailed topographic representation of the ground with a survey mark approximately every square metre. The LiDAR data used in this study across the Site was collected in 2020 with a resolution of 1 m.

The accuracy of the ground information obtained from LiDAR survey can be adversely affected by the nature and density of vegetation, the presence of steeply varying terrain, the vicinity of buildings and/or the presence of water. The accuracy is typically ± 0.15 m for clear terrain.

The horizontal accuracy of the data is 0.8 m at 95% confidence interval (CI), while the vertical accuracy is 0.3 m at 95% CI.

A comparison of the 2020 LiDAR to the 2009 LiDAR across the Site is provided in Figure 3. Broadly, in the vicinity of the site the 2020 LiDAR is slightly (<0.2m) higher than the 2009 LiDAR.

3.3. Model Updates

3.3.1. Refinements Undertaken in 2022 SSMP Assessment

The 2022 Rowan Village SSMP refined the hydrologic and hydraulic models from MOFFRMS (Lake Albert Sub-model) to develop a site specific assessment. These refinements included:

- Sub-catchment delineation around the Site and the Sunnyside Estate to the east was refined according to the boundaries of the Site and Sunnyside Estate, refined sub-catchments are shown on Figure 2;
- Areas were recalculated for those adjusted/new sub-catchments with fraction impervious retained as 0% as per the MOFFRMS;
- The IFD for each AEP was averaged for the study catchment rather than the whole MOFFRMS catchment;
- The ARFs were updated to the catchment area draining to Stringybark Creek, which were previously based on the entire catchment area;
- Hydraulic model was updated with new inflow locations (2d_sa) for the new/refined sub-catchments;
- Additional reporting locations/cross-sections (2d_po) were added to extract flow information within/around the Site.

These aspects have been applied to the current assessment.

Further details of the original model development are available in Reference 8.

3.3.2. TUFLOW Model Version

The TUFLOW model version was updated from 2018-03-AC-iSP-W64 to 2020-10-AF-iSP-w64 to allow the implementation of a refined model grid across a portion of the model domain via the Quadtree function.

3.3.3. DEM and Grid Resolution

The TUFLOW model grid across the Site was established by sampling from a triangulation of filtered ground points from the 2020 LiDAR dataset.

MOFFRMS implemented a TUFLOW model with a grid cell size of 5 m by 5 m, a portion of the model domain has been refined to 2m by 2m as part of this site specific impact assessment. This resolution provides sufficient detail for roads, localised features and overland flow paths. The remainder of the model domain is represented by that developed as part of MOFFRMS.

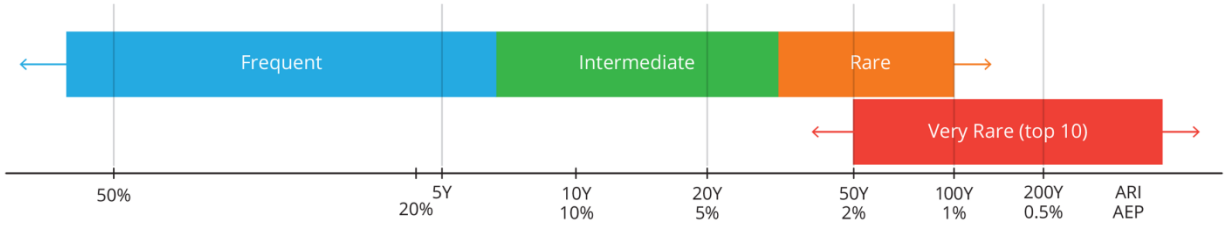
3.3.4. Representative Storm

The representative storm is a combination of temporal pattern and storm duration which best represents the flood behaviour (e.g. flow, level) for a specific design magnitude at the location of interest. MOFFRMS selected temporal patterns and durations based on an overall balance across the model domain, for this localised assessment a review of the selected representative storms for the site and immediate vicinity has been undertaken.

Temporal patterns are a hydrologic tool that describe how rainfall falls over time (storm duration) and are often used in hydrograph estimation. Given the variability in flood producing storms, ARR 2019 recommends an approach where an ensemble of different temporal patterns are investigated.

Temporal patterns for this assessment were obtained from ARR 2019 and accessed from the ARR Data Hub. The ARR 2019 method divides Australia into 12 temporal pattern regions, with the study catchment falling within the Murray-Darling Basin region. ARR 2019 provides 30 patterns for each duration, which are sub-divided into three temporal pattern bins based on the frequency of the events. Diagram 1 shows the three categories of bins (frequent, intermediate and rare) and corresponding AEP groups.

Diagram 1: Temporal Pattern Bins



The critical storm duration is the storm duration that produces the highest mean flow or level at a point of interest (where the mean is calculated from the ensemble of ten temporal patterns for that duration). Where there are multiple locations of interest with different contributing catchment sizes or flood mechanisms, there can be multiple critical durations that need to be considered.

Once the critical duration is established, it is usually desirable to select a single representative design storm temporal pattern that reproduces this behaviour for all points of interest. This representative storm can then be used for determining design flood behaviour. Peak flow is often used as an indicator to determine the representative temporal pattern. This approach was applied to the study area.

A range of storm durations (30 min to 12 hr) with an ensemble of ten temporal patterns per duration were run to produce peak flow estimates.

A summary of the adopted durations and temporal patterns for this assessment are shown in Table 1.

Table 1: Adopted durations and temporal patterns for design flood events

Event	Duration (min)	TP#
20% AEP	120 180	3956 3983
10% AEP and 5% AEP	60 120	3888 3901
2% AEP	60 90 120	3873 3890 3937
1% AEP, 0.5% AEP and 0.2% AEP	45 60 90	3844 3877 3794
PMF	TBD	TBD

3.3.5. Results

Across the site flood levels are increased by less than 0.3m during the 1% AEP event (Figure 4). Due to the model refinement additional areas of inundation are shown to occur along the western boundary, derived from flow coming from Holbrook Road and along the eastern boundary. Broadly across the updated model domain there are small localised changes to the flood extent. The refined grid resolution has also slightly reduced the flood extent centrally through the site.

The refined based case provides a suitable base against which the proposed development can be considered.

3.3.6. Probable Maximum Flood

The Probable Maximum Flood (PMF) was not assessed as part of the 2022 Rowan Village SSMP. In order to allow consideration of the full range of flood risks at the Site, the PMF has been assessed using the refined modelling tools. The approach applied is described below.

Design rainfalls for the Probable Maximum Precipitation (PMP) were derived using the BoM's GSDM (Bureau of Meteorology 2003). The GSDM is valid for durations up to 3 hours in this part of Australia and for catchment sizes up to 1,000km^2. Thus, the GSDM PMP depths were calculated for the catchment area of 95.7km^2 to the centroid of the Site. A 60% 'smooth' terrain was adopted for the catchment with a Moisture Adjustment factor of 0.64. Rainfall for durations up to 3 hours was distributed spatially as per the GSDM method, with the centroid focused on the Site. The derived rainfalls were then applied to the refined hydraulic model to define flood constraints in the PMF event.

3.3.7. Future Climate Scenario

The Flood Risk Management Manual places an emphasis on the importance of developing floodplain risk management plans that address existing, future, and continuing flood risk for flood prone land on a strategic, rather than an ad hoc or individual, proposal basis. As well as considering the current flood risk, consideration must be given to the potential future conditions. It is important to also understand how the masterplan will perform under future flood conditions. Consideration of future conditions assists in ensuring that the management of flood prone land is consistent with flood risk and that such development does not cause undue future distress to individuals, nor unduly increase potential flood liability to them or the community.

Climate change is expected to have adverse impacts upon sea levels and rainfall intensities into the future. Intensive scientific investigation is ongoing to estimate the effects that increasing amounts of greenhouse gases (water vapour, carbon dioxide, methane, nitrous oxide, ozone) may be having on the average earth surface temperature. Changes to surface and atmospheric temperatures may affect climate and sea levels. The extent of any permanent climatic or sea level change can only be established through scientific observations over several decades.

Both increases in sea levels and rainfall intensities have the potential to impact on flood behaviour.

Considering and understanding the sensitivity of the current catchment flood behaviour to these influences is crucial in the management of future flood risk. Potential increases in rainfall intensity are more likely to impact the flood behaviour within the Site.

As such increases to rainfall intensity only due to climate change, have been considered for the 1% AEP event, assuming current catchment conditions.

Any change in design flood rainfall intensities will increase the frequency, depth and extent of inundation across the catchment. The primary driver for this change is under a warmer climate, the atmosphere can hold more water, and hence more rainfall can occur in any given storm event. ARR 2019 provides some guidance about consideration of the impacts of climate change on design rainfall intensities. It suggests assuming that rainfall intensities can be assumed to scale up by 7 - 8% per degree of average surface warming. Projected increases to evaporation are also an important consideration because increased evaporation would lead to generally dryer catchment conditions, resulting in lower runoff from rainfall in dry years. The combination of uncertainty about projected changes in rainfall and evaporation makes it difficult to predict with confidence the exact changes to peak flows for large flood events within the catchments under warmer climate scenarios.

Australia Rainfall and Runoff 2019 Version 4.2 states:
There is unequivocal evidence that greenhouse gas emissions have caused global warming. The Intergovernmental Panel on Climate Change's sixth assessment report concluded that global surface temperatures have significantly increased above pre-industrial levels, with significant further warming expected (IPCC, 2023).

This warming is causing an increase in many drivers of flood risk, including an intensification of extreme rainfall events and the elevation of average and extreme sea levels (IPCC, 2023).

Traditionally, design flood estimation has assumed that historical observations are representative of current and future conditions. This is no longer the case. Records on historical flooding or flood drivers (such as extreme rainfall or sea level) can no longer be assumed to provide a direct analogue of current or future flood risk. To account for significant observed and projected changes to the drivers of flooding, it is necessary to account for the non-stationarity of flooding in the assessment of current and future flood risks.

The research used in developing the guidance in ARR2019 Version 4.2 has been applied to existing conditions in the catchment. To consider the potential consequences of a changing climate into the future, a range of scenarios have been developed, including SSP 2 – 4.5 2050 (14 – 27%) and SSP 3 – 7.0 2090 (29 – 59%). SSP 2 – 4.5 is considered the middle of the road scenario and SSP3 - 7.0 is considered a high-emission scenario.

4. FLOOD CONSTRAINTS

4.1. Overview

The Site is subject to overland flow flooding as initially defined by the Major Overland Flow Floodplain Risk Management Study undertaken by Wagga Wagga City Council. The hydraulic model established as part of the MOFFRMS was based on catchment conditions around 2018/2019, built from an initial base topography from 2009. As the current assessment is a localised site based assessment, the existing hydrologic and hydraulic models have been updated and refined. The outcomes of this update are documented in Section 3 and the results presented in the following sections are based on the updated hydraulic model.

The site and surrounding area slopes down from the south west to the north east, towards Lake Albert and then ultimately the Murrumbidgee River. Four (4) distinct sub catchments impact the Site:

- A creek line which enters at the southwest corner and discharges to the east side of the northern boundary and is a tributary to Stringybark Creek. This creek line is joined within the Site by a secondary flow from Holbrook Road. It appears as though this flow is generated originally from the creek line, breaking away and heading north along Holbrook Road. It first breaks into the Site as shallow sheet like flow, approximately 100m to the north of the Holbrook Road culvert crossing. A small catchment of 24 ha to the west of Holbrook Road, contributes additional flow, which then breaks into the Site over a 400m wide area of shallow sheet like flow, approximately 350m to the north of the Holbrook Road culvert crossing.
- A small (15 ha) north west portion of the site draining via the northern boundary into properties fronting Lloyds Road. This flowpath concentrates near to the Site's northern boundary.
- The southern portion of the site draining across the east boundary towards the Sunnyside Estate. This flowpath concentrates near to the Site's eastern boundary.
- The north east portion of the site draining via the north and east boundary into properties fronting Lloyds Road and the adjacent Sunnyside Estate, and ultimately into Stringybark Creek.

4.2. Peak Flood Depth

Peak design flood depths and levels are provided on Figure 5 to Figure 12 for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP and PMF events.

For the 20% AEP, flow from the upstream catchment enters the Site at the Holbrook Road culvert and creek line (through existing Lot 43 DP757246), and across Holbrook Road, approximately 600m to the north of the Holbrook Road culvert (through existing Lot 65 DP757246). Inundation is generally contained to the creek line as it conveys the upstream flow through the site, except for centrally in the Site (near the boundary of existing Lots 24 and 26 DP757246), where the two flowpaths converge. At this location, inundation extends more broadly over a width of 170m.

Downstream of this location (through existing Lots 26 DP757246 and 23 DP1063399), inundation is generally contained to the creek line with small areas extending slightly beyond the immediate creek line. The northern flowpath (through existing Lot 65 DP757246) generally travels in an easterly direction, spreading and inundating the natural topography. At its broadest it extends over a width of 250m. Flood depths are however generally very shallow, typically less than 0.1m, except along the main creek line, where depths are up to 1.0m and through local depressions in the natural topography, however these do not exceed 0.4m. The three other inundated areas along the northern boundary of existing Lot 18 DP1054800 and eastern boundary of existing Lot 24 DP757246 are also generally very shallow, typically less than 0.1m, with a maximum of 0.2m in small pockets.

There is a slight increase in the flood extent in the 10%, 5% and 2% AEP events, however the overall flood behaviour is very similar to the smaller 20% AEP event. Flood depths are also similar with only the main creek line increasing to a maximum of 1.3m, 1.5m and 1.9m deep, in the 10%, 5% and 2% AEP event, respectively. Additionally, during the 5% AEP event and larger, downstream of the central flowpath confluence, the flowpath is consistently beyond the immediate channel extending to a width of 40 m. The creek line, upstream of the central flowpath confluence, also widens to approximately 30 m in the 2% AEP event.

At events of the 1% AEP and larger, additional flow spills from Holbrook Road from approximately 100 m north of the Holbrook Road culvert. This flow inundates a width of 400m with shallow depths of less than 0.1m. Other than the overflow from Holbrook Road, the broadest area of inundation is the area around the central flowpath confluence, where the inundation spreads over 165m. Depth through this area are generally 0.2m with a maximum of 0.6m. Depths through the creek line are generally around 1m, with surrounding depths outside the waterway typically 0.2m. Along the northern boundary, where the creek line leaves the Site and flows through properties fronting Lloyd Road, conveyance begins to become restricted, and backwatering is shown to occur in the 1% AEP event. Depths pond up to 0.5m at the site boundary. Other inundated areas are consistent with the smaller events.

In the 0.5% and 0.2% AEP, the main creek line and overflow from Holbrook Road combine to almost completely inundate the immediate area, although with depths generally less than 0.1m. The creek line and original overflow from Holbrook Road reach maximum depths of 2.0m and 0.6m, respectively. In the 0.2% AEP, a new shallow (less than 0.1m) flowpath breaks from the immediate creek area (though existing Lot 26 DP757246) downstream of the central confluence.

Similar to the 0.5% and 0.2% AEP events, during the PMF the main creek line and the overflow from Holbrook Road combine to almost completely inundate the immediate area. Broadly these depths remain below 0.1m The creek line and original overflow from Holbrook Road reach maximum depths of 2.2m and 0.6m, respectively. The PMF extent through the main creek line is significantly broader than the smaller flood events. The new flowpath through existing Lot 26 DP757246 that commences in the 0.2% AEP event continues to carry flow. Depths along the main creek line at the northern boundary reach 0.75m. The shallow inundation through Lot 24 and Lot 26 DP757246, covers a slightly broader area in the PMF event but remains shallow, typically less than 0.1m.

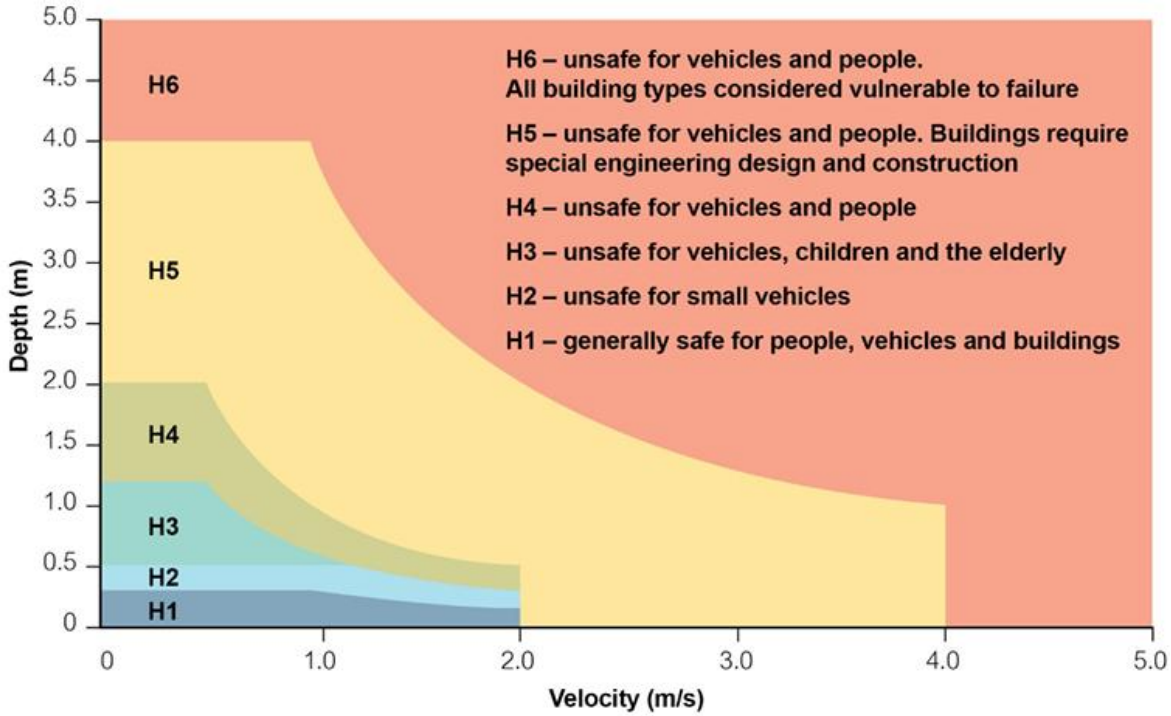
4.3. Hydraulic Hazard

Hazard classification plays an important role in informing floodplain risk management in an area, as it reflects the likely impact of flooding on development and people providing a measure of potential risk to life and property damage from flooding. Hydraulic hazard is typically determined by considering the depth and velocity of floodwaters.

Research has been undertaken to assess the hazard to people, vehicles and buildings based on flood depth, velocity ad velocity depth product.
Hydraulic hazard categories have been determined for the study area in accordance with the NSW Government Flood Risk Management Manual （NSW Government, 2023）and its accompanying guideline FB03 – Flood Hazard （NSW Government, 2023）. FB03 provides a best practice approach for understanding of the potential vulnerabilities as a result of hydraulic hazard of flood water.

The accompanying guideline FB03 contains information relating to the categorisation of flood hazard. A summary of this categorisation is provided in Diagram 1.

Diagram 1: General flood hazard vulnerability curves



This classification provides a more detailed distinction and practical application of hazard categories, identifying the following 6 classes of hazard:

- H1 – No constraints, generally safe for vehicles, people and buildings.
- H2 – Unsafe for small vehicles.
- H3 – Unsafe for vehicles, children and the elderly.
- H4 – Unsafe for people and all vehicles.

- H5 – Unsafe for people and all vehicles. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure. Buildings require special engineering design and construction; and
- H6 – Unsafe for people and vehicles. All building types considered vulnerable to failure.

It should be noted that these classifications are based on the physical flood behaviour in design flood events and do not account for other hazards that may exist (such as, road surface failure, loss of access) or the variability in real storm events

The majority of the Site is classified as H1 - No constraints, generally safe for vehicles, people and buildings, in the 20% AEP event. Areas with higher Hydraulic Hazard occur through the main creek line (up to H5 - Unsafe for people and all vehicles) and the natural depressions through the overflow from Holbrook Road (H2 - Unsafe for small vehicles).

Increasing event size from the 20% AEP through the 10%, 5%, and 2% AEP events, shows a similar distribution of Hydraulic Hazard across the Site. Larger areas of category H5 - Unsafe for people and all vehicles occur through the creek line and broader areas of category H2 - Unsafe for small vehicles through the overflow from Holbrook Road.

At the 1% AEP event, there is the larger area of overflow from Holbrook Road, however this still remains classified as category H1 - No constraints, generally safe for vehicles, people and buildings. Some areas of category H3 - Unsafe for vehicles, children and the elderly are introduced through the overflow from Holbrook Road. These areas increase in the 0.5% and 0.2% AEP events.

During the PMF event, larger areas of H4 – Unsafe for people and all vehicles and H5 - Unsafe for people and all vehicles occur through the main creek line. The breakout from the main creek line through existing Lot 23 DP1063399 and Lot 26 DP757246 also increases to H3 - Unsafe for vehicles, children and the elderly.

4.4. Future Climate Scenario Flood Behaviour

The 1% AEP event under the SSP2 – 4.5 2050 scenario, shows that flood levels are expected to increase by up to 0.1m. New areas of inundation are shown to occur in the western portion of the site as the main creek line and overflow from Holbrook Road combine. There is a slight increase to the extent of inundation through existing Lot 26 DP757246 and in the northern portion of existing Lot 24 DP757246.

In the SSP3 - 7.0 2090 scenario (1% AEP event), larger increases in flood depth of up to 0.25m are shown to occur. Newly inundated areas again occur in the western portion of the site as the main creek line and overflow from Holbrook Road combine. The Holbrook Road overflow also increases extent to the north, through existing Lot 66 DP757246. Two new flowpaths also form through existing Lot 26 DP757246, once from the main creek line and the other near the eastern boundary.

4.5. Access Constraints

The site is accessible from Rowan Road, Holbrook Road and Lloyd Road. Understanding the flood constraints on these roads helps to inform the emergency management of the development.

Inundation is shown to occur in events as frequent as the 20% AEP at the intersection of Lloyd and Holbrook Road, midway along the eastern Boundary on Holbrook Road as well as along Lloyd Road, between Ironbark Place and Plane Tree Drive and from Mallee Road to Plumpton Road. Depths are generally less than 0.05m, except near Plane Tree Drive, where the main creek line crosses Lloyd Road, where depths are up to 0.3m. These depths generally translate to Hydraulic Hazard of H1 - No constraints, generally safe for vehicles, people and buildings, with a small section on Lloyd Road being categories as H2 – Unsafe for small vehicles.

In the 1% AEP event, additional areas of Holbrook Road are inundated, although the majority remains at a shallow depth, deeper flows run adjacent to the road. In addition, the depth near Plane Tree Drive, where the main creek line crosses Lloyd Road increases to 0.4m. Again, these depth generally translate to Hydraulic Hazard of H1 - No constraints, generally safe for vehicles, people and buildings, with a small section on Lloyd Road being categories as H3 – Unsafe for vehicles, children and the elderly.

Inundation depths also increase to 0.2m at the main creek line crossing of Holbrook Road in the 0.2% AEP and PMF event and a resulting Hydraulic Hazard category of H2 – Unsafe for small vehicles, in the 0.2% AEP and H4 – Unsafe for people and all vehicles in the PMF event. Shallow inundation, categorised as H1 - No constraints, occurs along Rowan Road in the PMF event. At the crossing of Lloyd Road of the main creek line, the hydraulic hazard increases to H4 – Unsafe for people and all vehicles in the PMF event.

4.6. Flood Constraints for the Proposed Development Layout

The existing flood constraints have helped to guide the broad layout of the proposed development. It has been designed with a central riparian corridor which allows for the main creek line to move through the Site. The district park has been placed to allow for the overland flow which moves across the eastern boundary. The village centre is flood free up to the PMF event, while the Primary School site is broadly flood free, with a small area of shallow inundation in the south east corner in the 20% AEP event. The inundation across the School Site increases gradually as the event size increases to cover approximately half the site in the PMF event, although depths remain below 0.15m across all events. The senior living site is flood free up to the 0.5% AEP event, with a small flowpath commencing in the eastern portion of the site in the 0.2% AEP event. The majority of the proposed residential lots remain flood free.

An overland flow route to convey the primary flowpath from Holbrook Road has been designed for PMF capacity. Shallow overflow occurs across the western portion of the site (existing Lot 43 and 65 DP 757246), where lots are proposed, this flow also comes from Holbrook Road. This inundation is shallow, typically less than 0.05m but drainage will need to be designed to convey this flow to the main overland flow route.

Works on Holbrook Road may also assist in containing this flow. This inundation currently commences more broadly at the 1% AEP event, under a future climate scenario it will occur more frequently than this. Deeper areas of inundation through this area under existing conditions is not expected to occur in proposed conditions as topographic depressions would likely be removed in this area in the development process.

A series of basins are proposed to manage the stormwater runoff through the site. Additional drainage considerations will also be needed for the lots proposed along the southern boundary (existing Lot 24 DP 757246) as runoff will move towards the flowpath crossing the eastern site boundary. Similar considerations will be required for the runoff approaching the district park and the areas to the north and west.

Proposed bridges should be designed at an appropriate height as to not impede on the natural flow of the main creek line. Two bridges are proposed and depths at these locations in the 1% AEP event are 1.1m and 0.6m, for the southern and northern bridges, respectively. The current concept indicates that ground levels adjacent to the southern bridge are 232.6 mAHD and 235 m AHD on the west and eastern embankments, respectively. The existing maximum flood levels at this location for the 1% AEP and PMF event are 231.9m AHD and 232.3m AHD, respectively.

In the current 0.2% AEP event, a new flowpath is generated from the inundation within the district park. This flowpath travels to the north and through the proposed senior living site. This flowpath is also shown to occur under both future climate scenarios assessed for the 1% AEP event, indicating that this flowpath will occur more frequently in the future. Under all scenarios it remains fairly shallow (less than 0.05m) and should be considered in the drainage design for the senior living site.

In all modelled events, the existing conditions flood extent is shown to encroach into the proposed road and adjacent areas running through the existing Lot 26 DP757246 and Lot 23 DP1063399. In addition, during the 0.2% AEP and future climate scenarios a new flowath breaks into this area. Filling of these areas will likely resolve this inundation; however localised flood levels will likely increase within the riparian corridor. The current concept indicates that ground levels adjacent to this area is generally greater than 234.8 mAHD, PMF flood levels are below this.

5. LOCAL PLANNING DIRECTION

Local planning directions are issued under Section 9.1(2) of the *Environmental Planning and Assessment Act 1979* and apply to planning proposals lodged with the Department. Ministerial Direction 4.1 relates to flooding and has the following objectives:

> (a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (now Flood Risk Management Manual 2023), and
>
> (b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.

The specific requirements of Direction 4.1 and commentary on the compliance of the proposed master plan against the criteria are outlined in Table 2 below.

Table 2: Ministerial Direction 4.1 Flooding

Direction 4.1 Requirement	Comment
(1) A planning proposal must include provisions that give effect to and are consistent with: (a) the NSW Flood Prone Land Policy, (b) the principles of the Floodplain Development Manual 2005, (c) the Considering flooding in land use planning guideline 2021, and (d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	The proposed subdivision has been assessed using models developed as part of the adopted Wagga Wagga Major Overland Flow Floodplain Risk Management Study and Plan. This study and the assessment have been undertaken giving consideration to the NSW Flood Prone Land Policy, the principles of both the Floodplain Development Manual 2005 and the Flood Risk Management Manual 2023 and the Considering flooding in land use planning guideline 2021. The recommended flood risk management strategies as part of the subdivision are based on the guidance and recommendations in these documents.
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	The proposed subdivision maintains an area of C2 Environmental Conservation through the land classified as the flood planning area. Higher density residential, employment, and mixed use zones are proposed for areas beyond the flood planning area.
(3) A planning proposal must not contain provisions that apply to the flood planning area which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties,	The proposed subdivision maintains an area of C2 Environmental Conservation through the land classified as the flood planning area.

(c) permit development for the purposes of residential accommodation in high hazard areas, (d) permit a significant increase in the development and/or dwelling density of that land, (e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, (f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent, (g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or (h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	Proposed development is beyond areas classified as floodway and high hazard, as defined in the Wagga Wagga Major Overland Flow Floodplain Risk Management Study and Plan. The subdivision has appropriately responded to the identified flood constraints through the integration of a central riparian corridor, a district park accommodating overland flow, and the strategic placement of sensitive land uses such as the school and senior living site. This has minimised potential flood impacts. Overall, the proposed subdivision increases the density of development, however within the flood planning area, an area of C2 Environmental Conservation is proposed. Effective evacuation is not restricted by the flooding constraints. The assessment and proposed flood risk management strategies have been designed to minimise the requirement for government spending on emergency management services, flood mitigation and emergency response measures.
(4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties, (c) permit a significant increase in the dwelling density of that land, (d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, (e) are likely to affect the safe occupation of and efficient evacuation of the lot, or	A portion of the proposed subdivision is located within the PMF extent and parts are subject to shallow inundation which is typically not classified as major overland flow. In addition, the current design excludes development from the floodway and high hazard areas. The subdivision has appropriately responded to the identified flood constraints through the integration of a central riparian corridor, a district park accommodating overland flow, road placement, and the strategic placement of sensitive land uses such as the school and senior living site. Effective evacuation is not restricted by the flooding constraints.

	(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.	The assessment and proposed flood risk management strategies have been designed to minimise the requirement for government spending on emergency management services, flood mitigation and emergency response measures.
(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.		The flood planning area has been derived from the adopted Floodplain Risk Management Study and Plan which has been developed in accordance with the principles outlined in both the Floodplain Development Manual 2005 and Flood Risk Management Manual 2023.

6. CONCLUSIONS

A review of the existing flooding constraints against the proposed development layout has been undertaken for the 225ha site in Rowan located at the intersection of Rowan Road and Holbrook Road.

The updated hydrologic and hydraulic assessment for the Rowan Village Planning Proposal provides a refined and robust understanding of existing, future, and extreme flood behaviour across the 225-hectare site. By incorporating updated 2020 LiDAR data, applying a locally representative suite of ARR 2019 design storms, and refining the model resolution, the study delivers an improved depiction of overland flow patterns and associated flood constraints that inform the development layout and future infrastructure planning.

The refined modelling confirms that the site is primarily influenced by shallow, overland flow from four distinct sub-catchments, with the central creek line and the Holbrook Road overflow remaining the dominant drivers of flood behaviour. While flood extents and depths increase progressively with event magnitude, the majority of the site, particularly the proposed residential areas, village centre, and key infrastructure, remains largely flood-free across all design events up to the PMF, with only localised areas requiring targeted drainage or land-forming solutions.

The assessment demonstrates that the proposed masterplan has appropriately responded to the identified flood constraints through the integration of a central riparian corridor, a district park accommodating overland flow, and the strategic placement of sensitive land uses such as the school and senior living site. Additional considerations, including drainage design for shallow flowpaths, appropriate bridge levels, and local earthworks, will ensure flood risks are effectively managed without adversely impacting the development and surrounding areas.

Future climate scenarios indicate modest increases in flood depths and new shallow flowpaths, reinforcing the importance of designing stormwater and overland flow infrastructure with an allowance for climate resilience. The inclusion of these scenarios provides confidence that the masterplan can adapt to changing conditions while maintaining safety and functionality.

Overall, the updated flood assessment confirms that, with the recommended design considerations, the Rowan Village development can be delivered in a safe, resilient, and sustainable manner, supporting the expansion of Wagga Wagga’s southern growth area.

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Figures

FIGURE 1
SITE LOCATION

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Creeks

0 0.2 0.4 0.6 0.8 1 km

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FIGURE 2
REFINED WBNM LAYOUT

N

Site Boundary
Sub-catchments
Creeks

0 0.4 0.8 1.2 1.6 2 km

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FIGURE 3
DEM COMPARISON
LIDAR 2020 VS 2008

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot Boundary
Mesh Refined Area

Difference (m)

- <= -1
- -1 - -0.75
- -0.75 - -0.50
- -0.5 - -0.2
- -0.2 - -0.1
- -0.1 - -0.02
- -0.02 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.1
- 0.10 - 0.2
- 0.2 - 0.5
- 0.50 - 0.75
- 0.75 - 1
- >1

0 0.2 0.4 0.6 0.8 1 km

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FIGURE 4

CHANGE IN PEAK FLOOD LEVEL - CURRENT MODEL VS MOFFRMS MODEL
1% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Land
Lot boundary
Change in Level (m)
Reduction more than -0.3
-0.3 - -0.1
-0.1 - -0.05
-0.05 - -0.01
-0.01 - 0.01
0.01 - 0.05
0.05 - 0.1
0.1 - 0.3
0.3 - 1
1 - 2
Increment more than 2
No longer flooded
Newly flooded

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 5
PEAK FLOOD DEPTH AND CONTOURS
20% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours

Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 6
PEAK FLOOD DEPTH AND CONTOURS
10% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours
Peak Water Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 7
PEAK FLOOD DEPTH AND CONTOURS
5% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 8
PEAK FLOOD DEPTH AND CONTOURS
2% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 9
PEAK FLOOD DEPTH AND CONTOURS
1% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 10

PEAK FLOOD DEPTH AND CONTOURS
0.5% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours

Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 11

PEAK FLOOD DEPTH AND CONTOURS
0.2% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours

Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 12
PEAK FLOOD DEPTH AND CONTOURS
PMF EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space
1m Contours
5m Contours

Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
> 2

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. DEPTHS BELOW 0.05 M HAVE BEEN FILTERED. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 13
HYDRAULIC HAZARD
20% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 14
HYDRAULIC HAZARD
10% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 15
HYDRAULIC HAZARD
5% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 16
HYDRAULIC HAZARD
2% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 17
HYDRAULIC HAZARD
1% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 18
HYDRAULIC HAZARD
0.5% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 19
HYDRAULIC HAZARD
0.2% AEP EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 20
HYDRAULIC HAZARD
PMF EVENT

Lot 1 DP1171894
Lot 18 DP1054800
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Development
Proposed Open Space

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. AREAS IMPACTED BY DEPTHS BELOW 0.05M HAVE NOT BEEN TRIMMED AND ARE SHOWN ON THE MAP. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 21

CLIMATE CHANGE SCENARIO - SSP2-4.5 – 2050 (1.7 ºC INCREASE)
CHANGE IN PEAK FLOOD LEVEL
1% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

- Site Boundary
- Lot boundary
- Proposed Open Space
- Proposed Development

Change in Level (m)

- Reduction more than -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- Increase more than 0.5
- No longer flooded
- Newly flooded

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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FIGURE 22

CLIMATE CHANGE SCENARIO - SSP3-7.0 – 2090 (3.3 ºC INCREASE)
CHANGE IN PEAK FLOOD LEVEL
1% AEP EVENT

Lot 18 DP1054800
Lot 1 DP1171894
Lot 23 DP1063399
Lot 66 DP757246
Lot 26 DP757246
Lot 65 DP757246
Lot 2 DP1171894
Lot 24 DP757246
Lot 43 DP757246

N

Site Boundary
Lot boundary
Proposed Open Space
Proposed Development

Change in Level (m)
Reduction more than -0.3
-0.3 - -0.1
-0.1 - -0.05
-0.05 - -0.02
-0.02 - -0.01
-0.01 - 0.01
0.01 - 0.02
0.02 - 0.1
0.10 - 0.25
0.25 - 0.5
Increase more than 0.5
No longer flooded
Newly flooded

0 0.2 0.4 0.6 0.8 1 km

NOTE: INUNDATION PATTERNS AND/OR PEAK FLOOD LEVELS SHOWN FOR DESIGN EVENTS ARE BASED ON BEST AVAILABLE ESTIMATES OF FLOOD BEHAVIOUR. ACTUAL INUNDATION PATTERNS MAY VARY SLIGHTLY DURING AN EVENT. MODEL ACCURACY IS ASSUMED TO BE WITHIN ± 0.3 M.

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Appendix A

APPENDIX A. GLOSSARY

Taken from the Floodplain Development Manual (April 2005 edition)

acid sulfate soils	Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger event occurring in any one year (see ARI).
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Annual Damage (AAD)	Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
Average Recurrence Interval (ARI)	The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
caravan and moveable home parks	Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.
catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	The Council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of DIPNR, as having the function to determine an application.
development	Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act). **infill development:** refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. **new development:** refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.

	redevelopment: refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves an their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).
flood mitigation standard	

	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammetic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the Aflood liable land@ concept in the 1986 Manual.
Flood Planning Levels (FPLs)	FPL=s are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the Astandard flood event@ in the 1986 manual.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood readiness	Flood readiness is an ability to react within the effective warning time.
flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. **existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain. **future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain. **continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood

	storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.
freeboard	Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.
habitable room	**in a residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. **in an industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
hazard	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: - the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or - water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or

- major overland flow paths through developed areas outside of defined drainage reserves; and/or

- the potential to affect a number of buildings along the major flow path.

mathematical/computer models — The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.

merit approach — The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State=s rivers and floodplains.

The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.

minor, moderate and major flooding — Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:

minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.

moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.

major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.

modification measures — Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 with further discussion in the Manual.

peak discharge — The maximum discharge occurring during a flood event.

Probable Maximum Flood (PMF) — The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.

Probable Maximum Precipitation (PMP) — The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.

probability	A statistical measure of the expected chance of flooding (see AEP).
risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	Equivalent to Awater level@. Both are measured with reference to a specified datum.
stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	A plan prepared by a registered surveyor.
water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	The horizontal distance in the direction of wind over which wind waves are generated.