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Our ref: L.003064.001.03_FIRA.docx

30 November 2023

Newton Denny Chapelle (NDC) Pty Ltd
31 Carrington Street
Lismore NSW 2480

Attention: Luke Fittock

Dear Luke

RE: PP-2022-502 REARDONS/DARKES LANE, SWAN BAY – QUALITATIVE FLOOD IMPACT AND RISK ASSESSMENT

This letter documents a high-level qualitative Flood Impact and Risk Assessment (FIRA) that has been undertaken by BMT to accompany an application to the NSW Department of Planning and Environment (DPE) for a Planning Proposal (PP-2022-502) for the land at corner of Reardons Lane & Darke Lane, Swan Bay.f

We trust that this assessment is adequate for your purposes. If you require further information or clarification regarding any aspect of this assessment, please do not hesitate to contact me by email (Netsanet.Shiferaw@apac.bmt.org).

Yours Sincerely,

BMT

Netsanet Shiferaw
Principal Flood Engineer

1 Introduction

The Planning Proposal PP-2022-502 relates to the land at corner of Reardons Lane & Darke Lane, Swan Bay (hereafter referred as the “Site”). It seeks to rezone part of the land presently zoned “RU1 – Primary Production” to “R5 – Large Lot Residential” in accordance with the provisions of the Richmond Valley Local Environmental Plan 2012.

1.1 Site Description and Applicable Existing Flood Study Report

The Site is located approximately 3 km south of Richmond River and east of Bungawalbin Creek. It is bounded by large rural lots to the north and east, Darke Lane to the south and Reardons Lane to the west. Figure 1.1 shows the locality map.

BMT Commercial Australia Pty Ltd (“BMT”) has recently completed the final ‘Richmond Valley Flood Study (RVFS)’ (BMT, September 2023). This study defines flood behaviour for a range of Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events across the Richmond Valley Local Government Area (LGA) of which the Site is part. This RVFS has replaced historic studies previously used by Richmond Valley Council (RVC) within the different parts of the LGA.

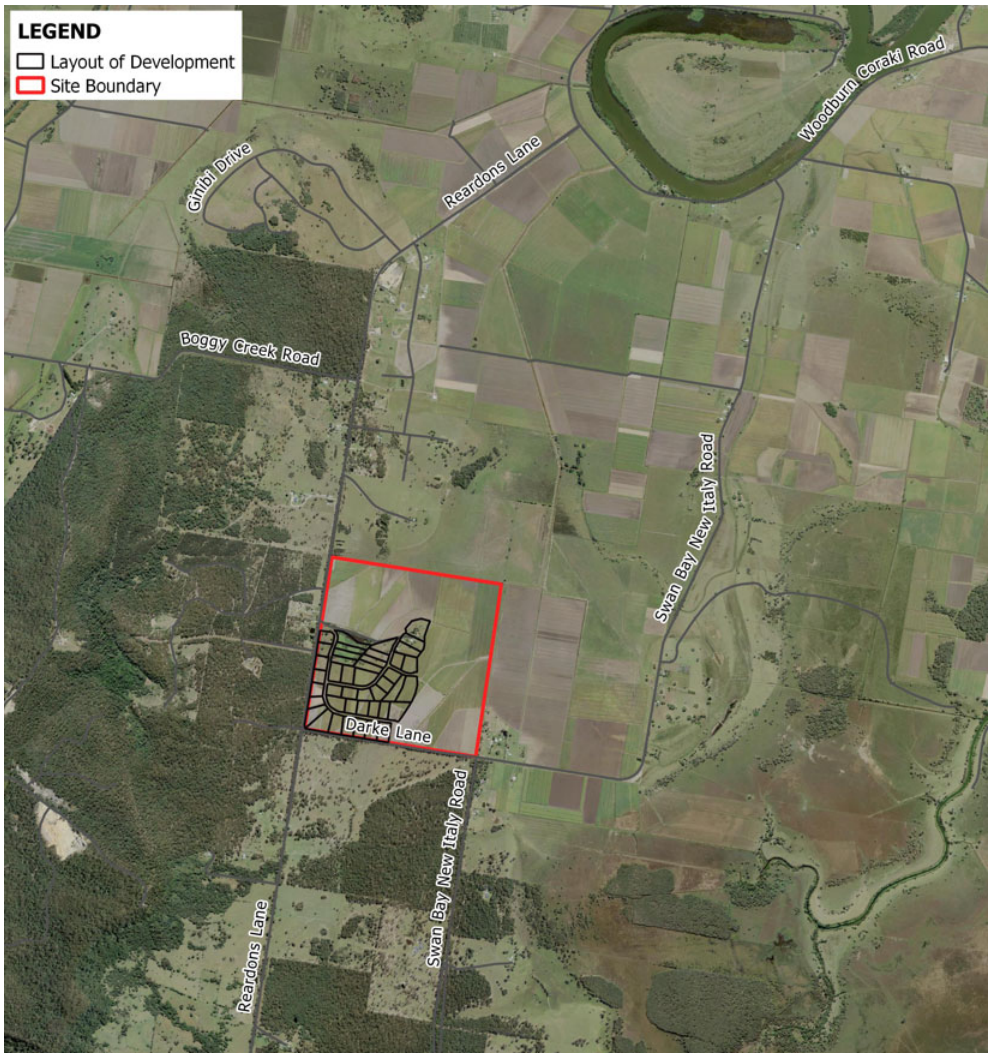

Figure 1.1 Site Locality Map

1.2 Existing Topography and Proposed Development Plan

Topographic (ground elevation) information was sourced from the RVFS model output. Figure 1.2 shows ground elevations across the Site. The minimum ground elevation is 1.4 m AHD, at the northwest corner. There is an existing ridge in the middle of the Site (with elevations ranging from 14.0m AHD to 16.2m AHD) that falls east or west.

Figure 1.3 shows the concept subdivision plan supplied by NDC that envisages 43 large residential lots. The lots are proposed to be situated on relatively higher grounds, with the low-lying land (below 5m AHD) retained as a farmland (not proposed to be rezoned).

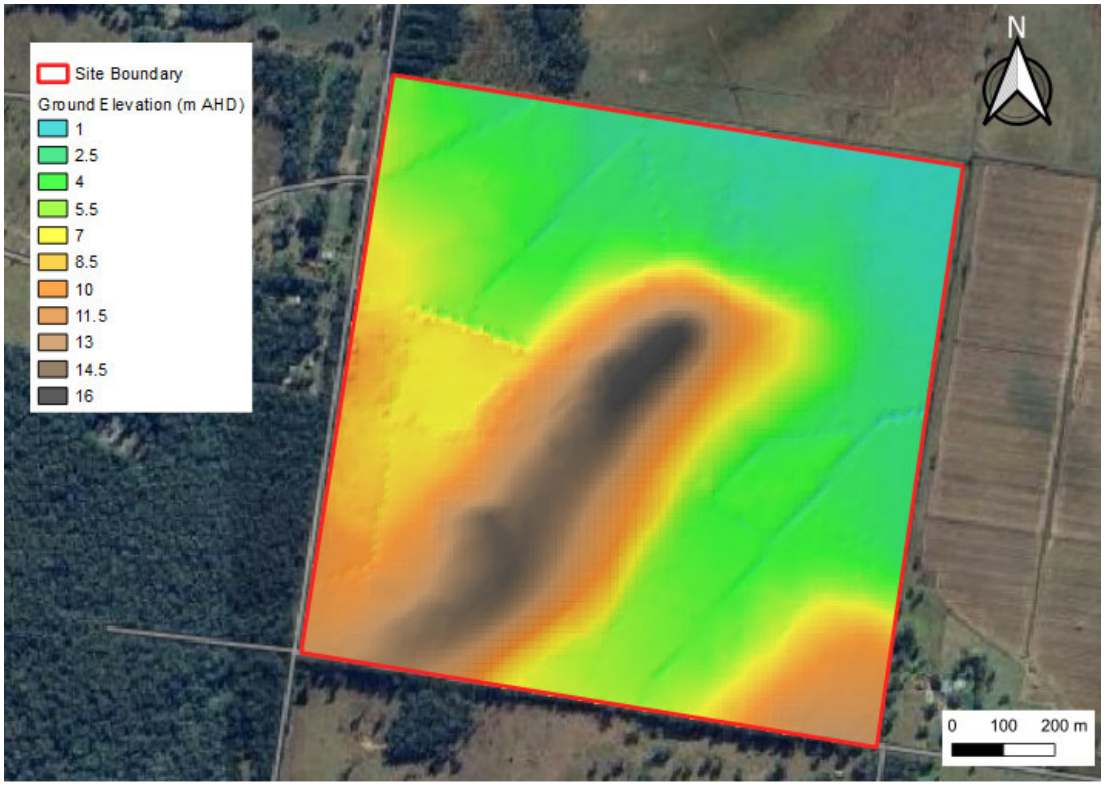

Figure 1.2 Modelled Exiting Topography (Sourced: RVFS BMT 2023)

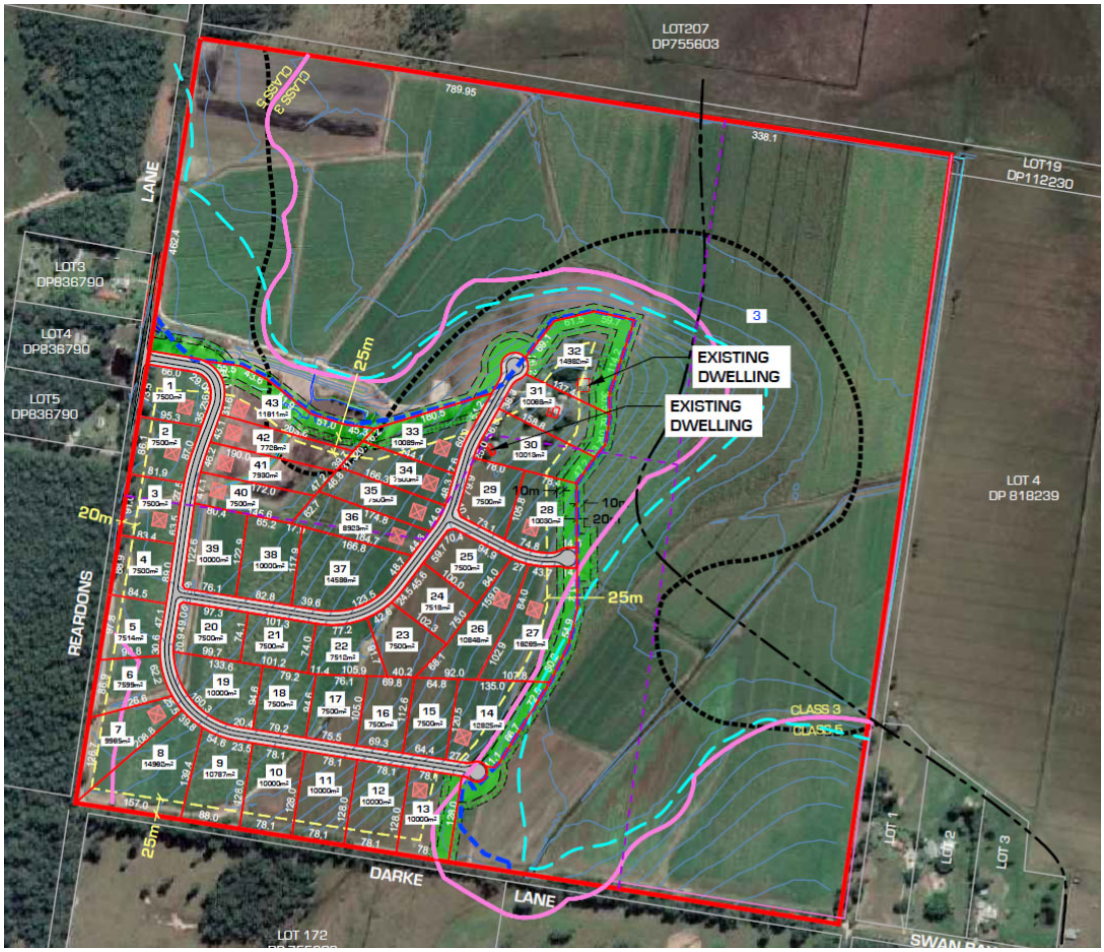

Figure 1.3 Concept Subdivision Plan (Revision J) (Source: NDC)

1.3 DPE's Flooding Requirements

Based on information supplied by NDC, DPE requires the following site-specific flood related requirements to assess the PP for a Gateway determination:

- Identify the flood risk up to and including the PMF level for the site;
- assess all flood and flood related hazards and risks;
- assess the impacts of any proposed filling on surrounding properties; and
- identify and evaluate evacuation routes including any areas proposed for shelter in place.

DPE recently released the Flood Impact and Risk Assessment (FIRA) guideline LU01 (DPE, 2023) which has two main assessment approaches, namely a detailed assessment or a simple assessment. NDC liaised with RVC and obtained confirmation of DPE agreement that the simple FIRA approach is adequate for the PP.

2 Defining Existing Flood Behaviour

2.1 Assessment Methodology

As per DPE's agreement, BMT has undertaken this FIRA based on the simple assessment approach. To that effect, a qualitative assessment of mainstream flood behaviour within and around the Site has been conducted based on an understanding of existing flood behaviour from the recently completed RVFS (BMT, September 2023). The assessment is detailed in the following sections.

2.2 Design Flood Conditions

2.2.1 Flood Mechanism

The flood mechanism at the Site was identified based on modelling results from the RVFS (BMT, September 2023) for a range of Annual Exceedance Probabilities (AEPs) and the probable maximum flood (PMF) event. The flood mechanism is described below, and the associated peak flood levels are shown in Figure 2.1 to Figure 2.5.

- **Richmond River flooding** - during the PMF, 0.2% AEP, 1% AEP, 2% AEP, and 5% AEP events, floodwaters break Richmond River's banks and spreads out to the floodplain, flowing southerly and inundating the Site across the northern and eastern Site boundaries.
- **Creek Tributary Overflow** - during the PMF, 0.2% AEP, 1% AEP and 2% AEP events, overflow from a small tributary of Bungawalbin Creek overtops Reardons Lane and flows into the Site in the northwest corner.

Figure 2.1 Design Peak Flood Levels - 5% AEP Event

Figure 2.2 Design Peak Flood Levels – 2% AEP Event

Figure 2.3 Design Peak Flood Levels – 1% AEP Event

Figure 2.4 Design Peak Flood Levels – 0.2% AEP Event

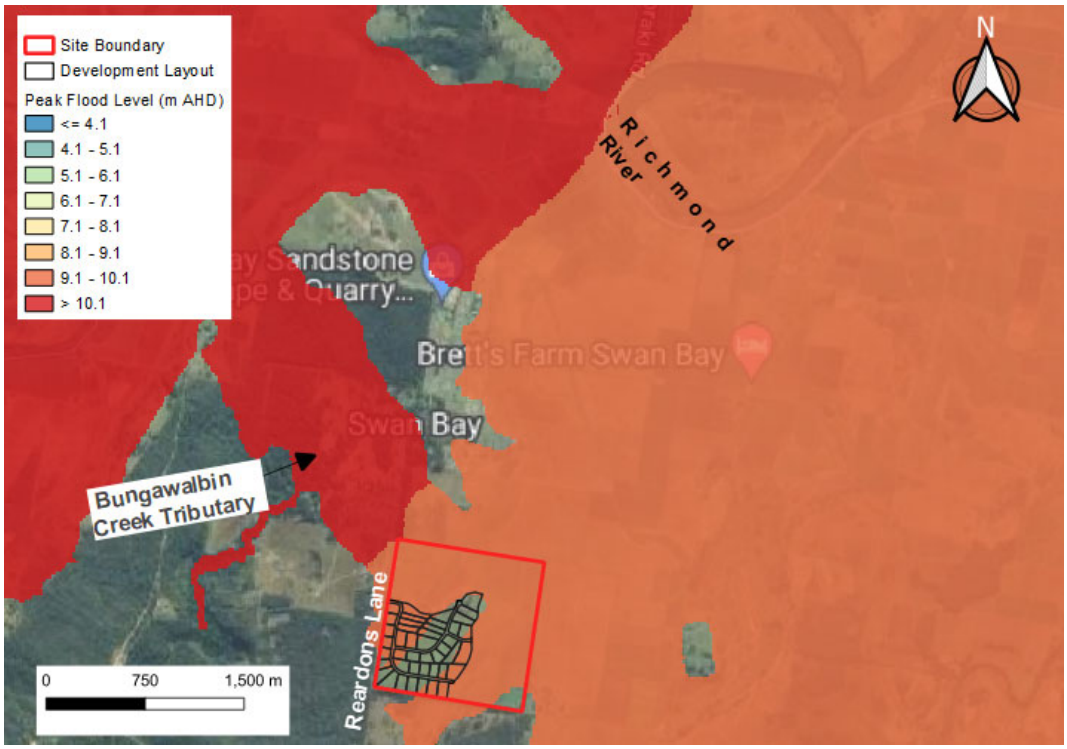

Figure 2.5 Design Peak Flood Levels – PMF Event

2.2.2 Peak Flood Levels

Design peak flood levels at the Site extracted from the RVFS (BMT, September 2023) are summarised in Table 2.1. Table 2.2 identifies the proposed lots that are significantly or fully inundated (orange highlighted), slight to minor inundated (yellow highlighted) and flood-free (green highlighted). With reference to Table 2.1, Table 2.2 and Figure 2.1 to Figure 2.5, commentary on flood effect (i.e. inundation) of the proposed conceptual subdivision plan is provided as follows:

- All of the 43 proposed lots are flood-free up to and including the 1% AEP event (green highlighted).
- There are 15 lots that are flood-free during the PMF event (green highlighted).
- There are 3 lots that are very slightly affected during the 0.2% AEP event (yellow highlighted).
- Thre are 11 lots that are slightly or partially inundated during the PMF event (yellow highlighted).
- There are 17 lots that are significantly or fully inundated during the PMF event (orange highlighted).

Table 2.1 Design Peak Flood Levels at the Site

Design Flood Event	Peak Flood Level at the northwest corner (m AHD)	Peak Flood Level at the northeast corner (m AHD)
5% AEP	4.15	4.15
2% AEP	4.61	4.61
1% AEP	5.02	5.01
0.2% AEP	5.99	5.98
PMF	10.10	10.08

Table 2.2 Level of Flood Affection of Proposed Lots

Flood Affection	1% AEP	0.2% AEP	PMF
Flood-free lots	All lots	All lots except for 13, 14 and 27	8, 9, 10, 16, 17, 18, 21, 22, 23, 24, 25, 29, 30, 31 and 37
Slightly to partially inundated lots	None	13, 14 and 27	7, 11, 15, 19, 26, 28, 32, 33, 34, 35, and 36
Fully inundated lots	None	None	1, 2, 3, 4, 5, 6,12, 13, 14, 27, 20, 38, 39, 40, 41, 42 and 43

2.3 Flood Depth and Flood Hazard

Peak flood depth maps are contained in Annex A of this letter, as listed below:

- Figure A-01 Peak Flood Depth - 5% AEP Event
- Figure A-02 Peak Flood Depth - 2% AEP Event
- Figure A-03 Peak Flood Depth - 1% AEP Event
- Figure A-04 Peak Flood Depth – 0.2% AEP Event
- Figure A-05 Peak Flood Depth - PMF Event

The Flood Hazard Guideline 7-3 of the Australian Disaster Resilience Handbook 7, *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017) represents current industry best practice with regards to defining flood hazard. The guideline recommends a composite six-tiered hazard classification that is determined based on predicted depth and velocity of floodwaters, and corresponds to the potential vulnerability of people, vehicles and structures (as reproduced in Figure 2.6 and listed in Table 2.3).

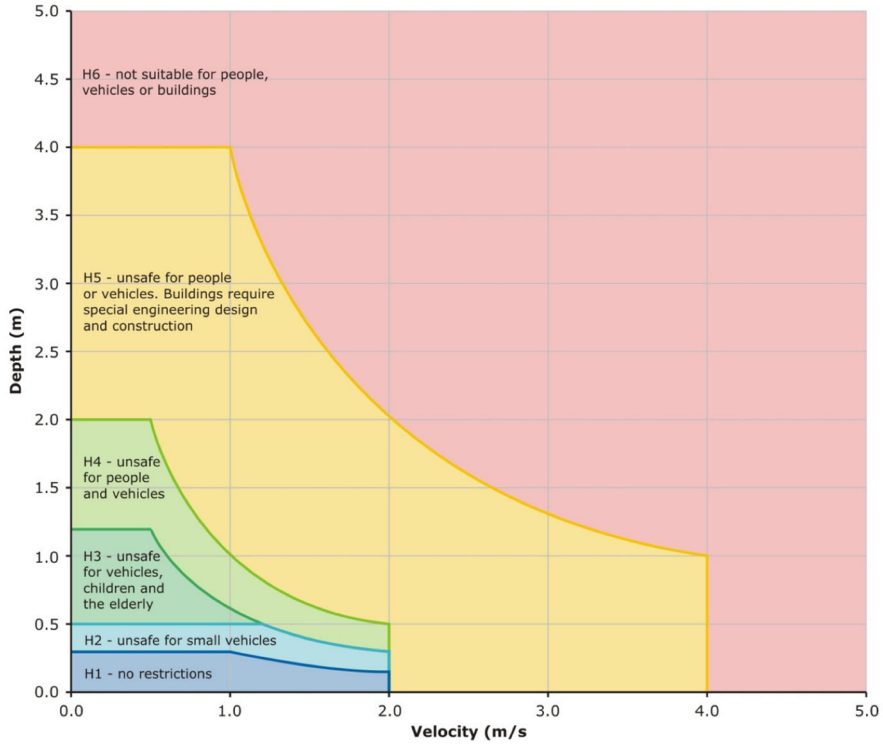

Figure 2.6 AIDR (2017) Combined Flood Hazard Curves

Table 2.3 Best Practice Provisional Flood Hazards (AIDR, 2017)

Hazard	Criteria	Description
H1	Depth < 0.3 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.3 m^2/s	Generally safe for vehicles, people and buildings.
H2	Depth < 0.5 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.6 m^2/s	Unsafe for small vehicles.
H3	Depth < 1.2 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.6 m^2/s	Unsafe for vehicles, children and the elderly.
H4	Depth < 2.0 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 1.0 m^2/s	Unsafe for vehicles and people.
H5	Depth < 4.0 m and Velocity < 4.0 m/s and Velocity*Depth ≤ 4.0 m^2/s	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
H6	Depth > 4.0 m OR Velocity > 4.0 m/s OR Velocity*Depth > 4.0 m^2/s	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Peak flood hazard maps are contained in Annex A of this letter, as listed below:

- Figure A-06 Peak Flood Hazard - 5% AEP Event
- Figure A-07 Peak Flood Hazard - 2% AEP Event
- Figure A-08 Peak Flood Hazard - 1% AEP Event
- Figure A-09 Peak Flood Hazard – 0.2% AEP Event
- Figure A-10 Peak Flood Hazard – PMF Event

Key results are summarised below.

- The land that is proposed to be retained as a farmland (not proposed to be rezoned) is classified predominately as H3 to H5 flood hazard during the 1% AEP event.
- The proposed lots subject to PMF inundation are classified as high hazard (predominately H3 to H5, with a maximum of H6 on the eastern lots).
- The land that is proposed to be retained as a farmland (not proposed to be rezoned) is classified as H6 flood hazard during PMF event.

2.4 Proposed Site Access

Located approximately 0.5 km south of the northern Site Boundary, the proposed site access is via Reardons Lane. The access is:

- Flood-free up to and including the 0.2% AEP event.
- Inundated and classified as H4 to H5 flood hazard during the PMF event.

2.5 Flood Behaviour of Regional Evacuation Routes

There are three potential evacuation routes from the Site. Flooding characteristics along these routes are described below.

North Bound Via Reardons Lane

Evacuation to the north via Reardons Lane is not considered viable during a major flood. Sections of Reardons Lane that are subject to flooding include:

- Reardons Lane between its intersection with Casuarina Drive to Woodburn-Coraki Road (hereafter referred as “North-Bound 1” and shown in Figure 2.7). It is cut off during the 5% AEP event.
- Reardons Lane between the proposed Lot 6 and the intersection with Eucalypt Drive (hereafter referred as “North-Bound 2” and shown in Figure 2.7). This section is:
  - Flood-free during the 5% AEP event.
  - Classified as H1 hazard (deemed generally safe for small vehicles and people) during the 2% AEP event.
  - Cut off during the 1% AEP event.

East Via Darke Lane and then South Via Swan Bay-New Italy Road

Flooding characteristics of Darke Lane halfway between intersections with Reardons Lane and Swan Bay-New Italy Road (hereafter referred as “East-Bound 1” and shown in Figure 2.7) is described below.

- It is flood-free up and including the 1% AEP event.
- During the 0.2% AEP event, it is classified as H1 flood hazard.
- During the PMF event, it is classified predominately as H5 flood hazard.

Whilst the Darke Lane (“East-Bound 1”) is flood-free up to and including 1% AEP event, Swan Bay-New Italy Road will be cut off during the 5% AEP approximate 2.5 km south of its intersection with Darke Lane (hereafter referred as “South-Bound 1” and shown Figure 2.7). Hence, this road cut off location will prohibit the ability to evacuate via Darke Lane to the south.

South Bound Via Reardons Lane

Heading south, Reardons Lane (starting from adjacent to the proposed Lot 6) leads to Moonem New Italy Road that in turn leads to an unnamed Road that leads to Cypress Road which ultimately connects with the M1 Pacific Motorway, spanning a distance of approximately 11 km. This route (hereafter referred as “South-Bound 2” and shown Figure 2.7) is predicted to be flood-free during the Richmond River PMF event.

Figure 2.8 to Figure 2.10 show stage hydrographs (flood depth over time) at the road cut off locations extracted from TUFLOW modelling results from the RVFS (BMT, September 2023). It is noted that the stage hydrographs were not simulated to zero flood depth. Thus, the stage hydrographs have been extrapolated based on the rate of drawdown, to approximate the total periods of inundation. Table 2.4 summarises the approximated total periods of inundation at the road cut off locations.

Table 2.4 Periods of Inundation at Road Cut Off Locations

Evacuation Route	5% AEP	1% AEP	PMF
North-Bound 1	3 to 5 days	5 to 6 days	9 days
North-Bound 2	Flood-free	2 days	8 days
East-Bound 1	Flood-free	Flood-free	6 days
South-Bound 1	3 days	4 to 5 days	8 days
South-Bound 2	Flood-free	Flood-free	Flood-free

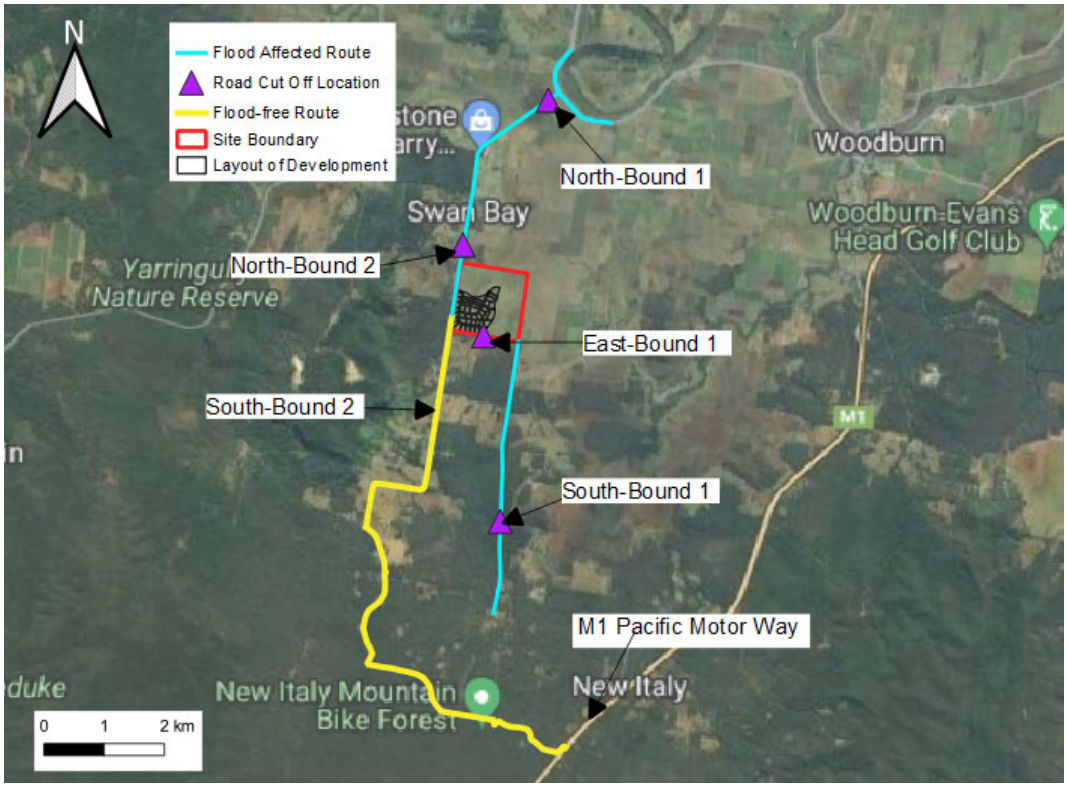

Figure 2.7 Regional Evacuation Routes and Road Cut Off Locations

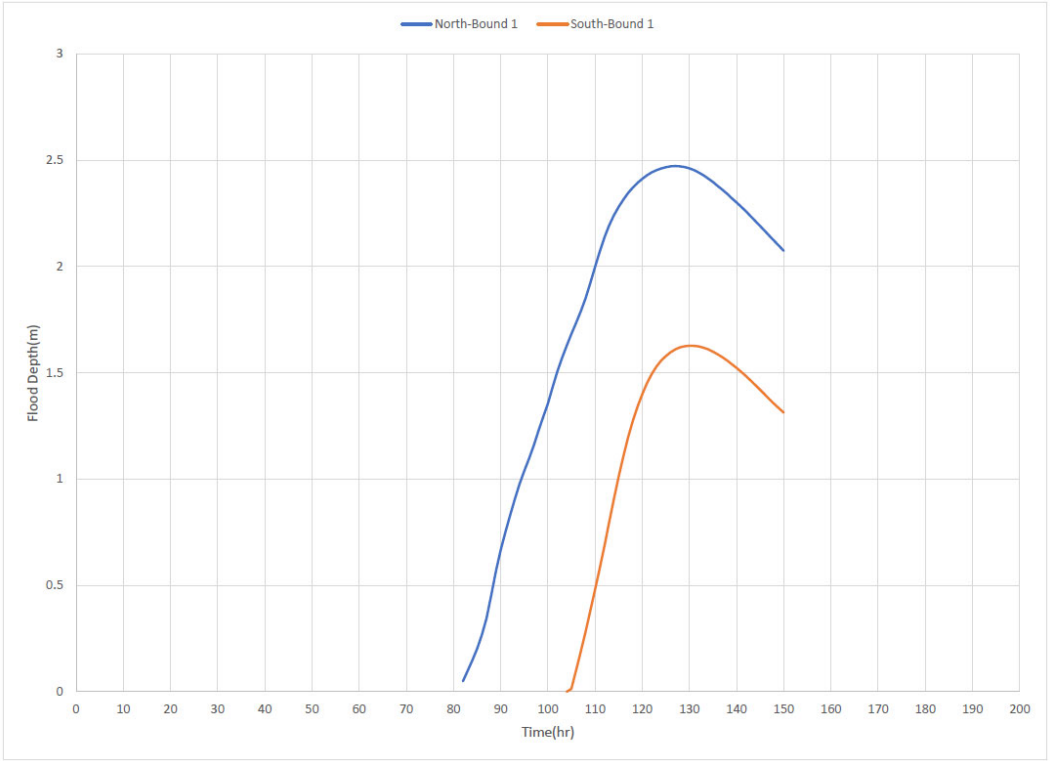

Figure 2.8 Flood Depth Hydrograph at Road Cut Off Locations – 5% AEP Event

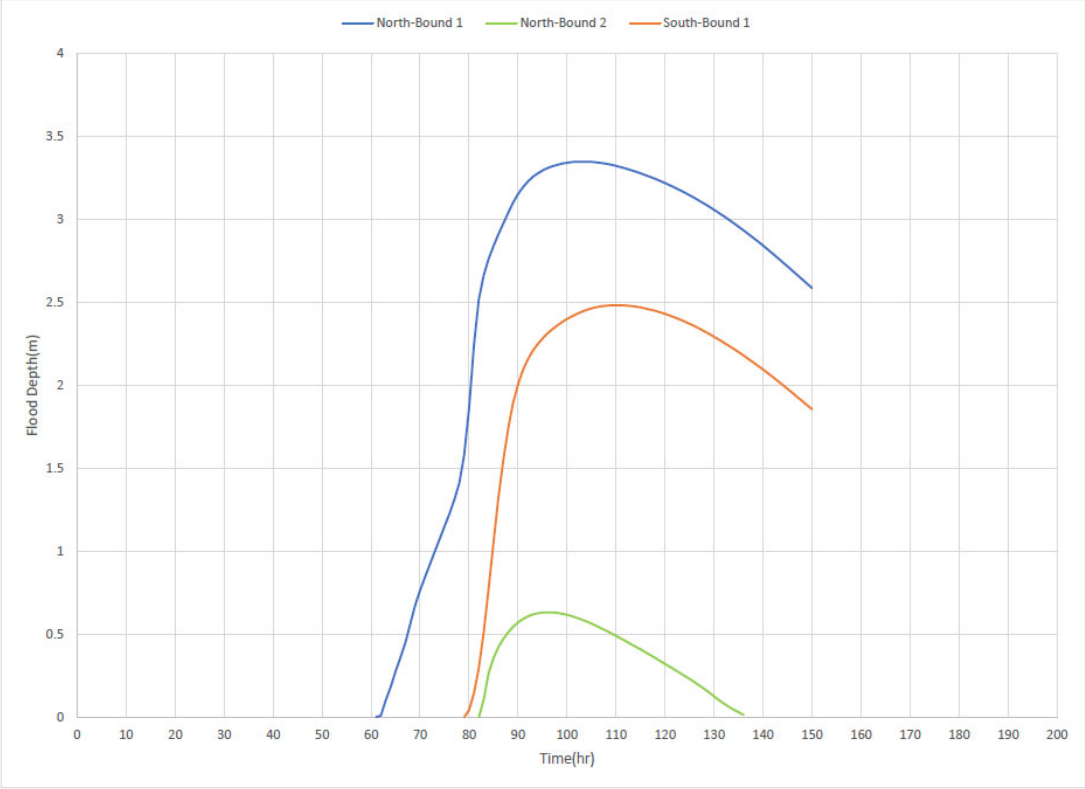

Figure 2.9 Flood Depth Hydrograph at Road Cut Off Locations – 1% AEP Event

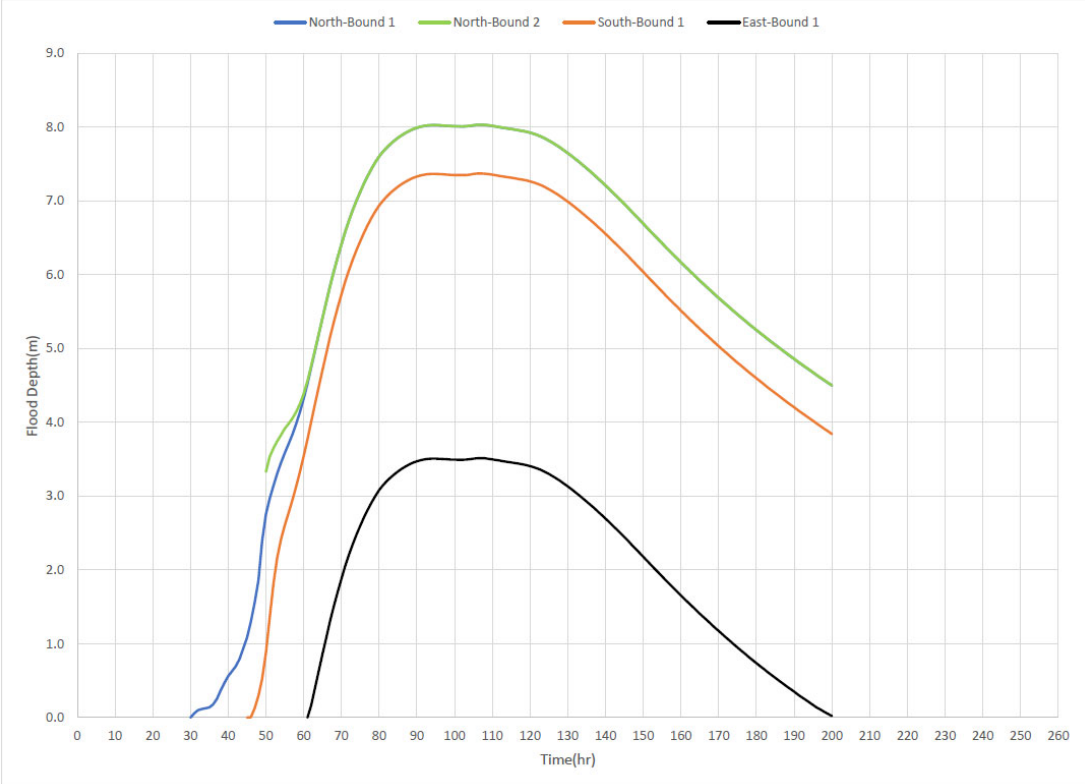

Figure 2.10 Flood Depth Hydrograph at Road Cut Off Locations – PMF Event

2.6 Bureau of Meteorology

The Bureau of Meteorology (BOM) provides flood information to assist with evacuation. BOM indicates that warning time for a Richmond River flood is typically 3-4 days. BOM provides the following flood gauge and associated information based on the gauge at Woodburn that can be used as a guide for riverine flood levels pertinent to Swan Bay:

- Station details**:** Station Number: 058061 Name: Richmond River at Woodburn
- Flood levels: Minor: 3.20 Moderate: 3.70 Major: 4.20. Refer to Figure 2.11.

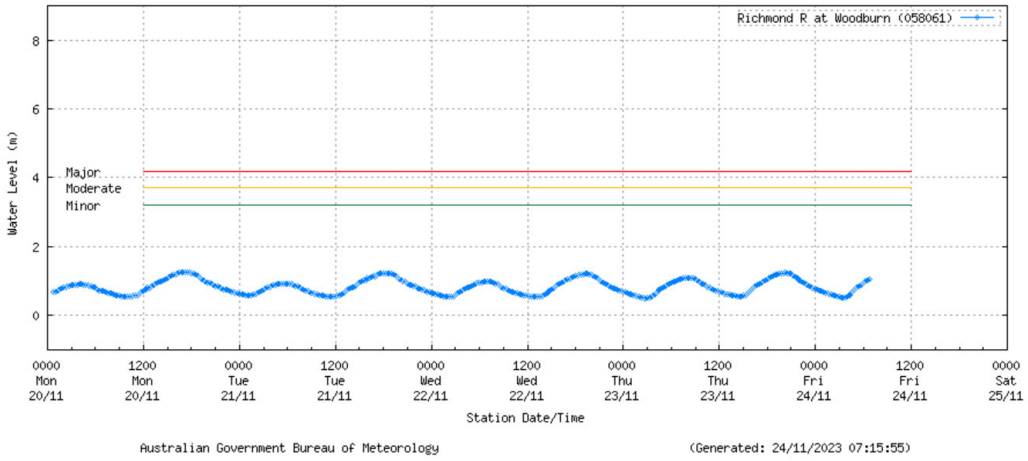

Figure 2.11 Flood Indicator at Woodburn Gauge (Source: BOM)

2.7 Review of Richmond Valley Flood Emergency Sub Plan 2023

The Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023) sets out the RVC level emergency management arrangements for prevention, preparedness, response and initial recovery for flooding in the LGA. Flood intelligence available within this plan, and pertinent to the Site, are summarised below.

- The Woodburn flood gauge provides flood information relevant for Swan Bay.
- Swan Bay may experience inundation of property from a 5% AEP flood event (approximately 1 property). In a 1% AEP event, this increases to approximately 17 properties in Swan Bay.
- At 3.4m on the Woodburn gauge, some roads may begin to close, including the Woodburn-Coraki Rd.
- At 3.95m Woodburn gauge, many rural areas are already affected by inundation or isolation, including Swan Bay.
- In a modelled 5% AEP event (equivalent to 4.4m at the Woodburn Gauge), flood depths affecting main access routes for Swan Bay range from 0.3m to >1m.
- In an event corresponding to a 5% AEP, there would be significant disruptions with many localised stretches of roads being inundated in the RVC LGA. In a 1% AEP flood, the majority of key roads in the LGA are affected by deep inundation to a depth greater than one metre.
- Potential periods of isolation for Swan Bay are estimated to be 3-5 days.

SES provides riverine flood levels and consequences based on flood gauge at Richmond River at Woodburn. This indicates that at moderate flood height Evacuation warnings will begin to be issued by NSW SES.

Heights at gauge	Expected consequence
5.22m	**Peak Height - Flood of record 1954**
5.12m	About 90% of Woodburn is now isolated.
5.07m	**Peak Height - February 1956**
4.91m	**Peak Height - March 1974**
4.70m	**Peak Height - April 1989**
4.40m	About 20 shops experience flooding.
4.20m	**Major Flood Height.** Approximate height at which water flows over the highway at the IGA Supermarket in River Street. The majority of the elevated residences in Woodburn will have water in the lower levels.
4.14m	Rocky Mount Creek breaks its banks flooding the lower areas in southern Woodburn.
4.12m	Flood water start to flow underneath the houses in the northern section of Woodburn.
4.04m	**Peak Height - April 1989**
3.70m	**Moderate Flood Height.** Evacuation warnings will begin to be issued by the NSW SES.
3.40m	Woodburn to Coraki Road could close from around this height.
3.20m	**Minor Flood Height.** Water starts to build over the road between Woodburn and Coraki.

Key heights in metres at the Woodburn flood gauge

Figure 2.12 Riverine Flood Levels and Consequences (Source: NSW SES)

3 Flood Impact and Risk Assessment

3.1 Offsite Flood Impact Assessment

3.1.1 Rare Food Event

As discussed in the preceding sections, the proposed concept subdivision plan avoids land affected by Richmond River flooding up to and including the 0.2% (1 in 500) AEP event. Hence, during these events, the proposed development is not expected to have an adverse offsite flood impact up to and including the 1 in 500 AEP events.

3.1.2 Extreme Event

During the PMF event, of the 43 proposed lots:

- 15 are predicted to be flood-free.
- 17 are predicted to be significantly inundated.
- 11 are predicted to be slightly/partially inundated.

The flood affected (flood prone) lots are classified as high hazard (predominately H3 to H5, with a maximum of H6 on the eastern lots). Given this, potential filling or proposed building structures could alter flood conditions during the PMF event. It is recommended to avoid significant filling or flow-obstruction within these lots. If filling or building support structures are proposed, it is necessary to undertake a detailed flood modelling, at the DA application stage, to demonstrate that the works will not cause an adverse flood impact to adjoining properties.

3.2 On-Site Flood Risk Appraisal

3.2.1 Approach

A flood risk assessment specific to the Site was therefore undertaken to confirm whether the likely development of the land, including appropriate risk mitigation measures, is compatible with the flood hazard. The risk assessment was prepared in accordance with recommendations and guidance included in the following document:

- Australian Institute for Disaster Resilience (AIDR) (2020). *National Emergency Risk Assessment Guidelines*.

The consequence and likelihood levels employed in the risk appraisal were also drawn from the *National Emergency Risk Assessment Guidelines* (AIDR, 2020). The adopted consequence and likelihood levels are listed in Table 3.1 and Table 3.2. It can be noted that the consequence and likelihood levels nominated for each identified risk relate to conditions without management measures in place.

Table 3.1 People Consequence Level

Consequence Level	Qualitative Description
Insignificant	Minor injuries; Deaths less than 1 in 10,000,000; no environmental impact detected.
Minor	Serious injuries greater than 1 in 1,000,000 people; Deaths greater than 1 in 10,000,000; minor impact on the environment.
Moderate	Serious injuries greater than 1 in 100,000 people; Deaths greater than 1 in 1,000,000; significant damage to environmental values; widespread inconveniences.
Major	Serious injuries greater than 1 in 10,000 people; Deaths greater than 1 in 100,000; severe damage to environmental values.
Catastrophic	Critical injuries for greater than 1 in 10,000 people; Deaths greater than 1 in 10,000; permanent destruction of environmental values.

Table 3.2 Likelihood Level

Likelihood Level	AEP	Average recurrence interval	Events extracted from RVFS (BMT, 2023)
Unlikely	1% to < 10%	10 to < 100-year	5% AEP
Rare	0.1% to < 1%	100 to < 1000-year	1% AEP and 0.2% AEP
Extremely rare	Less than 0.01%	10,000 years or more	PMF

The level of risk depends on the likelihood of the risk occurring and its consequence. The risk criteria employed for this assessment, which were drawn from the qualitative risk matrix presented the National Emergency Risk Assessment Guidelines (AIDR, 2020) are shown in Table 3.3.

Table 3.3 Qualitative Risk Matrix (Source: AIDR, 2020)

	CONSEQUENCE LEVEL				
LIKELIHOOD	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
ALMOST CERTAIN	Medium	Medium	High	Extreme	Extreme
LIKELY	Low	Medium	High	Extreme	Extreme
UNLIKELY	Low	Low	Medium	High	Extreme
RARE	Very low	Low	Medium	High	High
VERY RARE	Very low	Very low	Low	Medium	High
EXTREMELY RARE	Very low	Very low	Low	Medium	High

Table 3.4 Site-Specific Flood Risk

Proposed Lots	Flood Hazard			Period of Isolation		
	5% AEP	1% AEP	PMF	5% AEP	1% AEP	PMF
8, 9, 10, 16, 17, 18, 21, 22, 23, 24, 25, 29, 30, 31 and 37	None	None	None	3 to 5 days	5 to 6 days	8 to 9 days
7, 11, 15, 19, 26, 28, 32, 33, 34, 35, and 36 (Partially inundated)	None	None	H3 to H5	3 to 5 days	5 to 6 days	8 to 9 days
1, 2, 3, 4, 5, 6, 12, 13, 14, 27, 20, 38, 39, 40, 41, 42 and 43 (Fully inundated)	None	None	H3 to H5	3 to 5 days	5 to 6 days	8 to 9 days

Table 3.5 Site-Specific Flood Risk Matrix Without Adoption of Treatment Options

Proposed Lots	Flood Hazard			Isolation		
	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating
8, 9, 10, 16, 17, 18, 21, 22, 23, 24, 25, 29, 30, 31 and 37	None	None	None	Unlikely	Minor	Low
7, 11, 15, 19, 26, 28, 32, 33, 34, 35, and 36 (Partially inundated)	Extremely rare	Moderate	Low	Unlikely	Moderate	Low
1, 2, 3, 4, 5, 6,12, 13, 14, 27, 20, 38, 39, 40, 41, 42 and 43 (Fully inundated)	Extremely rare	Major	High	Extremely rare	Catastrophic	High

3.2.2 Identification and Flood Risk Treatment Options

Possible treatment options have been considered to manage the existing flood risks. Table 3.6 presents available treatment options.

With reference to Table 3.6, buildings must demonstrate structural stability up to the PMF so as to withstand the hydrostatic, hydrodynamic, buoyancy and debris loads of PMF conditions. Verification by a suitably qualified structural engineer and compliance with the Building Code of Australia would be required.

Table 3.7 shows site-specific residual risk matrix with the adoption of the proposed treatment options. It is noted that as off-site evacuation is proposed to be the primary flood emergency response strategy, and habitable floor levels are proposed to be above PMF, potential injury or death directly caused by flood hazard is unlikely, but there would be a risk of isolation for some of the lots that do not have PMF flood-free access (if off-site evacuation fails for various reasons). Given this, the 'moderate' consequence level was conservatively adopted for these lots with respect to risk of isolation.

Table 3.6 Site-Specific Flood Risk Treatment Options

Proposed Lots	Overall Risk Rating	Treatment Option	Evaluation of treatment option
8, 9, 10, 16, 17, 18, 21, 22, 23, 24, 25, 29, 30, 31 and 37	Low	-Early evacuation based on BOM flood warning. -Providing a secondary emergency access road at the south-west corner. -prepare a detailed FERP.	-It will avoid risk of long periods of isolation. -This will enable residents to evacuate off-site during PMF event. -to outline triggers and procedures for off-site evacuation.
7, 11, 15, 19, 26, 28, 32, 33, 34, 35, and 36 (Partially inundated)	Low	-Construct habitable floor on PMF flood-free land. -early evacuation based on BOM flood warning -prepare a detailed FERP.	-It will avoid direct exposure to high flood hazard -enables early off-site evacuation prior to major flooding. -outlines triggers and procedures for off-site evacuation.
1, 2, 3, 4, 5, 6,12, 13, 14, 27, 20, 38, 39, 40, 41, 42 and 43 (Fully inundated)	High	-Construct habitable floor level above the PMF level. -early evacuation based on BOM flood warning. -prepare a detailed FERP.	-It will avoid direct exposure to high flood hazard. -enables early off-site evacuation prior to major flooding -to outline triggers and procedures for off-site evacuation.

Table 3.7 Specific Flood Risk Matrix with Adoption of Treatment Options

Proposed Lots	Flood Hazard			Isolation		
	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating
8, 9, 10, 16, 17, 18, 21, 22, 23, 24, 25, 29, 30, 31 and 37	None	None	None	Extremely rare	None	Low

Proposed Lots	Flood Hazard			Isolation		
	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating
7, 11, 15, 19, 26, 28, 32, 33, 34, 35, and 36 (Partially inundated)	None	None	None	Extremely rare	Moderate	Low
1, 2, 3, 4, 5, 6,12, 13, 14, 27, 20, 38, 39, 40, 41, 42 and 43 (Fully inundated)	None	None	None	Extremely rare	Moderate	Low

4 High Level Flood Emergency Response Strategy

Based on the existing flood behaviour and risk at the Site and potential flood risk treatment options discussed in preceding sections, the following constraints and opportunities have been taken into consideration to formulate an appropriate flood risk management and emergency response approach.

4.1.1 Assessment of Available Strategies

There are two primary flood emergency response strategies, namely evacuation off-site and shelter-in-place (SIP), where SIP is the movement of occupants to a suitable flood-free location to shelter during a flood event (e.g., vertical refuge on the Site or near the Site at an elevation above the PMF level).

In accordance with the Department of Planning and Environment (DPE)'s 'Support for emergency management planning - Flood risk management guideline EM01' (DPE, 2023), the preferred emergency management approach is evacuation, where evacuation capacity and capability has been demonstrated as the most effective strategy to manage risks.

The following factors have been considered to formulate a high-level flood emergency response strategy for the proposed development:

- Warning time for a Richmond River flood is typically 3 to 4 days, providing adequate warning and preparation time for an early off-site evacuation.
- Most of regional evacuation routes are predicted to be cut off during the 5% AEP event. Hence, off-site evacuation is anticipated to be required more frequently than the 1 in 20 year event.
- The proposed development Site will be liable to long periods of isolation (up to 8 days during the 1% AEP event) if residents do not evacuate. There is potential risk of sewerage, power, phones and internet being lost during flood events, in addition to inadequate provisions of food, water and medication.
- 15 of the proposed lots are predicted to be flood-free during the PMF event. For the remainder of the lots, it is proposed that habitable floor levels be set above the PMF level. Proposed buildings must demonstrate structural stability up to the PMF so as to withstand the hydrostatic, hydrodynamic, buoyancy and debris loads of PMF conditions. Verification by a suitably qualified structural engineer and compliance with the National Construction Code (NCC) would be required.
- The "South-Bound 2" route is predicted to be flood-free during the PMF event. This route can serve as access to or egress from the Site during rare or extreme events for the lots that have PMF flood-free drive and access.

Based on the flooding behaviour and risk at the Site and along regional evacuation routes, and the proposed flood risk treatment options, the following strategies are proposed:

- Evacuation off-site is proposed as the primary flood emergency response strategy.
- Provision of refuge (habitable flood level) above the PMF in lots partially or fully inundated in the PMF event will also be provided as a secondary flood emergency response strategy. The requirement to construct lots in this fashion can be tied to land title at the time of sale and retained in perpetuity.

A detailed operational plan should be prepared outlining the proposed strategy for flood emergency response, including flood warning and trigger systems, what actions are required before, during and after a flood.

Education is critical to ensuring that the occupants of the Site are aware of actions to be taken before, during and after off-site evacuation and the key triggers that require these.

5 Conclusions

BMT has prepared this qualitative Flood Impact and Risk Assessment (FIRA) to accompany an application to the NSW Department of Planning and Environment (DPE) for a Planning Proposal (PP-2022-502). The Planning Proposal relates to the land at corner of Reardons Lane & Darke Lane, Swan Bay and seeks to rezone part of the land presently zoned Primary Production to Large Lot Residential in accordance with the provisions of the Richmond Valley Local Environmental Plan 2012. The proposed concept subdivision plan envisages 43 large residential lots.

The FIRA was based on the simple assessment approach in accordance with the FIRA guideline LU01 (DPE, 2023). The assessment was conducted based on an understanding of existing flood behaviour from the recently completed Richmond River Flood Study (RVFS) (BMT, September 2023).

Key findings of the FIRA are summarised below:

- The proposed residential lots are situated on relatively higher grounds, with the low-lying land (below 5m AHD) retained as a farmland (not proposed to be rezoned).
- The proposed concept plan avoids land affected by Richmond River flooding up and including the 0.2% (1 in 500) AEP events. Hence, during these events, the proposed development is not expected to have an adverse offsite flood impact up to and including the 1 in 500 AEP events.
- During the probable maximum flood (PMF), of the proposed 43 lots, 15 are predicted to be flood-free, 11 are predicted to be slightly/partially inundated and 17 are predicted to be significantly or total inundated. Flood affected (flood prone) lots are classified as high hazard (H3 to H5, with a maximum of H6 on the eastern lots). Filling or building works within the flood prone area has the potential to alter the flood behaviour. Thus, it is recommended to avoid significant filling or flow-obstruction within the flood prone land. If filling or building support structures are proposed, it is necessary to undertake a detailed flood modelling, at the DA application stage, to demonstrate that the works will not cause an adverse flood impact to adjoining properties.
- As habitable floor levels are proposed to be above the PMF level for all the proposed lots, the development will exceed the Flood Planning Level (FPL) requirement which is 1% AEP + 0.5m freeboard.
- Regional evacuation routes around the Site are predicted to be cut off in the 5% AEP event, resulting in 3 to 5 days period of isolation during this event. During the PMF event, the period of isolation can increase up to 9 days.
- Heading south, Reardons Lane (starting from adjacent to the proposed Lot 6) leads to the M1 Pacific Motor Way (spanning a distance of approximately 11 km) is predicted to be flood-free during the Richmond River PMF event. This route can serve as access to or egress from the Site during rare or extreme events.
- Warning time for a Richmond River flood is typically 3 to 4 days, providing adequate warning and preparation time for an early off-site evacuation.
- The major flood risks (without mitigation options) involve the direct exposure of the 28 proposed lots to high flood hazard (H3 to H5, with a maximum of H6 on the eastern lots) during the PMF event), and liability to periods of long isolation for all the proposed lots.

- As part of flood risk treatment options:
    - It is proposed that all habitable floor level be set above the PMF flood level, ensuring the buildings are to be designed and constructed commensurate with the hydrostatic, hydrodynamic, buoyancy and debris loads of PMF event.
    - It is recommended to provide a secondary flood emergency access at the southwest corner of the site that is flood-free during the PMF event.
    - The primary flood emergency response strategy is off-site evacuation prior to major flooding based on BOM's and SES flood warning system. It is proposed to prepare a detailed flood emergency response plan to outline triggers and procedures for initiating off-site evacuation consistent with current flood emergency planning outlined in the Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023).
- Following implementation of the flood risk treatment options described above, the residual flood risk is deemed to be low.

Annex B contains our responses to Table 5 of Appendix A ("Analysis, reporting and handover requirements") of the Flood risk management guideline LU01.

Overall, the proposed concept subdivision plan (incorporating the proposed flood risk treatment options) is considered to be compatible with the flood hazard.

6 References

- AIDR (2017). Guideline 7-3 Flood Hazard.
- AIDR (2020). National Emergency Risk Assessment Guidelines.
- BMT (September 2023). Richmond Valley Flood Study (RVFS), Volume 1.
- Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023).

Annex A Flood Depth and Hazard Maps

LEGEND

- Layout of Development
- Site Boundary

Peak Flood Level (m AHD)

0.5m

Peak Flood Depth (m)

- < 0.25
- 0.25 to 0.5
- 0.5 to 0.75
- 0.75 to 1.0
- 1.0 to 2.0
- 2.0 to 4.0
- > 4.0

Reardons Lane

Woodburn Coraki Road

Darke Lane

Swan Bay New Italy Road

Reardons Lane

Title:

Peak Flood Depth and Level Contours - 5% AEP Event

Figure: A-01

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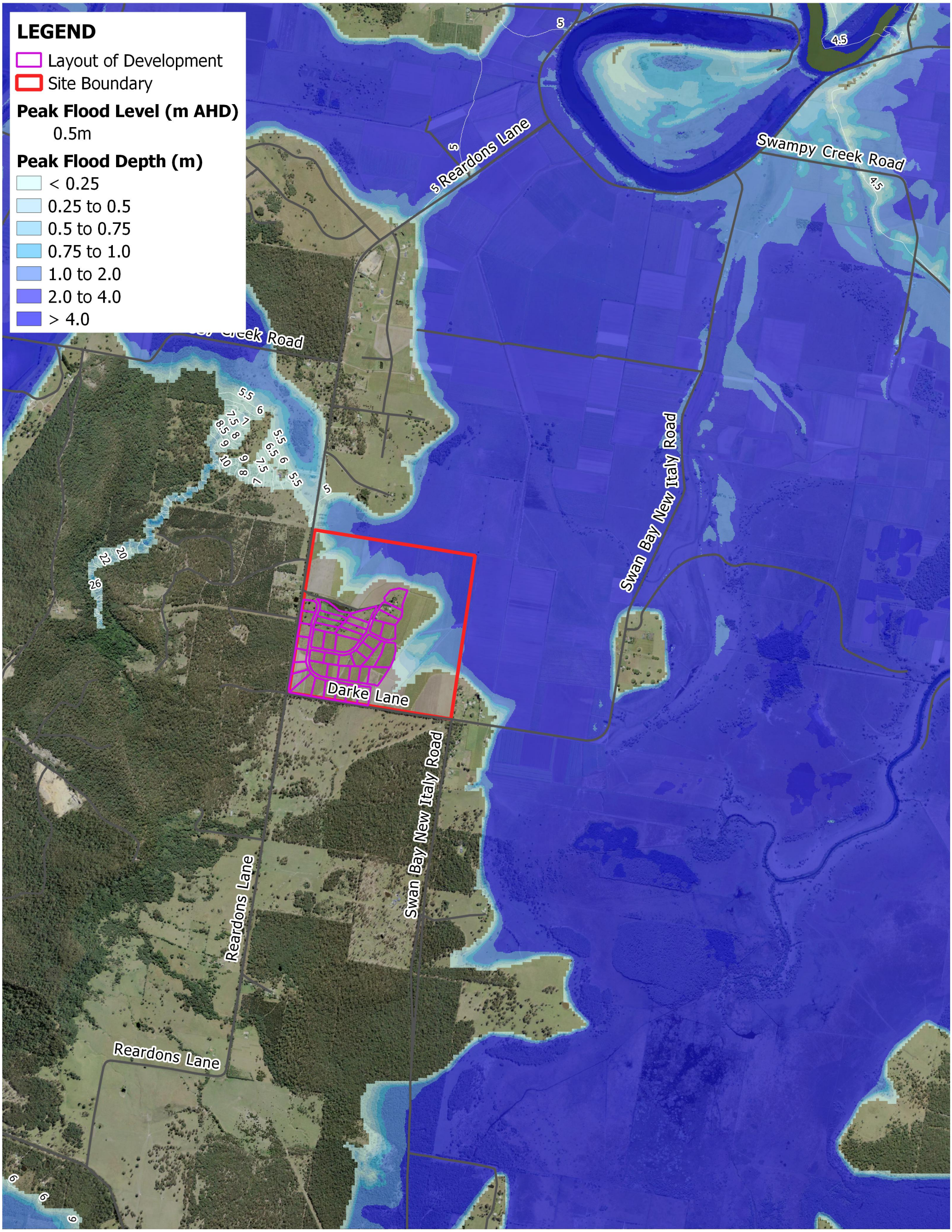

Title:

Peak Flood Depth and Level Contours - 2% AEP Event

Figure: A-02

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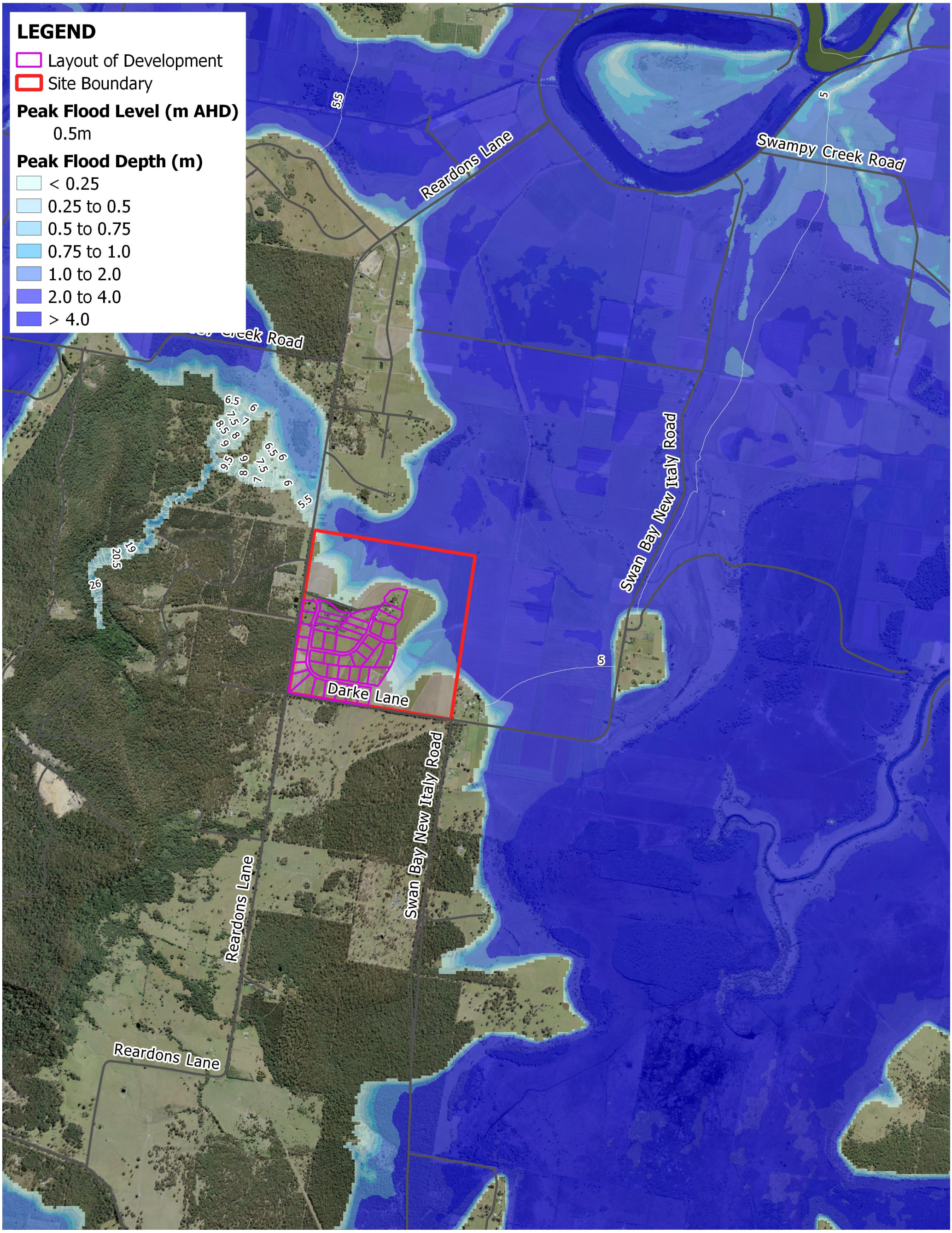

Title:

Peak Flood Depths and Level Contours - 1% AEP Event

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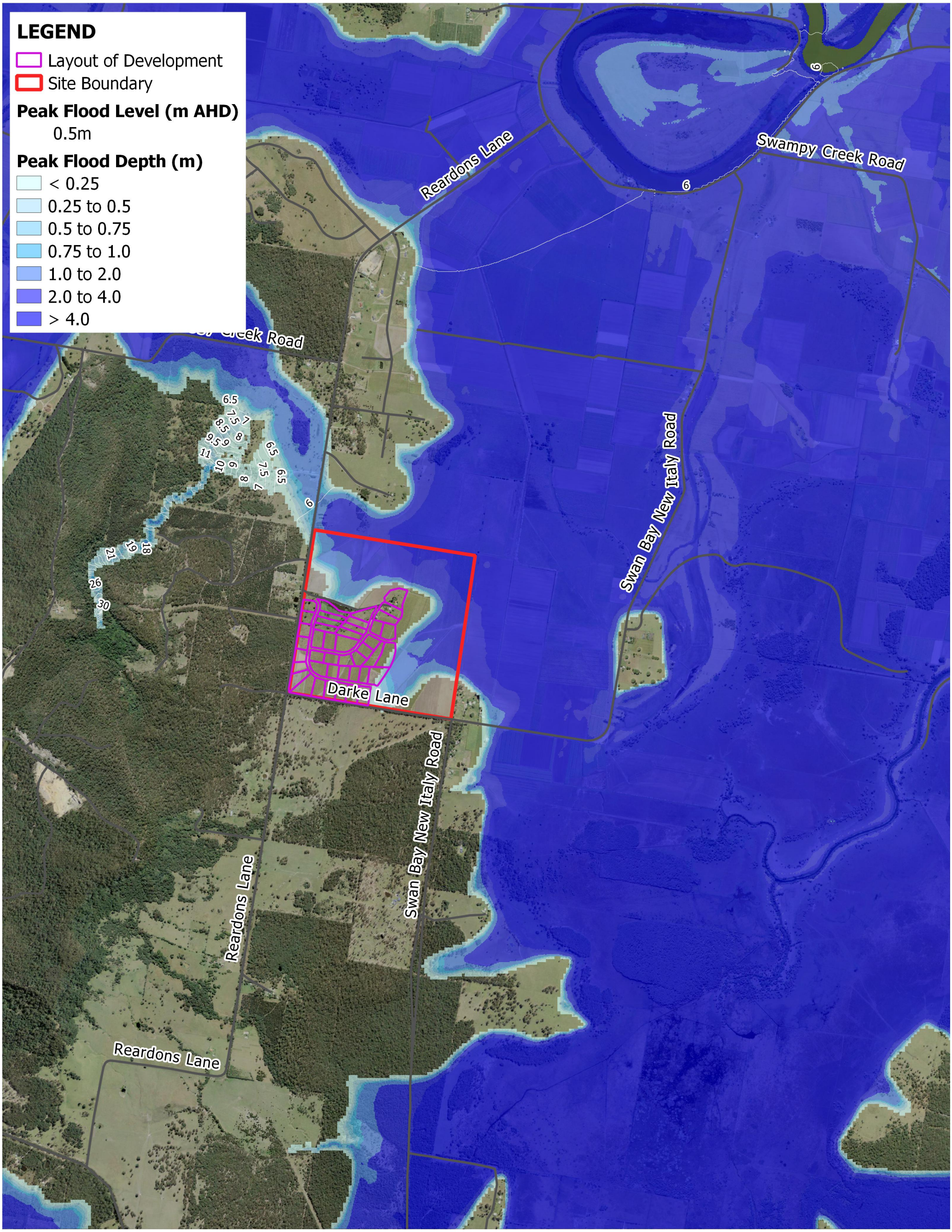

Title:

Peak Flood Depths and Level Contours - 0.2% Event

Figure: A-04

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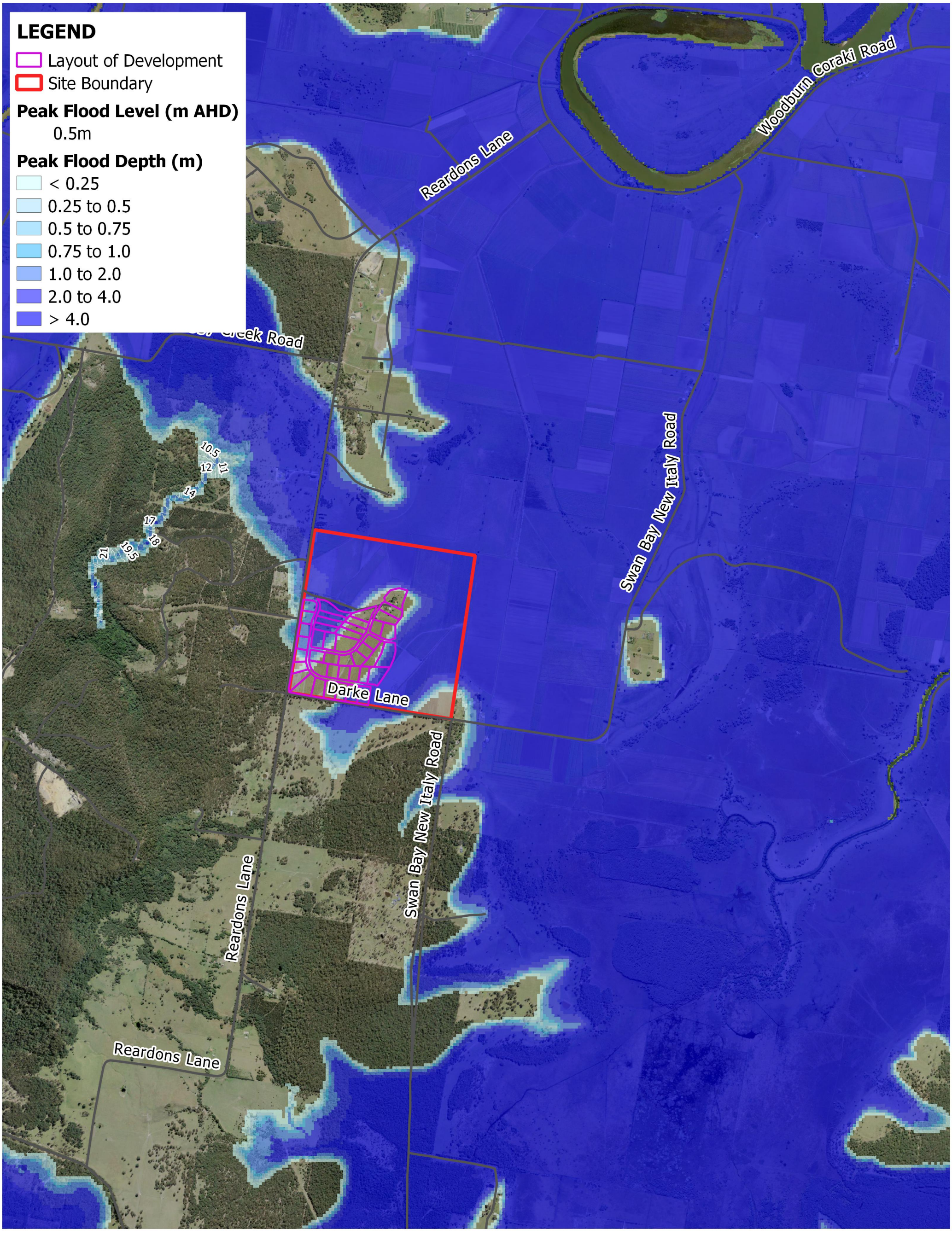

Title:

Peak Flood Depths and Level Contours - PMF Event

Figure: A-05

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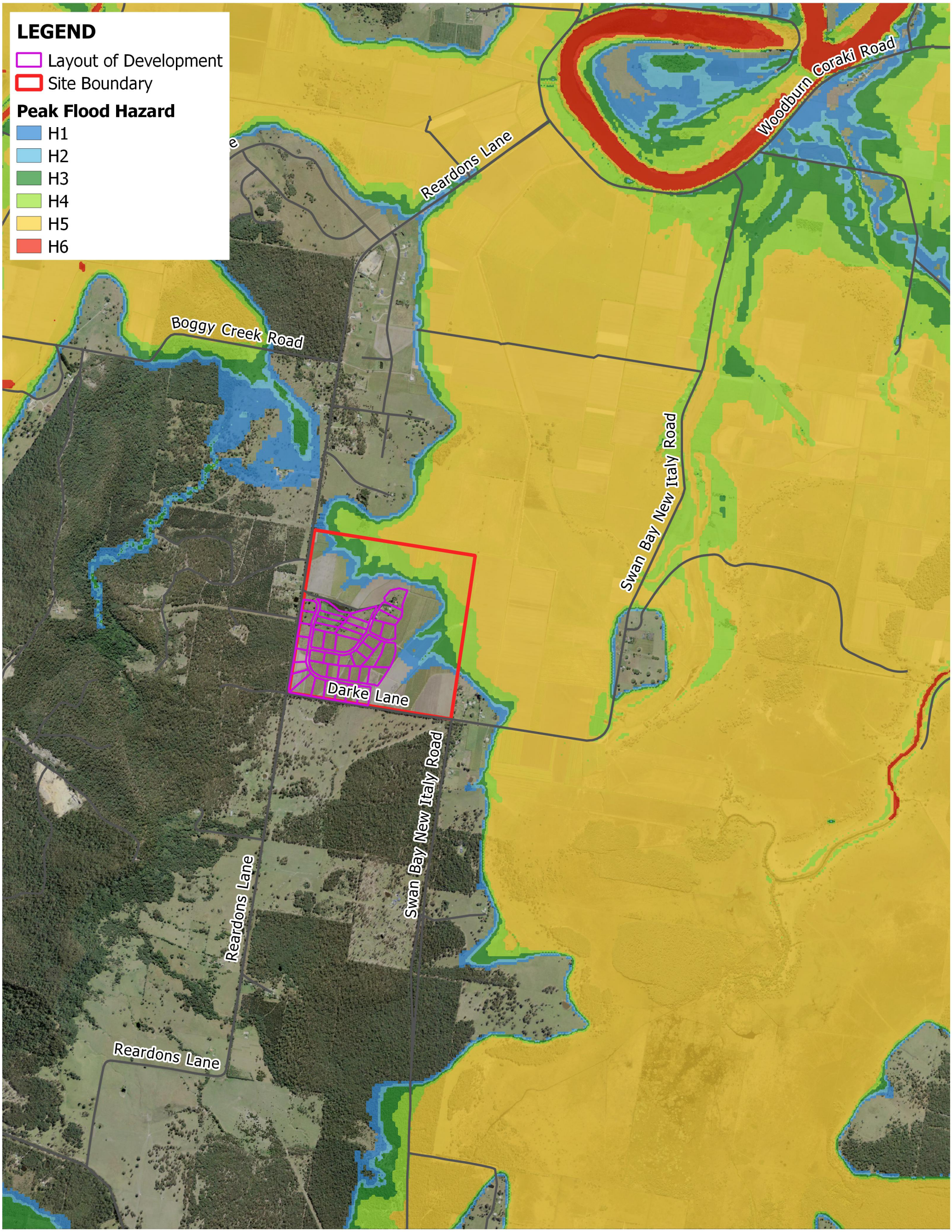

Title:

Peak Flood Hazard - 5% AEP Event

Figure: A-06

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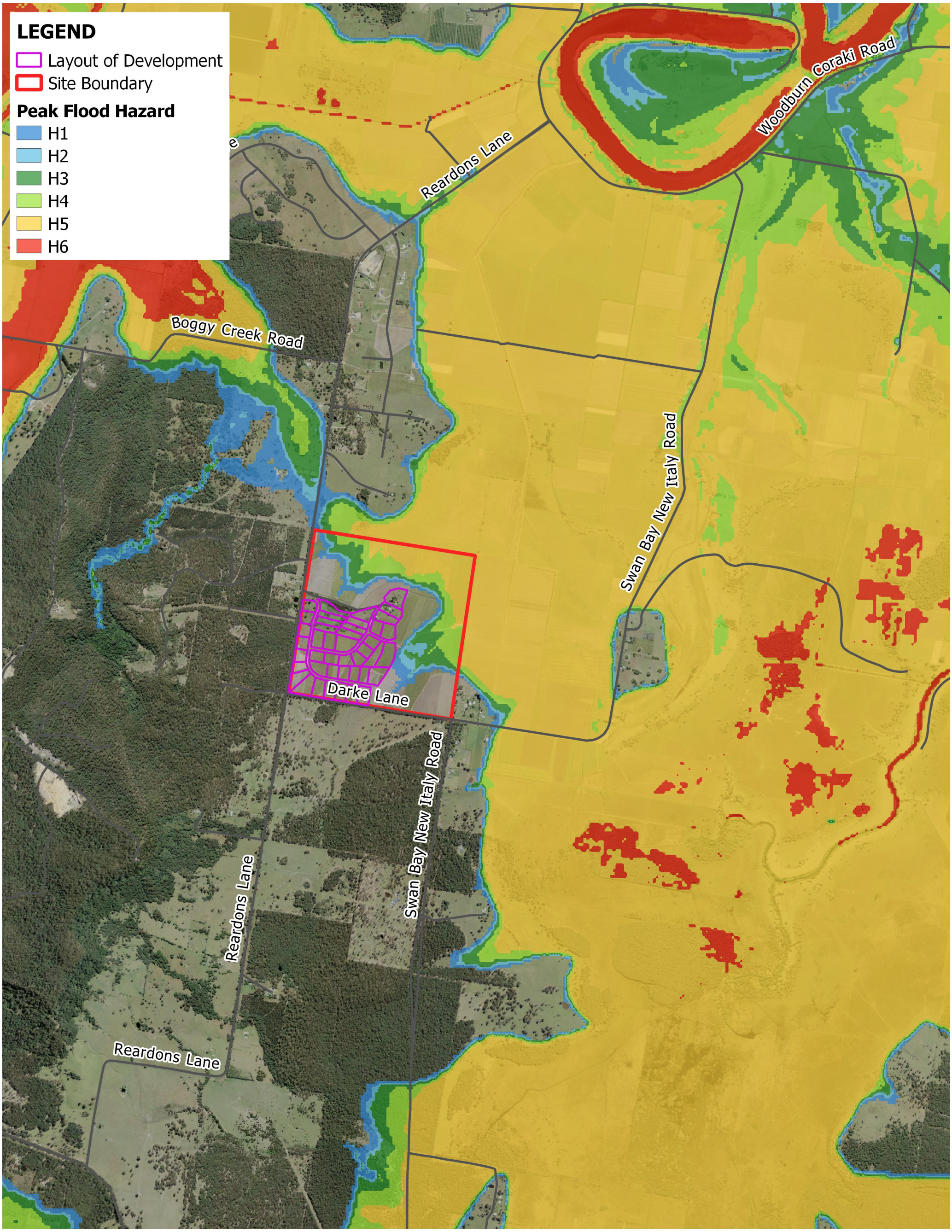

Title:

Peak Flood Hazard - 2% AEP Event

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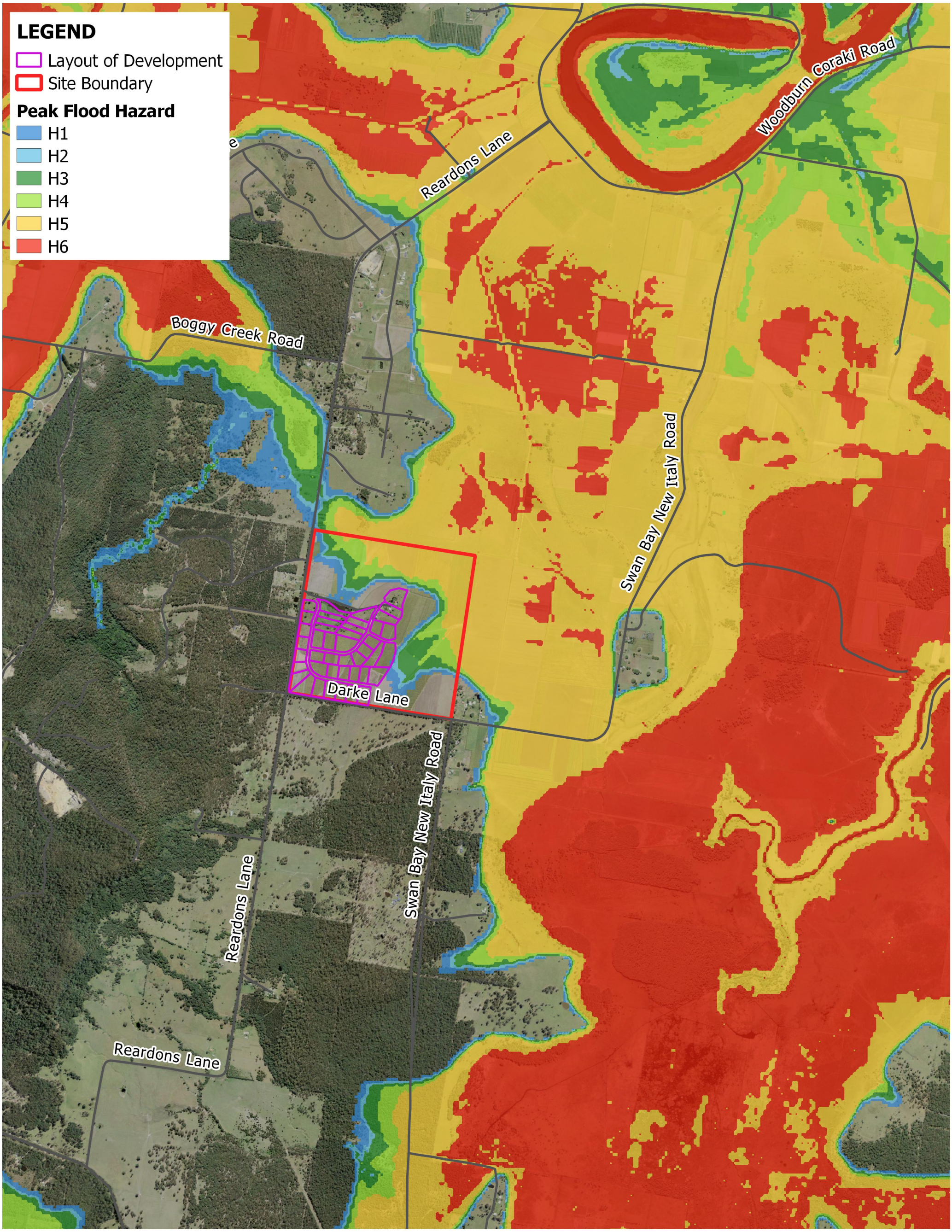

Title:

Peak Flood Hazard - 1% AEP Event

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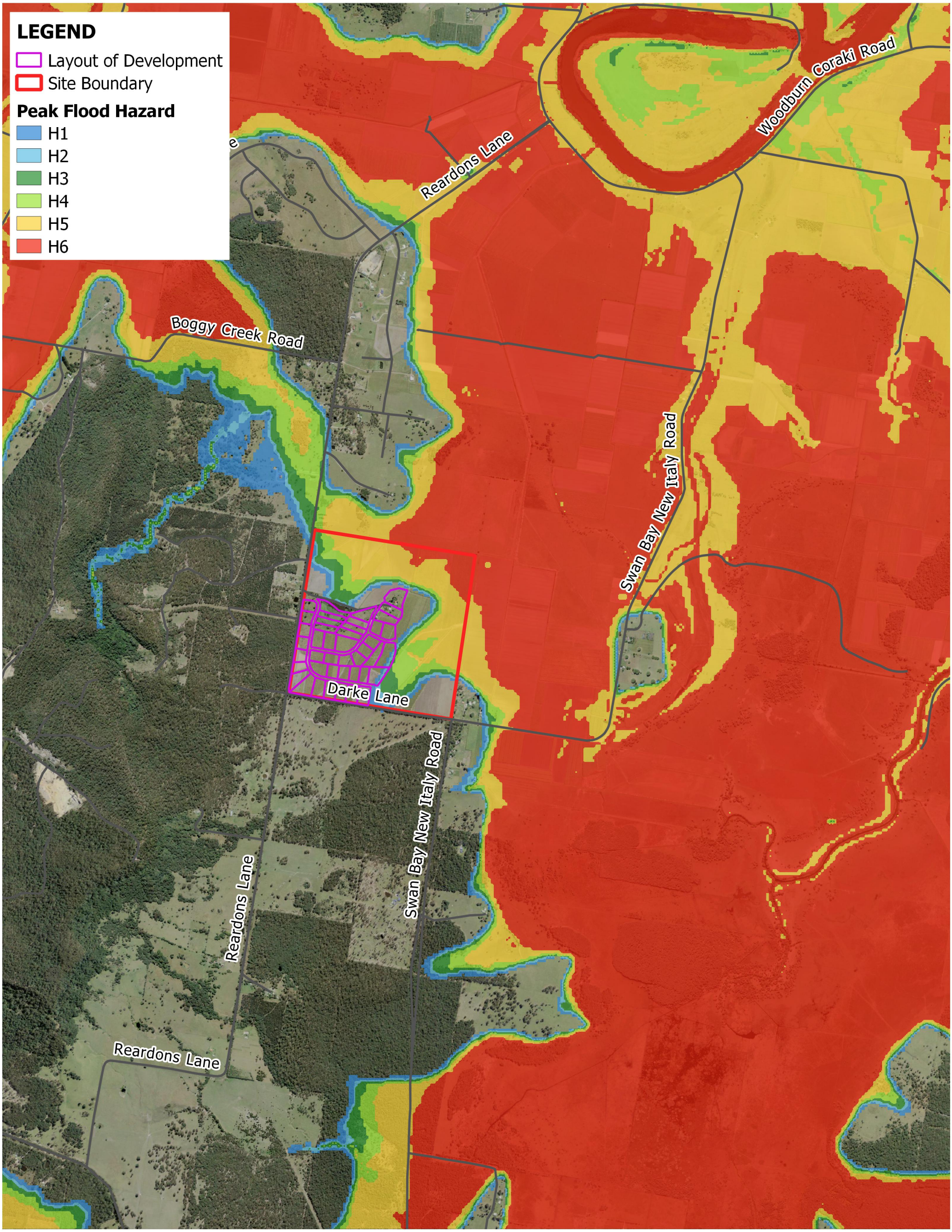

Title:

Peak Flood Hazard - 0.2% AEP Event

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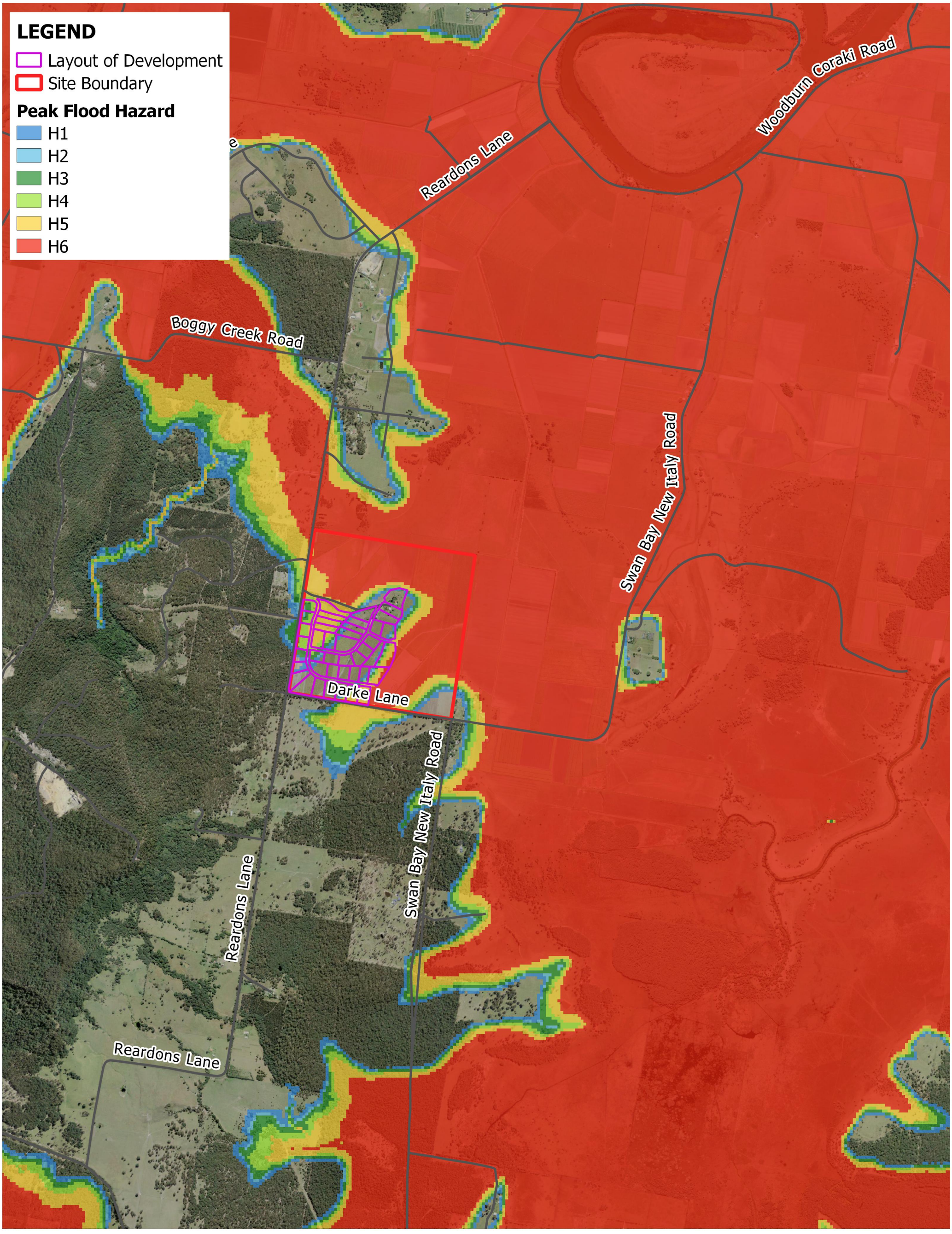

Title:

Peak Flood Hazard - PMF Event

Figure: A-11

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Annex B Responses to Table 5 of Appendix A of LU01 Guideline

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
Section	**Sub-Section**	**Simple Assessment**	**BMT Response**
Introduction	1.1 Background	Background: • purpose of the FIRA • client details • property address, size and description of location and details of proposed development	• A desktop qualitative Flood Impact Risk Assessment (FIRA) has been prepared as documented in the "PP-2022-502 Reardons/Darkes Lane, Swan Bay – Qualitative Flood Impact And Risk Assessment (BMT, November 2023). .The Purpose of the FIRA was to define the existing on-site flood risk and outline a high-level flood emergency response strategy the proposed development (hereafter referred as the "Site"). •The client is Newton Denny Chapelle (NDC) Pty Ltd on behalf of Mr Noel Newman •The Site is located at the corner of Reardons Lane & Darke Lane, Swan Bay •The total area of the Site is approximately 128.8 hecatres, of this total area approximately 44 hectares is proposed to developed, with the remainder of the Site retained as existing. •The proposed development consists of the 43 large resiential lots. Access will be via Reardons Lane.
	1.2 Project context	Description of project context: • any FIRAs or FRM studies or plans previously conducted and relevant to the site • history of the application	•The Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023) contains information related flood emergency response for the broader floodplain (including Swan Bay) based on the Richmond River flood behaviour and Bureau of Meteorlogy flood forecasting.

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
	1.3 FIRA requirements	Description of discussion with consent authority and requirements: • any correspondence with the consent authority and referral agencies on FIRA requirements • general relevant assessment requirements (see Sections 2 and 3 of this guideline)	
Background	2.1 Study area	Description of the study area: • catchments, topography, waterways, flood-dependent ecosystems, oceanic influences • land use and existing development • hydrologic/hydraulic controls	•The Site is located approximately 3 km south of Richmond River and east of Bungawalbin Creek. It is bounded by large rural lots to the north and east, Darke Lane to the south and Reardons Lane to the west. •The Site slopes to the east, with ground elavations ranging from 11.8 to 12m AHD along the western boundary to 11.3 to 11.6m AHD along the western boundary. •Ground elevations across the Site. The minimum ground elevation is 1.4 m AHD, at the northwest corner. There is an existing ridge in the middle of the Site (with elevations ranging from 14.0 m AHD to 16.2m AHD) that falls east or west. •The existing site includes a rural property. •The Richmond Valley Development Control Plan 2021 (DCP), complementing the Richmond Valley Local Environmental Plan 2012, is the main planning instrument. This DCP contains detailed flood-related objectives and controls that will be used by Council when determining development applications.

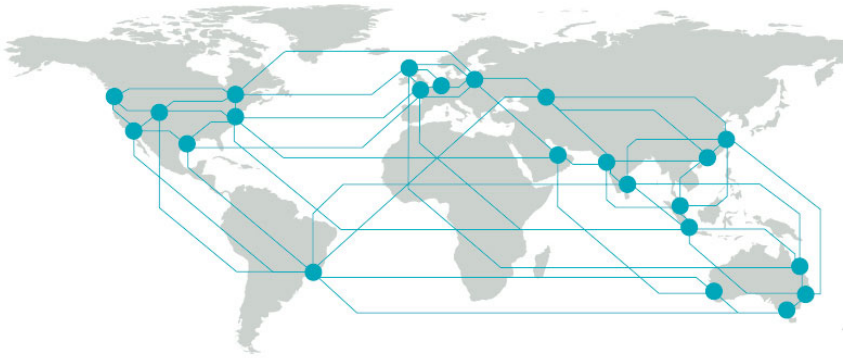
Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
	2.2 Known flood behaviour	Description of the flood behaviour: · type · duration and how often inundated · existing flood problems · hydrologic/hydraulic controls' effect on flooding · coincident tributary flooding · other factors (e.g. blockage, high tides, antecedent conditions)	·Mainstream Richmond River flood inundation durations are discussed in Section 2.2.3 of the FIRA (BMT, November, 2023). ·Existing mainstream flooding conditions (peak flood levels, depth and hazard) are summarised in Section 2.2 to Section 2.5 of the FIRA (BMT, November 2023). ·consideration of hydraulic controls such as coincident tributary flooding, will be made as part of the detailed FIRA.
	2.3 Flood history	Description of the flood history: · recent and largest recorded events · area of inundation and impacts on the community · catchment description at historical event relative to present day for key events	·Based on Richmond Valley Flood Study (RVFS) (BMT, September, 2023), four historic events were used for model calibration/validation purposes. The events of February/March 2022, January 2008 and May 2009 were used to calibrate the hydrologic and hydraulic models and the March/April 2017 event was used to validate the models. These events were selected as they are some of the largest events to occur within recent years.
	2.4 Emergency management	Outline existing EM strategy for the area Description of the existing EM: · response/preparation time · warning systems and time · local/regional EM strategies or plans	·There is no site-specific flood emergency management plan for the existing Site. ·The Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023) contains information related flood emergency response for the broader floodplain (including Swan Bay) based on the Richmond River flood behaviour and Bureau of Meteorlogy flood forecasting. ·There is a BOM flood gauge on gauge at Richmond River at Woodburn that is used by SES to issue flood warnings for the broader area including Swan Bay.

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
			Section 2.7 of the FIRA (BMT, November 2023) provides further information with regards to the gauge.
3. Available information		List and describe: • previous studies and model files, including whether the information is fit for purpose for the assessment; if yes then it will need to be reproduced in the report including figures and detailed descriptions • relevant legislation, policy and guidance • flood EM plans (e.g. local flood plans) • historic data, including summary of key events and available data • hydrologic and hydraulic data, including stream flow records, rating curves, rainfall records, ocean and water level data and rainfall gauges • site visit, including any observations that may impact or be impacted by flood; photos and figures should be included where relevant • survey data, including existing or new survey data, for example, DEMs, LiDAR data, creek/river cross-sections or hydro surveys, location of drainage assets, floor levels and existing structures • geographic information system (GIS) data, including cadastral layers, waterways, natural environment areas, street names, roads and land-use zoning	Previous studies relevant for the Site include the following: •BMT (September 2023). Richmond Valley Flood Study (RVFS), Volume 1. •Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023).

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
			·The details of historical flood events, rating curves, rainfall records, DEM are LiDAR data are detailed in RFVS (BMT, September 2023)
4. Flood related requirements		Describe flood related requirements: · requirements of the consent authority and referral agencies · relevant legislation, policies and guidelines · scale of assessment · identify compatibility or deviation from existing FRM plans	·The following policies and guidelines may be relevant for flood impact and risk assessment of devevelopment on the Site: -The Richmond Valley Development Control Plan 2021 (DCP) -Department of Planning and Environment(DPE, 2023a). Flood Risk Management Manual - The policy and manual for the management of flood liable land. -DPE, 2023b. Flood impact and risk assessment - Flood risk management guideline LU01.
5. Pre-developed modelling and analysis	5.1 Existing flood modelling	Description of methodology and modelling as applicable including: · design events assessed · hydrologic and hydraulic controls and any changes over time, particularly since calibration, validation events or completion of existing studies · flood modelling techniques and results · model checks as required	·No hydrologic or hydraulic modelling was undertaken as part of the FIRA (BMT, November 2023). .The FRA was based on a qualitivate flood invesgation based on knowledge of existing flood modelling results/outputs from the RVFS (BMT, September 2023). ·Detiled flood modelling will be undertaken as part of DA application stage to model and assess the existing site conditions in detail.
	5.2 Existing flood impacts	Describe and document existing: · flood behaviour for the full range of flooding at and surrounding the site · flood impacts on surrounding properties · any additional data	·The FIRA (BMT, November 2023) presents the existing flood conditions as follows: -Existing mainstream flooding conditions (peak flood levels, depth and hazard) are summarised in Section 2.2 to Section 2.5.

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
6. post-developed modelling and analysis	6.1 proposed development flood modelling/assessment	Describe and document - Analysis undertaken including modelling and modelling assumptions as required - Changes due to proposed development – difference between existing and post-development outputs at key locations	·No post-development hydrologic or hydraulic modelling was undertaken as part of the FIRA (BMT, November 2023). The FIRA was based on a qualitative flood investigation based on existing flood modelling results/outputs from the RVFS (BMT, September 2023). ·Detiled flood modelling will be undertaken as part of DA application stage to model and assess the proposed site conditions, including necessary flood mitigation works.
	6.2 flood impacts of proposed development	Describe and document changes due to proposed development in: - Impacts to flood behaviour - Changes to frequency/scale of inundation of existing properties, where know - The impacts on the proposed devellopemnt and users	·No post-development hydrologic or hydraulic modelling was undertaken.
7. key risks to be managed		Describe and document - Proposed management measures or alterations t the development required to address impacts to the development and its users and any offsite impacts - Comparison of pre- and post-manageent measure impacts considering management measures with development requirements from consent authotiy and how they meet any flood related objectives - Effectiveness, limitations and any necessary additional requirements to address risk to the development and its users or offsite impacts - Residual risks to users of the development	·No post-development hydrologic or hydraulic modelling was undertaken as part of theFIRA (BMT, November 2023. ·The FRA was based on a qualitative flood investigation. ·Approriate flood mitigation/management measures will be investigated and modelled using the RVFS (BMT, September 2023) model at a DA application stage. ·A detailed flood risk assessment will be undertaken as at a DA application stage.

Response to Flood Risk Management Guideline LU01 – Appendix A Analysis, reporting and handover requirements			
Table 5 – Typical simple and details assessment scopes of works and information requirements for FIRAs			
8. conclusions and recommendations		Describe and documents - Conclujsions - Management measures to reduce flood impacts and any residual impacts and recommendations including mapping and GIS outputs - Compatibility or deviation from consent authority requirements	·The FIRA (BMT, November 2023) has recommended off-site evacuation as the primary flood emergency response strategy, as discussed in Section 3.3.2 and Section 4. ·A detiled flood modelling will be undertaken as part of DA application phase that will include appropriate flood mitigation measures to ensure that the proposed development shall not cause an adverse flood impact to adjoining properties.
9. References		List key references used in the report	• AIDR (2017). Guideline 7-3 Flood Hazard • AIDR (2020). National Emergency Risk Assessment Guidelines • BMT (September 2023). Richmond Valley Flood Study (RVFS), Volume 1. • Richmond Valley Flood Emergency Sub Plan (NSW SES, 2023). • Department of Planning and Environment (DPE, 2023a). Support for emergency management planning - Flood risk management guideline EM01. • DPE, 2023b. Flood impact and risk assessment - Flood risk management guideline LU01. • The Richmond Valley Development Control Plan 2021 (DCP)



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