

# Pacific Brook Christian School Flood Emergency Response Plan

R.T2583.001.02



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Final

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## Synopsis

Report documenting the development of a Flood Emergency Response Plan for the proposed Pacific Brook Christian School. The report details the flood behaviour at the Site, flood forecasts and flood warning availability, and formulates a Flood Emergency Response Plan for managing on-site flood risk incorporating school closure, evacuation and shelter in place measures.

*Cover image NBRS Architecture*

## Revision History

Revision	Description	Date
01	Draft	22/07/2024
02	Final	06/08/2024

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## Executive Summary

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Torrent Consulting was engaged by Impact Group on behalf of Pacific Group of Christian Schools Ltd trading as Pacific Brook Christian School (PBCS) to prepare a Flood Emergency Response Plan (FERP) for the establishment of a new K-12 school (Pacific Brook Christian School) 72-74 Maitland Road, Muswellbrook (the Site).

The school will accommodate 140 students and 16 staff with School class operating hours Monday to Friday 8:50am to 3:10pm.

### Flood Risk

Flood risk at the Site is principally from the mainstream flooding of the Muscle Creek channel and floodplain. During flood events, inundation is known to occur within the Muswellbrook Golf Course, which is located adjacent to the Site. Once the capacity of the Muscle Creek channel is exceeded, overbank flows are initiated through the Golf Course with floodwater spilling from the left bank on the creek channel. The key observations in this regard include:

- The Site is initially inundated only at the 1% AEP flood level with the inundation limited to the lowest parts of the Site in the north-east. There is no inundation in the vicinity of the school buildings at the 1% AEP flood level.
- The school buildings area remains flood free up to 0.2% AEP (1 in 500) design flood magnitude. The elevated floor levels of the buildings provide for a flood immunity (no above floor flooding) up to 0.01% AEP (1 in 10,000) design flood magnitude. Accordingly, the design flood immunity afforded to the Site represents a very low risk of exceedance.
- For extreme flood events in excess of these magnitude, up to the PMF event, the predicted high hazard flood conditions warrant the Site to not be occupied. The peak PMF level provides for flood depths across the Site more than 2m, with up to 1.2m depth above the proposed school building floor levels.

### Flood Warning

The BoM has a few generalised warning services that can provide an indication of an increased likelihood of flooding, including:

- Severe Weather Warnings
- Severe Thunderstorm Warnings
- Flood Watches
- Flood Warnings

This warning service is to be monitored for forecasts of expected flood conditions that impact upcoming activities at the school. Such warnings can be issued a few days in advance and give the school the option of suspending planned activities a day in advance, if deemed an appropriate course of action.

Additional lead flood warning time based on the Site inundation is achievable in enacting early warning triggers based on recorded rainfall. Give the lack of existing rainfall gauges in the Muscle Creek catchment, the FERP proposes the installation of an automated weather station with pluviometer to record site rainfall and provide the basis for a rainfall trigger linked to an emergency

response action plan. Additionally, an automatic flood alert level gauge is proposed at the Site low point providing a trigger for initial Site inundation for events at the 1% AEP flood level and higher.

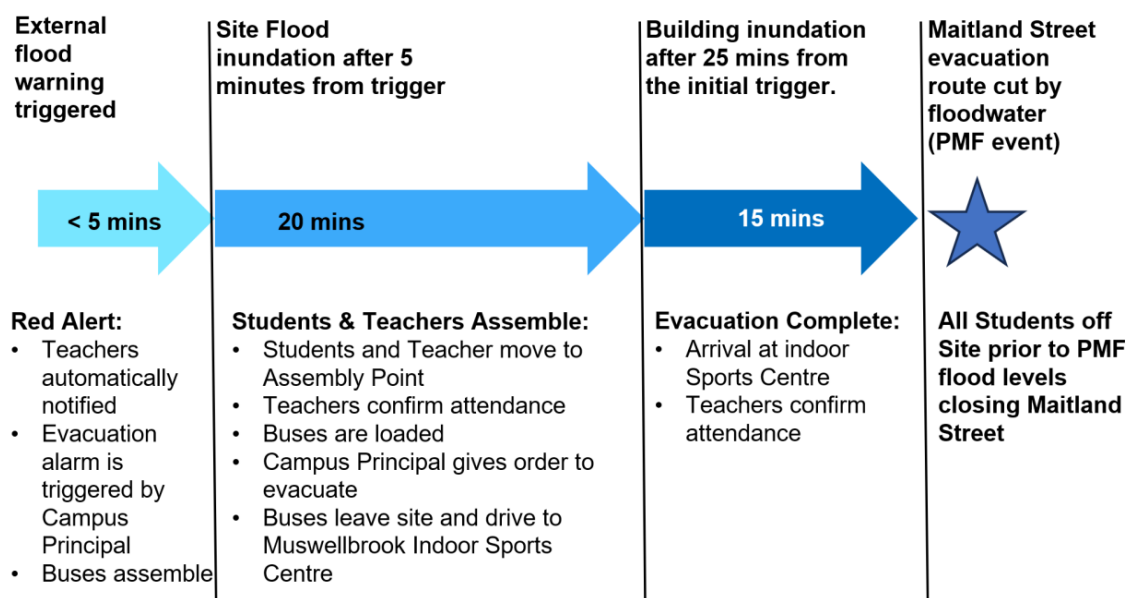
### Flood Emergency Response

The recommended Flood Emergency Response comprises:

- School closure
- Evacuation to nominated flood refuge (Muswellbrook Sports Centre)

The available flood warning opportunity is expected to limit flood risk exposure via initial flood avoidance through school closures. Given the length of the school day, school terms and the duration of Muscle Creek flood events, there is only around a 25% chance that any given flood event will coincide with potential occupation of the Site. The availability of flood warning intelligence to inform potential flood risk in advance of the peak flooding conditions provides significant opportunity for school closure and risk elimination. Accordingly, this represents the principal emergency response.

In the unlikely event of flood condition exceeding 0.2% AEP (1 in 500) design flood magnitude within the hours of school operation, evacuation of the Site to the nominated flood refuge can be executed within available warning times. A flood evacuation timeline analysis has demonstrated evacuation capability for all events up to and including the PMF event within initial inundation of the Site.



**Figure E1 - Minimum Flood Warning and Emergency Response Timeline and Action Plan**

The responsibilities and actions for effective flood emergency response management are defined for the PBCS Management Team, Chief Warden, and Wardens. This will ensure that the structure, facilities and training are in place and adequately maintained, to enable effective execution of a flood emergency response.

To assist in managing flood risks and communicating response actions, three flood Alert Modes have been developed:

- Amber: flooding of the Site is possible within the hours of operation
- Red: imminent flooding of the Site is expected
- Green: all clear, floodwaters have receded and local access to the Site is available

The Amber Alert Mode is called following the issuing of a Severe Weather Warning, Severe Thunderstorm Warning, Flood Watch, or Flood Warning for Muswellbrook by the BoM (Bureau of Meteorology) and indicates an increased potential for flooding.

The Red Alert Mode is triggered following the issuing of an evacuation order by SES, or Site rainfall and water level gauges indicates that possible flooding of the Site is imminent.

The Green Alert Mode is called following a flood event, once flood waters have receded.

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# 1 Introduction

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## 1.1 Background

Torrent Consulting was engaged by Impact Group on behalf of Pacific Group of Christian Schools Ltd trading as Pacific Brook Christian School (PBCS) to prepare a Flood Emergency Response Plan (FERP) to assist in the approval process for the proposed development at the 72-74 Maitland Road, Muswellbrook, NSW (the Site), as presented in Figure 1-1. The proposed development is for the establishment of a new K-12 school (Pacific Brook Christian School) on the Site.

This Site is located within the Muscle Creek catchment and is subject to potential flood inundation during extreme rainfall events. The design flood conditions at the Site are established in the Muscle Creek Flood Study (RHDHV, 2017) and Muswellbrook Floodplain Risk Management Study and Plan (RHDHV, 2019). It is understood the defined flood conditions has informed the development of an existing Flood Impact Assessment and Flood Emergency Management Plan for a previous Development Application. Impact Group has outlined a revised development application requiring preparation of updated/new documentation relevant to the modified proposal and considering previous advice/commentary provided by relevant authorities including Muswellbrook Shire Council (Council), State Emergency Service (SES) and Dept. of Climate Change, Energy, the Environment and Water (DCCEEW).

A Flood Impact Assessment has been completed by Torrent Consulting for the proposed development (R.T2583.002.02). The flood modelling undertaken for the impact assessment has been used to inform development of this FERP.

## 1.2 Site Overview

The proposed development will comprise site preparation and remediation, tree removal, construction of new school buildings, covered outdoor learning area, covered walkways, car parking, landscaping and associated works. The school will accommodate 140 students and 16 staff.

Specifically, the proposed development will deliver one (1) administration and staff area, five (5) General Learning Areas (GLA's), one (1) science classroom, one (1) staff and student amenities block, Covered Outdoor Learning Area (COLA) and ancillary step/ramp access to each.

The Site operation will house a mainstream Kindergarten to Year 12, and other normal activities associated with schooling. The nominal hours of operation are:

- Monday to Friday - 7.30am to 6.30pm, comprising:
  - School class operating hours Monday to Friday 8:50am to 3:10pm
- Saturdays, Sundays and Public Holidays – Nil



Title:

## Site Locality

0 0.5 1 km



approx. scale

Figure:

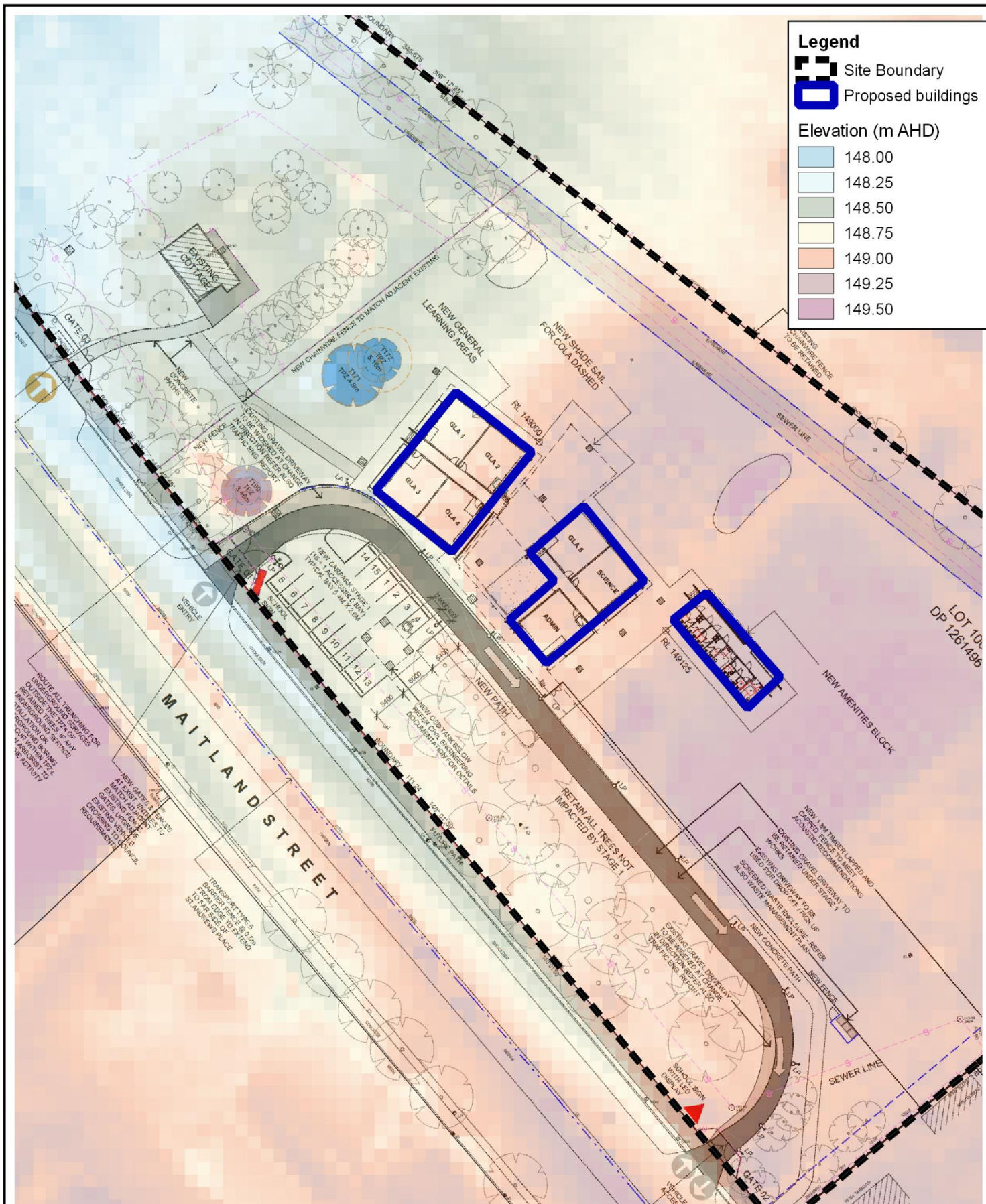
**1-1**

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<p>Title:</p> <p><b>Site Layout and Topography</b></p>	<p>0 20 40 m</p> <p>approx. scale</p>
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## 2 Flood Behaviour

### 2.1 Flood Probabilities

The Australian Rainfall and Runoff (ARR) 2019 guidelines describe two approaches that are typically used to express the probability of flood events:

- Annual Exceedance Probability (AEP) – the probability of an event being equalled or exceeded within a year. Typically, the AEP is estimated by extracting the annual maximum in each year to produce an Annual Maxima Series (AMS); and
- Average Recurrence Interval (ARI) – the average period between occurrences equalling or exceeding a given value. Usually, the ARI is derived from a Peak over Threshold series (PoTS) where every value over a chosen threshold is extracted from the period of record.

A summary of flood probability terminology from ARR 2019 is reproduced in Figure 2-1.

Frequency Descriptor	EY	AEP (%)	AEP	ARI
			(1 in x)	
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
Intermediate	0.11	10	10	9.49
	0.05	5	20	19.5
Rare	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	

Figure 2-1 Flood Probability Terminology

Very frequent flood events are expressed as exceedances per year (EY). At the other end of the probability spectrum, the Probable Maximum Flood (PMF) event is a function of the Probable Maximum Precipitation (PMP), which is the most rainfall that can be practically considered as being possible to occur over a given location or area. It is an extreme event with an approximate probability of between a 1-in-10,000 and a 1-in-10,000,000 AEP, dependant on catchment area. For small catchments up to 100km<sup>2</sup> such as Muscle Creek the approximate probability of the PMF event is a 1-in-10,000,000 AEP.

## 2.2 Flooding of the Site

The flood-producing weather events most-likely to affect the Site include East Coast Lows (ECL). The Bureau of Meteorology (BoM) defines ECLs as being very intense low-pressure systems characteristic of the eastern coastline of Australia, occurring on average several times each year. Although they can occur at any time of the year, they are more common during autumn and winter with a maximum frequency in June. East Coast Lows will often intensify rapidly over a period of 12-24 hours making them one of the more dangerous weather systems to affect the eastern coast.

Other weather systems that present a flood risk at the Site include ex-tropical cyclones that occasionally move south into NSW and severe thunderstorms that can develop quickly and affect relatively small areas.

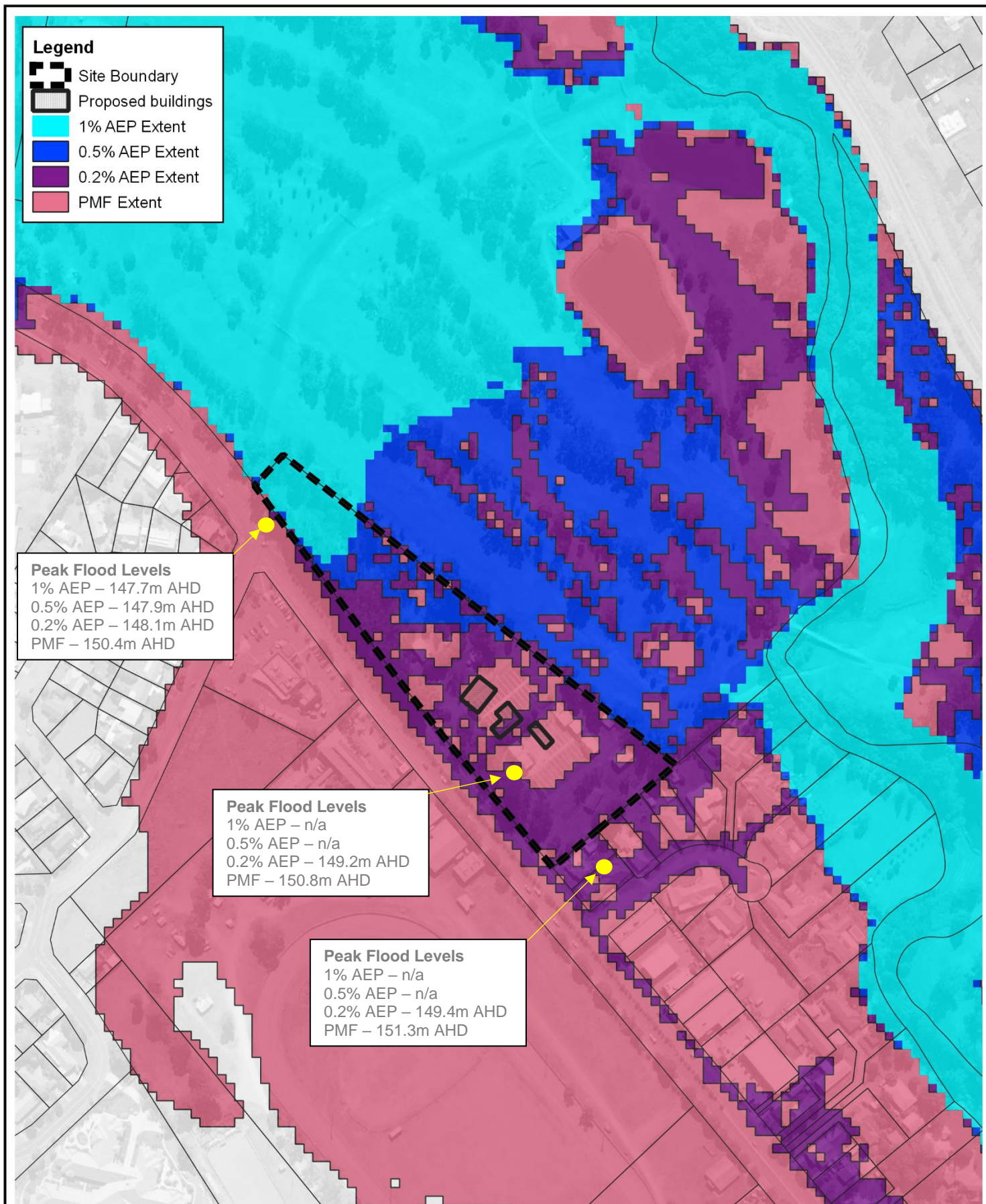
Muscle Creek drains 92 km<sup>2</sup> of catchment upstream of Muswellbrook covering predominantly undeveloped land east of the Site. The Muscle Creek channel alignment flows centrally through the township of Muswellbrook before joining the Hunter River.

During flood events, inundation is known to occur within the Muswellbrook Golf Course, which is located adjacent to the Site. Once the capacity of the Muscle Creek channel is exceeded, overbank flows are initiated through the Golf Course with floodwater spilling from the left bank on the creek channel. As flood flows increase, the flood inundation initially impacts the lower end of the Site at the 1% AEP level. Further channel breakouts are initiated upstream of the Site in extreme events, providing for flow directly through the Site and down Maitland Street in a general north westerly direction.

### 2.2.1 Flood Extent and Levels

The design flood extents for the 1% AEP, 0.5% AEP, 0.2% AEP and PMF events were modelled as part of the proposed development flood impact assessment and are representative of rare to extreme flood conditions. The simulated peak flood inundation extents are shown in Figure 2-2, with design peak flood levels annotated and various locations within the Site. Peak flood depth mapping for the simulated 1% AEP, 0.5% AEP, 0.2% AEP and PMF events is presented in Appendix A.

At the 1% AEP flood event inundation affects only the lower end of Site, with localised backwater flooding from upstream of the flow constriction at Bell Street. Similarly for the 0.5% AEP event, inundation is limited to the lower end of the Site albeit increasing in general extent across the Site. Flow through the Site, particularly in the location of the proposed building areas is firstly initiated at the 0.2% AEP flood magnitude. Overland flow paths are initiated from floodwater escaping the Muscle Creek channel upstream of the Site. At the 0.2% AEP flood magnitude, these overland flow paths through the Site are somewhat minor in terms of total convective flow, however, the flows increase considerably with increasing flood magnitude up to the PMF design event.



Title:  
**Design Flood Extents**

Figure: **2-2** Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

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The proposed buildings have nominal finished floor level of 149.62m AHD. These floor levels provide for flood immunity for the buildings in excess of the 0.2% AEP design flood magnitude. At this flood magnitude not all of the Site is flood affected, with areas of inundation typically limited to shallow overland flood depths <0.2m.

At the PMF flood event inundation affects the entire Site, including the ground floor levels of the buildings. The peak flood depth above floor level is of the order of 1.2m.

The design flood immunity for the buildings, i.e. event at which above floor inundation is initiated, is estimated at between a 1 in 10,000 (0.01%) AEP and 1 in 20,000 (0.005%) AEP. This estimate is derived from the flood frequency distribution shown in Figure 2-3 using the design flood flows summarised in Table 2-1. The flood modelling provides for an approximate Muscle Creek flow of 940m<sup>3</sup>/s resulting in peak flood levels of 149.62m AHD to initiate above floor flooding. The corresponding frequency of this event is interpolated using the frequency distribution extended between the 1 in 500 (0.2%) AEP and the PMF event (nominally 1 in 10,000,00 AEP). The interpolation is dependent on the assigned probability of the PMF, such that a secondary flood frequency distribution is shown in Figure 2-3 with the PMF assigned as 1 in 1,000,00 AEP.

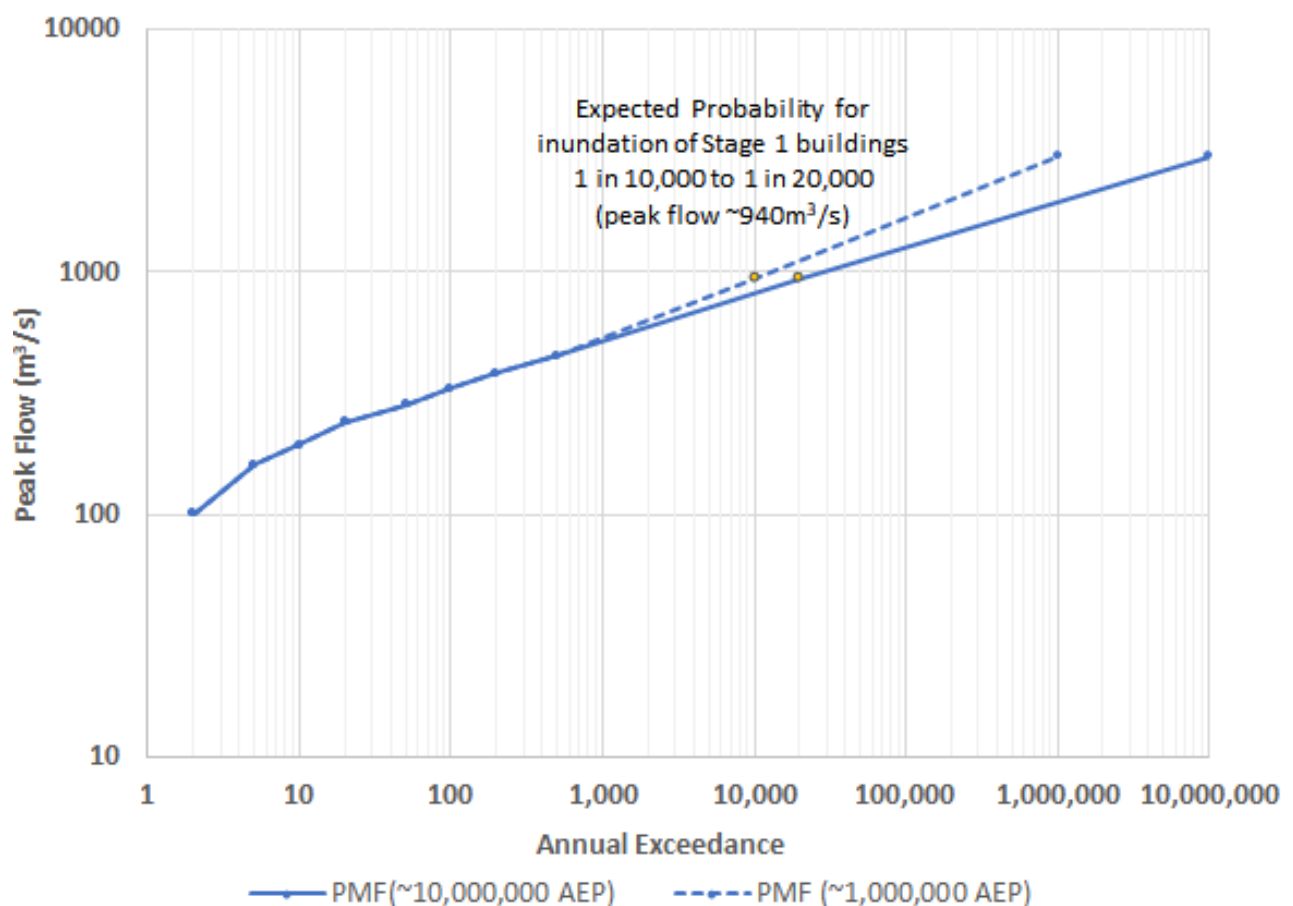


Figure 2-3 Flood Frequency Distribution for Muscle Creek Design Flows

**Table 2-1 Design Flood Flows for Muscle Creek**

Design Event	Peak Flow (m <sup>3</sup> /s)
1 in 2 (50%) AEP	101
1 in 5 (20%) AEP	160
1 in 10 (10%) AEP	194
1 in 20 (5%) AEP	240
1 in 50 (2%) AEP	284
1 in 100 (1%) AEP	331
1 in 200 (0.5%) AEP	382
1 in 500 (0.2%) AEP	454
PMF	3000

### 2.2.2 Flood Hazard

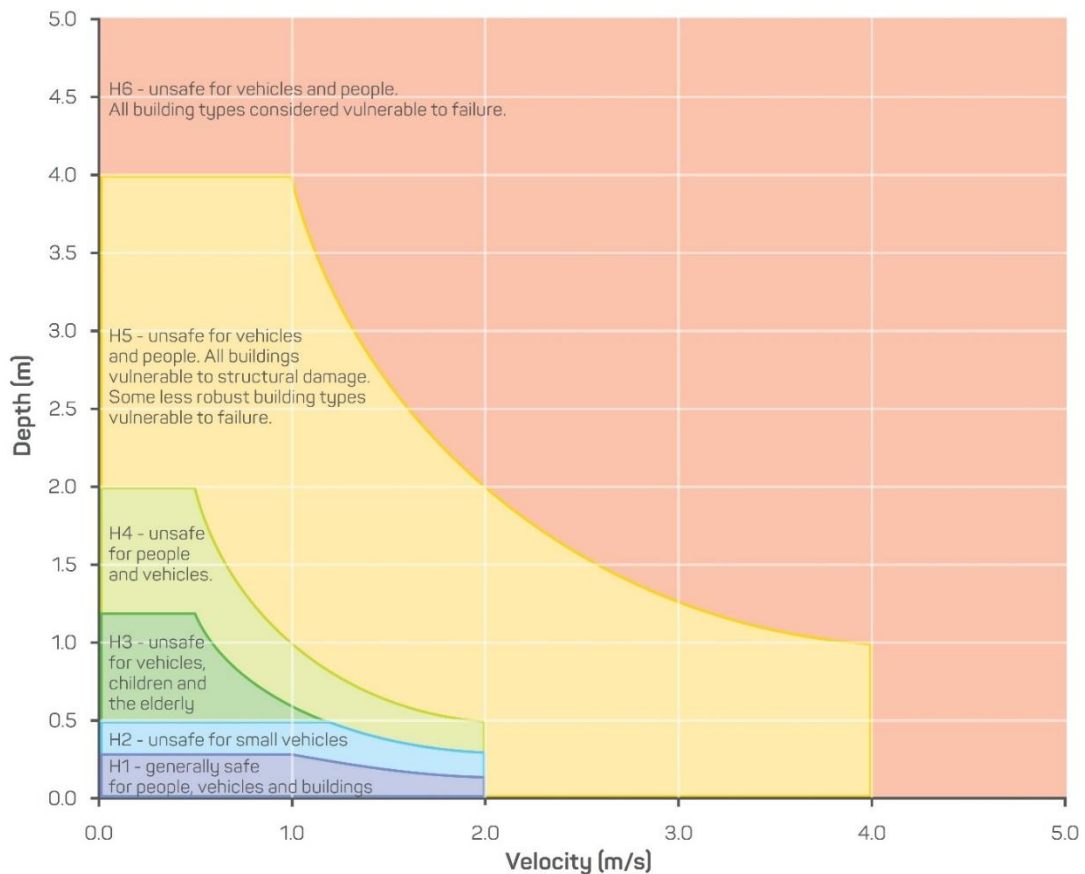
The flood hazard conditions are a function of both flood depth and flood velocity and can be used to help understand the potential risk to people exposed to flooding at the Site.

The flood hazards have been determined in accordance with 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). This produces a six-tier hazard classification, based on modelled flood depths, velocities, and velocity-depth product. The hazard classes relate directly to the potential risk posed to people, vehicles, and buildings, as presented in Figure 2-4.

Flood hazard mapping for the simulated 1% AEP, 0.5% AEP, 0.2% AEP and PMF events is presented in Appendix B.

For all flood events up to the 0.2% AEP level, the hazard of inundation across the majority of the Site, and in particular the proposed building locations, is very low (H1) and does not present a significant risk to people located there. This low hazard is a function of the limited depth and velocity of areas inundated by the minor overland flows up to these design flood magnitudes. It is noted at the lower end of the Site there are localised areas of low to medium hazard (H3 to H4).

At the PMF event extensive high hazard (H5 to H6) flood waters are present throughout the Site and surrounding area. This presents a significant risk to people, vehicles, and buildings.



**Figure 2-4 General Flood Hazard Vulnerability Curves (AIDR, 2017)**

### 2.2.3 Flood Rate of Rise and Duration

Because of the nature of the local flood environment the rate of rise of flood waters can be rapid, particularly in an extreme event. However, this environment also produces floods of a relatively short duration, with flood waters quickly receding following the peak conditions.

For events up to the 0.2% AEP event, flood levels in Muscle Creek rise gradually over a period of hours. The approximate timing from initial inundation at the lower end of the Site to initiation of overland flow paths through the upstream part of the Site in the 0.2% AEP event is over a number of hours. Peak flood conditions typically occur within 2 to 6 hours of initial Site inundation.

The potential rate of rise in the PMF event is more significant with potentially less than 2 hours from initial Site inundation to the peak flood level condition. However, it is noted that flood access and evacuation routes are cut well below the peak PMF level, providing for a significantly shorter evacuation window.

The duration of floodplain inundation will vary on an event-specific basis but is expected to be in the order of between 2 to 6 hours.

Additional detail regarding timing of Site inundation and assessment of evacuation timelines is provided in Section 3.3.

## 3 Flood Forecasts and Warnings

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### 3.1 Bureau of Meteorology

The BoM has a few generalised warning services that can provide an indication of an increased likelihood of flooding, including:

- Severe Weather Warnings
- Severe Thunderstorm Warnings
- Flood Watches
- Flood Warnings

These warning types are summarised below.

#### 3.1.1 Severe Weather Warnings

The BoM issues Severe Weather Warnings whenever severe weather is occurring in an area or is expected to develop or move into an area. The warnings describe the area under threat and the expected hazards. Warnings are issued with varying lead-times, depending on the weather situation, and range from just an hour or two to 24 hours or sometimes more.

Severe Weather Warnings are issued for:

- Sustained winds of gale force (63 km/h) or more
- Wind gusts of 90 km/h or more (100 km/h or more in Tasmania)
- Very heavy rain that may lead to flash flooding
- Abnormally high tides (or storm tides) expected to exceed highest astronomical tide
- Unusually large surf waves expected to cause dangerous conditions on the coast
- Widespread blizzards in Alpine areas

#### 3.1.2 Severe Thunderstorm Warnings

The BoM issues Severe Thunderstorm Warnings to alert communities of the threat of these more dangerous thunderstorms. A severe thunderstorm is one that produces any of the following:

- Large hail (20 mm in diameter or larger)
- Giant hail (50 mm in diameter or larger)
- Damaging or destructive wind gusts (generally wind gusts exceeding 90 km/h)
- Heavy rainfall which may cause flash flooding
- Tornadoes

Most thunderstorms do not reach the level of intensity needed to produce these dangerous phenomena, so the BoM does not warn for all thunderstorms.

Standard public forecasts will include information when there is a reasonable risk of severe storms. This information will allow people to prepare for the potential severe weather. Severe thunderstorms can be quite localised and can develop quickly. The exact location of severe thunderstorms can be hard to predict. As it is difficult to forecast the precise location and movement of severe storms before they have started to develop, detailed warnings will generally be provided once they have been observed or detected. The detailed warnings are usually issued without much lead-time before the event.

### 3.1.3 Flood Watches

The BoM issues a Flood Watch to provide early advice of a developing situation that may lead to flooding. A Flood Watch is not a warning of imminent flooding.

A Flood Watch provides information about a developing weather situation including forecast rainfall totals, catchments at risk of flooding, and indicative severity where required. The product also provides links to weather warnings, other BoM flood-related products, and contact details and information of relevant emergency services.

Although there is uncertainty attached to a Flood Watch, its early dissemination can help individuals and communities to be better prepared should flooding eventuate. A Flood Watch may discuss possible snowmelt, local flooding, or tidal impacts but a Flood Watch will not be issued solely based on these phenomena.

A Flood Watch is generally issued up to four days in advance of the expected onset of flooding. A Flood Watch can be issued before, during and after the rainfall has occurred, depending on the level of maturity of the flood warning systems and services, and flood impact information made available from the local emergency services or state agency.

Flood Watches are updated at least daily and finalised once all areas are covered by flood warnings or the risk of flooding has passed.

### 3.1.4 Flood Warnings

Flood Warnings are issued by the BoM to advise that flooding is occurring or expected to occur in a geographical area based on defined criteria. Flood Warnings may include either qualitative or quantitative predictions or may include a statement about future flooding that is more generalised. The type of prediction provided depends on the quality of real-time rainfall and river level data, the capability of rainfall and hydrological forecast models and the level of service required.

A quantitative or qualitative flood warning of Minor, Moderate or Major flooding is provided in areas where the BoM has specialised warning systems. They provide advanced warning about the locations along river valleys where flooding is expected, the likely class of flooding and when it is likely to occur. Predictions of expected water levels and the timing of flood peaks are provided at key forecast locations.

The BoM also provides generalised flood warnings when there is not enough data to make specific predictions or in the developing stages of a flood. They typically rely on forecast rainfall and knowledge of historical flood response. Generalised warnings contain statements advising that flooding is expected in particular river valleys but do not provide information about flood class nor precise locations.

As part of its Severe Weather Warning Service, the BoM also provides warnings for severe weather that may cause flash flooding. State emergency services or local authorities may provide flash flood warnings in some locations.

### 3.1.5 Accessibility of BoM Warning Services

The current BoM Warnings active in NSW can be accessed at <http://www.bom.gov.au/nsw/warnings/>

The rainfall recently recorded by rainfall warning gauge locations across the Hunter region can be accessed at <http://www.bom.gov.au/nsw/flood/midnorth.shtml>

Current rainfall radar monitoring for the Newcastle (Williamtown Airport) 128 km radius loop can be accessed at <http://www.bom.gov.au/products/IDR043.loop.shtml#skip>

Figure 3-1 shows the location of relevant rainfall and water level gauges to the Muscle Creek catchment. Whilst there are no specific gauges in the Muscle Creek catchment, gauges in neighbouring catchments may be useful for monitoring regional rainfall conditions and potential flood response. The relevant gauges include:

Rainfall Gauges: ([1 Hour Rainfall Bulletin - Mid North Coast \(NSW\) \(bom.gov.au\)](#))

- Aberdeen
- Denman
- Rouchel Brook
- Upper Rouchel
- Antiene Creek (Lidell)

Water Level gauges:

- Rouchel Brook ([River Height data for Rouchel Bk at Rouchel Brook \(bom.gov.au\)](#))
- Muswellbrook ([River Height data for Hunter R at Muswellbrook \(bom.gov.au\)](#))

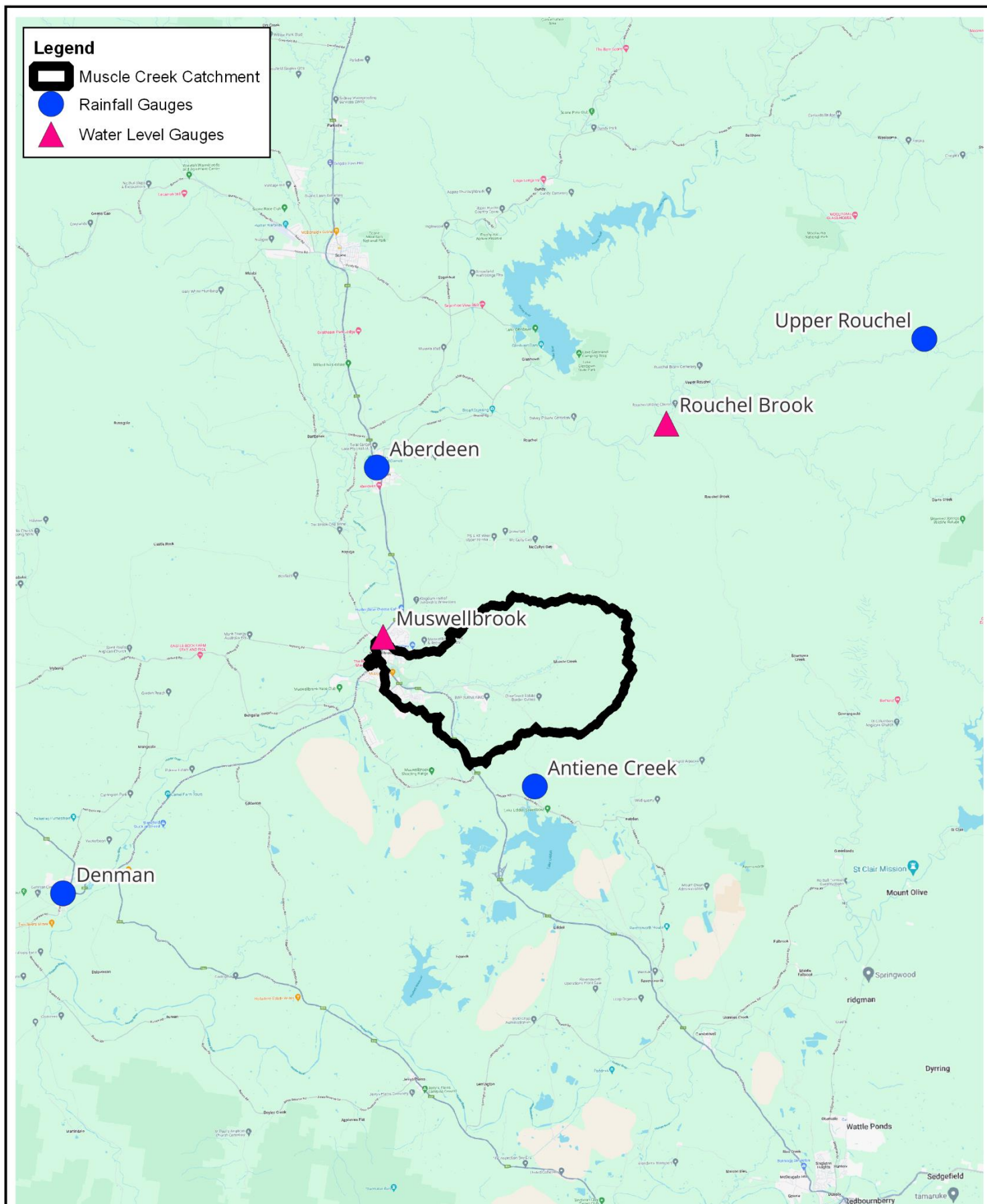
Notwithstanding the proposed Muscle Creek Flood Warning System discussed below, given the lack of relevant gauges in close proximity to the Site it is recommended Site specific rainfall and flood level alert gauges are installed on the Site to use for flood monitoring and emergency response as part of the FERP. The BoM gauges as noted above will remain useful monitoring locations to assess broader regional rainfall conditions.

## 3.2 Muscle Creek Flood Warning System

RHDHV prepared the Muscle Creek Flood Warning System (FWS) Concept Design Study (2022). The document outlines the concept design of a flood warning system for Muscle Creek. It is expected that a flood warning system (including a number of proposed water level and rain gauges) for Muscle Creek will be implemented, however, it is understood at the time of writing this system is not in place.

The Muscle Creek Flood Warning System FWS is not critical to the PBCS Flood Emergency Response Plan, but should it eventuate it may allow for increased warning times for the Site. The flood warning messaging and communication protocols with the FWS may not provide direct warning to the school, however, in the least it would be anticipated that rainfall and water level gauge data would be available providing additional intelligence on local flood conditions to inform the trigger points for school closure and evacuation.

This FERP should be reviewed and updated once the FWS has been implemented and tested.



Title:  
**Rainfall and Water Level Gauge Locations**

0 8 16 km  
approx. scale

Figure: **3-1** Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

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### 3.3 Flood Warning Triggers and Timeline Analysis

Monitoring of the BoM Warning services can provide a few days' notice of weather systems producing an increased potential for flooding at the Site. When warranted, these Warnings will result in the precautionary closure of the Site. Therefore, it is only rapidly developing, localised intense storms that might require an emergency evacuation response.

It is significant to reiterate that the building areas are subject to inundation only for events of the 0.2% AEP (1 in 500) and above, with the buildings having floor levels up to a 0.01% AEP (1 in 10,000). Weather systems of this magnitude and across the 100km<sup>2</sup> scale of the Muscle Creek catchment would be subject to early warning services from the Bom. Put simply, these rainfall systems would not suddenly appear and restrict emergency response to short periods of less than an hour. Moreover, the advance warning associated with rainfall systems of this magnitude would invariably provide for the appropriate school closure in advance of the flood affectation of the Site.

Notwithstanding this likelihood of considerable lead warning time, the following timeline analysis represents a worst-case scenario for the PMF event (already ~1 in 10,000,000 AEP) assuming no warning and a reactive response in the event the Site is occupied.

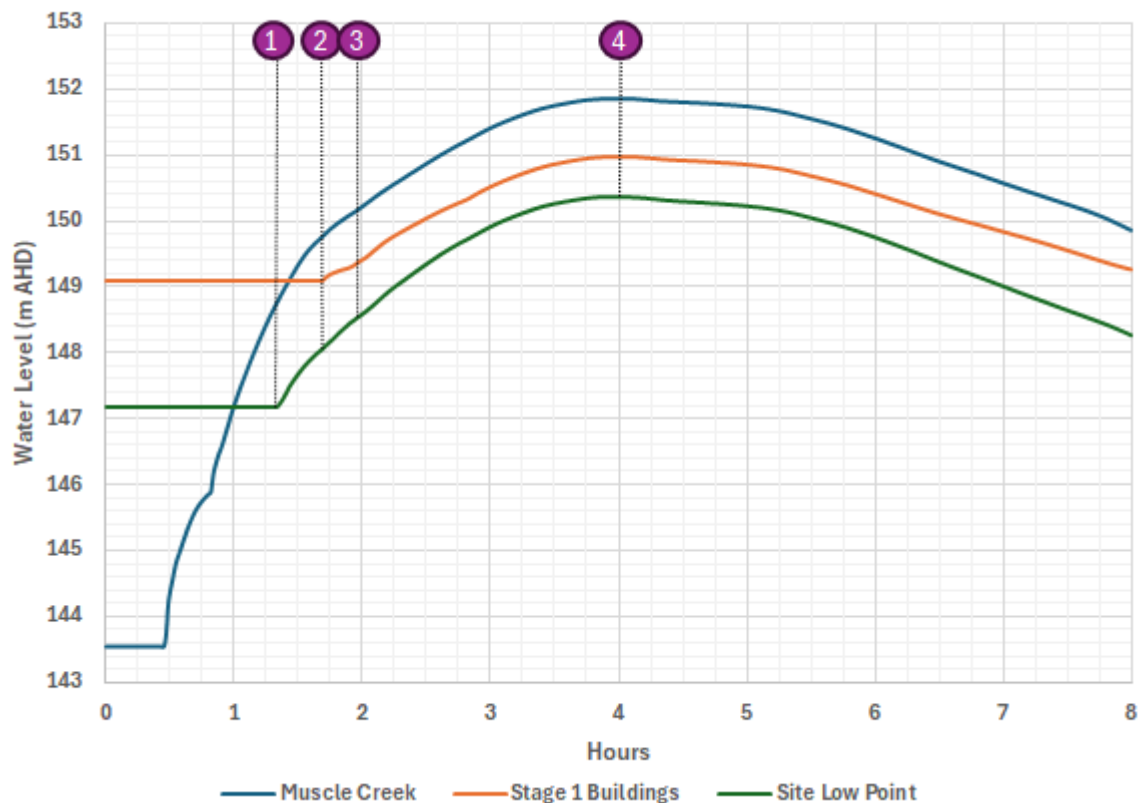
Figure 3-2 shows the simulated flood level response for the PMF event at the following reference points:

- Muscle Creek channel adjacent to the upstream Site boundary – this location provides for the general rise in flood level in the creek channel
- Proposed building area – representing above ground water levels and provides for the onset of overland flooding in the location of the buildings (note: references ground level, not floor level)
- Site low point – the lowest existing ground level at the north-east Site boundary and initial point of inundation of the Site for events of 1% AEP magnitude and above (no Site flooding for lower order events)

The timing in Figure 3-2 is from time zero (0-hours) at the commencement of the design PMF rainfall.

Four key trigger points are identified on Figure 3-2:

1. Initial inundation of the Site at the low point –occurs at time 1hr20min into the simulation from the onset of the PMF rainfall.
2. Initial inundation of ground levels surrounding the proposed building locations - occurs at time 1hr20min into the simulation (i.e. 20-minute window between trigger 1 and 2).
3. Maitland Street unviable as evacuation route due – occurs at time 1hr55min into the simulation (i.e. 35-minute window between trigger 1 and 3)
4. Peak flood condition which corresponds to ~1.2m depth of above floor flooding in proposed buildings – occurs at time 4hr into the simulation.



**Figure 3-2 Timing of Flood Level Response - PMF Event**

To further appreciate the changing risk profile on the Site as the flooding increases, Figure 3-3 shows the progression of the flood inundation extents and flood hazard classification surrounding the Site. The four images correspond to the trigger points noted above.

Inundation of the Site at the low point at trigger 1 is preceded by the adjacent Muscle Creek channel experiencing a rise in flood level of over 3.5m (approaching the 1% AEP peak flood level). These elevated creek levels, also corresponding to a flooded width in excess of 100m, would provide a relevant visual cue for a flooding condition to initiate a flood response.

Broader floodplain inundation across the Golf Course and the start of proposed building area inundation at trigger 2 is initiated by the overland breakout flows from Muscle Creek upstream of the Site. These overland flows increase through to trigger 3 with flows initiated down Maitland Street and providing flood hazard conditions that require evacuation to have been effected from this point.

The peak flood condition represented as trigger 4 shows extensive floodplain inundation and typically high hazard classes H5 and H6 across the majority of inundation area, except the floodplain fringes. The nominal evacuation centres (refer to Section 4.1.2) are located outside the PMF extent. During this flood event access to the Site will be impacted, both locally within the surrounding roadways, but potentially more broadly through impacts to other transport routes across Muswellbrook.

Peak flood hazard surrounding the proposed buildings is at H5 level, and accordingly the typical building construction would provide for structural integrity of these buildings at the peak PMF flood condition.

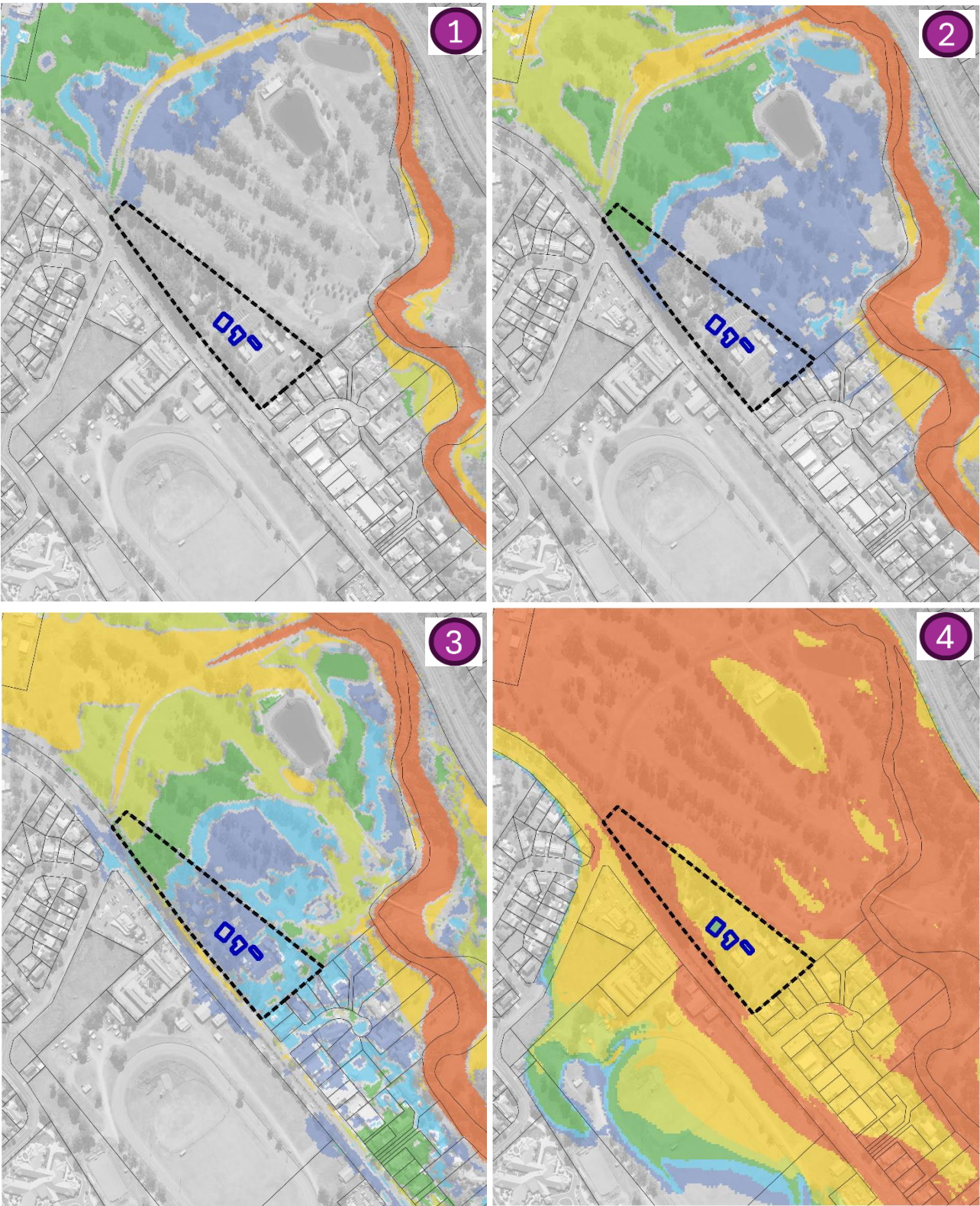
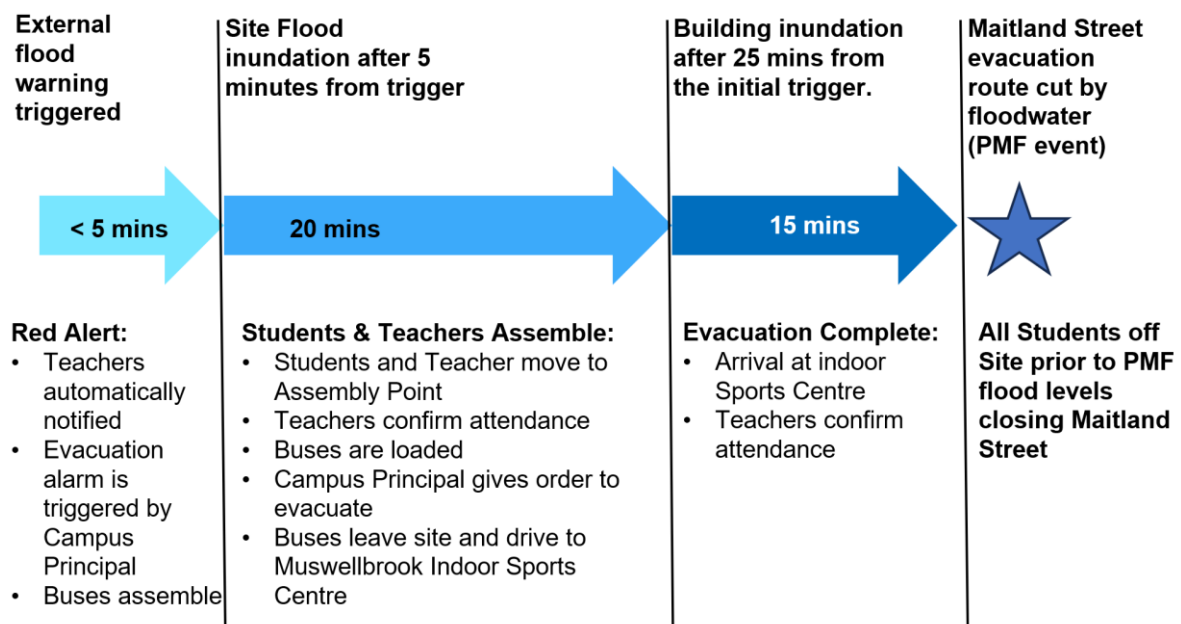


Figure 3-3 Progression of Flood Hazard - PMF Event

In the unlikely event that early warning is comprised, the time taken to respond to an on-site inundation flood alert and effect an evacuation to an offsite Flood Refuge is expected to be less than 35 minutes.

Figure 3-4 shows a representative minimum response timeline available for the Site to achieve an appropriate evacuation. Note minimal time (<5mins) is provided for receiving an appropriate external warning. These external warnings may represent official BoM and SES emergency warnings, live rainfall gauge triggers (refer to Section 3.3.1) and visual references such as Muscle Creek water levels.



**Figure 3-4 Minimum Flood Warning and Emergency Response Timeline and Action Plan**

### 3.3.1 Rainfall Evacuation Triggers

The initial trigger point for the evacuation timeline is linked to initiation of flood inundation at the low point of the Site at the northeast corner. This FERP recommends the installation of an on-site water level gauge at this location with flood alert capability linked to the school's emergency systems.

Additional lead flood warning time prior to an evacuation response based on the Site inundation is achievable in enacting early warning triggers based on recorded rainfall. Give the lack of existing rainfall gauges in the Muscle Creek catchment, the FERP recommends the installation of an automated weather station with pluviometer to record site rainfall and provide the basis for a rainfall trigger.

Design rainfall depths were sourced from the BoM IFD portal and are summarised in Table 3-1 for various design event magnitudes and storm durations. A nominal 50mm rainfall in 30minutes is equivalent to a 1in 2000 AEP event (noting the buildings have a representative design flood immunity of 1in 10,000 AEP). Accordingly, this threshold of rainfall trigger would provide appropriate warning time for all of the events up to the very rare categorisation.

The frequency this rainfall threshold of 50mm is reached is demonstrated in the highlighted cells in Table 3-1. For example, the design 1% AEP rainfall depth of 50mm would occur over a longer 2-hour duration. Similarly, a 50mm rainfall depth for the 10% AEP occurs over 6-hour period.

The design PMF event provides for some 540mm of rainfall in 4-hours, representing an average intensity of 140mm/hour or an equivalent 70mm in 30 minutes. The adopted 50mm in 30-minute rainfall threshold effectively captures this intensity and would be an appropriate trigger to initiate evacuation in the event the PMF rainfall intensities are sustained for a longer duration.

**Table 3-1 Design IFD Rainfall**

Duration (mins)	10% AEP	5% AEP	2% AEP	1% AEP	1 in 200	1 in 500	1 in 1000	1 in 2000
<b>30</b>	21	24.2	28.8	32.2	35.4	40.3	44.1	<b>48.1</b>
<b>45</b>	25.3	29.1	34.2	38.3	42.1	47.8	<b>52.4</b>	57.1
<b>60</b>	28.4	32.5	38.1	42.5	46.6	<b>53</b>	57.9	63.1
<b>90</b>	32.8	37.5	43.6	48.4	<b>53</b>	60	65.5	71.1
<b>120</b>	36.1	41.1	47.7	<b>52.7</b>	57.5	64.9	70.7	76.7
<b>180</b>	41.5	47.1	<b>54.4</b>	59.9	65.1	73.2	79.6	86.3
<b>270</b>	48.4	<b>54.9</b>	63.8	70.5	76.6	86.5	94.1	102.1
<b>360</b>	<b>54.5</b>	62.3	73	81.2	88.2	101	110.4	120.4

## 4 Flood Emergency Response Plan

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### 4.1 The Emergency Response Strategy

The recommended flood emergency response strategy is derived from the understanding of flood risk for the Site. The key observations in this regard include:

- The proposed building area remains flood free up to 0.2% AEP (1 in 500) design flood magnitude. The elevated floor levels of the buildings provide for a flood immunity (no above floor flooding) up to 0.01% AEP (1 in 10,000) design flood magnitude. Accordingly, the design flood immunity afforded to the Site represents a very low risk of exceedance.
- For extreme flood events in excess of these magnitude, up to the PMF event, the predicted flood conditions warrant the Site to not be occupied. For the scale and magnitude of such flood events, it is expected that flood and emergency warnings will be in place for not only the Muscle Creek catchment, but the broader mid-Hunter region. These advance warnings are expected to facilitate school closure prior to any on-site flooding exposure.
- In the unlikely event of flood condition exceeding 0.2% AEP (1 in 500) design flood magnitude within the hours of school operation, evacuation of the Site to a nominated flood refuge can be executed within available warning times. A flood evacuation timeline analysis has demonstrated evacuation capability for all events up to and including the PMF event within initial inundation of the Site. Lead warning times are enhanced with installation of rainfall and water level gauges within the Site.

The available flood warning opportunity is expected to limit flood risk exposure via initial flood avoidance through school closures. In the unlikely event the Site is occupied during an extreme flood event, effective site evacuation procedures enable relocation from Site to the nominated flood refuge prior to potential flood inundation of the buildings. The recommended flood emergency response comprises:

- School closure
- Evacuation to nominated flood refuge

The responsibilities and actions for effective flood emergency response management at the Site are outlined in this FERP. The FERP forms part of the broader Risk and Emergency Management framework of Pacific Brook Christian School (PBCS).

#### 4.1.1 School Closure

Given the length of the school day (say 8:30am-3:30pm) and the number of school days outside holiday periods, there is only around a 15% chance that any given flood event will coincide with potential occupation of the Site. The availability of flood warning intelligence to inform potential flood risk in advance of the peak flooding conditions provides significant opportunity for school closure and risk elimination. Accordingly, this represents the principal emergency response.

As noted, the events providing for inundation of the buildings are well in excess of the 1% AEP flood magnitude. Accordingly, flood events requiring Site closure are expected to be preceded by official BoM warnings. In most circumstances these warnings will allow for the school closure prior to start of the school day, or provide appropriate lead warning time during school operation to facilitate a closure prior to flood affectation.

#### 4.1.2 Evacuation

Site evacuation is to be initiated by any the following triggers:

- Order by SES or other emergency services
- Flood alert via installed water level gauge at Site low point
- Recorded rainfall of 50mm or more in a 30-minute period via the installed rain gauge on-site or other monitored gauge locations
- Visual cue of Muscle Creek flood inundation

The flood hazard within the local and regional road network can be higher than within the Site and so leaving the Site at an inappropriate time, outside of the Flood emergency Response Plan would increase the level of risk, particularly given the context of the local “flash flood” environment. Coupled with a relatively short warning time, these conditions make evacuation from the Site during an unlikely PMF event challenging, from both a logistical and risk-based perspective.

Notwithstanding these potential challenges, the evacuation assessment provides for an effective route within an appropriate timeline to evacuate the Site.

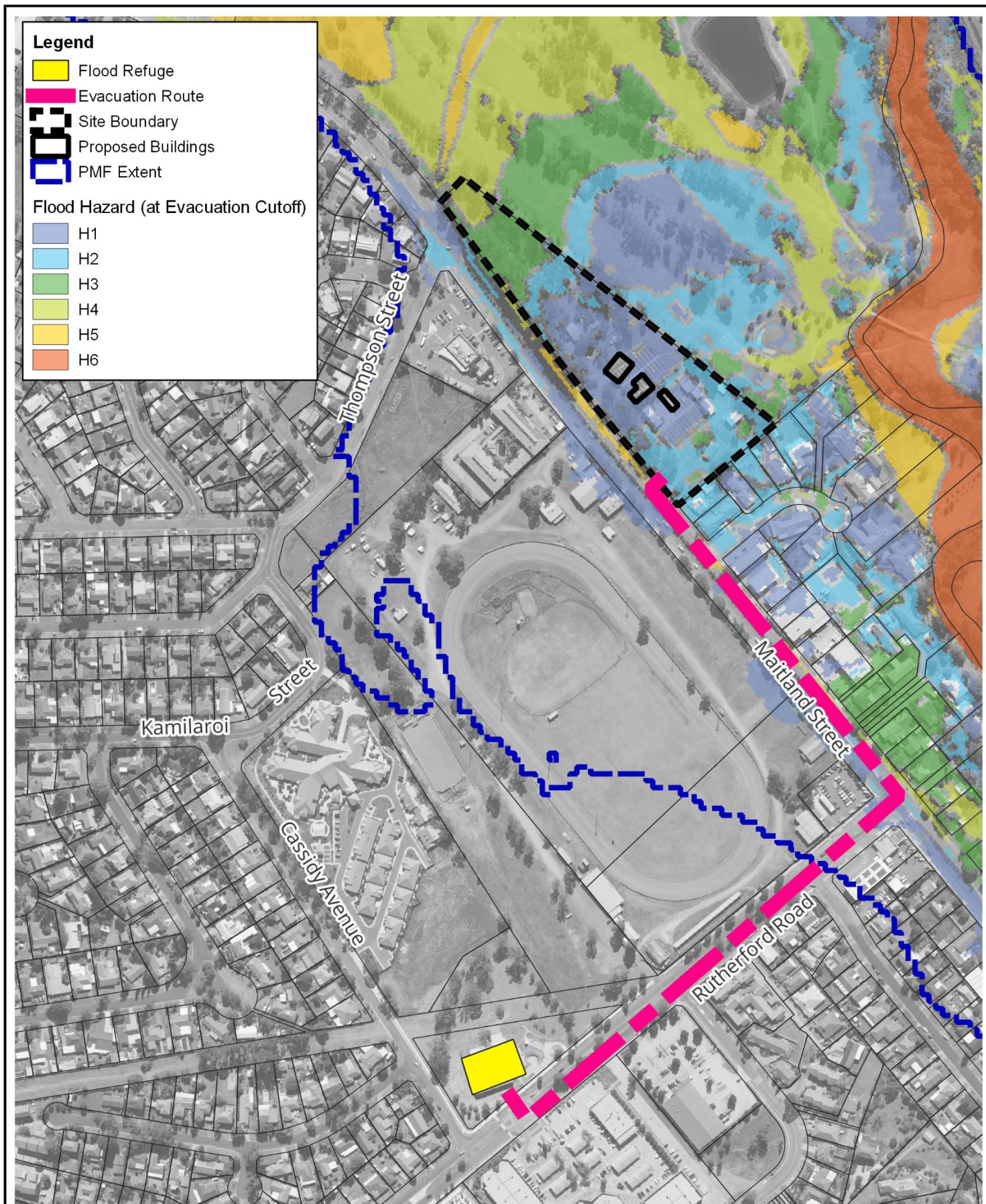
The evacuation centre/flood refuge is identified as Muswellbrook Indoor Sports Centre (corner of Rutherford Road and Cassidy Avenue. The Sports Centre is located outside the PMF extent with operating hours Monday to Saturday 9am to 9pm, compatible with school opening hours.

PBCS has confirmation from Council (refer Appendix D) that Muswellbrook Indoor Sports Centre is the appropriate flood refuge in accordance with existing emergency management arrangements.

The nominal evacuation route is via Maitland Street and Rutherford Road as shown in Figure 4-1 and represents a distance of some 900m.

The flood risk profile along the potential evacuation routes and evacuation timeline analysis was discussed in Section 3.3.

The proposed method of evacuation is via school buses stationed on the school premises. This type of heavy vehicle transport provides additional protection for staff and students during the relocation to the Flood Refuge. In the event bus transport is not available (e.g. off-site, inoperable) the same evacuation triggers enable pedestrian evacuation via the same route within the available warning times.



Title: <b>Flood Evacuation Route</b>		0 100 200 m  approx. scale	
Figure:	<b>4-1</b>	Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.	
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## 4.2 Responsibilities

Roles and responsibilities in case of an emergency are defined in the School Work Safe Policies. This section provides an overview of the key information that is relevant to a flood emergency.

The responsibility of successful implementation of the FERP sits with PBCS (specifically the Chief Warden), however, the NSW SES as the State combat agency for flood events and the NSW Police Force have right to and may intervene before, after or during a flood to provide guidance or prescriptive directions to PBCS.

PBCS will provide the following staff resources to coordinate the management of flood emergencies:

- Chief Warden (currently nominated as School Principal) – will be present on Site and responsible for decision making during an event and for assisting in communication and management of stakeholders, and have access to the resources necessary to manage an incident (e.g. flood alert triggers, CCTV cameras, PA system).
- PBCS Management - responsible for overseeing review, maintenance and training for equipment and procedures required to implement the FERP, including the Warden structure
- Flood Wardens - will be present on Site and have access to the resources necessary to manage an incident (e.g. flood alert triggers, CCTV cameras, PA system). A Warden will be delegated as acting Chief Warden when the Chief Warden is absent from the Site

Wardens will be trained to deal with flood emergencies and will follow the directions of the Chief Warden. A total of at least three Wardens will always be present onsite.

### 4.2.1 NSW State Emergency Services

The NSW State Emergency Service (SES) is the lead combat agency for flooding in NSW. It can command resources from other government organisations including local Councils, Transport for NSW, and the Police to assist in flood operations under its command.

Under the State Emergency and Rescue Management Act, 1989, the SES has the power to direct any citizen or organisation to take actions in response to flooding. This includes the power to order evacuations.

Any flood response directive issued by the SES or by delegated authority to others acting on its behalf must be followed by PBCS staff, students, and visitors. This includes any order to evacuate the Site or not evacuate the Site, irrespective of what decisions have been made by management in accordance with this FERP.

### 4.2.2 PBCS Management Team

In the event of a critical incident, an action plan will be implemented. Both the plan and its implementation are the responsibility of the PBCS Management Team, under the direction of the Chief Warden (School Principal). The Team will decide on the specifics of the action plan and how it will be implemented, depending upon the extent, nature, and complexity of the incident. A flood emergency response will activate the Team whether on duty or otherwise.

The PBCS Management Team will not need to meet to discuss or make a decision during a flood emergency response. However, they are all aware of the requirements and process and will be available to support the Warden structure, as required.

The PBCS Management Team (or other group with delegated emergency management function) will be responsible for ensuring that this FERP is:

- reviewed annually or after any flood event to reflect any lessons learnt or changes in the Site layout, features, or operations or to incorporate new data on flood behaviour as this becomes available
- is included in induction and training of Site staff (i.e. Chief Wardens, Wardens, etc.) to a level appropriate to their responsibilities under the FERP

The PBCS Management Team will also be responsible for the following tasks:

- Ensure that the Chief Warden or delegates are aware of flood risks and of the risk management actions and responsibilities detailed in this FERP
- Ensure that there are enough Wardens to coordinate the FERP
- Ensure that a maintenance schedule for the on-site flood level alert and rainfall gauge is kept and maintained
- Organise an annual drill of the flood emergency response procedures
- Document FERP reviews, flood emergency response drills and post-event reviews of actual flood emergency responses
- Support the Chief Warden and Wardens in their duties
- Ensure an annual audit is undertaken of the resources necessary to implement this FERP

#### 4.2.3 Chief Warden

During a flood emergency response, the Chief Warden is responsible for:

- High-level decision making relating to flood emergency response
- External stakeholder communication (parents and carers, State Emergency Services, etc.).

The Chief Warden will be responsible for the following tasks:

- Monitoring of flood warning network services
- Support the PBCS Management Team in its duties
- Ensure that the Wardens receive the required training to assist in the implementation of the FERP.

The Chief Warden (or delegate) will:

- Ensure that all Wardens who are on Site are aware of the flood risks and the flood management procedures detailed in this FERP
- Support the Wardens in their duties
- Ensure that the Site flood management measures and infrastructure are functional
- Lead the annual drill of the flood emergency response procedures
- Monitor Warnings and Alert Mode triggers in accordance with this FERP
- Escalate Alert Modes in accordance with the relevant triggers set in this FERP
- Assist, coordinate and communicate flood response messages to Wardens, staff, students, and visitors in accordance with this FERP
- Coordinate all flood emergency procedures
- Participate in a review of this FERP annually and following a flood event

#### 4.2.4 Wardens

The Wardens will:

- Assist the Chief Warden implement flood emergency response procedures, as required
- Participate in the annual test of the flood emergency response procedures
- Participate in a review of this FERP annually and following a flood event

#### 4.2.5 Staff, Students and Visitors

Staff, students, and visitors will:

- Follow the directions of the Chief Warden, Wardens, or PA announcements
- Report any concerns

#### 4.2.6 Training

All staff with FERP responsibilities are to undertake the required training. Ensuring that this training is provided is the responsibility of the PBCS Management Team. Most training is consistent with the broader Emergency Management Planning and Critical Incident Management requirements and not specific to the FERP. This includes standard training for Wardens and First Aid Officers, etc.

Familiarisation with the FERP should form part of the induction and regular training for relevant staff. In addition, a full drill of a flood emergency response will be undertaken annually. The performance outcomes of the drill will be reviewed by the PBCS Management Team.

Specific training is also to be provided to the Chief Warden and members of the PBCS Management Team as to the accessibility and interpretation of the available flood warning information and how this can improve the decision-making process during the management of a flood emergency response.

Annual communications will be provided by PBCS to parents and carers, educating them about the FERP and their requirement not to attempt to collect their children during a flood emergency response, until advised to do so.

### 4.3 Communication Methods

The Chief Warden / PBCS Management Team is responsible for communications with external stakeholders during a flood emergency response.

In situations where a potential flood event is identified by the BoM via a Warning being issued, the PBCS Management Team and Chief Warden will communicate with one another using their standard means. If the decision is made to close the school in advance of an expected flood event, then this will be communicated by PBCS to students, parents and carers, the morning of the event or the day prior.

In situations where the Site is currently in use and a flood event is imminently expected (i.e. a Red Alert Mode) then communication is made, advising occupants as to the need for responsive action. This will be done as per the PBCS standard procedure for lockdown situations and drills, i.e. via pre-recorded messaging in the phone system being broadcast to phones and the playground amp. A siren will be sounded via the PA system (unless the Site is locked and not in use). The PBCS Management Team, Chief Warden and Wardens can continue to communicate via mobile phone if those systems are still operational, or by using the two-way radios, as required.

When a Red Alert Mode is activated then automatic messaging will be issued to parents and carers via the standard communication procedures. This will inform them that the school is in refuge for potential flood isolation and that they will be notified again when the flood risk concern at the Site has passed. It is important that parents and carers are instructed not to attempt collection of students from the Site prior to the subsequent advice to do so. Annual communications will be provided by PBCS to parents and carers, educating them about the FERP and this requirement, led by the PBCS Management Team. This will include examples of the standardised messaging that will be received.

In situations where the Site has been subject to a flood event and the event has subsequently receded (i.e. a Green Alert Mode) then the PBCS Management Team, Chief Warden and Wardens can continue to communicate via mobile phone if those systems are still operational, or by using the two-way radios, as required.

Once normal operations are resumed then this will be communicated by the PBCS Management Team to parents and carers, via the standard communication procedures, including arrangements for collection of the students from the Site, as required. It is important that those being asked to collect people from Site are advised to first check for any road closures due to flooding. Whilst the roads local to the Site will have re-opened, others across the broader school catchment area could still be affected.

The Flood Refuge will inherently contain numerous laptops and mobile phones that can be used to facilitate communication with external stakeholders. Many of these will likely have sufficient charge to last throughout the duration of emergency response. However, as a contingency the Flood Refuge will contain external battery sources capable of powering a laptop and mobile phone.

The members of the PBCS Management Team and Chief Warden are each to have ready access to this FERP, both through the online cloud storage and as hardcopies located in the Administration Office and Staff Rooms. Broader access to the FERP will be provided through having a printed and laminated copy of the Summary FERP document (refer Appendix C) available within each classroom and other appropriate locations across the Site.

## 4.4 What to do Before, During and After a Flood

### 4.4.1 Normal Operation

During normal day-to-day operations, when the Site is not in a state of flood alert, the PBCS Management Team will:

- Ensure that this FERP is reviewed annually or after any flood event to reflect any lessons learnt or changes in the Site layout, features, or operations or to incorporate new data on flood behaviour as this becomes available
- Ensure that this FERP is included in induction and training of Site staff (i.e. Chief Wardens, Wardens, etc.) to a level appropriate to their responsibilities under the FERP
- Ensure that the Chief Warden or delegates are aware of flood risks and of the risk management actions and responsibilities detailed in this FERP
- Ensure that there are enough Wardens to coordinate the FERP
- Organise a drill of the flood emergency response procedures annually

The Chief Warden (or delegate) will:

- Daily monitor the sources of information for the triggers of the Alert Modes

- Ensure that all Wardens who are on Site are aware of the flood risks and the flood management procedures detailed in this FERP
- Maintain a register of the staff, students, and visitors present on Site, including contact details and emergency contacts
- Ensure that the Site flood management measures and infrastructure are functional
- Lead the annual drill of the flood emergency response procedures
- Participate in a review of this FERP annually and following a flood event

The Wardens will:

- Participate in the annual test of the flood emergency response procedures
- Participate in a review of this FERP annually and following a flood event

#### 4.4.2 Alert Modes

To assist in managing flood risks and communicating response actions, three flood Alert Modes have been developed for use in this FERP. They are:

- Amber: flooding of the Site is possible within the hours of operation
- Red: imminent flooding of the Site is expected
- Green: all clear, floodwaters have receded and local access to the Site is available

The Amber Alert Mode is called following the issuing of a Severe Weather Warning, Severe Thunderstorm Warning, Flood Watch, or Flood Warning for Muswellbrook or surrounds by the BoM and indicates an increased potential for flooding.

The Red Alert Mode is triggered following the issuing of a specific Flood Warning or evacuation Order by the BoM or SES, or rainfall/water level thresholds are exceeded and indicates that possible flooding of the Site is imminent.

The Green Alert Mode is called following a flood event, once flood waters have receded.

#### 4.4.3 Amber Alert Mode

The Amber Alert Mode is called by the PBCS Management Team/Chief Warden in advance of school hours, or by the Chief Warden during school hours, if any of the relevant triggers are detected. Under the Amber Alert Mode, a flood affecting the Site within the hours of operation is possible. The management actions to be undertaken will depend on when the Amber Alert Mode is called and are reported below.

##### Triggers to call an Amber Alert Mode

The following Warnings issued by the BoM for Muswellbrook may trigger an Amber Alert Mode:

- A Severe Weather Warning (see explanation below) OR
- A Severe Thunderstorm Warning OR
- A Flood Watch OR
- A Flood Warning

Any of the above Warnings listed on the BoM Warnings page that reference a geographical area that includes Muswellbrook will be accessed and reviewed. The Warnings are often descriptive in nature and will elaborate on the weather conditions that are expected to occur. Key indicators to be aware

of are Severe Weather or Thunderstorm Warnings that include references to heavy rainfall, particularly if local catchment and/or flash flooding is mentioned.

Flood Watches and Flood Warnings tend to be issued for larger river catchments with flood level gauge locations and longer warning times, such as the Hunter River. However, they could potentially be issued for local catchment and/or flash flooding within local areas such as Muswellbrook. This is expected to be the scenario upon commissioning of the Muscle Creek Flood Warning System.

#### **Prior to commencement of a regular school day or out of hours event**

Details regarding any applicable BoM Warnings are reviewed by the Chief Warden (in consultation with the PBCS Management Team) as to the potential for flooding to occur during the upcoming hours of operation for the Site. The Warnings can be issued days in advance, in which case they will be periodically updated as the forecast event approaches.

Warnings that indicate heavy rainfall with a likelihood of local catchment and/or flash flooding and have an expected coincidence with upcoming hours of operation at the Site indicate an increased likelihood that a Red Alert Mode might be triggered. Depending on the nature of planned activity at the Site and the expected severity of the weather event, the PBCS Management Team will consider closing the Site, suspending the planned activities, or using alternative remote access arrangements, if possible. This decision will need to be taken 12-24 hours in advance to effectively communicate closure of the school.

#### **During a regular school day or out of hours event**

Most BoM Warnings are provided at least a day in advance and so the issuing of a Warning that impacts a current school day or event without prior notice would be limited to rapidly developing, localised storm systems such as thunderstorms.

If a BoM Warning is issued that impacts the current school day or event, then the Chief Warden and PBCS Management Team will determine whether it is appropriate to continue with the planned operations, with the Wardens being notified of such and prepared for an increased likelihood that a Red Alert Mode might be triggered. In such circumstances, the risk of people being caught in transit by severe weather needs to be considered against the risk of becoming isolated by flood waters at the Site. The Wardens will equip themselves with the two-way radios and high-vis vests during an Amber Alert Mode to provide improved communication.

#### **4.4.4 Red Alert Mode**

The Red Alert Mode is called immediately upon the school receiving notification that the Flood Alert Service has triggered a Flood Warning. Under the Red Alert Mode, a flood affecting the Site is imminently expected. The management actions to be undertaken will depend on when the Red Alert Mode is called and are reported below.

##### **Triggers to call a Red Alert Mode**

The following triggers are used to call a Red Alert Mode:

- A Flood Evacuation Order issued by the NSW SES or other emergency response agency.
- 50mm of rainfall recorded in 30-minutes or less at on-site rainfall gauge.
- On-site floodwater alarm from flood level alter gauge indicating inundation of the Site.

Other supporting trigger mechanisms can include visual indication of Muscle Creek flooding and recorded rainfall in neighbouring catchment gauges (refer Figure 3-1).

If the Chief Warden is concerned about intense rainfall that is being experienced but a Flood Warning alert has not been issued, then they can consider initiating a flood emergency response and relocate staff and students to the Flood Refuge before an official warning has been received.

#### **Prior to commencement of a regular school day or out of hours event**

Any planned use of the Site will be suspended immediately by the Chief Warden. Once the flood event has passed and safe access to the Site is possible, the Chief Warden will inspect the Site to check for any flood damage or associated hazards that need addressing. The Site can then be re-opened, and planned activities resumed once it is safe to do so. Communication is to be issued to parents and carers advising students not to travel to school.

#### **During a regular school day or out of hours event**

If a Red Alert Mode is triggered shortly after an Amber Alert Mode is called, then the following actions should be completed if not already done so:

- Wardens are to equip themselves with the available two-way radios and high-vis vests
- A hardcopy list of current day Site attendees will be printed out in the Flood Refuge from the online cloud services

When a Red Alert Mode is triggered, then the following actions are also to be undertaken:

- Communication is made, advising occupants as to the need for responsive action, via pre-recorded messaging in the phone system being broadcast to phones and the playground amp. A siren will be sounded via the PA system (unless the Site is locked and not in use)
- Messaging is issued, advising parents and carers of the situation, advising them not to attempt collection of students from the Site prior to receiving subsequent advice to do so
- The Chief Warden will coordinate the Wardens in relocating staff, students, and visitors to the Flood Refuge location
- Staff, students, and visitors are to remain within the Flood Refuge until it is safe to resume normal operation of the Site.

#### **4.4.5 Green Alert Mode**

The Green Alert Mode is called by the Chief Warden (in consultation with the PBCS Management Team), once flood waters are receding and the flood emergency has passed. For minor, localised events this will be evident from observation of conditions surrounding the Flood Refuge. However, for major flood events consultation with the NSW SES will be required, to ensure that conditions more broadly across Muswellbrook are safe to begin vacating the Flood Refuge and further flooding is not expected. The management actions to be undertaken are reported below.

The Chief Warden (or delegate) will:

- Communicate to the Wardens that the flood emergency has now passed
- Keep monitoring the sources of information for the triggers of the Alert Modes
- Listen to the local radio station for updates on the weather / flood situation
- If the Site has experienced any flooding, then inspect the Site and adjacent roads for signs of any potential hazards that could present a risk for access to and from the Site

- Audit that all refuge supplies are returned to their resident locations

The Wardens will:

- Help people exit the Flood Refuge when the Chief Warden has confirmed that this can be undertaken
- Provide support while students leave the Site
- Help address any concerns of students arising from their potential collection from the Site, if required
- Identify any medical concerns and report them to the first aid team

The PBCS Management Team will:

- Coordinate with parents and carers of the students to facilitate their collection from the Site, as required
- Arrange subsequent inspection of the school buildings by a Structural Engineer if they have been inundated by flood waters
- Review this FERP to reflect any lessons learnt or changes in the Site layout, features, or operations or to incorporate new data on flood behaviour as this becomes available

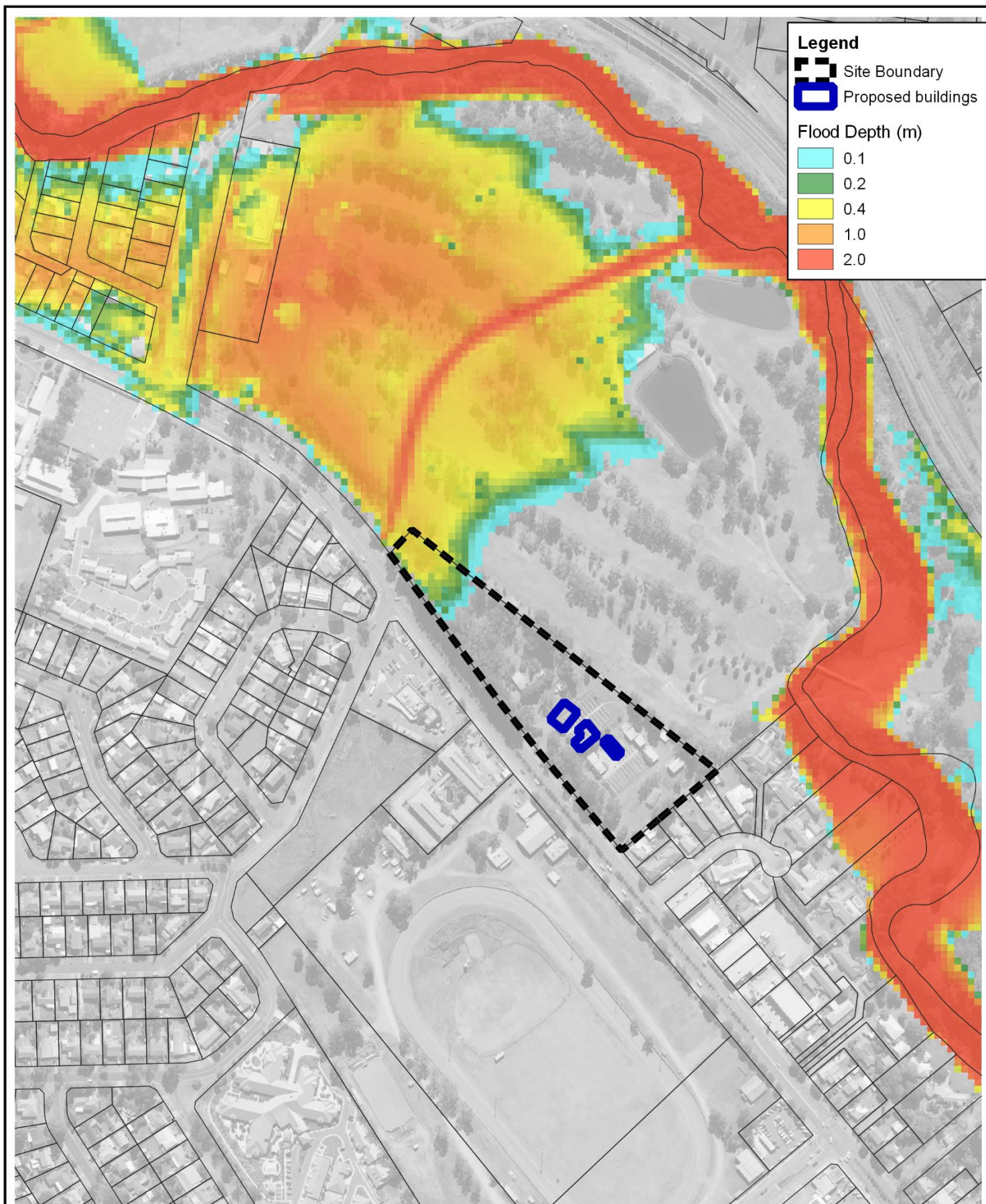
## 5 References

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- AIDR (2017) *Guideline 7-3, Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*
- BoM of Meteorology (2003) *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*
- BoM of Meteorology (2016) *Intensity-Frequency-Duration (IFD) design rainfalls*
- Muswellbrook Shire Council (2012) *Development Control Plan*
- Geoscience Australia (2019) *Australian Rainfall and Runoff: A Guide to Flood Estimation*
- Royal Haskoning DHV (2017) *Muscle Creek Flood Study*
- Royal Haskoning DHV (2019) *Muswellbrook Floodplain Risk Management Study and Plan*
- Torrent Consulting (2024) *Pacific Brook Christian School Flood Impact Assessment*

## Appendix A Design Flood Depth Mapping

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Title:

## Peak Flood Depth - 1% AEP Event

0 100 200 m



approx. scale

Figure:

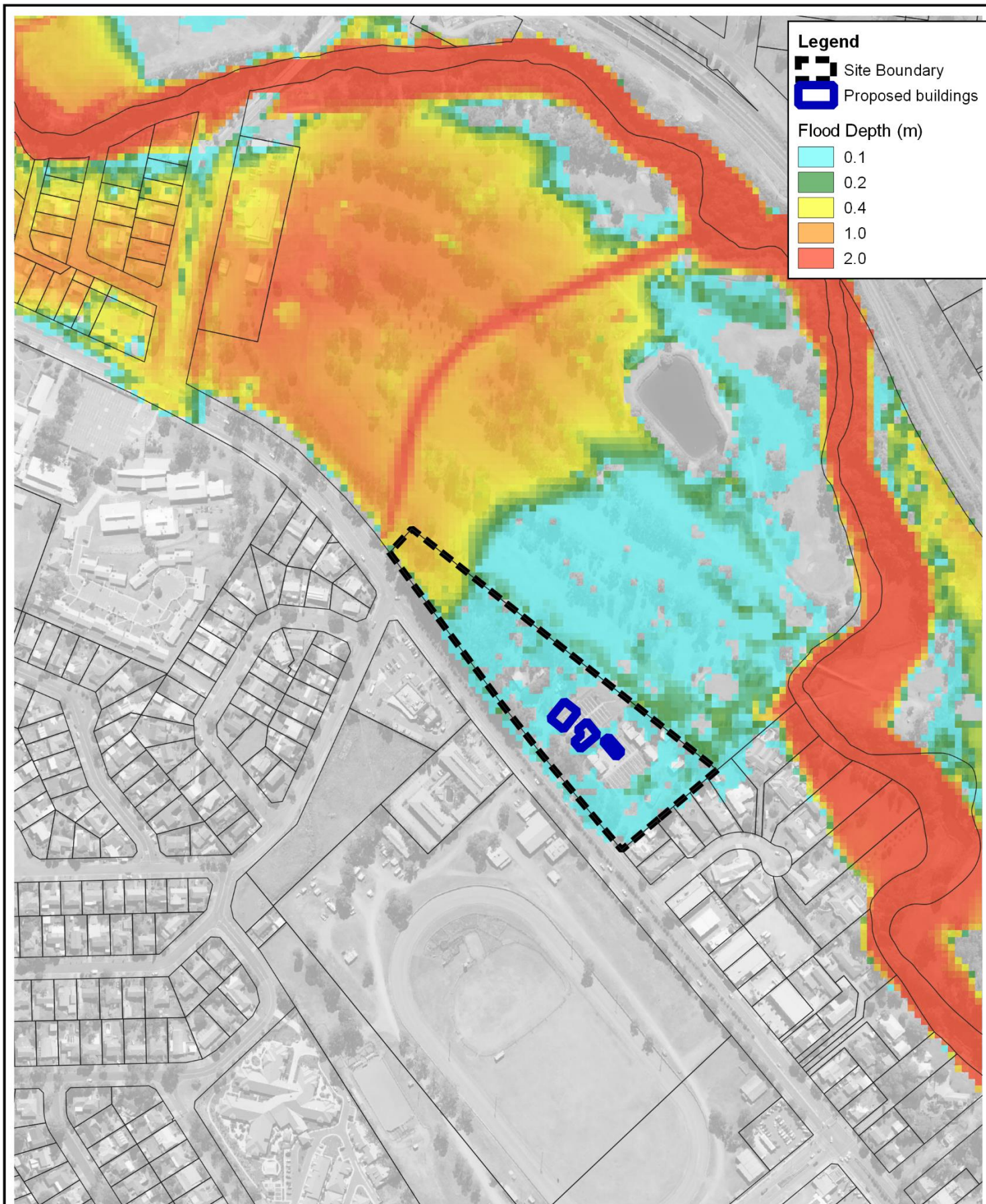
**A-1**

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

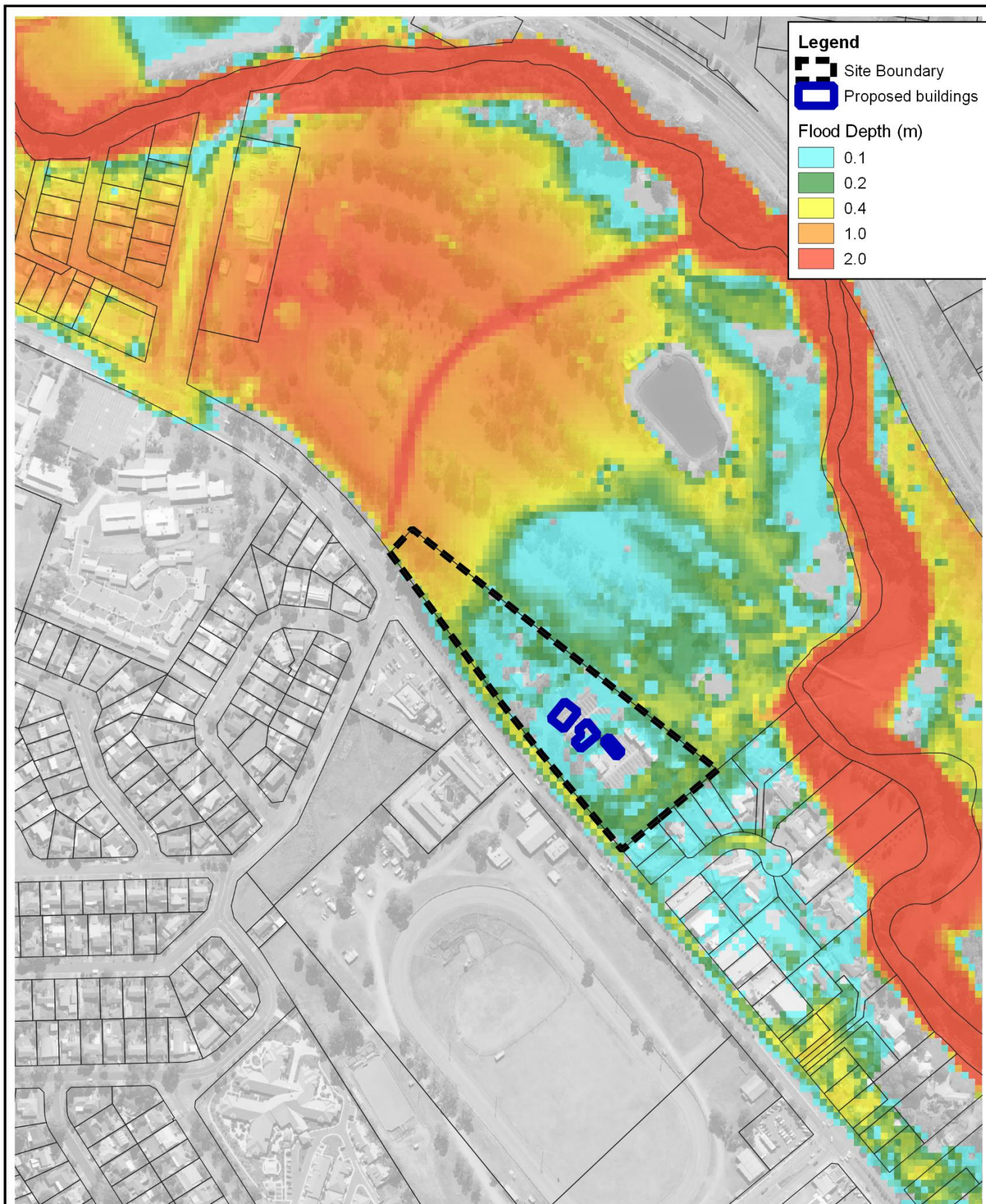
Revision:

**A**





<p>Title:</p> <p><b>Peak Flood Depth - 0.5% AEP Event</b></p>		<p>0 100 200 m</p> <p>approx. scale</p>	
Figure:	<b>A-2</b>	<p>Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.</p>	
Revision:	<b>A</b>		
<p>Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_008_240701_200y_Depth.qgz</p>		<p>N</p> <p><b>Torrent</b> CONSULTING www.torrentconsulting.com.au</p>	






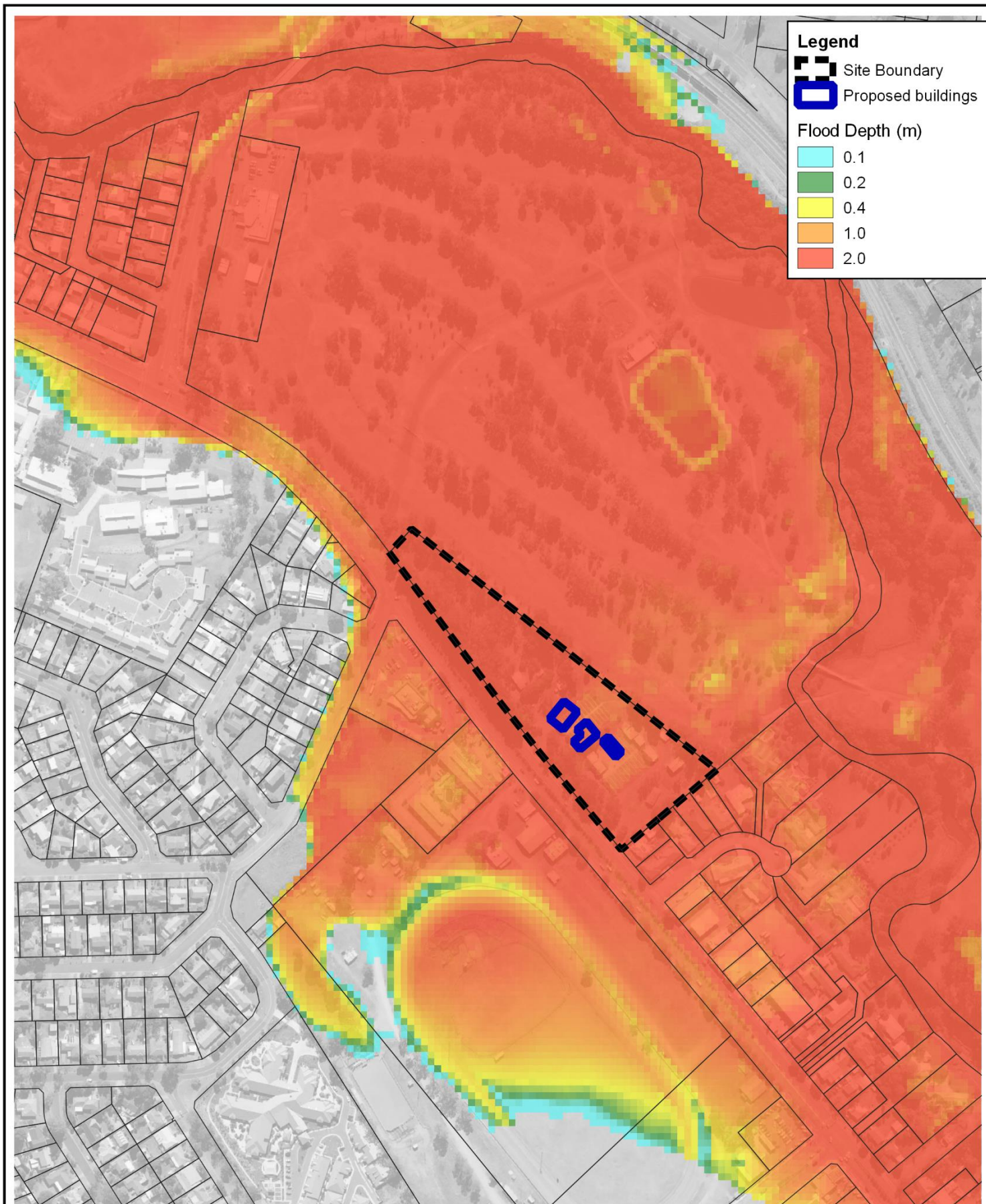
**Legend**

Site Boundary  
 Proposed buildings

**Flood Depth (m)**

0.1  
 0.2  
 0.4  
 1.0  
 2.0

Title: <b>Peak Flood Depth - 0.2% AEP Event</b>		0100200 m  approx. scale	
Figure:	<b>A-3</b>	 	
Revision:	<b>A</b>		
Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_009_240701_500y_Depth.gqz			



Title:  
**Peak Flood Depth - PMF Event**

0 100 200 m  
approx. scale

Figure: **A-4** Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

Revision: **A**

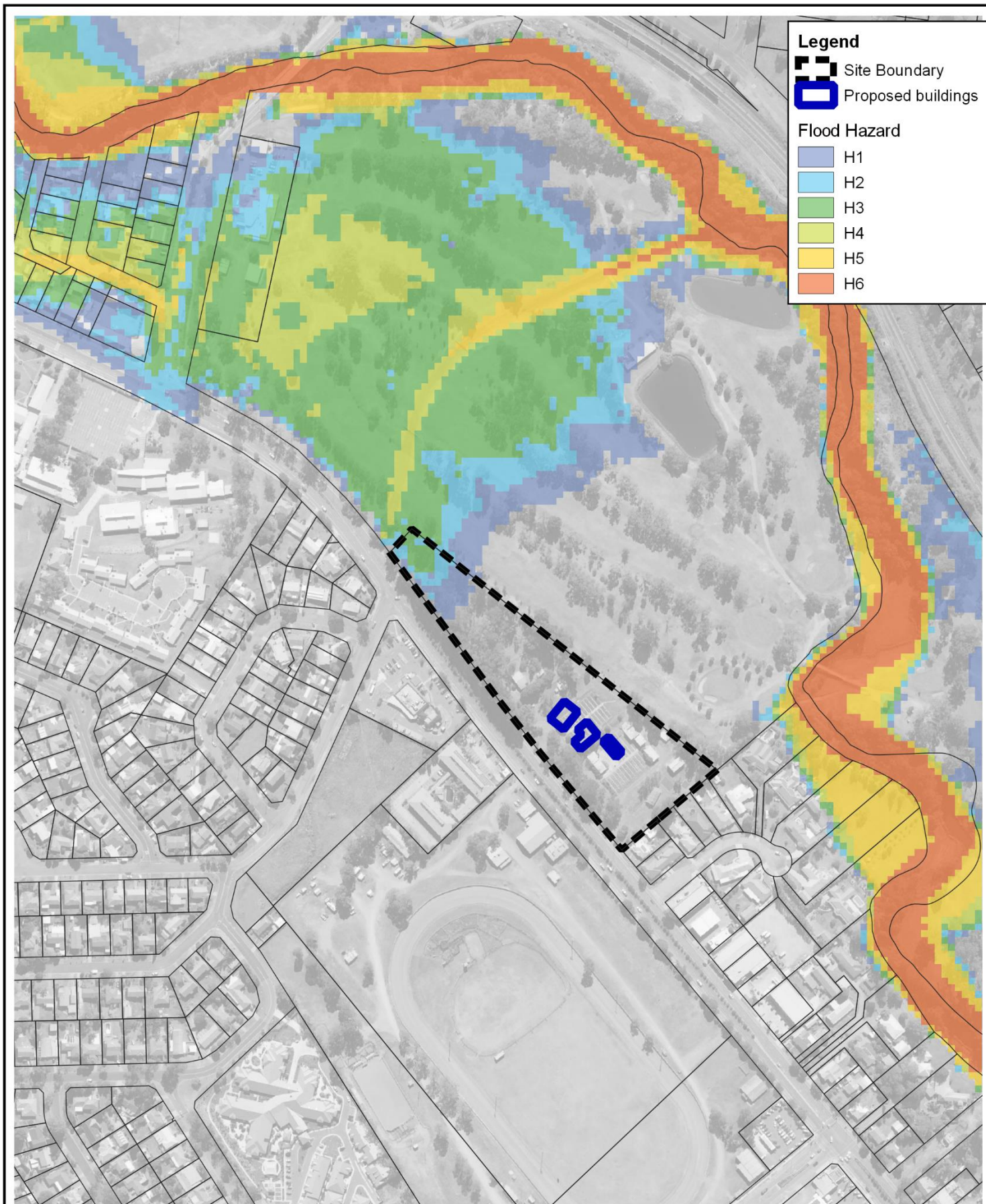
Filepath: Z:\Projects\T2583\_Pacific\_Brook\GIS\T2583\_010\_240701\_PMF\_Depth.gqz



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## Appendix B Design Flood Hazard Mapping

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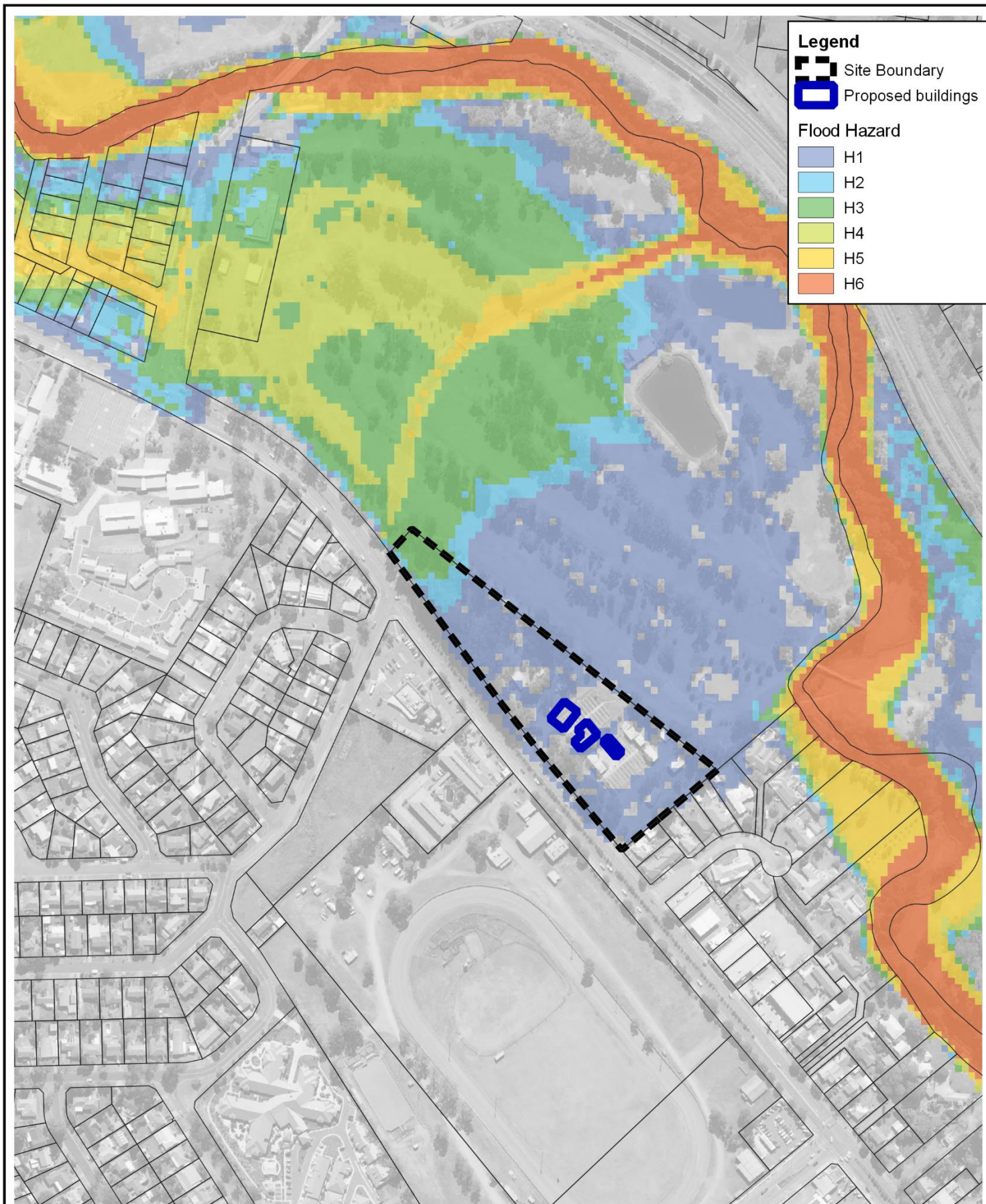
**Legend**

Site Boundary  
 Proposed buildings

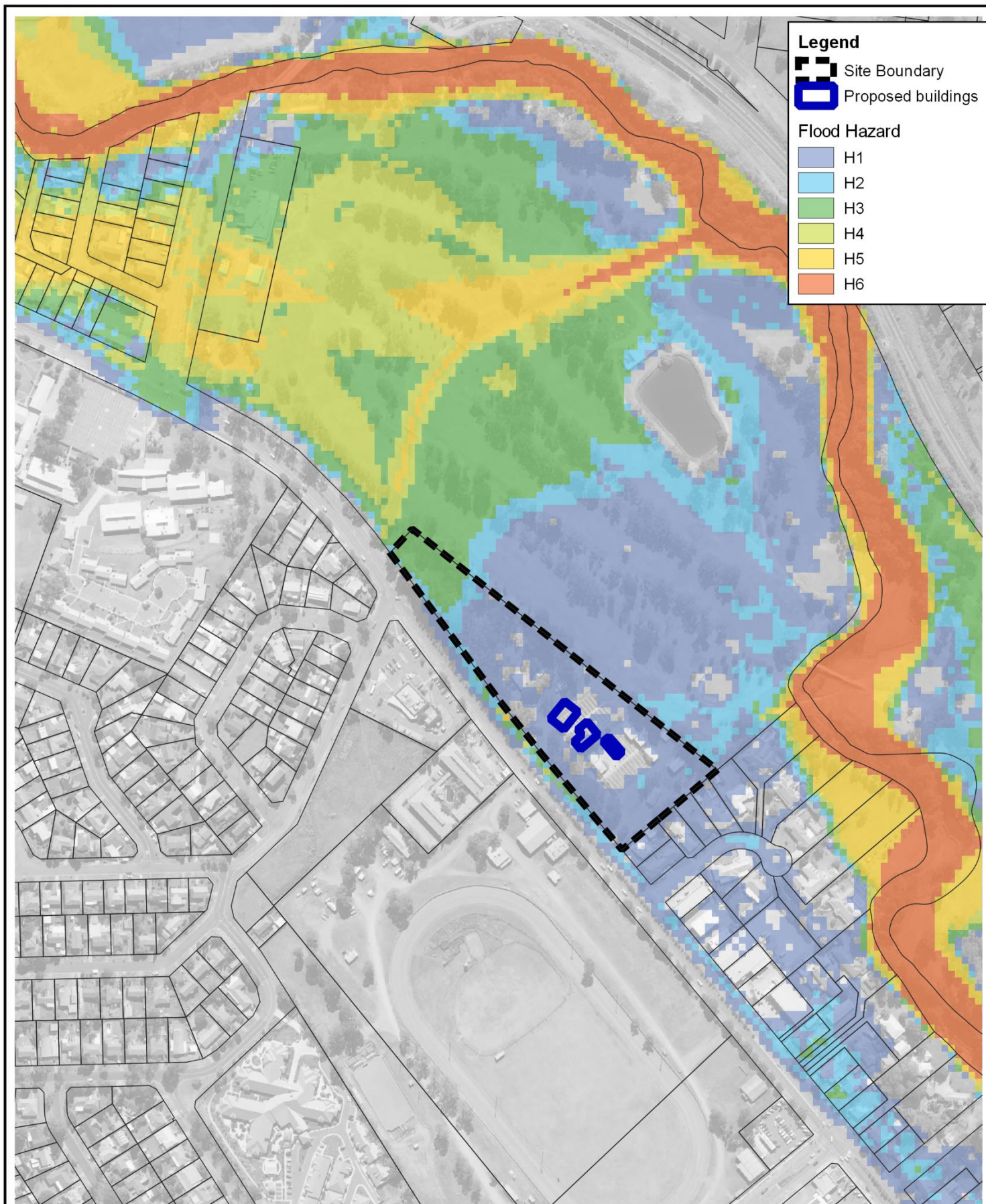
**Flood Hazard**

H1  
 H2  
 H3  
 H4  
 H5  
 H6

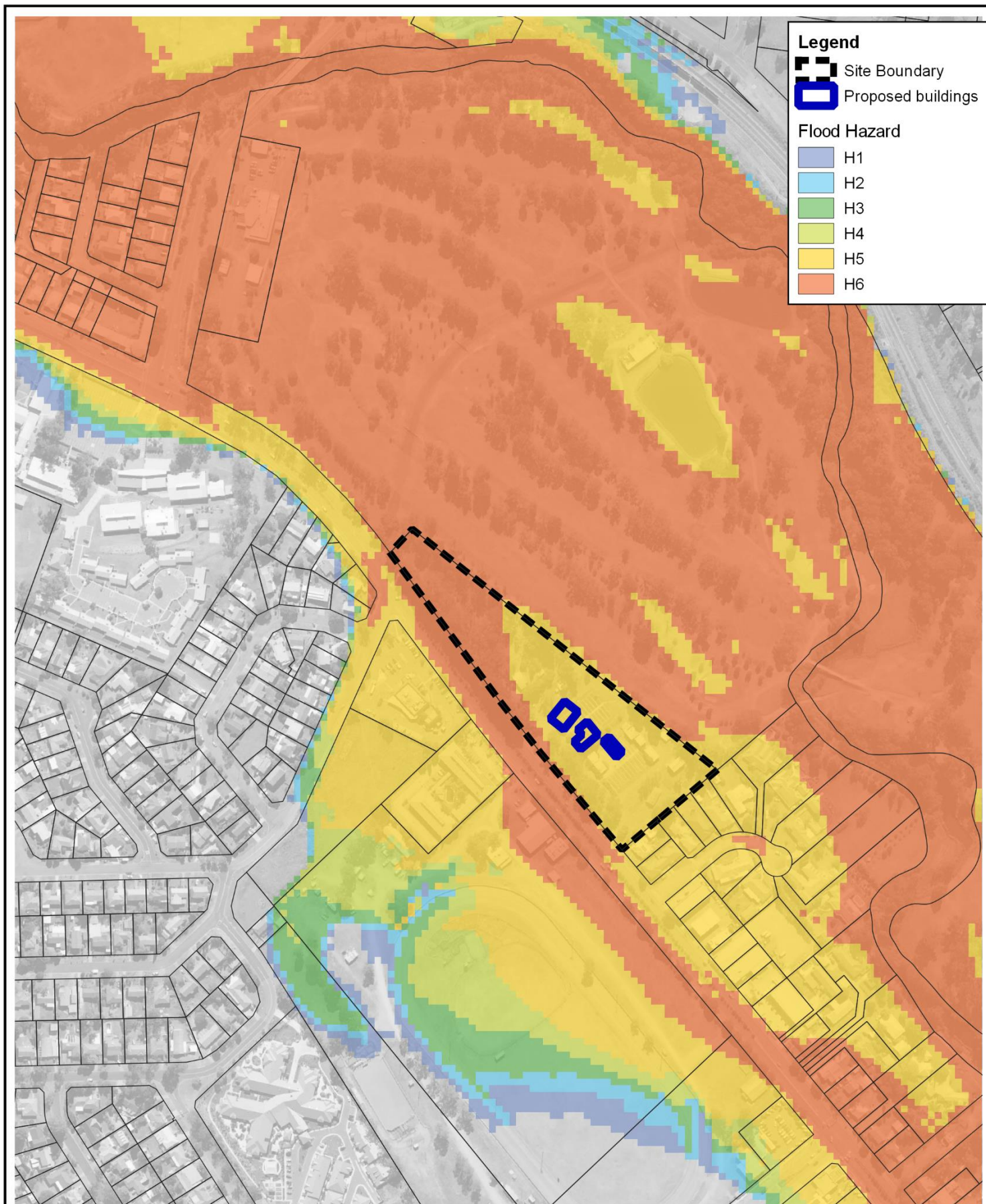
Title: <b>Peak Flood Hazard - 1% AEP Event</b>		0 100 200 m  approx. scale	
Figure: <b>B-1</b>	Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.		
Revision: <b>A</b>	<div style="display: flex; align-items: center;"> <div> <p><b>Torrent</b></p> <p>CONSULTING</p> <p><a href="http://www.torrentconsulting.com.au">www.torrentconsulting.com.au</a></p> </div> </div>		
Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_006_240701_100y_Hazard.qgz			



<p>Title:</p> <p><b>Peak Flood Hazard - 0.5% AEP Event</b></p>		<p>0 100 200 m</p> <p>approx. scale</p>	
<p>Figure:</p> <p><b>B-2</b></p>	<p>Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.</p>		
<p>Revision:</p> <p><b>A</b></p>	<p>N</p> <p><b>Torrent</b> CONSULTING <a href="http://www.torrentconsulting.com.au">www.torrentconsulting.com.au</a></p>		
<p>Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_004_240701_200y_Hazard.qgz</p>			



<p>Title:</p> <p><b>Peak Flood Hazard - 0.2% AEP Event</b></p>		<p>0 100 200 m</p> <p>approx. scale</p>	
Figure:	<b>B-3</b>	<p>Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.</p>	
Revision:	<b>A</b>		
<p>Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_004_240701_500y_Hazard.qgz</p>		<p>N</p>	<p><b>Torrent</b> CONSULTING</p> <p><a href="http://www.torrentconsulting.com.au">www.torrentconsulting.com.au</a></p>



# Legend

- Site Boundary
- Proposed buildings
- Flood Hazard
  - H1
  - H2
  - H3
  - H4
  - H5
  - H6

Title: <b>Peak Flood Hazard - PMF Event</b>		0 100 200 m  approx. scale	
Figure:	<b>B-4</b>	Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarantees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.	
Revision:	<b>A</b>		
Filepath: Z:\Projects\T2583_Pacific_Brook\GIS\T2583_003_240701_PMF_Hazard.qgz			 <a href="http://www.torrentconsulting.com.au">www.torrentconsulting.com.au</a>

## Appendix C Summary FERP

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## PBCS Flood Emergency Response Strategy

Frequent to rare flood events, whilst potentially resulting in localised inundation of the school, only produce low hazard flood conditions that do not present a significant risk to people located there. However, for very rare and extreme flood events much of the School site will be inundated, including the potential for internal flooding of buildings. The flood hazard within the local and broader Muswellbrook road network can be higher than at the school. Also, limited warning time is available, making the logistics and safety of a full evacuation from the site extremely challenging. The recommended flood emergency response (if people are present at the school during a flood) is therefore to evacuate to the nominated flood refuge at Muswellbrook Sports Centre (corner of Rutherford Road and Cassidy Avenue). The responsibilities and actions for effective flood emergency response management are outlined in the Flood Emergency Response Plan document.

To assist in managing flood risks and communicating response actions, three flood Alert Modes have been developed, and are summarised below.

### Normal Operation

During normal operation of the school the Flood Emergency Response Plan is maintained and reviewed annually or following a flood event. The school will ensure that the responsible staff are trained and equipped to respond to a potential flood emergency. An annual drill will be undertaken to test and familiarise people with the flood emergency response procedure. The Chief Warden will monitor Bureau of Meteorology Warnings for any indication of potential forecast flood events and respond accordingly.

### Amber Alert Mode

An Amber Alert Mode is called by the Chief Warden when the BoM issue a Warning that indicates the possibility of forecast flood conditions impacting the upcoming school activities. The day before the forecast flood conditions the decision will be taken as to whether the school will remain open, or alternative arrangements need to be made. This will depend on the nature of activities taking place at the school and the severity of the forecast weather conditions. If an Amber Alert Mode is called during school operations, then the Wardens are prepared for an increased likelihood of an escalation of the Alert Mode and a subsequent flood emergency response.

### Red Alert Mode

A Red Alert Mode is triggered by the on-site flood level and rainfall gauges indicating that potential flooding of the school is imminently expected and that a flood emergency response is required. If a Red Alert Mode is triggered during school operations then the school will communicate this to staff and students. The Chief Warden will coordinate the Wardens in relocating staff, students and visitors to the at Muswellbrook Sports Centre via the on-site bus transports. The relocation of people to the Flood Refuge should be undertaken within 20 minutes, to ensure safe egress during a worst-case flood event scenario.

### Green Alert Mode

A Green Alert Mode is called by Chief Warden once flood waters are receding and the flood emergency has passed. For major flood events with widespread impacts, this will require confirmation from the NSW SES. The school grounds will be inspected to make sure that it is safe for normal operation of the school to resume. If collection of students from the school is required, then the school will communicate accordingly with parents and carers. People travelling to the school should be advised to check for any road closures that might impact their intended route.

# PBCS Flood Emergency Response Procedure

**External flood warning triggered**

**< 5 mins**

**Red Alert:**

- Teachers automatically notified
- Evacuation alarm is triggered by Campus Principal
- Buses assemble

**Site Flood inundation after 5 minutes from trigger**

**20 mins**

**Students & Teachers Assemble:**

- Students and Teacher move to Assembly Point
- Teachers confirm attendance
- Buses are loaded
- Campus Principal gives order to evacuate
- Buses leave site and drive to Muswellbrook Indoor Sports Centre

**Building inundation after 25 mins from the initial trigger.**

**15 mins**

**Evacuation Complete:**

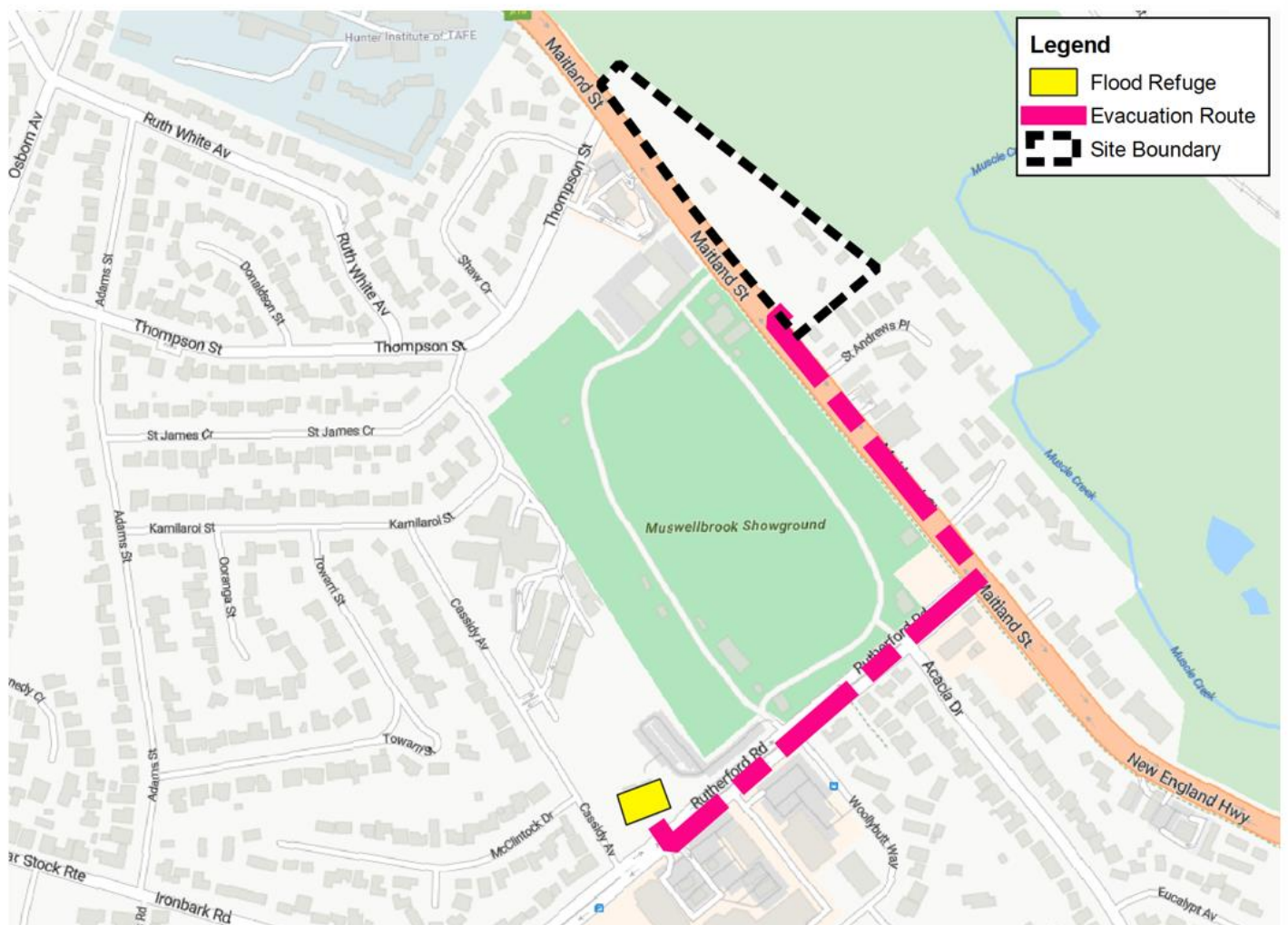
- Arrival at indoor Sports Centre
- Teachers confirm attendance

**Maitland Street evacuation route cut by floodwater (PMF event)**



**All Students off Site prior to PMF flood levels closing Maitland Street**

## Evacuation Route to the Flood Refuge:



## Appendix D Muswellbrook Sports Centre Confirmation

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**From:** Lee Pratt <lpratt@pacifichills.nsw.edu.au>  
**Sent:** Wednesday, 16 August 2023 4:57 PM  
**To:** Chris Baldry  
**Cc:** Tracey Young  
**Subject:** FW: Pacific Brook Christian School, 72-74 Maitland Street Muswellbrook - Evacuation point

Hi Chris,

Here you are.

Cheers,

**Lee Pratt**  
Pacific Group Property Manager



Junior, Middle & Senior School (Est 1979) Wisdom and Knowledge in Christ  
**Phone** +61 2 9651 0700 **Address** 9 - 15 Quarry Road Dural NSW 2158  
Pacific Group of Christian Schools Limited **ABN** 11 001 832 828  
**Web** [www.pacifichills.nsw.edu.au](http://www.pacifichills.nsw.edu.au) **CRICOS No.** 02340G

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**From:** Derek Finnigan <Derek.Finnigan@muswellbrook.nsw.gov.au>  
**Sent:** Wednesday, August 16, 2023 3:49 PM  
**To:** Lee Pratt <lpratt@pacifichills.nsw.edu.au>  
**Cc:** Sharon Pope <Sharon.Pope@muswellbrook.nsw.gov.au>; Matthew Lysaught <Matthew.Lysaught@muswellbrook.nsw.gov.au>; Peter Ball <Peter.Ball@muswellbrook.nsw.gov.au>  
**Subject:** RE: Pacific Brook Christian School, 72-74 Maitland Street Muswellbrook - Evacuation point

Dear Mr Pratt,

Thank you for your email.

in relation to your request, I can confirm that the Muswellbrook Indoor Sports Centre has suitable space and amenities to provide short term accommodation for Pacific Brook School in a flood event that requires evacuation of your students and staff.

The Muswellbrook Indoor Sports Centre is one of two evacuation centres for Muswellbrook, under the endorsed Muswellbrook Shire Council Local Emergency Management Plan 2022.

I hope this is of assistance. If you need any further information, please let me know.

Kind regards,



**Derek Finnigan | General Manager | Muswellbrook Shire Council**  
T: 02 6549 3750 | M: 0419 465 572 | E: [derek.finnigan@muswellbrook.nsw.gov.au](mailto:derek.finnigan@muswellbrook.nsw.gov.au) |  
[www.muswellbrook.nsw.gov.au](http://www.muswellbrook.nsw.gov.au)

*I respectfully acknowledge the local Aboriginal people who are the Traditional Owners and Custodians of the land on which I work.*

---

**From:** Lee Pratt <[lpratt@pacifichills.nsw.edu.au](mailto:lpratt@pacifichills.nsw.edu.au)>  
**Sent:** Tuesday, August 15, 2023 2:39 PM  
**To:** Derek Finnigan <[Derek.Finnigan@muswellbrook.nsw.gov.au](mailto:Derek.Finnigan@muswellbrook.nsw.gov.au)>  
**Subject:** Pacific Brook Christian School, 72-74 Maitland Street Muswellbrook - Evacuation point

CAUTION: This email originated from outside of the organisation. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Hello Mr Finnigan,

As the Group Property Manager for our schools, I am writing regarding our property at 72-74 Maitland Street Muswellbrook NSW.

In the process of our SSDA we have been developing a comprehensive Flood Evacuation/ Management Plan (attached). In this process we have been advised verbally that in a very extreme weather event, the Muswellbrook Indoor Sports Centre on Rutherford Street would be council's preferred "Identified Evacuation Point" for Pacific Brook Christian School once we are operating from 72-74 Maitland Street. While evacuation needs to be considered, our primary risk mitigation strategies (prior to evacuation) involve early closure of the school.

Our student numbers to begin with, will be approximately 140 with the maximum of 656 if our site is fully developed. Would you know the current capacity of the Muswellbrook Indoor Sports Centre? We are seeking confirmation that the Muswellbrook Indoor Sports Centre will be a suitable evacuation point, in the case where fast evacuation is necessary.

If you have any questions or need further clarification, please do not hesitate to contact me. My mobile number is 0431 842 498.

Thank you for your time. I look forward to hearing from you.

Best Regards,

**Lee Pratt**  
Pacific Group Property Manager



Junior, Middle & Senior School (Est 1979) Wisdom and Knowledge in Christ  
**Phone** +61 2 9651 0700 **Address** 9 - 15 Quarry Road Dural NSW 2158  
Pacific Group of Christian Schools Limited **ABN** 11 001 832 828  
**Web** [www.pacifichills.nsw.edu.au](http://www.pacifichills.nsw.edu.au) **CRICOS No.** 02340G

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Muswellbrook Shire Council ABN 86 864 180 944