Flood Impact and Risk Assessment

Box Hill Public School and Box Hill High School

Prepared for Department of Education / 21 July 2025

231099

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Contents

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JM	PMcA	For Review	B	01.09.23
RC	PMcA	For Review	C	28.06.24
RC	MK	REF – For Review Existing Scenario Only	D	27.05.25
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Executive Summary

This Flood Impact and Risk Assessment (FIRA) has been prepared by TTW (NSW) Pty Ltd on behalf of the Department of Education (DoE) to assess potential flood-related impacts associated with the proposed development of the new Box Hill Public School and Box Hill High School at 50–52 Terry Road, Box Hill, NSW.

Council's hydraulic model (TUFLOW) was modified to assess overland flow and flood impacts under pre- and post-development conditions, using local council data and incorporating updated rainfall intensity projections from the ARR2019 guidelines. The model evaluated flood behaviour for several flood events, including 10%, 5%, 1%, 0.2% Annual Exceedance Probability (AEP), and the Probable Maximum Flood (PMF). Sensitivity testing for climate change was conducted under SSP2-4.5, with rainfall increases projected for 2030, 2050, and 2090.

Key findings include:

- An overland flow path exists on No. 48 Terry Road, immediately south of the subject site, which marginally affects the southern portion of the site during a PMF event.
- Proposed building works are focussed on the northern portion of the lot, and therefore are located outside of the PMF extent.
- The south of the site is impacted by some flooding in the PMF event, though this is located at the proposed car parks, and this only occurs in the PMF (with the site still flood-free in the 0.2% AEP).
- The site complies with the flood planning controls outlined in Part C, Section 6 of The Hills Development Control Plan (DCP), which requires:
  - Non-habitable floors to be above FPL3 (1% AEP + 500 mm freeboard)
  - Habitable floors to be above FPL4 (PMF level), or higher where applicable
  - Car parks to be above FPL1 (5% AEP level)
- Pedestrian and vehicular access is maintained above the PMF level via Keeneland Street, ensuring flood-safe egress.
- A Site Flood Emergency Response Plan (FERP) has been developed, providing actions for preparation, response, and recovery related to flood events.

Based on the findings of this assessment, and assuming implementation of the recommended flood mitigation and planning controls, the proposed development is not expected to have a significant adverse impact on flooding or the environment.

1.0 Introduction

This Flood Impact and Risk Assessment (FIRA) Report has been prepared by TTW (NSW) Pty Ltd on behalf of the Department of Education (DoE) to assess the potential environmental impacts that could arise from the new Box Hill Public School and Box Hill High School (the activity) at 50-52 Terry Road, Box Hill (the site).

This report has been prepared to outline the existing constraints of flooding and overland flow paths at the site alongside the post-development flood conditions, including likely flood impacts (if any) that the proposed school will cause to the surrounding properties. The details of this report are based on currently available information and correspondence undertaken at the time of writing.

1.1 Guidance Documents

The following documents have been reviewed and referenced in preparing this report:

- Australian Institute of Disaster Resilience (AIDR) Guideline 7-3: Flood Hazard (2017);
- NSW Department of Planning and Environment (2021) Considering Flooding in Land Use Planning Guideline;
- NSW Department of Planning and Environment (2023) Flood Impact and Risk Assessment – Flood Risk Management Guide LU01;
- NSW Department of Planning and Environment (2023) Flood Risk Management Manual;
- NSW Department of Planning and Environment (2022) Guidelines for Division 5.1 assessments, June 2022;
- NSW Department of Planning, Housing and Infrastructure (2024) Guidelines for Division 5.1 assessments – Consideration of environmental factors for health service facilities and schools – Addendum October 2024;
- NSW Department of Planning, Housing and Infrastructure – Planning Circular PS 24-001, Update on addressing flood risk in planning decisions, 1st March 2024;
- School Infrastructure (SI) NSW Guidelines for School Site Selection and Master Planning, 2023;
- The Hills Development Control Plan (DCP) 2012;
- The Hills Local Environmental Plan (LEP) 2019;
- The Hills Shire Council Flood Modelling and Stormwater Design Guideline, Revision 1, February 2024.

1.2 Project Description

This report accompanies a Review of Environment Factors that seeks approval for the new Box Hill Public School and Box Hill High School, which involves the following works:

- Demolition, tree removal and site preparation works.
- Construction of a new 1,000 student Public School of up to 3-storeys in height, and a 1,000 student High School of up to 4-storeys in height, including co-located halls.
- Construction of a 60-place preschool.
- Associated site landscaping, fencing and open space including sports fields and games courts.
- Changes to vehicular access including internal access road and car parking, new bus zone and kiss and drop zones, pedestrian access, waste storage and loading areas.
- Augmentation of services and utilities to support the new school.

The Review of Environmental Factors prepared by Ethos Urban provides a full description of the proposed works.

1.3 Significance of Environmental Impacts

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential impacts are low, and will not have significant adverse effects on the locality, community and the environment;
- Potential impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community.

1.4 REF Reporting Requirements

Refer to Table 1 for the relevant REF requirements covered within this report.

Table 1: REF Reporting requirements and the relevant section of this report.

Item	REF Requirement	Relevant Section of Report
1.0	**Flood Hazard**	
1.1	If a FIRA has been prepared, does it: state that it has been prepared in accordance with the updated Floodplain Management Manual and Toolkit, including Planning Circular PD24-001?	Section 1.1
1.2	detail consultation undertaken with the local council and any relevant agencies (i.e. State Emergency Service) to identify existing, draft and proposed flood studies relevant to the site?	Section 1.6, Section 4.1
1.3	describe the flood potential of the site and key access routes having regard to available flood studies and information, the conditions of the site, and the types of flood: ▪ Mainstream flooding ▪ Overland flows ▪ Flash flooding	Section 4.0, 6.0
1.4	describe the key flood mechanisms?	Section 4.0, 6.0
1.5	include flood modelling showing flood extent, levels, depths, velocities and hazard classifications for all relevant events, including: ▪ 1% AEP / 1 in 100yr ▪ 5% AEP / 1 in 20yr ▪ 10% AEP / 1 in 10yr ▪ 0.2% AEP / 1 in 500yr ▪ 0.02% AEP / 1 in 5000yr ▪ PMF	Refer Section 6.0 and Appendix C & Appendix D. Modelling has been completed for the 10% AEP, 5% AEP, 1% AEP, 0.2% AEP and the PMF event.
1.6	consider the timeframe for flood waters to inundate the site and timeframe for water to hit peak levels?	This is considered in the Flood Emergency Response Plan submitted alongside this report.
1.7	consider the impacts of climate change on future flood frequency and levels?	Section 7.2
2.0	**Risk/Impact of flood on the activity**	
2.1	If a FIRA has been prepared, does it: determine whether the proposal is in a high-risk catchment?	Section 4.0
2.2	the location of the proposal in relation to flood behaviour and constraints including floodway, flood storage area or flood fringe area?	Section 4.0, 6.0
2.3	the hazard vulnerability classification of the land?	Section 5.2, 6.0

2.4	frequency of inundation?	Section 6.0, Appendix C, Appendix D
2.5	whether the proposal provides for safe occupation and efficient and effective evacuation in flood events and how it is to be achieved?	This is considered in the Flood Emergency Response Plan submitted alongside this report.
2.6	in high-risk catchments, whether the proposal is likely to result in a significant increase to the risk to life in other parts of the catchment in a PMF flood event?	Section 7.1
2.7	any known evacuation constraints such as the flood emergency response classification for the area and available warning times (including rate of rise and when the evacuation route is cut off by floodwater)?	This is considered in the Flood Emergency Response Plan submitted alongside this report.
2.8	whether the proposal is for a sensitive or hazardous land use, or other higher risk uses and what mitigation strategies (if any) are proposed to reduce any identified risks?	Section 3.0, 8.0, 9.0
3.0	**Impact of the activity on flood outside of the site**	
3.1	If a FIRA has been prepared, does it address the matters to consider set out in PS-24-001, including has it determined: potential impacts of cut and fill and other building works on flood behaviour?	Section 7.1
3.2	whether there may be adverse flooding impacts on surrounding properties?	Section 7.1
3.3	ability of proposed development to withstand flood impacts?	Section 8.0
4.0	**Building and structure design**	
4.1	If a FIRA has been prepared, does it: nominate a flood planning level (minimum floor level plus freeboard) for proposed buildings?	Section 8.0
4.2	recommend any other mitigations such as flood resistant materials or structural requirements?	Section 8.0
5.0	**Conclusion**	
5.1	Does the FIRA: conclude that the proposal would not be likely to result in significant environmental effects?	Section 1.3, 9.0
5.2	list any mitigation measures identified in the assessment?	Section 9.0

1.5 Proposed Development

The proposed new buildings are sited on the east, west and north of the site with playing fields in the centre and car parking to the west and south sides which are accessed from Keeneland Street and Terry Road.

School operations are generally grouped as follows:

- Preschool and facilities on the west side
- Primary School and facilities along the west – north sides
- High School and facilities along the north-east-south sides
- A shared building, halls, and outdoor facilities within the central portion of the school extending from north to south sides.

The proposed ground level site plan is provided in Figure 1 below and showcases the proposed building alignments, carparking alignment and site entry at boundary alignments. The indicative location of the proposed sports field is in the central portion of the school, close to the southern boundary.

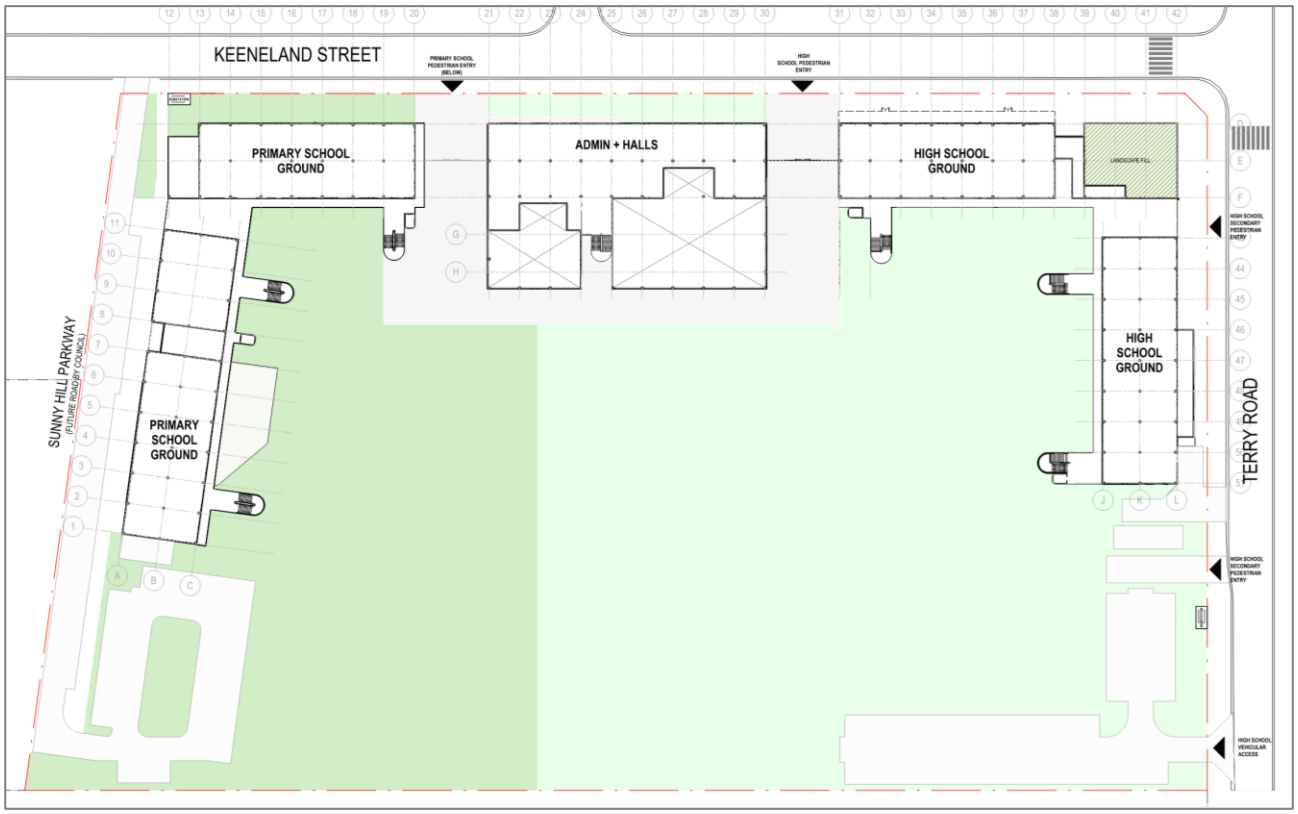


Figure 1: Draft Architectural Ground Floor Plan (Source: Architectus)

1.6 Consultation

The Hills Shire Council were contacted by TTW in August 2023 to obtain more information on the site and flood behaviour in the immediate vicinity. Correspondence from this consultation is contained within Appendix A.

A letter was also provided to NSW SES on 12 May 2025. This letter detailed the existing flood behaviour at the site, alongside the proposed flood emergency response strategy to be contained within TTW's Flood Emergency Response Plan for the site. Recommendations provided by NSW SES are outlined in Table 2, and have been addressed in the Flood Emergency Response Plan (dated 21 July 2025 and submitted alongside this report).

Table 2: Consultation with NSW SES

Item	NSW SES Recommendations	Response
1	We recommend implementing early triggers in the Flood Emergency Response Plan (FERP), such as monitoring Severe Weather Warnings and Flood Warnings and consider closing the school ahead of the start of the school day, particularly considering the flash flooding risk in the area. A strategy of isolation or sheltering in buildings surrounded by flood water are not equivalent, in risk management terms, to evacuation.	This is recommended in the FERP. Monitoring flood warnings has been detailed as a trigger for the site, and pre-emptive evacuation is the recommended strategy where possible.
2	We recommend pursuing, if relevant, site design and stormwater management that reduces the impact of flooding and minimises any risk to the community. Any improvements that can be made to reduce flood risk will benefit the community.	This is noted. The site design has considered flooding and minimising risk to the community, with a bund incorporated at the south of the site to ensure offsite impacts are avoided.
3	We recommend exercising flood emergency plans regularly, similar to building fire evacuation drills. The NSW	This is recommended in the FERP.

	SES also recommends updating the FERP at regular intervals and whenever additional flood information is available or highlighted during the drills or flood events. The frequency of exercising and updating emergency plans should be detailed within the FERP itself.	
4	Considering the impact of climate change on the flood risk and incorporating that into any updated FERPs.	The impact of climate change has been considered in Section 7.2. The FERP considers flooding up to and including the PMF, as specified in The Hills Shire Council Flood Modelling and Stormwater Design Guideline.

2.0 Site Characteristics

2.1 Site Location

The site is located at 50 and 52 Terry Road, Box Hill. The site comprises two (2) separate lots, which have a combined area of 4.7ha, within a broadly rectangular parcel of land. The legal description of the site includes Lot 299 in DP 1285364 (50 Terry Road) and Lot 10 in DP 1285590 (52 Terry Road). An aerial map of the site is provided in Figure 2.

Both of the existing lots consist of small-scale rural farming and grazing lots with buildings such as dwellings, machinery sheds, local small dams for water supply, associated driveways and fences. The sites are generally grassed with a very sparse covering of trees as shown in Figure 2. The site is bound to the north by Keeneland Street, to the east by Terry Road, No. 48 Terry Road (Lot 30 DP10157) to the south, and by grassland to the west. Site images are attached in Appendix B.

The site is located in Box Hill in The Hills Shire Council Local Government Area (LGA) in the north-west of Sydney. Box Hill is part of the North-West Growth Centre, which is being re-developed from rural/residential land to low- and medium-density residential subdivisions. The area was rezoned in 2013 to form the Box Hill Release Area. By completion, Box Hill will be home to approximately 42,480 residents (13,276 dwellings).

Figure 2: Aerial image showing site location (Source: Nearmap / Ethos Urban, March 2025)

2.2 Site Topography

To assess the topography of wider area, the latest available elevation data (2020) was obtained from the Elevation Information System (ELVIS). As presented in the Digital Elevation Model (DEM) in Figure 3, the site elevations across the two lots generally fall from the northeast to the southwestern corner of the site, with a natural surface gradient varying between 2% to 5%. The highest level of approximately RL48.0m AHD occurs at the eastern corner of No. 52, falling towards the lowest level of approximately RL35.0m AHD along the western boundary of No. 50. An overland flow route is directed through No. 48 Terry Road just south of the site (refer Figure 4), forming tributaries to the Killarney Chain catchment.

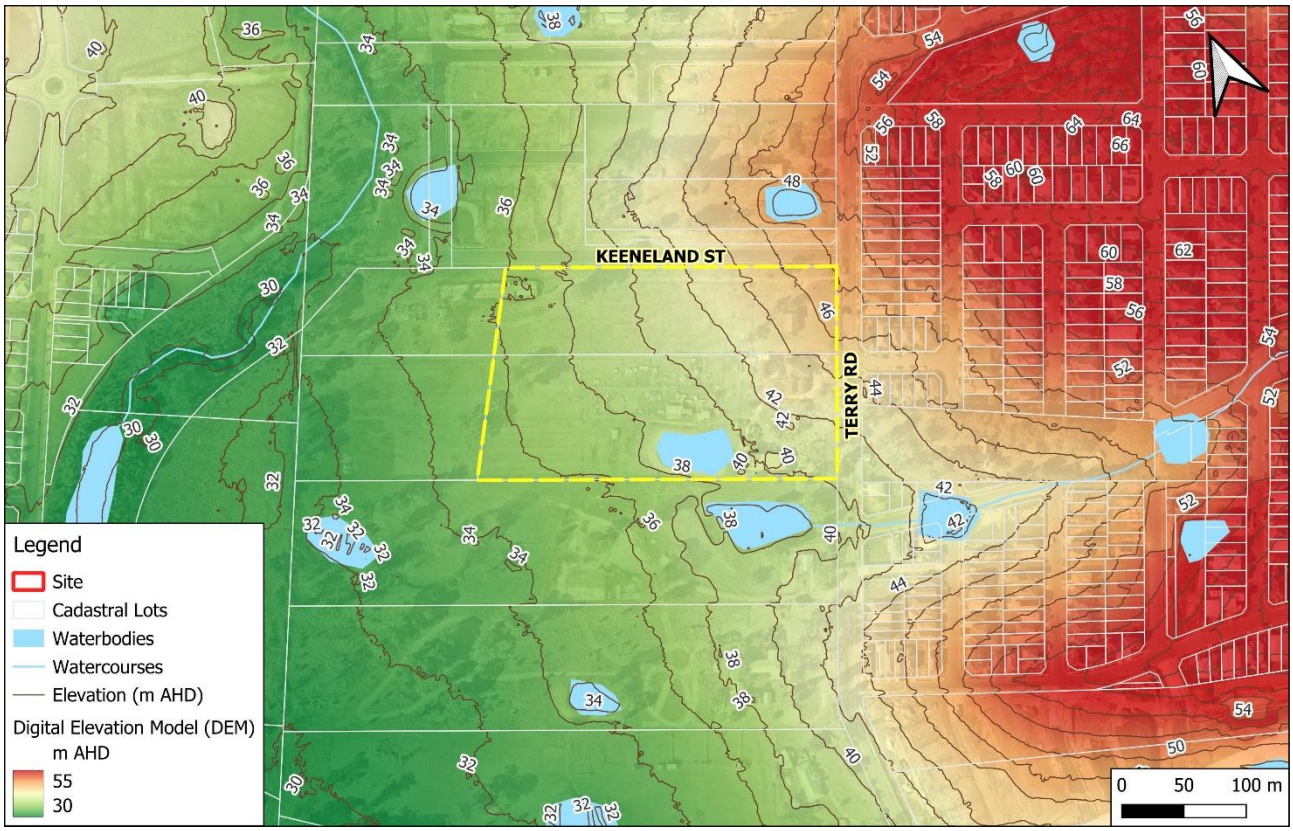


Figure 3: Elevation at the site and surrounding area (Source: ELVIS Lidar, 2020)

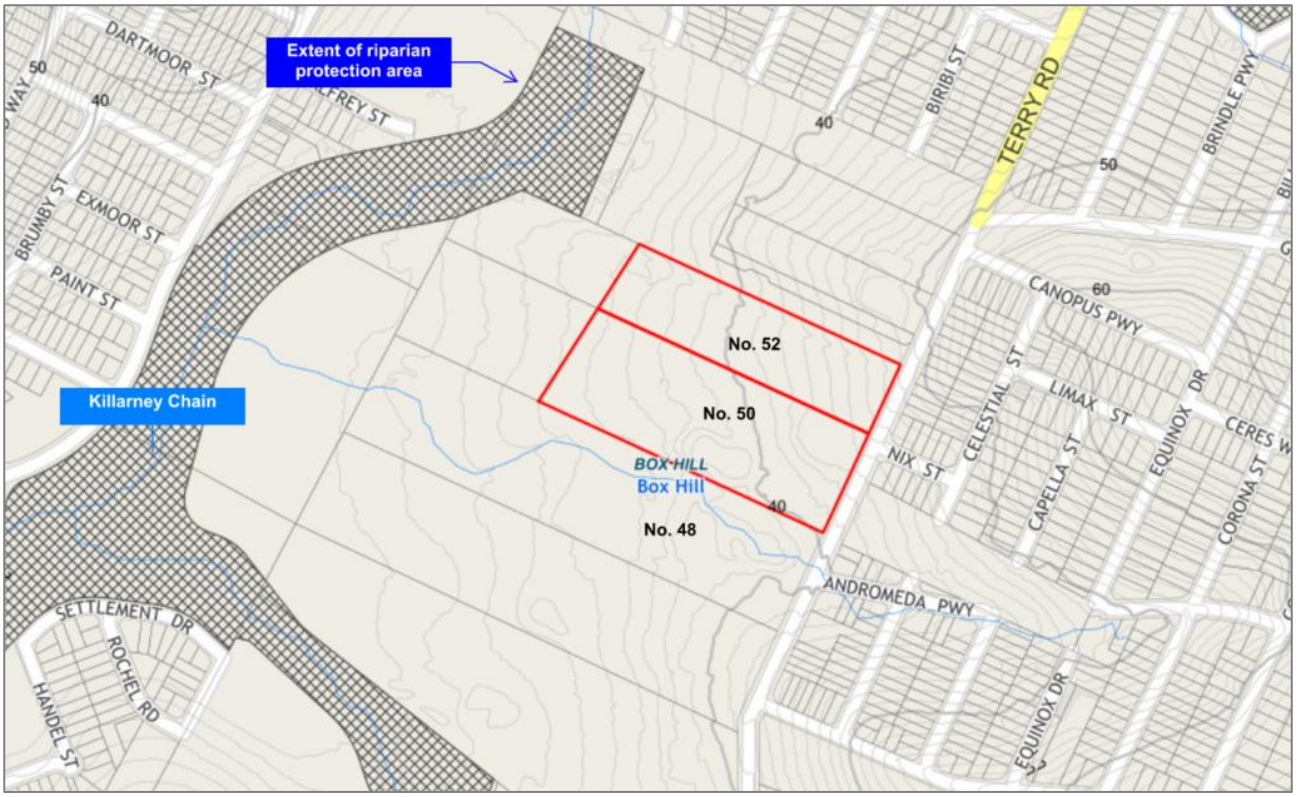


Figure 4: Map showing site location, riparian protection area and topography (Source: Hills LEP)

Existing piped stormwater assets are present in Terry Road which primarily capture surface runoff from the road reserve and the subdivision development on the eastern side of Terry Road as shown in Figure 3. A

culvert crossing allows for the overland flows to drain freely under Terry Road and through No. 48 Terry Road. As shown in Figure 5, existing drainage infrastructure and surface elevations convey runoff across Terry Road.

There is no existing Council stormwater infrastructure within the site boundaries. Rainfall runoff within the site's boundaries travels overland and is conveyed freely into the adjacent water courses.

Figure 5: Map showing aerial imagery and existing stormwater assets (Source: Hills LEP)

3.0 Flood Planning Controls

3.1 The Hills Development Control Plan

While compliance with the Development Control Plan (DCP) is not required under the REF pathway, relevant DCP provisions have been reviewed and are acknowledged in this study to demonstrate consideration of Council's planning objectives.

The current Development Control Plan (DCP) in place for the site is The Hills Shire DCP (2012), which provides detailed planning and design guidelines to support the planning controls set out in The Hills Local Environmental Plan (LEP) 2019 when designing a development.

Part C 'General Development' Section 6 'Flood Controlled Land' of The Hills DCP outlines the development controls which apply to flood liable land in the LGA.

Flood planning controls in The Hills LGA are based on land use category. There are six land use categories within The Hills DCP – critical uses and facilities; sensitive uses and facilities; residential; commercial or industrial; recreation or non-urban uses; and concessional development. Based on Schedule 2 of Council's DCP, educational establishments are considered 'sensitive uses and facilities'.

The Hills DCP outlines four distinct flood planning levels (FPLs) that are to be applied dependent on land use type, presented in Figure 6. Sensitive developments are subject to the flood controls laid out in Figure 7.

Table 1 – Flood Planning Levels

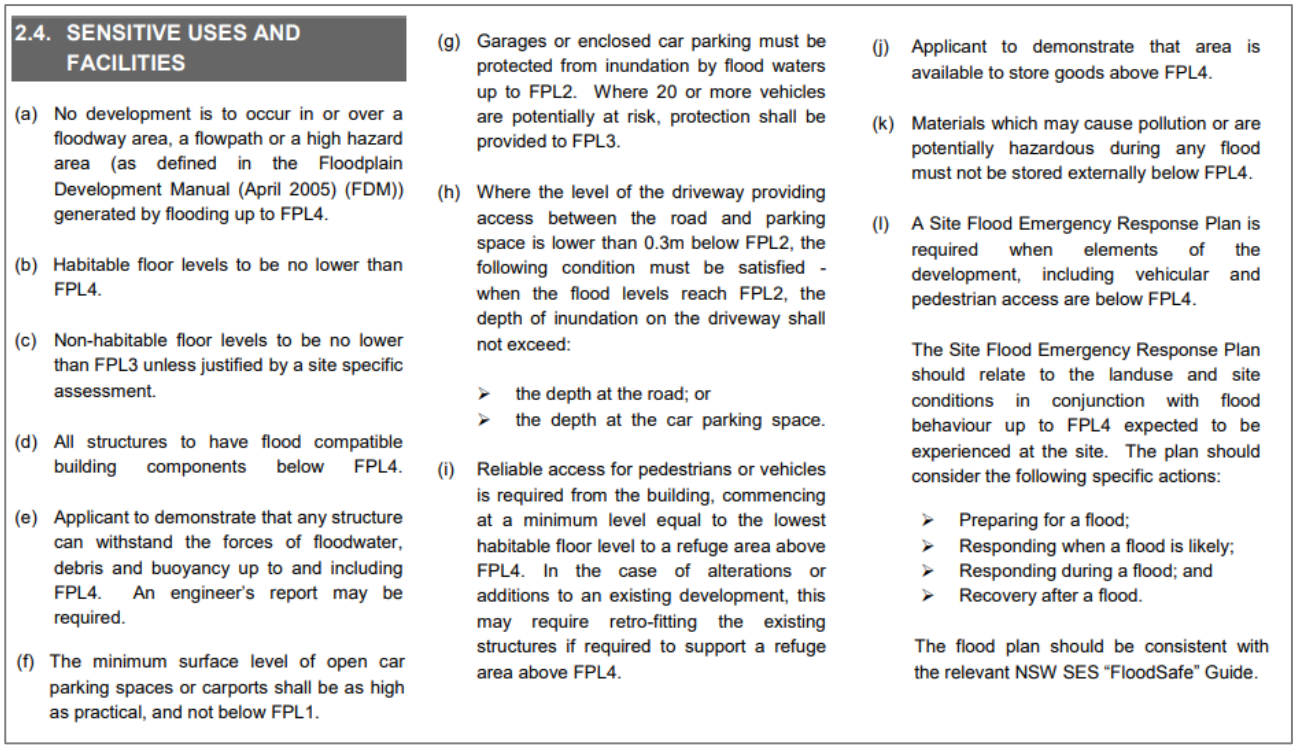
Reference	Flood Planning Level
FPL1	20 Year ARI
FPL2	100 Year ARI
FPL3	100 Year ARI + 0.5m Freeboard
FPL4	PMF

Notes:

1. FPL1, FPL2 and FPL 4 have zero freeboard.
2. The design flood levels and FPLs in **Table 1** may be obtained from Council if available or otherwise will be required to be determined by the proponent in accordance with Section 4. These levels will normally be 'rounded up' to the nearest 0.1m and referred to Australian Height Datum (AHD).

FPL= Flood Planning Level.
ARI = Average Recurrence Interval.
PMF = Probable Maximum Flood.

Figure 6: Flood Planning Levels laid out in The Hills DCP



2.4. SENSITIVE USES AND FACILITIES

(a) No development is to occur in or over a floodway area, a flowpath or a high hazard area (as defined in the Floodplain Development Manual (April 2005) (FDM)) generated by flooding up to FPL4.

(b) Habitable floor levels to be no lower than FPL4.

(c) Non-habitable floor levels to be no lower than FPL3 unless justified by a site specific assessment.

(d) All structures to have flood compatible building components below FPL4.

(e) Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including FPL4. An engineer's report may be required.

(f) The minimum surface level of open car parking spaces or carports shall be as high as practical, and not below FPL1.

(g) Garages or enclosed car parking must be protected from inundation by flood waters up to FPL2. Where 20 or more vehicles are potentially at risk, protection shall be provided to FPL3.

(h) Where the level of the driveway providing access between the road and parking space is lower than 0.3m below FPL2, the following condition must be satisfied - when the flood levels reach FPL2, the depth of inundation on the driveway shall not exceed:

- the depth at the road; or
- the depth at the car parking space.

(i) Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to a refuge area above FPL4. In the case of alterations or additions to an existing development, this may require retro-fitting the existing structures if required to support a refuge area above FPL4.

(j) Applicant to demonstrate that area is available to store goods above FPL4.

(k) Materials which may cause pollution or are potentially hazardous during any flood must not be stored externally below FPL4.

(l) A Site Flood Emergency Response Plan is required when elements of the development, including vehicular and pedestrian access are below FPL4.

The Site Flood Emergency Response Plan should relate to the landuse and site conditions in conjunction with flood behaviour up to FPL4 expected to be experienced at the site. The plan should consider the following specific actions:

- Preparing for a flood;
- Responding when a flood is likely;
- Responding during a flood; and
- Recovery after a flood.

The flood plan should be consistent with the relevant NSW SES "FloodSafe" Guide.

Figure 7: Flood planning controls which apply to sensitive uses and facilities (Source: adapted from The Hills DCP)

3.2 SI Guidelines

School Infrastructure (SI) NSW have their own framework and guidelines for educational site selection and development which should also be met. For flooding, the framework provides the following guidelines:

- Site must be located above the 1-in-200-year (0.5% AEP) flood level,
- Site must provide flood free access for pedestrians and vehicles (in particular, emergency vehicles during a flood event),
- Buildings must be located on land above the Flood Prone Land Contour (i.e., land susceptible to flooding in the Probable Maximum Flood - PMF) where possible.

The available flood information for the site is summarised in Section 4.0, and the results of TTW's flood assessment is outlined in Section 6.0. An assessment of the proposed development against The Hills Shire Council DCP is then provided in Section 8.0.

4.0 Existing Flood Information

4.1 Council Flood Information

The flood information presented in Council's '*The Hills - Development Control Plan 2012*' (DCP) is derived from the TUFLOW models developed as part of the *Box Hill Industrial Precinct - Water Cycle Management Strategy (2012)*. These models were initially prepared by J. Wyndham Prince, Consulting Civil Infrastructure Engineers (JWP), and TTW are informed that they were later updated by Cardno Engineering Services. TTW is informed that this is the most reliable information available to the Council (see Appendix B).

Flood planning information for the site was requested from Council. While Council could not provide flood planning levels for the properties, they were able to supply their 1% AEP event creek flood levels for the ultimate developed catchment as well as the ultimate developed case TUFLOW model for the Box Hill catchment, as shown in Figure 8. The corresponding discussions with Council identified that these were to be used to assess the site.

It is noted that this information, although inclusive of an existing overland flow route through No. 48, does not include any flood extents around this channel. This is consistent with the developed case models prepared by JWP.

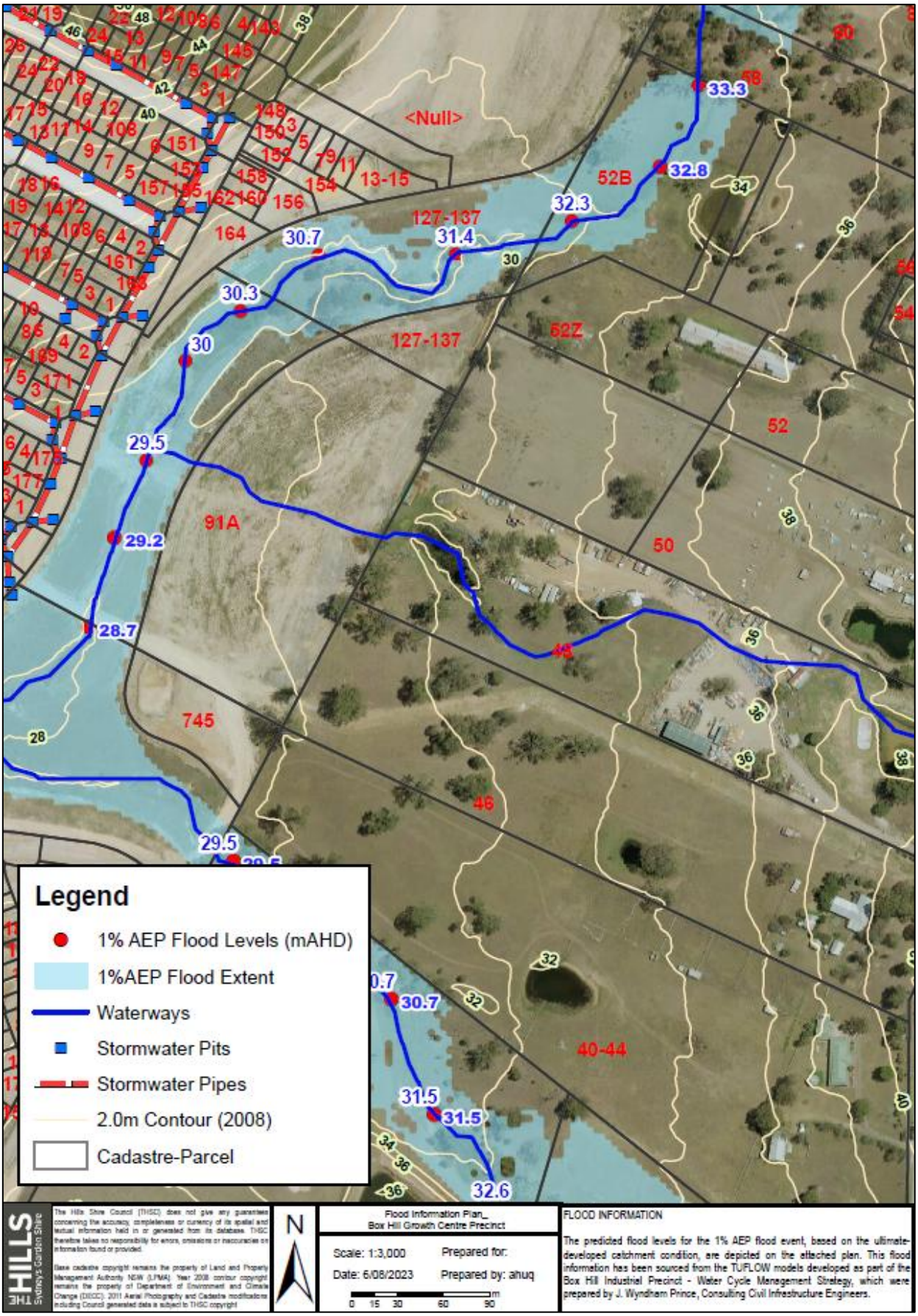


Figure 8: Council supplied flood levels during the 1% AEP event (ultimate developed catchment)

4.2 Box Hill Industrial Precinct - Water Cycle Management Strategy (2012)

In the 'developed condition' modelling contained within the 2012 Water Cycle Management Strategy report, the development of the Box Hill area was shown to remove the flood extents over No. 48 Terry Road. This is evident in modelling of the developed case 100-year Annual Recurrence Interval (ARI) event (now referred to as the 1% Annual Exceedance Probability (AEP) event) in Figure 9, and in modelling of the PMF event in Figure 10.

As part of the overall precinct development, sequential detention basins have been proposed just upstream of the proposed development site to manage stormwater runoff for storm events up to the 100-year annual recurrence interval (ARI) (1 % AEP) and designed to ensure discharge flow rates are attenuated to that of the pre-development conditions. These basins would not however have had an impact on the catchment upstream of No.48.

Based on this strategy, the Water Cycle Management Report (2012) provides a flooding analysis of the post development condition for a 1% AEP event as well as for the PMF. The extent of flooding is shown in Figure 9 and Figure 10 respectively.

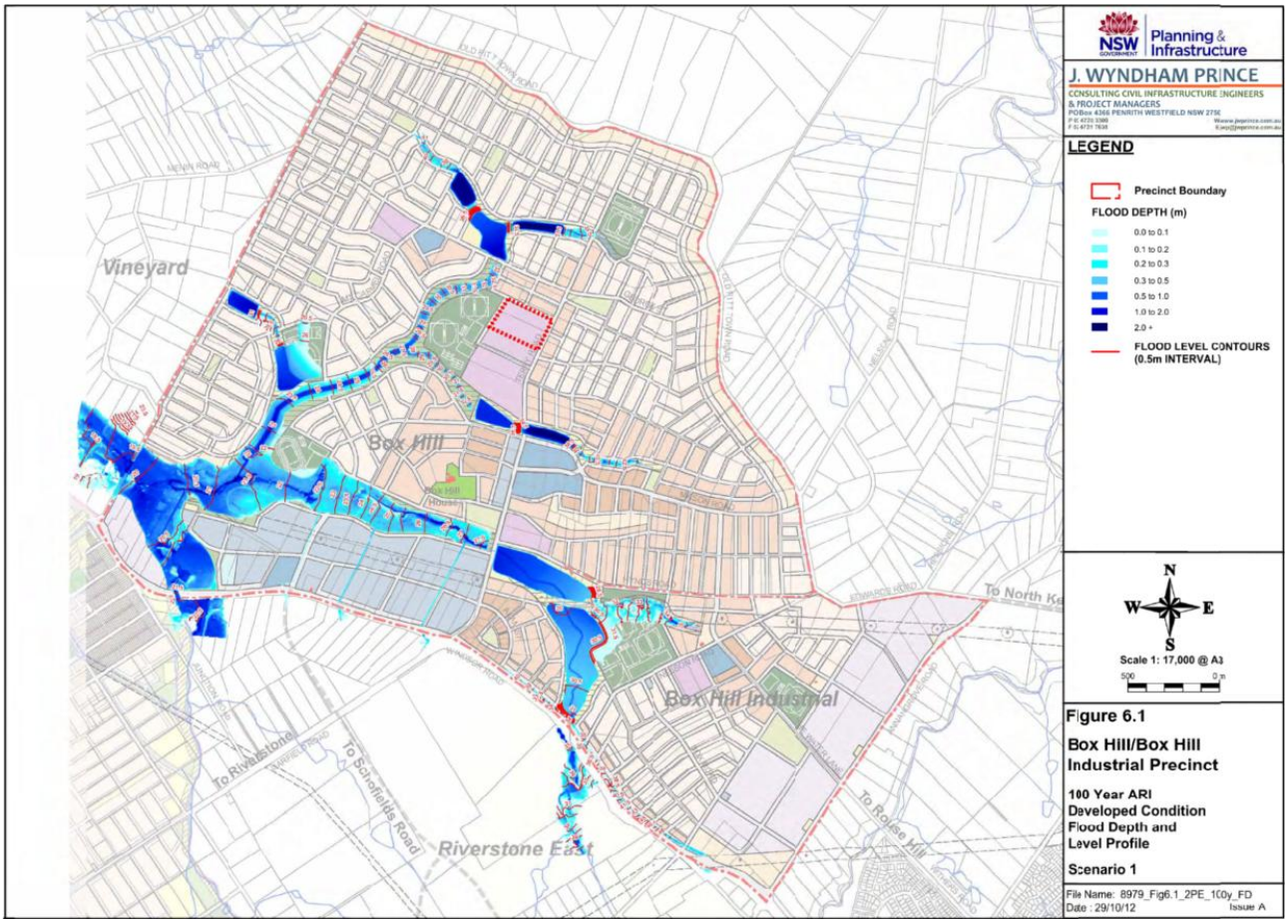


Figure 9: 1% AEP flood extents in the Developed Conditions scenario (J. Wyndham Prince, 2012)

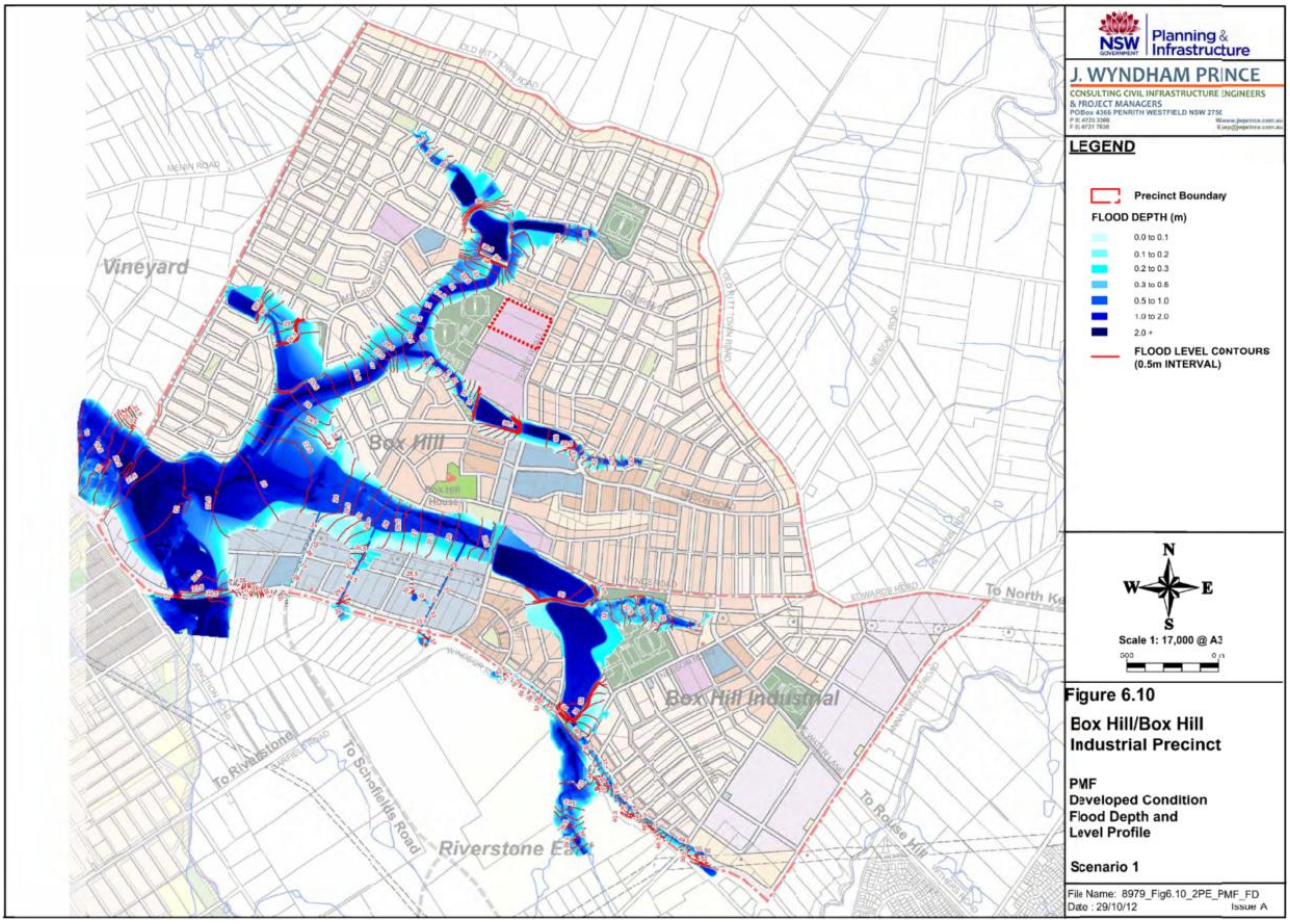


Figure 10: PMF extents in the Developed Conditions scenario (J. Wyndham Prince, 2012)

Figure 11 further identifies that the overland flows route through No. 48 Terry Road no longer exists in the developed precinct modelling (green indicating that where there once was inundation in the existing scenario, there is no longer inundation in the ultimate developed case).

Although this overland flow route is no longer included in the JWP or Council models, Council could not provide information on how this drainage would be managed. Upon further investigation it was discovered that the area draining through No. 48 had been omitted from Councils' Box Hill model (which is likely why it no longer appears on the developed scenario maps). This likely occurred as the focus of this model was placed on the creek's upstream detention basins.

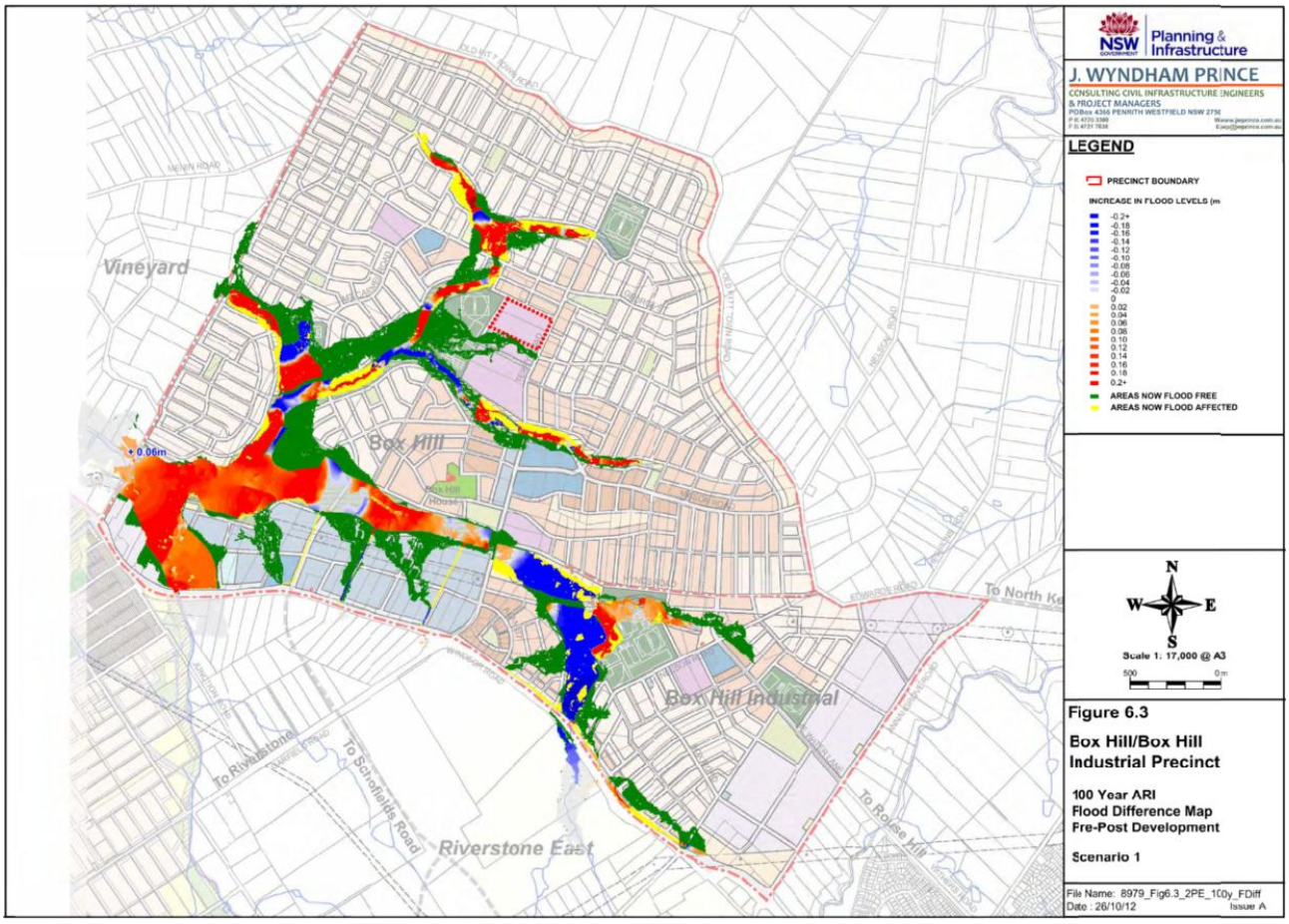


Figure 11: Flood difference map,1% AEP (J. Wyndham Prince, 2012)

5.0 TTW Flood Analysis

5.1 TTW Hydraulic Model

To analyse the subject study area, Council's TUFLOW model has been modified by TTW to show the extents of the overland flow in the 10%, 5%, 1%, 0.2% AEP and PMF events. This model uses Councils developed scenario elevation data as well as their material layers (although altered to represent the undeveloped site on No. 48), whilst incorporating the inflow at the culvert under Terry Road.

5.1.1 Hydrology

It was also discovered that although not used within the hydraulic model, the No.48 upstream catchment existed in the RAFTS hydrological model. The 1% AEP event hydrographs were retrieved from the RAFTS model, while the 10%, 5%, 0.2% AEP and PMF events were generated within the RAFTS model by TTW for input into the TUFLOW model.

These inputs assume a worst-case scenario, in lieu of other information, for flows across No.48, whereby it is assumed that all developed flows from the upstream catchment are allowed to pass under Terry Road unmitigated. As the overland flows from the newly developed catchment upstream of No.48 will not be mitigated by the main detention basins on the creek, it could also be assumed that the upstream development would include its own detention storages, to prevent the increase of flows from this proposed highly impervious catchment, and their impacts on the downstream and adjacent lots and properties. However, this information was not available from Council and not included in their models, and therefore not been included in TTW's modelling. As such, the overland flow routes in this report are conservative and the inundation extents likely to be less.

The model extent, downstream boundary and model inflows are shown in Figure 12.

Figure 12: Key features in TTW's hydraulic model

5.1.2 Topography

The existing Council model was updated with new survey data for the site and surrounding area, including along the recently constructed Keeneland Street to the north, and to the centreline of Terry Road at the eastern frontage.

The data was collected by Astrea on 6th March 2025 and was incorporated into the existing model to increase the accuracy of surface levels within and surrounding the site. The survey data collected is shown as a DEM in Figure 13.

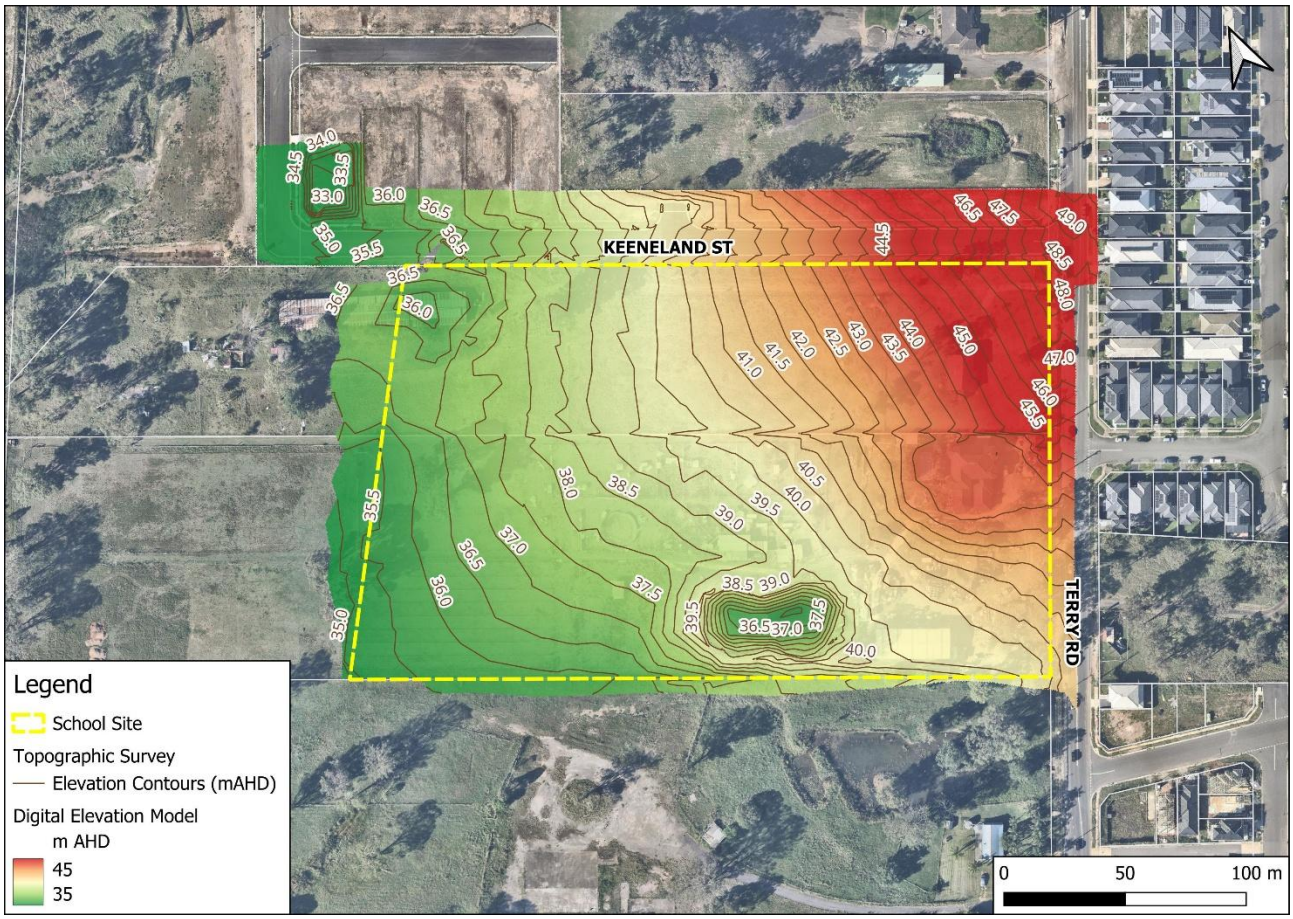


Figure 13: Extent of updated survey information for the site

5.1.3 Post-development

To allow for flood assessment of the site in post-development conditions, the post-development flood model was modified to include the updated design surface, as well as the proposed buildings and associated works of the proposed development.

The post-development design surface is to be finalised as part of the detailed design stage. A high-level design surface has been incorporated in the post-development scenario, which contains 'blocks' with indicative surface levels, assuming a 1% crossfall. The following assumptions have been made as part of the civil design:

- Building platform FFLs have been adopted from Architectural documentation;
- Internal landscape FLs have adopted indicative levels with 1% crossfall to expedite flood modelling surface as part of this REF submission.

As post-development surface levels have been lowered at some locations to the south of the site, a bund will be incorporated into the design surface along the southwest to ensure excess flows from No. 48 Terry Road do not inundate the site. The bund has been incorporated into the model via manual adjustments to the design surface, set to the approximate PMF level. This is shown alongside the high-level design surface in Figure 14. The bund elevation has been specified at three locations and is interpolated between this.

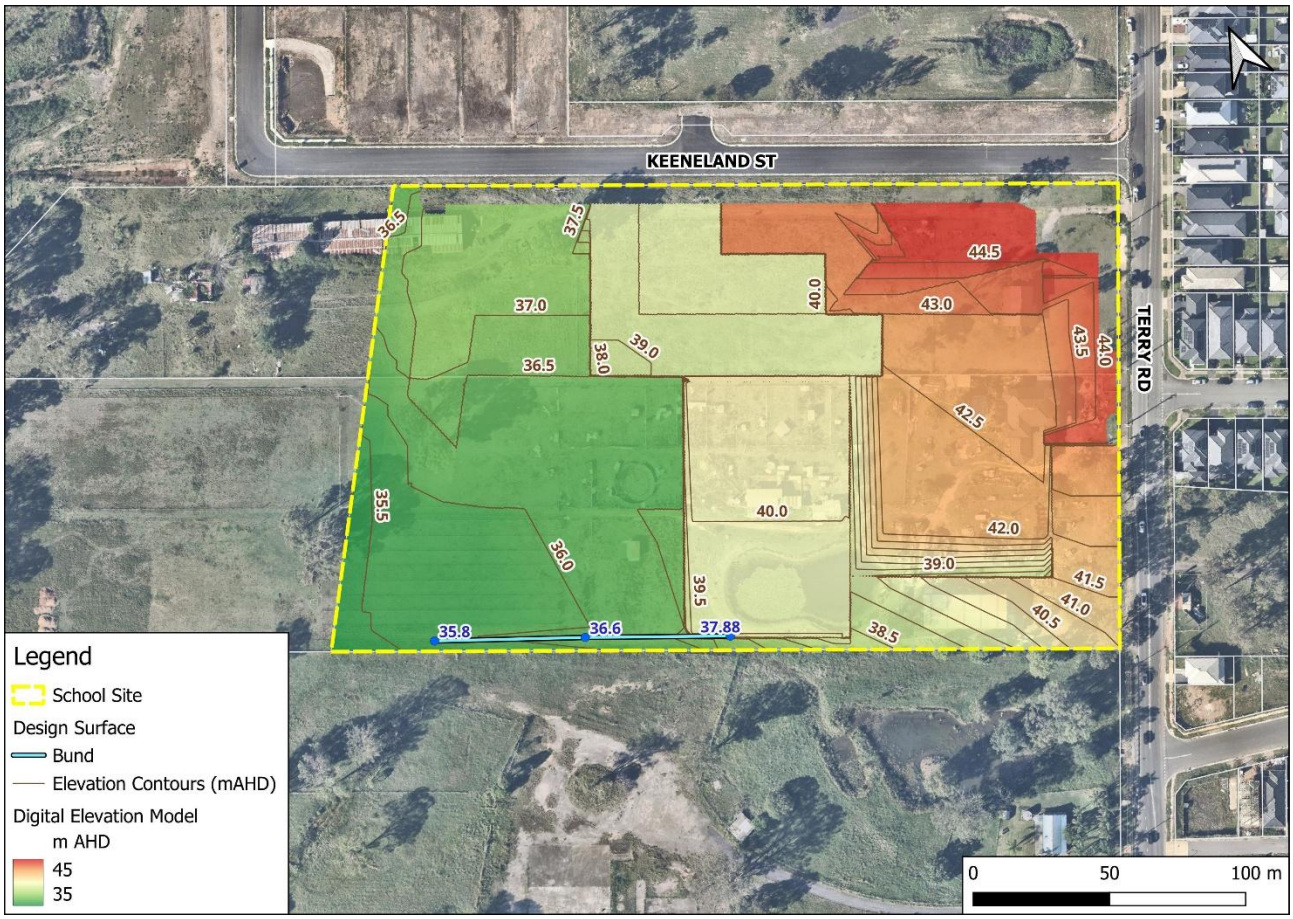


Figure 14: Design surface elevation model for the site

5.2 Flood Hazard Categories

The relative vulnerability of the site to flood hazard has been assessed by using the flood hazard vulnerability curves set out in 'Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia' of the Australian Disaster Resilience Handbook Collection (2017).

These curves assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. The flood hazard categories are outlined in Figure 15, ranging from a level of H1 (generally safe for people, vehicles and buildings) to H6 (unsafe for vehicles and people, with all buildings considered vulnerable to failure). Table 3 outlines the threshold limits for each hazard category.

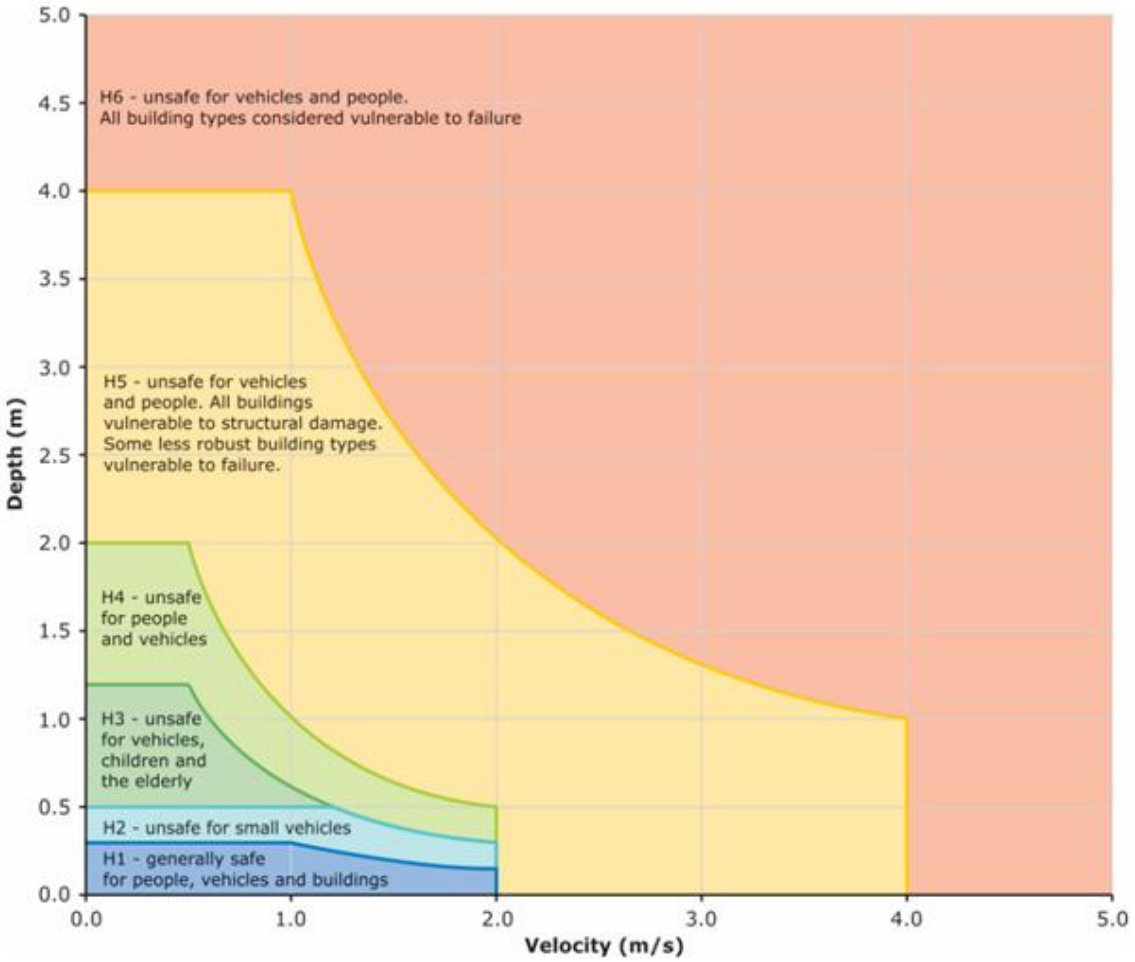


Figure 15: Flood hazard vulnerability curve (Source: Flood Risk Management Guide FB03 - Flood Hazard, NSW Department of Planning and Environment, 2022)

Table 3: Hazard vulnerability threshold limits

Hazard	Description	Classification Limit (m2/s)	Limiting still water depth (D) (m)	Limiting velocity (V) (m/s)
H1	Generally safe for people, vehicles and buildings	D x V ≤ 0.3	0.3	2.0
H2	Unsafe for small vehicles	D x V ≤ 0.6	0.5	2.0
H3	Unsafe for vehicles, children and the elderly	D x V ≤ 0.6	1.2	2.0
H4	Unsafe for people and vehicles	D x V ≤ 1.0	2.0	2.0
H5	Unsafe for people and vehicles. All buildings vulnerable to structural damage.	D x V ≤ 4.0	4.0	4.0
H6	Unsafe for people and vehicles. All building types considered vulnerable to failure.	D x V > 4.0	No Limit	No Limit

6.0 Results

The existing flood conditions on-site during the critical 1% AEP and PMF events are assessed in the following sections. Existing flood conditions during the 10% AEP, 5% AEP and 0.2% AEP events are attached in Appendix C, while the post-development 10%, 5% and 0.2% AEP events are attached in Appendix D.

The base critical storm durations for the site and its immediate vicinity were identified as the 120-minute storm for the 10% AEP, and as 90-minutes for the 1%, 5% and 0.2% AEP events. The 15-minute storm was the base critical storm duration for the PMF event.

The maximum flood levels and depths, flood velocities and flood hazards have been mapped and discussed in the following sections.

6.1 Existing Scenario

6.1.1 1% AEP Event

The peak flood levels and depths, velocities, and hazards during the existing 1% AEP event are shown in Figure 16, Figure 17, and Figure 18, respectively.

The following observations can be made:

- The 1% AEP flood extent is largely outside of the school site boundary, aside from a small portion which is partially flood affected towards the southwest of the property.
- Flood level here reaches approximately 36.3m AHD, with depths of 0.15m.
- No. 48 is considerably flood-affected in the 1% AEP event, with a peak flood level of 40.6m AHD close to Terry Road, and peak depths of approximately 0.75m.
- Peak velocities in the existing 1% AEP event reach around 3.5 m/s along the southwest of No. 48.
- Flood hazard south of the site generally ranges between H1-H3, though there is a small area of H6 within the southwestern portion of No.48 Terry Road.
- Within the site boundary, flood velocity is generally around 0.4 m/s, with a hazard rating of H1.

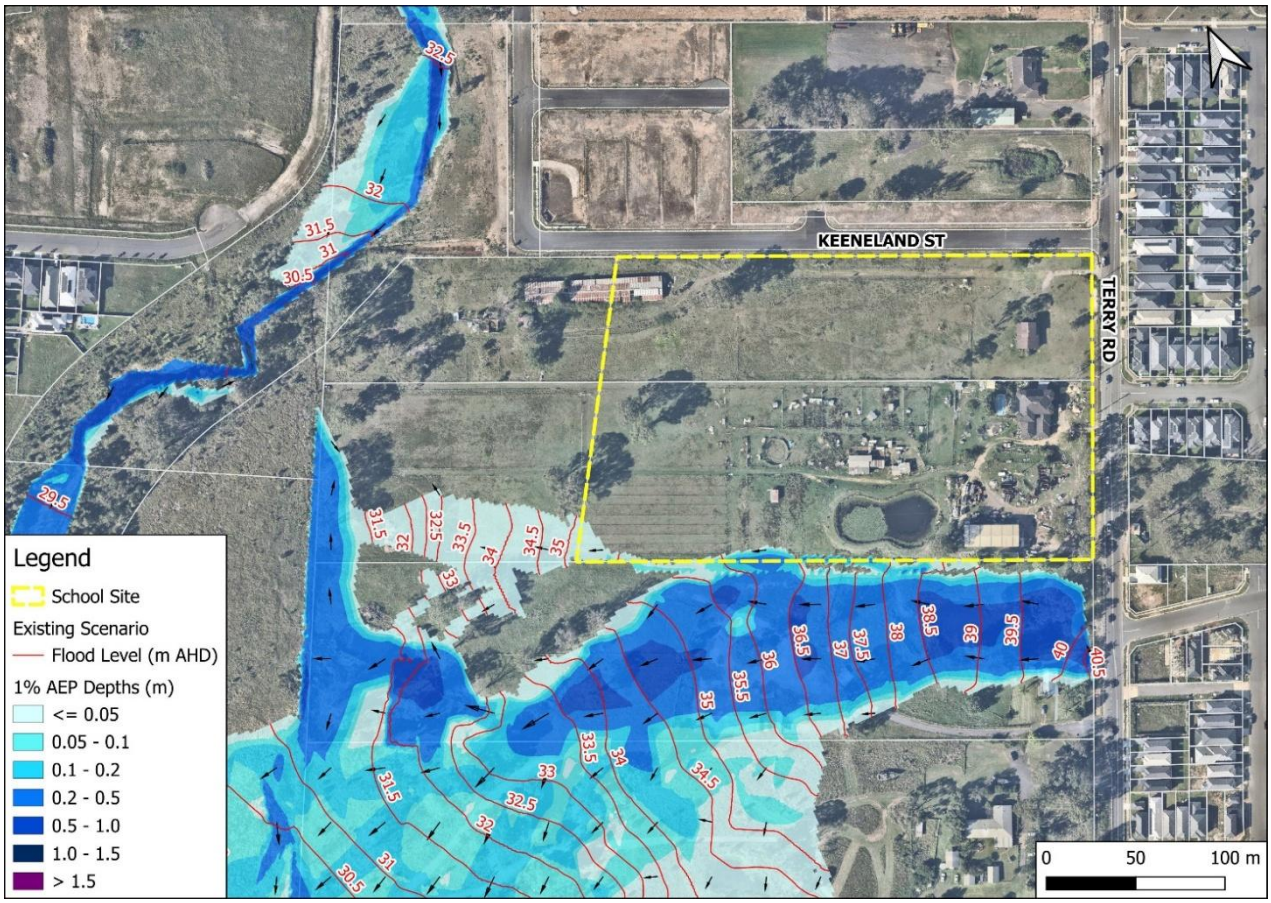


Figure 16: Peak flood levels and depths at the site in the 1% AEP event, pre-development of school

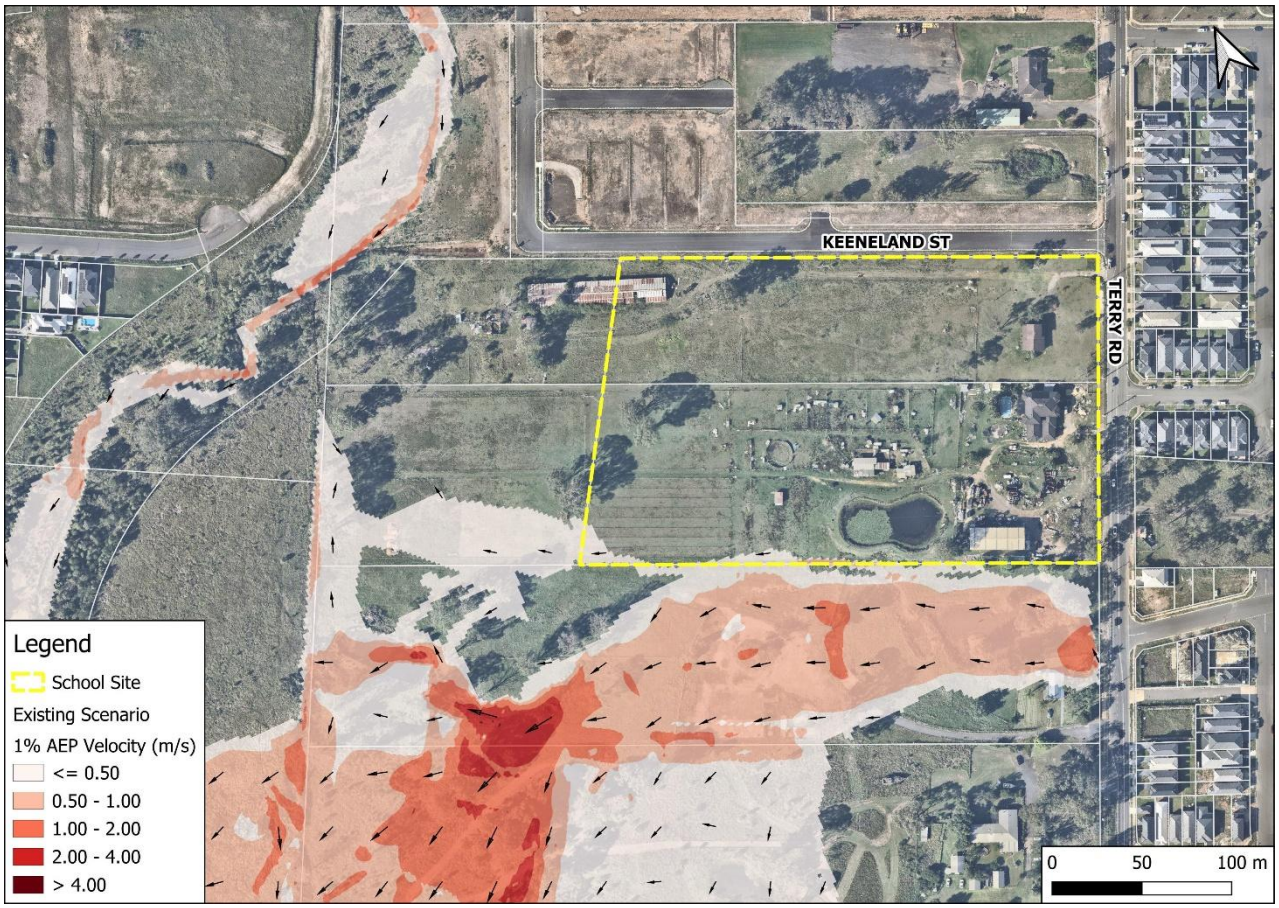


Figure 17: Peak flood velocity at the site in the 1% AEP event, pre-development of school

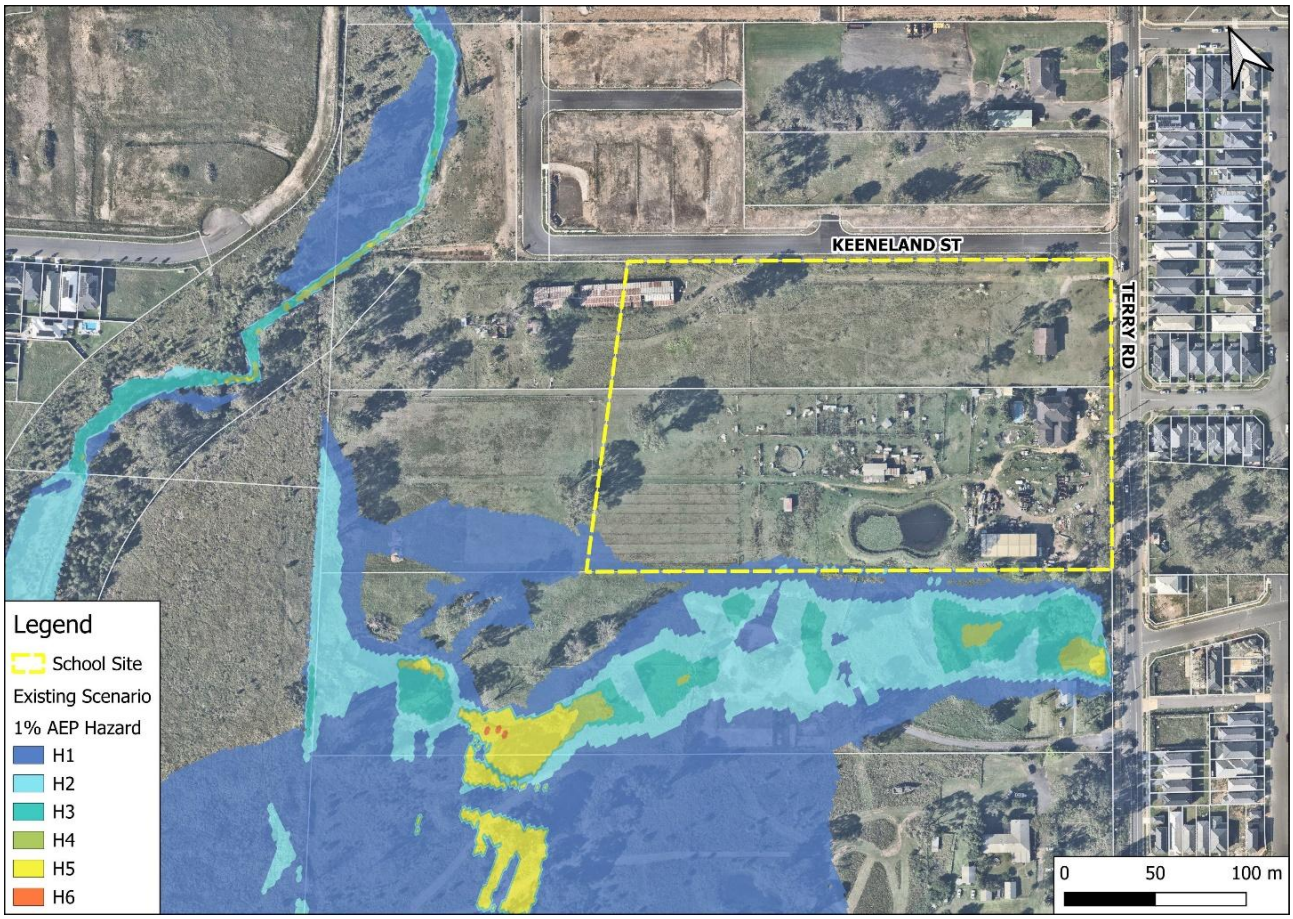


Figure 18: Peak flood hazard at the site in the 1% AEP event, pre-development of school

6.1.2 PMF Event

The peak flood levels and depths, velocities, and hazards during the PMF event are shown in Figure 19, Figure 20, and Figure 21, respectively.

The following observations can be made:

- The PMF extent enters the south of the proposed development site in the existing scenario and is primarily centred around the waterbody which currently occupies the property, with flood depths here reaching a peak of 1.8m.
- Flood levels onsite peak at 41.0m AHD at the southeastern corner at the Terry Road frontage.
- Flood depths and levels at No. 48 are increased in the PMF event, with peak depths of approximately 1.6m.
- Peak PMF flood velocities within the site itself are generally less than 0.3 m/s, though they reach over 0.8 m/s at the south of No. 50.
- Similarly, PMF hazards are generally H1-H2 onsite, reaching H5 within the waterbody.
- Along No. 48, flood hazard is generally H5 across the entire lot.

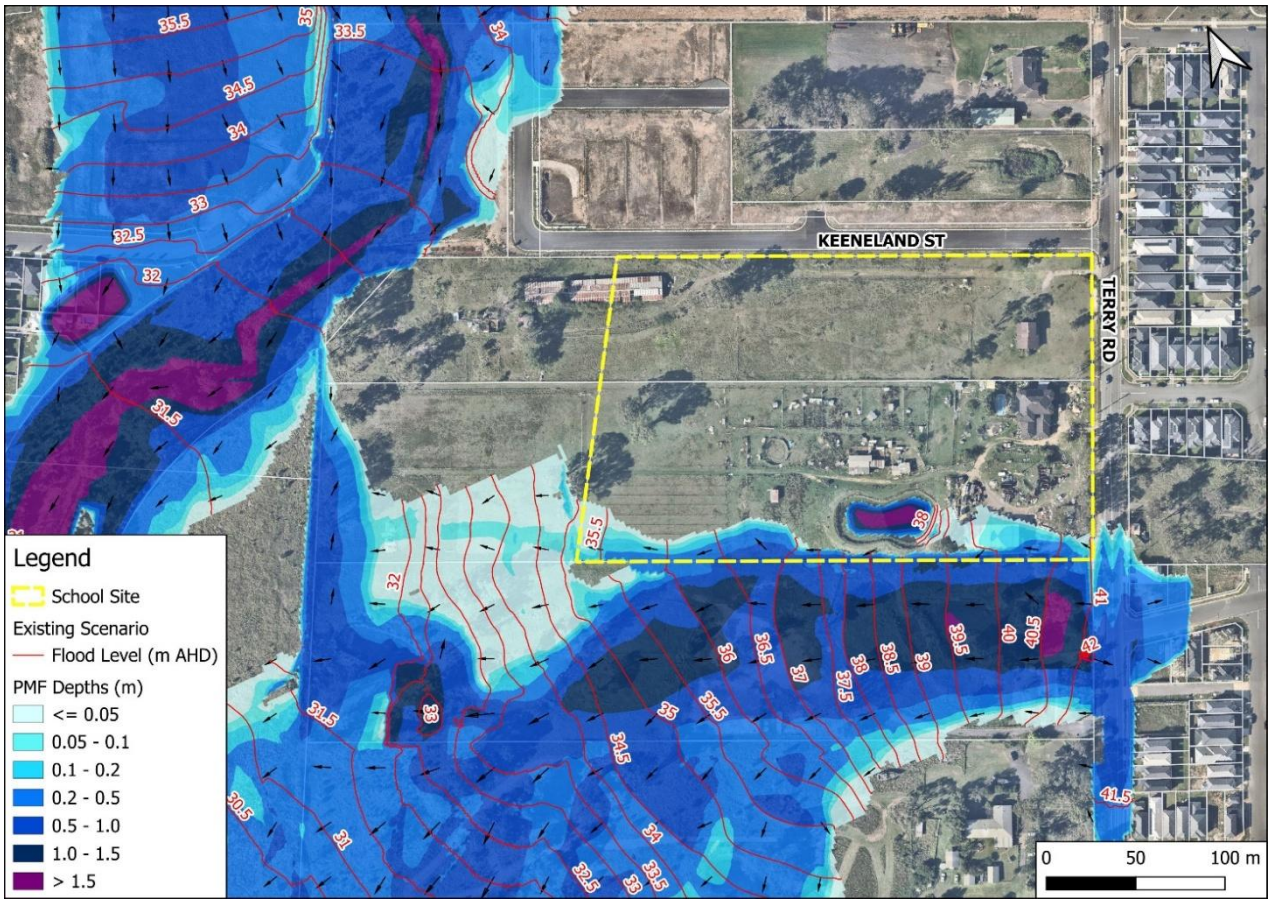


Figure 19: Peak flood levels and depths at the site in the PMF event, pre-development of school

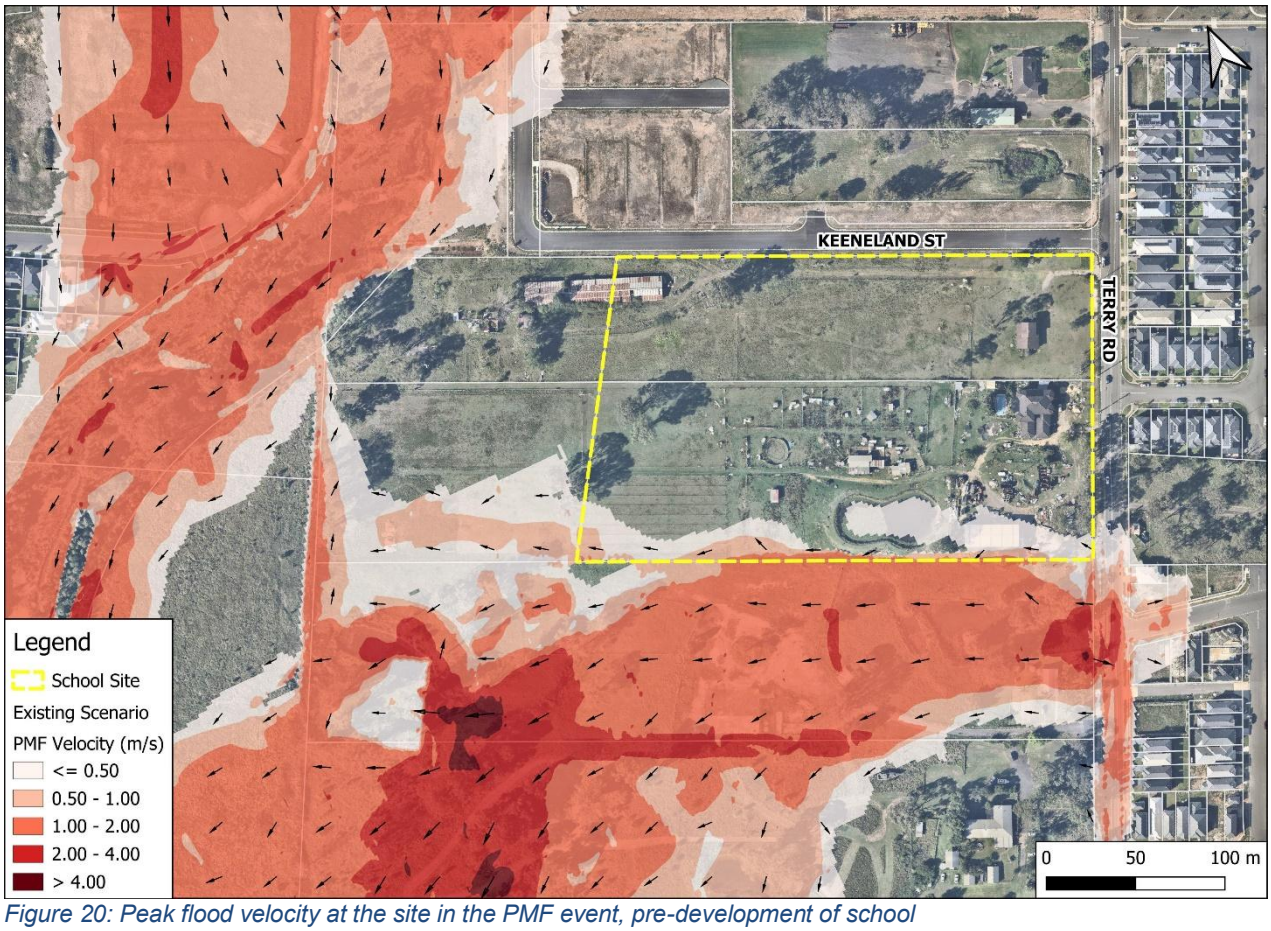


Figure 20: Peak flood velocity at the site in the PMF event, pre-development of school

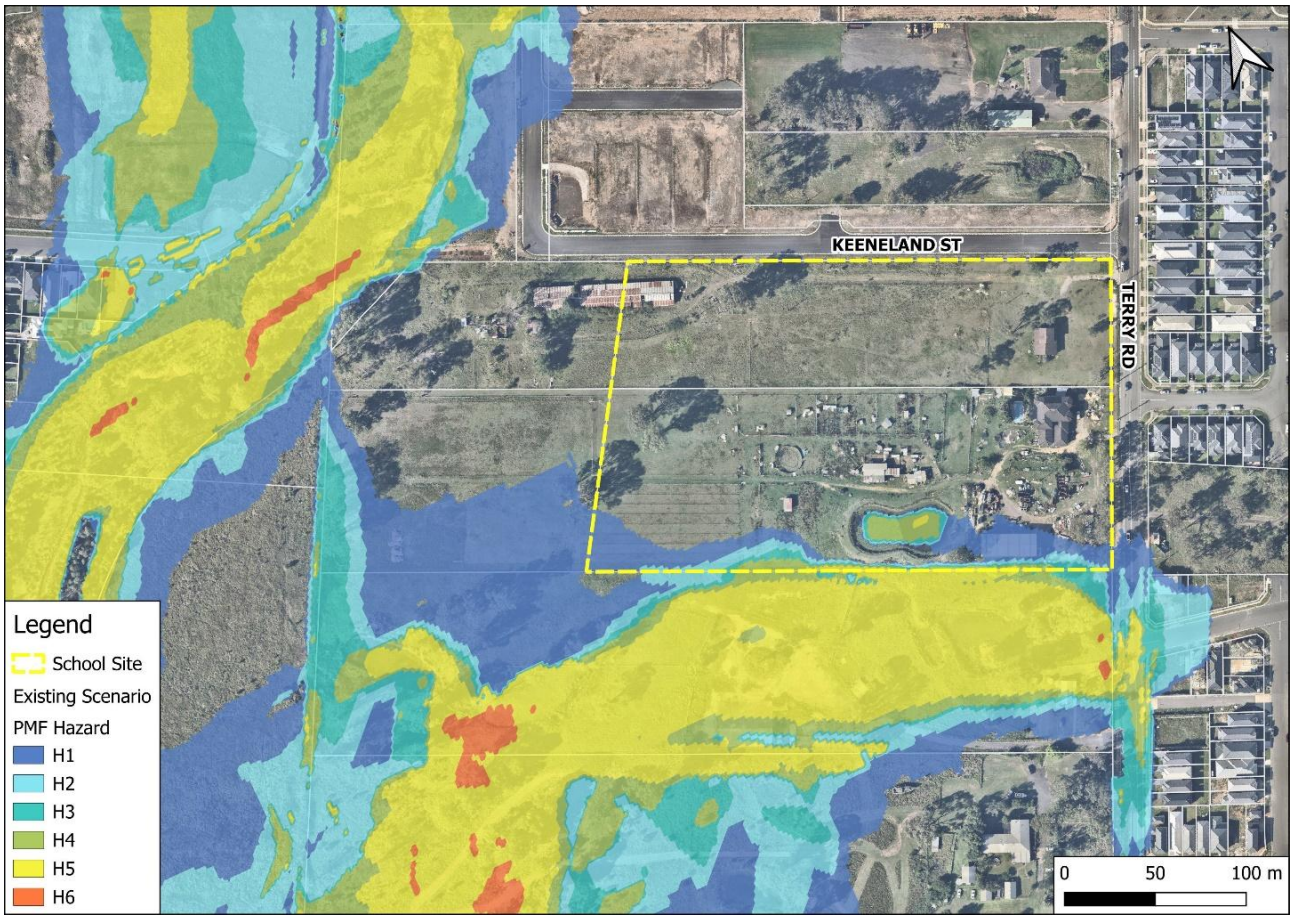


Figure 21: Peak flood hazard at the site in the PMF event, pre-development of school

6.2 Post-Development Scenario

6.2.1 1% AEP Event

The peak flood levels and depths, velocities, and hazards during the post-development 1% AEP event are shown in Figure 22, Figure 23 and Figure 24, respectively.

The following observations can be made:

- The 1% AEP flood extent is mostly outside of the school site boundary, aside from a small portion directly south of the proposed location of the sports pitch.
- Flood level here reaches between approximately 36.5m AHD to 37.9m AHD, with peak depths of 0.25m.
- Consistent with the existing scenario, No. 48 is considerably flood-affected in the 1% AEP event, with a peak flood level of 40.6m AHD close to Terry Road, and peak depths of approximately 0.75m.
- Peak velocities in the post-development 1% AEP event are consistent with the existing scenario at No. 48, peaking at approximately 3.5 m/s at the southwest.
- Flood hazard both onsite and south of the site are consistent with the existing 1% AEP scenario. Within the site, any floodwaters are H1 hazard. South of the site, hazard is H1-H3, though there is a small area of H5-H6 within the southwestern portion of No.48 Terry Road.
- The driveway entrances to both the high school and primary school carparks are flood-free in the 1% AEP.

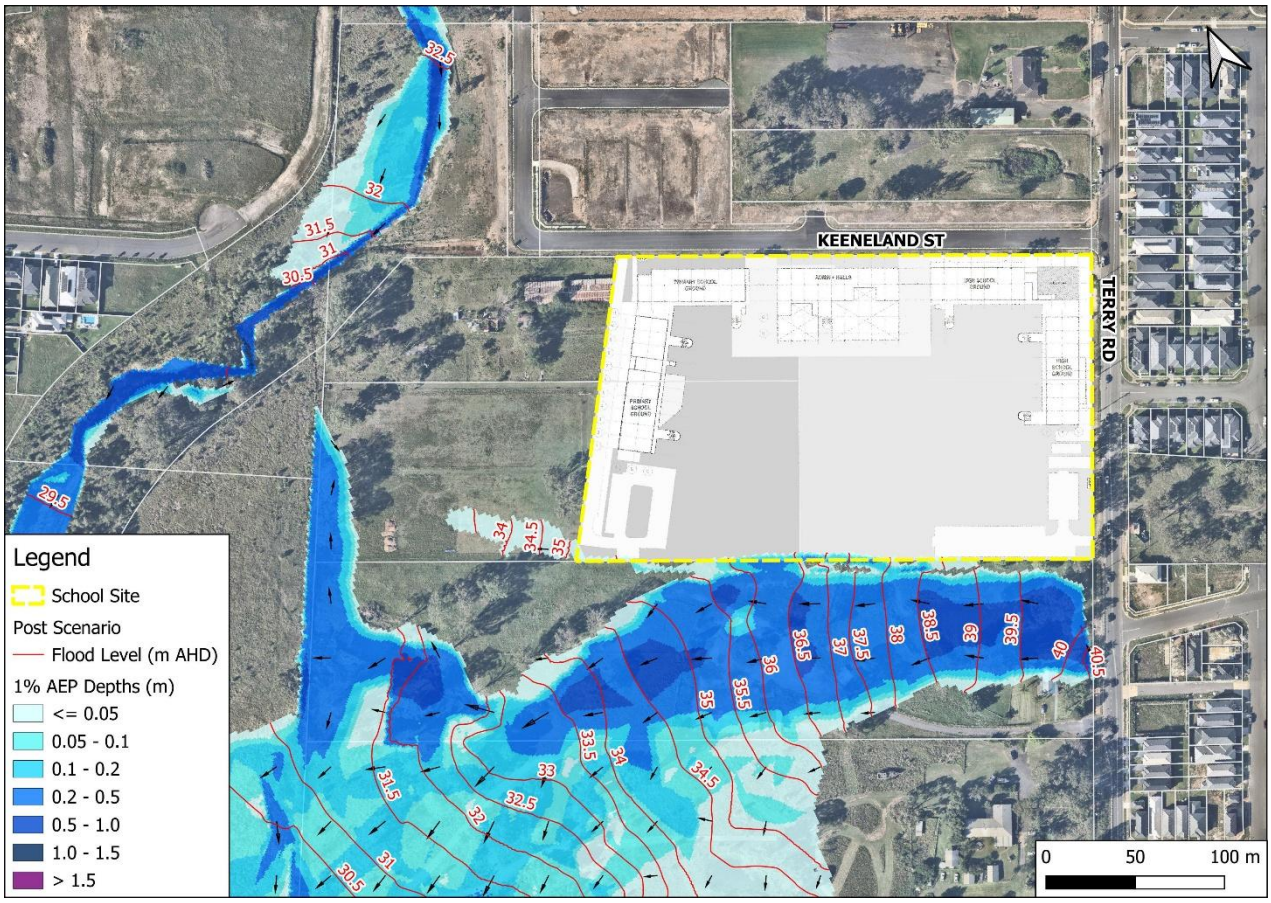


Figure 22: Peak flood levels and depths at the site in the 1% AEP event, post-development of school

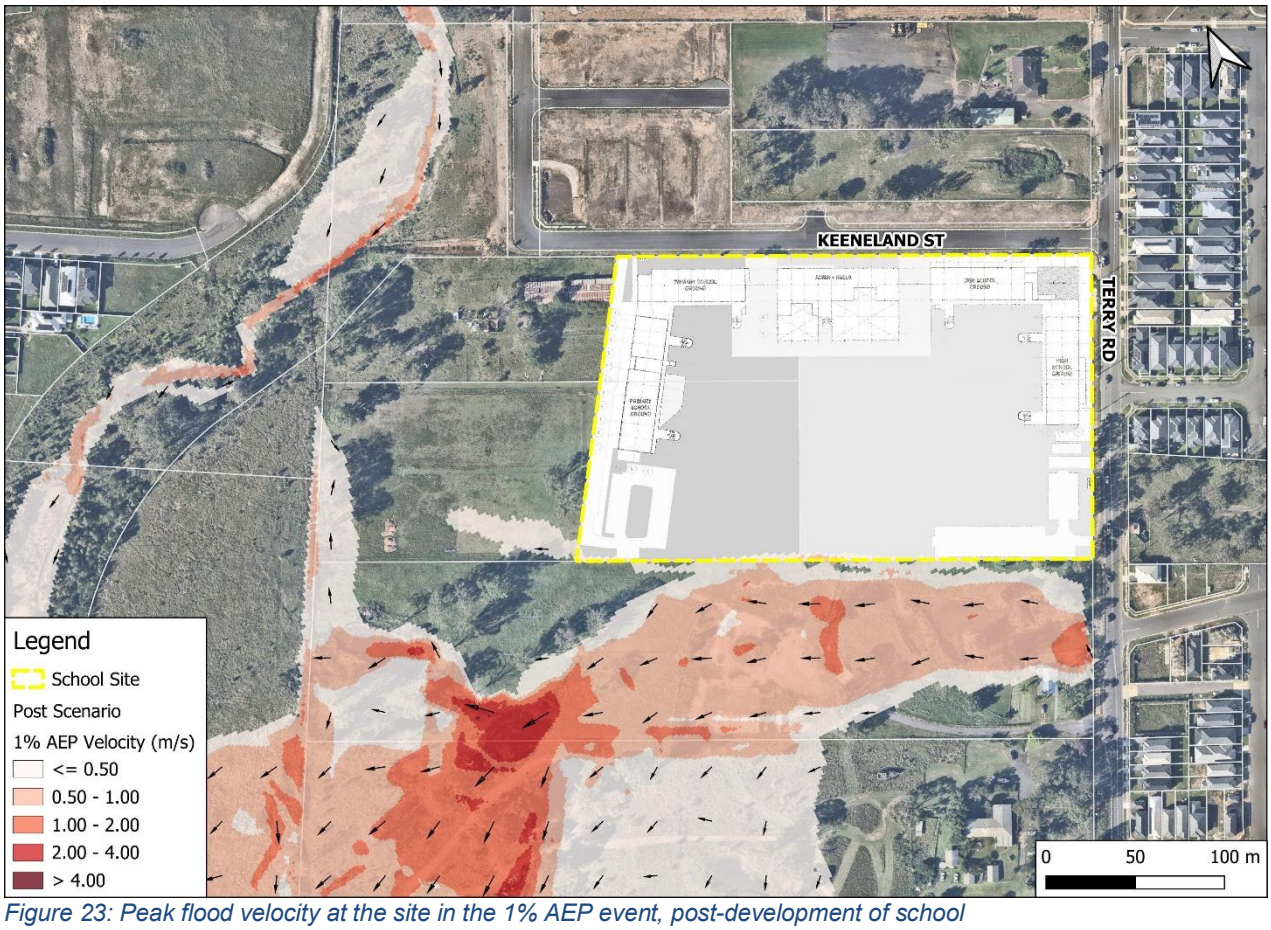


Figure 23: Peak flood velocity at the site in the 1% AEP event, post-development of school

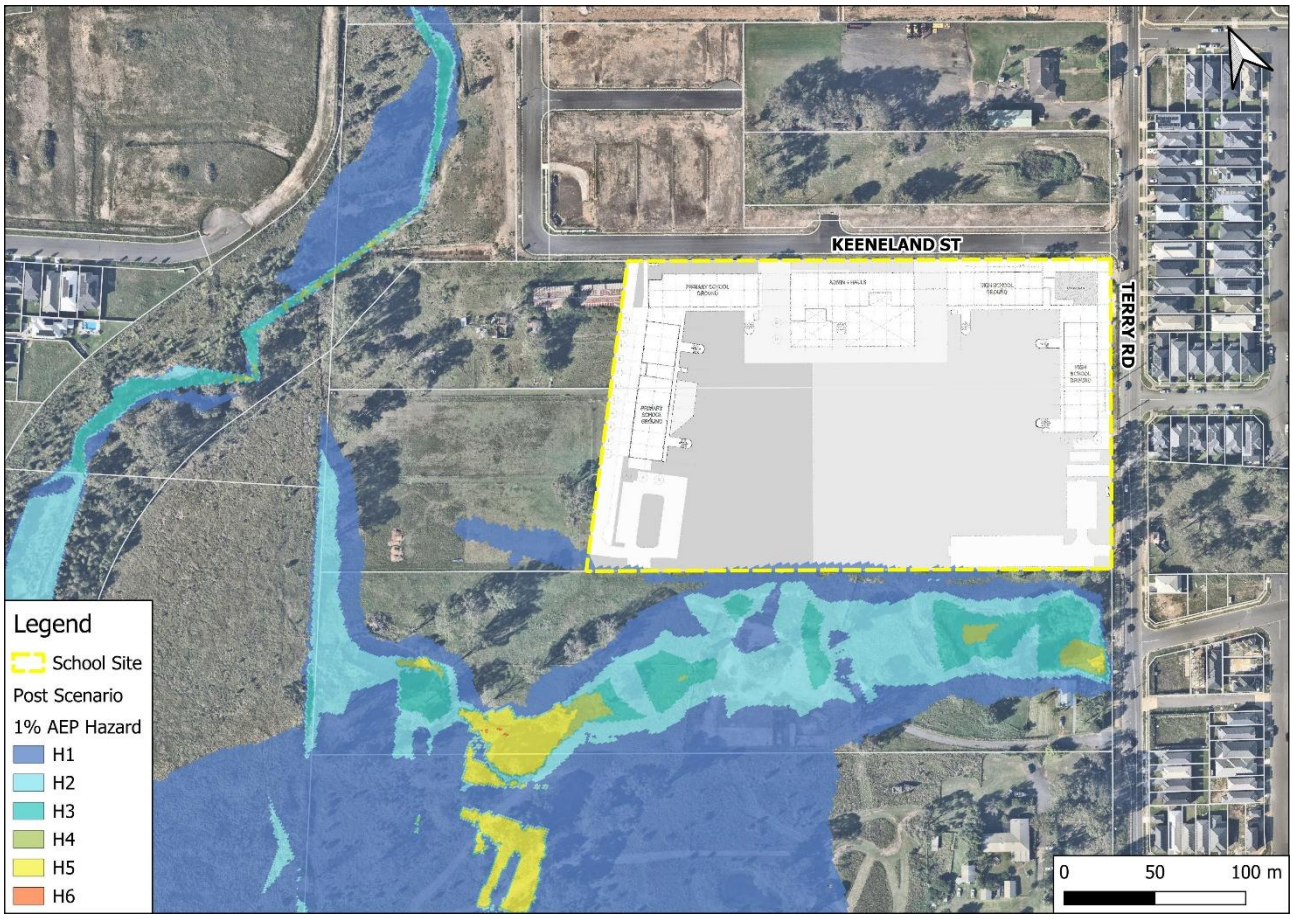


Figure 24: Peak flood hazard at the site in the 1% AEP event, post-development of school

6.2.2 PMF Event

The peak flood levels and depths, velocities, and hazards during the PMF event are shown in Figure 25, Figure 26 and Figure 27, respectively.

The following observations can be made:

- The southwestern primary school and preschool car park is impacted by some overland flooding in the PMF, with peak depths of 150-170mm. Flood hazard here remains H1.
- The high school car park to the southeast of the site is impacted by ponding of floodwaters, with depths ranging from 0.1m to a peak of almost 0.9m at the southwestern corner of the car park. Flood hazard ranges from H1 to H4.
- Despite this, access to and from the high school car park is retained, with the driveway entry free from hazardous floodwaters. While there is a small portion of the entry impacted by surface water, this is categorised as H1 hazard ('generally safe for people, vehicles and buildings') and is considered trafficable. Similarly, flooding on Terry Road directly adjacent to the driveway entrance remains at H1 hazard (Figure 27).
- Offsite flood hazard in the post-development scenario is consistent with the existing scenario, with H5 hazard across most of the No. 48 property south of the site.

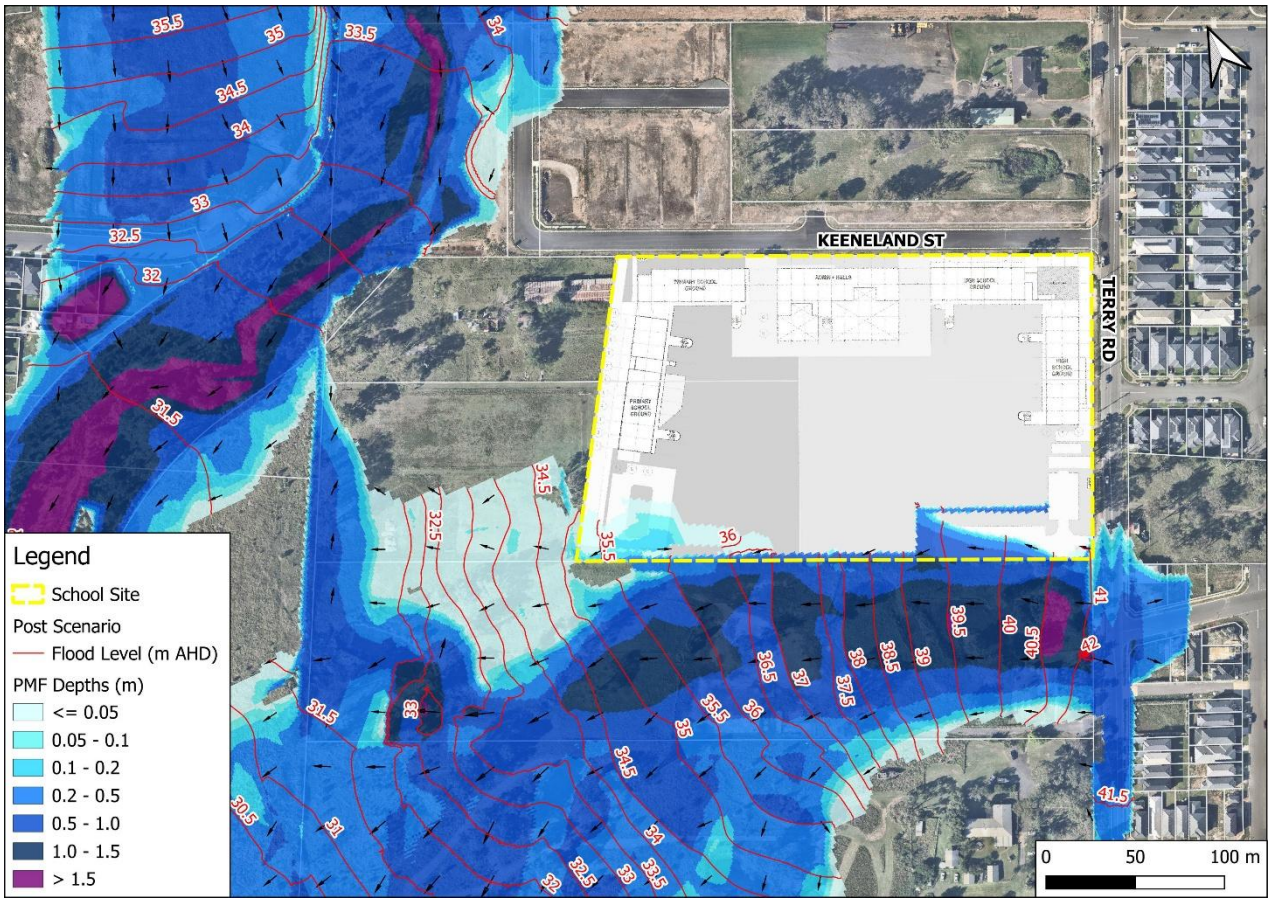


Figure 25: Peak flood levels and depths at the site in the PMF event, post-development of school

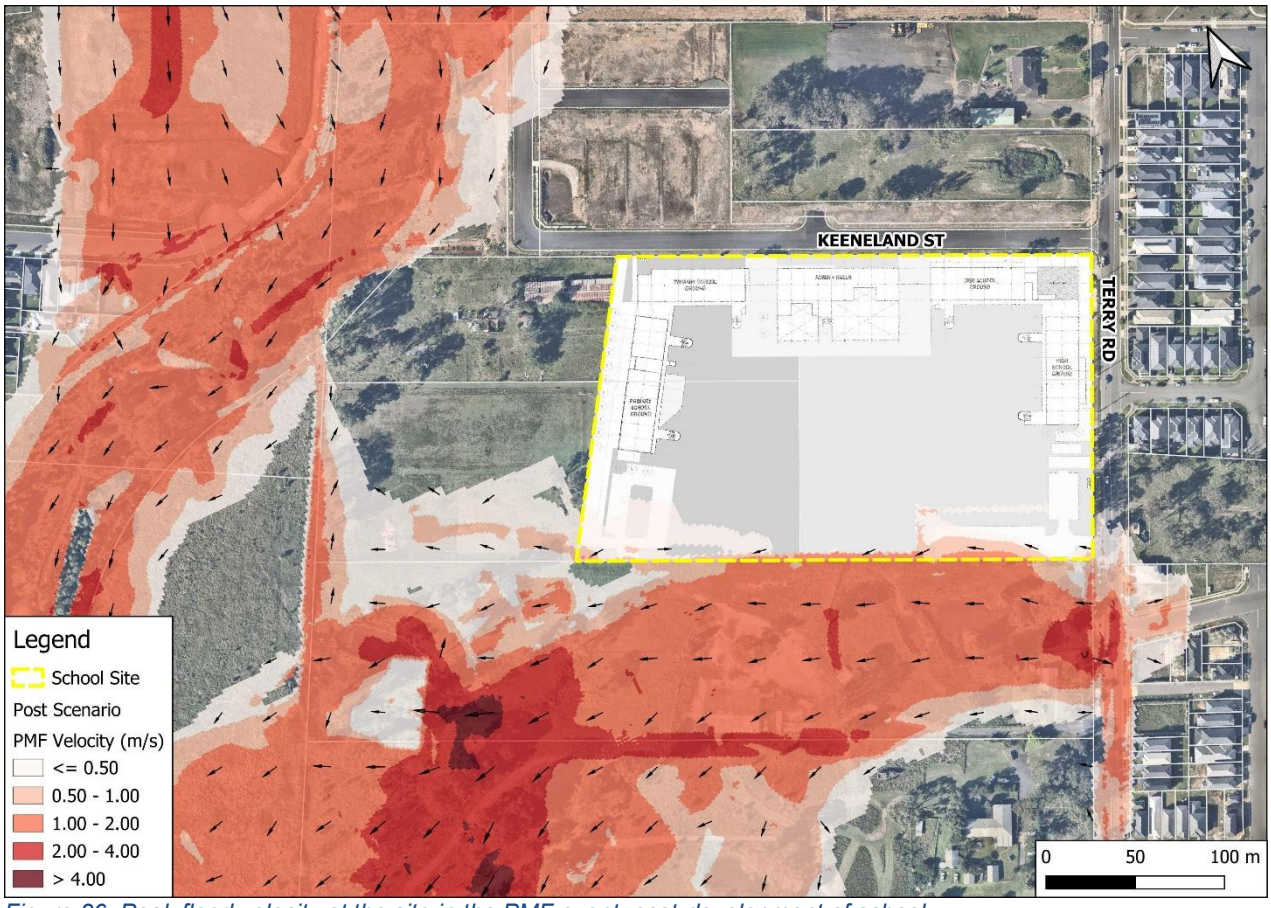


Figure 26: Peak flood velocity at the site in the PMF event, post-development of school

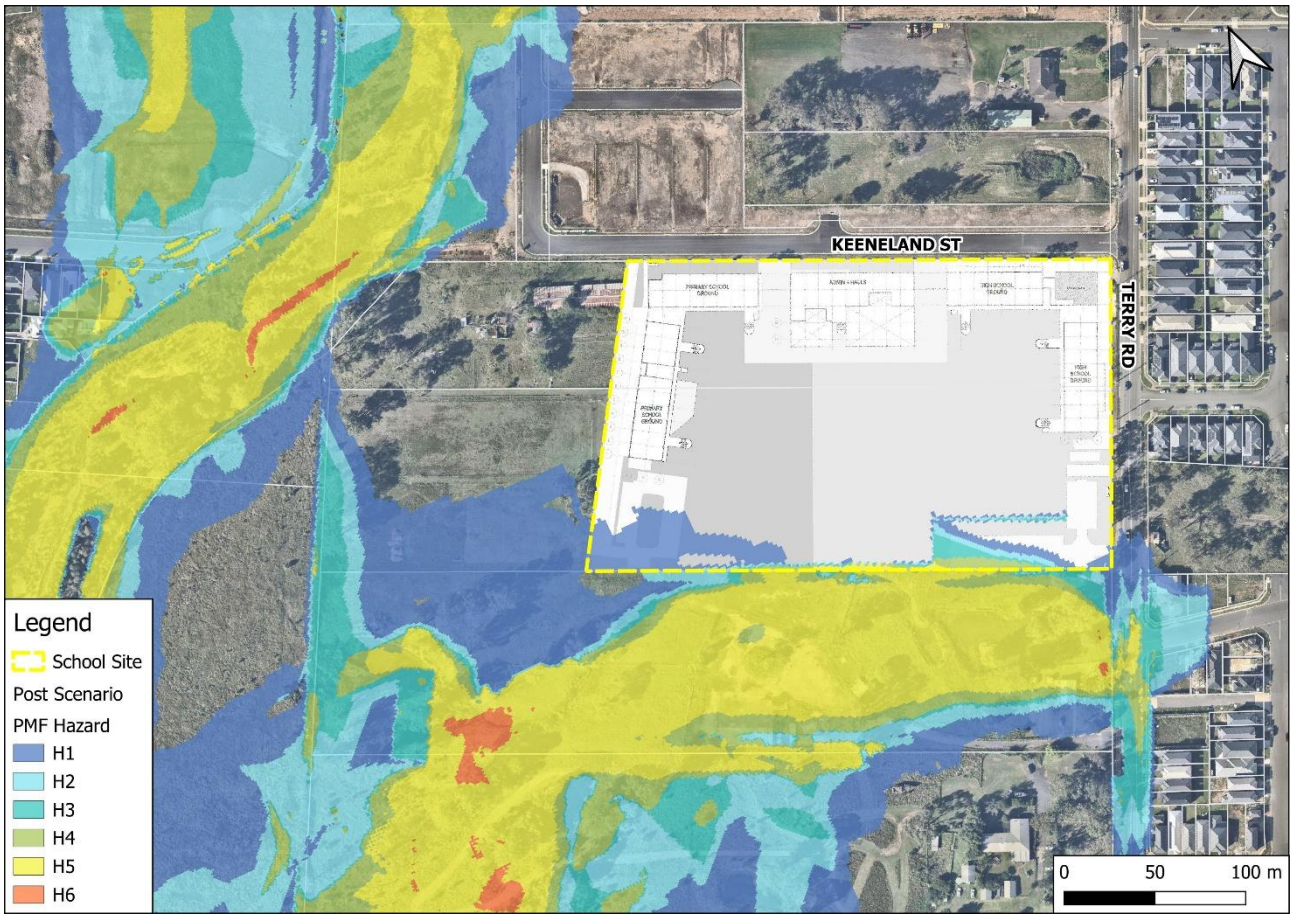


Figure 27: Peak flood hazard at the site in the PMF event, post-development of school

7.0 Impact Assessment

7.1 Impact of Activity

A flood impact assessment has been undertaken to ensure the proposed activity would result in either an unacceptable flood level increase or worsening of the flood conditions over neighbouring properties. The flood level impact map for the proposed activity in the 1% AEP event is shown in Figure 28.

The flood impact assessment shows that there are some local changes in flood level within the site due to modification to the ground level. Surface levels at the southern boundary of the site have slightly reduced in the post-development scenario, thereby allowing some additional surface flow to enter at the site (blue 'was dry now wet' area). The addition of the bund within the site has reduced runoff to the west of the site and at the proposed Sunny Hill Parkway (future road by Council), as indicated by the area of 'was wet now dry' in brown.

Offsite, there is largely no change to flood level, although there is a small portion south of the site boundary with a minor increase ranging between 11-30mm in the 1% AEP event. This localised increase is not considered significant as it does not affect adjacent residential properties, and it is located within the existing waterway corridor immediately downstream of the site. Further, the results show that the flood hazard for this area remained unchanged (refer to Figure 18 and Figure 24 for the 1% AEP event flood hazard mapping of the existing and post scenarios, respectively). There is also an offsite reduction in flood level just west of this, ranging between -15mm to -50mm.

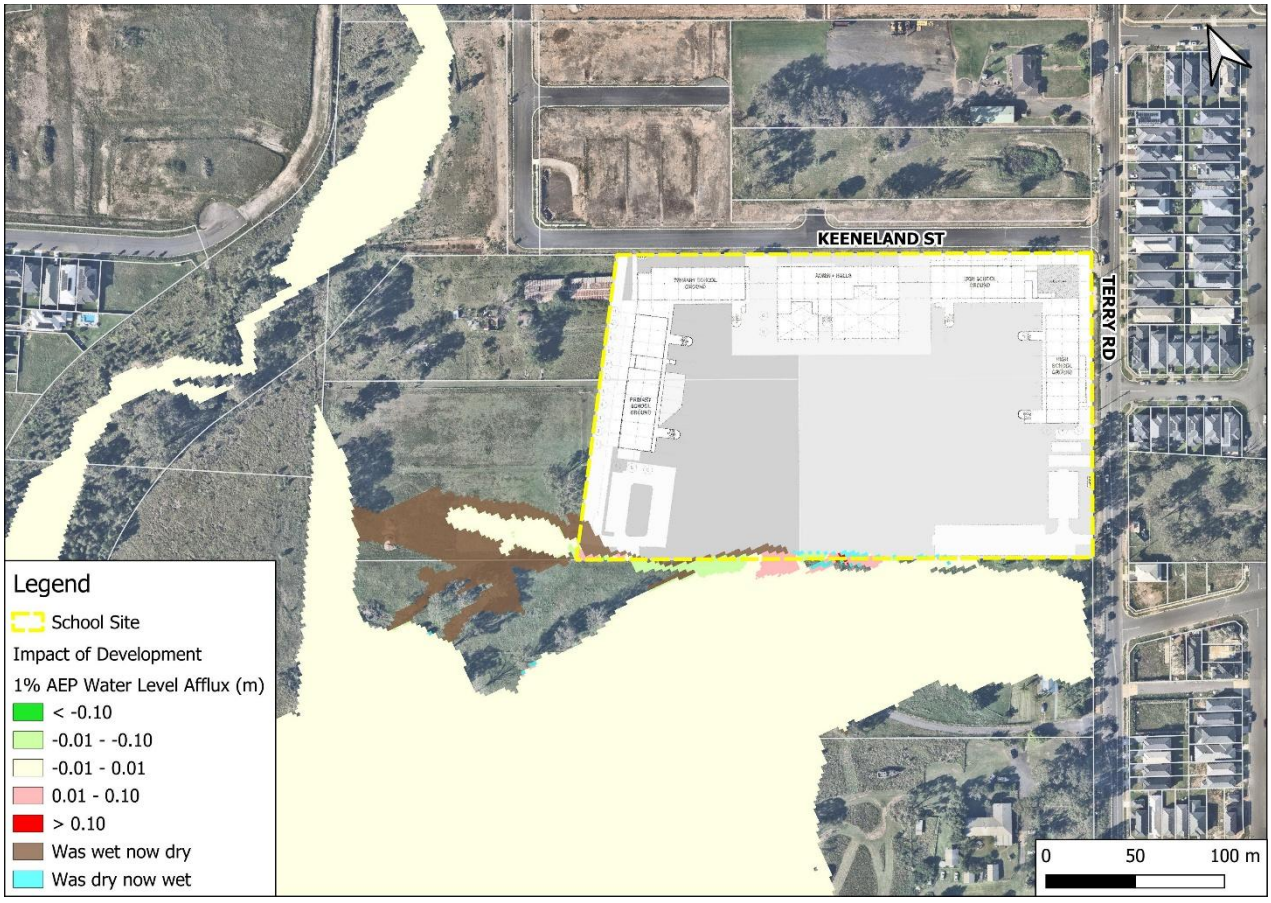


Figure 28: Impact of development: existing vs post-development flood level afflux in the 1% AEP event

7.2 Impact of Climate Change

Climate change is expected to have an adverse impact on rainfall intensities, which has the potential to have significant impact on flood behaviour at specific locations.

The ARR2019 guidelines were updated on 27th August 2024 with new guidance on how to consider climate change when planning for future floods, which includes variable rainfall adjustments based on storm duration. The projected increase in rainfall during short-duration events are higher than the previous estimates.

For this study, a sensitivity analysis has been carried out to determine the impact of climate change on local flood conditions under the Shared Socioeconomic Pathway (SSP) 2-4.5. SSP2-4.5 is an intermediate greenhouse gas emissions scenario that assumes that CO_2 emissions continue around current levels until 2050, then decrease (but do not reach net zero) by 2100.

Two climate change scenarios have been assessed in this study:

- Projected 2050 (CC2050): Rainfall increase of 24%
- Projected 2090 (CC2090): Rainfall increase of 36%

These climate change factors were applied to the 1% AEP event rainfall. The projected flood level increase in the CC2050 and CC2090 scenarios are mapped in Figure 29 and Figure 30, respectively. The following observations have been made:

- In both the CC2050 and CC2090 scenarios, flood extent increases west of the site, with a large area of 'was dry now wet'. This overland flow path is consistent with the existing scenario overland flow path (refer Figure 16) that was removed in the post-development scenario.
- Flood extent does not increase significantly within the site, with only a slight increase in extent to the southeast.
- Flood level increase onsite is highest along the central southern boundary, with a peak increase of 75mm in CC2050, and 130mm in CC2090.
- Offsite, flood level increase along No. 48 Terry Road is generally between 30-75mm in CC2050, rising to mostly between 60-110mm.

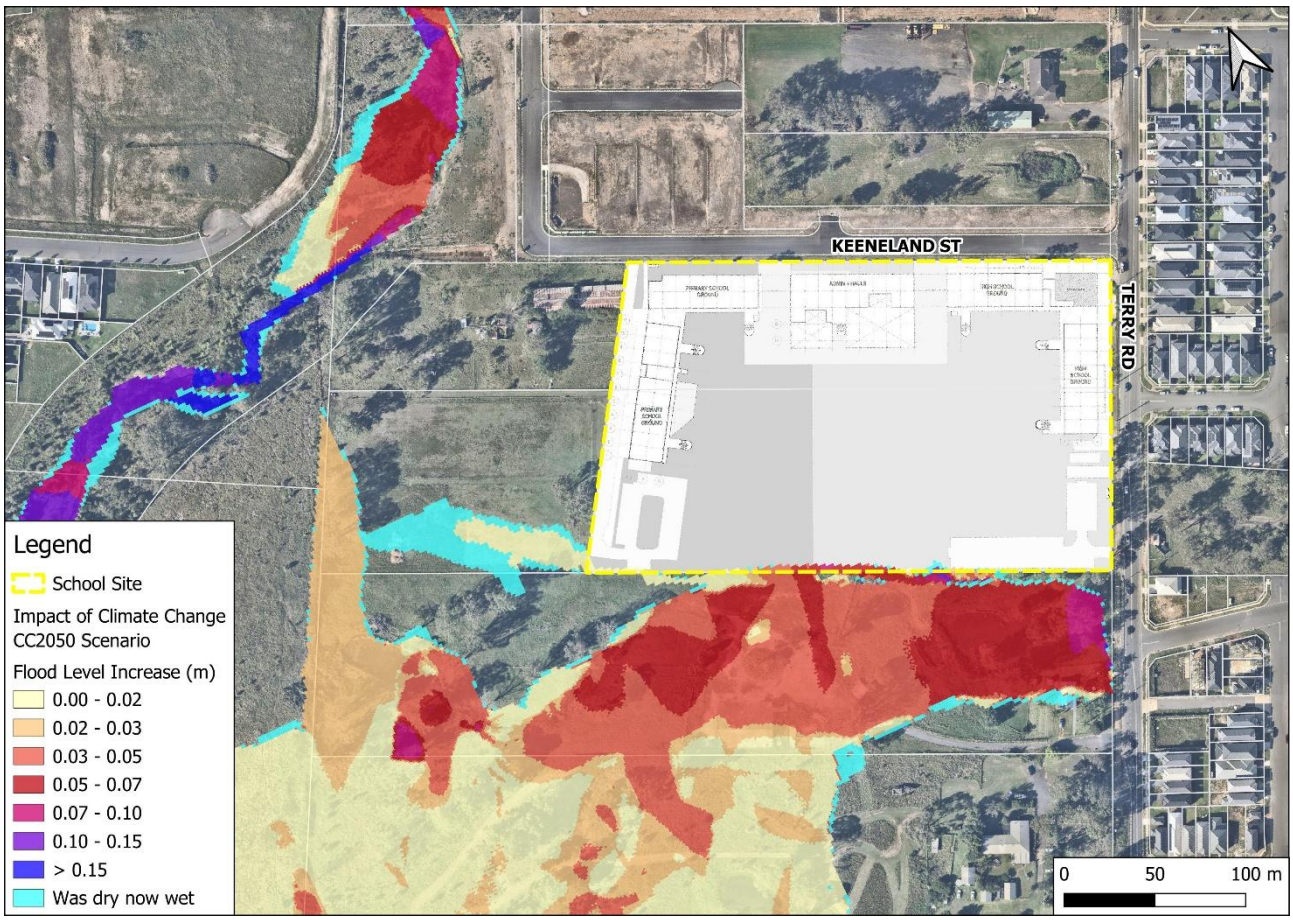


Figure 29: Impact of climate change: projected increase in flood level in the CC2050 scenario

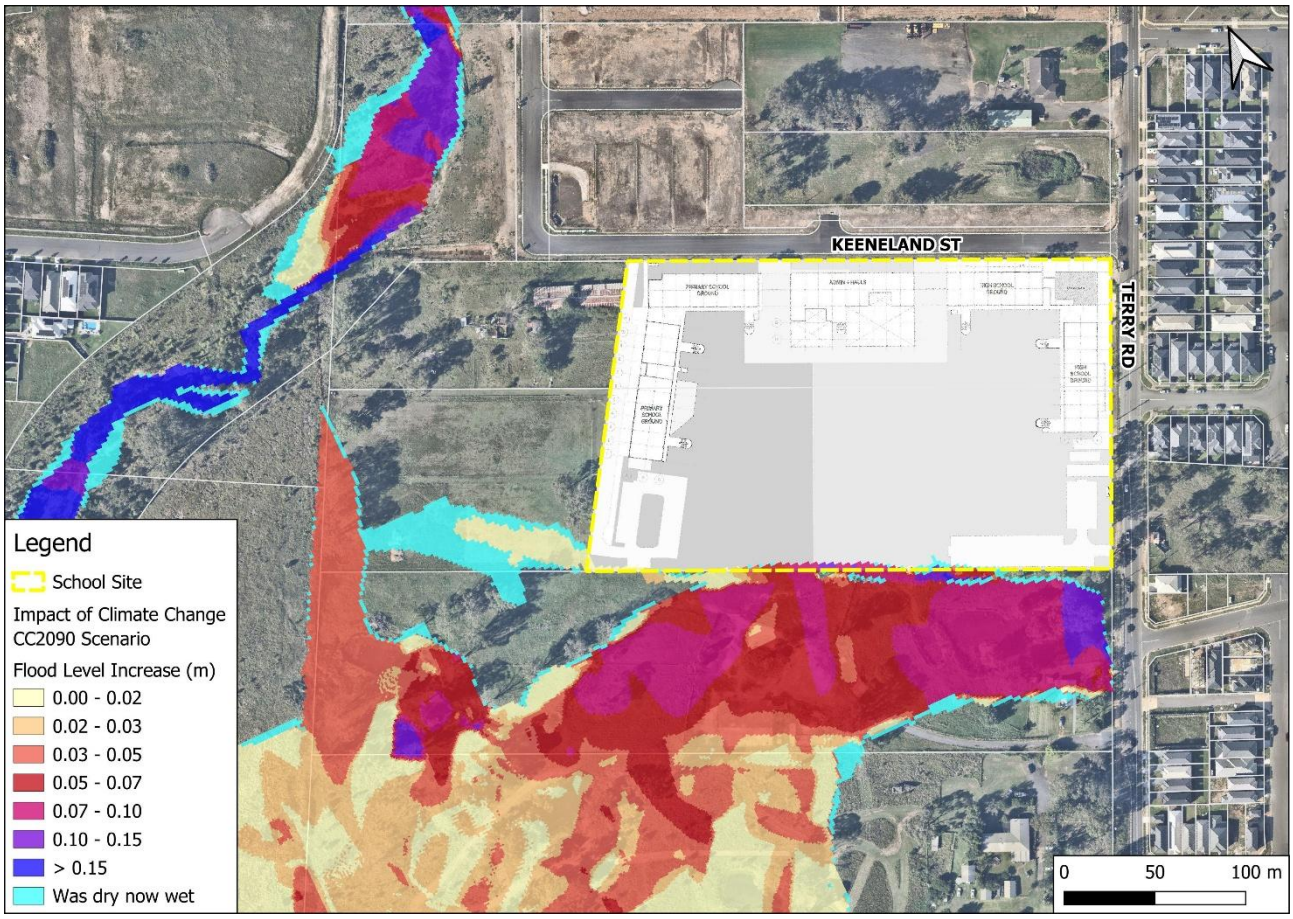


Figure 30: Impact of climate change: projected increase in flood level in the CC2090 scenario

8.0 Review of Flood Planning Controls

While compliance with the Development Control Plan (DCP) is not required under the REF pathway, relevant DCP provisions have been reviewed and are acknowledged in this study to demonstrate consideration of Council's planning objectives.

As outlined in Section 3.0, the site is considered a 'sensitive' use. Part C 'General Development' Section 6 'Flood Controlled Land' of The Hills DCP (shown in Figure 7) states that non-habitable floor levels of sensitive sites should be no lower than FPL3 (1% AEP level plus a 500mm freeboard), while habitable floor levels must be no lower than FPL4 (PMF level). However, in some instances, the FPL3 is a higher level than the FPL4 (PMF). In this circumstance, the more conservative level should be adopted for habitable floor levels.

As the site is flood free in the 1% AEP event, the PMF level should be taken as the Flood Planning Level (FPL) for habitable floors. Modelling of the post-development scenario indicates that all buildings are wholly located outside the PMF extent. While FFLs of the buildings are still to be finalised, it has been stated that the FFL of the preschool building to the southwest will be no lower than 36.5m AHD. Flood level in the PMF peaks at 35.67m AHD at the preschool carpark, with the building set well above this level (refer Figure 31).

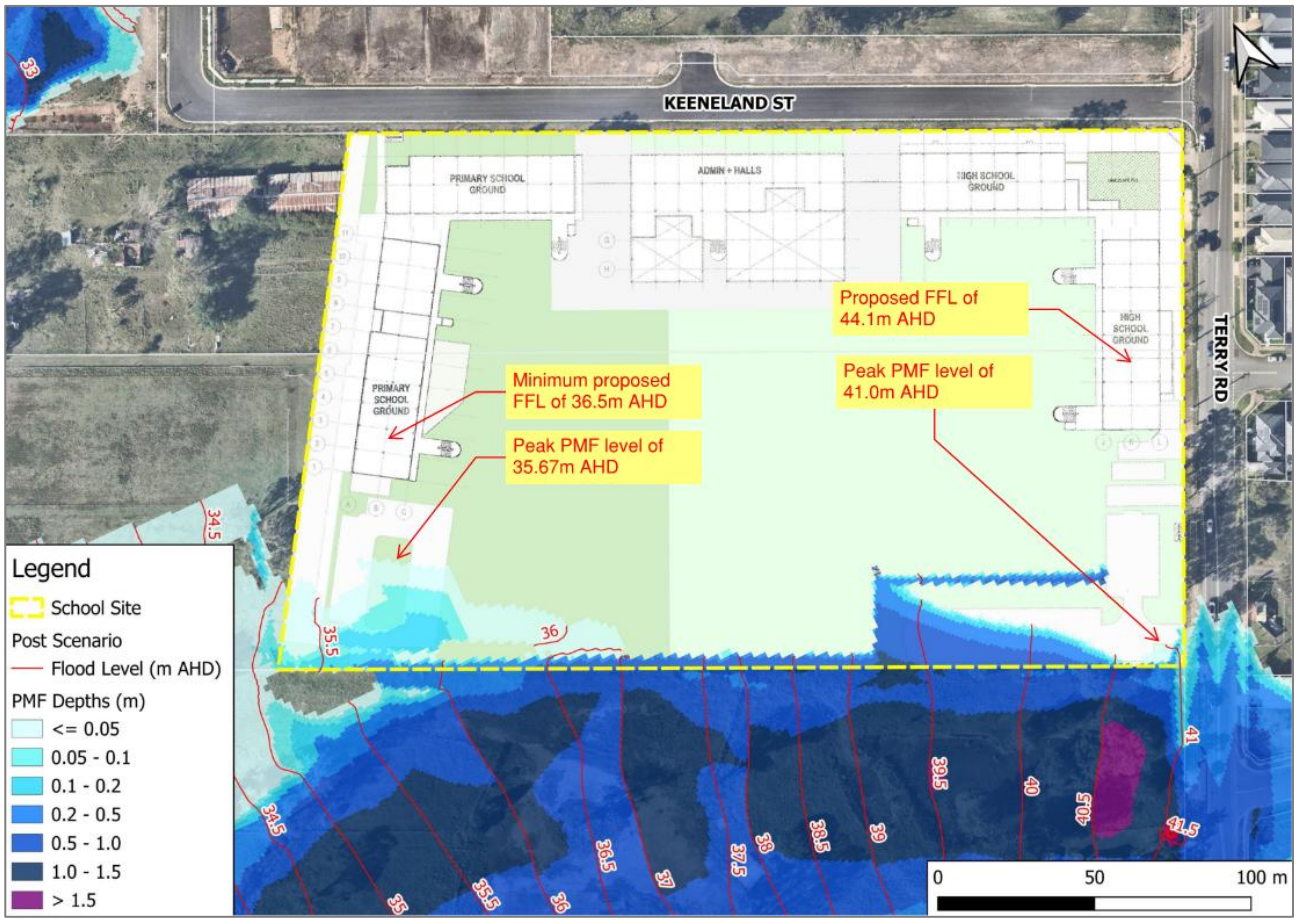


Figure 31: Flood Planning Levels

Table 4 assesses the flood planning controls contained within The Hills DCP against the site. As aforementioned, compliance with the DCP is not required under the REF pathway.

Table 4: Site's compliance with the flood controls laid out in The Hills DCP

	Control	Site Assessment
a	No development is to occur in or over a floodway area, a flowpath or a high hazard area (as defined in the Floodplain Development Manual (April 2005) (FDM)) generated by flooding up to FPL4.	Although the south of the site is partially flood-affected in the existing PMF event, the flows here are not considered a floodway, flow path or as high hazard in the PMF (see Figure 21). No development is therefore occurring at a location impacted by such flooding.
b	Habitable floor levels to be no lower than FPL4.	All proposed buildings are outside of the PMF extent (i.e. FPL4).
c	Non-habitable floor levels to be no lower than FPL3 unless justified by a site-specific assessment.	All proposed buildings are outside of the PMF extent (i.e. FPL4).
d	All structures to have flood compatible building components below FPL4.	All proposed buildings are outside of the PMF extent (i.e. FPL4).
e	Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including FPL4. An engineer's report may be required.	All proposed buildings are outside of the PMF extent (i.e. FPL4).
f	The minimum surface level of open car parking spaces or carports shall be as high as practical, and not below FPL1.	Modelling of the 5% AEP event (FPL1) in Appendix C indicates that in the post-development scenario, both the preschool/primary school car park (west) and the high school car park (east) are flood immune up to and including the 0.2% AEP event and are therefore located well above the 5% AEP event level.
g	Garages or enclosed car parking must be protected from inundation by flood waters up to FPL2. Where 20 or more vehicles are potentially at risk, protection shall be provided to FPL3.	There are no garages or enclosed car parking proposed at the site.
h	Where the level of the driveway providing access between the road and parking space is lower than 0.3m below FPL2, the following condition must be satisfied - when the flood levels reach FPL2, the depth of inundation on the driveway shall not exceed: ▪ the depth at the road; or ▪ the depth at the car parking space.	Both driveway entries are located above the 1% AEP (FPL2).
i	Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to a refuge area above FPL4. In the case of alterations or additions to an existing development, this may require retro-fitting the existing structures if required to support a refuge area above FPL4.	There is reliable access for pedestrians and vehicles from the building. The main pedestrian access to the school is via Keeneland Street at the northern frontage of the site. This road is flood free up to and including the PMF event, providing flood free access for pedestrians and vehicles above the PMF. Terry Road is also flood free directly adjacent to the proposed high school buildings.
j	Applicant to demonstrate that area is available to store goods above FPL4.	All proposed buildings are located above PMF. Area is consequently available to store goods about FPL4.

k	Materials which may cause pollution or are potentially hazardous during any flood must not be stored externally below FPL4.	All proposed buildings are located above PMF. No such materials will be stored below FPL4.
l	A Site Flood Emergency Response Plan is required when elements of the development, including vehicular and pedestrian access are below FPL4. The Site Flood Emergency Response Plan should relate to the landuse and site conditions in conjunction with flood behaviour up to FPL4 expected to be experienced at the site. The plan should consider the following specific actions: ▪ Preparing for a flood; ▪ Responding when a flood is likely; ▪ Responding during a flood; and ▪ Recovery after a flood. The flood plan should be consistent with the relevant NSW SES “FloodSafe” Guide.	A Flood Emergency Response Plan (FERP) has been prepared by TTW and submitted alongside this FIRA. The FERP assesses flood warning time and the duration of isolation to assist in preparing a flood emergency strategy for the site. The FERP outlines actions for all site users in preparing for a flood, as well as actions during and after a flood event.

9.0 Conclusion

An analysis of the existing conditions at the proposed Box Hill Public School and Box Hill High School site has found that the southern portion of the site is partially flood-affected in the Probable Maximum Flood event due to the presence of an overland flow path through No. 48 Terry Road, south of the subject site.

In summary:

- An overland flow path is present on No. 48 Terry Road, south of the subject site.
- Overland flows are mostly contained within No. 48. In modelling of the existing flood scenario, flows partially impact upon the southern portion of the site in the PMF event.
- Proposed buildings works are focussed on the northern portion of the lot, and therefore are located outside of the PMF extent.
- The south of the site is impacted by some flooding in the PMF event, though this is located at the proposed car parks, and this only occurs in the PMF (with the site still flood-free in the 0.2% AEP).
- While compliance with the Development Control Plan (DCP) is not required under the REF pathway, relevant DCP provisions have been reviewed and are acknowledged in this study to demonstrate consideration of Council's planning objectives.
- As a sensitive facility, the proposed Box Hill Public School and Box Hill High School, the DCP would require all habitable floors to be located above the PMF level. All proposed buildings are set above the PMF.
- The DCP similarly would require car parks to be set above the 5% AEP event, which is met at this site.

Subject to implementing the mitigation measures set out below, the conclusion of this assessment is that the proposed activity is not likely to significantly affect the environment in relation to flood matters.

Mitigation Measures

Mitigation measures identified as necessary are outlined in Table 5.

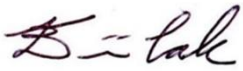
Table 5: Mitigation Measures

Aspect	ID	Name	Timing	Mitigation Measure
Soil & Water	SWMM5	Stormwater Management System	Design	The operational stormwater management system must be designed by a suitably qualified civil engineer. The system must: a. Ensure that the system capacity has been designed in accordance with the relevant Australian Standards; and b. Ensure that the system has been designed in accordance with the *Australian Rainfall and Runoff (Engineers Australia, 2016)* and *Managing Urban Stormwater: Council Handbook (EPA, 1997) Guidelines*.
Operational Flooding	OPFMM1	Operational Flood Emergency Response Plan	Prior to commence of operation	Prepare a final operational FERP. A preliminary Flood Emergency Response Plan has been produced and submitted alongside this report. This must be reviewed prior to the commence of operation, with roles assigned to relevant staff members.

Prepared by
TTW (NSW) PTY LTD

RACHEL CALDWELL
Civil Flood Modeller

Authorised By
TTW (NSW) PTY LTD



EIRIAN CRABBE
Associate Director (Flood)

Appendix A

Council Flood Information

FW: 211317 - Box Hill/Box Hill Industrial Precinct - Flood Levels and H&H Models

Reply | Reply All | Forward

Sun 6/08/2023 7:48 PM

AH Anisul Huq <ahuq@thehills.nsw.gov.au>
To Jamie Marshall; Bala Kilaparty
Cc Philip McAteer; Stephen Brain; Eric Ruiz

General\All Employees (unrestricted)

This sender ahuq@thehills.nsw.gov.au is from outside your organization.

Flood Information Plan_Box Hill Growth Centre Precinct.pdf
5 MB

[External Email]: Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Jamie,

Please find attached the flood information plan for the subject area under the ultimate-developed catchment condition.

The flood information presented in the plan is derived from the TUFLOW models developed as part of the Box Hill Industrial Precinct - Water Cycle Management Strategy. These models were initially prepared by J. Wyndham Prince, Consulting Civil Infrastructure Engineers, and later updated by Cardno Engineering Services. Currently, this is the most reliable information available to the Council.

Where future development of the site is being considered, and the site is Flood Controlled Land, reference should be made to Council's Flood Controlled Land Development Control Plan (DCP). A copy of the DCP is available on Council's website.

Feel free to contact me at 98430464 if you have any questions regarding the provided information.

Regards,

Anisul Huq
Senior Floodplain Systems Engineer
9843 0464 | ahuq@thehills.nsw.gov.au
Administration Centre, 3 Columbia Court Norwest NSW 2153
PO Box 7064, NORWEST NSW 2153
www.thehills.nsw.gov.au

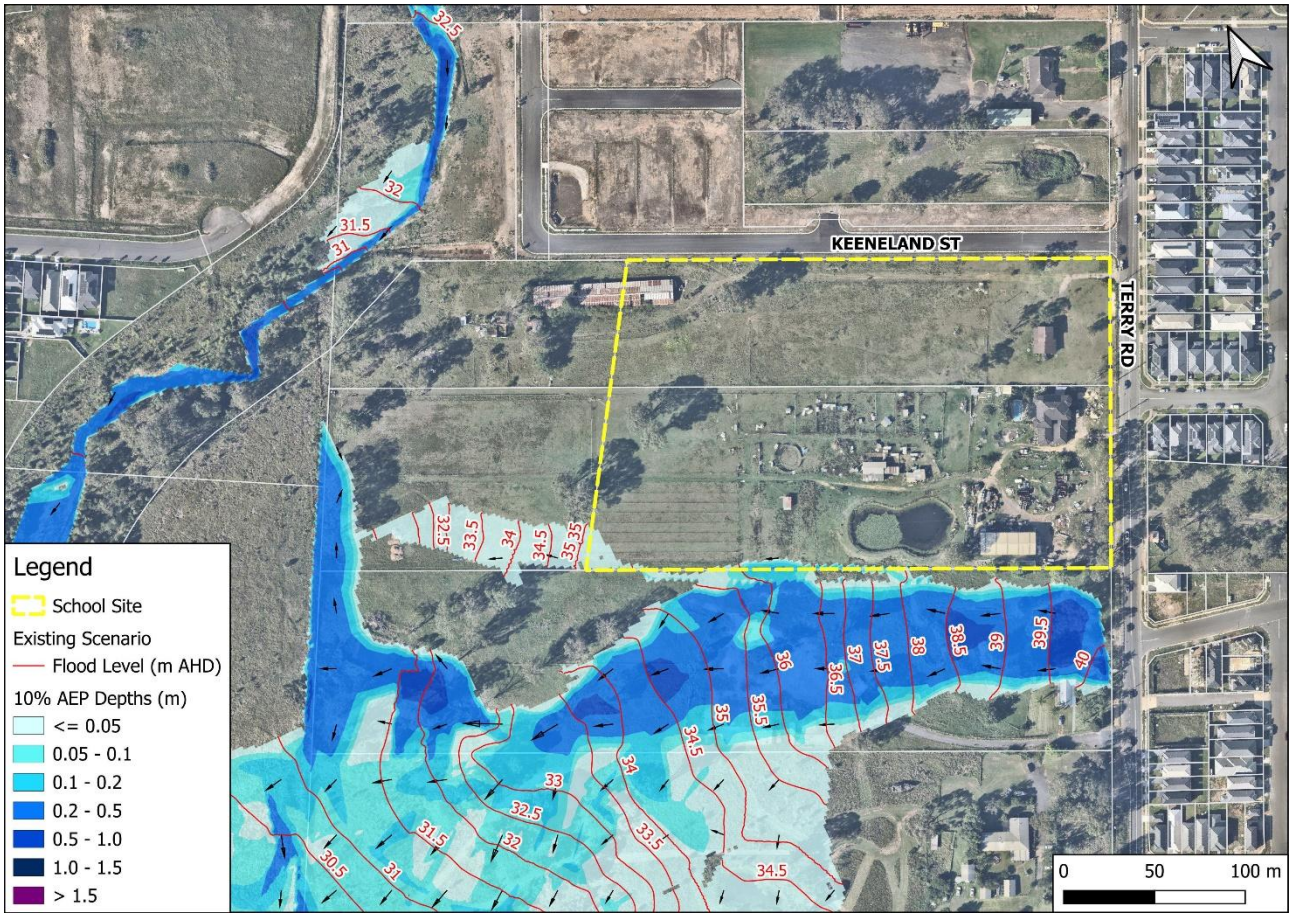
Appendix B

Site Images

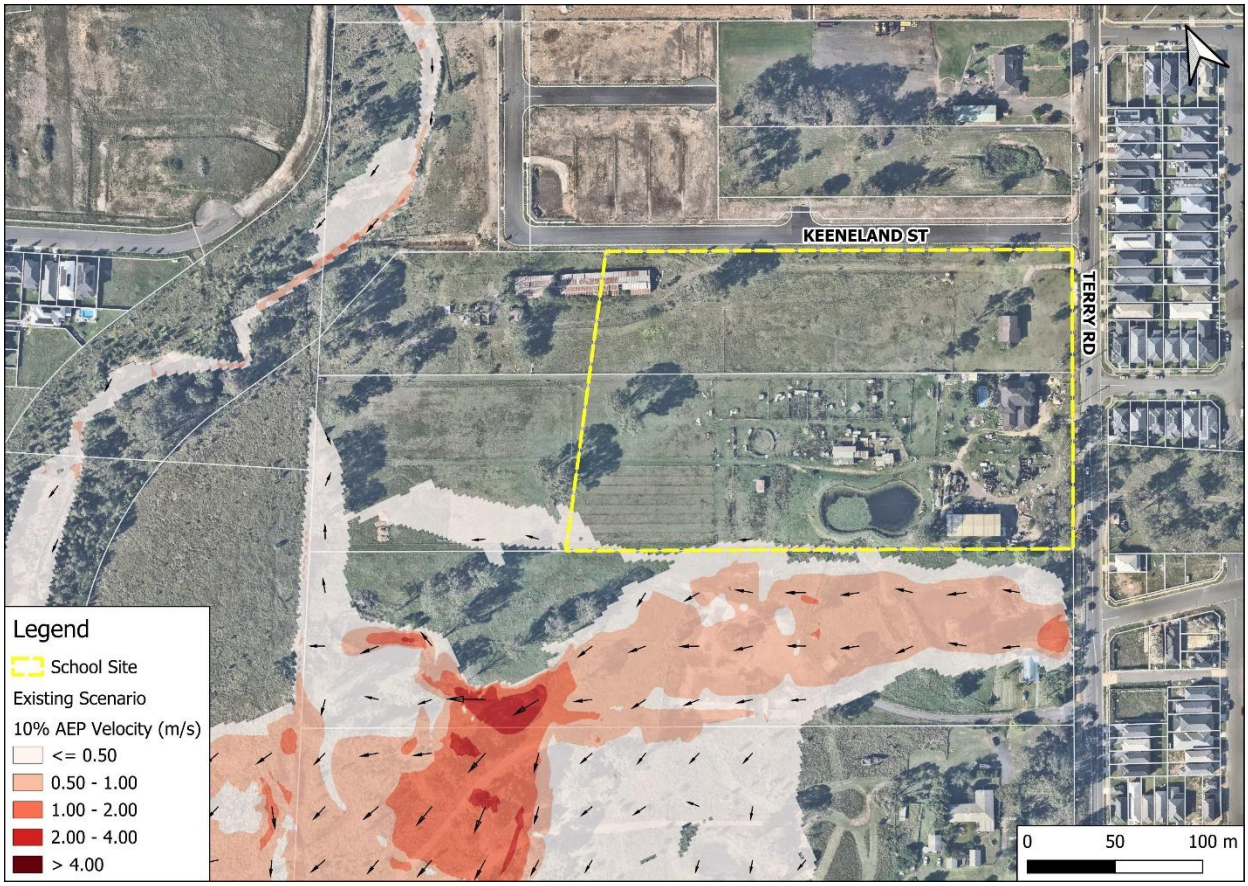
Appendix C

10%, 5% and 0.2% AEP Flood Results (Existing)

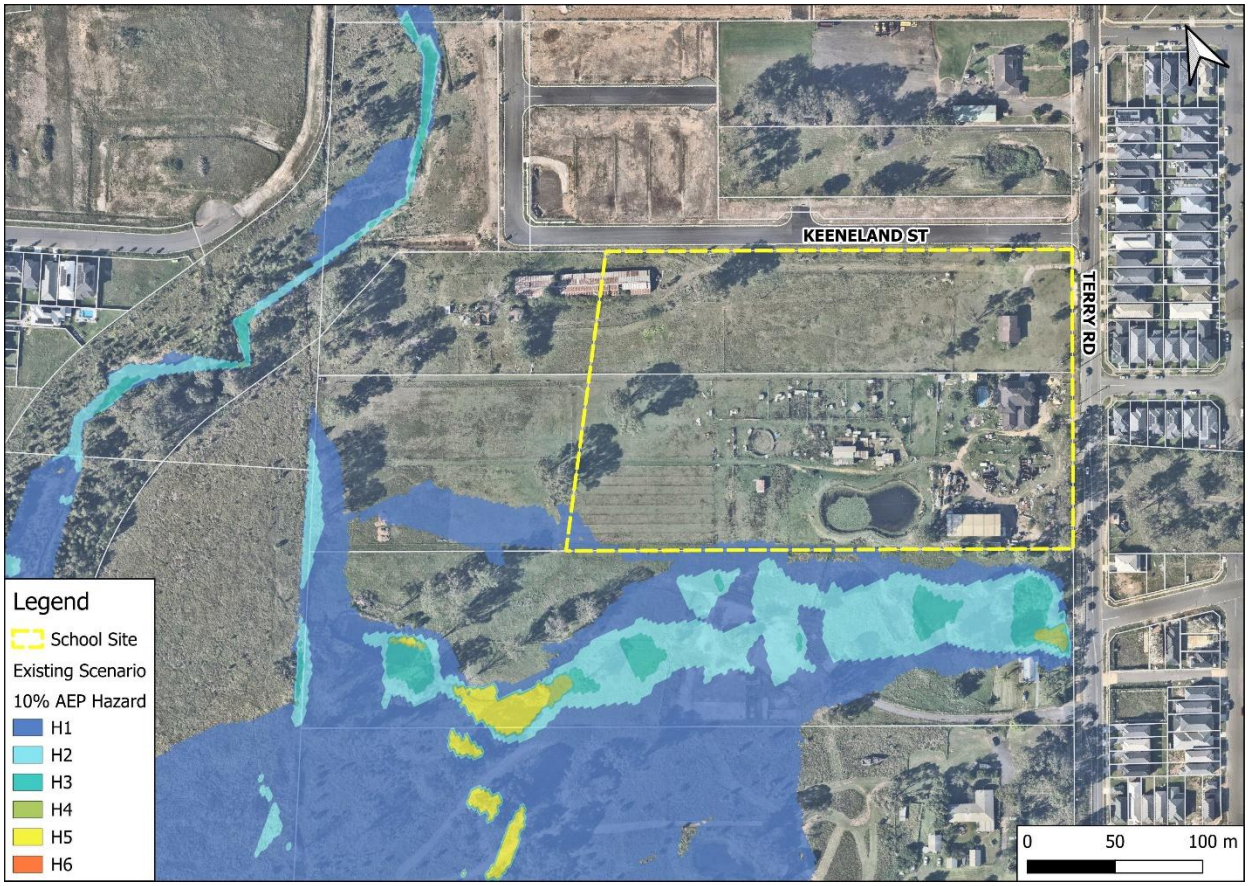
10% AEP Event



10% AEP Event – Existing Scenario – Flood levels and depths

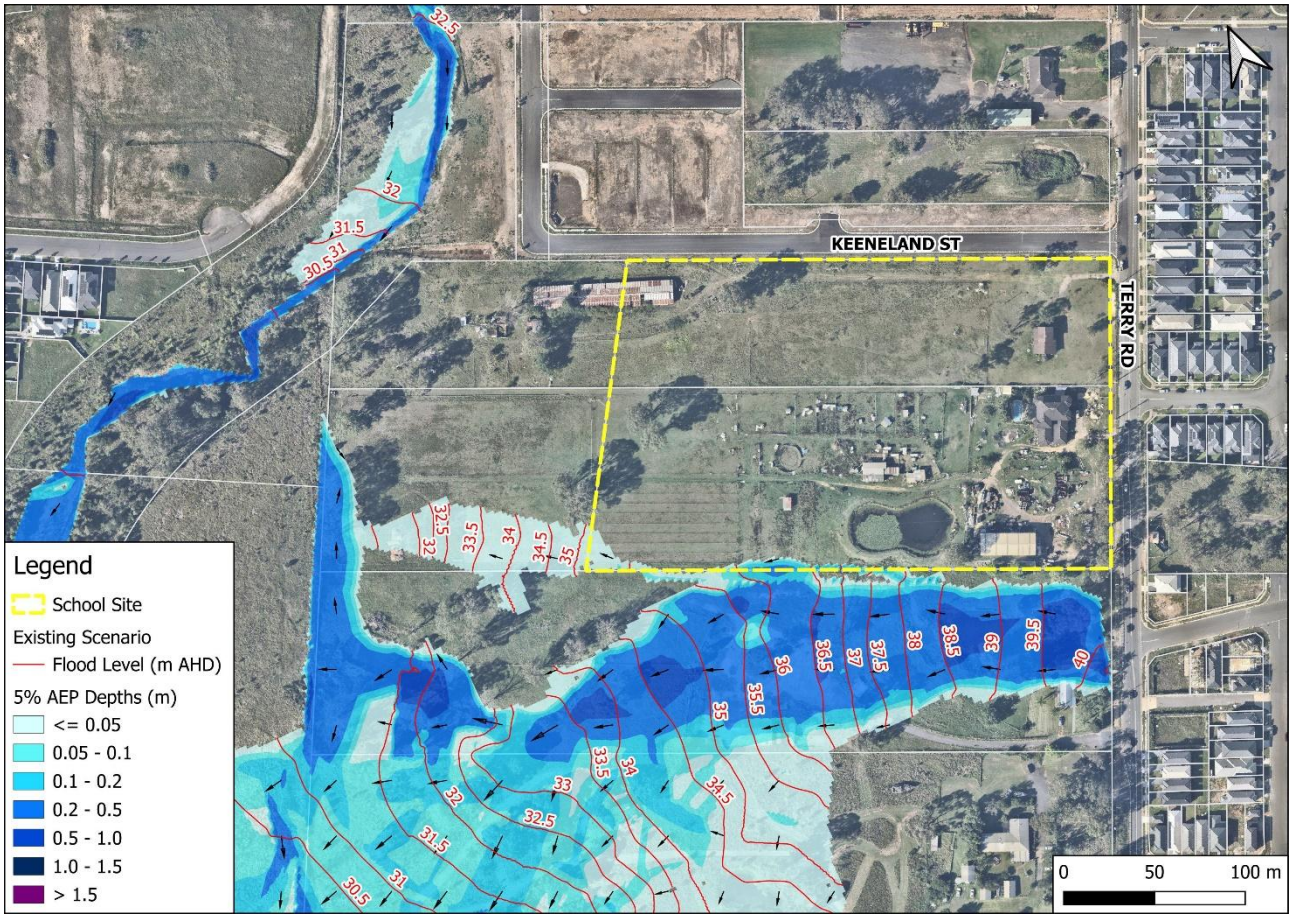


10% AEP Event – Existing Scenario – Flood velocity

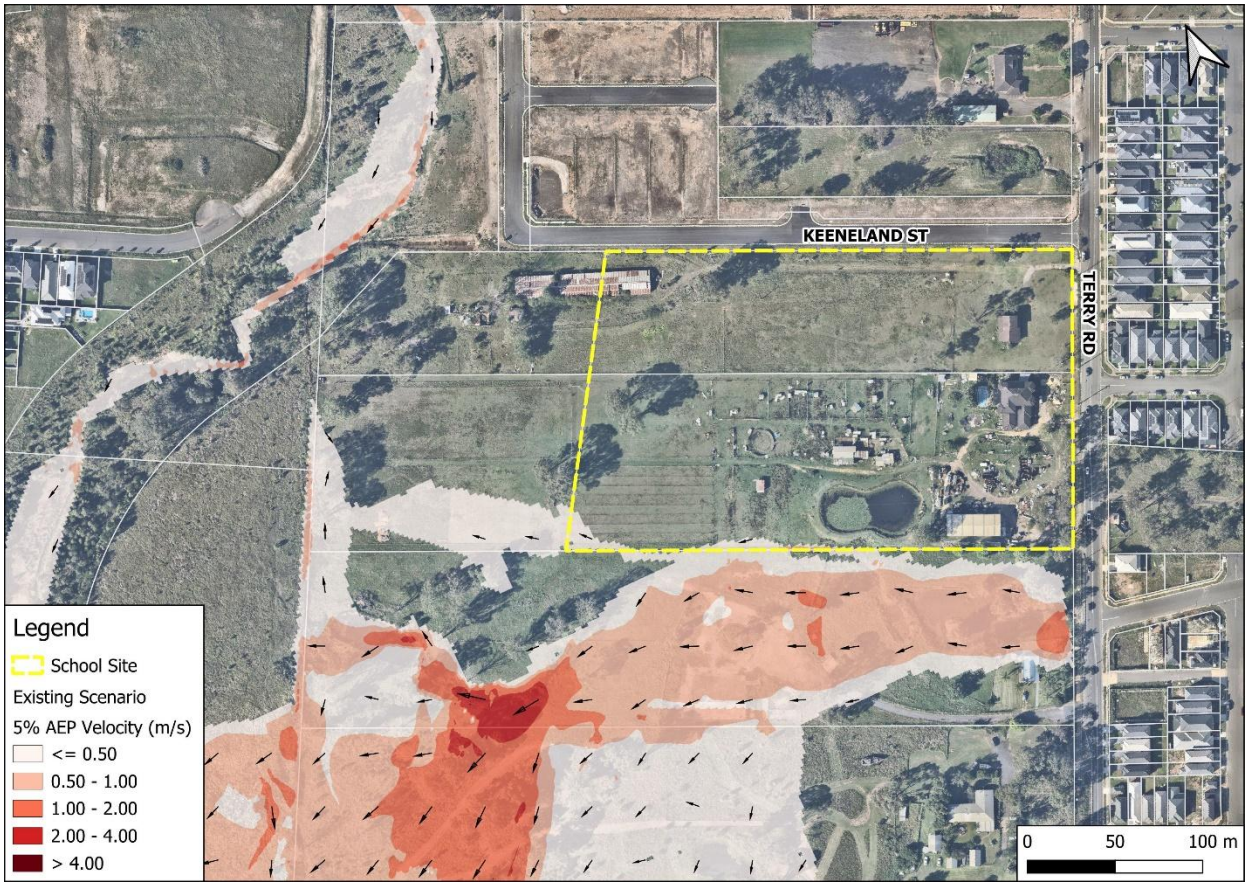


10% AEP Event – Existing Scenario – Flood hazard

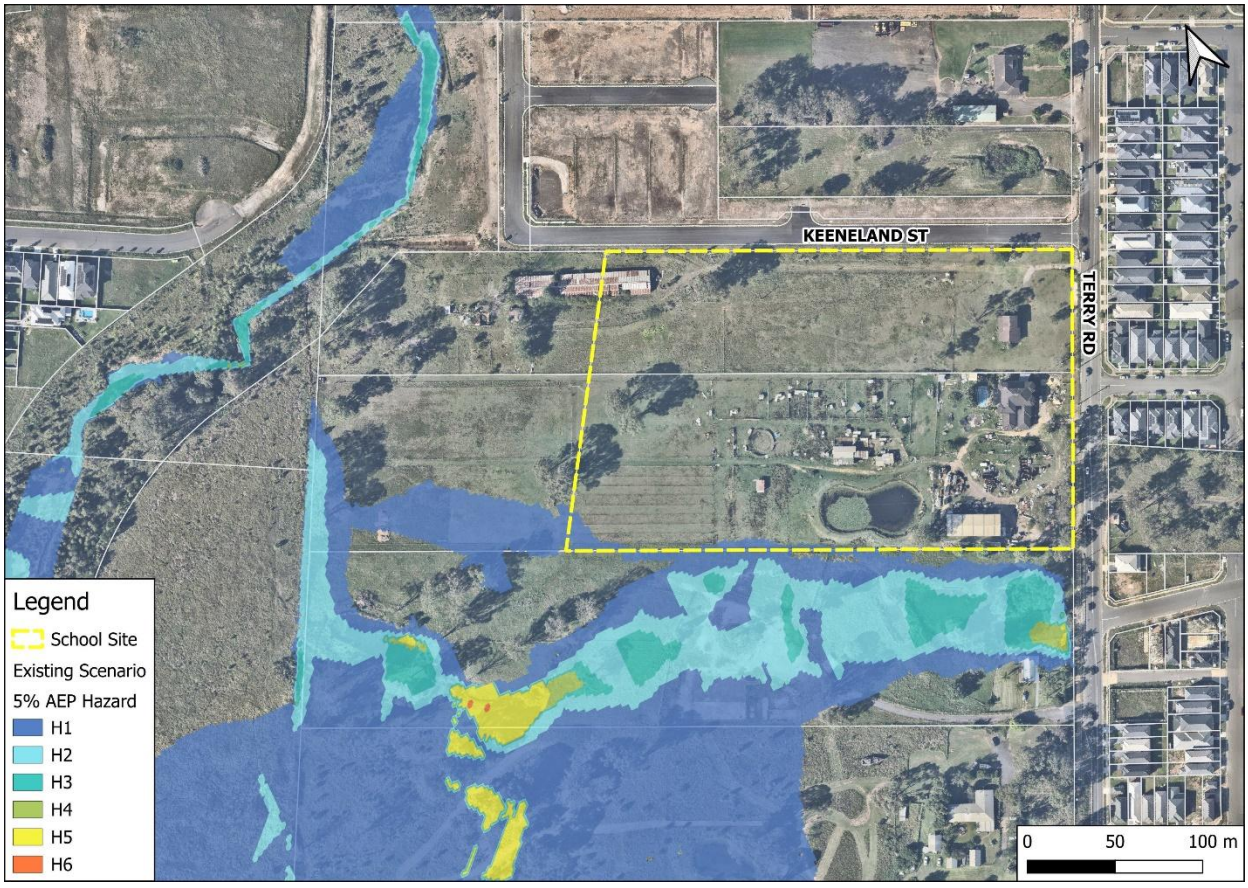
5% AEP Event



5% AEP Event – Existing Scenario – Flood levels and depths

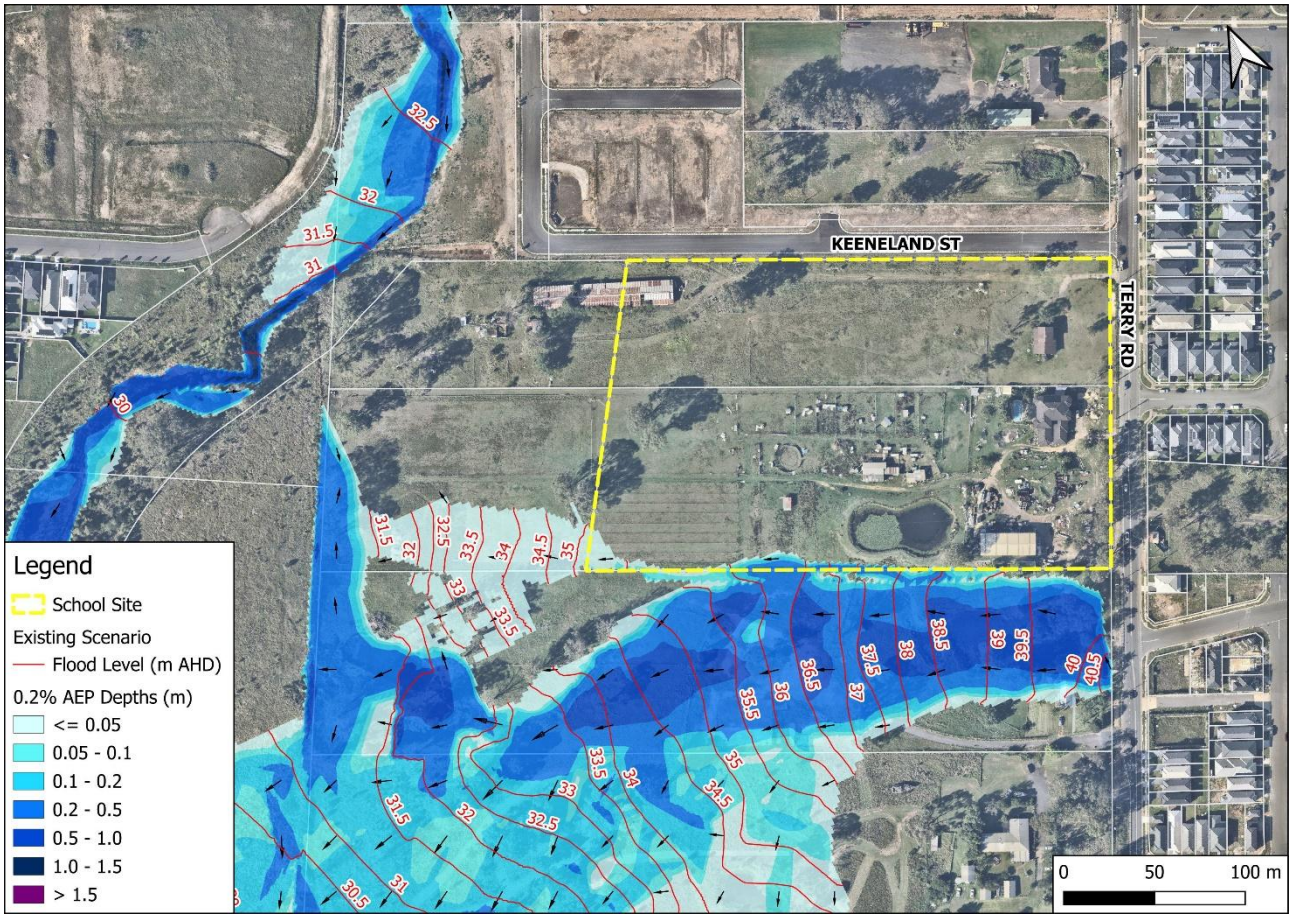


5% AEP Event – Existing Scenario – Flood velocity

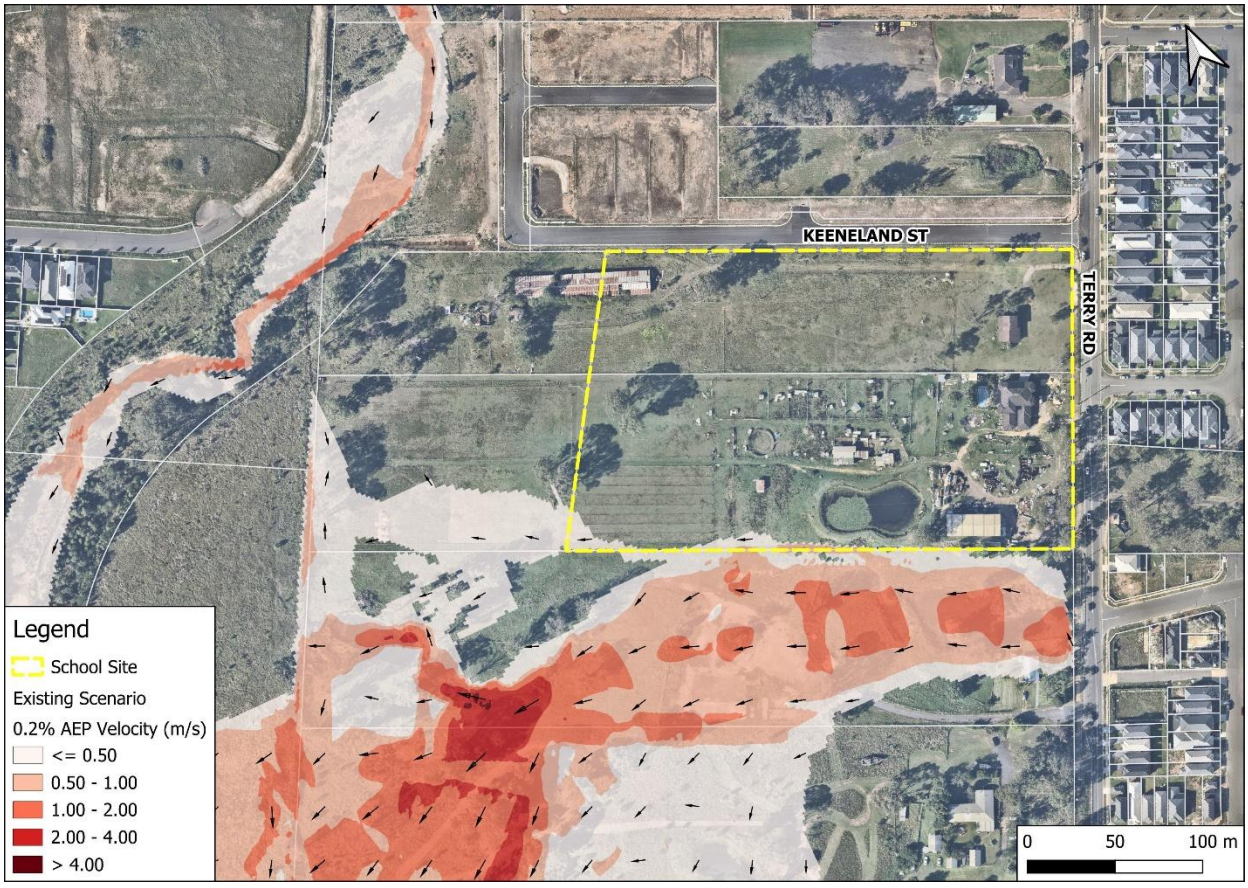


5% AEP Event – Existing Scenario – Flood hazard

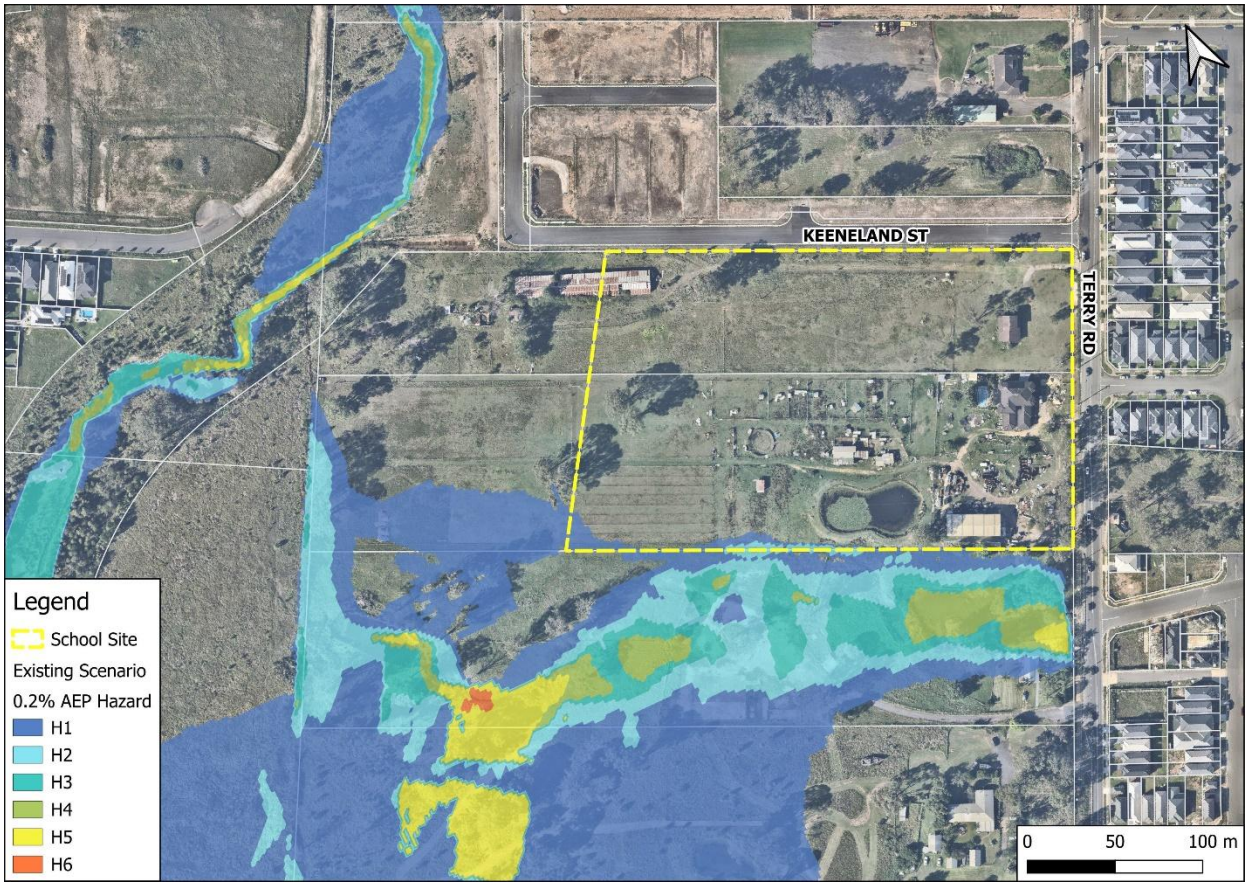
0.2% AEP Event



0.2% AEP Event – Existing Scenario – Flood levels and depths



0.2% AEP Event – Existing Scenario – Flood velocity

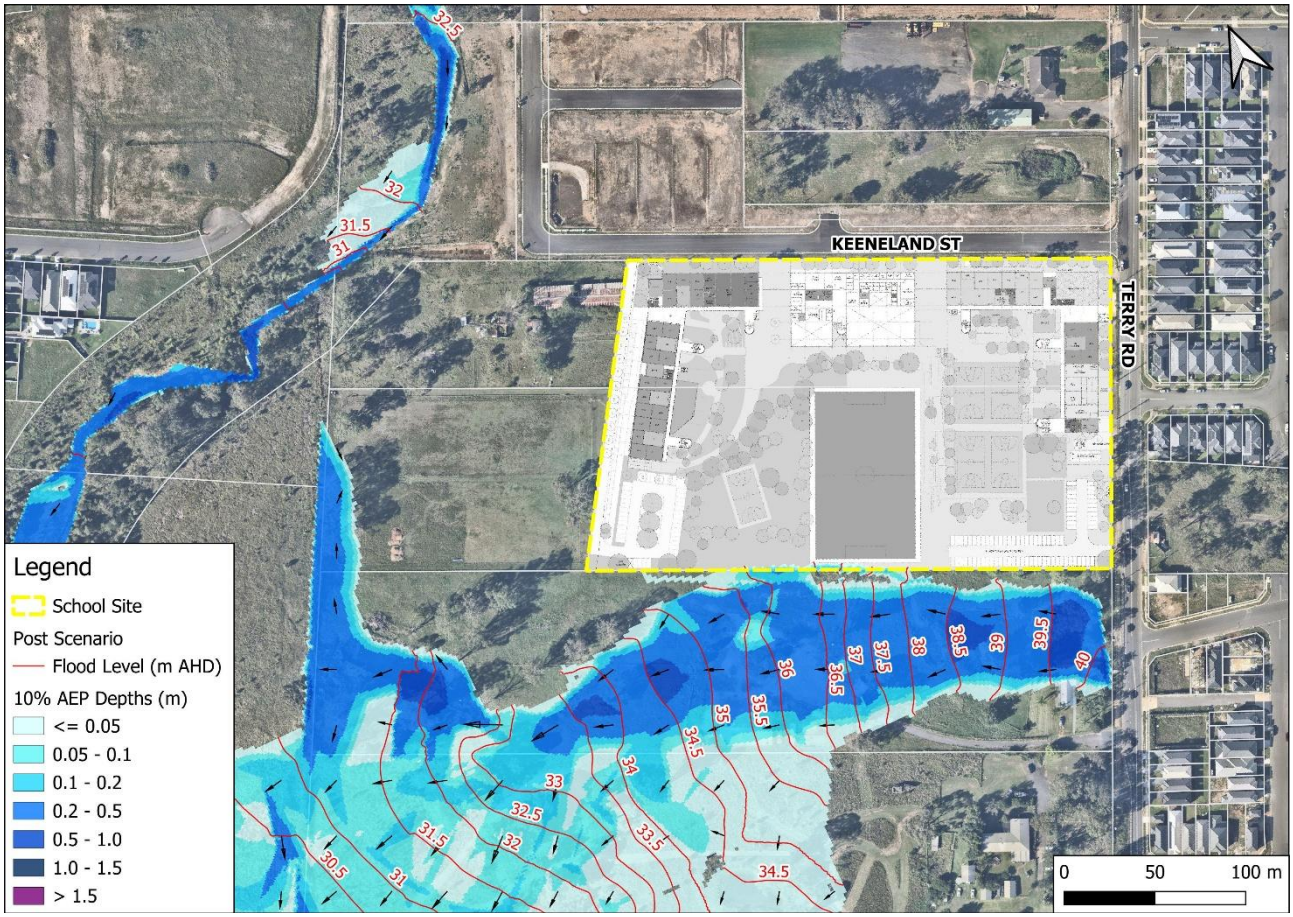


0.2% AEP Event – Existing Scenario – Flood hazard

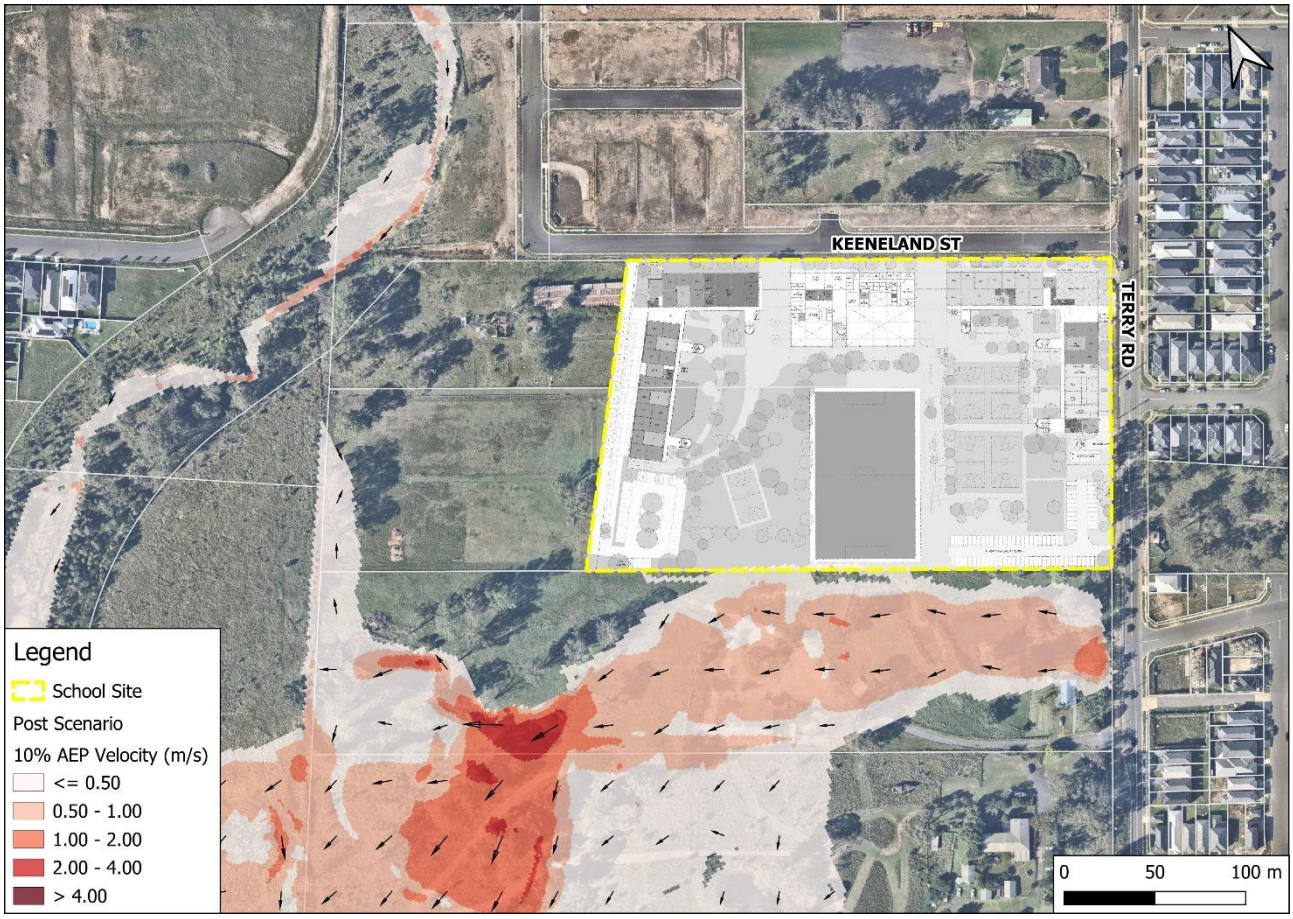
Appendix D

10%, 5% and 0.2% AEP Flood Results (Post)

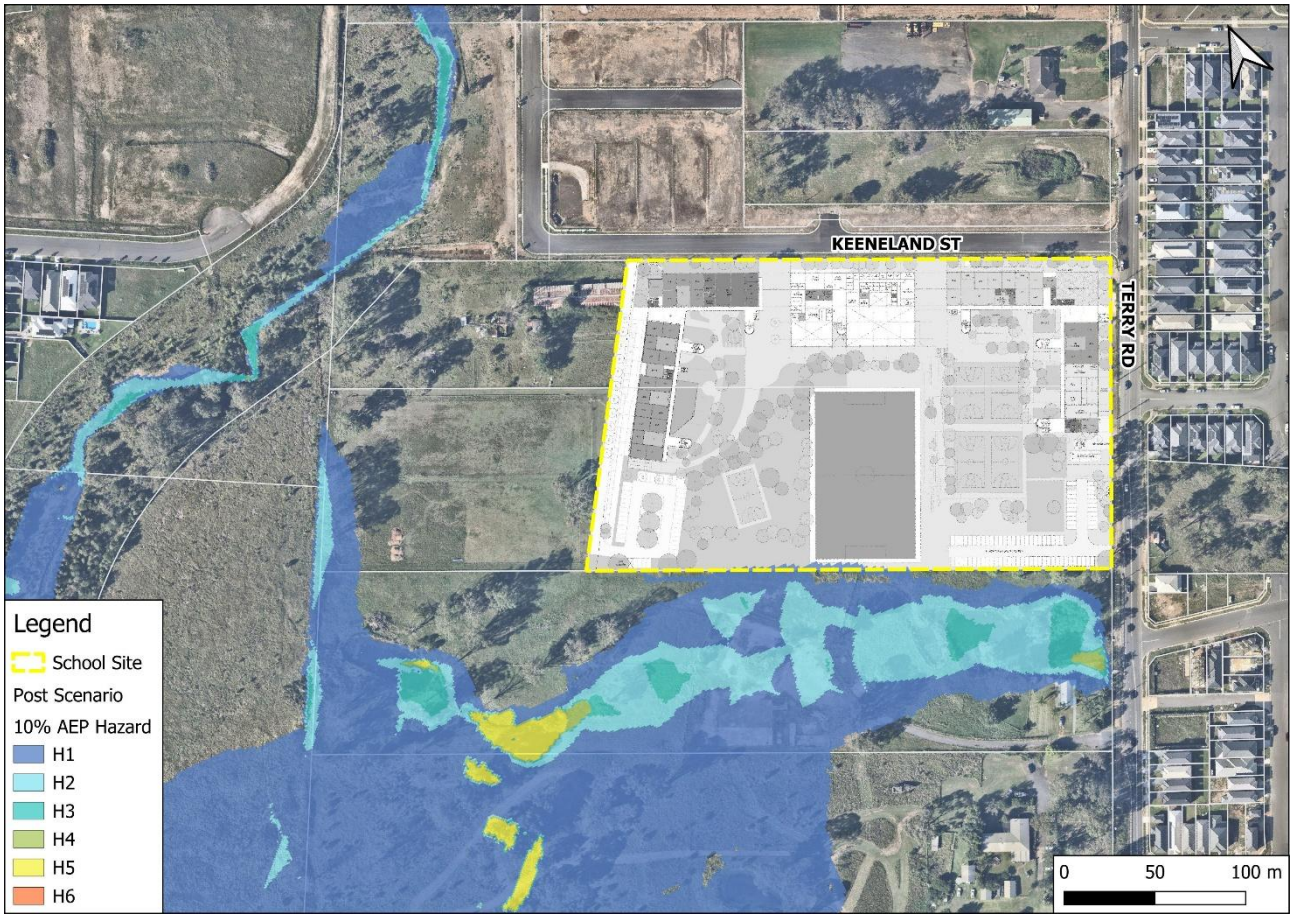
10% AEP Event



10% AEP Event – Post Scenario – Flood levels and depths

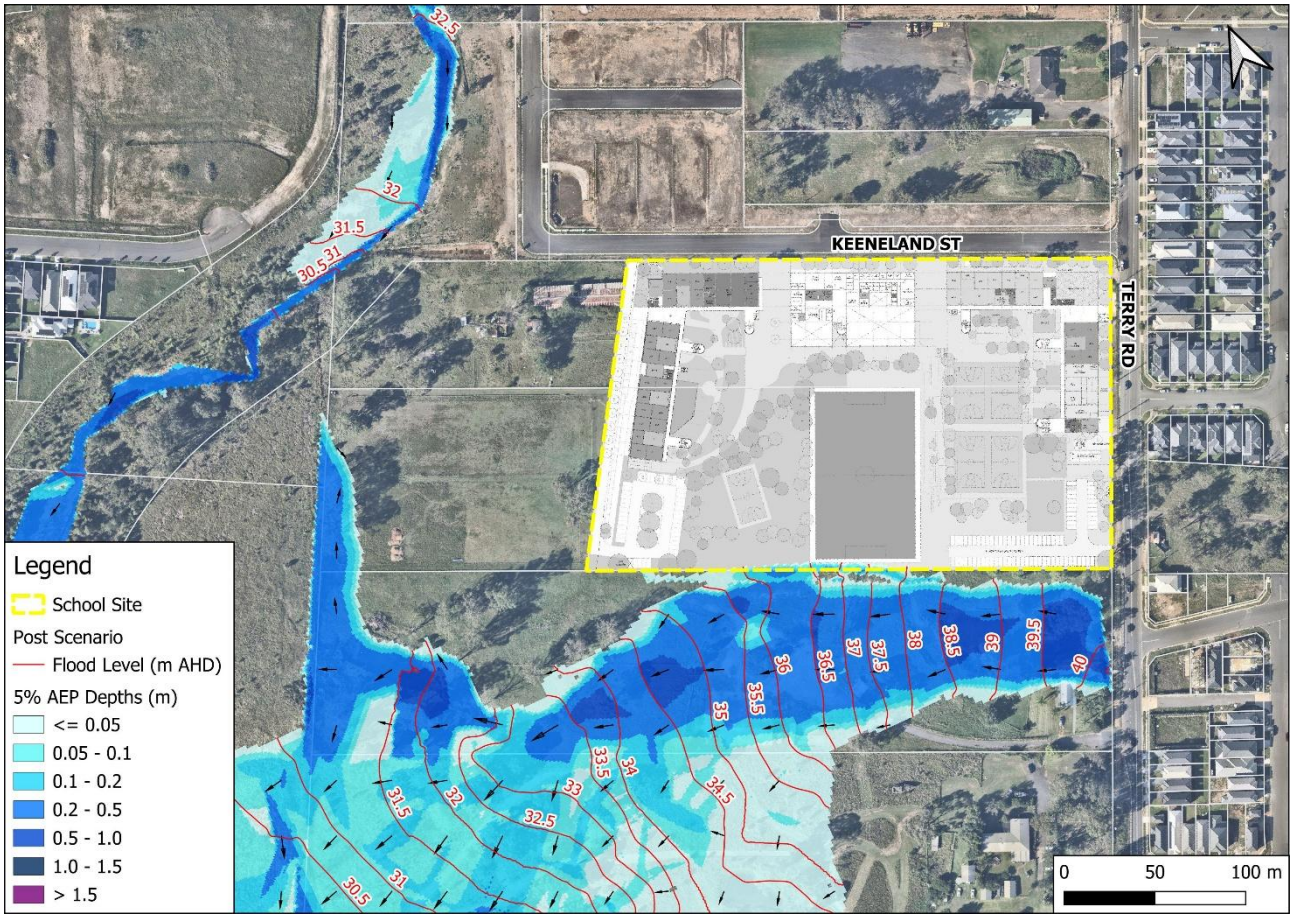


10% AEP Event – Post Scenario – Flood velocity

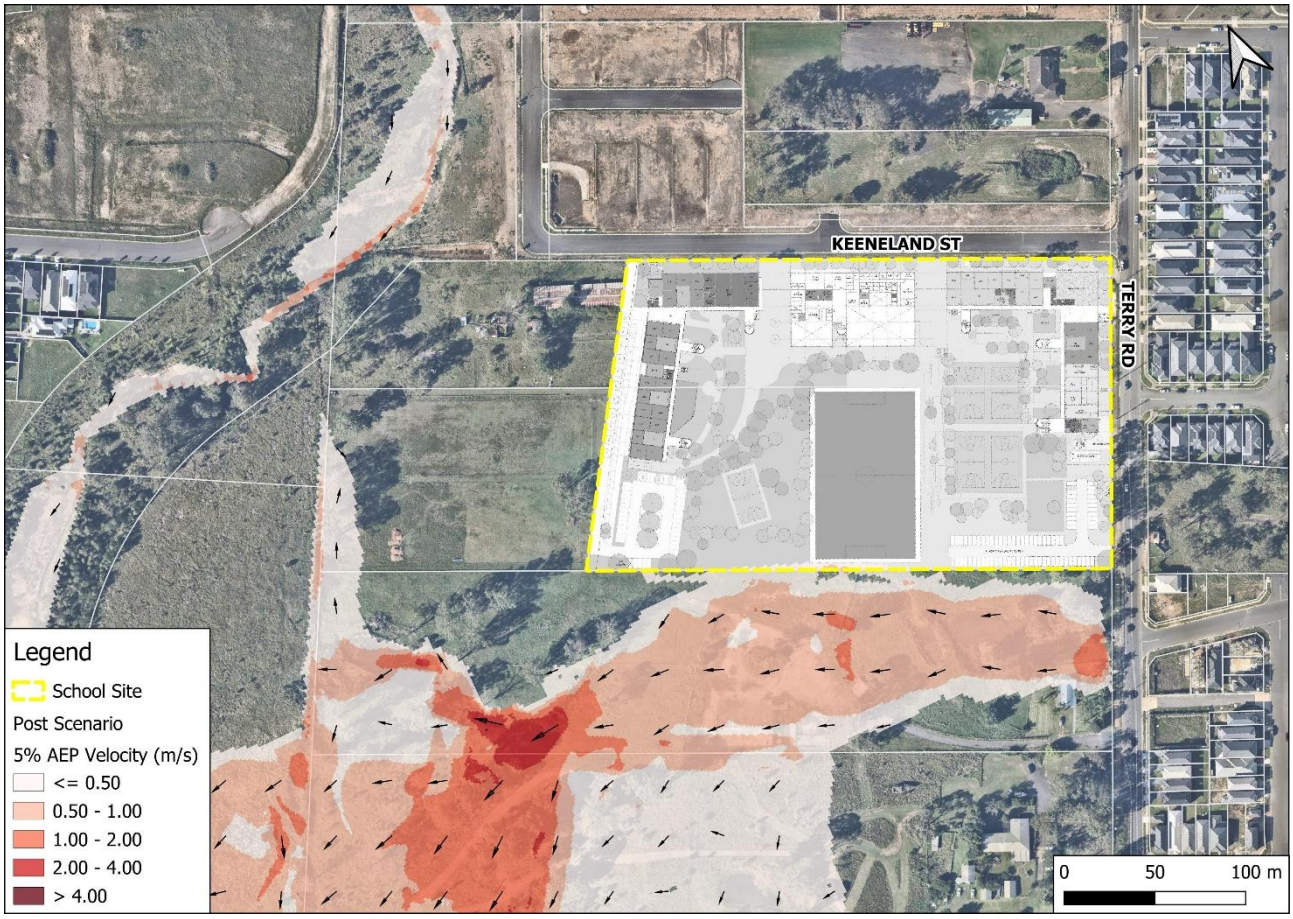


10% AEP Event – Post Scenario – Flood hazard

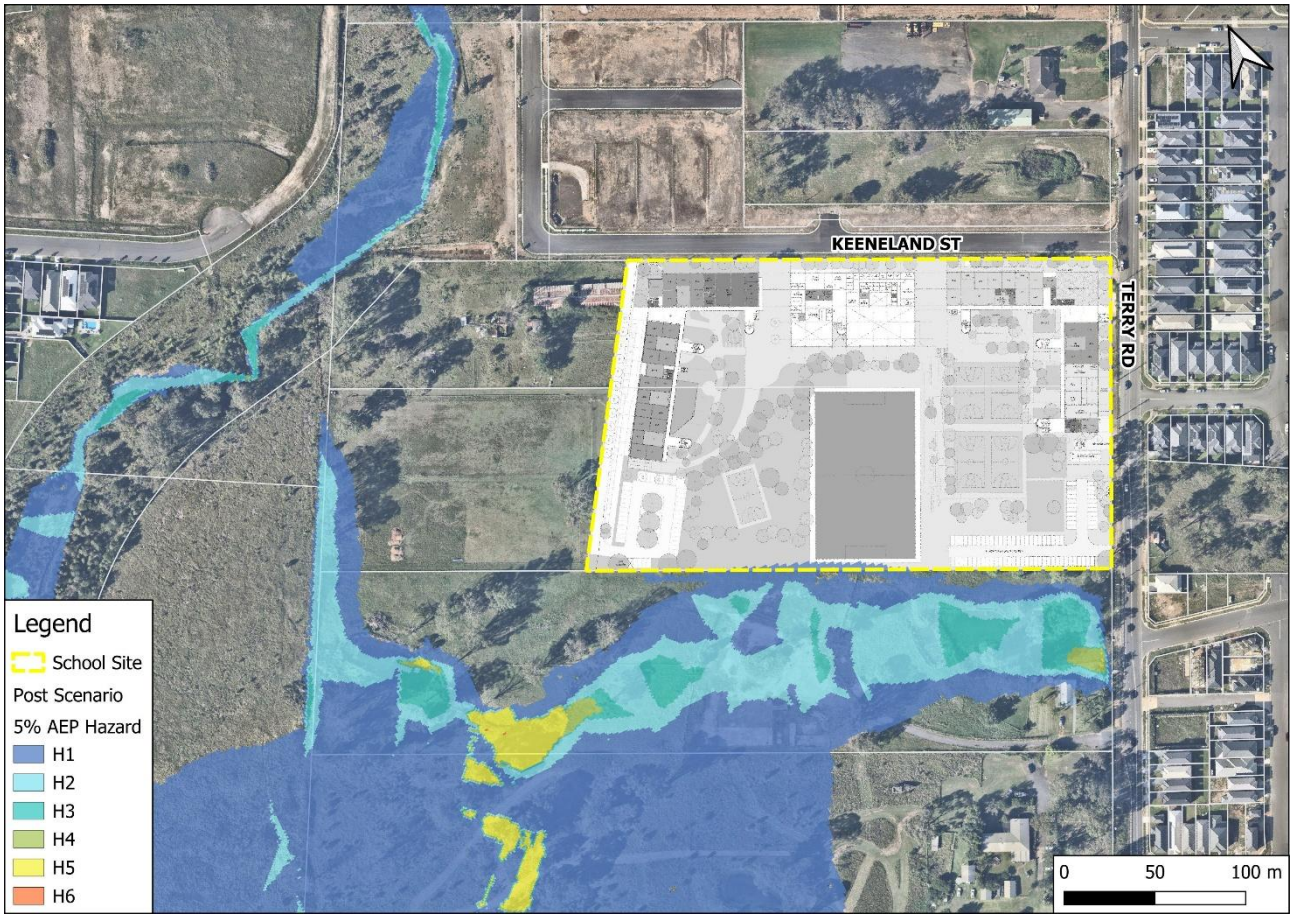
5% AEP Event



5% AEP Event – Post Scenario – Flood levels and depths

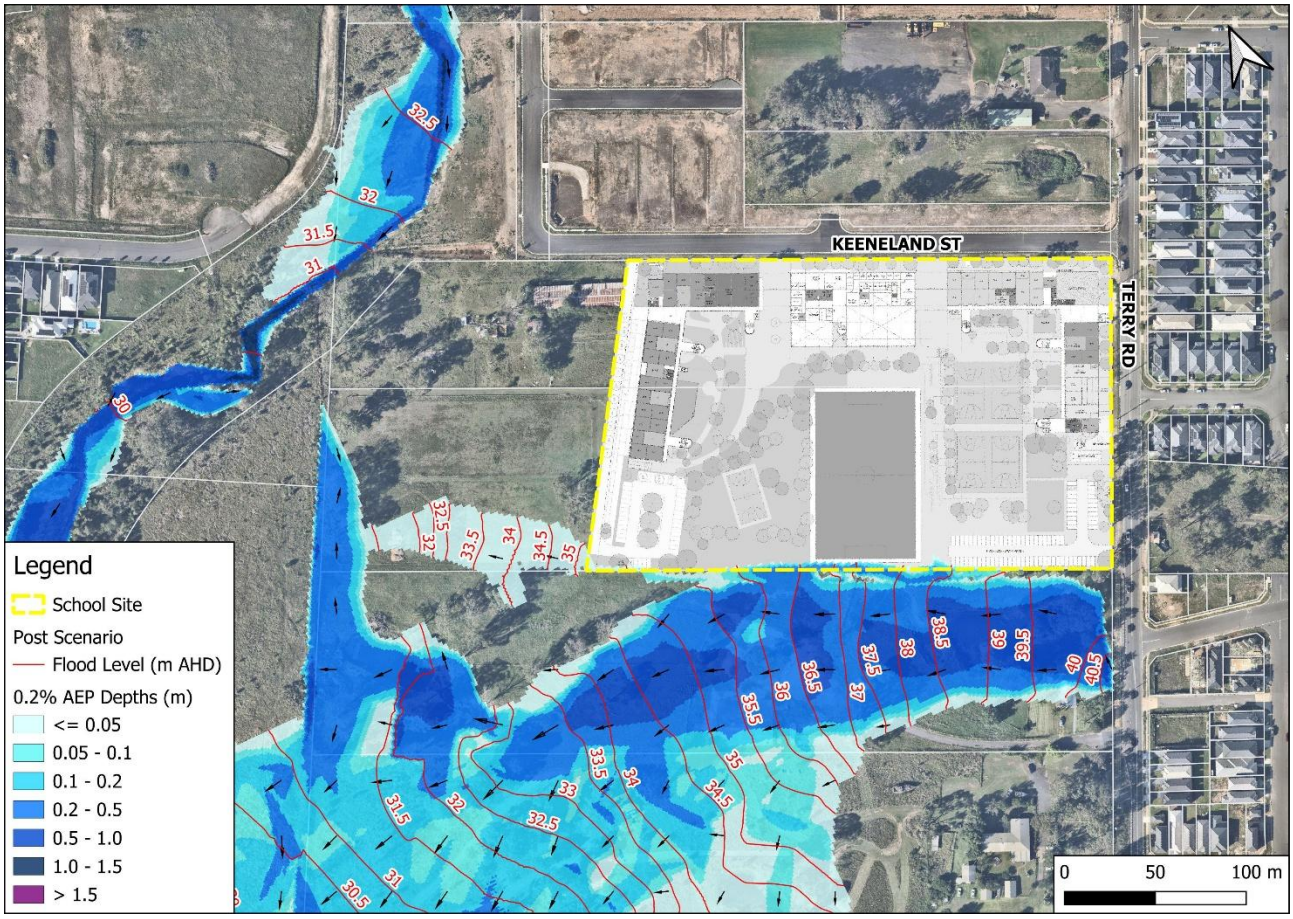


5% AEP Event – Post Scenario – Flood velocity

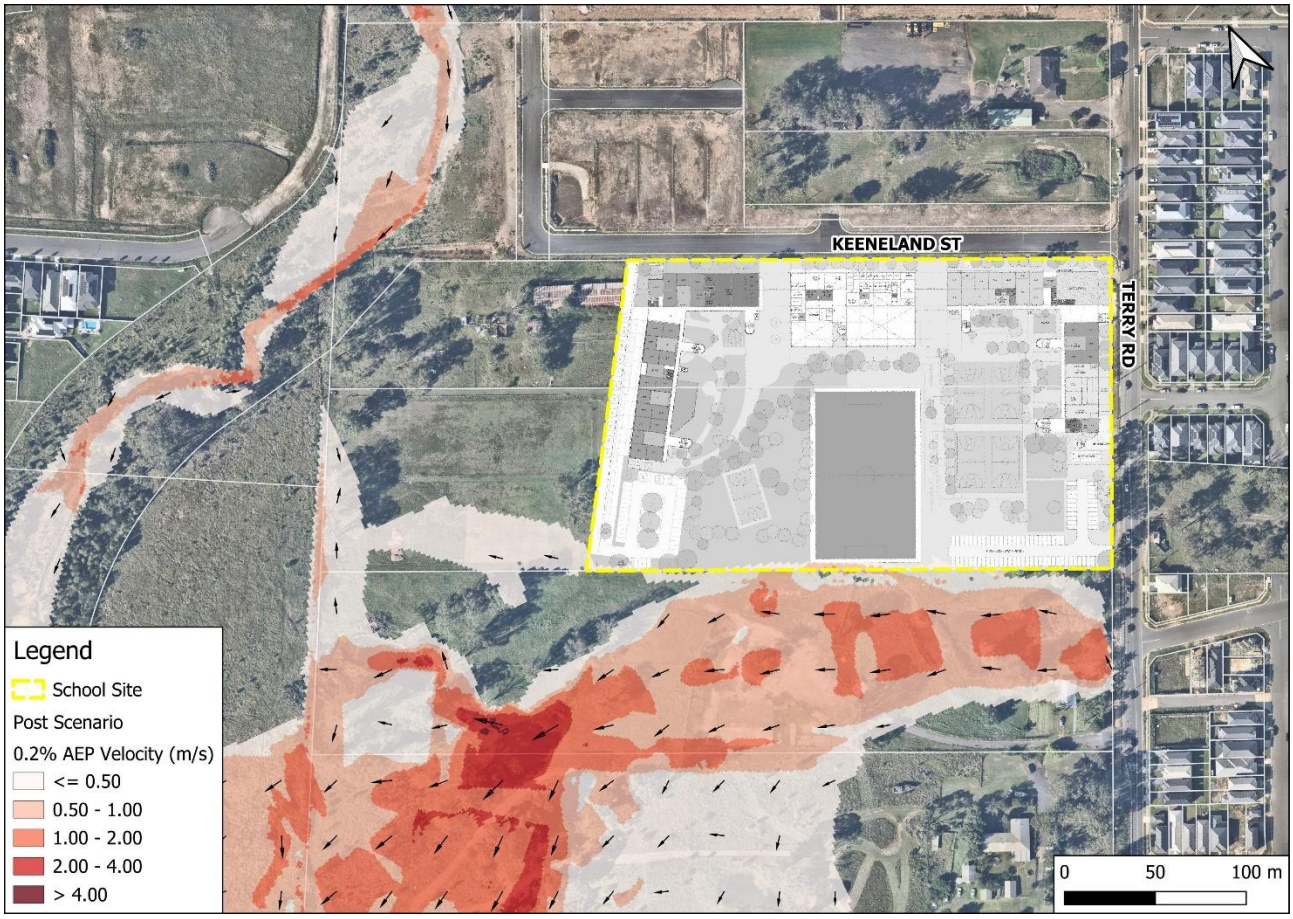


5% AEP Event – Post Scenario – Flood hazard

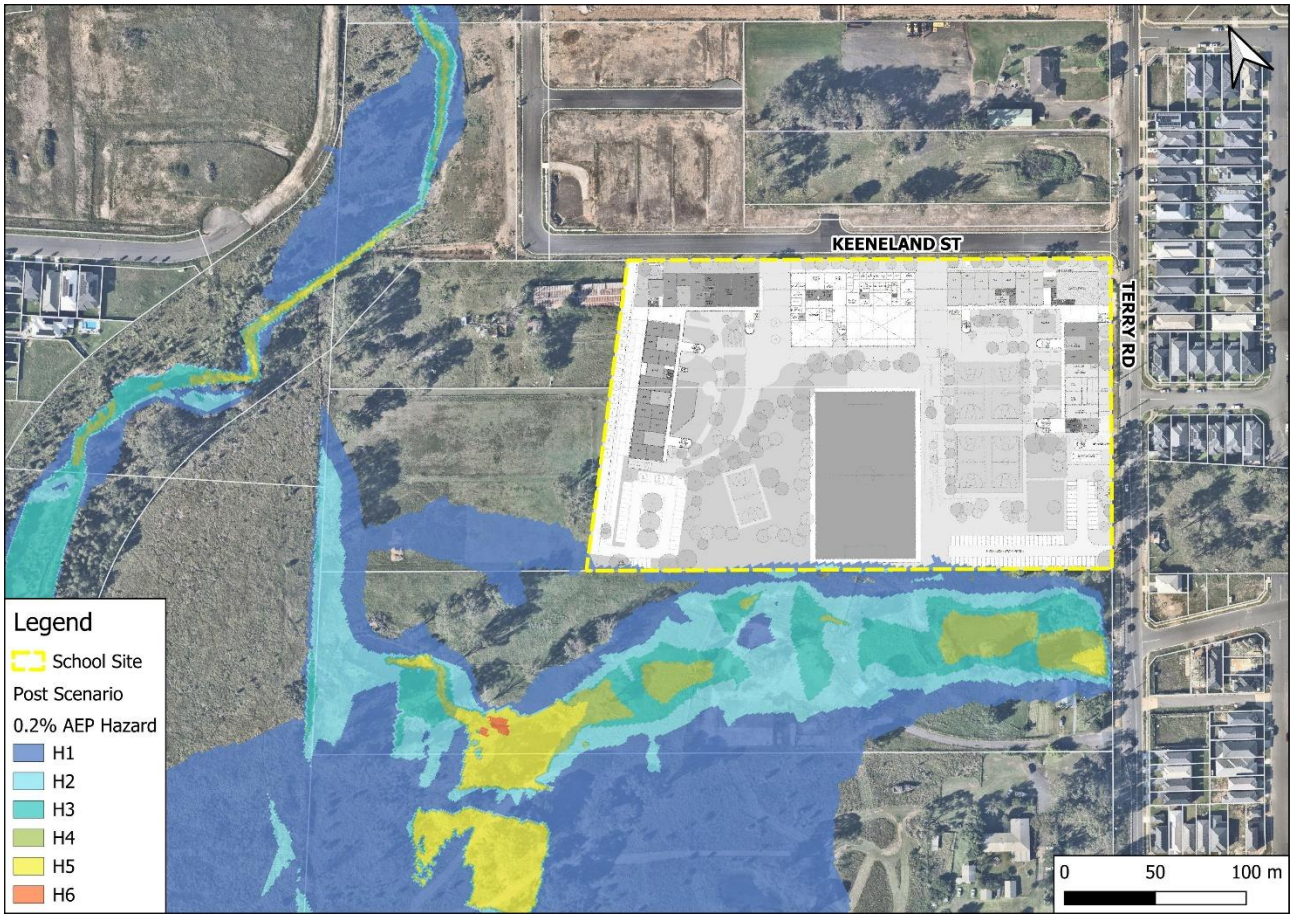
0.2% AEP Event



0.2% AEP Event – Post Scenario – Flood levels and depths



0.2% AEP Event – Post Scenario – Flood velocity



0.2% AEP Event – Post Scenario – Flood hazard