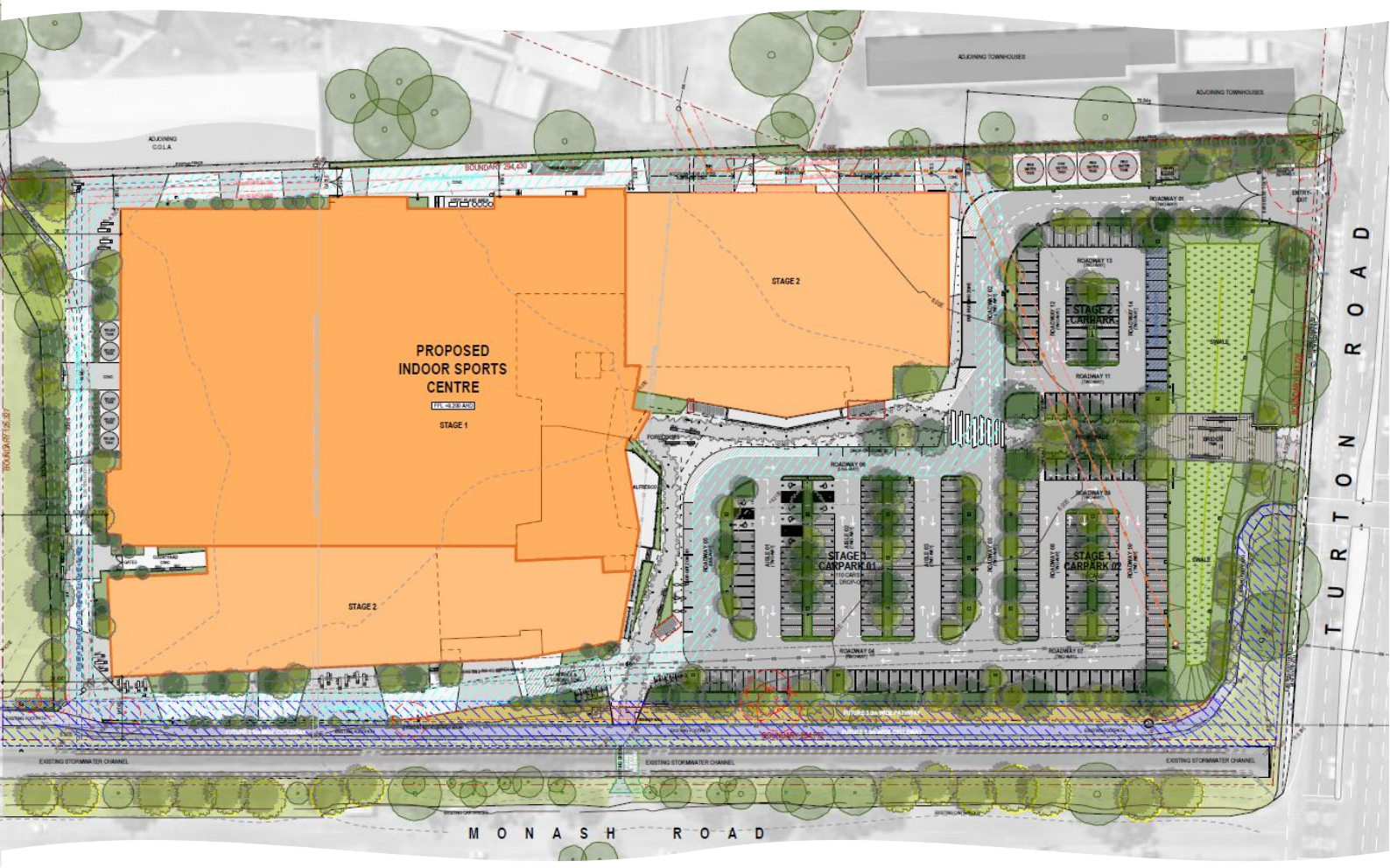
Hunter Indoor Sports Centre

Flood Impact and Risk Assessment

R.T2468.001.09



March 2026

Response to Submissions Round 2 Final

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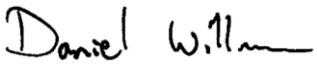

Synopsis

Flood Impact and Risk Assessment for proposed development on the Hunter Indoor Sports Centre at 2 Monash Road and 24 Wallarah Road, New Lambton, NSW.

Revision History

Revision	Description	Date
01	Draft	16/04/2024
02	Draft	15/05/2024
03	Final	20/05/2024
04	Response to Submissions Draft	26/05/2025
05	Response to Submissions Draft	3/06/2025
06	Response to Submissions Final	11/06/2025
08	Response to Submissions Round 2 Draft	24/02/2026
09	Response to Submissions Round 2 Final	16/03/2026

Disclaimer

Executive Summary

This Flood Impact and Risk Assessment is prepared to support the proposed development of the Hunter Indoor Sports Centre at 2 Monash Road and 24 Wallarah Road, New Lambton NSW. The assessment is underpinned by detailed modelling of design flood conditions of the Lambton Ker-rai Creek floodplain for a range of design flood magnitudes.

A TUFLOW software hydrodynamic model was developed to represent existing design flood conditions local to the proposed development. The modelling undertaken has aimed to provide consistency with the recent Throsby, Styx, and Cottage Creeks Flood Study.

The proposed development was designed with consideration of the existing flood risk as defined by the modelling, current flood planning controls and floodplain risk management objectives. The flood assessment investigated the existing and post-development flood conditions for a range of design flood event magnitudes including the 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events. The 0.5% AEP and 0.2% AEP events are used by CN as proxies for the 1% AEP event at the 2050 and 2100 planning horizons, accounting for future climate change impacts.

The developed flood model was utilised to assess the potential impact of any proposed works on existing flood conditions. The impact assessment indicated the proposed development has no material impact on existing flood conditions across the range of flood events considered (10% AEP up to the PMF event).

This amended FIRA presents a reduction in off-site impacts at the PMF event to those presented in the application as lodged and a significant improvement in the flood hazard conditions within the car park.

The proposed development has been assessed against the flood risk management requirements of the Newcastle LEP, Newcastle DCP, and requirements specific to the SEARs. This found the proposed development to satisfy all the requirements except condition C-1 of the Management of Flood Storage Areas section of the Newcastle DCP, which relates to the retention of existing on-site floodplain storage volumes.

The DCP Management of Flood Storage Areas condition C-1 requirement was previously satisfied but through the project amendments undertaken as part of the response to submissions, the level of the proposed car park has been raised to reduce the flood hazard exposure. However, despite the reduction in available flood storage volume (to around 71% and 64% of baseline conditions, at the 1% AEP 20250 and PMF events, respectively), the flood impact modelling has found an overall improvement in off-site flood impacts compared to the application as lodged (which provided around a 95% retention of flood storage volume).

Ultimately, the definition of flood storage at a catchment-wide flood study level is arbitrary and detailed site-specific flood impact assessment modelling is a more rigorous test as to the potential impact of a proposed development on flood function. Whilst not meeting the nominal storage retention specified in the DCP, the proposed development satisfies the intent of this requirement and has demonstrated as such through the modelling-based flood impact assessment.

The key requirements for development of an effective FERP have been established. The development and adoption of a FERP requires full integration with the site management, health and safety and incident management structures and is typically required prior to occupation.

However, the overall flood emergency response strategy is outlined in this report, with a separate standalone FERP document being developed.

A shelter-in-place strategy is the appropriate flood emergency response, with a nominated flood refuge area on the first-floor level of the building. With an available floor area of around 2400 m^2, the Flood Refuge can accommodate up to 2500 people potentially present on the Site. Being a fully functioning part of the building, the Flood Refuge is inherently well-equipped to service the needs of potential occupancy for an expected period of a few hours.

On-site flood refuge requires structural certification that the proposed building can withstand the expected hydraulic loads of the PMF event. The modelled flood depths adjacent to the building at the PMF event are locally as high as 1.4 m, with peak velocities typically no higher than up to 1.7 m/s. Confirmation has been provided by Northrop (the Project Structural Engineers) that the proposed building can be designed to resist the expected forces of flood waters and remain structurally adequate.

With the recommended flood risk management measures in place, the proposed development is supportable from a flood risk management assessment perspective.

For ease of reference, Table 1 lists the project SEARs as well as the advice letters received from City of Newcastle and agencies that accompanied the SEARs and provides the relevant report section in which they are addressed.

Table 2 outlines the key issues identified in the submissions and a summary of the response implemented within this revised assessment. Table 3 provides responses to the key flooding issues identified in the DPHI letter of 24 October 2025.

Table 1 SEARs Table Response

Project SSD - 65595459	Section
SEARs	
13. Flooding Identify and describe any on-site flood impacts and risks associated with the proposed development, having regard to the relevant provisions of the NSW Floodplain Development Manual and other local or State studies and guidance.	6
Describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	3
• Assess the impacts of the development, including any changes to flood risk both on-site or off-site, and identify any mitigation and management measures to minimise the impacts of flooding on the proposed development.	5.4
Provide a Flood Emergency Response Plan prepared by a suitably qualified person that addresses: • Likely flood behaviour;	7 FERP (R.T2468.002)

• Flood warning systems; • Education awareness program; • Evacuation and evasion procedures; • Evacuation routes and flood refuges; and • Flood preparedness and awareness procedures for visitors.	
BCD Response	
9. The EIS must map the following features relevant to flooding as describe in the Floodplain Development Manual 2005 (NSW Government 2005) including: • Flood prone land • Flood planning area, the area below the flood planning level • Hydraulic categorisation (floodways and flood storage areas)	0 2.3
10. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	3
11. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: • Current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	5.4
12. Modelling in the EIS must consider and document: • The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood. • Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. • Relevant provisions of the NSW Floodplain Development Manual 2005.	5.4
13. The EIS must assess the impacts on the proposed development on flood behaviour, including: • Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. • Consistency with CN floodplain risk management plans. • Compatibility with the flood hazard of the land. • Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. • Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. • Whether there will be direct or indirect increase in erosion, siltation, destruction of	5.4 6.2 6.1

riparian vegetation or a reduction in the stability of river banks or watercourses. • Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and CN. • Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and CN. • Emergency management, evacuation and access, and contingency measures for the development considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of CN and the SES. • Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	6.2 7 FERP (R.T2468.002) 5.4
City of Newcastle Response	
Site specific flood information: The development and the SEARs need to address the below flood conditions of the site: • The Throsby, Styx, and Cottage Creek Flood Study (Rhelm 2023) (TSCC), identifies the subject allotment is affected by Local Catchment Flooding during both the 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events. The pertinent characteristics of this flooding are set out in Table 1 of Schedule 1 (attached) for the Applicant's information. • It is noted that the TSCC uses the 1% AEP 2050 as the Defined Flood Event and presents flood hazard using the H1-H6 scale provide in 'Flood Hazard – Flood risk management guideline FB03' by the Department of Planning and Environment (NSW). • A review of flood function diagrams in TSCC 2023 indicates the subject site is bisected diagonally by a large floodway which carries high velocity overland flow overtopping the Lambton Ker-rai Creek during the Probable Maximum Flood event due to flow restrictions at an existing pedestrian bridge over the creek channel. Similarly, a second overland floodway develops immediately downstream at the Turton Road culvert and crosses north through the subject site. Refer to Figures 1 to Figure 4 of Schedule 1 (attached).	3 0 2.3
Flood risk management requirements: The applicant must engage a suitably qualified engineer to address flood risks and flood impacts at the development in accordance with the relevant sections of the Newcastle Development Control Plan 2012 (NDCP 2012). The SEARs should have specific requirements for: • Flood modelling to assess the impacts of the development on existing floodways over the site, with results and recommendations provided in a Flood Impact Assessment Report prepared by a suitably qualified engineer. • Not more than 20% of any flood storage area is filled, or not more than 20% of flood volume is displaced by development over areas identified as flood storage during both the 1% AEP and the PMF events.	5.4 6.2

Flood emergency response plan: A draft flood emergency response plan should be prepared by a professional engineer who is experienced in flood management, and included in documentation for a development proposal. The flood emergency response plan is to include, but not be limited to, the following components: • Likely flood behaviour • Flood warning systems • Education awareness program • Evacuation and evasion procedures • Evacuation routes and flood refuges, and • Flood preparedness and awareness procedures for visitors. Considerations are to include the full range of flood risks, the proposed use of the site, site access constraints and local area evacuation routes to high ground. The plan is to be aimed at self-directed evacuation or evasion to minimise the draw on limited State Emergency Services resources.	7 FERP (R.T2468.002)

Table 2 DPHI Key Issues Response

DPHI, Economic, Environmental and Social Impacts – Flooding	
Issue(s) Raised	**Response / Action**
Address Biodiversity, Conservation and Science - Department of Climate Change, Energy, the Environment and Water (BCS), Council and NSW State Emergency Service advice (with consideration to public submissions and the draft Broadmeadow Place Strategy), in particular relating to (but not limited to): - the flood assessment does not appropriately address existing or future flood behaviour, risk or constraints on the site or to the surrounding land uses and/or road network. - cumulative impacts to peak probable maximum flood levels. - use of further permeable surfaces within the car park to increase flood storage capabilities and potentially reduce hazard risks	The project design has been amended in response to some of the key issues identified within the submissions, including flooding. The assessment of the updated design is documented in this FIRA and addresses the key issues raised in the submissions, including the management of flood risk in the car park and off-site flood impacts to existing property.
Flood Emergency Response Plan - the Flood Emergency Response Plan is based on inaccurate assumptions and does not address emergency management constraints on the site. - The RtS must also be accompanied by an updated Flood Emergency Response Plan developed by a suitably qualified flood risk and emergency	The FERP (refer R.T2468.002) has been updated to include details of emergency response and management arrangements to be implemented for the HISC during adverse weather conditions likely to lead to flooding events, including clear and quantifiable triggers for emergency management actions.

management consultant in consultation with NSW State Emergency Service and be in accordance with current best practise flood emergency management. The Flood Emergency Management Plan must provide clear, quantifiable triggers for each emergency management action.	

Table 3 DPHI October 2025 Key Issues Response

DPHI, Economic, Environmental and Social Impacts – Flooding	
Issue(s) Raised	**Response / Action**
a) Address the comments provided by agencies and Council.	The comments provided by agencies and Council have been addressed in this response.
b) Note that the issues raised by the CPHR Group will need to be addressed as part of the submissions report, not post-approval as referenced in the comments.	As per the 5th paragraph, bullet point 6 of Section 7, the updated design provides rising access from the car park to the building. This makes self-evacuation to the on-site refuge evident and straightforward in the highly unlikely scenario that someone is in their vehicle in the car park during the onset of flood inundation at the site. Only flood events exceeding the 1% AEP 2050 condition will present a risk to vehicles within the car park becoming mobilised. It is highly unlikely that vehicles would be present on site during such an event and the risk of structure blockage associated with the mobilisation of vehicles within the site is negligible. If this occurred then the most likely scenario would be for vehicles to be moved north-eastwards, being deposited within the swale or along the site boundary, rather than into the Lambton Ker-rai Creek to the south. Further, there is a much greater existing risk of vehicles being transported into Lambton Ker-rai Creek from the nearby residential areas, which are much more susceptible to flooding than the proposed car park will be.
c) Provide detailed responses to the queries raised by the public throughout the exhibition process.	Provided within a subsequent item of this table.
d) Provide solutions to minimise the additional flood level, impact of the proposal on the properties along Monash Road, in the 1% AEP and 0.5% AEP events.	Flood mitigation has been documented within a new Section 5.2, with the swale being the principal mitigation measure. Additional improvements to off-site flood impacts have been realised through the

	exclusion of vegetation planting within the 3 m wide buffer zone for the future shared path expansion and through the inclusion of proposed stormwater drainage detail in the Stage 1 car park. Provision of 300 mm diameter pipes (the maximum feasible size) in the car park helps provide a marginal gain in terms of modelled off-site impacts. To ensure that the modelled off-site impacts are acceptable, the modelled change in 1% AEP 2050 peak flood level was interrogated at all local residential properties, to ensure that the desired 10 mm impact limit was satisfied.
e) The Department refers to the City of Newcastle Council's comment relating to the modelled PMF levels and the filling of floodways. Further information is required to understand the full extent of this impact.	The modelling and assessment of flood impacts at the PMF event is not standard practice as not only is it highly uncertain, but it is also overly restrictive with no tangible benefit. This has been addressed in detail on pages 41-42 within Section 5.4. In summary, the modelled consequence of impacts at the PMF event is barely tangible (+60 mm flood level increase to existing flood depths of around 1.5 m) and the probability is virtually zero (the PMF event in this instance representing in the order of a 1-in-10,000,000 AEP). Therefore, the combination of probability and consequence as a risk is negligible.
f) The FIRA is to consider the future cumulative impact of the Broadmeadow Place Strategy and the outcomes of the "Housing the Hunter: a plan for renewal at Broadmeadow – Flooding and Water Cycle Management Report".	When combined with the expected outcomes of the Broadmeadow Place Strategy, there will be a significant net benefit to peak flood level impacts in the area surrounding the HISC. This has been documented in Section 5.4.2.
g) The FERP provides management strategies for the final completed development but must also provide management strategies for the operation of Stage 1. Provide an updated FERP	The flood emergency response strategy is consistent for both the Stage 1 and Stage 2 development, with the only difference being the amount of floor space area available for flood refuge. Following the completion of Stage 1, the first floor of the building will provide 2 m^2 refuge area for the maximum capacity of Site usage. This is also the case for typical usage following the completion of Stage 2, except for occasional exhibition events. This has been clarified in the final paragraph of page 54 of Section 7, with a paragraph also added to the end of Section 4.1 of the FERP to address this.

h) The FERP must also make clear provision for patrons with disabilities including a solution for wheelchair users. Provide an updated FERP.	An evacuation chair will be available at each of the stair wells within the building to assist site management in the relocation of physically impaired patrons to the upstairs flood refuge area. Reference to this has been added to the end of Section 4.1.2 in the FERP.
i) The applicant must consult with the NSW SES when preparing the amended FERP. Provide details of any consultation, including feedback.	A meeting was held with SES staff to discuss the issues that were raised and how these could be addressed in the FERP.
SES Response	
The NSW SES recommends that consideration of flooding issues is undertaken in accordance with the requirements of NSW Government's Flood Prone Land Policy as set out in the Flood Risk Management Manual 2023 (the Manual) and supporting guidelines, including the Support for Emergency Management Planning and relevant planning directions under the Environmental Planning and Assessment Act, 1979.	These references have been considered in preparation of the FIRA and FERP.
We refer to our previous response dated 11 November 2024, with reference ID2728, including the key considerations relating to emergency management. We provide further advice below, based on our review of the proposed amendments and updated project documentation. • Recommend considering site design to avoid entry or exit through high hazard areas (such as the Turton Road exit). • Recommend investigating alternative site design options that may provide vehicular access northwest to Womboin Road, if feasible, noting that currently this is the proposed pedestrian emergency access – which appears to remain flood free up to and including the 0.2% AEP events and provides rising road access, thus providing improved flood resilience compared to the Turton Road access.	Vehicular access from Womboin Road was considered during the early stages of the development planning but was found to not be feasible.
• Support the approach of early closure of the site ahead of the weather event, particularly given the flash flooding nature of the local catchment that would provide insufficient opportunity to evacuate.	This has now been referenced in the first bullet point of Section 7 and in Section 1.3 of the FERP.

• Recommend referring to the considerations in the Shelter in Place Guideline (DPHI, 2024, including the considerations for the refuge area design.	The SIP Guideline has been considered, and it is noted that the proposed development satisfies the intent of the Guideline in the fourth paragraph of Section 7. The proposed development satisfies all the recommendations in the Guideline, except for the minimum floor space area of 2 m^2 per person during occasional exhibition events. However, the Australian Red Cross guidance of 1 m^2 per person is still provided in the worst-case scenario. In practical terms, given the very remote probability of a worst-case scenario, the building can be expected to comfortably provide 2 m^2 per person in the unlikely event of it being used for flood refuge. Discussion of this has been added to Section 7.
• Recommend removing any reference to people wading through floodwater from the FERP. Evacuation must not require people to drive or walk through flood water.	This has been addressed in Section 7 and in Section 1.3 of the FERP.
• Recommend considering building design able to withstand the potential flood forces and debris loading of the PMF, so that structural failure is avoided during a flood, especially considering the flash flood nature at the site.	This has been reviewed by Northrop, who are the Project Structural Engineers. They have confirmed that the proposed building can be designed to resist the expected forces of flood waters and remain structurally adequate.
• Recommend seeking advice from NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) regarding the impacts of the proposed development on flood behaviour at the site and neighbouring and downstream properties, particularly as the proposal includes significant fill within the floodplain.	Comments have been received from NSW DCCEEW CPRH and addressed accordingly.
In existing conditions, a small part in the northeastern corner of the site becomes impacted by flooding (less than 0.2 metres peak) as frequently as 10% Annual Exceedance Probability (AEP) events, however, site vehicular access (onto Turton Road) would be cut in these frequent events, and therefore access/egress and evacuation would be restricted. In a 1% AEP the eastern half of the site becomes inundated with flood depths peaking around 1 metre depth and H3 flood hazard level, with the higher flood depths and hazard level around its vehicular	The PMF inundation duration analysis in the Broadmeadow Place Strategy FIRA confirms that the Site and surrounds are subject to inundation periods of 6-9 hours. This has now been referenced in the fifth bullet point of Section 7 and in Section 1.3 of the FERP. The combination of scenarios that would lead to the building being used for flood refuge with less than a 2 m^2 per person floor space area available at any stage of the development is rarer than a 1-in-30,000,000 AEP. The proposed building design therefore

access/egress point. It is understood that in post-development conditions some of the flood flows are captured within the proposed swale (that can see flood depths in excess of 2 metres in a 1% AEP event), however the site access/egress remains impacted by H3 hazard level flooding which is unsafe for people and vehicles. In a Probable Maximum Flood (PMF) event, almost the entire site becomes inundated with flood depths that can exceed 2 metres and flood hazard peaking at H4 - H5, noting that in both existing and post-development conditions, the site's vehicular access/egress onto Turton Road is cut by H5 hazard level flooding.10 It is understood that the building ground floor is expected to become flooded in a PMF event, with a depth of around 0.5 metres. The duration of isolation is anticipated to be less than six hours, based on the critical duration design events, however this has not been demonstrated in the current report. We note that the FERP acknowledges that "the provision of space and toilets is slightly less than recommended in the Australian Red Cross guidelines," with the nominated flood refuge area on the first-floor level of the building, providing an "available floor area of around 2400m², the Flood Refuge can accommodate up to 2500 people potentially present on the Site."	adequately meets the flood refuge requirements in practical terms. This has also been addressed in Section 7 and in Section 1.3 of the FERP.
The FERP also implies it is safe to enter floodwater, "Even during the peak conditions of a PMF event, pedestrian egress from the Site would still be possible to Womboin Road, albeit by wading through medium hazard flood waters." Floodwaters should not be entered, particularly by school children who are particularly vulnerable to the hydraulic hazards and potential debris and contaminants. Further, it is noted that "An on-site flood warning system monitors the water level within the swale area at the front of the Site adjacent to Turton Road. Once the water level reaches a sufficient height to compromise egress from the Site (7.8 m AHD), an alarm will be activated inside the building. This enables a remotely operated boom gate to be closed, preventing vehicular egress from the Site. A second alarm will be activated if	Section 3.2 of the FERP has been updated to reiterate that the BOM/SES is the primary source of flood warning and that this is an additional layer of warning. The reference to the boom gate has been updated to a manually operated hinge bar gate The wading through floodwaters comment has already been addressed above.

the water level in the swale continues to rise to a level high enough to initiate flooding within the car park (8.2 m AHD). This provides sufficient time to relocate people to the first floor of the building prior to any potential (albeit extremely unlikely) internal inundation of the building." While the NSW SES does not advise against having the on-site water level sensors as an additional layer for warning, we would like to emphasise that the Bureau of Meteorology (BOM) and NSW SES official warning products must be the primary source of truth to trigger evacuation from/closure of the site and these official warnings will override any indication/decision made by the site Flood Wardens based on the on-site flood level sensor indications. We appreciate that the FERP acknowledges that "any flood response directive issued by the SES or by delegated authority to others acting on its behalf must be followed by BANL staff 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."	
CPHR Response	
The Flood Emergency Response Plan (FERP), prepared by Torrent Consulting, June 2025 has not adequately addressed CPHR's concerns that people may become trapped in vehicles during extreme flood events, where flood depths in the car park can exceed 2 m. The FERP acknowledges the dangers of people remaining in their vehicles and proposes that all people should relocate to the stadium. However, it is not clear how the chief warden could know if people are in vehicles or how they could communicate with them. Recommended action: Assess the risk of people becoming trapped in their cars during a major flood event.	As per the 5th paragraph, bullet point 6 of Section 7, the updated design provides rising access from the car park to the building. This makes self-evacuation to the on-site refuge evident and straightforward in the highly unlikely scenario that someone is in their vehicle in the car park during the onset of flood inundation at the site.
The Flood Risk Impact Assessment, prepared by Torrent Consulting has not assessed CPHR's concerns of cars becoming mobile and blocking drains.	Only flood events exceeding the 1% AEP 2050 condition will present a risk to vehicles within the car park becoming mobilised. It is highly unlikely that vehicles would be present on site during such an

Recommended action: Evaluate the risk and potential impact to property and life upstream of the stadium from vehicle-related blockages of channels and culverts.	event and the risk of structure blockage associated with the mobilisation of vehicles within the site is negligible. If this occurred then the most likely scenario would be for vehicles to be moved north-eastwards, being deposited within the swale or along the site boundary, rather than into the Lambton Ker-rai Creek to the south. Further, there is a much greater existing risk of vehicles being transported into Lambton Ker-rai Creek from the nearby residential areas, which are much more susceptible to flooding than the proposed car park will be.
FRNSW Response	
The Flood Risk Management report does not consider the flood modelling outcomes of the Place Strategy or the exhibited Housing the Hunter: a plan for renewal at Broadmeadow – Flooding and Water Cycle Management Report which proposes flood mitigation areas at Kentish Oval and Arthur Edden Oval. These have the potential to directly affect the flood response on the HISC site upon which the FIRA is based. However, it is unlikely that this would have a material effect on operations at MJS as the Broadmeadow Place Strategy has a much wider scope and far greater influence on flooding. Recommendation: The report include reference to the Flooding & Water Cycle Management Report, any cumulative impacts from the development and any opportunities to assist in solving broader precinct wide issues via additional flood storage.	When combined with the expected outcomes of the Broadmeadow Place Strategy, there will be a significant net benefit to peak flood level impacts in the area surrounding the HISC (of around a 0.15 to 0.2 m reduction). This has been documented in Section 5.4.2
City of Newcastle Response	
Adequacy of shelter in place arrangements CN recommends consideration be given to the shelter-in-place arrangements at each stage of development against the design criteria provided in the DPHI's publication 'Shelter in place Guideline for flash flooding'. Consideration should be given to the available floor area for refuge and likely attendance at each stage of the development. We provide conditions regarding flooding in our	The flood emergency response strategy is consistent for both the Stage 1 and Stage 2 development, with the only difference being the amount of floor space area available for flood refuge. However, the combination of scenarios that would lead to the building being used for flood refuge with less than a 2 m2 per person floor space area available at any stage of the development is rarer than a 1-in-30,000,000 AEP. The proposed building design therefore adequately meets the flood refuge requirements in

schedule of recommended conditions.	practical terms. A paragraph has been added to the end of Section 4.1 of the FERP to address this.
Community Response	
Flood modelling shows dramatic increases in hazard levels on key evacuation routes. Turton Rd, Duke St and Monash Rd rise from H4 (unsafe for vehicles and people to H5 (potentially life-threatening). A H5 hazard classification means floodwaters are so deep and fast that no person, vehicle, or emergency responder can safely enter the area. Approving a major public facility that pushes evacuation routes into this category exposes both residents and thousands of visitors to extreme danger. For local residents in particular, this means ordinary streets that should provide safe access to and from homes instead become impassable, trapping families in life-threatening conditions.	This is in reference to the PMF event, which has an expected probability in the order of a 1-in-10,000,000 AEP and so this impact is extremely unlikely to be realised. Also, the roads that are being impacted are already unsafe for evacuation with a hazard level of H4, so localised increases to an H5 hazard to not present a tangible difference to evacuation potential.
Secondly, flooding is still not mitigated. Everything I am reading about the risk management relates to the site and the patrons. There is a lack of documentation related to how the surrounding residents and houses will be affected.	The entire of Section 5.4 is dedicated to the documentation of off-site impacts. The impact to surrounding residents and houses is minimal and does not constitute a tangible adverse impact.
Flood risk increases from 0.1-0.2 m/s to 0.3-0.7 m/s in school's covered area.	This is again in reference to the PMF event, which has an expected probability in the order of a 1-in-10,000,000 AEP and so this impact is extremely unlikely to be realised. Also, the school would almost certainly be closed during such a flood scenario and if it wasn't then students would not be occupying the COLA, given the adverse weather conditions.
The landscape/flood corridor allowance is only 10m (Appendix F), which is grossly inadequate for a high-hazard floodplain. Council's Floodplain Risk Management Guidelines generally recommend 30- 50m buffers.	It is not understood what is meant by this, as there is no such requirement in Council's FRM Guidelines. Potentially this is alluding to the Office of Water riparian vegetation corridor offsets, which is for natural watercourses in more rural settings and is not applicable to the concrete-lined Lambton Ker-rai Creek.

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1 Introduction

1.1 Project Overview

Torrent Consulting has been commissioned by Basketball Association of Newcastle Limited (BANL) to prepare this report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the State Significant Development Application (SSD- 65595459) for the proposed Hunter Indoor Sport Centre with courts, indoor stadium, amenities and associated civil and landscaping works, at 2 Monash Road and 24 Wallarah Road, New Lambton (the Site).

The Site is located at 2 Monash Road and 24 Wallarah Road, New Lambton (refer to Figure 1-1), within the Newcastle local government area (LGA). The site comprises multiple parcels of land and is legally described as:

- Lot 2380 DP755247
- Lot 2379 DP755247
- Lot 2378 DP755247
- Lot 2377 DP755247
- Lot 1 DP1304081

The Site is located beside Lambton Ker-rai Creek, which is a tributary of Styx Creek, located some 450 m downstream. The Site is known to be flood-prone, as identified in the Newcastle City-wide Floodplain Risk Management Study (BMT WBM, 2012) and the recent update to the Throsby, Styx, and Cottage Creeks Flood Study (Rhelm, 2024).

This Flood Impact and Risk Assessment (FIRA) supports Round 1 and Round 2 of the Response to Submissions (RTS) and Amendment Report for State Significant Development Application (SSD-65595459) for the proposed Hunter Indoor Sport Centre (HISC) at 2 Monash Road and 24 Wallarah Road, New Lambton. SSD-65595459 sought development consent for an indoor stadium, amenities and associated civil and landscaping works.

The Amendment Report seeks changes to the original development proposal SSD-65595459.

The key project amendments include moving the building footprint and carpark west, adding turfed open space near Turton Road, and shifting the access driveway south. The realigned pedestrian promenade within the carpark includes a bridge over the open space.

The height at the south-eastern corner of the building will be increased to provide flexibility to use the upper level of the building for gymnastics and other activities, there are also minor internal reconfigurations to fit the revised footprint.

Within the public domain works include widening the Turton Road footpath, adding pedestrian safety fencing, and retaining the existing cycle/pathway on the south-eastern corner of the site. The landscaping and public domain changes mean that four trees on the Turton Road frontage (previously proposed to be removed) can now be retained.

On the southern edge of the site, landscaping elements have been removed. Space is provided for the future expansion of pedestrian / cycleway route along this corridor (works to be delivered by others).

Title:

Study Locality

0 100 200 m

approx. scale

Figure: 1-1

Revision: A

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The active recreation area, including a half basketball court, has been deleted from the proposal.

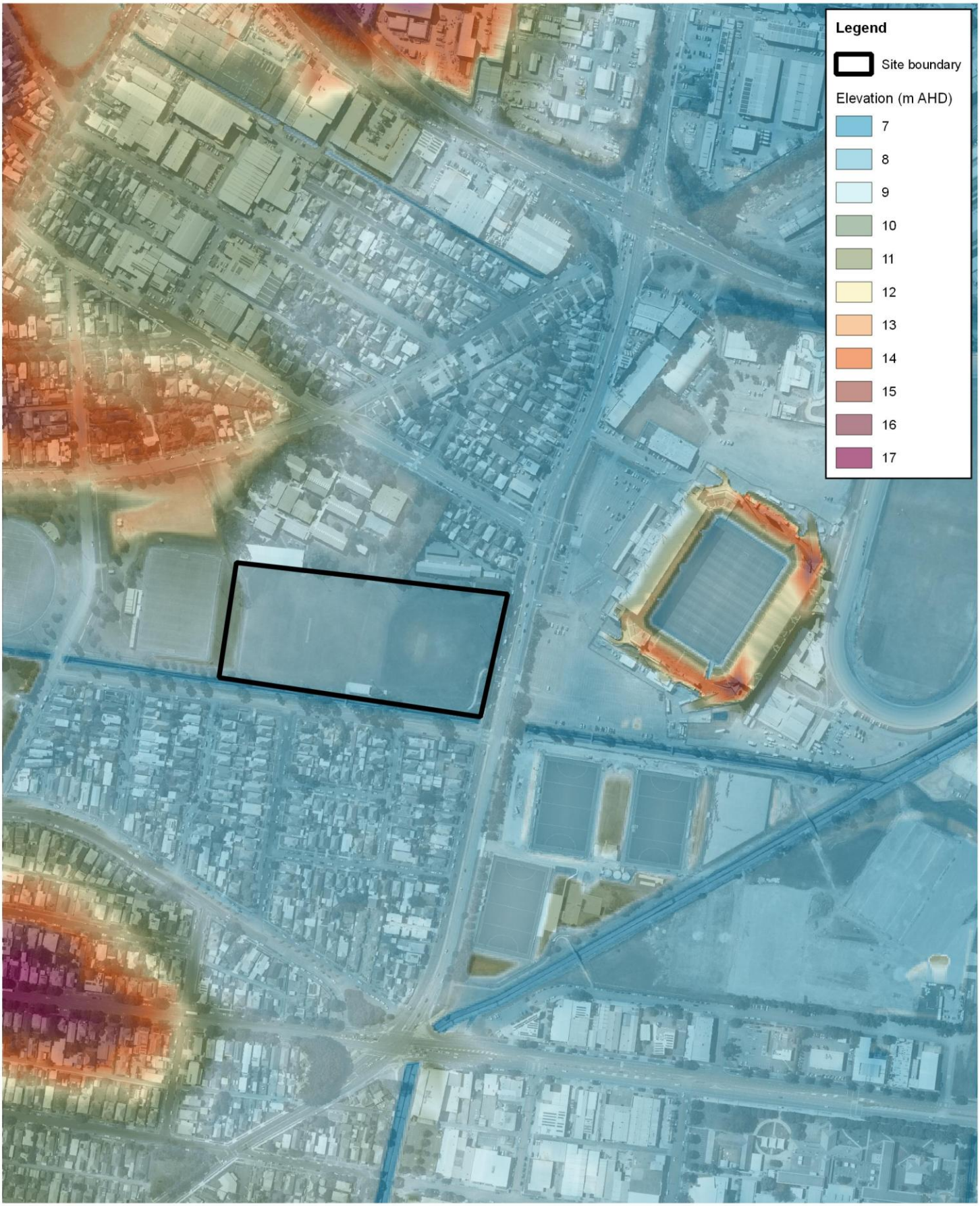
Development consent is sought for the entire proposal, with the flexibility to deliver the project in two construction and operational stages.

1.2 Scope of Assessment

This flood impact and risk assessment aims to review the existing design flooding constraints at the Site, investigate Site development potential and associated flood impacts, and identify potential flood mitigation options, if required. The Site location in the context of the local floodplain topography is shown in Figure 1-2.

The key components of the assessment summarised in the following document include :

- Review of existing flood risk information including previous studies and available flood mapping.
- Review of relevant flood related planning controls and development guidelines.
- Establishment of numerical hydraulic model to define existing flood risk for the Site and development constraints.
- Flood impact assessment of proposed development using hydraulic model and identify requirement for flood mitigation.
- Review flood warning and emergency response opportunity.
- Assessment of compatibility of proposed development with established flood risk.



Title:

Local Floodplain Topography

0 100 200 m

approx. scale

Figure: 1-2

Revision: A

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2 Flood Planning Requirements

A summary of relevant planning provisions with respect to flood risk management is provided hereunder.

2.1 Planning Secretary's Environmental Assessment Requirements

The Planning Secretary's Environmental Assessment Requirements (SEARs) relating to the proposed State Significant Development (SSD) were issued by the NSW Department of Planning and Environment on 22 January 2024 (SSD-65595459). The requirements relating to flooding are reproduced below.

The EIS must:

- identify and describe any on-site flood impacts and risks associated with the proposed development, having regard to the relevant provisions of the NSW Floodplain Development Manual and other local or State studies and guidance.
- describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.
- assess the impacts of the development, including any changes to flood risk both on-site or off-site, and identify any mitigation and management measures to minimise the impacts of flooding on the proposed development.
- Provide a Flood Emergency Response Plan prepared by a suitably qualified person that addresses:
    - Likely flood behaviour;
    - Flood warning systems;
    - Education awareness program;
    - Evacuation and evasion procedures;
    - Evacuation routes and flood refuges; and
    - Flood preparedness and awareness procedures for visitors.
- address matters raised by Biodiversity Conservation Division (BCD) at Attachment B.
- address matters raised by CN at Attachment B.

The BCD requirements in Attachment B referenced above are consistent with those typically issued in SEARs and can be summarised as:

- Map flood prone land, the flood planning area and flood function.
- Describe the flood assessment and modelling undertaken.
- Include the 10% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events.
- Assess the impact of the proposed development on the existing flood behaviour.

The CN requirements in Attachment B request:

- Address the flood risks and flood impacts in accordance with the Newcastle DCP.
- Flood modelling to assess the impacts of the development on the existing floodways within the site.
- To not fill more than 20% of the flood storage area at either the 1% AEP or PMF event.
- Preparation of a Flood Emergency Response Plan.

2.2 Newcastle Local Environmental Plan (2012)

The Newcastle Local Environment Plan (LEP) 2012 provides a framework for development of land and land use in the City of Newcastle (CN) LGA. Clause 5.21 relates to flood planning which states the following objectives:

> *a) to minimise the flood risk to life and property associated with the use of land;*
>
> *b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change;*
>
> *c) to avoid significant adverse impacts on flood behaviour and the environment.*
>
> *d) to enable the safe occupation and efficient evacuation of people in the event of a flood.*

In supporting these objectives, the LEP includes provision that development consent must not be granted unless the consent authority is satisfied that the development:

> *(a) is compatible with the flood function and behaviour on the land, and*
>
> *(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and*
>
> *(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and*
>
> *(d) incorporates appropriate measures to manage risk to life in the event of a flood, and*
>
> *(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*

2.3 Newcastle Development Control Plan (2023)

The Newcastle Development Control Plan (DCP 2023) supplements the LEP 2012 by outlining controls that apply to various types of development across the LGA. Specifically, the DCP outlines development principles, objectives and standards that are intended to assist in the preparation of development applications by development proponents, and in the assessment of development applications by CN. Section B1(b) of the DCP 2023 specifically relates to development on flood prone land within areas for which a flood study has been undertaken after the release of the Australian Rainfall and Runoff (ARR) 2019 Guidelines.

The DCP 2023 specifies controls which are to be met for the development of flood-prone land, which fall under four objectives:

- The retention of floodways
- The protection of flood storage areas
- The management of risk to property
- The management of risk to life.

The controls supporting these objectives are detailed in Section 2.3.1 to Section 2.3.4.

2.3.1 Floodways

The planning controls relating to the retention of floodways are:

- C-1: no building or structure can be built, and no land can be filled with any materials in areas identified as floodways, except for small changes to ground levels that do not significantly change the flow patterns for roads, parking, below ground structures or landscaping.
- C-2: where dividing fences across floodways are unavoidable, they are constructed only of open type fencing that does not restrict the flow of flood waters and are resistant to blockage. New development is designed to avoid fences in floodways.

Mapping of floodways is provided by CN in Flood Function mapping at the 1% AEP 2050 planning horizon and the PMF events, as shown in Figure 2-1 and Figure 2-2, respectively. The 1% AEP mapping shows a floodway propagating northwards from the Lambton Ker-rai Creek channel into the south-east corner of the Site. At the PMF event the floodway extends across the eastern side of the Site and continuing northwards along Turton Road. A secondary floodway is also shown at the PMF event that traverses the Site in a north-easterly direction, joining the primary floodway in the north-east corner of the Site.

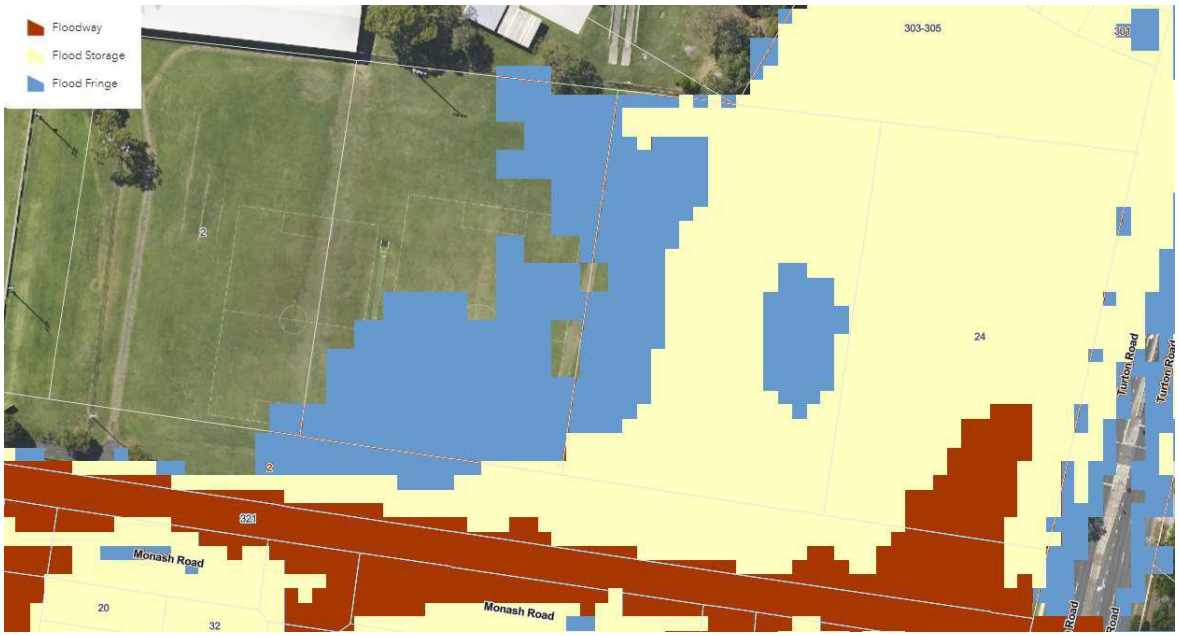


Figure 2-1 1% AEP (2050) Flood Function from Rhelm, 2024

While the consideration of floodways for events rarer than a 1% AEP is warranted, it is considered unreasonable to enforce planning controls based on a mapped floodway extent at the PMF event. This is due to the relatively arbitrary methods of floodway definition employed in flood studies and the extreme rarity of such event, which in small catchments such as the Throsby Creek system is around a 1-in-10-million annual probability.

Ultimately a floodway is best defined as land within which any obstructions will significantly impact flood behaviour, with relative flood impact assessment being used as a tool to determine this.

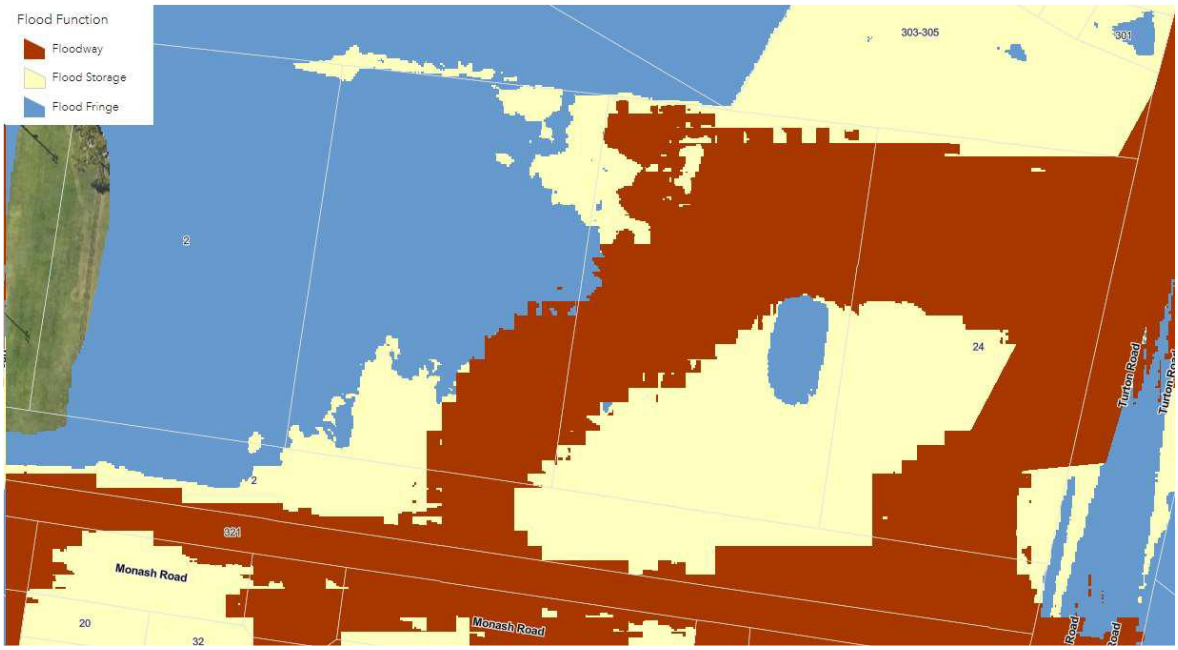


Figure 2-2 PMF Flood Function from Rhelm, 2024

2.3.2 Flood Storage Areas

The planning controls relating to the protection of flood storage areas are:

- C-1: not more than 20% of the area of any development site in a flood storage area is filled. The remaining 80% is generally developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction.
- C-2: where it is proposed to fill development sites, the fill does not impede the flow of ordinary drainage from neighbouring properties, including overland flow.

Mapping of flood storage areas is provided by CN in Flood Function mapping at the 1% AEP 2050 planning horizon and the PMF events, as shown in Figure 2-1 and Figure 2-2, respectively. The flood storage area covers around the eastern 40% of the Site at the 1% AEP event, increasing to around the eastern 50% at the PMF event.

2.3.3 Management of Risk to Property

The planning controls relating to the management of risk to property from flooding are:

- C-1: floor levels of all occupiable rooms of all buildings are not set lower than the FPL.
- C-2: garage floor levels are no lower than the 1% 2050 AEP event. However, it is recognised that in some circumstances this may be impractical due to vehicular access constraints. In these cases, garage floor levels are as high as practicable.
- C-3: Basement garages may be acceptable where all potential water entry points are at or above the PMF, excepting that vehicular entry points can be at the FPL. In these cases, explicit points of refuge are accessible from the carpark in accordance with the controls for risk to life set out below.
- C-4: electrical fixtures such as power points, light fittings and switches are sited above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building.

- C-5: swimming pools are to be located to ensure they are not inundated from minor flooding events. Electrical connections and fixtures around swimming pools are to be sited at the FPL.
- C-6: Where parts of the building are proposed below the FPL, they are constructed of water-resistant materials.
- C-7: areas where cars, vans and trailers are parked, displayed or stored are only located in areas subject to property hazard of P1. Containers, bins, hoppers and other large floatable objects are not to be stored in these areas. Heavy vehicle parking areas can only be located in locations subject to P1 or P2 categories.
- C-8: timber framed, light steel construction, cavity brickwork and other conventional domestic building materials are generally suitable forms of construction where the property hazard is P1 to P4.
- C-9: property hazard of P5 is generally unsuitable for building construction and building is discouraged from these areas. Where building is necessary, the structure is certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.
- C-10: property hazard of P6 is unsuitable for any type of building construction.

The risk to property hazard categories P1 to P6 are defined as the 1% AEP (2050) H1 to H6 hazards of the classification system defined in 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). The hazard classification system is based on a combination of flood depth, flood velocity and the velocity-depth product, as shown in Figure 2-3.

2.3.4 Management of Risk to Life

The planning controls relating to the management of risk to life from flooding are:

- C-1: risk to life category L5 is generally unsuitable for building construction and building is discouraged from these areas. Reliable safe escape to high ground is likely not possible and normal building construction would likely suffer structural failure from the force of floodwaters, so that any people seeking refuge in the building would likely perish. Where building is necessary, the structure is certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.
- C-2: risk to life category of L6 is unsuitable for any type of building construction.
- C-3: the formation of islands in the floodplain during a flood is a potentially dangerous situation, especially when floods larger than the FPL totally inundate the island for an extended period. Development of such land is considered with great care.
- C-4: on-site refuge is to be provided for all development where the risk to life category is L3 or higher unless: the proposed development is less than 40 m from the perimeter of the PMF extent and the higher ground is accessible, or the proposed use is defined as commercial premises or industry in which case onsite refuge is only required where the hazard category is L4 or higher.
- C-5: where on-site refuge is required for a development, it should comply with the following minimum standards: the minimum on-site refuge level is the level of the PMF. On-site refuges are designed to cater for the number of people reasonably expected on the development site and are provided with emergency lighting, and on-site refuges are of a

construction type able to withstand the effects of flooding. Design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF).

- C-6: emergency egress procedure for basements. A plan is developed detailing emergency egress procedures during a flood, as well as any refuge areas in reasonable proximity of the development. The plan is to be positioned in the basement car park in an easily recognisable location/s.

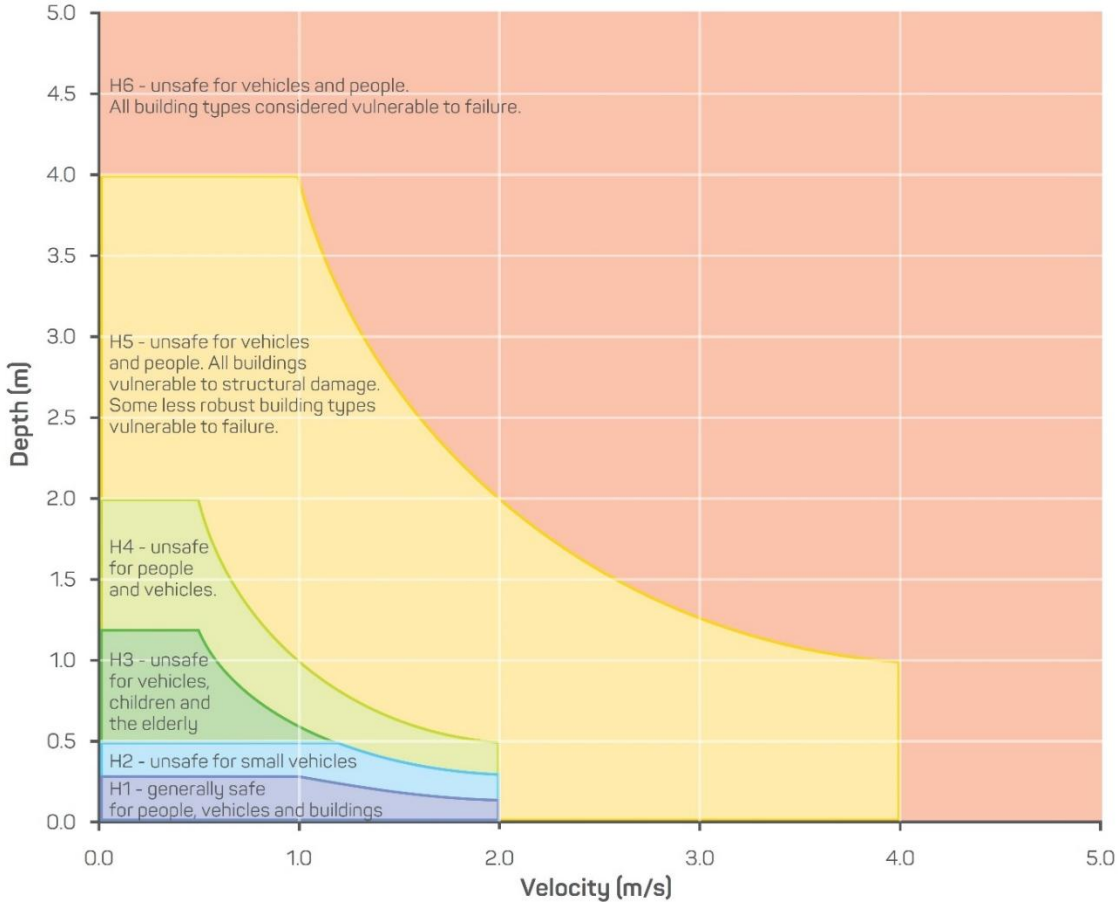


Figure 2-3 General Flood Hazard Vulnerability Curves (AIDR, 2017)

The risk to life hazard categories L1 to L6 are determined from the PMF H1 to H6 hazards of the AIDR classification system, with H1-H2 becoming L2 and H3-H6 mapping to L3-L6, respectively. The L1 classification is for Hunter River and ocean flooding, where significant warning times limit the risk to life.

3 Model Development

Detailed flood modelling of the Site is included within the recent update to the Throsby, Styx, and Cottage Creeks Flood Study (Rhelm, 2024). At the time of undertaking the assessment this study is still in the process of being finalised with regards to model handover and the protocols of future model use. Therefore, a TUFLOW model covering the area local to the Site has been developed to enable the undertaking of a relative flood impact assessment. However, during the review of this assessment at the response to submissions stage, the Rhelm model was made available and the TUFLOW model developed for the assessment was updated to provide improved consistency.

The TUFLOW model developed for the initial assessment utilised an existing model prepared by Torrent Consulting for CN in the assessment of local pedestrian bridge rail replacement works. It utilised the 2014 NSW Spatial Services LiDAR data product, downloaded via the ELVIS Foundation Spatial Data portal to define the floodplain topography. A 2 m model grid cell resolution was adopted, with sub-grid sampling from a 1 m resolution DEM.

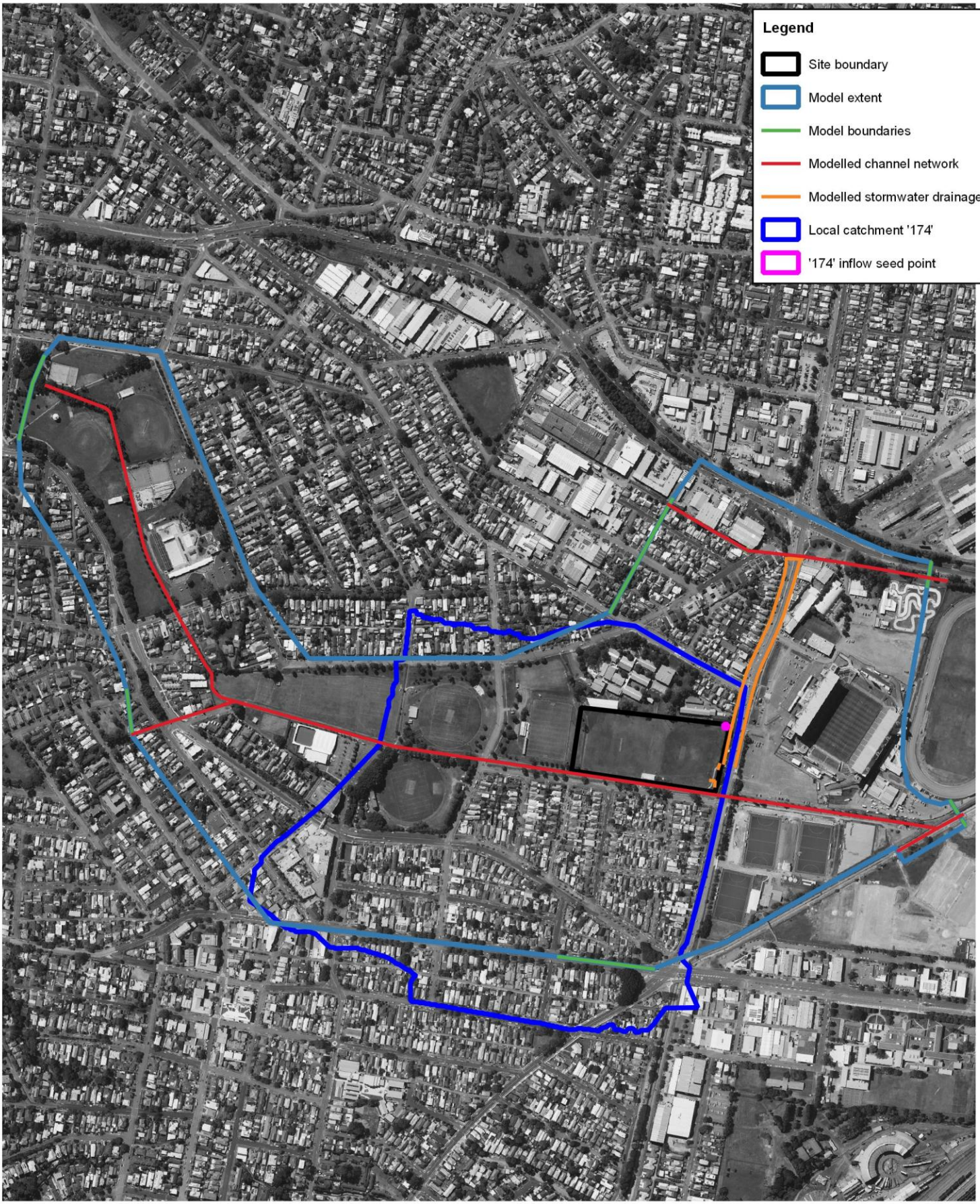
Channel and structure geometry was sourced from the original Throsby, Styx, and Cottage Creeks TUFLOW model (BMT WBM, 2012) and modelled as a 1-D network, dynamically linked to the 2-D floodplain representation. Appropriate model inflows and downstream boundary conditions were initially extracted from the original TUFLOW model. The extent and configuration of the model is presented in Figure 3-1. The local catchment boundary for sub-catchment “174” of the Rhelm WBNM hydrological model and its inflow seed point within the TUFLOW model is also shown, with detailed discussion as to the context of this to follow.

During the response to submissions stage of the assessment, the recently completed Rhelm TUFLOW model was made available. This was reviewed and used to update and improve the TUFLOW model developed for the FIRA. The approach was adopted in preference to full use of the model developed by Rhelm for CN given the coarser model resolution and longer simulation times associated with the CN’s whole-of-catchment scale model. The improvements made to the FIRA TUFLOW model to ensure consistency with the CN/Rhelm model include:

- Updating the floodplain topography using the 2021 LiDAR survey dataset
- Extraction of modelled inflow and tailwater levels from the catchment scale model at the corresponding boundaries of the FIRA model
- Improved consistency with the adopted hydraulic roughness values, particularly the 0.3 value used for urban allotments
- Representation of larger and/or standalone building structures with a hydraulic roughness value of 1.0, rather than as a physical obstruction in the model geometry.

The 1D representation of the stormwater drainage network was found to be largely unaltered in the Rhelm model from the original BMT version. There are two main differences between the modelling undertaken by Rhelm for CN and this FIRA:

- This FIRA model adopts a hydraulic roughness value of 0.04 for grassed areas rather than the 0.03 value adopted by Rhelm
- This FIRA model inputs local catchment hydrological inflows directly to the 1D stormwater drainage network, whereas the Rhelm model applies them to the 2D floodplain.



Title:

Local TUFLOW Model Configuration

0 200 400 m

approx. scale

Figure: **3-1**

Revision: **D**

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A hydraulic roughness value of 0.03 is regarded as being too low for grassed surfaces, with adopted hydraulic roughness values for 2D modelling typically being slightly larger than standard literature reference values, accounting for sub-model-scale influences. With 0.035 being a typical literature reference value for grassed surfaces, 0.04 is often adopted in TUFLOW.

Further, the Rhelm model includes a gridded input of surface materials that has been derived from aerial survey. A drawback of this method is that the canopy extent of trees is captured and represented with a high roughness value of 0.09. Whilst this is appropriate for extensive blocks of forest, it is not so for individual street trees. Much of this gridded input is overwritten in the model with additional material layers but it is often retained within the nature strips of road reserves and areas of open recreational space. On balance, this artefact of overly high roughness being adopted for individual street trees may offset the overly low roughness being adopted for grassed areas.

Overall, the impact of the difference in hydraulic roughness representation between the Rhelm/CN TUFLOW model and the one used for this FIRA is considered minor at most and is probably negligible.

The main point of difference between the two TUFLOW models is the chosen representation for local catchment hydrological inflows. There are only six local hydrological catchments within the extent of the FIRA model, but their treatment has a significant impact on the model results. In the FIRA model, these local inflows (as derived from WBNM hydrological modelling undertaken by Rhelm) are applied directly to the applicable reaches of open stormwater drainage channel in the 1D model domain. The assumption behind this method is that the local rainfall will typically be conveyed via the stormwater drainage network to the channels prior to the onset out out-of-bank flooding once the main flood flows arrive from the broader upstream catchment.

In the TUFLOW model developed by Rhelm for CN these local catchment hydrological inflows are applied to the ground surface within the 2D model domain. The inflows are initially seeded into the lowest point within the local catchment and then once broader flood inundation is modelled, the inflow becomes evenly distributed across all “wet” model cells within the local catchment. Water will then flow overland into the stormwater drainage network, where possible.

Both the direct application of local flows into the stormwater network and onto low-lying floodplain areas are valid. However, there is one local catchment within the FIRA model extent for which the chosen method significantly impacts the model results – the WBNM catchment “174”. Catchment 174 is around 54 ha in size and covers the area bounded approximately by Womboin Road to the north, Russell Road to the south, Turton Road to the east and New Lambton Bowling Club to the west – as shown in Figure 3-1.

In the Rhelm TUFLOW model developed for CN, catchment 174 is being seeded into a model cell in the north-eastern corner of the Site, meaning that catchment runoff from south of Lambton Ker-rai Creek is being input to the northern side of the creek in the model. In rare flood events such as the 1% AEP, when a large area floodplain is activated, the impact of this error is minimal. However, for more frequent events such as the 10% AEP and 5% AEP, it results in an artificially large amount of flood water being input to the Site and the surrounding area. This is evident through comparison of the FIRA model results with the results adopted by CN.

Prior to access being given to the Rhelm/CN TUFLOW model, the local inundation to the Site at each event was replicated in the FIRA model by further increasing the model inflows to match the mapped flood extents. However, following the review undertaken during the response to

submissions stage, the model inflows have been left unaltered to provide a more accurate depiction of the local flood conditions at the Site. For the rarer flood events such as the 1% AEP and 0.5% AEP events, the FIRA model was found to give more consistent results to the Rhelm model adopted by CN.

In summary, the result of this update of the FIRA TUFLOW model following review of CN's Throsby and Cottage Creek Flood Study TUFLOW model, is that the modelled flood levels, depths and hazards for events more frequent than the 1% AEP are much lower in this FIRA than CN's Flood Study mapping (and from mapping presented in the application as lodged). However, results for the 1% AEP and rarer events remain relatively consistent.

The simulated flood conditions are consistent with those of the CN model, being the 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events. The 0.5% AEP and 0.2% AEP events are also used as proxies for the 1% AEP event under expected future climate change conditions at the 2050 and 2100 planning horizons, respectively.

Details of the stormwater drainage within Turton Road have also been incorporated within the TUFLOW model, as shown in Figure 3-1. This infrastructure was not significant enough to have been included within CN's Throsby, Styx and Cottage Creeks Flood Study and was therefore also not within the modelling originally developed for this assessment. Inclusion of the Turton Road stormwater drainage has enabled the proposed internal Site stormwater drainage design associated with the Project to be incorporated and assessed.

4 Design Flood Conditions

Design flood events are theoretical floods that represent a condition attributable to an expected probability of occurrence, which is expressed as a percentage annual exceedance probability (AEP). An event with a 10% AEP is expected to be exceeded on average (over a very long timeframe) once in every ten years, with a 1% AEP event expected to be exceeded on average once in every 100 years.

The Probable Maximum Flood (PMF) is a representation of the worst-case scenario, i.e. an occurrence of the most water that is physically capable as being precipitated as rainfall and is typically used in floodplain risk management to avoid locating critical infrastructure such as hospitals within the floodplain and for critical dam failure assessments. There is much uncertainty in assigning an expected probability to the PMF. However, ARR provides a best estimate of probability for the probable maximum precipitation (PMP) in Figure 8.3.2, reproduced in Figure 4-1.

Figure 4-1 shows that for catchments of 100 km^2 or smaller (i.e. Throsby Creek) the best estimate of the AEP of the PMP (and hence PMF) is 1-in-10,000,000, with a 75% confidence that it lies between an AEP of 1-in-1,000,000 to 1-in-100,000,000 and within the upper and lower bounds of 1-in-100,000 and 1-in-1,000,000,000.

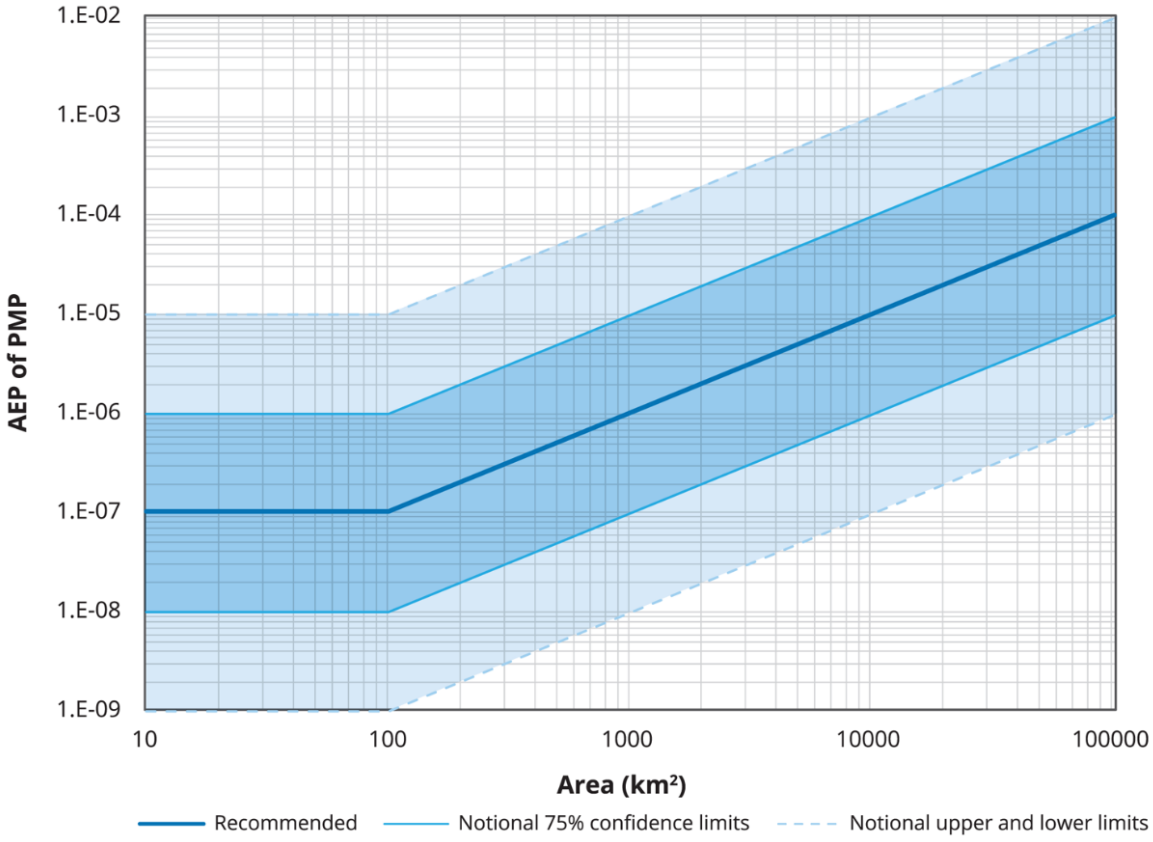
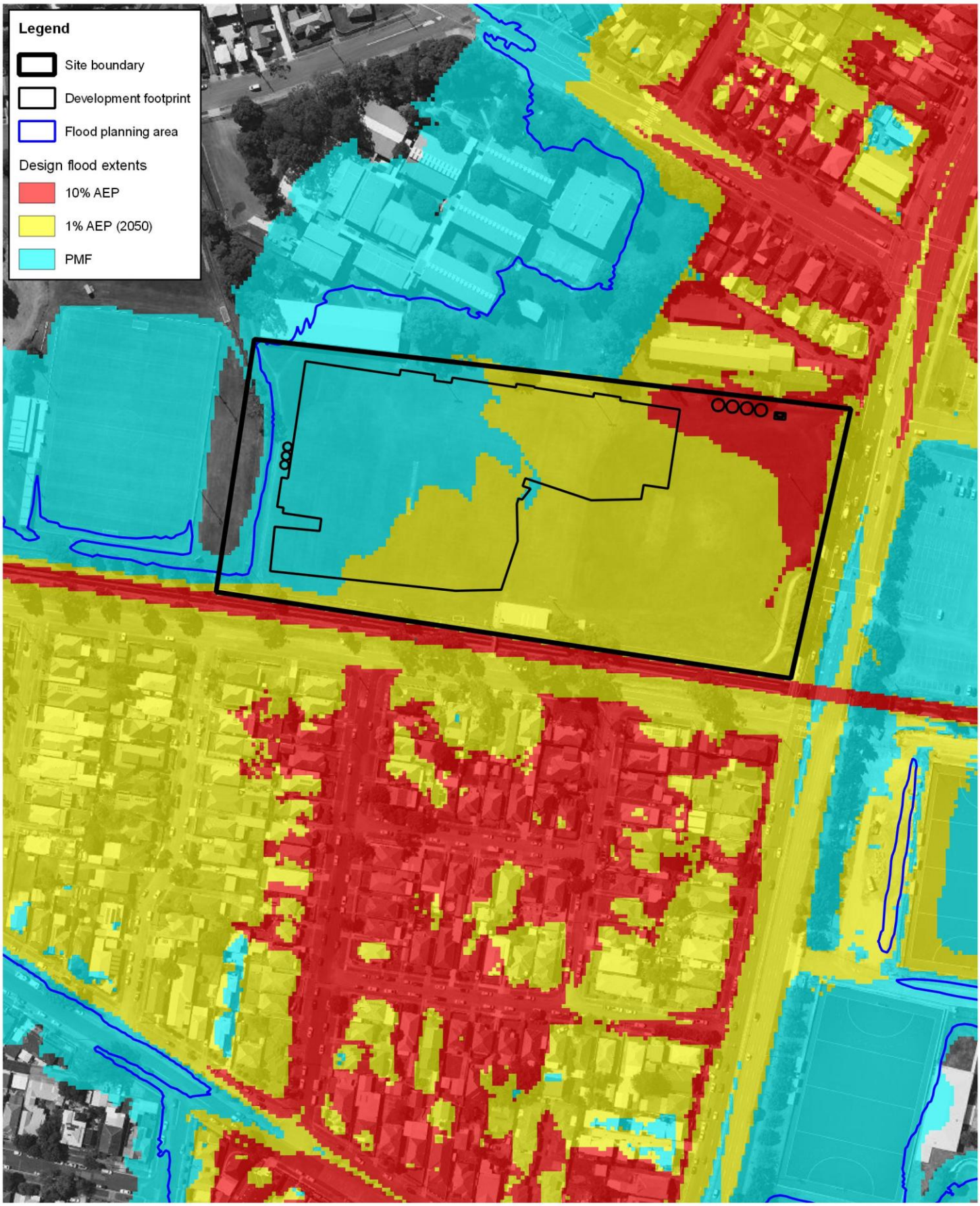


Figure 4-1 Estimated AEP of the PMP

A comparison of the modelled design flood extents for the 10% AEP, 1% AEP (2050) and PMF events is shown in Figure 4-2, providing an indication of the increase in flood extent with increasing flood magnitude.



Title:

Modelled Design Flood Extents

0 60 120 m

approx. scale

Figure: **4-2**

Revision: **D**

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Less than 5% of the Site is inundated at the 10% AEP event, around 70% at the 1% AEP event and almost the entire Site at the PMF event. The Flood Planning Area (FPA) is defined as the land that is elevated below the FPL, the extent of which is included in Figure 4-2. The building footprint of the proposed development is also shown for context.

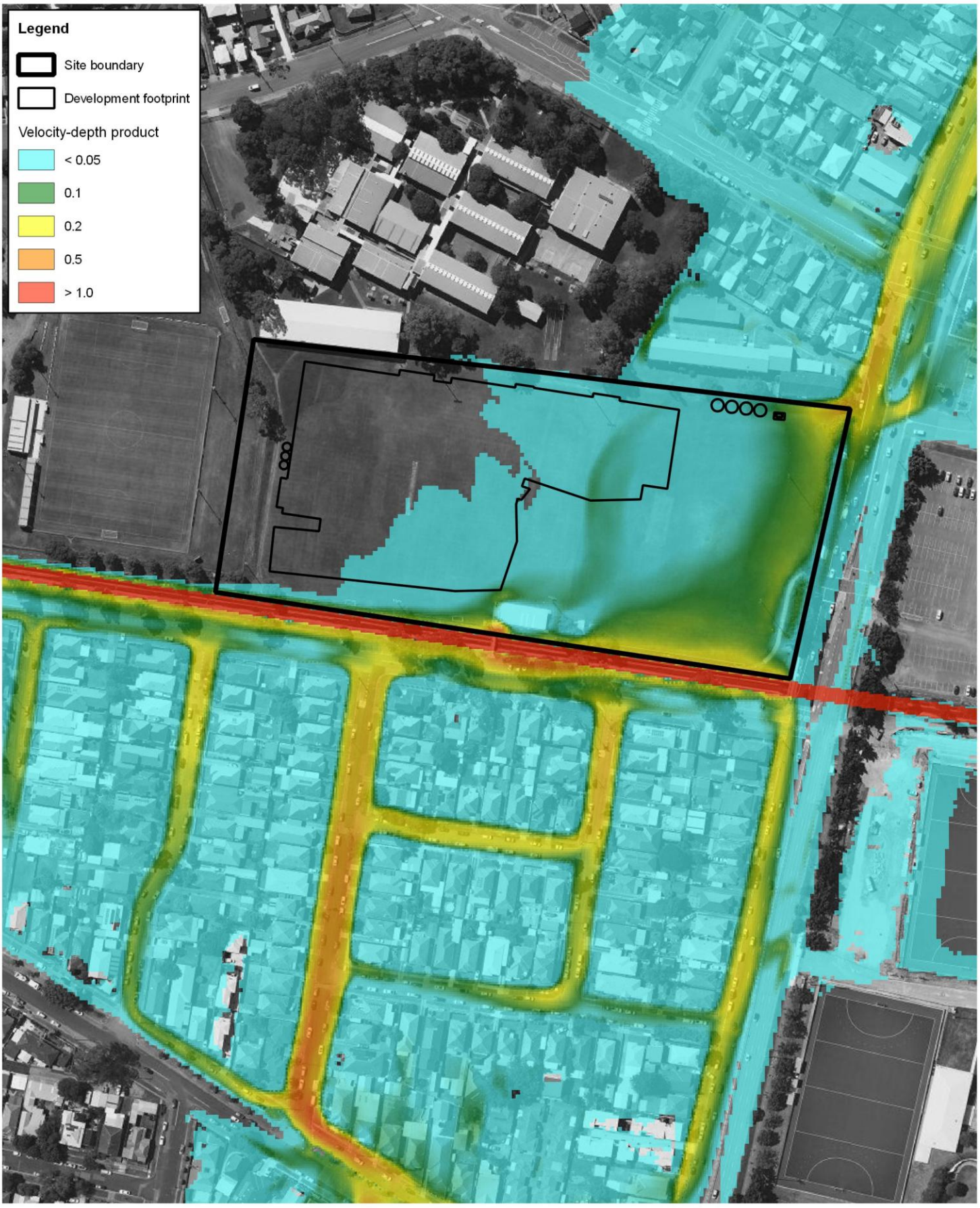
Consideration of the amendments to the Site layout included the location of the proposed building to minimise potential impacts on flooding, whilst maintaining a visible frontage from Turton Road. Figure 4-3 presents the modelled flood flow distribution (velocity-depth product) at the 1% AEP (2050) event. It shows that flood flows are concentrated along and immediately adjacent to the Lambton Ker-rai Creek channel. When the capacity of the channel is exceeded, the physical obstruction of Turton Road and the Newcastle International Hockey Centre directs excess floodwaters overland thorough the Site, before flowing north (and downhill) along Turton Road to the drainage alignment running east along the southern side of Griffiths Road.

The function of the south-eastern corner and eastern edge of the Site as an important floodway for the conveyance of overland flow is evident in the yellow colouration mapped in Figure 4-3. The location of the building footprint has been designed to sit outside of the highly convective areas of the floodplain. It should be noted that the existing building structure located between the channel and the proposed building footprint is to be demolished as part of the development and so the flow path around the northern side if the building will realign itself parallel to the channel.

Figure 4-4 to Figure 4-6 show the modelled peak flood depth for the 10% AEP, 1% AEP (2050) and PMF events. At the 10% AEP event the Site is inundated by relatively shallow flood waters, to a depth of up to 0.5 m. The deepest depths within the Site increase to around 0.8 m at the 1% AEP (2050) event and to around 1.8 m at the PMF event.

Figure 4-7 to Figure 4-9 show the flood hazard mapping using the AIDR General Flood Hazard Vulnerability Curves (as shown in Figure 2-3) for the 10% AEP, 1% AEP (2050) and PMF events. At the 10% AEP event there is only minor localised inundation within the north-east corner of the Site and is only a low hazard (H1) flood environment. The lowest-lying part of the Site becomes a medium hazard (H3) flood environment at the 1% AEP (2050) event. At the PMF event most of the Site is a medium hazard (H3-H4) flood environment, with localised areas of higher conveyance becoming a high hazard (H5) flood environment.

Flood depth and flood hazard mapping for existing conditions is provided for additional design flood events in Appendix A, together with peak flood velocity mapping for all events.



Title:

Modelled 1% AEP (2050) Flood Flow Distribution

0 60 120 m

approx. scale

Figure: **4-3**

Revision: **D**

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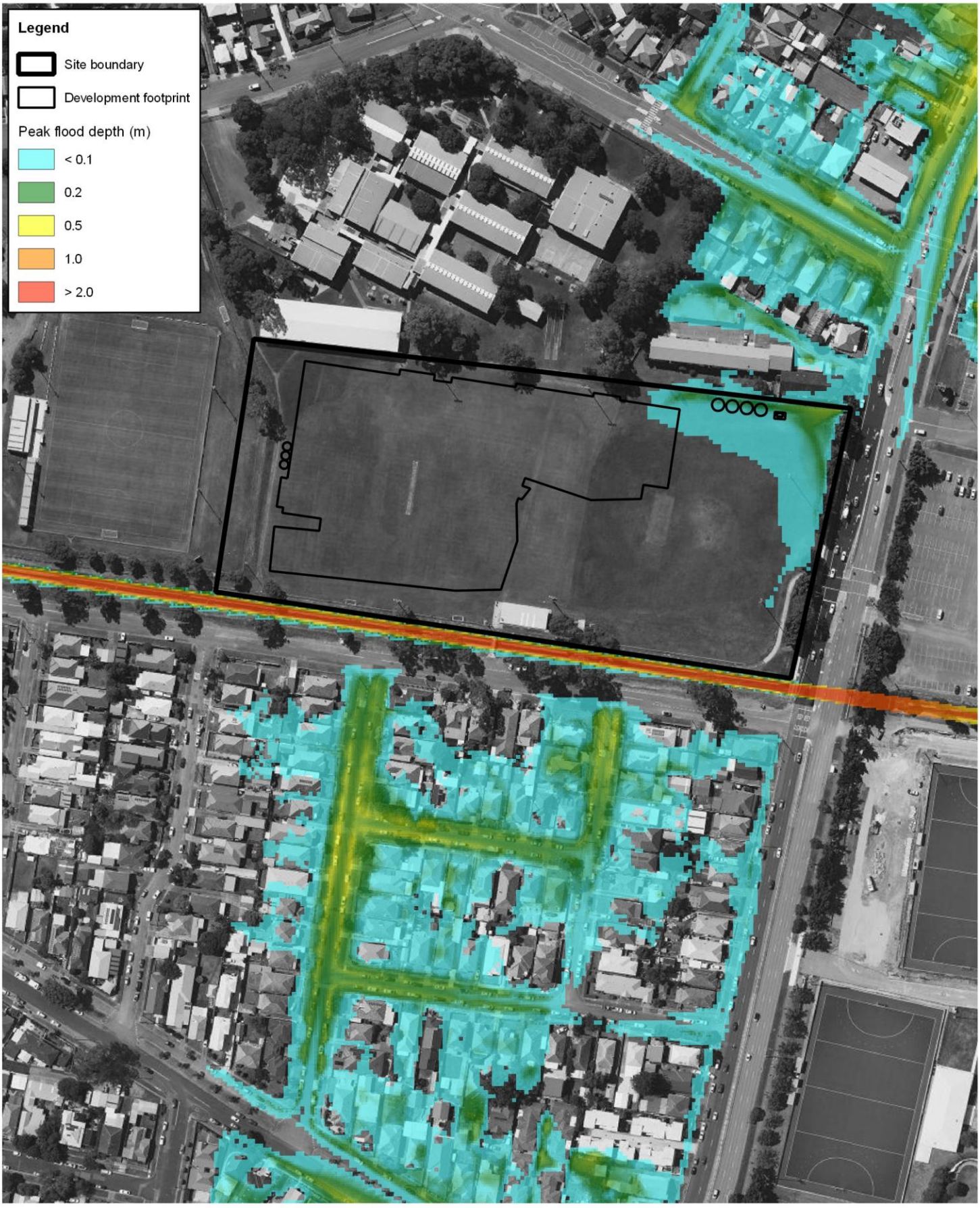

Title:

Modelled 10% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **4-4**

Revision: **D**

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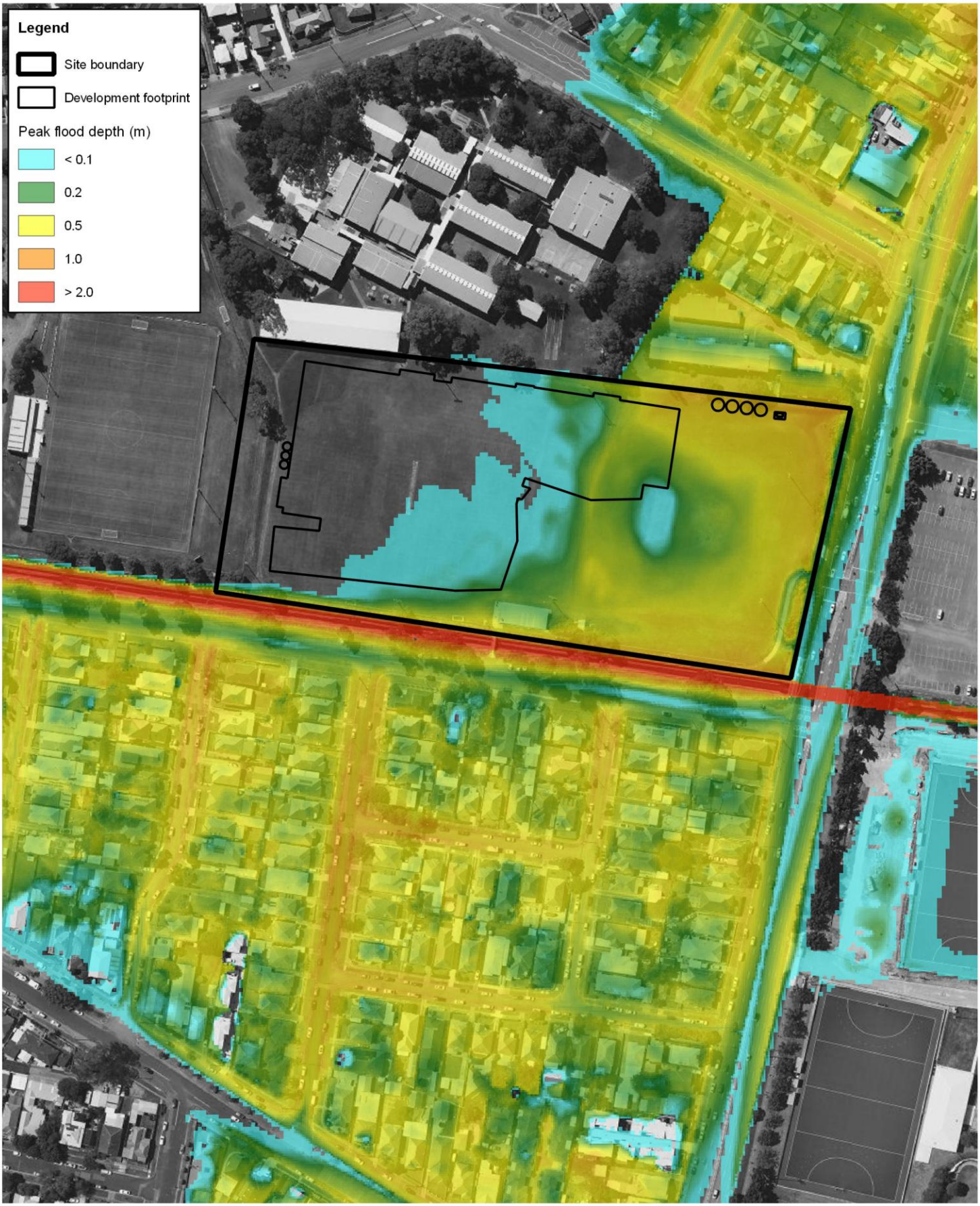

Title:

Modelled 1% AEP (2050) Peak Flood Depth

0 60 120 m

approx. scale

Figure: **4-5**

Revision: **D**

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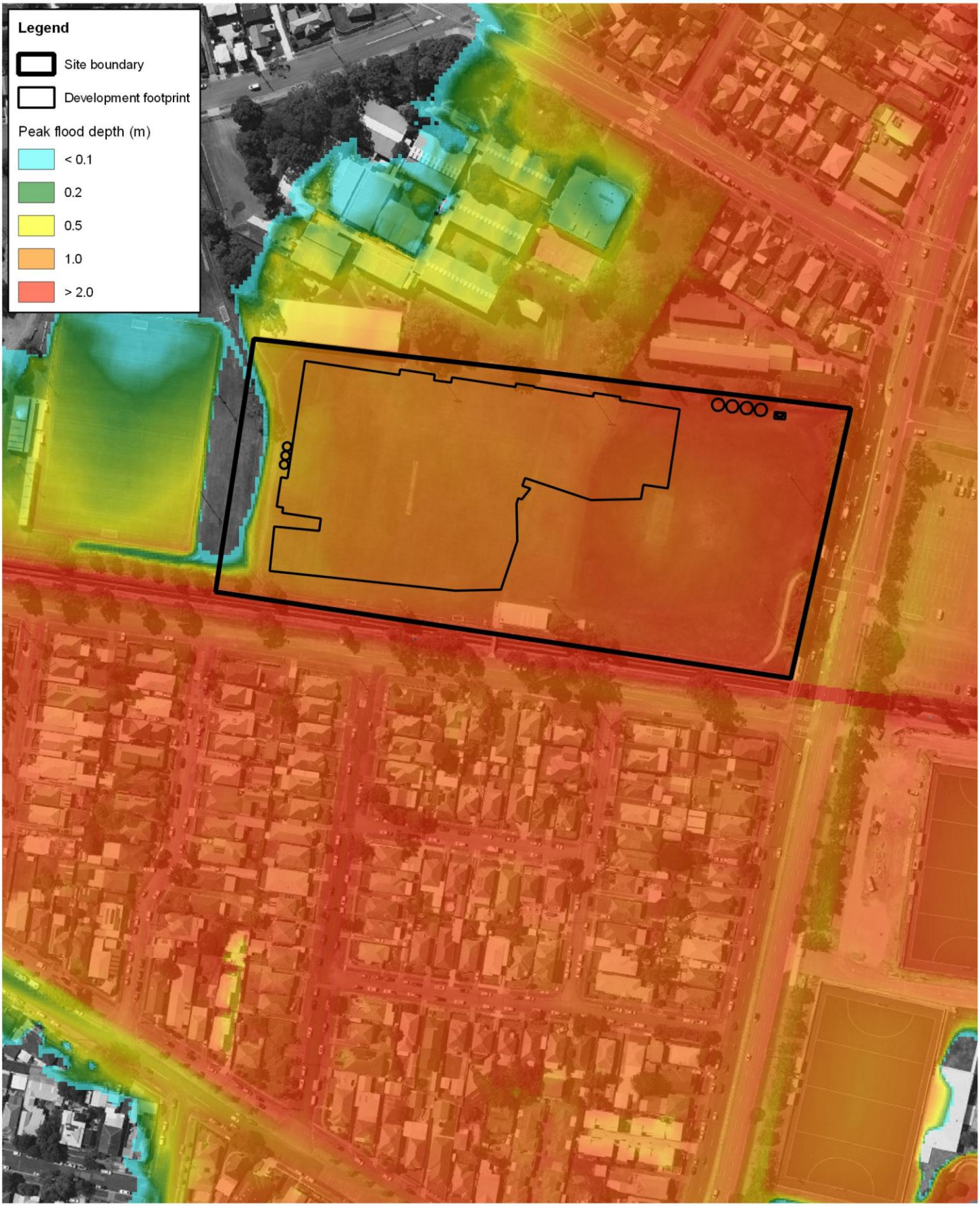

Title:

Modelled PMF Peak Flood Depth

0 60 120 m

approx. scale

Figure: **4-6**

Revision: **D**

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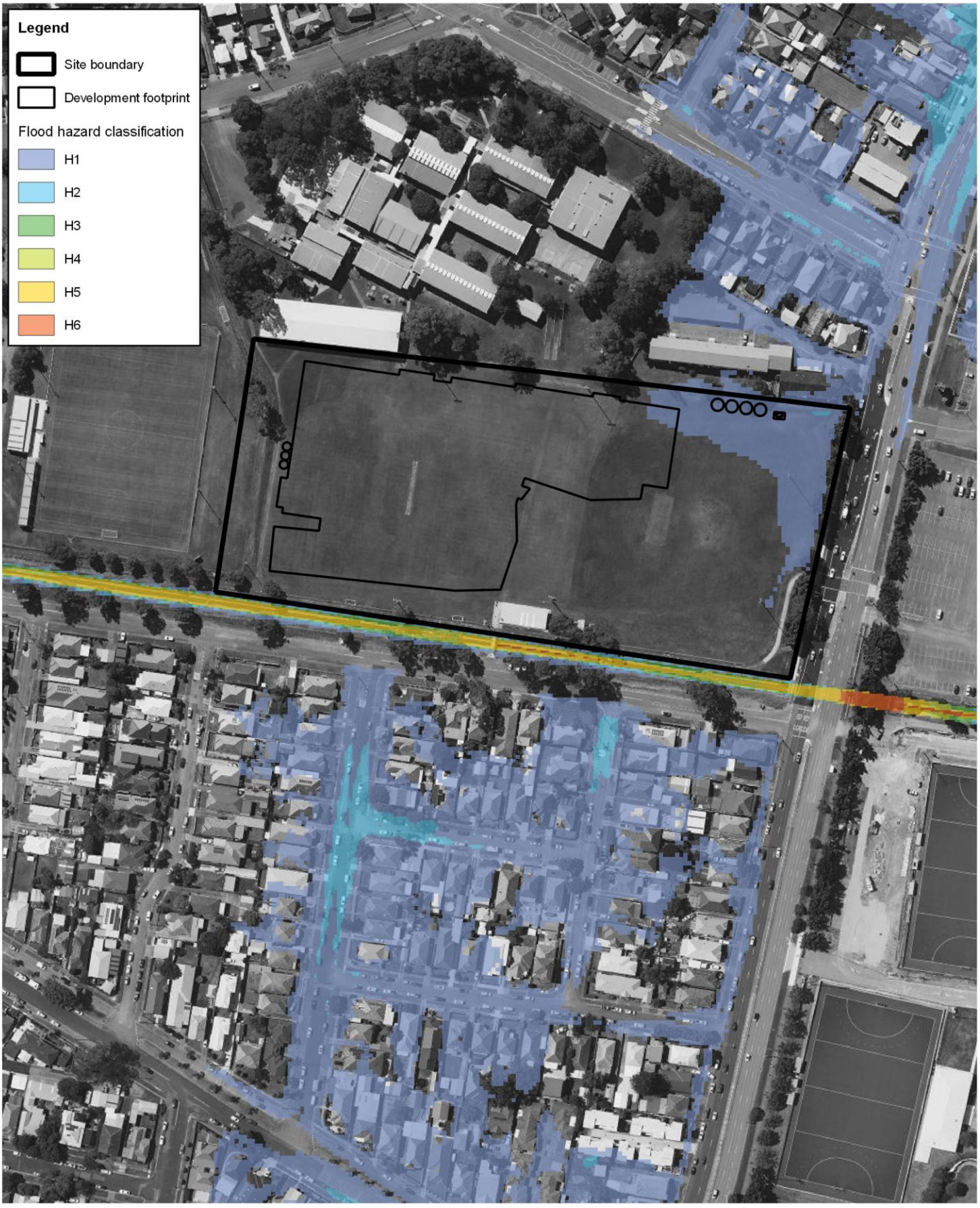

Title:

10% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **4-7**

Revision: **D**

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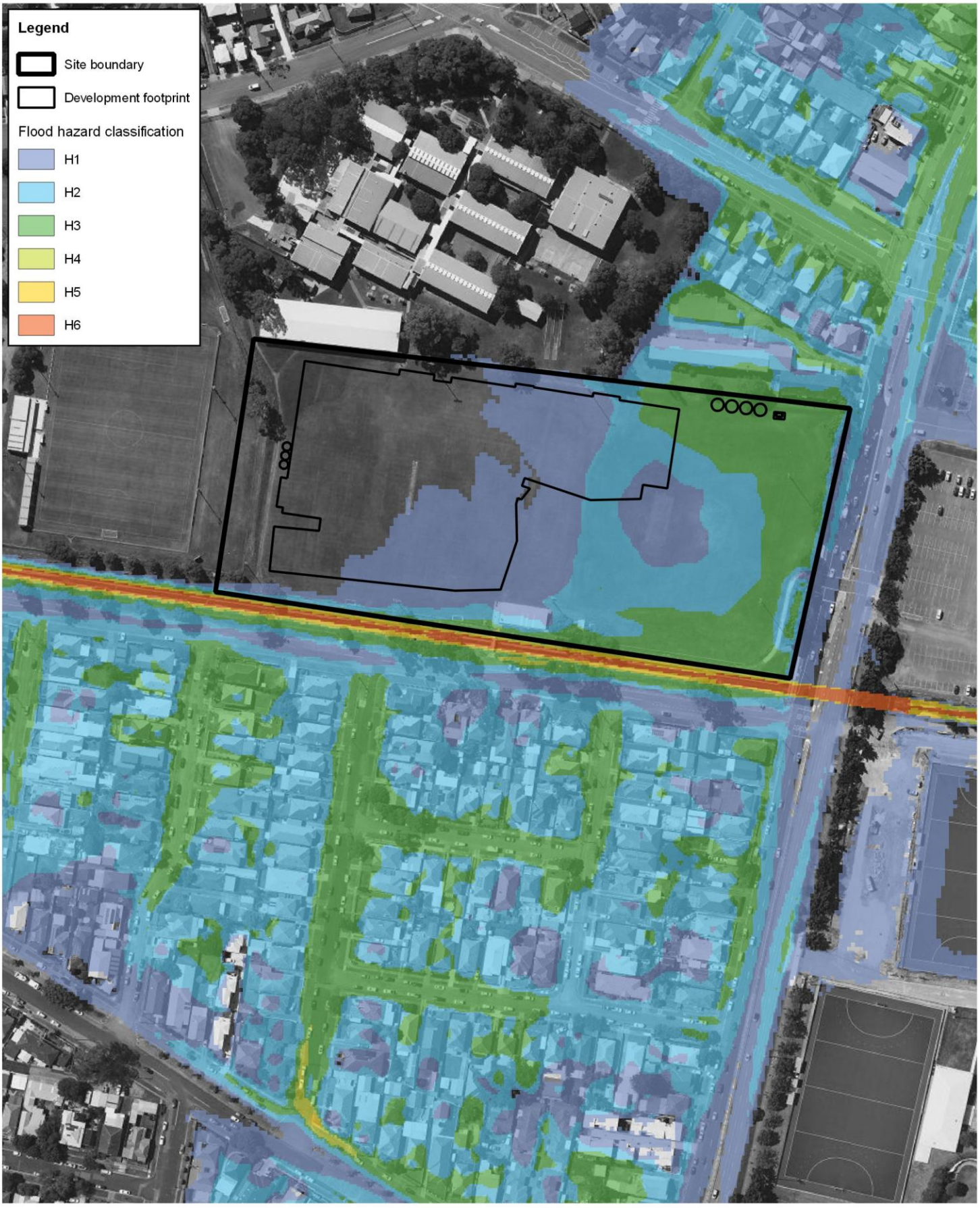

Title:

1% AEP (2050) Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **4-8**

Revision: **D**

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Title:

PMF Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **4-9**

Revision: **D**

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5 Proposed Development

5.1 Design Layout and Model Representation

The proposed development details relating to the building footprint and internal features were provided by EJE in an architectural drawing set (rev.C, dated 9 January 2026). The proposed finished surface levels for external areas were provided by Groundswell as a civil design surface triangulation (DESIGN TIN.dwg, dated 19 February 2026).

The design external surface levels were processed into a 0.5 m resolution digital elevation model and integrated into the TUFLOW model to modify the existing LiDAR survey elevations. The proposed building footprint was incorporated within the model as a hydraulic roughness value of 1.0. Other development details implemented in the TUFLOW model are the fire water tanks and electricity substation kiosk along the northern Site boundary.

Modifications were made to the proposed design during the response to submission stage, in which the building footprint was relocated around 20 m to the west, providing significant benefit to the management of flood risk. The relocation of the building facilitates the creation of a grassed swale area to be landscaped between the proposed car park and Turton Road. This aids the conveyance of floodwater within the Site floodway and in turn enables the finished surface level of the car park to be raised and limit the resultant flood hazard and risk exposure within the Site.

The hydraulic roughness values for external surfaces within the Site were modified to represent the proposed design, being set to 0.015 for areas of hardstand in the car park and surrounding the building, 0.04 for areas of turf and where the existing ground cover will remain, 0.05 for areas of native vegetation planting and 1.0 for the building footprint and ancillary structures, as identified in Figure 5-1. Scattered tree planting is acceptable throughout the planting areas (including the modified ones) as the hydraulic roughness is dominated by the groundcover.

The proposed bridge structure spanning the swale was incorporated using the layered flow constriction functionality in TUFLOW, with appropriate blockage factors and hydraulic losses to represent the substructure and superstructure components.

5.2 Flood Impact Mitigation

Although off-site flood impacts associated with the proposed development are minimal, an additional effort was made to further reduce the modelled impacts. The swale that runs north-south along the Turton Road frontage of the Site is the principal flood mitigation measure, improving the efficiency of the floodway located there. The swale provides a flood storage and conveyance function and is around 95 m in length. It has a bed width of around 5 m at the southern end, increasing to around 16 m at the northern and 1-in-4 sloped batters. The swale will remain free of vegetative planting, with a covering of maintained grass.

Other improvements have been made to the design in terms of flood hydraulics performance since the previous submission of June 2025. This includes the retention of a 3 m wide buffer zone to the north of the existing shared path that runs along the northern side of Lambton Ker-rai Creek. Whilst the principal function of this buffer zone is to facilitate future widening of the shared path, retaining this as a maintained grass verge and excluding heavier vegetative planting provides a lower resistance to the flow of flood waters.

Title:

Developed Model Roughness and Stormwater Drainage Representation

0 20 40 m

approx. scale

Figure: **5-1**

Revision: **D**

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Details of the stormwater drainage within Turton Road have also been incorporated within the TUFLOW model, as shown in Figure 5-1. This infrastructure was not significant enough to have been included within CN's Throsby, Styx and Cottage Creeks Flood Study and was therefore also not within the modelling originally developed for this assessment. Inclusion of the Turton Road stormwater drainage has enabled the proposed internal Site stormwater drainage design associated with the Project to be incorporated and assessed.

The proposed stormwater drainage design includes four west-east pipe alignments draining the Stage 1 car park into Lambton Ker-rai Creek, a pipe draining the southern end of the swale into the creek and a headwall at the northern end of the swale connecting into the existing Turton Road stormwater drainage. The assessment found that providing the maximum feasible size of 300 mm diameter pipes for the Stage 1 car park drainage also helps reduce the level of off-site flood impacts, improving flood flow conveyance through the Site.

The combination of these improvements provided a few mm benefit to the modelled off-site impacts to peak flood levels.

5.3 Post-Development Flooding Conditions

The models developed to establish existing flood conditions have been modified to represent post-development conditions as described above.

Figure 5-2 to Figure 5-4 show the modelled peak flood depth mapping under post-development conditions for the 10% AEP, 1% AEP (2050) and PMF events. The corresponding flood hazard mapping is provided in Figure 5-5 to Figure 5-7. Flood depth and hazard mapping for additional design events under post-development conditions is provided in Appendix B, together with flood velocity mapping for all events.

The raising of finished surface levels within the proposed car parking areas results in slightly shallower flooding than the existing conditions, with deeper flooding in the grassed swale area, as evident in the flood hazard classification at the 1% AEP event, where the extent of medium hazard (H3-H4) in the Site is confined to the swale and shared pathway areas, with low hazard (H1) conditions in the car park. The obstruction of the proposed building re-distributes flood flows through the Site at the PMF event, concentrating them through the car parking areas, as evident within the mapping of the high hazard (H5) distribution.

5.4 Impact Assessment

The relative impact of the proposed development has been considered in terms of potential changes to existing flood behaviour. The modelled change in peak flood level and flood velocity distribution is mapped for the 10% AEP, 1% AEP (2050) and PMF events, with flood level impact maps provided in Figure 5-8 to Figure 5-10 and the flood velocity impact maps provided in Figure 5-11 to Figure 5-13. Flood impact mapping for additional events is provided in Appendix C, together with the mapped percentage change in modelled peak velocity and the change in mapped flood hazard class for all events.

At the 10% AEP event the impacts are largely limited to a change in the extent of on-site flood inundation due to the regrading of the Site and creation of the large swale.

Title:

Modelled 10% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **5-2**

Revision: **D**

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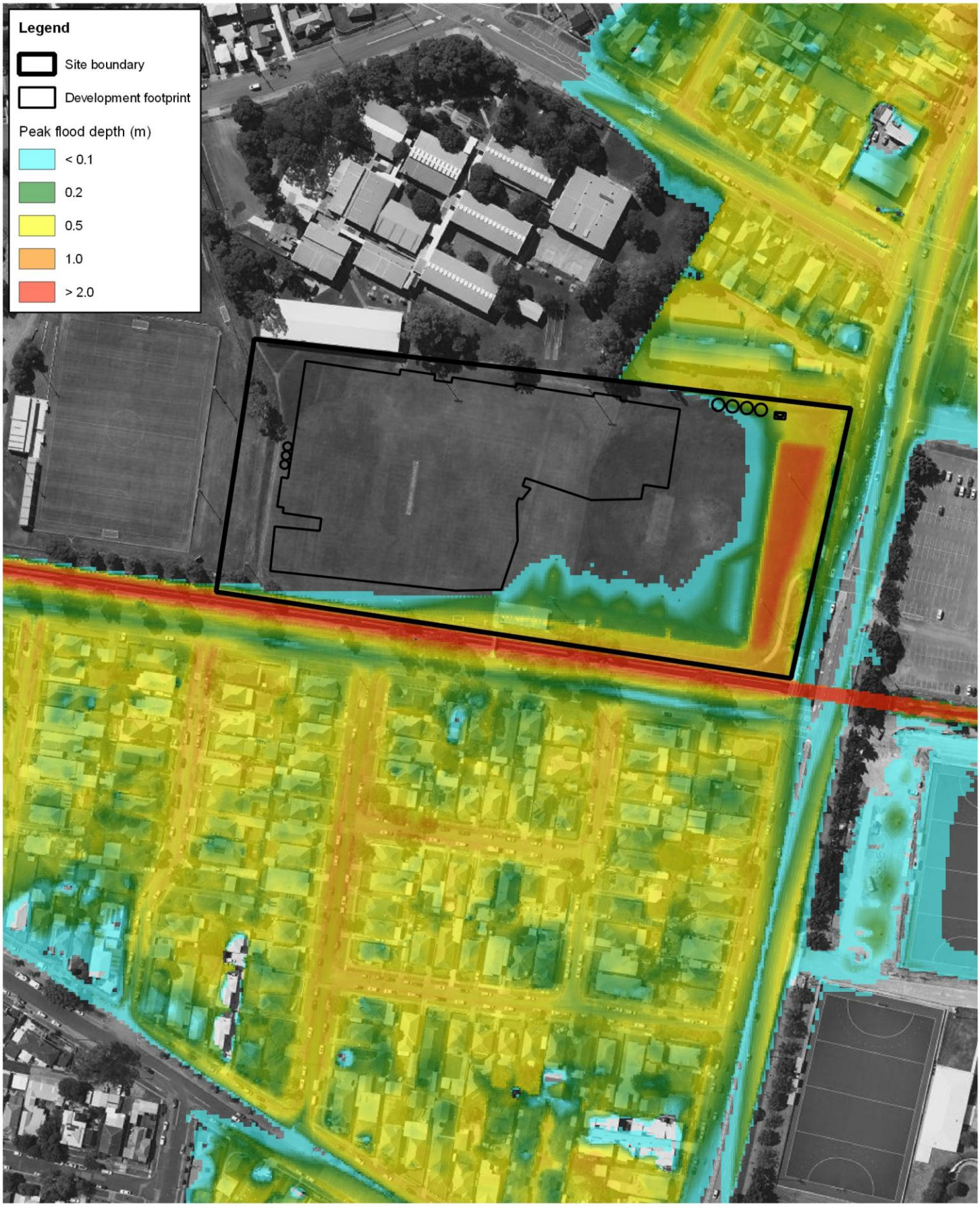

Title:

Modelled 1% AEP (2050) Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **5-3**

Revision: **D**

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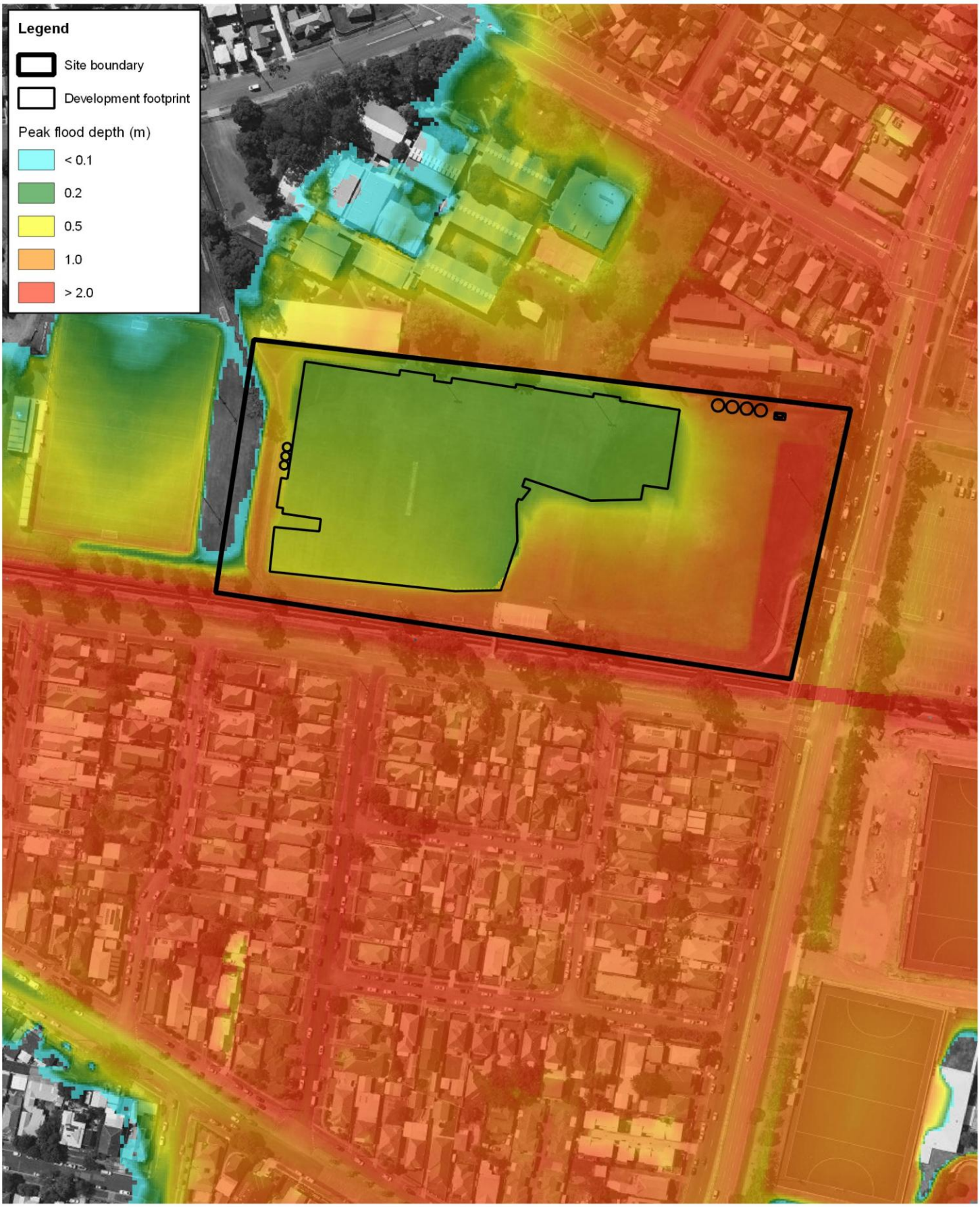

Title:

Modelled PMF Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **5-4**

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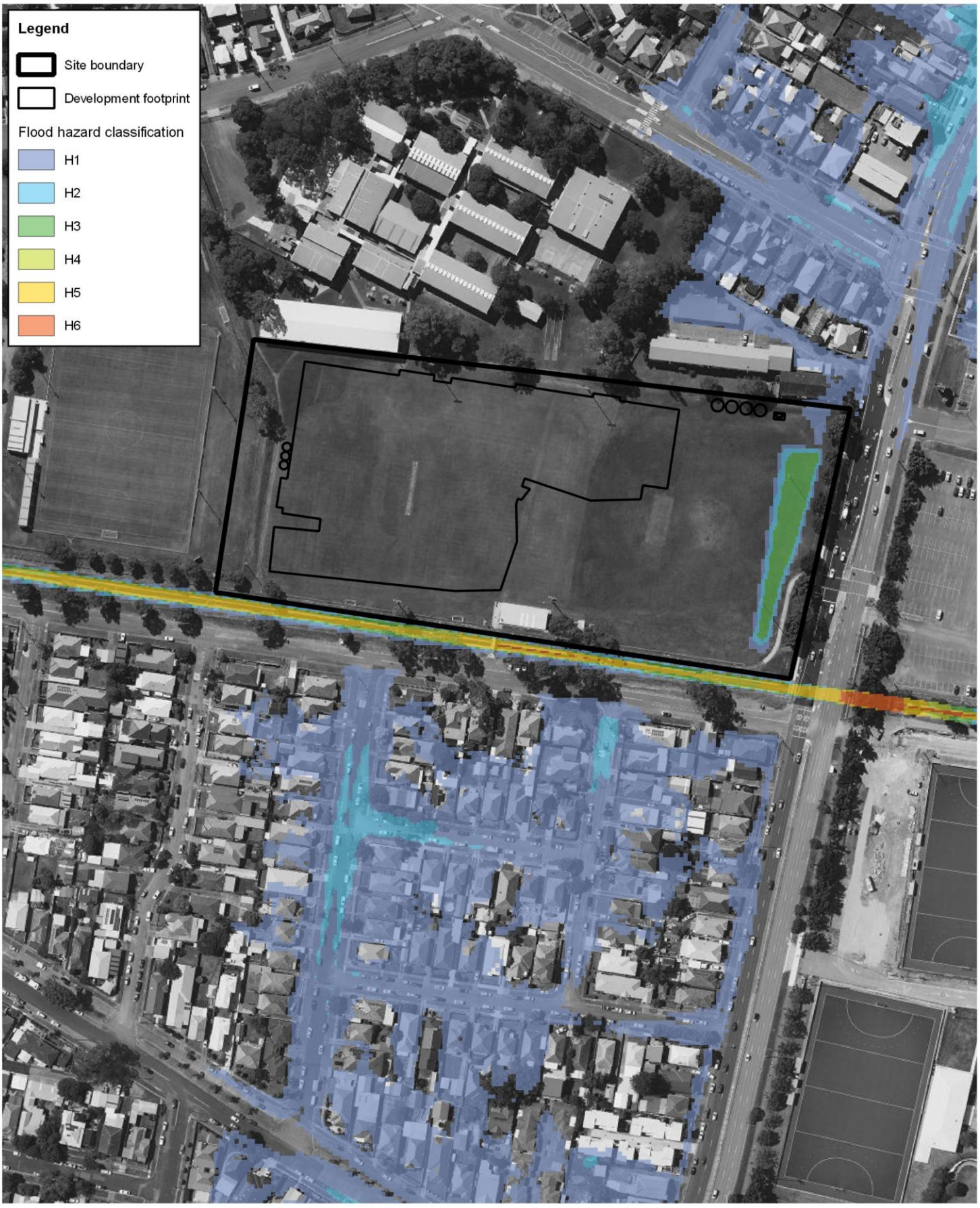

Title:

10% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **5-5**

Revision: **D**

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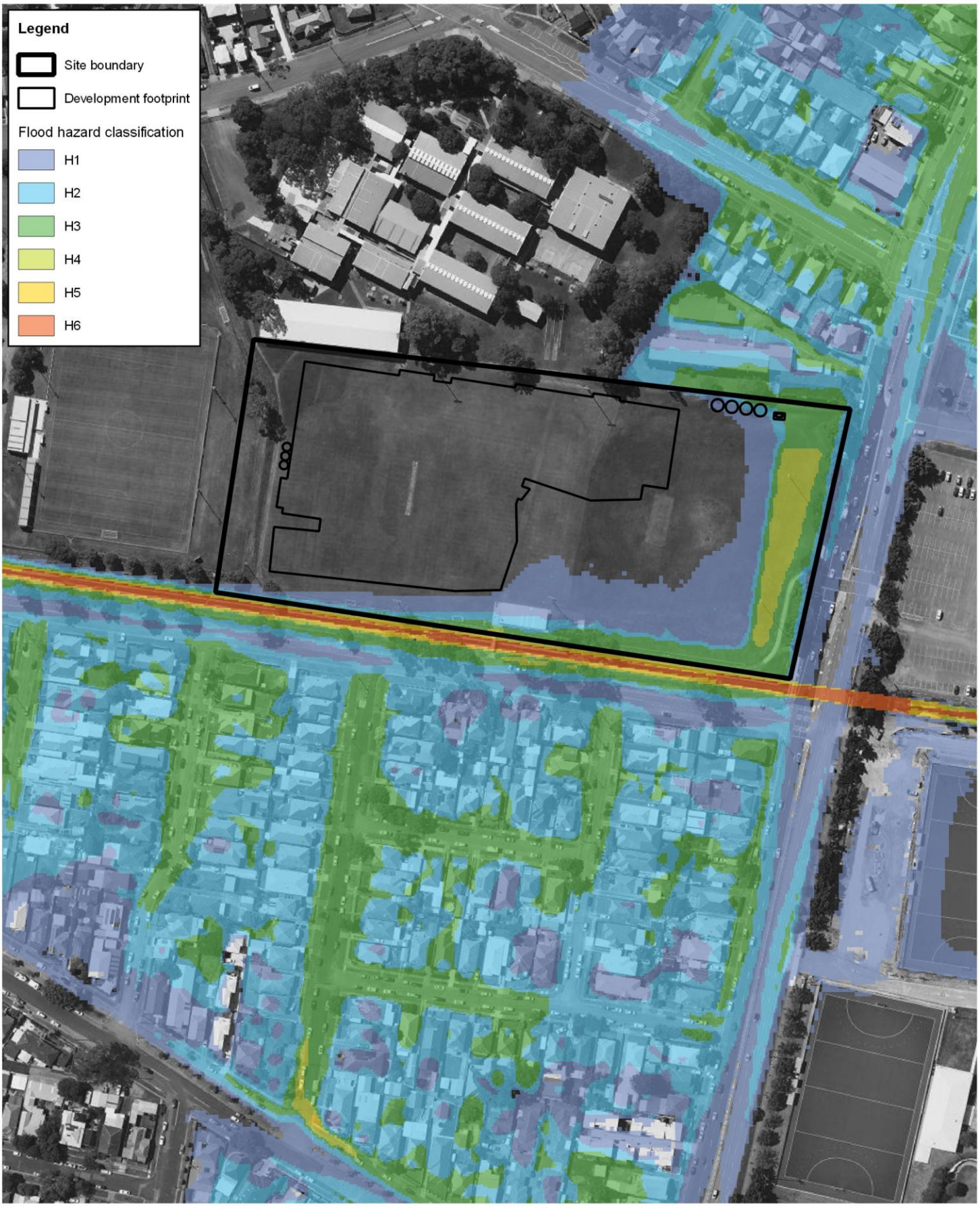

Title:

1% AEP (2050) Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **5-6**

Revision: **D**

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Title:

PMF Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: 5-7

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Title:

Modelled 10% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **5-8**

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Title:

Modelled 1% AEP (2050) Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **5-9**

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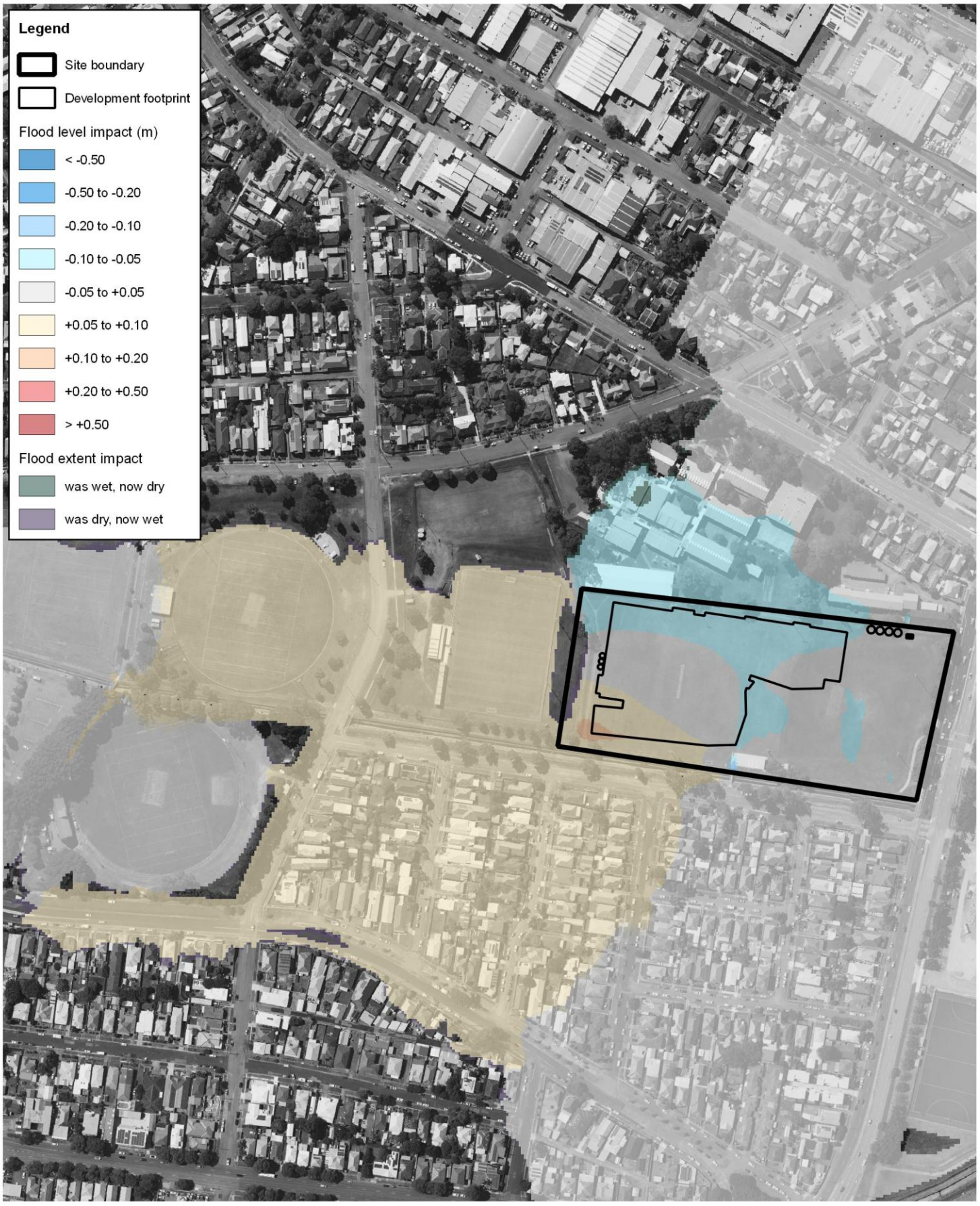

Title:

Modelled PMF Peak Flood Level Impact

0 100 200 m

approx. scale

Figure: **5-10**

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Title:

Modelled 10% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **5-11**

Revision: **D**

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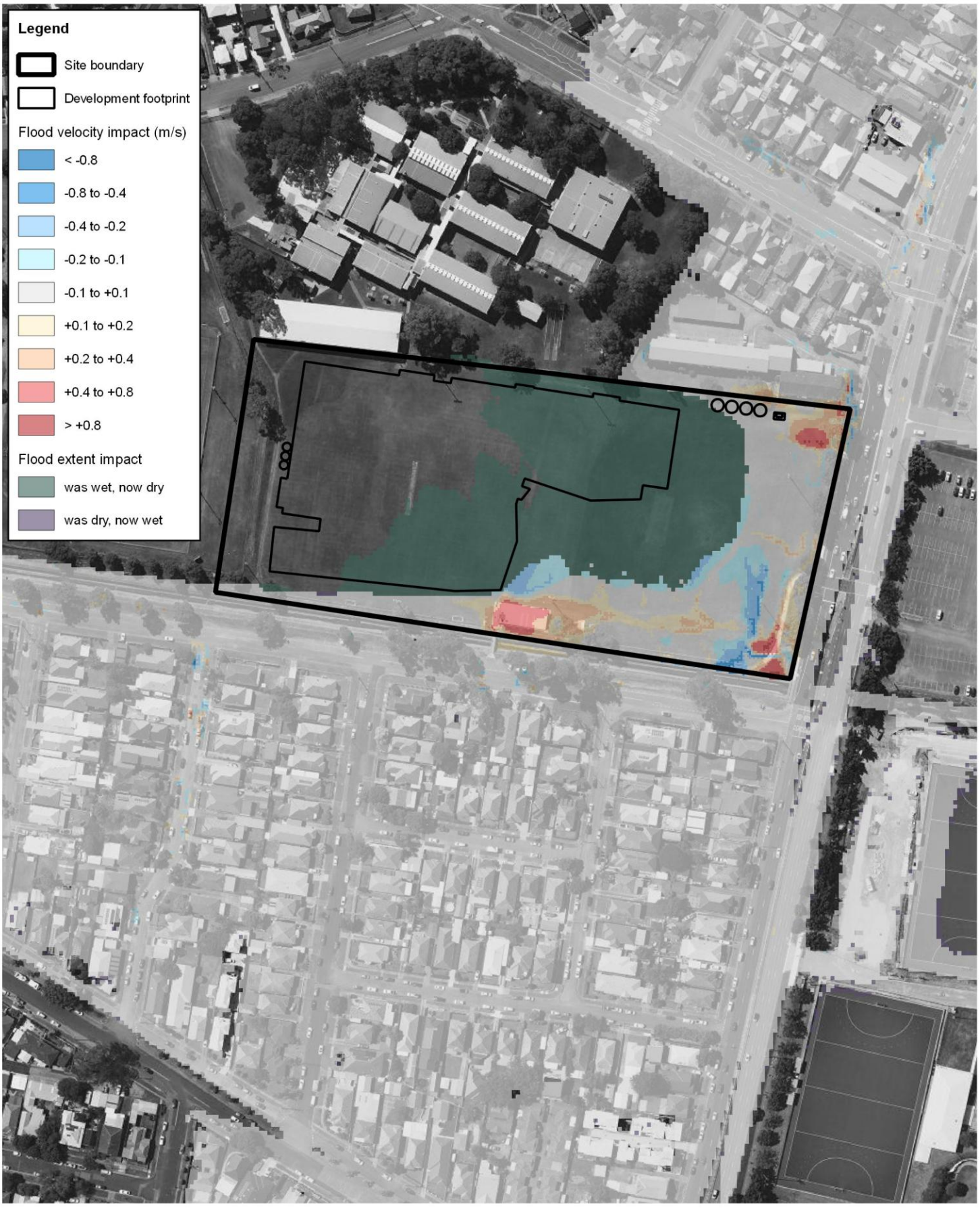

Title:

Modelled 1% AEP (2050) Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **5-12**

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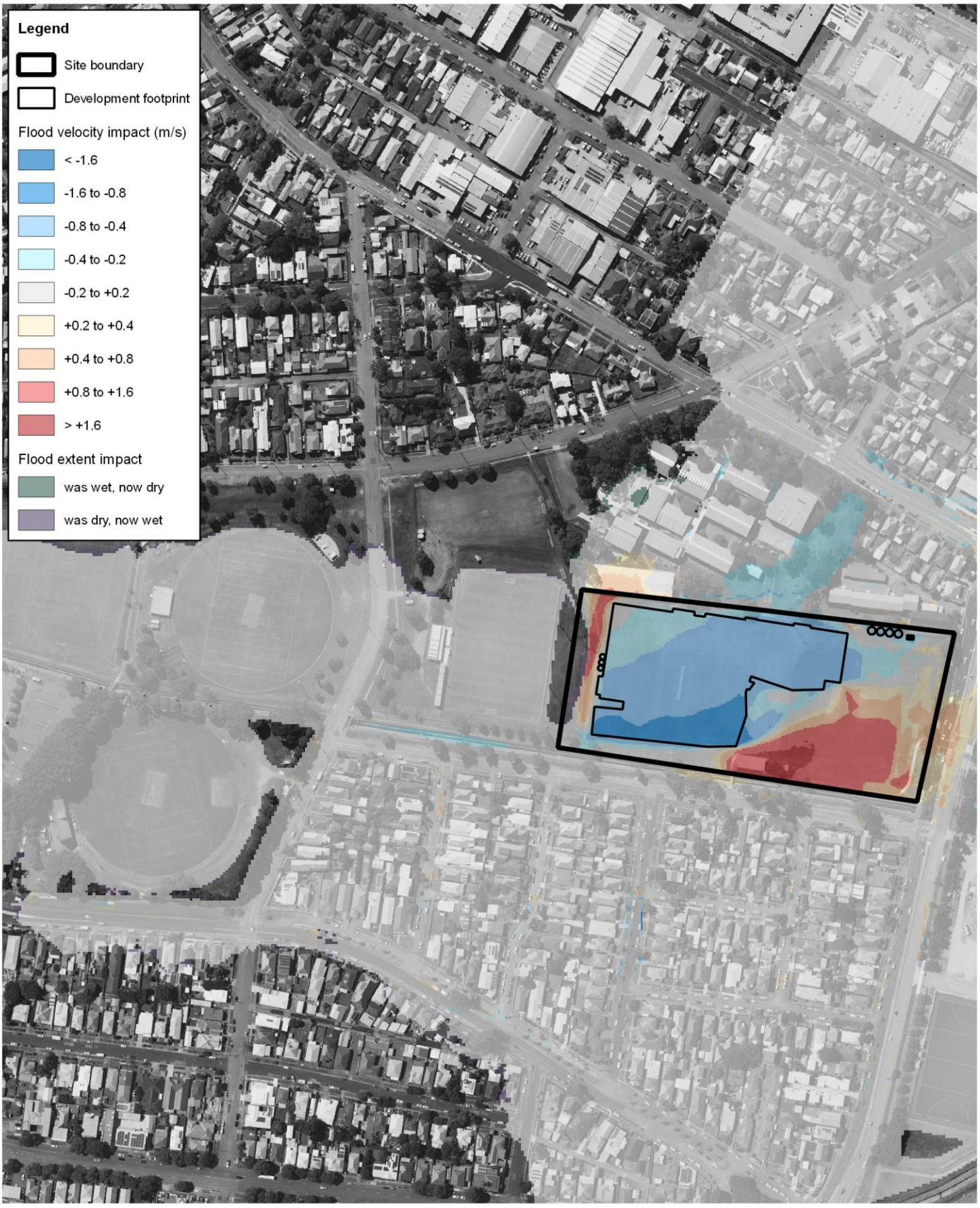

Title:

Modelled PMF Peak Flood Velocity Impact

0 100 200 m

approx. scale

Figure: **5-13**

Revision: **D**

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At the 1% AEP (2050) event the raising of the proposed car park level slightly reduces the flow path through the Site, resulting in a localised increase in modelled peak flood level of 20-30 mm within the Site. The modelled impact reduces off-site to around 15 mm within the Monash Road corridor and around 10 mm along the northern property boundaries along Monash Road. To ensure that the modelled off-site impacts are acceptable, the modelled change in 1% AEP 2050 peak flood level was interrogated at all local residential properties, to ensure that the desired 10 mm impact limit was satisfied.

The modelled change in peak flood velocity distribution is effectively contained within the Site and is a function of the removal of the existing building structure along the southern boundary and the creation of the grassed swale area, both of which result in localised increases to the velocity. Baseline velocities within and downstream of the existing building footprint are 0.0-0.2 m/s, which increase to 0.4-1.0 m/s following demolition. Along the swale alignment the baseline velocities are 0.2-0.6 m/s. These remain relatively consistent in the post-development scenario but locally increase up to 1.5 m/s where water spills into the swale at the southern end and 1.0 m/s where water spills from the swale at the northern end.

At the PMF event the obstruction of the proposed building results in a modelled increase of peak flood level of 50-70 mm between approximately the Harker and Ford Ovals to the west and Marina Avenue to the east. There is a corresponding reduction in modelled peak flood level of 60-80 mm at Lambton High School, which is sheltered by the proposed development.

The modelled change in peak velocity distribution is again largely contained within the Site, albeit with some minor extension beyond the Site boundary. Within the Site, the displacement of convective flows by the proposed building increases the flood velocity within the proposed car park area, where baseline velocities of 0.4-0.6 m/s increase to 1.5-2.5 m/s. There is also an increase around the western side of the building, where baseline velocities of 0.1-0.3 m/s increase to 0.9-1.5 m/s. Off-site there are localised velocity increases within Turton Road from a baseline of 0.8-1.8 m/s up to 1.1-2.2 m/s. Within the outdoor covered area in the south-west corner of Lambton High School the baseline velocities of 0.1-0.2 m/s are increased to 0.3-0.7 m/s.

There is significant uncertainty in modelling the extreme hydraulic conditions of the PMF event, as there would be widespread destruction of property and scour erosion, which cannot be represented within the model. Therefore, absolute changes in modelled peak flood level or velocity are not typically scrutinised in flood impact assessments.

The principal consideration for flood impact assessment at the PMF event is any potential wholesale change in flood risk profile, such as the creation of new flood flow paths or the changing of low hazard flood environments to high hazard ones. Comparison of the pre- and post-development PMF hazard mapping in Figure 4-9 and Figure 5-7 confirms that the high hazard distribution remains relatively consistent. The most significant off-site change is locally within some of the surrounding roads, where the existing flood hazard of H4 becomes H5. However, because this does not change the overall trafficability of the roads, this does not represent a tangible adverse impact.

In their review of the initial submission CN requested that additional mapping be provided showing the change in modelled peak flood velocity as a percentage change from baseline conditions and the change in mapped flood hazard category between baseline and post-development conditions. These additional mapping series are included within Appendix C.

A percentage change in flood velocity is typically used at a full floodplain width scale (as used for the assessment of large levee and dam constructions within inland watercourse floodplains) and does not translate well to detailed spatial mapping of 2D model outputs. For example, if the baseline velocity is locally 0.1 m/s and is increased to 0.5 m/s then this represents a 500% increase in velocity impact even though the tangible impact of this is negligible. Even very minor changes to modelled peak velocity can map as large percentage impacts when the baseline velocity condition is low, highlighting modelling artefacts as well as true expected changes.

Therefore, the mapping presented in Appendix C has been shown as no change in the modelled velocity percentage where the resultant absolute modelled peak flood velocity does not exceed 1.0 m/s. This was initially tested at a threshold of 0.5 m/s but there were still some model artefacts being exhibited at velocities of closer to 0.6 m/s. The threshold could even be increased to 1.5 m/s as that is the lower bounds of scour erosion considerations. Overall, the change in peak velocity percentage mapping reflects the change in absolute peak velocity mapping, being principally due to the removal of the existing building structure and spilling of water into the swale, plus displacement of flows around the proposed building at the PMF event.

Change in modelled flood hazard class is also something that doesn't translate well to detailed spatial mapping when considering an absolute change in hazard class at a cell-by-cell basis. There are inevitably a large proportion of model cells for which the baseline results are close to the threshold values between being mapped as one hazard class or another. Small changes in the model results (particularly peak flood depth) can increase the mapped hazard class within a model cell and exaggerate the visual impression of impact when mapped as a change in hazard class. It is therefore difficult to read too much into mapped changes in flood hazard class of +/-1 (unless extending across a significantly large area), with only changes of +/-2 or more being indicative of clear tangible changes in flood hazard from the baseline conditions.

Within the change in flood hazard mapping provided in Appendix C, the clearest impact is the increased flood hazard conditions within the proposed swale area, resulting from the lowering of the existing ground surface and increased flood depths. However, this increased depth of water within the swale is necessary to provide the required conveyance capacity for flood waters flowing through the Site, in either a northerly or southerly direction adjacent to Turton Road.

There is also a reduction in hazard within the proposed car parking areas, where the existing ground surface is being raised and flood depths reduced. At the 0.5% AEP, 0.2% AEP and PMF events there are some minor localised impacts mapped in off-site areas, attributable to the sensitivity discussed previously. However, the mapped increase in flood hazard within Turton Road at the PMF event is a genuine representation of the proposed development, as noted previously.

Overall, the modelled flood impacts are minor and represent a negligible change in flood risk to existing property and infrastructure. This confirms the compatibility of the proposed development design with the existing flood function and that retention of the secondary floodway that is mapped across the Site at the PMF is not essential.

In their review of the initial submission CN expressed concern with the modelled off-site peak flood level impacts at the PMF event, which were locally as high as +140 mm. An ideal limit of +50 mm was suggested, with an allowance of +100 mm for cumulative development. Torrent Consulting has significant reservations regarding these thresholds as given the extreme rarity of occurrence (best estimate of a 1-in-10,000,000 AEP, as per Figure 4-1), together with the substantial uncertainty

(widespread destruction of buildings and extensive scour erosion) and model sensitivity to any development within the floodplain, as demonstrated by the Honeysuckle Redevelopment Area and Broadmeadow Place Strategy. The adoption of such restrictive thresholds is extremely challenging to achieve in balance with other constraints and benefits, contrary to both the philosophy of the NSW Floodplain Management Manual and Engineering principles.

A supporting argument for the adoption of these thresholds by CN is to preserve the integrity of flood refuge requirements that are in place for re-development of the floodplain areas across the city, which have floor levels set at or above the PMF level and so the PMF level needs to remain relatively static. Whilst the rationale behind this position is appreciated, the notion that changes in PMF level greater than +100 mm compromise the effectiveness of flood refuges is misplaced, for reasons including the following:

- With the significant uncertainty associated with extreme flood estimation, the function of the flood refuges can only serve as an intention to safeguard people from all but the very worst possible outcome and not as an absolute guarantee of immunity
- If the PMF level is increased by 100 mm the adopted refuge levels are still going to be above most theoretical extreme flood occurrences, e.g. a 1-in-5,000,000 AEP event rather than 1-in-10,000,000 AEP event
- The flood refuges are set at or above the modelled PMF level when their intended function is to safeguard life in the most extreme of flood event scenarios and they will still perform this intended function even if subject to some degree of internal flood inundation
- Often the floor level of a nominated flood refuge is set at the first floor level of a re-developed residence, as it is usually a preferable outcome to the construction of a separate dedicated flood refuge space, for example, the residential area to the south of the Site has ground surface levels in the order of 8.0 m AHD and a PMF level in the order of 9.7 m AHD and so first-floor flood refuges will have a substantial freeboard above the PMF level, particularly given that the FPL for setting the finished ground floor levels is around 9.0 m AHD.

Nevertheless, despite being extremely challenging thresholds to satisfy, it is considered that the modelling results of the flood impact assessment demonstrate compliance with the desired outcome. The modelled off-site peak flood level impacts are only +60-70 mm at the PMF event, which only just exceeds the +50 mm threshold and is well within the +100 mm threshold for cumulative development. The development of the Site represents the majority of what could potentially affect the modelled area of impact, with (hypothetically) the future development of Arthur Edden Oval being the only other area of open space that if filled would directly impact the same area being impacted by the proposed development.

5.4.1 Impact of On-site Detention

In the pre-DA meeting CN expressed a concern regarding the proposed development not including on-site detention (OSD) of stormwater. OSD was omitted from the design because the Site in constrained by flood water inundation at intermediate events such as the 10% AEP and 5% AEP. Further, the Site's location within the receiving environment of the catchment (below around 10 m AHD) rather than within the upper catchment, makes the potential benefit of OSD provision questionable.

Located within upper catchment areas, OSD limits the impact of development from increasing resultant peak runoff further downstream. However, further down the catchment, it can be more beneficial to let local stormwater discharge from a site earlier during a rainfall event to drain prior to the arrival of the peak flood flow from upstream.

With the Site being located at the inland end of the lower catchment, CN requested a modelling-based assessment to support the position that not providing OSD at the Site would not worsen downstream flood conditions.

To assess this impact Northrop provided modelled Site runoff hydrographs for the post-development condition both with and without the provision of OSD, for the 10% AEP and 5% AEP 2-hour duration rainfall events. The 2-hour duration event was used as this is consistent with the catchment flood simulations.

The hydrographs were input to the TUFLOW model, and the 10% AEP and 5% AEP flood conditions were simulated for the with OSD and without OSD scenarios. The modelled flow hydrographs downstream of the Site were compared at Turton Road for both the Lambton Ker-rai Creek channel and the overflow along Turton Road to the north. This confirmed that the modelled flood conditions displayed only minor sensitivity to the OSD scenario, as shown in Table 5-1.

The impact of on-site detention assessment was not updated during the response to submissions stage as it has previously been confirmed to have a negligible impact on existing flood conditions and does not warrant re-visiting.

Table 5-1 Modelled OSD Scenario Peak Flows (m^3/s)

Design Scenario	Channel	North
10% AEP with OSD	25.7	1.21
10% AEP without OSD	25.7	1.19
5% AEP with OSD	26.5	2.53
5% AEP without OSD	26.5	2.50

5.4.2 Cumulative Impact of the Broadmeadow Place Strategy

The Broadmeadow Place Strategy is a key planning document which provides a blueprint for how the area will change over the next 30 years and caters for an increased population. The technical document *Housing the Hunter: a plan for renewal at Broadmeadow – Flooding and Water Cycle Management Report* (Rhelm, 2025) includes a FIRA.

Flood impact mapping is included within Appendix B of the FIRA for the Broadmeadow Place Strategy. This identifies that the Site and surrounding area are expected to see a reduction in peak flood levels in the order of 0.2 m for rare to extreme flood events such as the 1% AEP and PMF.

The modelling undertaken in this FIRA for the proposed Hunter Indoor Sport Centre does not take account of the expected change in flood conditions associated with the Broadmeadow Place Strategy, with the current development conditions being used as the baseline for assessment. Whilst the modelling of cumulative development impacts for the Broadmeadow Place Strategy and

Hunter Indoor Sport Centre is beyond the scope of this assessment, it is reasonable to assume that the impacts of each can be summed to estimate the expected cumulative impacts. This would see peak flood level impacts in the area surrounding the Site remain close to -0.2 m at the 1% AEP 2050 event and become closer to -0.15 m at the PMF event.

Whilst the proposed development results in some minor increase to the local modelled peak flood levels, when combined with the expected outcome of the Broadmeadow Place Strategy, there will still be a significant overall reduction in peak flood levels.

6 Flood Risk Management

6.1 Newcastle LEP

As established in Section 2.2, development consent must not be granted unless the consent authority is satisfied that the development:

> *(a) is compatible with the flood function and behaviour on the land, and*
>
> *(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and*
>
> *(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and*
>
> *(d) incorporates appropriate measures to manage risk to life in the event of a flood, and*
>
> *(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*

Items (a), (b) and (d) are closely related, as to demonstrate compatibility of development with the flood function and behaviour of the land requires both the off-site flood impacts and the management of flood risk to be adequately addressed. The flood impact assessment presented in Section 5.4 has concluded that the proposed development will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties. The incorporation of appropriate measures to manage risk to life in the event of a flood is a requirement of the Newcastle DCP and is demonstrated in Section 6.2.

Item (c) is dependent on a suitable flood emergency response, which is addressed in Section 7. Item (e) relates to natural watercourses and so is not applicable to the Site given the nature of the constructed drainage infrastructure. Nevertheless, the flood impact assessment in Section 5.4 did not identify significant changes in the flood velocity distribution that would provide concern even if the Lambton Ker-rai Creek was a natural watercourse.

6.2 Newcastle DCP

As established in Section 2.2, the Newcastle DCP specifies controls which are to be met for the development of flood-prone land, which fall under four objectives:

- The retention of floodways
- The protection of flood storage areas
- The management of risk to property
- The management of risk to life.

The assessment of the proposed development against the requirements of these four objectives is addressed in Section 6.2.1 to Section 6.2.4.

6.2.1 Floodways

The planning controls relating to the retention of floodways are:

- C-1: no building or structure can be built, and no land can be filled with any materials in areas identified as floodways, except for small changes to ground levels that do not significantly change the flow patterns for roads, parking, below ground structures or landscaping.
- C-2: where dividing fences across floodways are unavoidable, they are constructed only of open type fencing that does not restrict the flow of flood waters and are resistant to blockage. New development is designed to avoid fences in floodways.

As discussed in Section 2.3.1 and shown in Figure 2-1 and Figure 2-2, the existing flood behaviour within the Site is consistent with a floodway within land located at the eastern end of the Site, within which flood waters are conveyed northward from Lambton Ker-rai Creek to towards the Turton Road – Griffiths Road intersection. The proposed building and external surface design has deliberately avoided obstruction of this floodway. The minor structures of the fire water tanks and the electricity substation kiosk are located here but the flood impact assessment in Section 5.4 has confirmed that they do not adversely impact the existing flood function of the land.

CN's mapping in Figure 2-2 identifies a secondary floodway at the PMF event that flows across the location of the proposed building. However, with the other existing local hydraulic controls and the retention of the principal floodway through the east of the Site, the flood flows obstructed by the proposed building are readily re-distributed around the building without adversely impacting the existing flood function of the land at the PMF event, as confirmed through the flood impact assessment. The proposed development does not include any impermeable fence structures and so both conditions C-1 and C-2 are adequately satisfied.

6.2.2 Flood Storage Areas

The planning controls relating to the protection of flood storage areas are:

- C-1: not more than 20% of the area of any development site in a flood storage area is filled. The remaining 80% is generally developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction.
- C-2: where it is proposed to fill development sites, the fill does not impede the flow of ordinary drainage from neighbouring properties, including overland flow.

The capacity of the floodplain to store flood waters was assessed within the flood storage (and floodway) areas identified in CN's mapping for the 1% AEP (2050) and PMF events (refer Figure 2-1 and Figure 2-2, respectively). This found the existing flood storage volume within the areas mapped as floodway or flood storage to be around 8500 m^3 at the 1% AEP (2050) event and around 44 300 m^3 at the PMF event. The accuracy of calculation was improved during the response to submissions stage, with access to the CN/Rhelm modelling.

The calculation of the available flood storage volume within the areas mapped as floodway or flood storage post-development is around 6000 m^3 at the 1% AEP (2050) event and around 28 600 m^3 at the PMF event. This represents around a 71% and 64% retention of existing flood storage volume, respectively, which does not satisfy condition C-1. However, the results of the flood impact assessment show that an 80% retention is not required at the Site, as the modelled flood impacts are comparable to the application as lodged at the 1% AEP (2050) event and are improved at the PMF event, despite the application as lodged constituting a 95% retention of flood storage volume. This was a function of the existing ground surface levels within the proposed car park being

lowered within the original submission, whereas they are now being raised following the response to submissions.

Ultimately, the definition of flood storage at a catchment-wide flood study level is arbitrary and detailed site-specific flood impact assessment modelling is a more rigorous test as to the potential impact of a proposed development on flood function. Whilst not meeting the nominal storage retention specified in the DCP, the proposed development satisfies the intent of this requirement and has demonstrated as such through the modelling-based flood impact assessment.

A comparison of the existing and post-development surface levels around the perimeter of the Site has identified that the only location that the proposed development has the potential to impact local drainage is along the boundary with 303 Turton Road. The existing land at the rear of properties on the southern side of 303 Turton Road drains to a shallow swale that runs along the northern boundary of the Site and is located within the Site. As the stormwater drainage design for the proposed development is further progressed, measures should be incorporated to ensure that this location can still freely drain.

6.2.3 Management of Risk to Property

The planning controls relating to the management of risk to property from flooding are:

- C-1: floor levels of all occupiable rooms of all buildings are not set lower than the FPL.
- C-2: garage floor levels are no lower than the 1% 2050 AEP event. However, it is recognised that in some circumstances this may be impractical due to vehicular access constraints. In these cases, garage floor levels are as high as practicable.
- C-3: Basement garages may be acceptable where all potential water entry points are at or above the PMF, excepting that vehicular entry points can be at the FPL. In these cases, explicit points of refuge are accessible from the carpark in accordance with the controls for risk to life set out below.
- C-4: electrical fixtures such as power points, light fittings and switches are sited above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building.
- C-5: swimming pools are to be located to ensure they are not inundated from minor flooding events. Electrical connections and fixtures around swimming pools are to be sited at the FPL.
- C-6: Where parts of the building are proposed below the FPL, they are constructed of water-resistant materials.
- C-7: areas where cars, vans and trailers are parked, displayed or stored are only located in areas subject to property hazard of P1. Containers, bins, hoppers and other large floatable objects are not to be stored in these areas. Heavy vehicle parking areas can only be located in locations subject to P1 or P2 categories.
- C-8: timber framed, light steel construction, cavity brickwork and other conventional domestic building materials are generally suitable forms of construction where the property hazard is P1 to P4.
- C-9: property hazard of P5 is generally unsuitable for building construction and building is discouraged from these areas. Where building is necessary, the structure is certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.

- C-10: property hazard of P6 is unsuitable for any type of building construction.

The proposed development does not include garages, basement parking or swimming pools and so conditions C-2, C-3 and C-5 are not applicable.

The finished floor level of the proposed building is set at 9.2 m AHD, which is 0.3 m above the FPL nominated by CN. Therefore, condition C-1 is inherently satisfied. Because the internal areas are above the FPL, condition C-4 is also inherently satisfied.

The entire building structure will be located above the FPL and so conditions C-6, C-8, C-9 and C-10 are satisfied.

As shown in Figure 5-6, with the raising of the proposed car park levels, the resultant flood hazard exposure within the car park is limited to H1 at the 1% AEP (2050) event. This translates to a P1 risk to property hazard and so condition C-7 is satisfied.

6.2.4 Management of Risk to Life

The planning controls relating to the management of risk to life from flooding are:

- C-1: risk to life category L5 is generally unsuitable for building construction and building is discouraged from these areas. Reliable safe escape to high ground is likely not possible and normal building construction would likely suffer structural failure from the force of floodwaters, so that any people seeking refuge in the building would likely perish. Where building is necessary, the structure is certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.
- C-2: risk to life category of L6 is unsuitable for any type of building construction.
- C-3: the formation of islands in the floodplain during a flood is a potentially dangerous situation, especially when floods larger than the FPL totally inundate the island for an extended period. Development of such land is considered with great care.
- C-4: on-site refuge is to be provided for all development where the risk to life category is L3 or higher unless: the proposed development is less than 40 m from the perimeter of the PMF extent and the higher ground is accessible, or the proposed use is defined as commercial premises or industry in which case onsite refuge is only required where the hazard category is L4 or higher.
- C-5: where on-site refuge is required for a development, it should comply with the following minimum standards: the minimum on-site refuge level is the level of the PMF. On-site refuges are designed to cater for the number of people reasonably expected on the development site and are provided with emergency lighting, and on-site refuges are of a construction type able to withstand the effects of flooding. Design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF).
- C-6: emergency egress procedure for basements. A plan is developed detailing emergency egress procedures during a flood, as well as any refuge areas in reasonable proximity of the development. The plan is to be positioned in the basement car park in an easily recognisable location/s.

The proposed development does not include a basement, is not located on a flood island and is not located within a risk to life category of L6 and so conditions C-2, C-3 and C-6 are not applicable.

As shown in Figure 5-7, the highest flood hazard exposure to the proposed building at the PMF event is typically H3. However, there is a local H5 classification where flows within the proposed car park interface with the southern extent of the proposed building. This translates to an L5 risk to life hazard and so condition C-1 needs to be satisfied through structural certification that the proposed building can withstand the expected hydraulic loads of the PMF event. The modelled flood depths adjacent to the building at the PMF event are locally as high as 1.4 m, with peak velocities typically no higher than up to 1.7 m/s. Confirmation has been provided by Northrop (the Project Structural Engineers) that the proposed building can be designed to resist the expected forces of flood waters and remain structurally adequate.

The range of flood hazard conditions across the Site at the PMF event between H3 and L5 (corresponding to risk to life categories of L3 to L5) make the requirements to satisfy conditions C-4 and C-5 ambiguous. Nevertheless, both flood evacuation and on-site refuge are available options to the proposed development and are addressed in Section 7.

6.3 Planning Secretary's Environmental Assessment Requirements

The SEARs relating to flood assessment for the proposed specify that the EIS must:

- identify and describe any on-site flood impacts and risks associated with the proposed development, having regard to the relevant provisions of the NSW Floodplain Development Manual and other local or State studies and guidance.
- describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.
- assess the impacts of the development, including any changes to flood risk both on-site or off-site, and identify any mitigation and management measures to minimise the impacts of flooding on the proposed development.
- Provide a Flood Emergency Response Plan prepared by a suitably qualified person that addresses:
    - Likely flood behaviour;
    - Flood warning systems;
    - Education awareness program;
    - Evacuation and evasion procedures;
    - Evacuation routes and flood refuges; and
    - Flood preparedness and awareness procedures for visitors.
- address matters raised by Biodiversity Conservation Division (BCD) at Attachment B.
- address matters raised by CN at Attachment B.

The BCD requirements in Attachment B referenced above are consistent with those typically issued in SEARs and can be summarised as:

- Map flood prone land, the flood planning area and flood function.
- Describe the flood assessment and modelling undertaken.
- Include the 10% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events.
- Assess the impact of the proposed development on the existing flood behaviour.

The CN requirements in Attachment B request:

- Address the flood risks and flood impacts in accordance with the Newcastle DCP.
- Flood modelling to assess the impacts of the development on the existing floodways within the site.
- To not fill more than 20% of the flood storage area at either the 1% AEP or PMF event.
- Preparation of a Flood Emergency Response Plan.

The NSW Flood Risk Management (FRM) Manual 2023 provides an overarching philosophy and framework for the management of flood risk. It is supported by several guidelines dealing with different aspects of the floodplain risk management process, including flood impact and risk assessment. This broadly requires consideration of the management of risk to life and risk to property from flooding, plus the potential of development to result in adverse impacts to the existing flood conditions, as provided in this assessment.

The flood modelling that has been undertaken for this assessment is described in Section 3 and Section 4 and includes modelling of the 10% AEP, 1% AEP and PMF events.

The assessment of impacts from the proposed development to the existing flood conditions is addressed in Section 5.4. The mitigation measures to minimise flood impacts include the construction of a grassed swale (which provides retention of the floodway along the eastern side of the Site and the retention of on-site flood storage) and the limitation of obstructions within the external car park area, as discussed. A grassed verge buffer zone alongside the existing shared path and on-site stormwater drainage pipes also help provide an additional reduction in modelled flood impacts.

The foundations for development of a Flood Emergency Response Plan (FERP) are provided in Section 7.

Flood prone land is defined as any land within the PMF extent. This has been mapped together with the FPA in Figure 4-2. The flood function mapping produced at the 1% AEP (2050) and PMF events was provided by CN, as shown in Figure 2-1 and Figure 2-2, respectively.

The flood assessment and modelling undertaken is described in Section 3 to Section 5. The 10% AEP, 1% AEP (2050) and PMF events have been included in these Sections. The 0.5% AEP and 0.2% AEP events have also been assessed (as have the 5% AEP and 2% AEP events) and flood depth, flood hazard and flood impacts mapping is provided for these in Appendix A to Appendix C.

The impact of the proposed development on the existing flood behaviour is assessed in Section 5.4.

The flood risks and flood impacts have been assessed in accordance with the Newcastle DCP, as presented in Section 6.2.

Flood modelling to assess the impacts of the development on the existing floodways within the Site has been undertaken, with the results discussed in Section 5.4.

The proposed development does result in a net loss of greater than 20% of the existing flood storage volume, being around 29% at the 1% AEP (2050) event and 36% at the PMF event, as assessed in Section 6.2.2. However, whilst not meeting this nominal specification of storage retention, the proposed development satisfies the intent of this requirement and has demonstrated as such through the modelling-based flood impact assessment.

The overarching strategy for flood emergency management and the support FERP document are provided in Section 7.

7 Flood Emergency Management

This section addresses the key requirements of an effective FERP. The development and adoption of an FERP requires full integration with the site management, health and safety and incident management structures and is typically required prior to occupation. However, the overall flood emergency response strategy is outlined below.

A standalone document is being developed for the FERP (refer R.T2468.002), including flood intelligence, warning, triggers, actions, roles, and responsibilities. The FERP document is typically finalised for approval prior to issuing of an Occupation Certificate. At this stage of the approval process the key objective is to present the overall flood emergency management strategy for review and acceptance, as this will underpin the subsequent development of the adopted FERP.

Flood emergency response for the management of risk to life from flooding typically involves evacuation of flood-affected areas on major river systems with sufficient warning time to execute a safe evacuation to flood-free land. In local catchment “flash flood” environments such as Newcastle, a shelter-in-place policy is preferred, as there is insufficient opportunity to affect an evacuation, and the risk exposure is typically lower within the buildings than the surrounding roadways.

A shelter in place policy for the management of risk to life from flooding is adopted by CN, for which the requirements are satisfied by the proposed development. The project design also satisfies the intent of the Shelter in Place Guideline for Flash Flooding (DPHI, 2025) requirements, which include a maximum period of duration for isolation of 12 hours and the provisions expected to be afforded by a Flood Refuge.

The key elements of the proposed development design that support the shelter-in-place flood emergency response strategy include:

- The nature of Site usage enables operations to be suspended, and the Site closed when major flood events are forecast, with the NSW SES indicating their support for this approach
- The finished floor level of 9.2 m AHD limits internal flood inundation at the PMF to below 0.5 m and a low hazard (H1-H2) flood condition
- Access to a first-floor internal area for flood refuge above the PMF level
- Limited high hazard (H5) exposure to the building at the PMF within the service loading zone, with the heavy building construction expected to withstand the hydraulic forces
- Flood inundation times of less than 12 hours (the PMF inundation duration analysis in the Broadmeadow Place Strategy FIRA confirms that the Site and surrounds are subject to inundation periods of 6-9 hours)
- The external site grading provides rising access from parked cars to the building and flood refuge location
- Emergency egress/ingress to Womboin Road is available even during the peak of a PMF event.

Typical Site usage is up to around 200 people, with a daily peak of around 800 people. Weekly usage is expected to peak at around 1000-1200 people. The number of people present at the Site

is only expected to exceed this a few times a year during special exhibition events, for which the maximum capacity is 2500 people.

The Shelter in Place Guideline for Flash Flooding recommends a minimum floor space of 2 m^2 per person. For the typical expected usage of the Site, the first floor of the building has sufficient space available to satisfy this recommendation. However, if the Site is at capacity in the extremely unlikely event of flood refuge being required, the available area on the first floor is reduced to around 1 m^2 per person. This is consistent with the Australian Red Cross guidelines for refuge areas.

It is important to consider that a floor area of less than 2 m^2 being available represents a worst-case scenario, in which the Site is being used during a flood event, that it is being used for an event that fills the venue to capacity and that the flood event will inundate the ground floor of the building. The probability of this scenario is so remote (rarer than a 1-in-30,000,000 AEP) that in practical terms the proposed development is expected to comfortably provide above a 2 m^2 floor area per person in the event of it being used for flood refuge.

The principal risk management measure is to close the Site when flood conditions are expected, for example when a large weather system threatens to bring heavy rain. Most rare flood events are associated with large weather systems, such as East Coast Lows and ex-tropical cyclones. The most likely scenario in the event of a flood impacting the Site is that the Site has been closed and nobody is present there. However, some level of risk remains that a flood event impacting the Site is not forecast, such as a rapidly developing thunderstorm.

The typical expected usage of the Site also serves to significantly reduce the risk exposure. From typical expected use rates for the Site provided by BANL, the following summarises the number of people that are expected to be present at the Site during a flood event if advance warning has not been provided to facilitate closure of the Site:

- There is around a 33% chance that at the onset of a flood, the Site is closed (as part of normal operations, not a pre-emptive closure for flood risk management)
- There is around a 42% chance that at the onset of a flood, there are fewer than 200 people present at the Site
- There is around a 24% chance that at the onset of a flood, there are between 200 and 1200 people present at the Site
- There is less than a 1% chance that at the onset of a flood, there are over 1200 people present at the Site.

The critical thresholds for flood affectation at the Site are the point at which vehicular access will be cut, the point at which flooding of the car park will occur and the onset of internal inundation of the building. These occur at a flood level of around 7.8 m AHD, 8.2 m AHD and 9.2 m AHD, respectively. The best estimate of probabilities at which these thresholds will be exceeded are around a 10% AEP, 1.5% AEP and 1-in-300,000 AEP.

To understand the potential level of flood risk exposure at the Site, the probabilities of flood inundation and people present at the Site have been combined, as presented in Table 7-1. It is important to note that this represents an unrealistic scenario in which either no expectation of flooding rainfall is forecast by the BOM or such a forecast warning is overlooked or ignored.

Table 7-1 Probability of Flood Risk Exposure Ignoring Flood Warnings (1-in-X AEP)

Site Affectation	Site Occupancy		
	< 200	200 - 1200	> 1200
Site access cut (~7.8 m AHD)	25	40	1000
Car park flooded (~8.2 m AHD)	180	310	7500
Building flooded (~9.2 m AHD)	700 000	1 250 000	30 000 000

The worst-case probabilities presented in Table 7-1, assuming no risk management measures are in place, are significantly reduced given the expected forecast warnings and preventative measures to close the Site. For example, if we assume that 80% of the time, a flood event will be expected and the Site closed in advance, then the probabilities are reduced by a factor of five, as presented in Table 7-2.

Table 7-2 Assumed Probability of Flood Risk Exposure Given Flood Warnings (1-in-X AEP)

Site Affectation	Site Occupancy		
	< 200	200 - 1200	> 1200
Site access cut (~7.8 m AHD)	120	210	5000
Car park flooded (~8.2 m AHD)	900	1600	37 500
Building flooded (~9.2 m AHD)	3 600 000	6 250 000	150 000 000

In the unlikely event that people are present on Site and are affected by a flood event rare enough to require relocation to the first floor, there is ample time to achieve this even for PMF conditions. The two main staircases are estimated to have a combined capacity for around 300 people per minute, which even if occupied to maximum capacity, can facilitate the transfer of people from the ground floor upstairs in under ten minutes. There are also an additional three smaller sets of stairs available. From model simulations of the PMF event, there is around a 40-minute period between the onset of inundation to the car park and internal inundation of the building.

The maximum attendance at the Site following completion of the Stage 1 works is around 550 people, with a first-floor area of around 1100 m^2 available. Therefore, around 2 m^2 per person would be available for flood refuge in all scenarios. As discussed previously, this refuge space is also provisioned during typical expected use of the Site at the completion of the Stage 2 works, being up to around 1200 people with a first-floor area of around 2400 m^2. There will be an occasional event held at the Site following completion of Stage 2 that exceeds this typical usage, with up to a capacity 2500 people. This would only provide around 1 m^2 per person refuge area on the first floor. However, in this case there are a few mitigating circumstances:

- As per Table 7-1 and Table 7-2, it is extremely unlikely that the first floor will ever need to be utilised for the purposes of a flood refuge in an event resulting in inundation of the building

- If the building is inundated and the flood refuge utilised, then it is highly likely that an area more than 2m^2 per person will be available, given the likely occupancy of the Site
- At the peak of the modelled PMF event, the inundation of the ground floor only reaches a depth of around 0.5 m and the duration of above-floor flooding only lasts around one hour.

Given the above, in the extremely unlikely event that refuge on the first floor is required to be utilised and less than 2 m^2 per person is available, this will not compromise people's safety. There would be sufficient space for people to sit on the floor or the available furniture.

The Australian Red Cross sheltering guidelines recommend the availability of one toilet per 50 people for immediate sheltering periods of less than 18 hours. The first-floor refuge will provide around one per 78 people if filled to a capacity 2500 people but at least one per 37 people in the much more likely scenario that fewer than 1200 people are present. Following the completion of Stage 1 works these provisions will be one per 38 people with the maximum 550 people present on Site. This is in line with the guidance, particularly given that inclusion of the ground floor toilets effectively triples these provisions during the period that they would still be accessible.

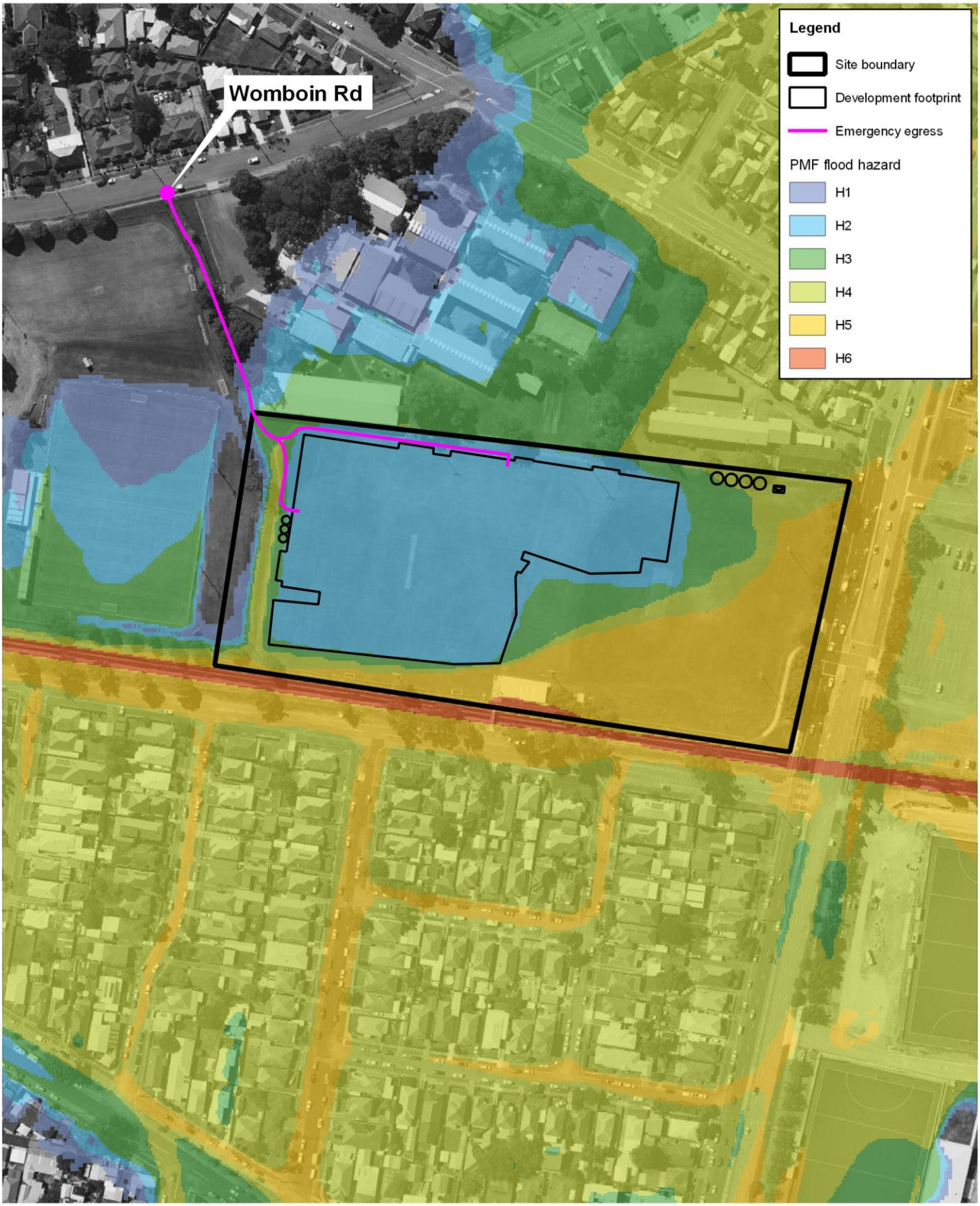
Emergency lighting and limited power supply will be provided from the on-site battery storage system.

An alarm system is proposed to be activated once the water level within the swale area is sufficiently high to require an emergency response. This will occur when Site egress by vehicle is compromised through flooding of the access road and Turton Road. A remotely operated gate at the Site entrance will then be closed, to be re-opened once it is safe to vacate the Site. If the flood level continues to rise to a level at which the car park becomes flooded then a second alarm will be activated, signalling a requirement to relocate to the first floor of the building. These two alarms will be triggered at a flood level of around 7.8 m AHD and 8.2 m AHD, respectively.

If people are present at the Site when impacted by a flood event that prevents egress, then vehicles will be unable to leave the car park until the flood waters in Turton drain to a low enough level. The exact timing from initial closure of the Site would vary depending on the specifics of the flood event. In the simulated critical duration design flood events, vehicular access to the Site is cut for around a three-hour period at the 1% AEP 2050 event and four hours at the PMF event. It is therefore a reasonable expectation that isolation of the Site would not last much longer than around six hours and almost certainly shorter than a duration of 12 hours.

Even during the peak conditions of a PMF event, an overland escape route is available through medium hazard flood waters (refer Figure 7-1). Although facing its own challenges and constraints, this provides an opportunity for ingress by emergency services in the event of a medical emergency.

A flood depth marker sign is to be installed at the lowest point of the Site access road, with appropriate signage also placed around the swale area to warn of the potential for deep flood waters within it.



Title:

Flood Egress / Ingress Route

0 60 120 m

approx. scale

Figure: 7-1

Revision: D

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8 Project Staging

The proposal has been designed so that the project can be delivered as an initial block of eight courts with a future staged construction, as described below:

Stage 1

A single storey building with total gross floor area (GFA) of approximately 8900 m^2 comprising:

- Ground floor: 8 x basketball courts, amenities to support the functioning of the complex including bathrooms, change rooms, lobby and foyer, retail tenancy and café.
- Car park with 185 spaces, including drop-offs.

Stage 2

- Ground floor 3 x courts including show court with retractable grandstand seating over the two adjacent courts area with a GFA of approximately 3600 m^2.
- Extension to the southern side of the building to provide 1 x court plus high-performance training area with a GFA of approximately 3400 m^2.
- Mezzanine level: function rooms, administration space and training areas.
- Expansion of existing car park to provide 240 spaces.

This Flood Impact and Risk Assessment has considered the ultimate Stage 2 configuration of the proposed development. Following the completion of Stage 1 works but prior to completion of Stage 2 the swale will exist, but the building footprint will be reduced from what has been assessed in this FIRA. Therefore, modelled off-site impacts to flooding will be even less than presented in this report.

As discussed in Section 7, there will be an increased available floor area per person within the first-floor level of the building between the completion of Stage 1 and Stage 2, if required for flood refuge purposes, with the recommended 2 m^2 per person available even during maximum Site attendance.

The development of an FERP will need to be updated to be correct for the current development at the time of occupation.

9 Conclusions

This Flood Impact and Risk Assessment is prepared to support the proposed development of the Hunter Indoor Sports Centre at 2 Monash Road and 24 Wallarah Road, New Lambton NSW. The assessment is underpinned by detailed modelling of design flood conditions of the Lambton Ker-rai Creek floodplain for a range of design flood magnitudes.

A TUFLOW software hydrodynamic model was developed to represent existing design flood conditions local to the proposed development. The modelling undertaken has aimed to provide consistency with the recent Throsby, Styx, and Cottage Creeks Flood Study.

The proposed development was designed with consideration of the existing flood risk as defined by the modelling, current flood planning controls and floodplain risk management objectives. The flood assessment investigated the existing and post-development flood conditions for a range of design flood event magnitudes including the 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events. The 0.5% AEP and 0.2% AEP events are used by CN as proxies for the 1% AEP event at the 2050 and 2100 planning horizons, accounting for future climate change impacts.

The developed flood model was utilised to assess the potential impact of any proposed works on existing flood conditions. The impact assessment indicated the proposed development has no material impact on existing flood conditions across the range of flood events considered (10% AEP up to the PMF event). This amended FIRA presents a reduction in off-site impacts at the PMF event to those presented in the application as lodged and a significant improvement in the flood hazard conditions within the car park.

The proposed development has been assessed against the flood risk management requirements of the Newcastle LEP, Newcastle DCP, and requirements specific to the SEARs. This found the proposed development to satisfy all the requirements except condition C-1 of the Management of Flood Storage Areas section of the Newcastle DCP, which relates to the retention of existing on-site floodplain storage volumes.

The DCP Management of Flood Storage Areas condition C-1 requirement was previously satisfied but in response to submissions the level of the proposed car park has been raised to reduce the flood hazard exposure. However, despite the reduction in available flood storage volume (to around 71% and 64% of baseline conditions at the 1% AEP 2050 and PMF events, respectively), the flood impact modelling has found an overall improvement in off-site flood impacts over the original submission (which provided around a 95% retention of flood storage volume). However, whilst not meeting the nominal storage retention specified in the DCP, the proposed development satisfies the intent of this requirement and has demonstrated as such through the modelling-based flood impact assessment.

The key requirements for development of an effective FERP have been established. The development and adoption of an FERP requires full integration with the site management, health and safety and incident management structures and is typically required prior to occupation. However, the overall flood emergency response strategy is outlined in this report, with a separate standalone FERP document being developed.

A shelter-in-place strategy is the appropriate flood emergency response, with a nominated flood refuge area on the first-floor level of the building. With an available floor area of around 2400 m^2,

the Flood Refuge can accommodate up to 2500 people potentially present on the Site. Being a fully functioning part of the building, the Flood Refuge is inherently well-equipped to service the needs of potential occupancy for an expected period of a few hours.

On-site flood refuge requires structural certification that the proposed building can withstand the expected hydraulic loads of the PMF event. Given the heavy construction type of the building this is expected to be readily achieved. The modelled flood depths adjacent to the building at the PMF event are locally as high as 1.4 m, with peak velocities typically no higher than up to 1.7 m/s.

With the recommended flood risk management measures in place, the proposed development is supportable from a flood risk management assessment perspective.

10 References

AIDR (2017) *Guideline 7-3, Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*

City of Newcastle Council (2023) *Development Control Plan*

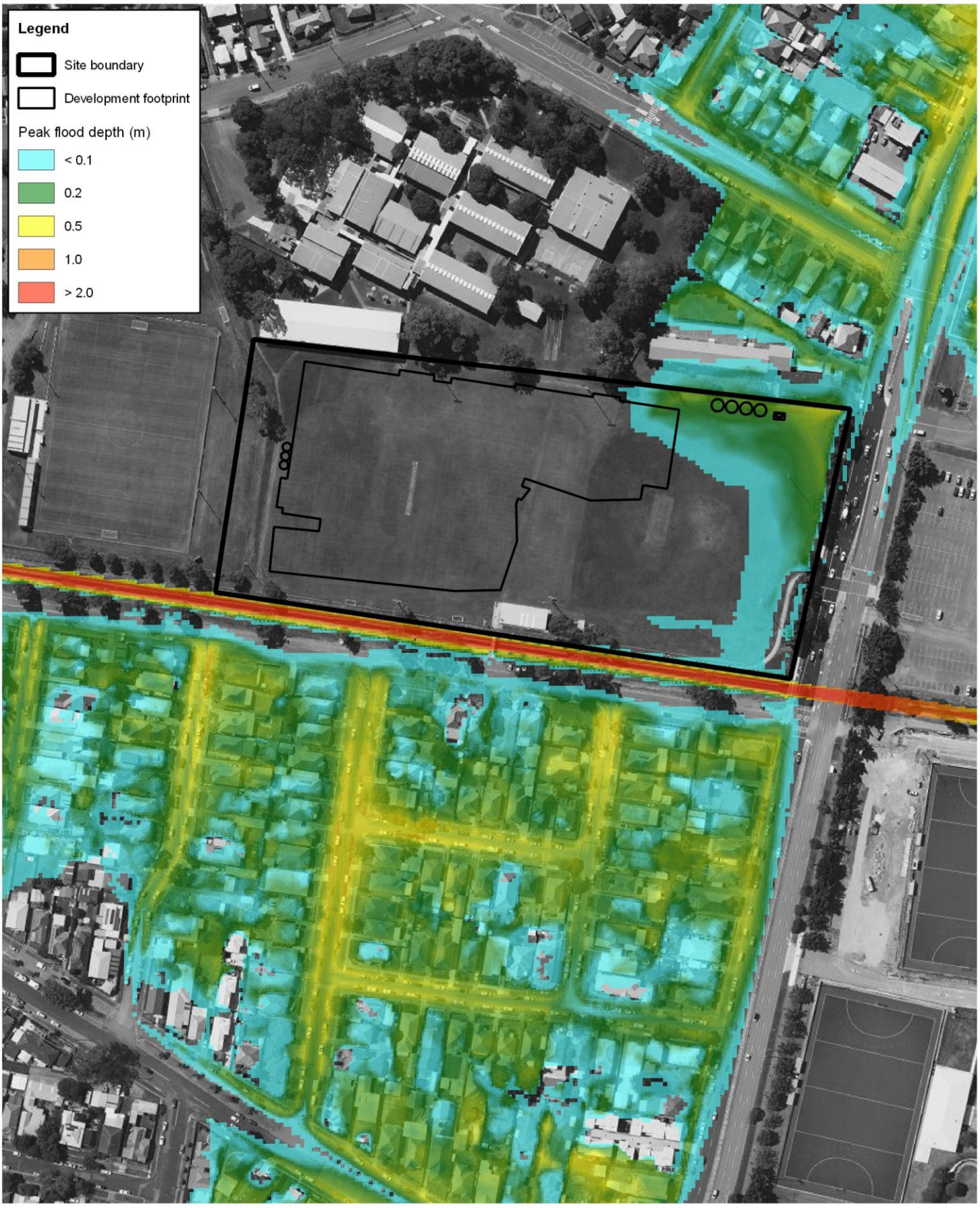
DPHI (2025) *Shelter in Place Guideline for Flash Flooding*

Geoscience Australia (2019) *Australian Rainfall and Runoff: A Guide to Flood Estimation*

Red Cross Australia (2014) *Preferred Sheltering Practices for Emergency Sheltering in Australia*

Rhelm (2024) *Throsby, Styx, and Cottage Creeks Flood Study*

Appendix A Existing Conditions Flood Mapping



Title:

Modelled 5% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **A-1**

Revision: **D**

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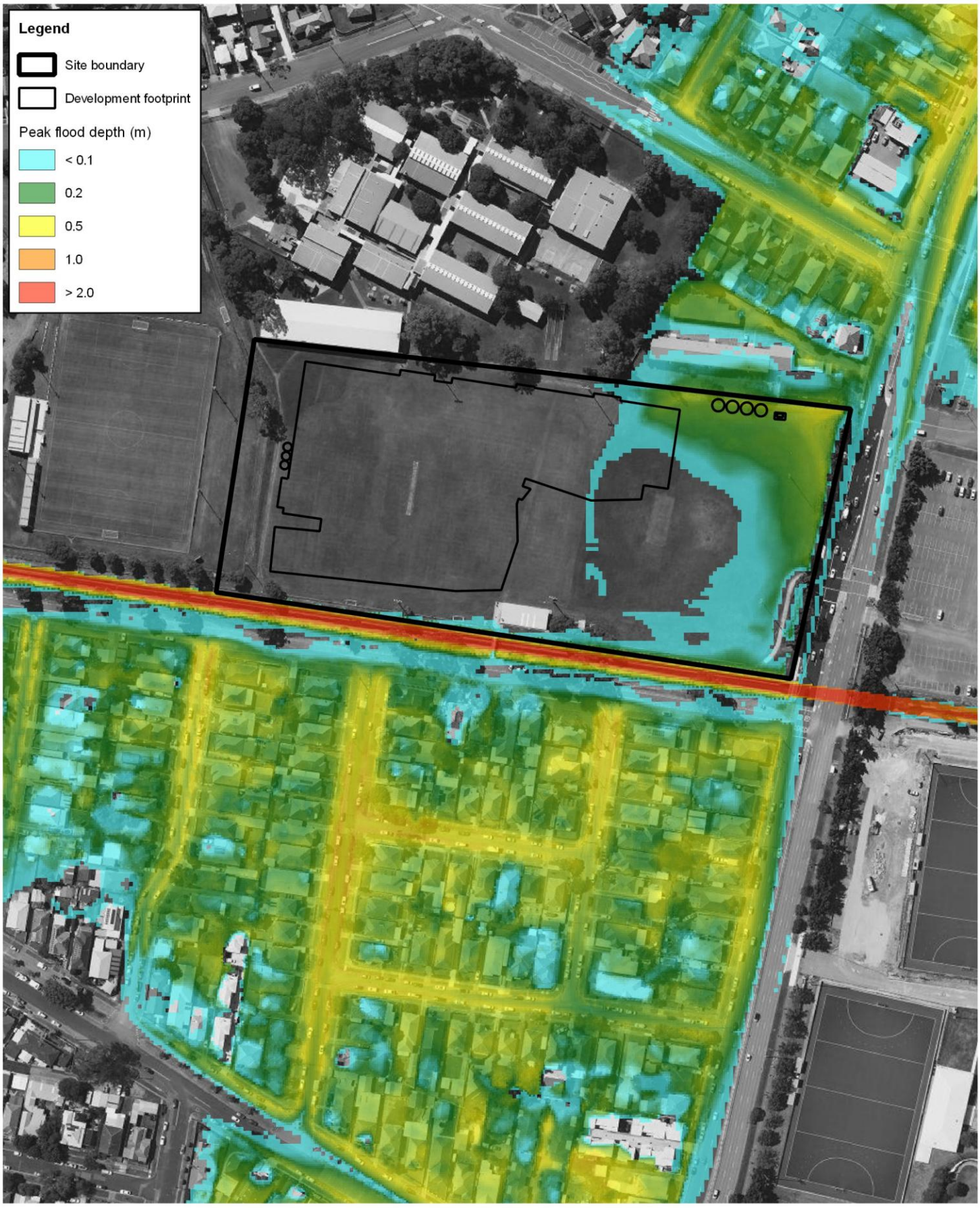

Title:

Modelled 2% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **A-2**

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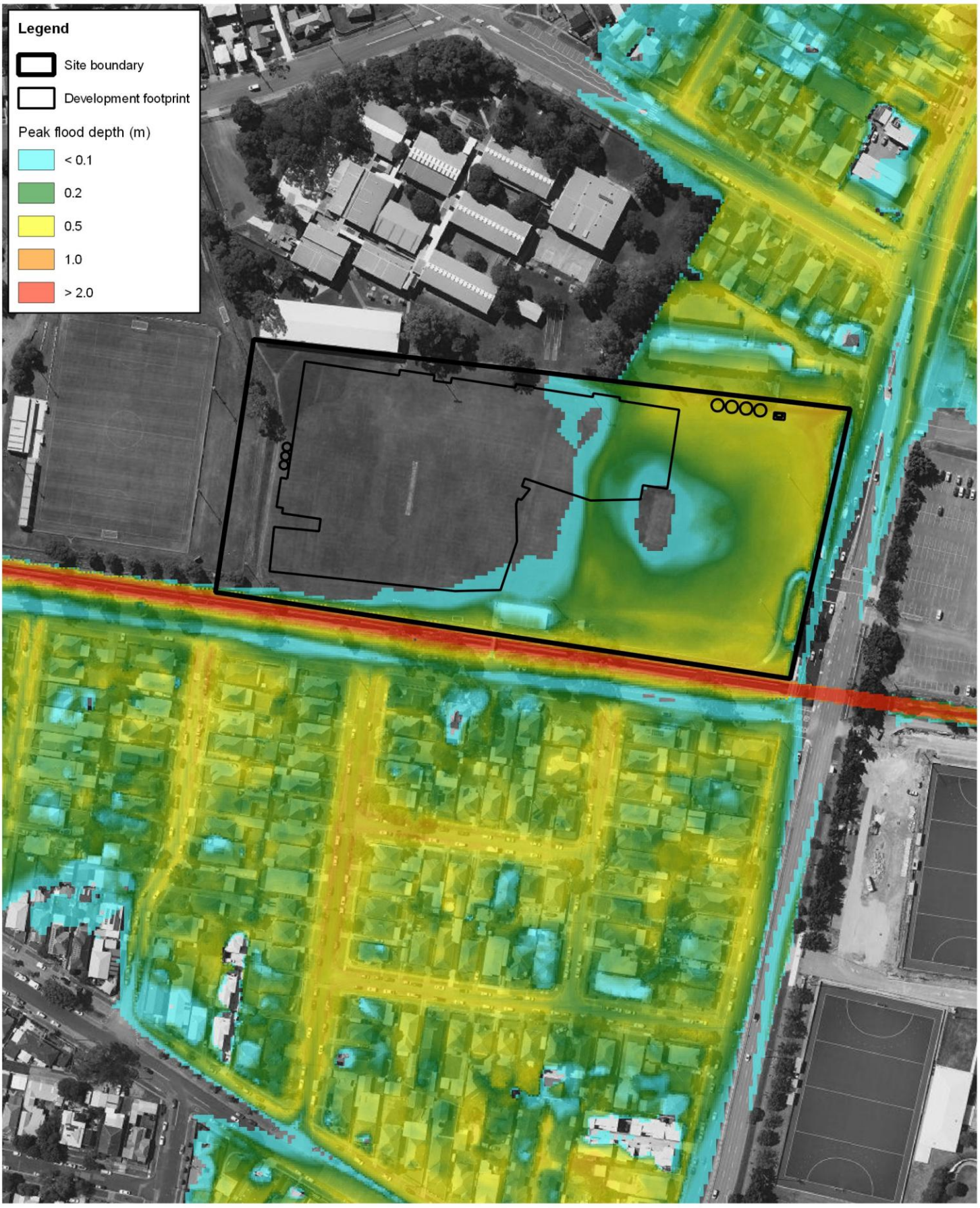

Title:

Modelled 1% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **A-3**

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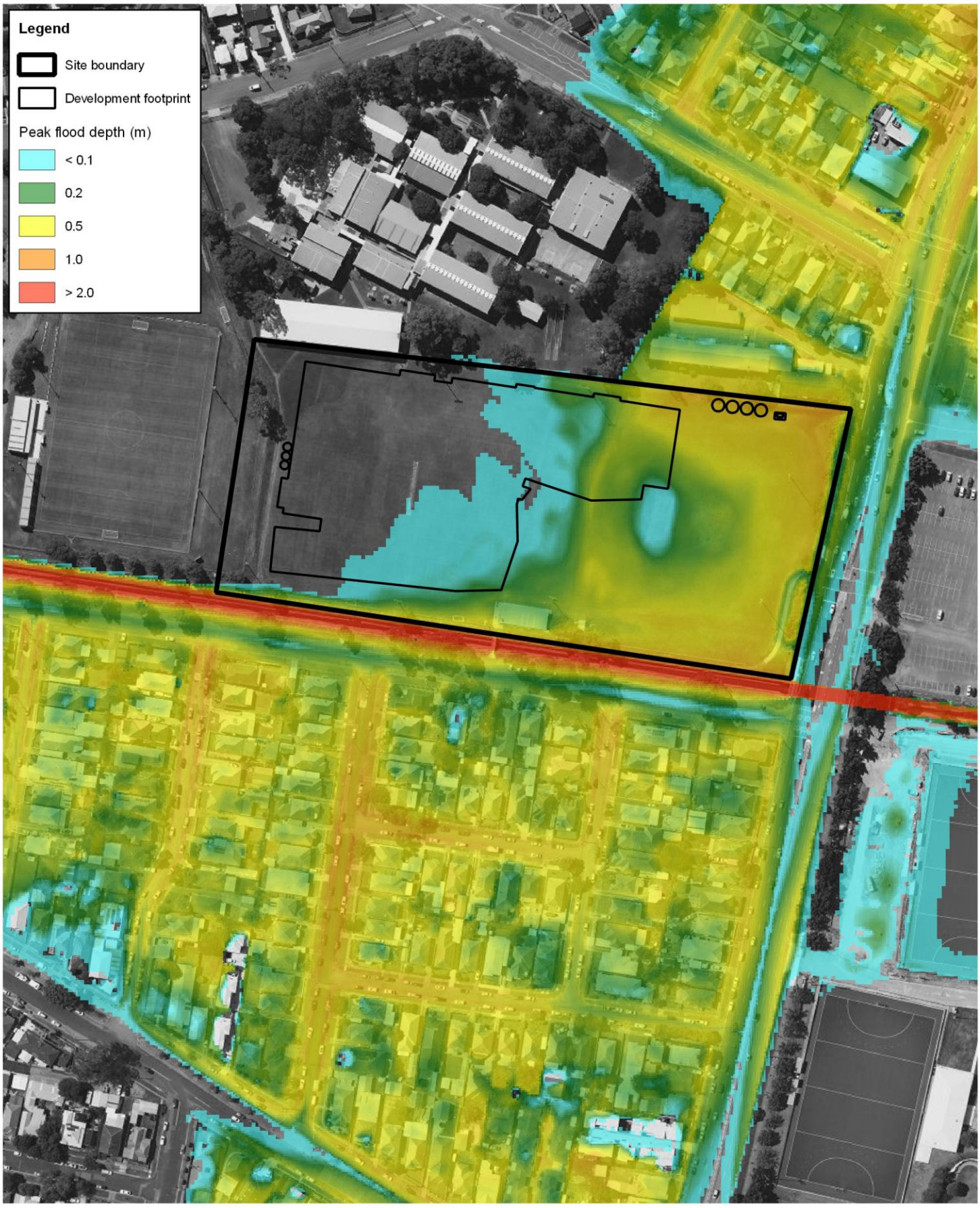

Title:

Modelled 0.5% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **A-4**

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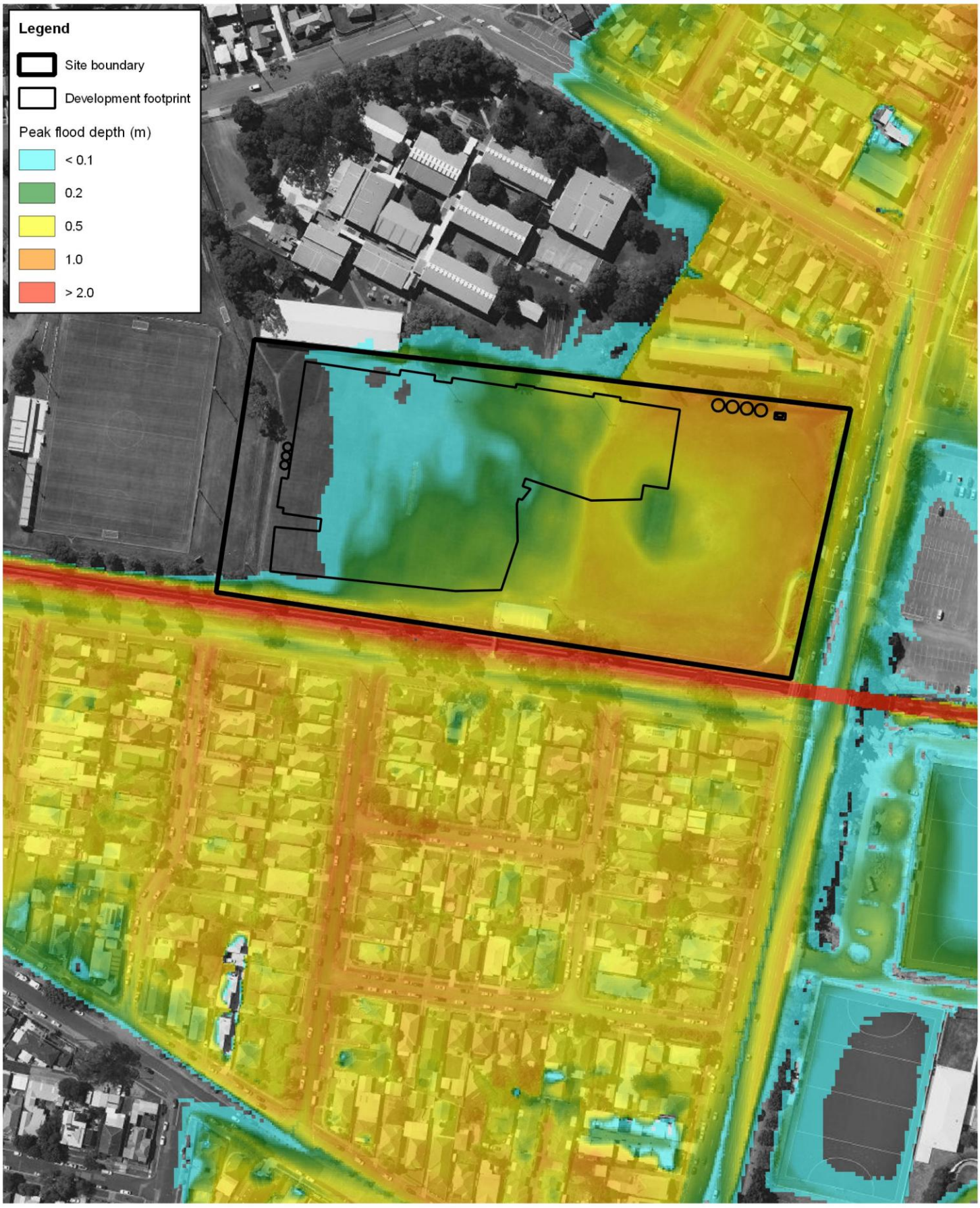

Title:

Modelled 0.2% AEP Peak Flood Depth

0 60 120 m

approx. scale

Figure: **A-5**

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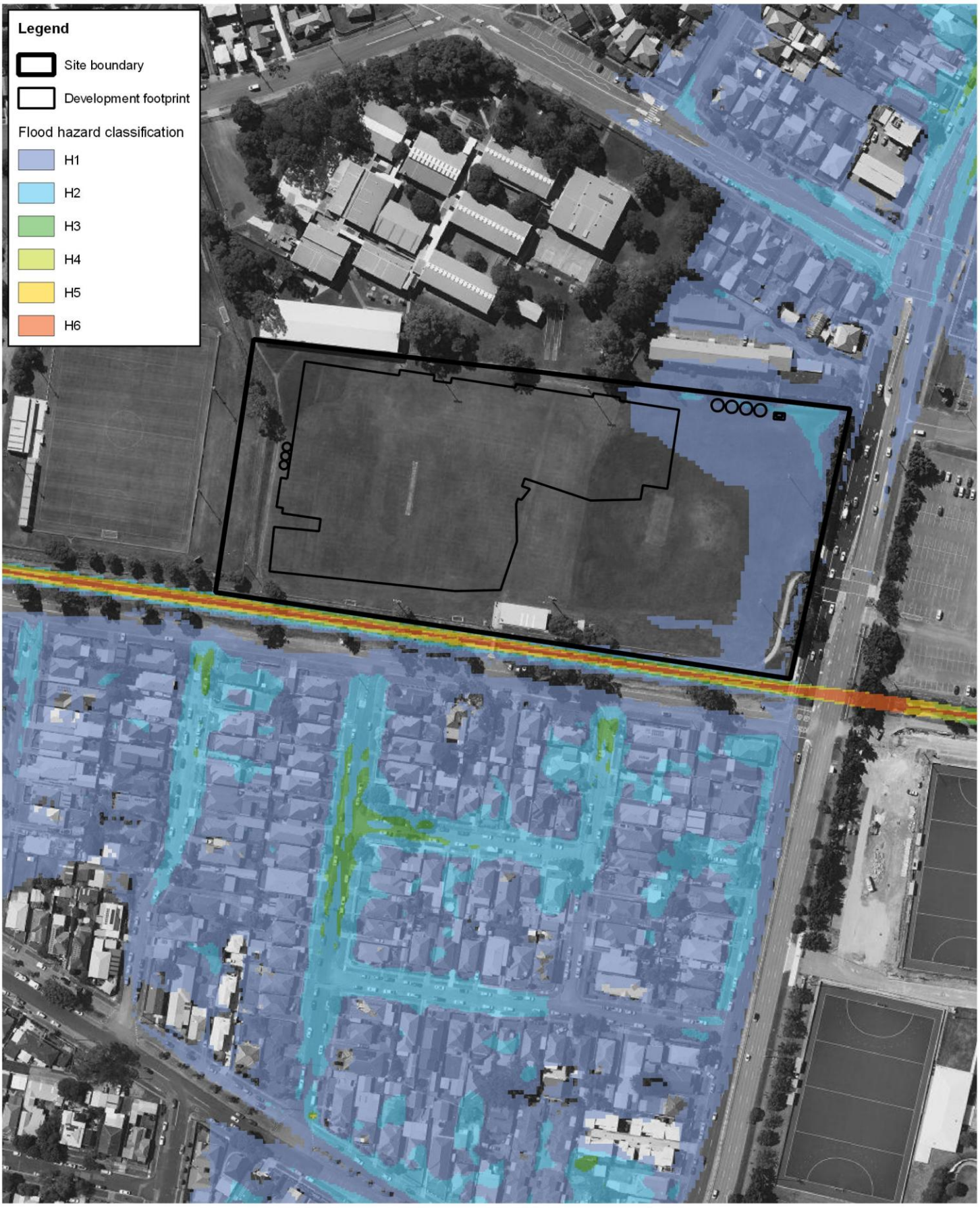

Title:

5% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **A-6**

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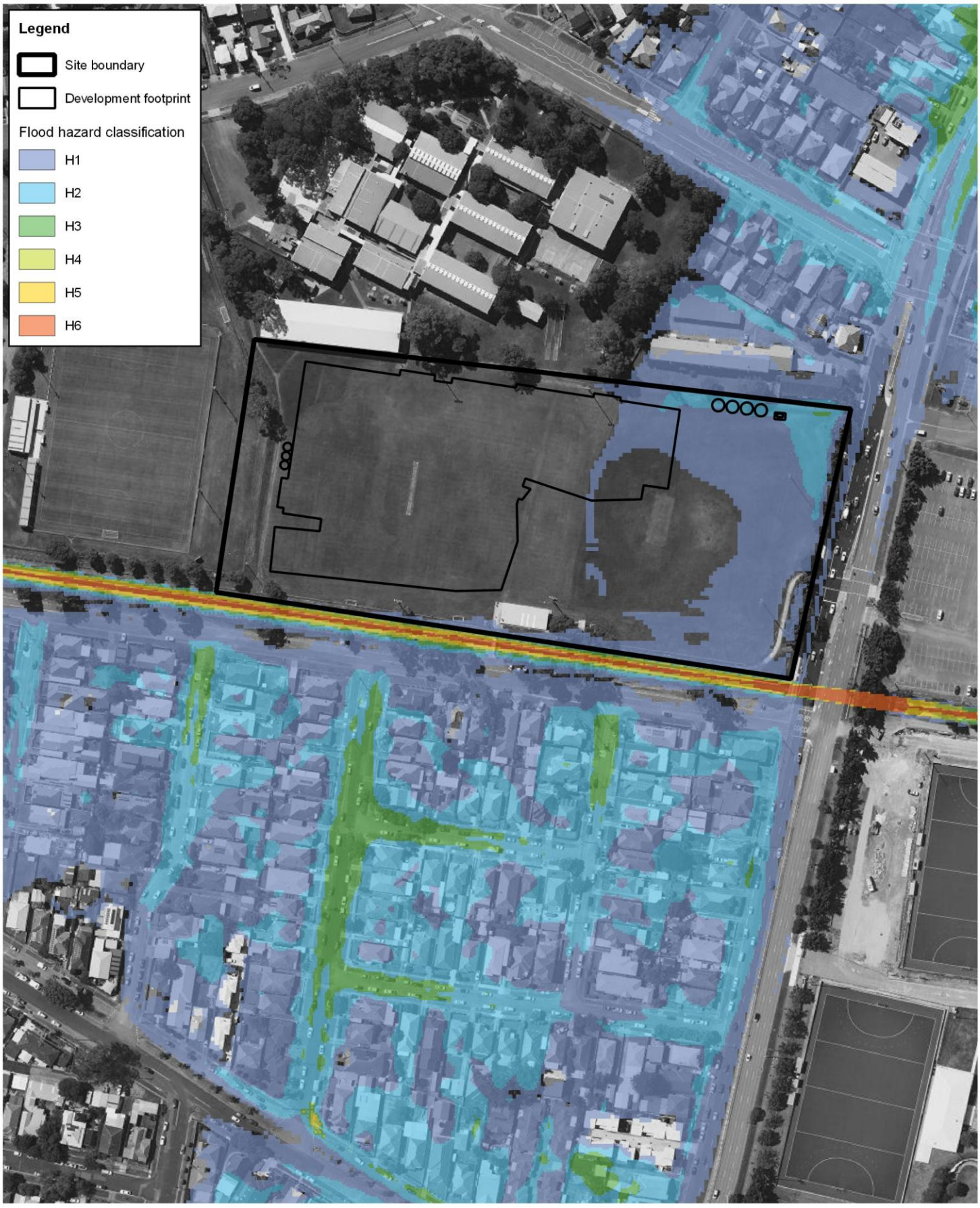

Title:

2% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **A-7**

Revision: **D**

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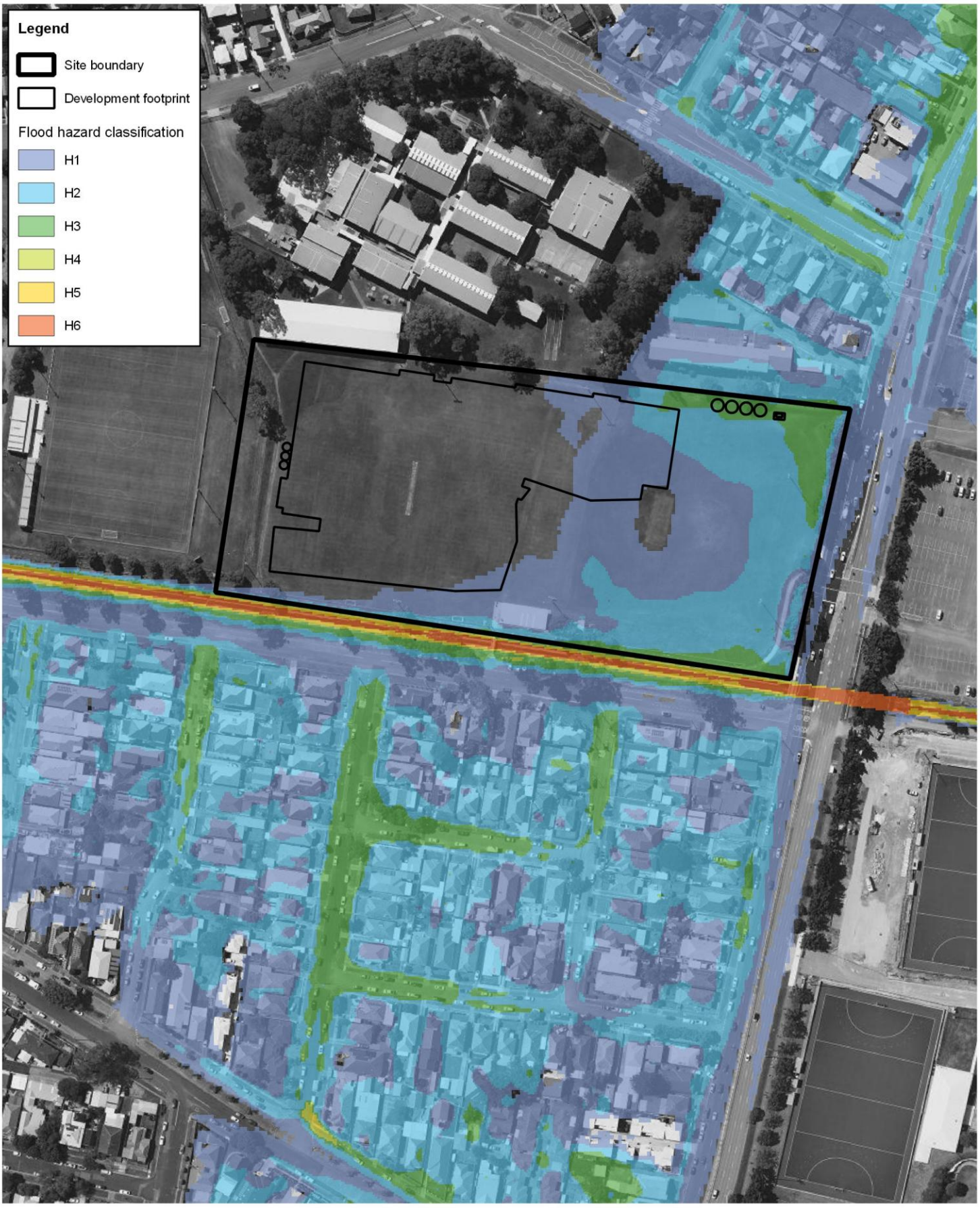

Title:

1% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **A-8**

Revision: **D**

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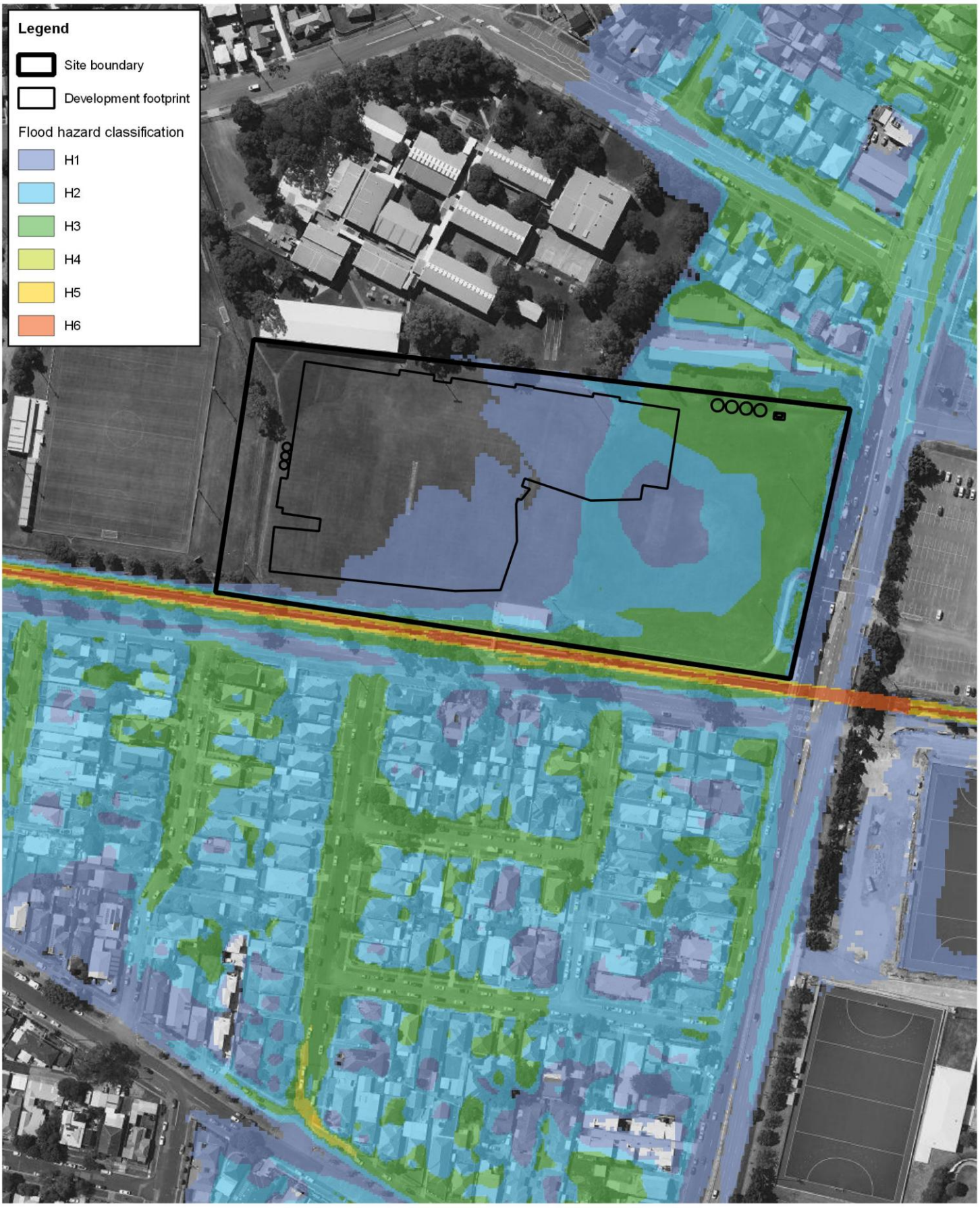

Title:

0.5% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **A-9**

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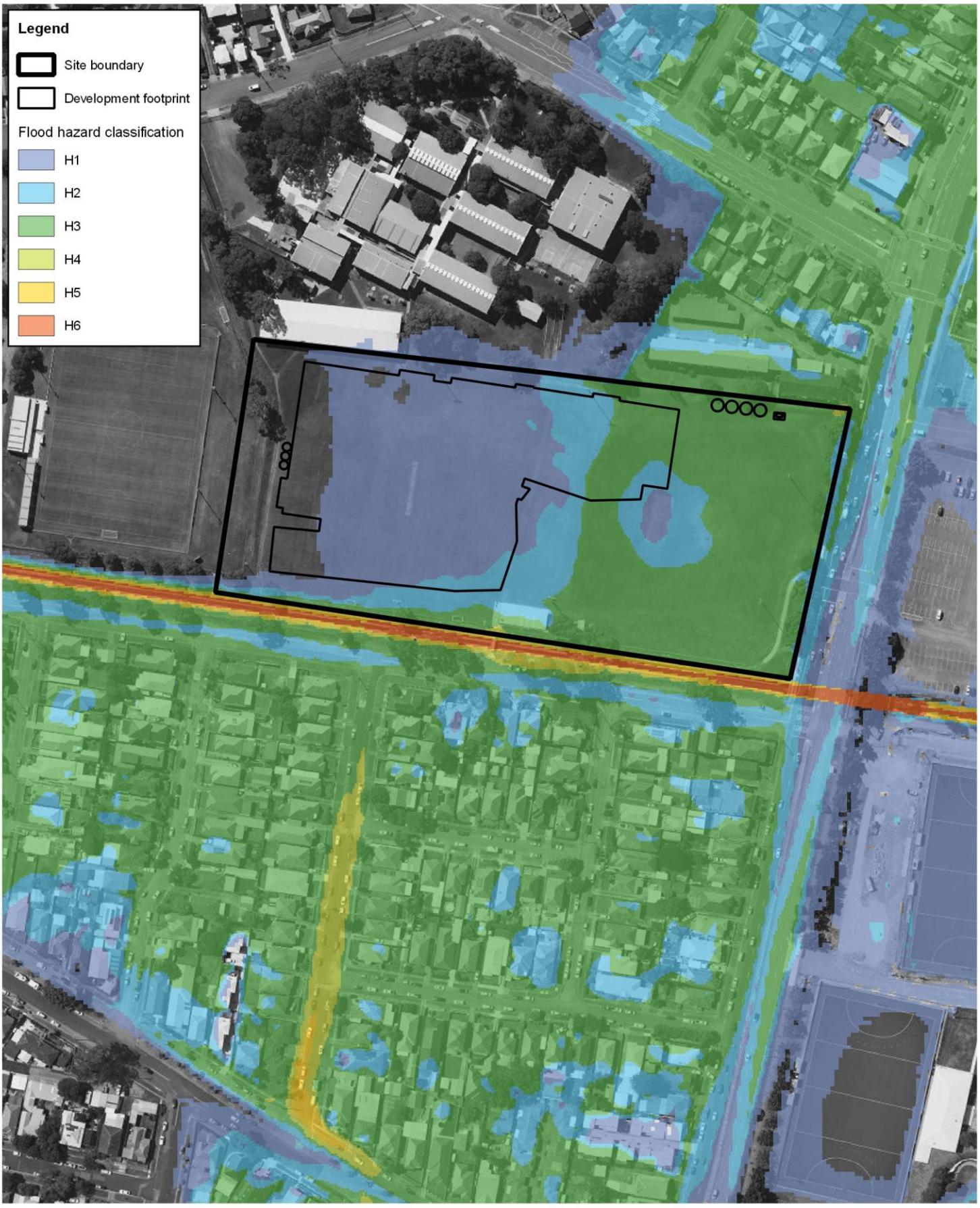

Title:

0.2% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **A-10**

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Title:

Modelled 10% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-11**

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Title:

Modelled 5% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-12**

Revision: **D**

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Title:

Modelled 2% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-13**

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Title:

Modelled 1% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-14**

Revision: **D**

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Title:

Modelled 0.5% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-15**

Revision: **D**

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Title:

Modelled 0.2% AEP Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-16**

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Title:

Modelled PMF Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **A-17**

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Appendix B Post-Development Flood Mapping

Title:

Modelled 5% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-1**

Revision: **D**

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Title:

Modelled 2% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-2**

Revision: **D**

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Title:

Modelled 1% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-3**

Revision: **D**

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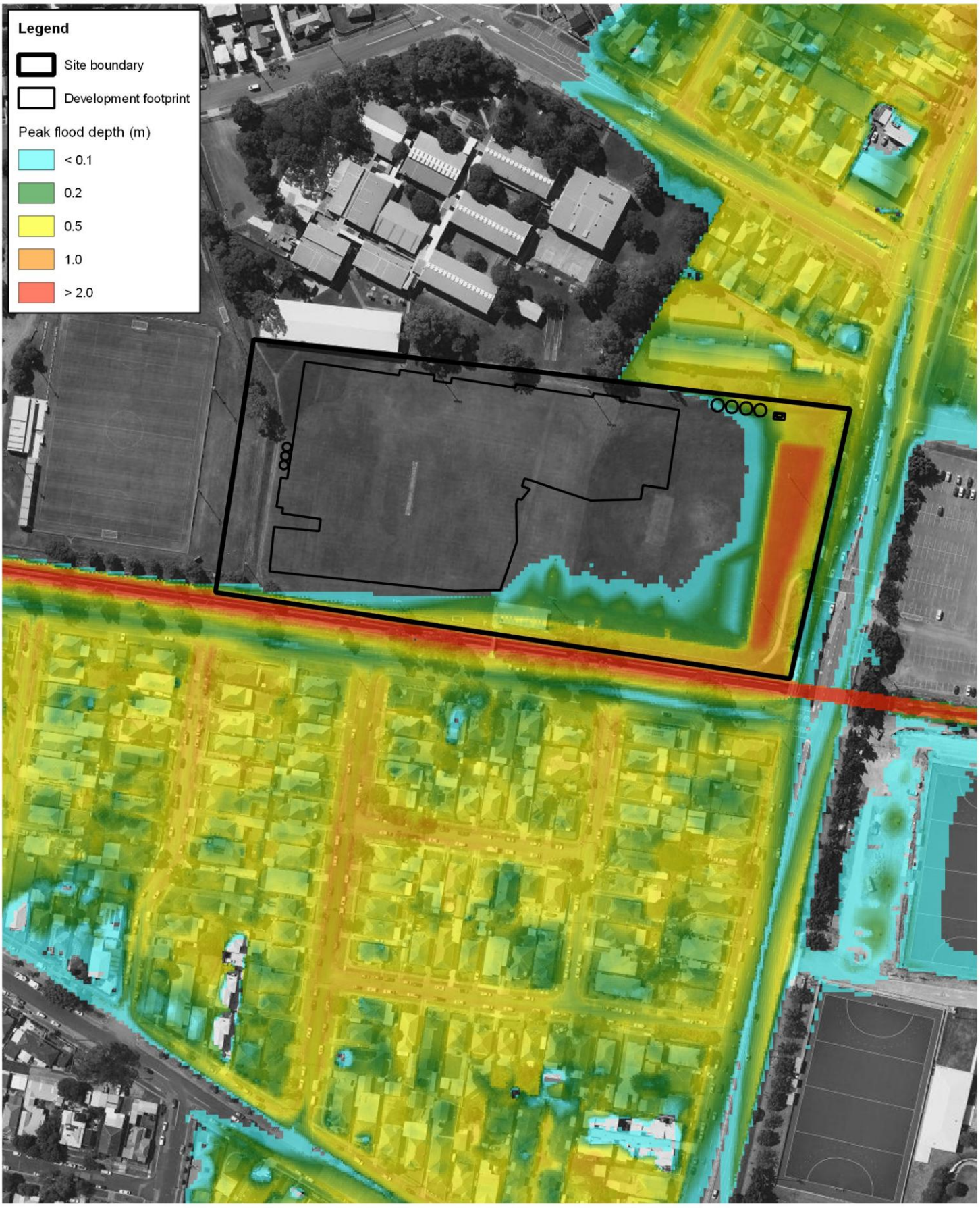

Title:

Modelled 0.5% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-4**

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Filepath: Z:\Projects\T2468_Newcastle_Basketball\GIS\T2468_038_240307_200y_depth_dev.qgz

Title:

Modelled 0.2% AEP Peak Flood Depth for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-5**

Revision: **D**

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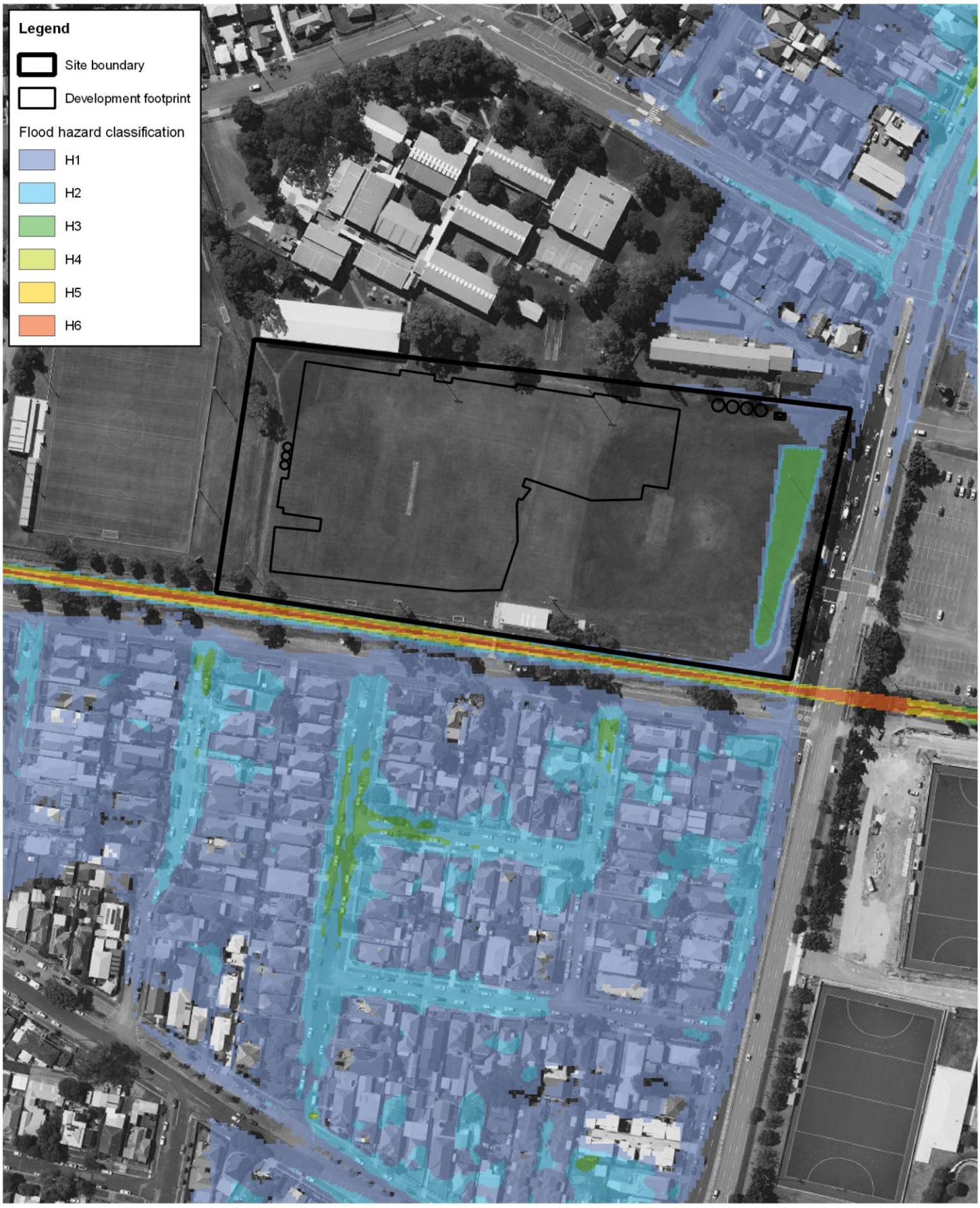
Filepath: Z:\Projects\T2468_Newcastle_Basketball\GIS\T2468_039_240307_500y_depth_dev.qgz



Title:

5% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-6**

Revision: **D**

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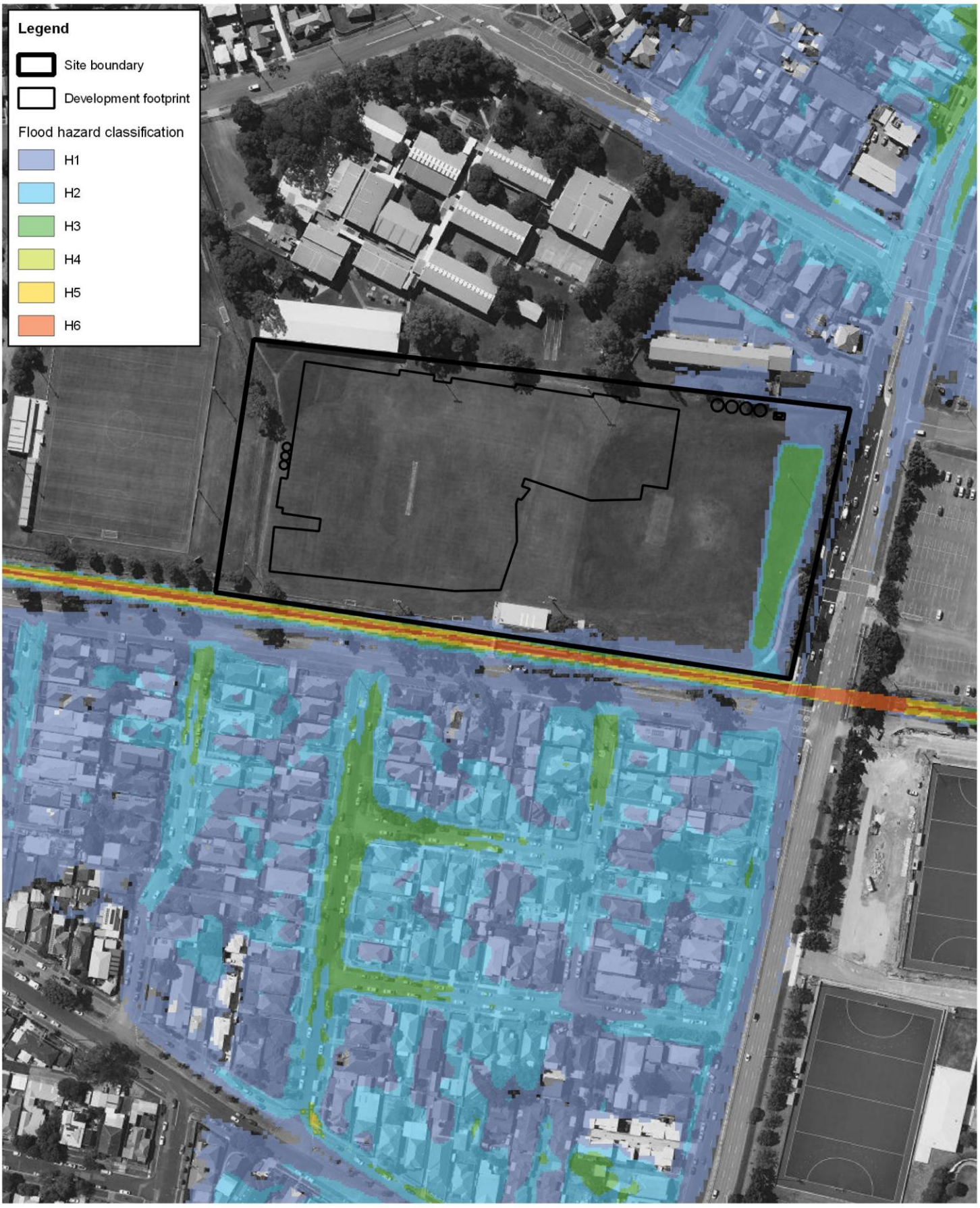

Title:

2% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-7**

Revision: **D**

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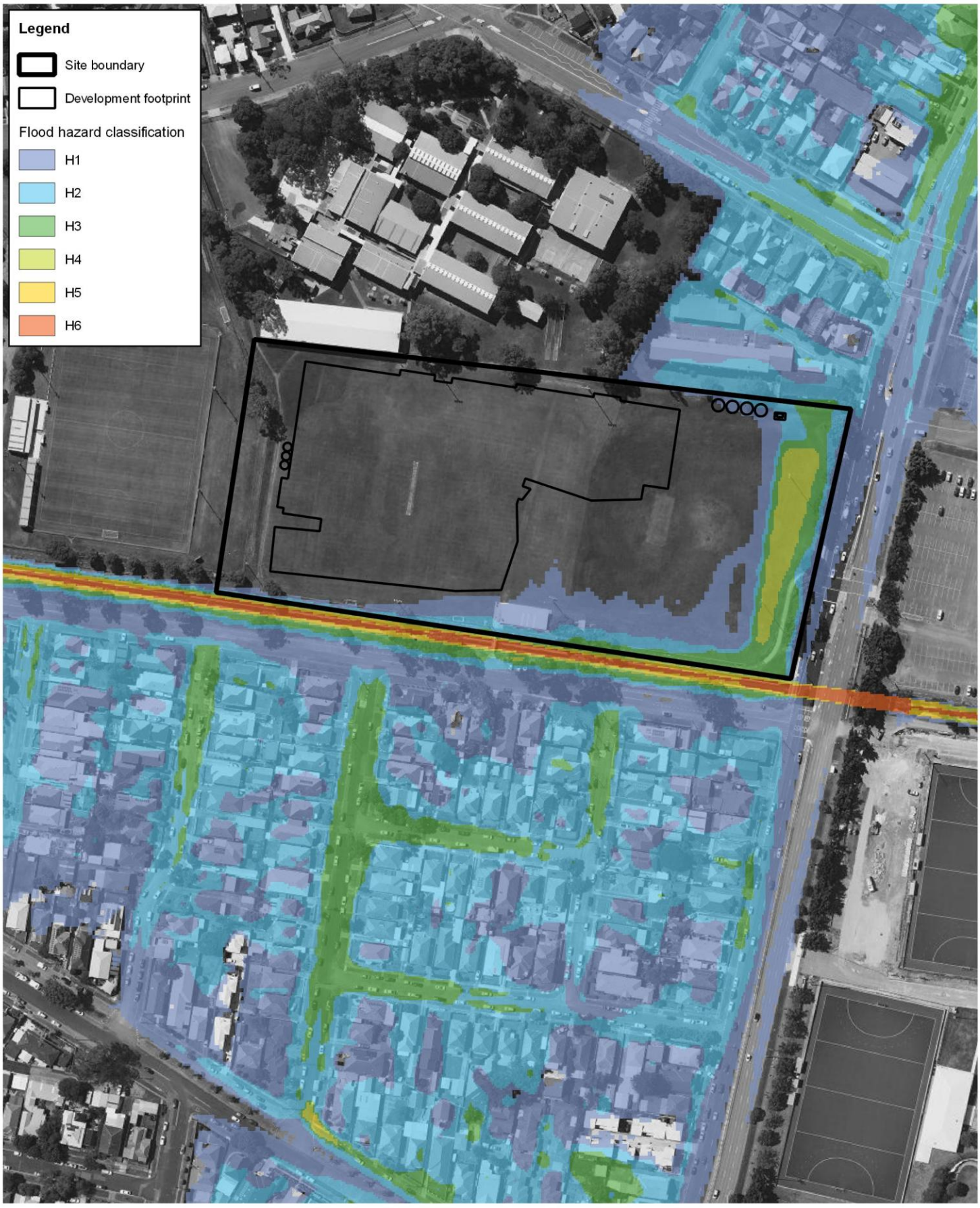
Filepath: Z:\Projects\T2468_Newcastle_Basketball\GIS\T2468_041_240307_50y_hazard_dev.qgz



Title:

1% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-8**

Revision: **D**

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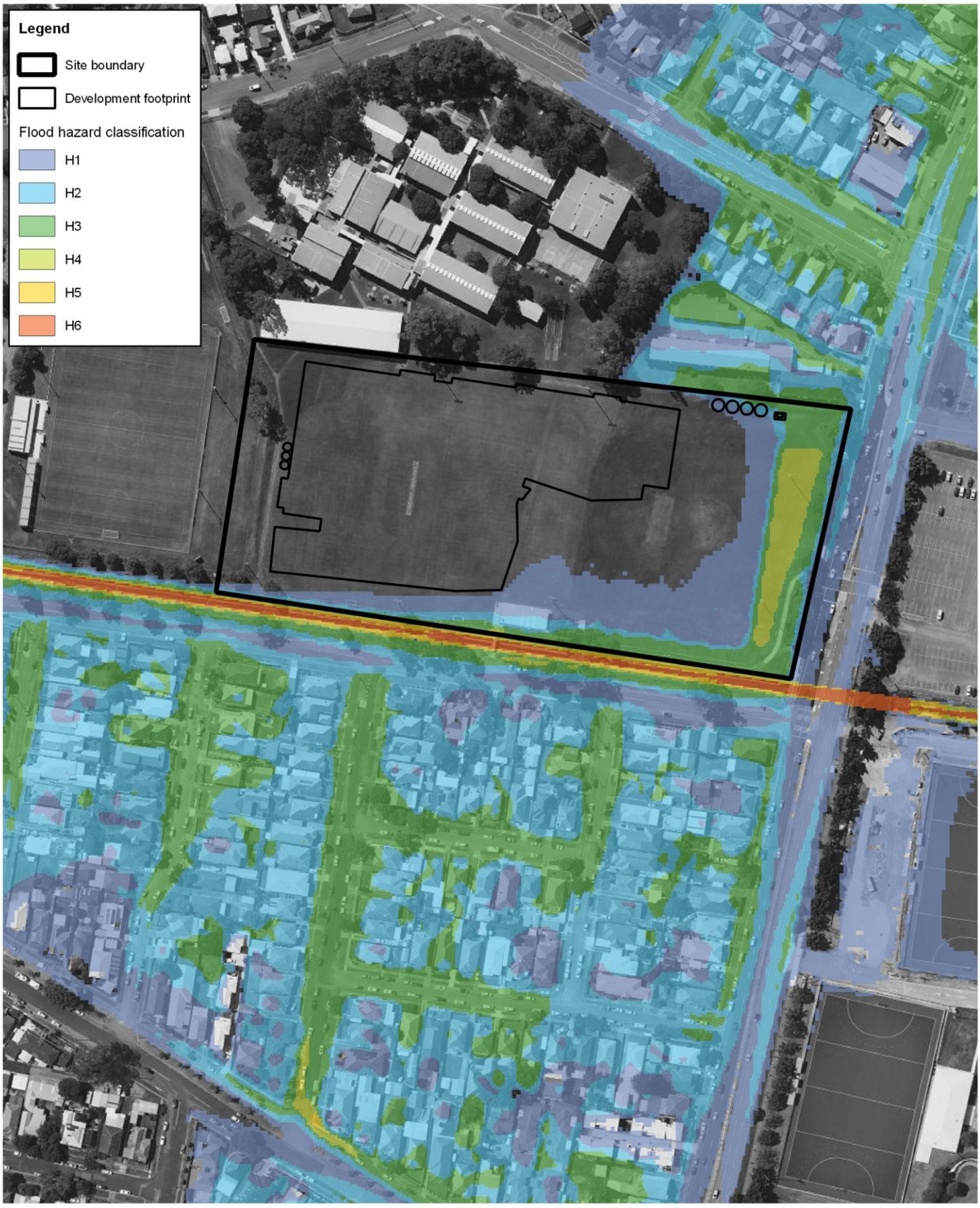

Title:

0.5% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-9**

Revision: **D**

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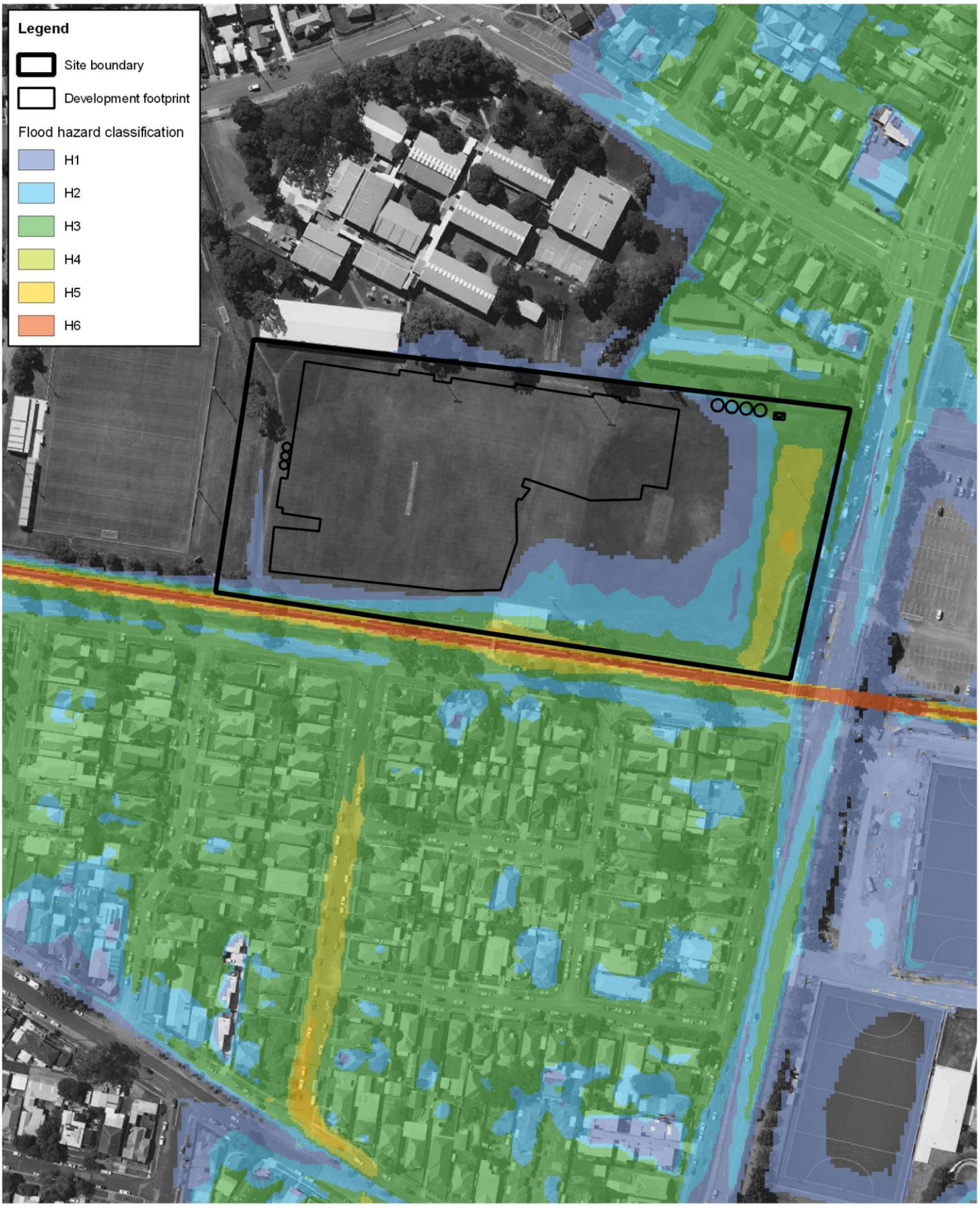

Title:

0.2% AEP Flood Hazard Classification for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-10**

Revision: **D**

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Title:

Modelled 10% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-11**

Revision: **D**

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Title:

Modelled 5% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-12**

Revision: **D**

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Title:

Modelled 2% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-13**

Revision: **D**

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Title:

Modelled 1% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-14**

Revision: **D**

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Title:

Modelled 0.5% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-15**

Revision: **D**

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Title:

Modelled 0.2% AEP Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-16**

Revision: **D**

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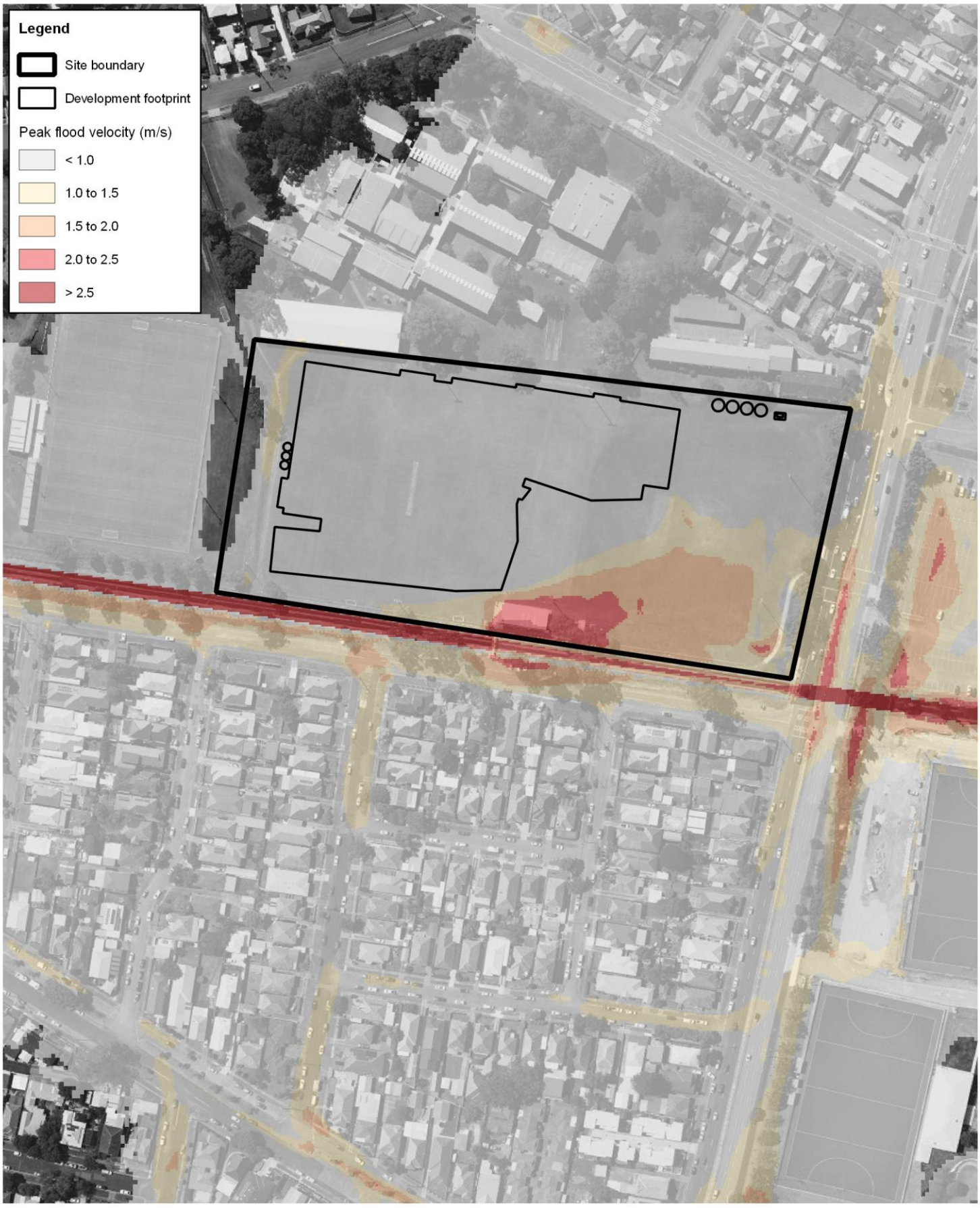

Title:

Modelled PMF Peak Flood Velocity for Post-development Conditions

0 60 120 m

approx. scale

Figure: **B-17**

Revision: **D**

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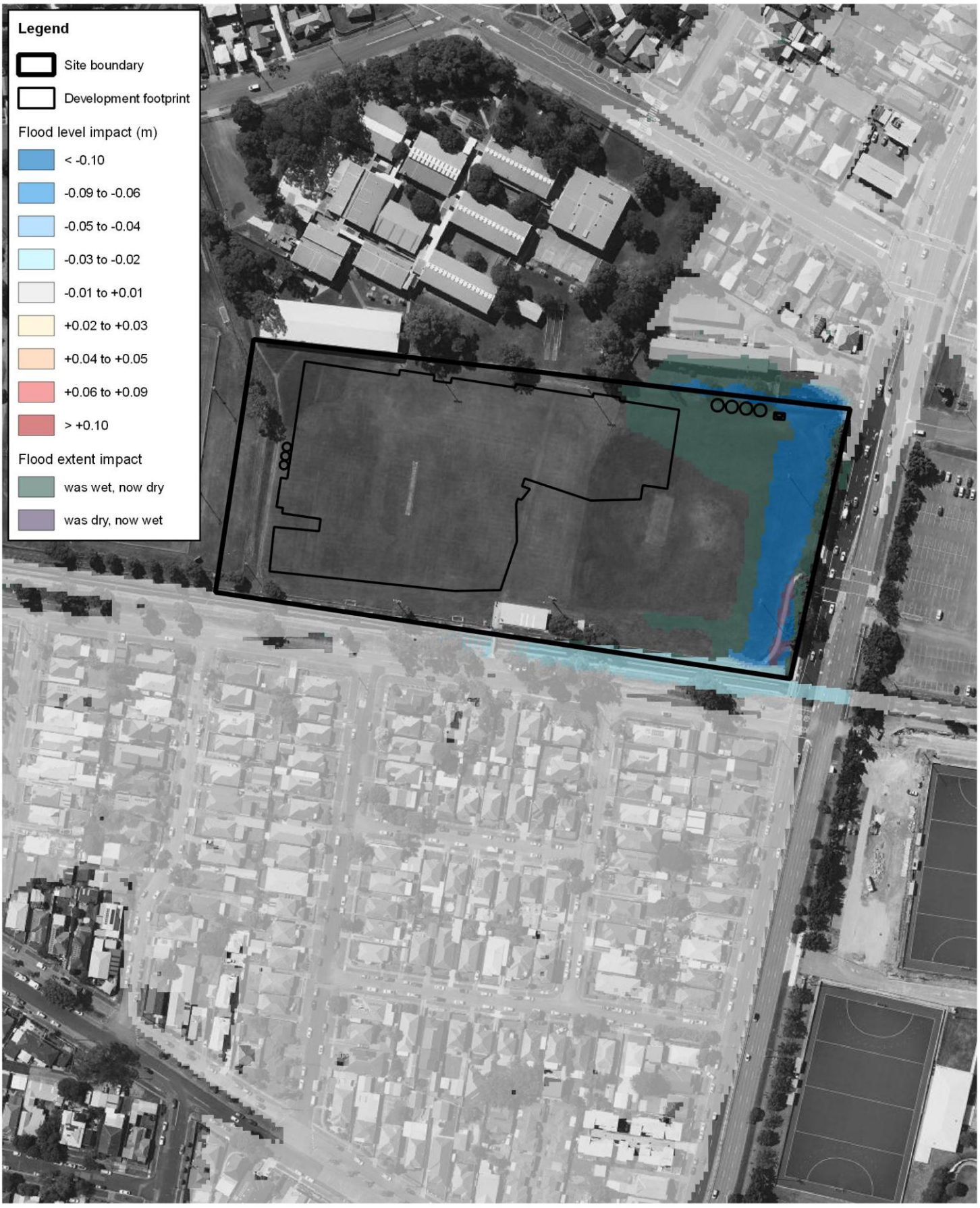
Appendix C Flood Impact Mapping



Title:

Modelled 5% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **C-1**

Revision: **D**

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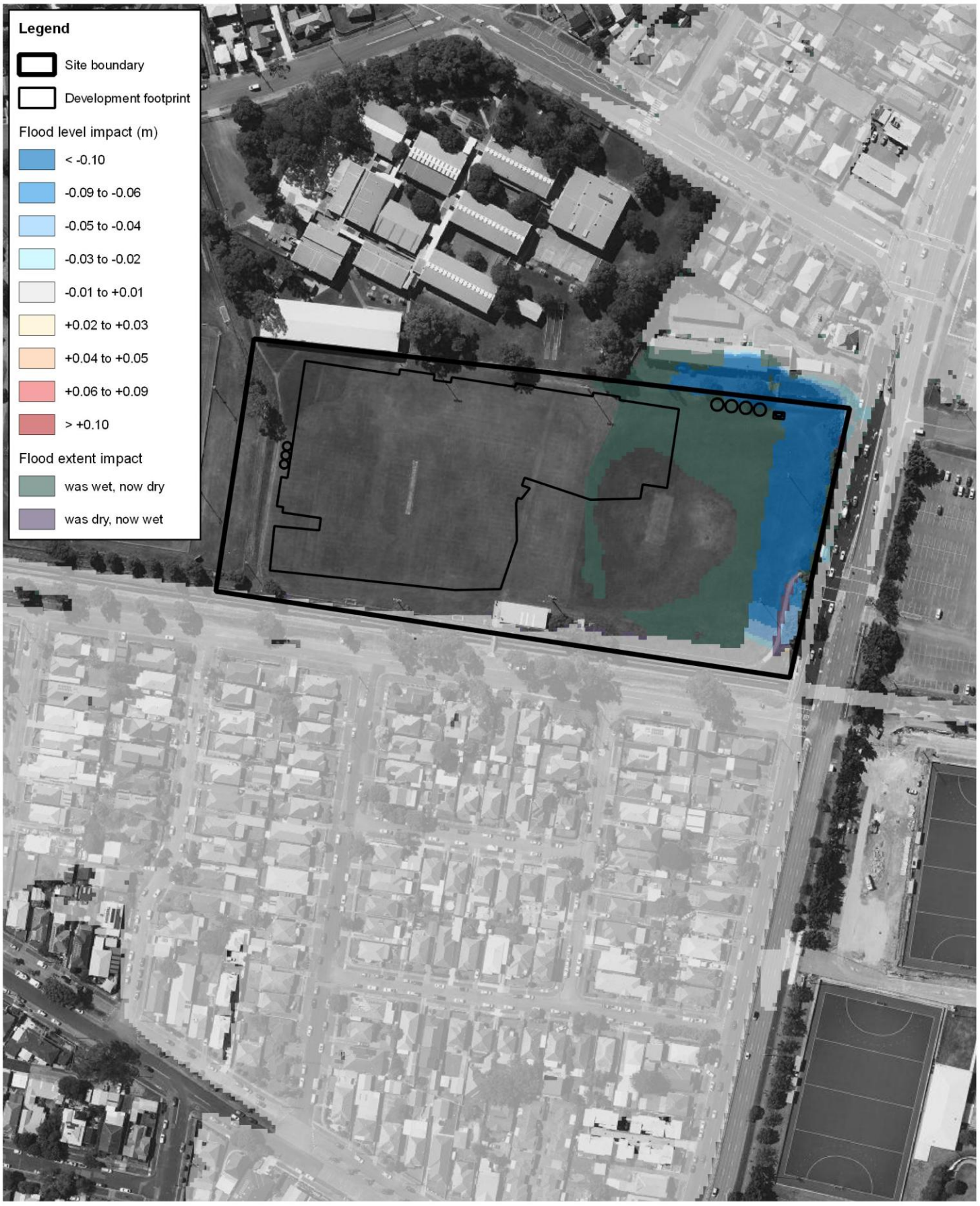

Title:

Modelled 2% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **C-2**

Revision: **D**

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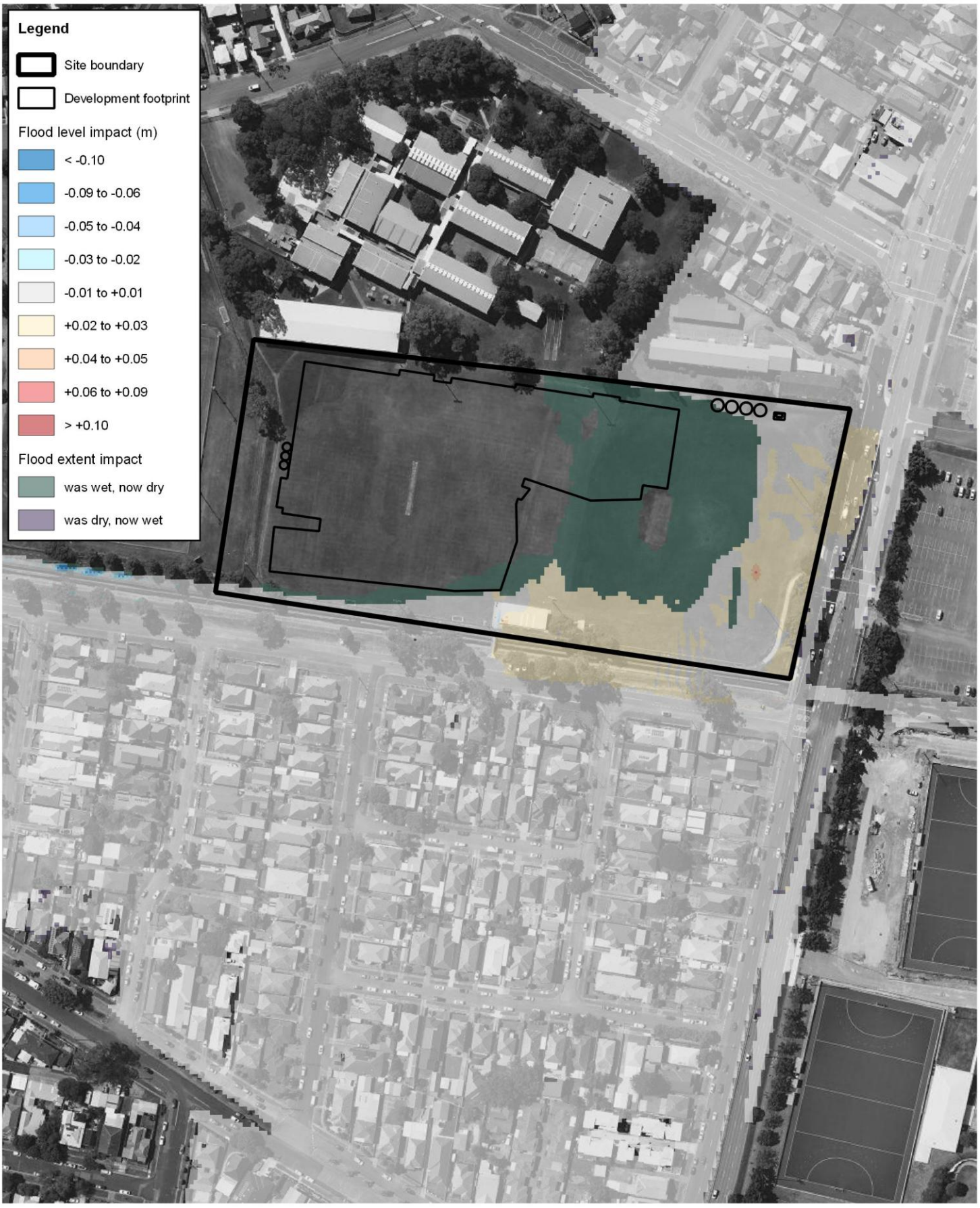

Title:

Modelled 1% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **C-3**

Revision: **D**

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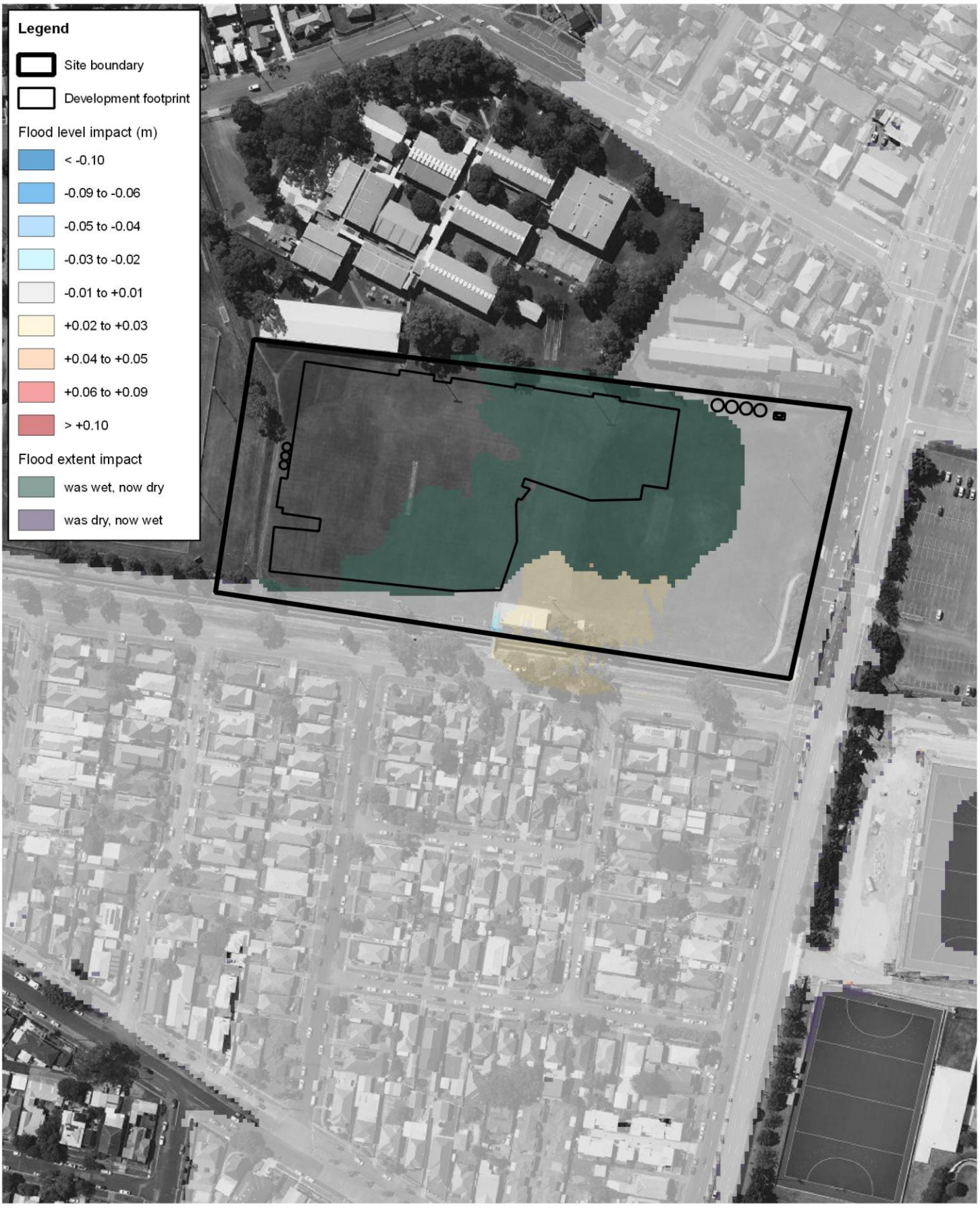

Title:

Modelled 0.5% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **C-4**

Revision: **D**

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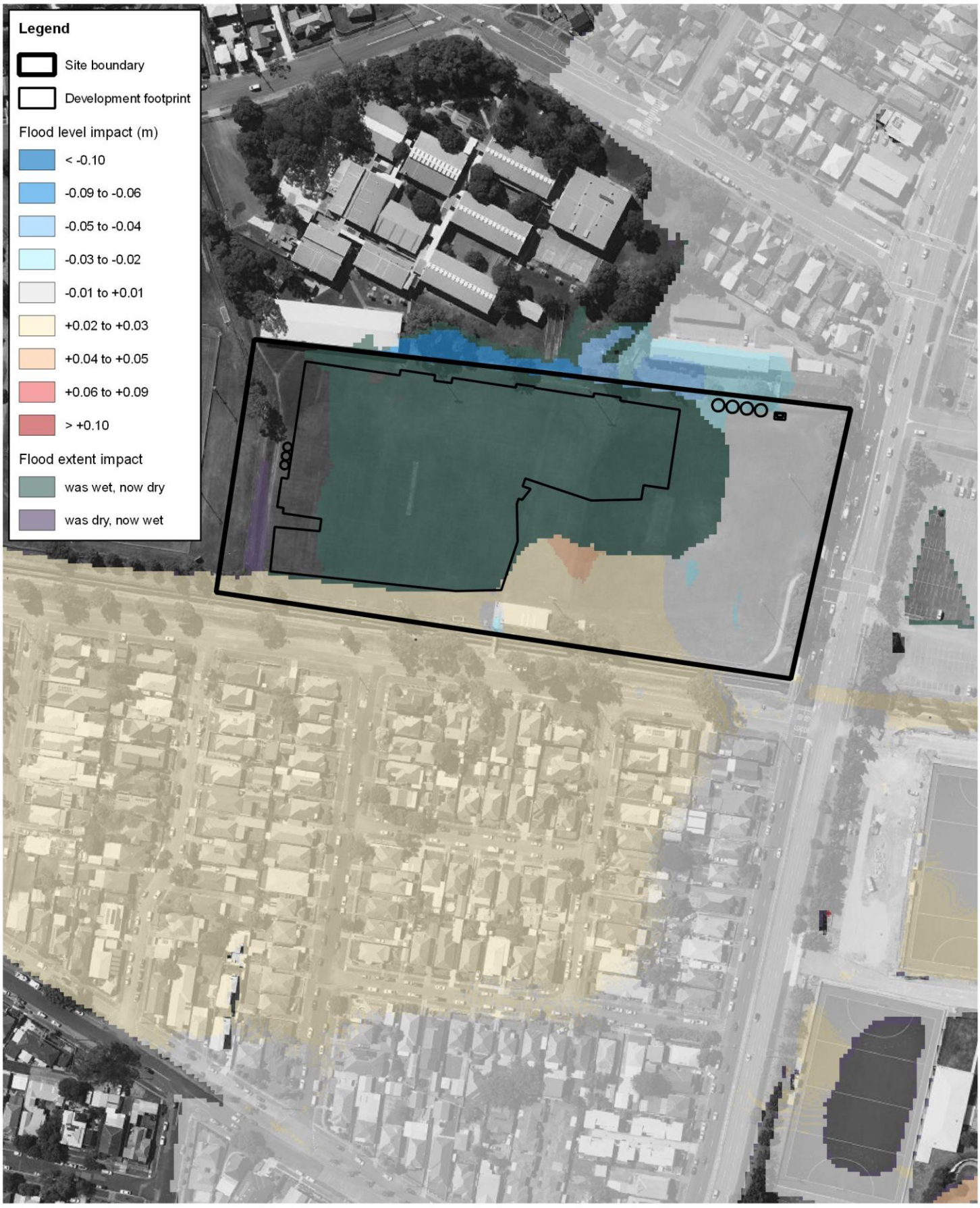

Title:

Modelled 0.2% AEP Peak Flood Level Impact

0 60 120 m

approx. scale

Figure: **C-5**

Revision: **D**

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Title:

Modelled 5% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **C-6**

Revision: **D**

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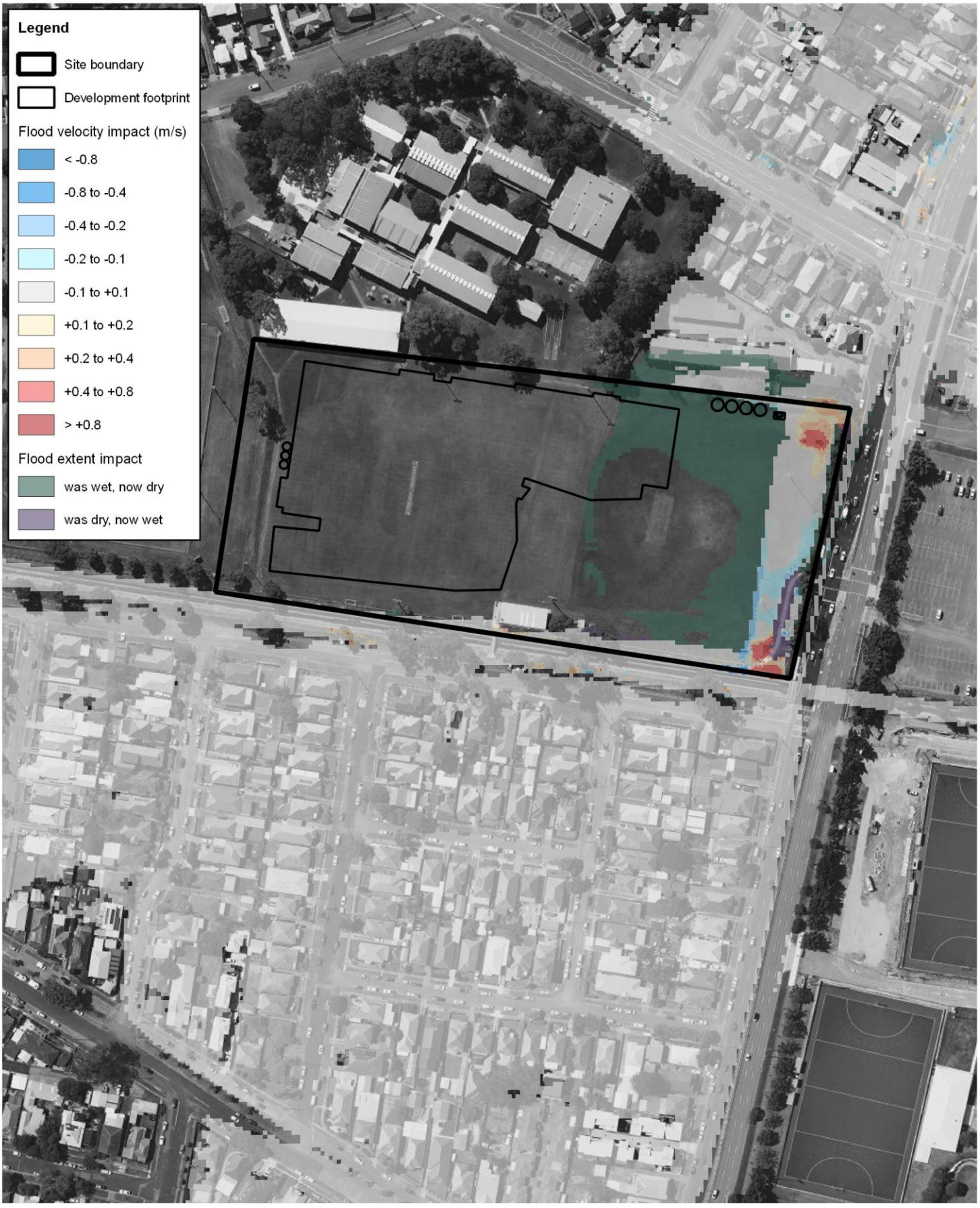

Title:

Modelled 2% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **C-7**

Revision: **D**

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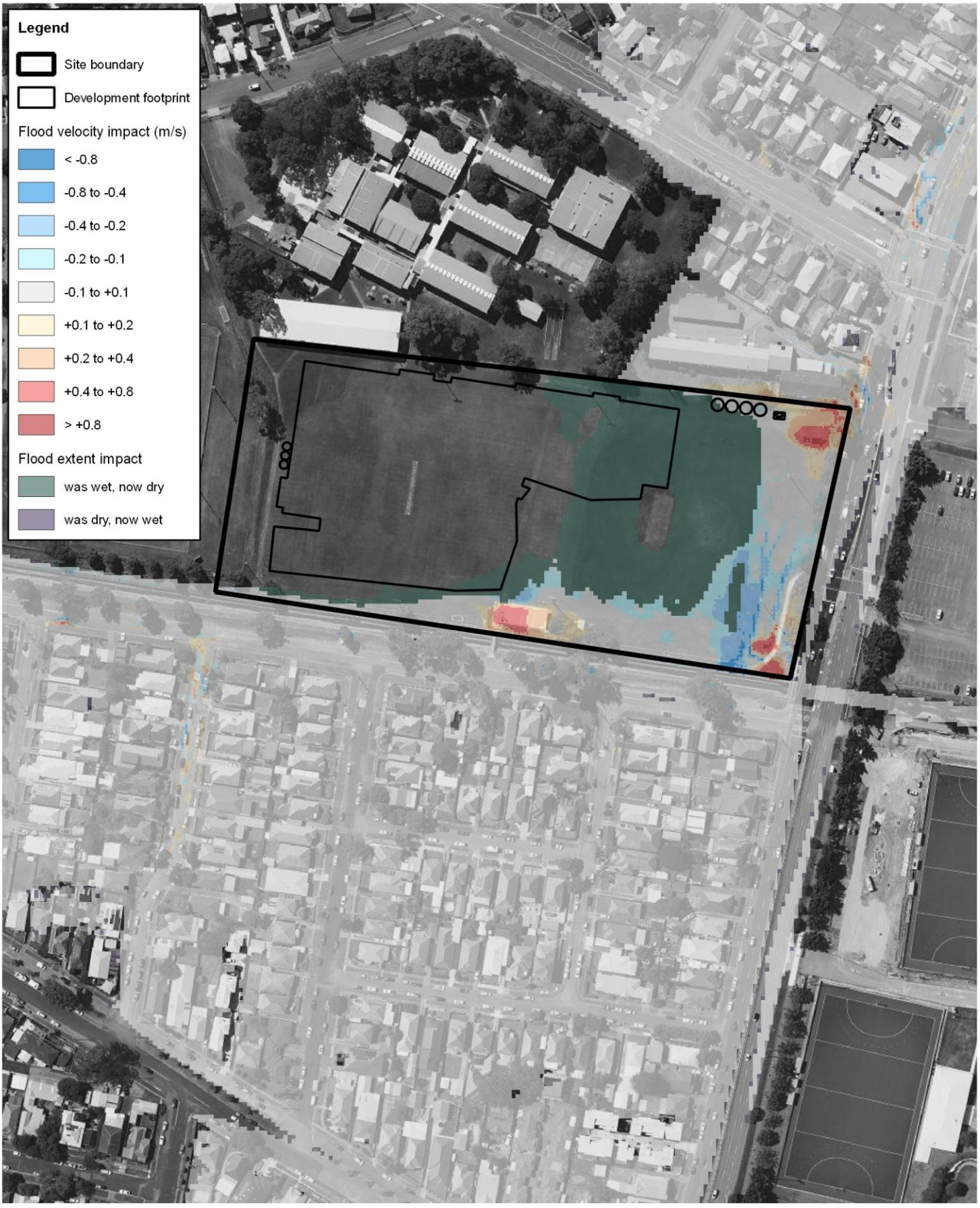

Title:

Modelled 1% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **C-8**

Revision: **D**

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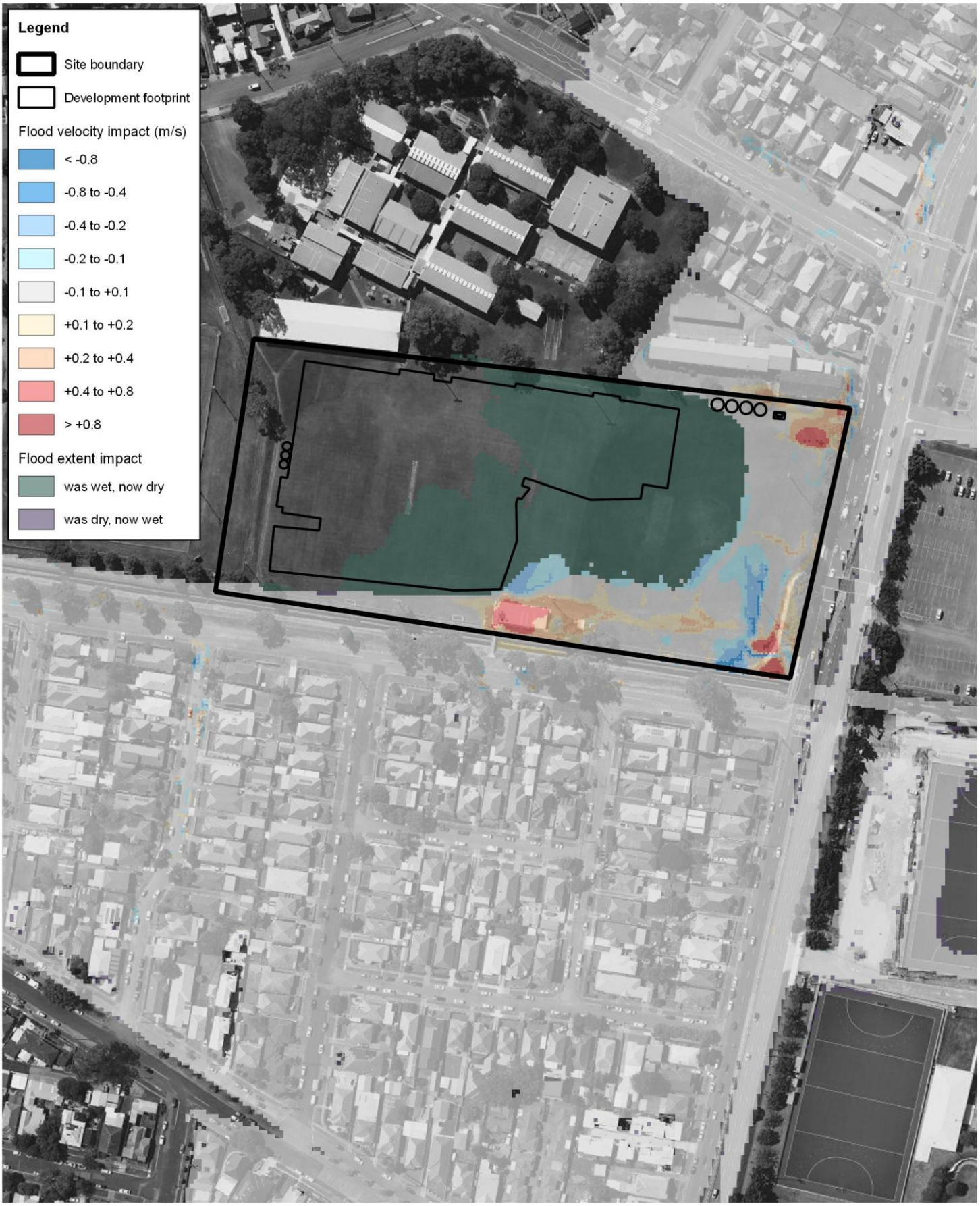

Title:

Modelled 0.5% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **C-9**

Revision: **D**

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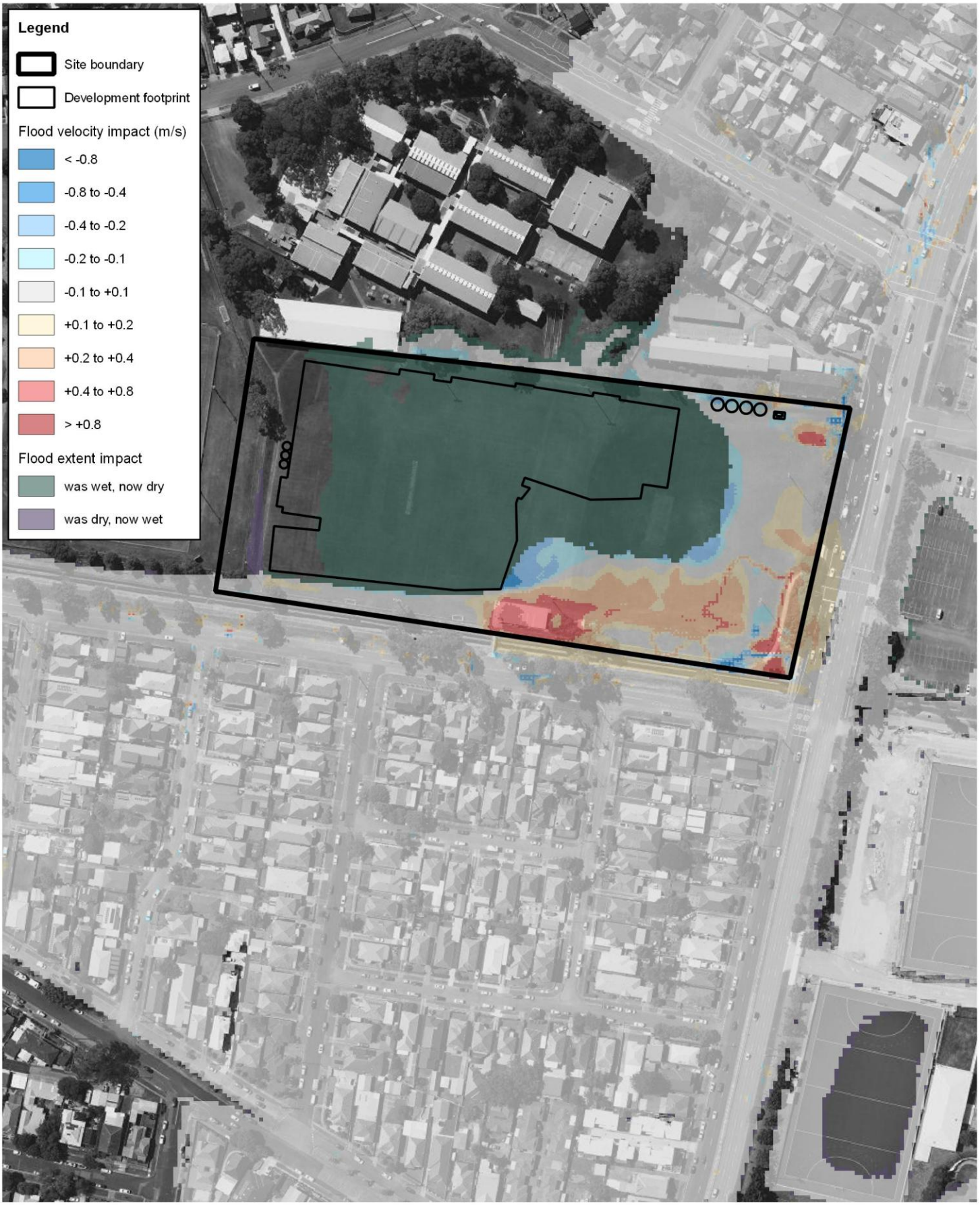

Title:

Modelled 0.2% AEP Peak Flood Velocity Impact

0 60 120 m

approx. scale

Figure: **C-10**

Revision: **D**

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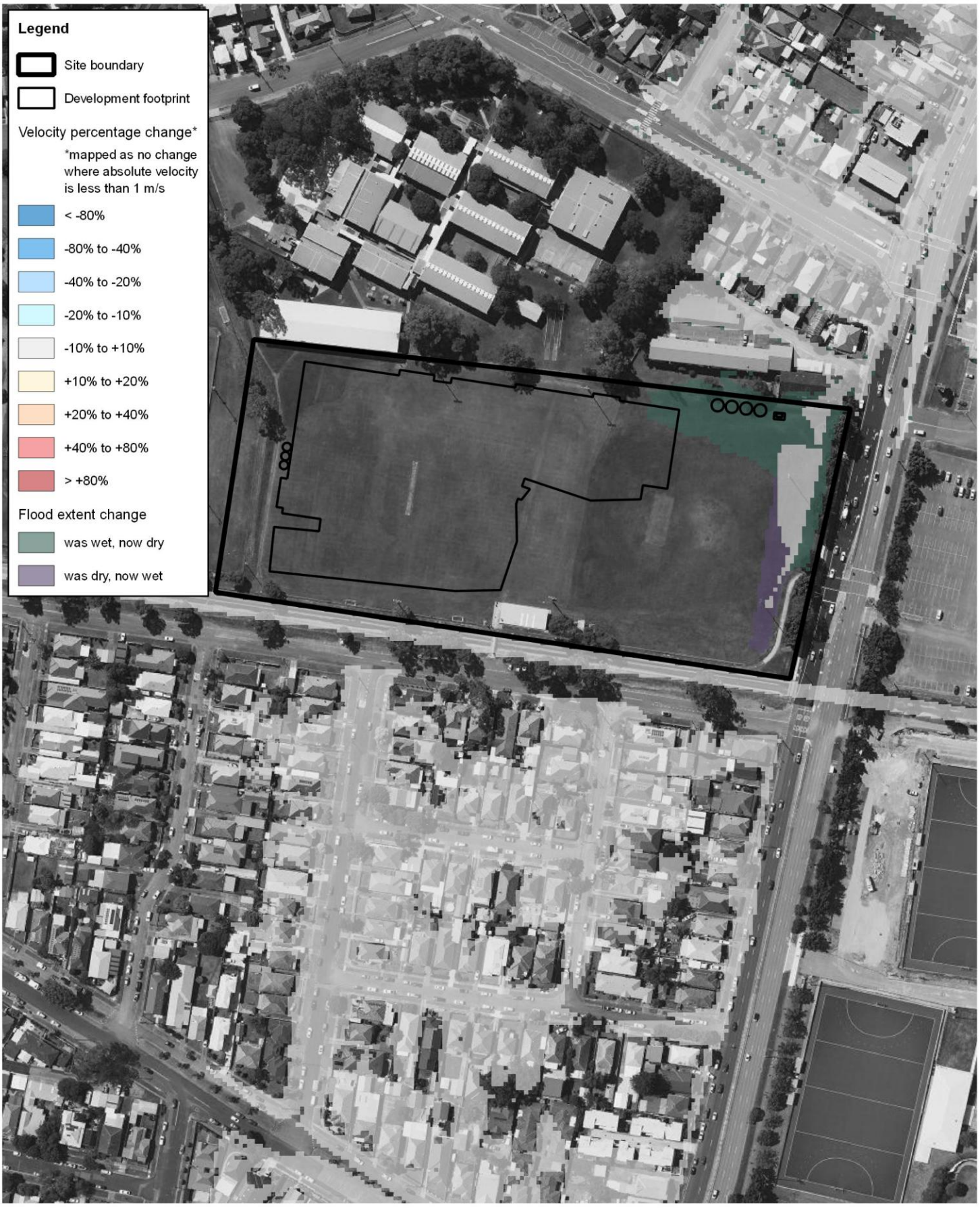

Title:

Modelled 10% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-11**

Revision: **D**

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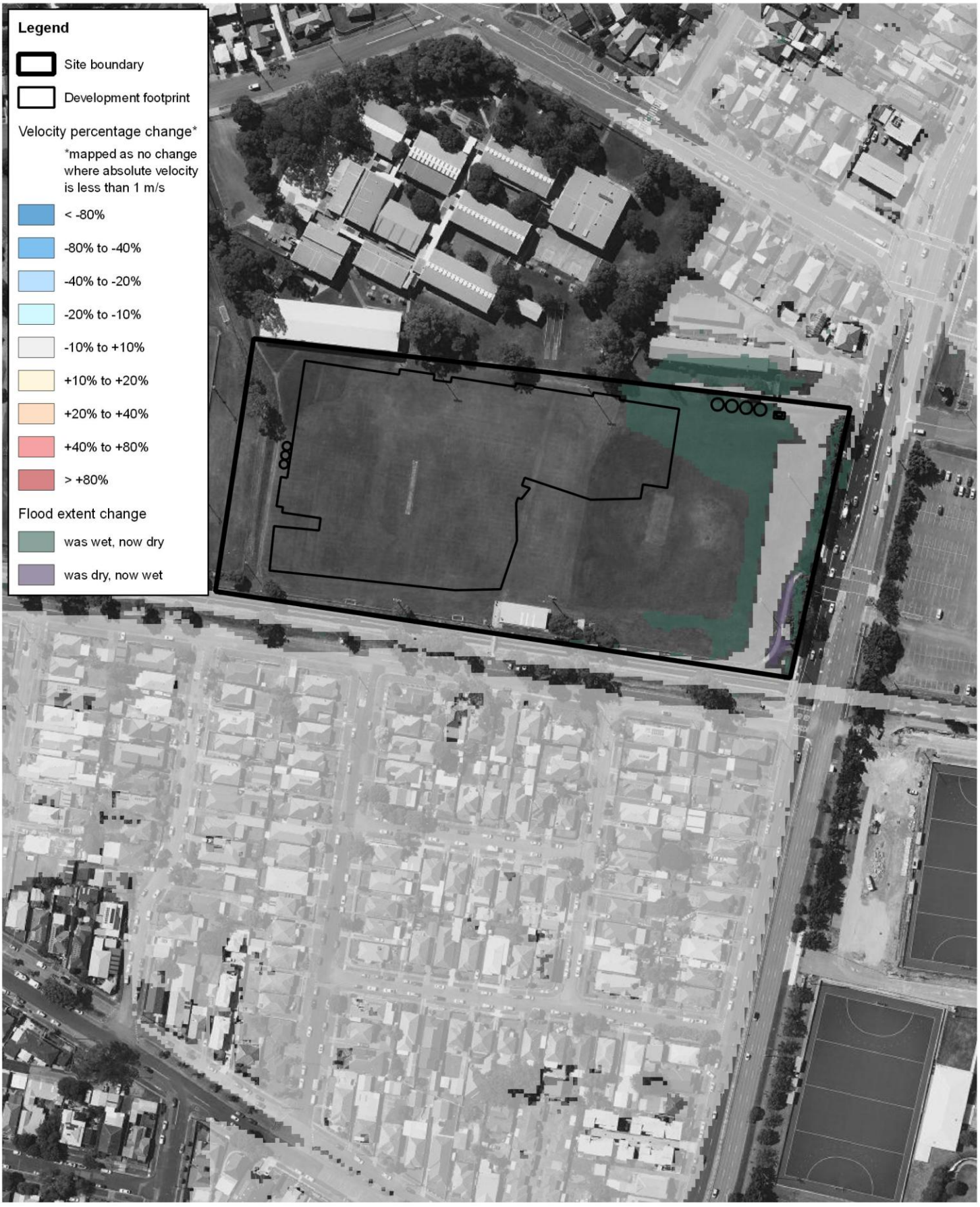

Title:

Modelled 5% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-12**

Revision: **D**

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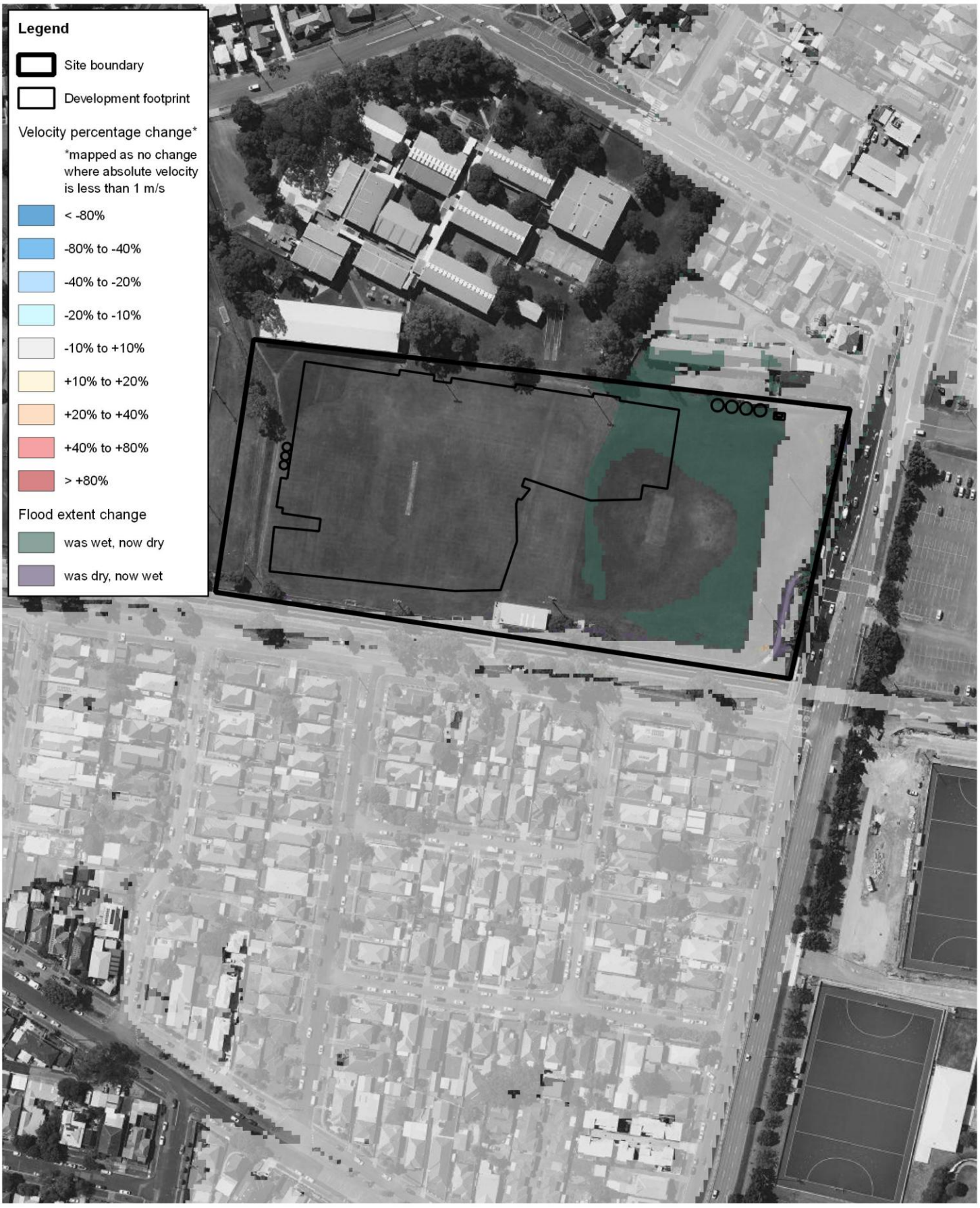

Title:

Modelled 2% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-13**

Revision: **D**

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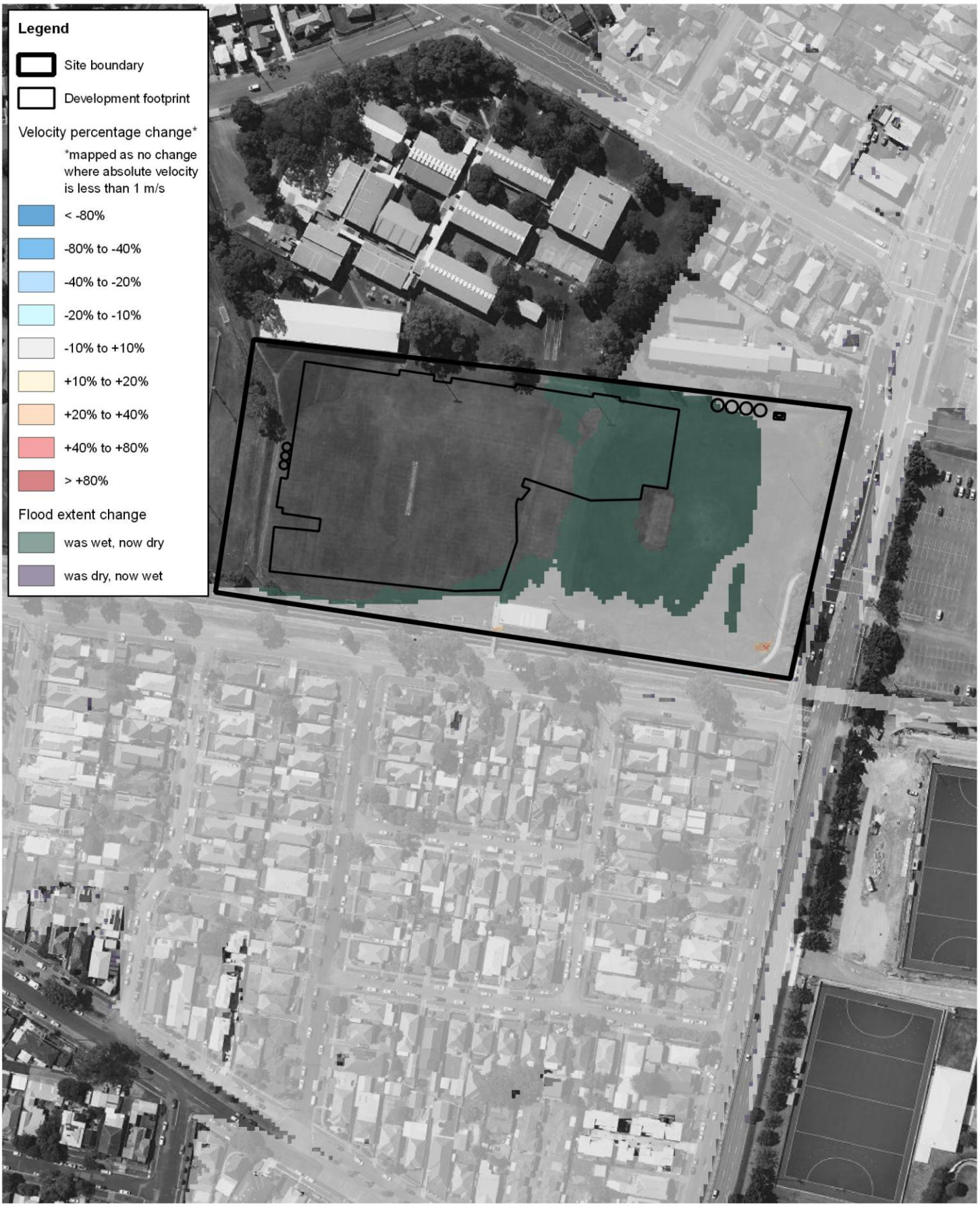

Title:

Modelled 1% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-14**

Revision: **D**

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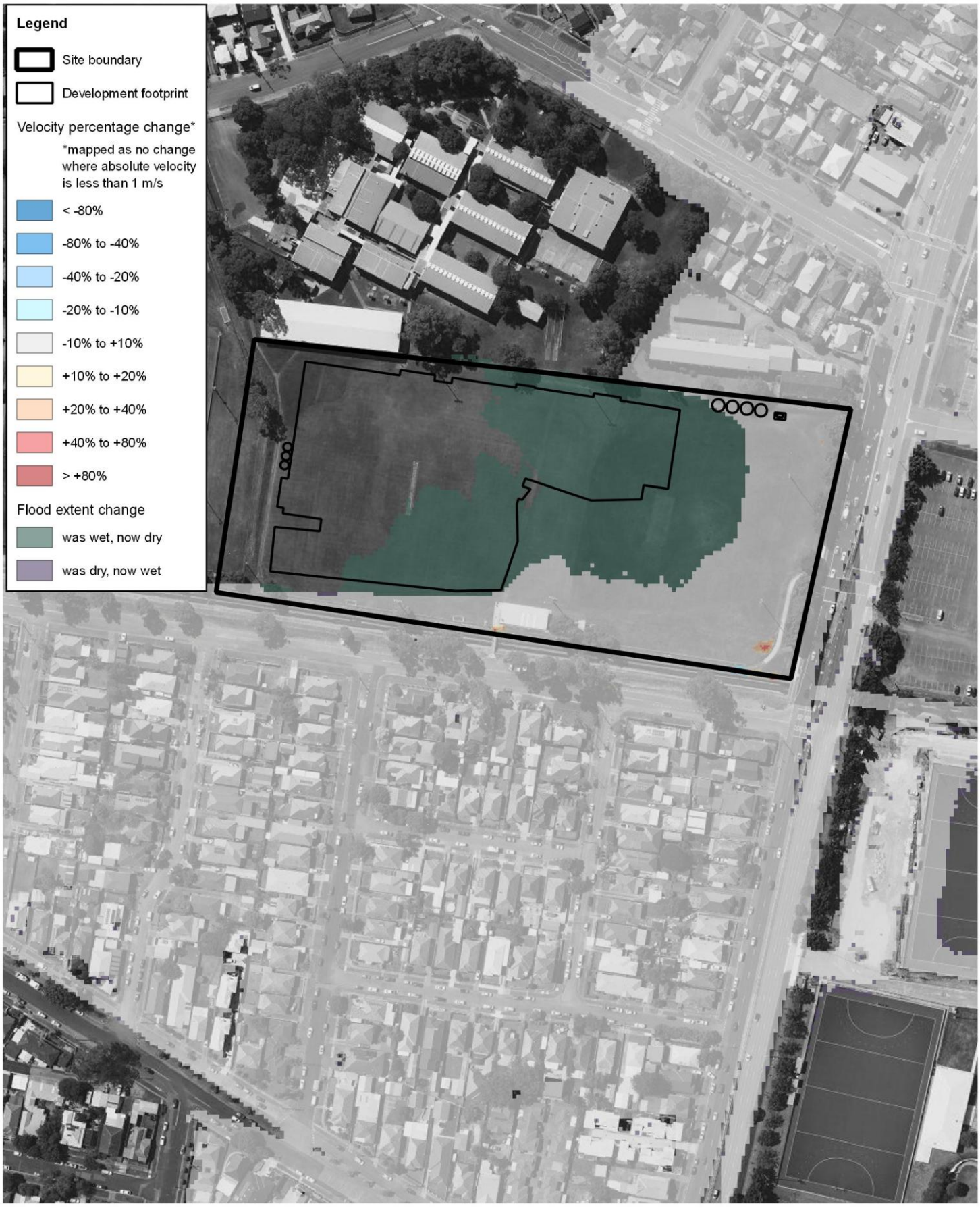

Title:

Modelled 0.5% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-15**

Revision: **D**

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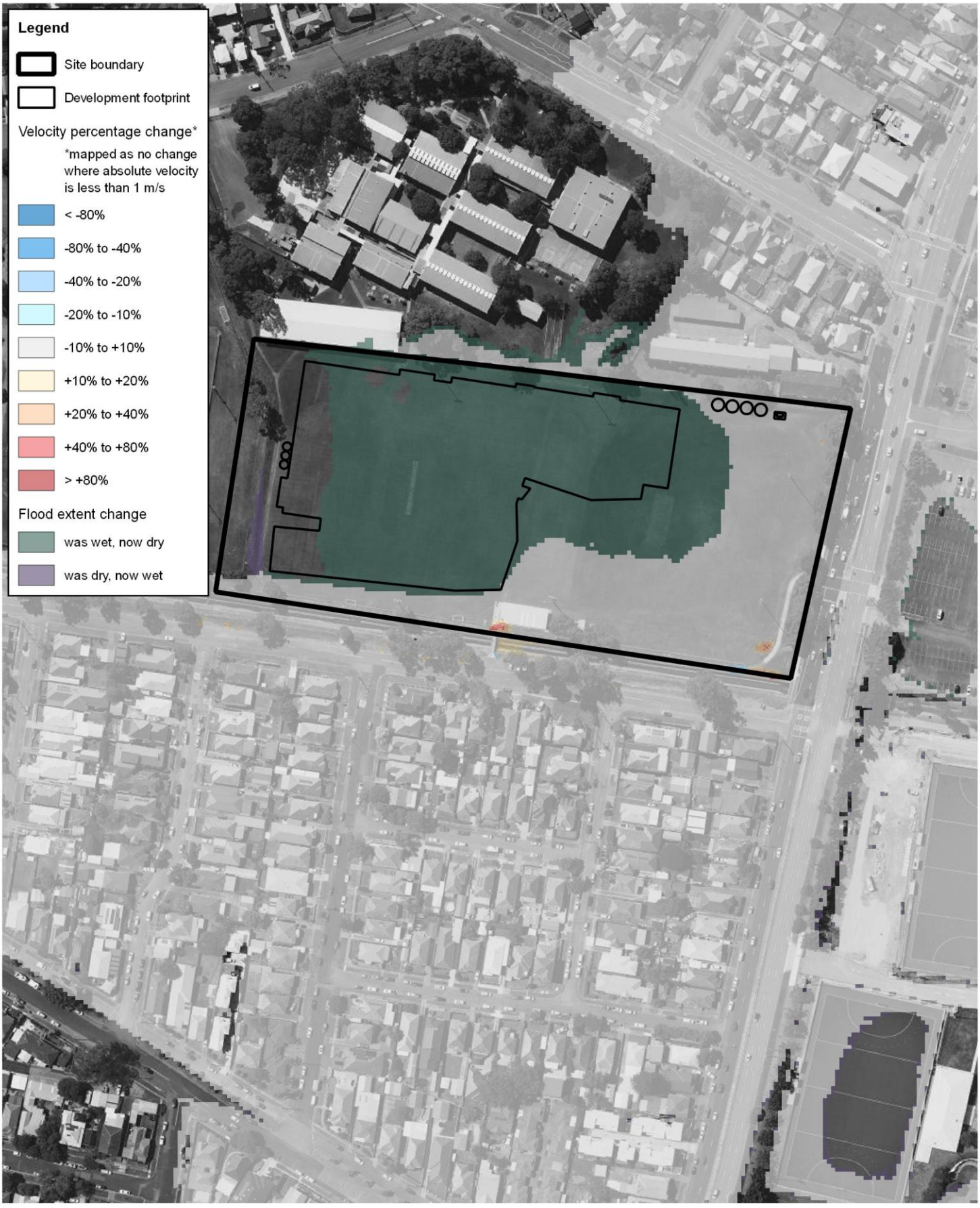

Title:

Modelled 0.2% AEP Percentage Change in Peak Flood Velocity

0 60 120 m

approx. scale

Figure: **C-16**

Revision: **D**

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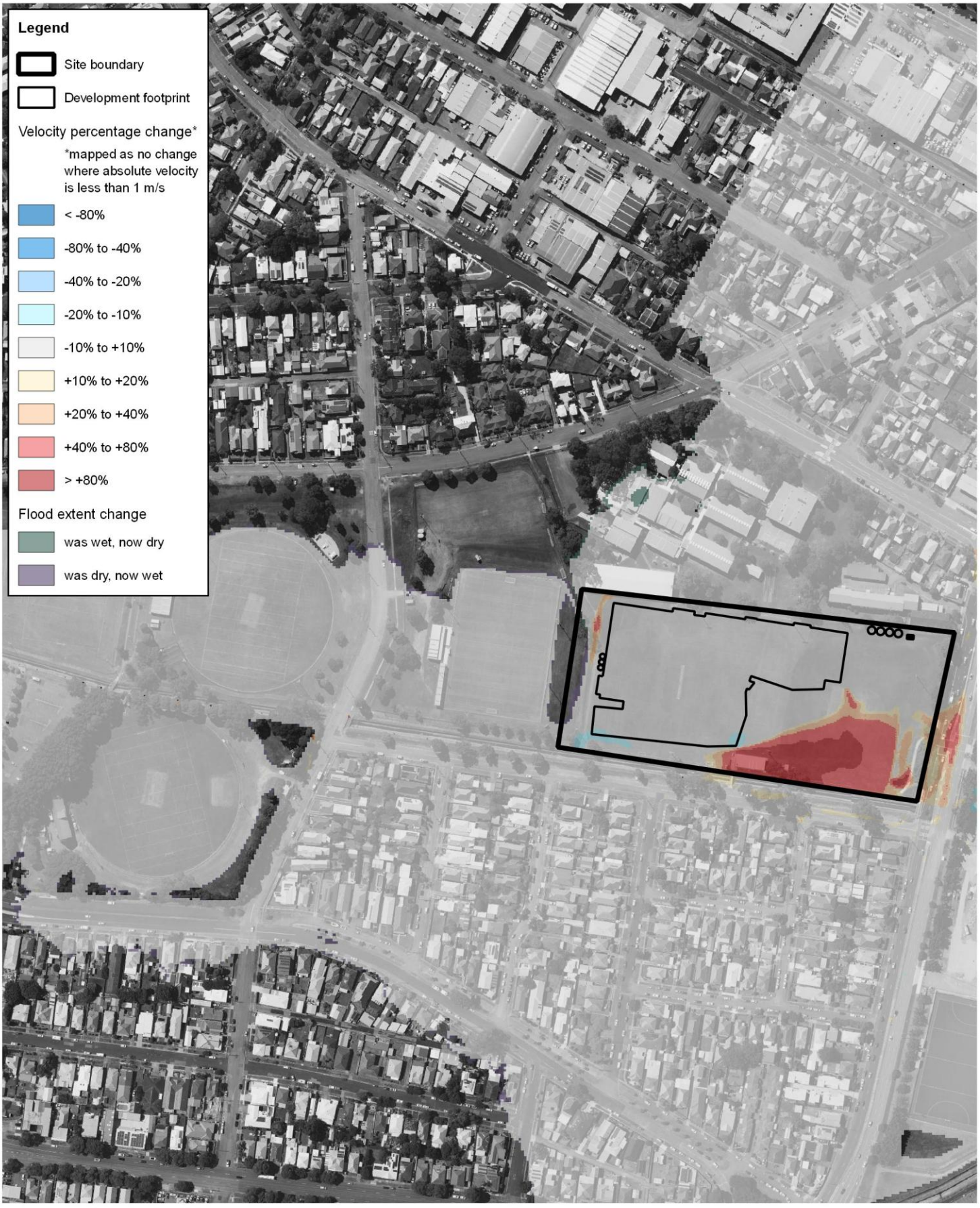

Title:

Modelled PMF Percentage Change in Peak Flood Velocity

0 100 200 m

approx. scale

Figure: **C-17**

Revision: **D**

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Title:

Modelled Change in 10% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-18**

Revision: **D**

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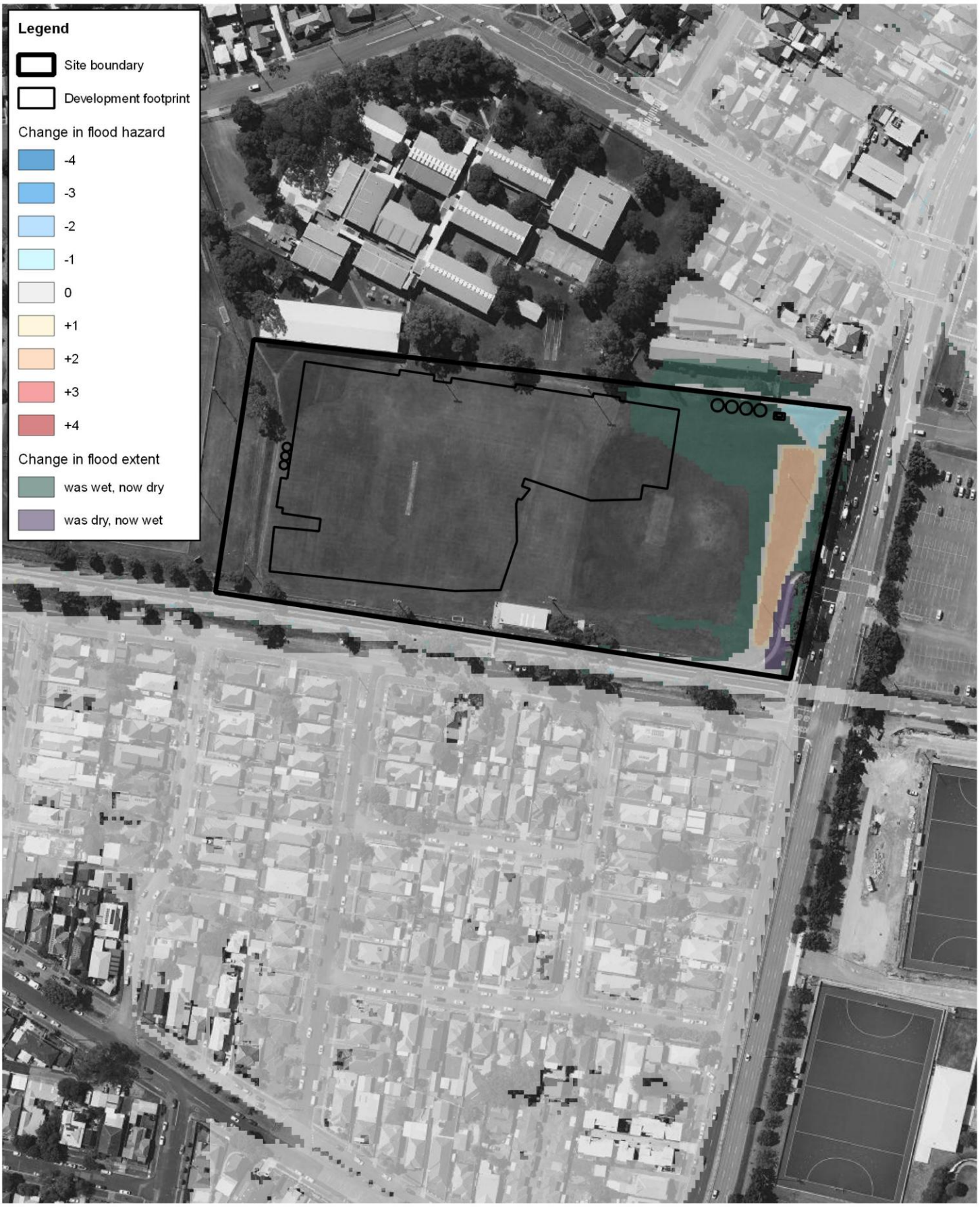

Title:

Modelled Change in 5% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-19**

Revision: **D**

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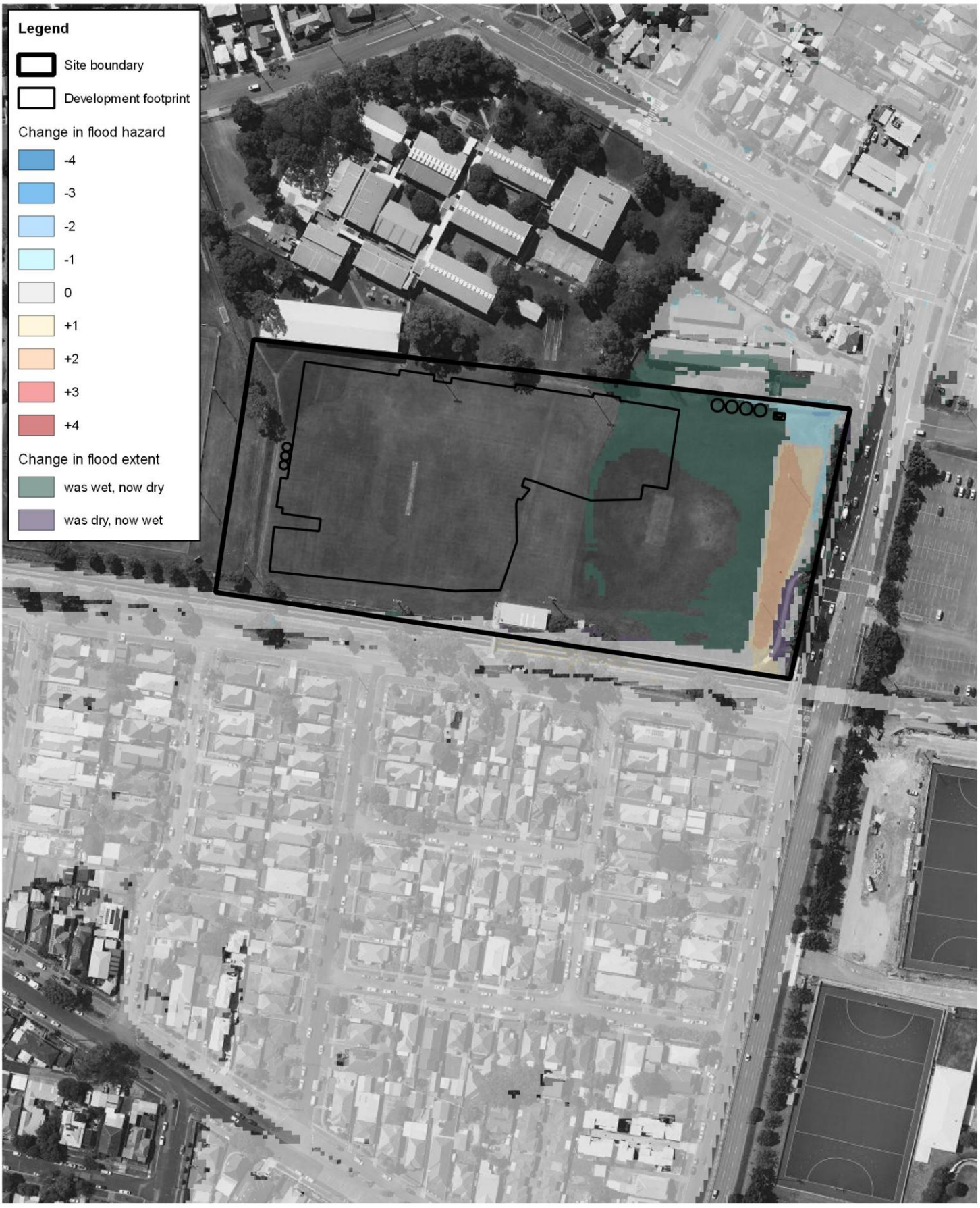

Title:

Modelled Change in 2% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-20**

Revision: **D**

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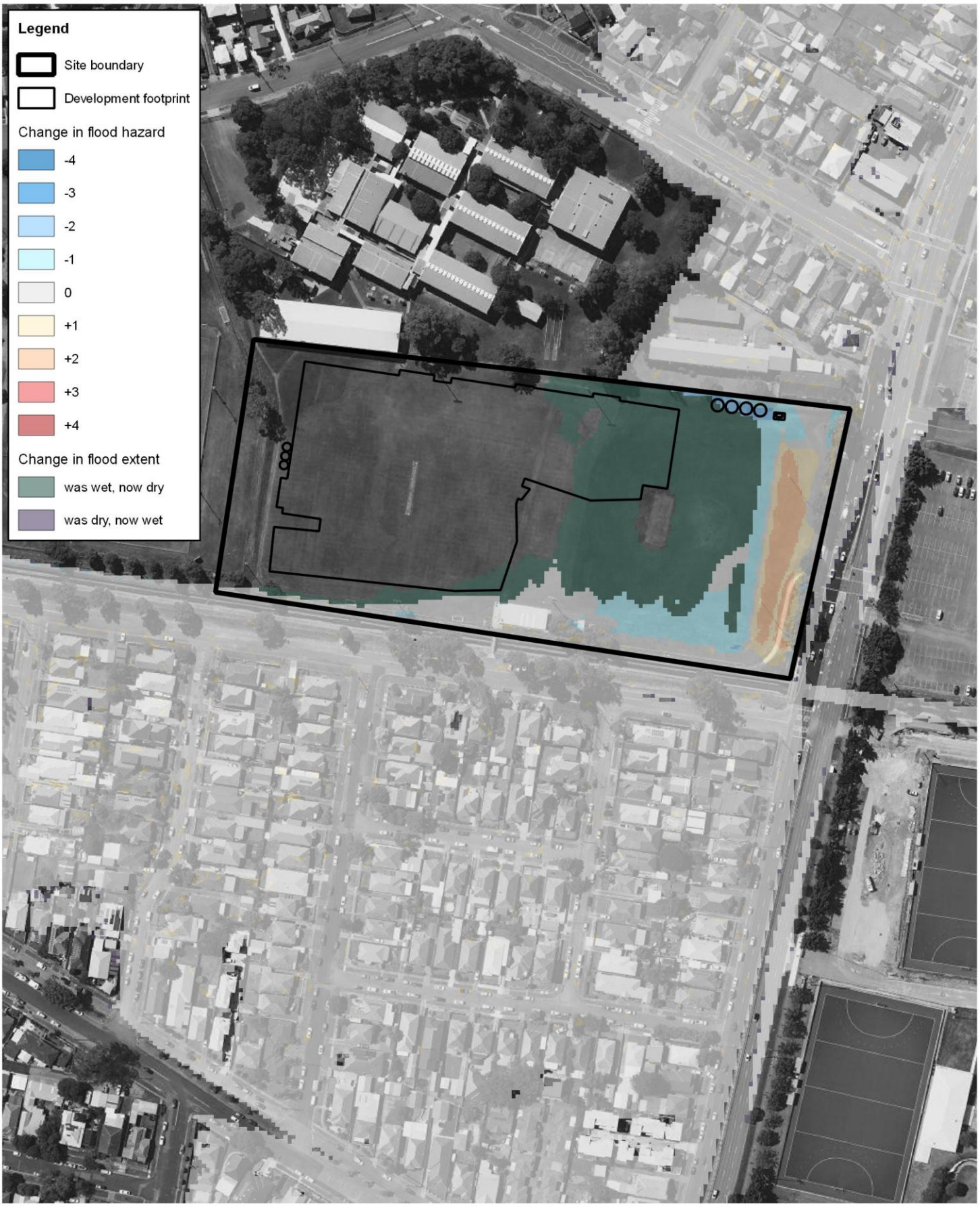

Title:

Modelled Change in 1% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-21**

Revision: **D**

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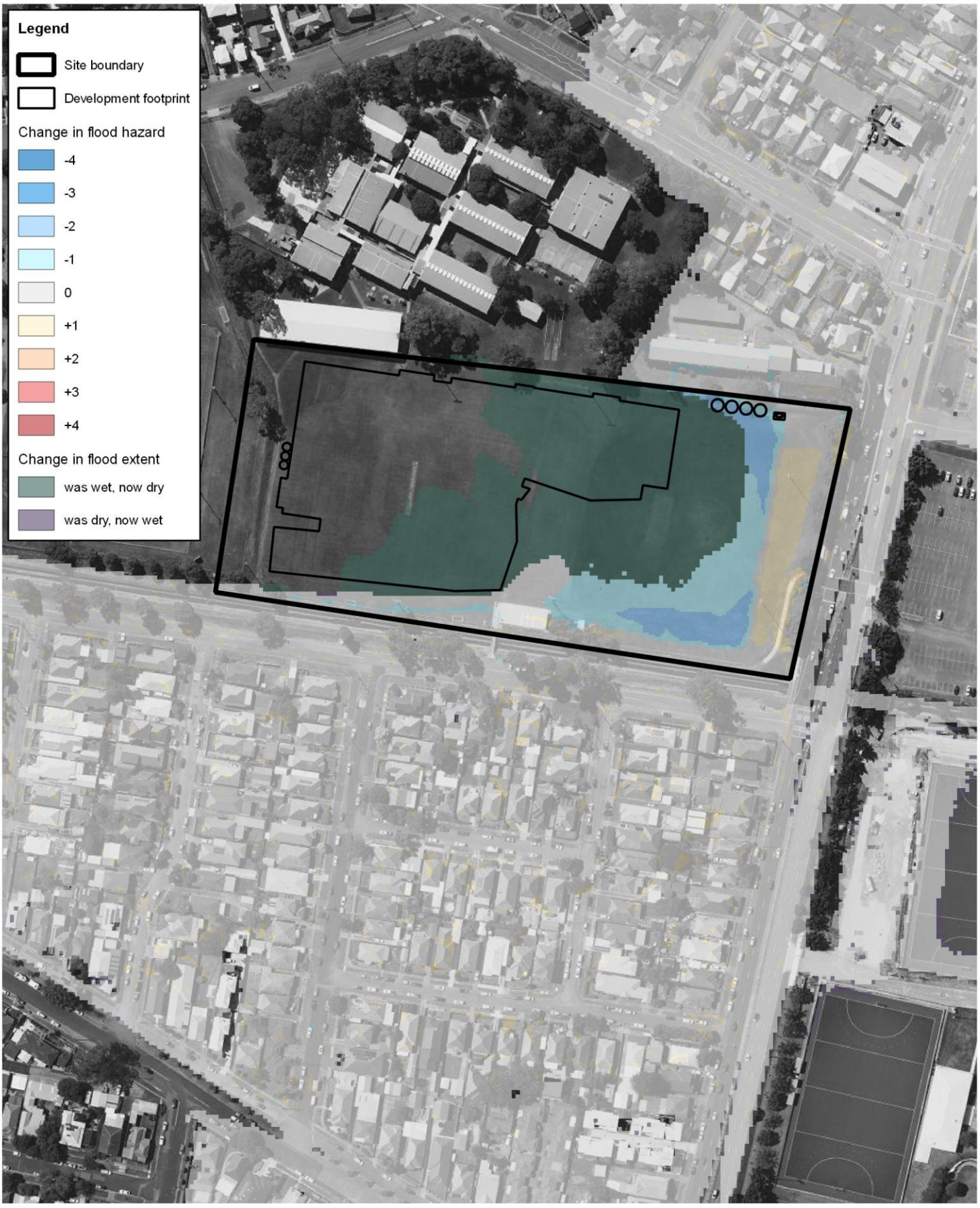

Title:

Modelled Change in 0.5% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-22**

Revision: **D**

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Title:

Modelled Change in 0.2% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **C-23**

Revision: **D**

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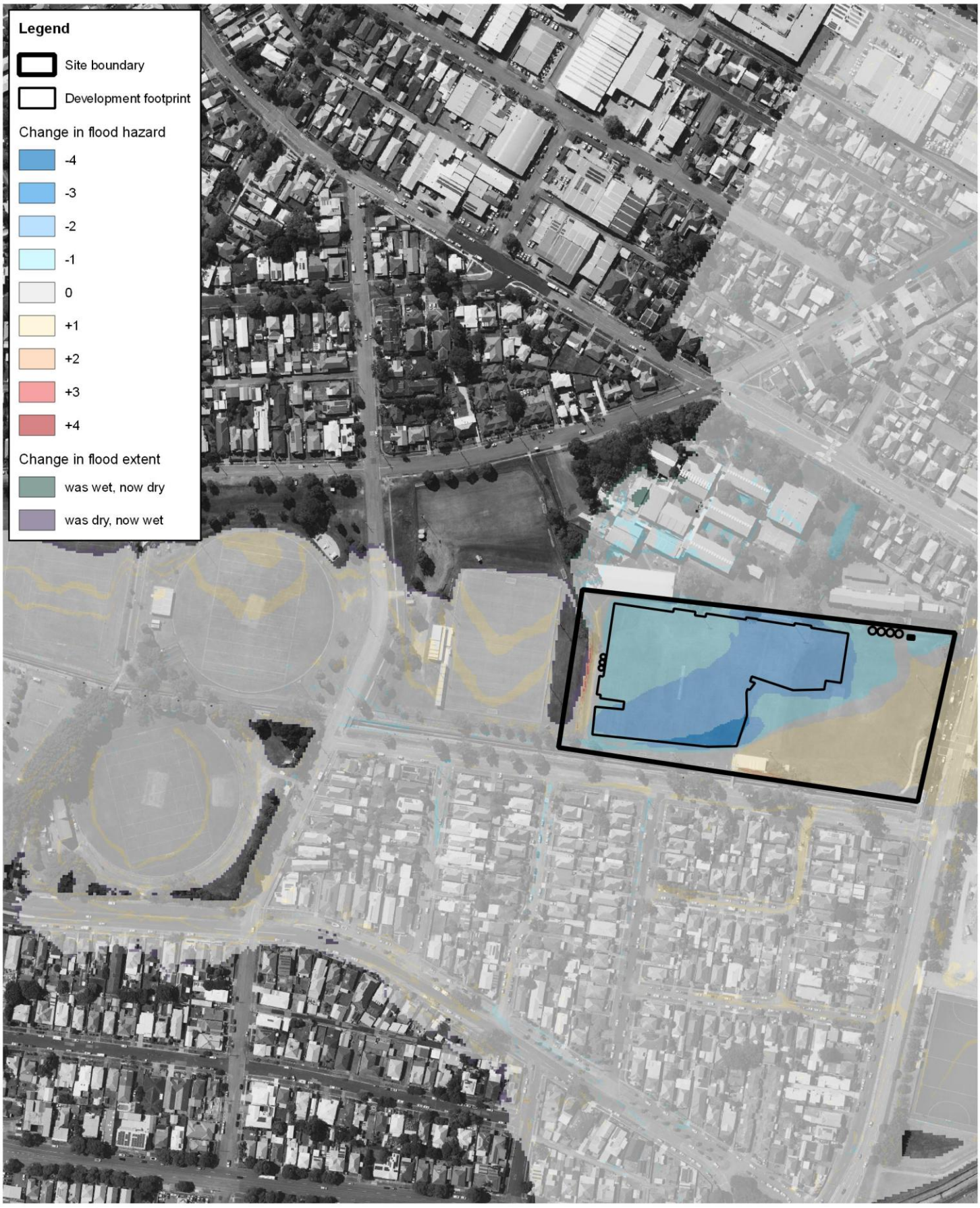

Title:

Modelled Change in PMF Flood Hazard Classification

0 100 200 m

approx. scale

Figure: **C-24**

Revision: **D**

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