Torrent Consulting Pty Ltd
PO Box 57
Wallsend NSW 2287

ABN 11 636 418 089

www.torrentconsulting.com.au

Our Ref: DJW: L.T2345.004.docx

27 November 2024
Williams River Steel
25 Old Punt Rd
Tomago NSW 2322
Attention: Kris Webb

Dear Kris

RE: FLOOD IMPACT ASSESSMENT FOR PROPOSED FUNCTION CENTRE WITHIN 29, 33, & 35 GREY STREET, CLARENCE TOWN, NSW

Background

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the development of a proposed function centre within 29, 33, and 35 Grey Street, Clarence Town, NSW (the Site). A flood assessment is required to satisfy Council requirements in relation to the management of risk to life and risk to property from flooding and to minimise any off-site impacts to the existing flood conditions.

This Site is located within the floodplain of the Williams River and the tributary watercourse (Town Creek) that drains the local catchment runoff, which is some 0.7 km^2 in area, as shown in Figure 1 and Figure 2. The design flood conditions are detailed in the Williams River Flood Study (BMT WBM, 2009) and the Clarence Town Flood Study (BMT WBM, 2012). Information contained in these studies will be used to summarise the existing flood conditions and risks in the context of the Site and the proposed development.

TUFLOW modelling of the local catchment has also been undertaken in accordance with the ARR 2019 guidelines to define design flood conditions that are relatively consistent with those of the adopted flood study. The details of the development were then incorporated into the TUFLOW model and the design events re-simulated. Comparison of pre- and post-development flood conditions were undertaken for the purposes of a relative flood impact assessment.

Model Development

To model the local inflow, a TUFLOW hydrologic model was developed covering the local catchment draining to the Site plus the downstream receiving environment south of Queen Street; a total modelled area of around 0.85 km^2. The model utilised the NSW Spatial Services LiDAR data, downloaded via the ELVIS Foundation Spatial Data portal to define the floodplain topography. The model was constructed using a 2 m horizontal grid cell resolution.

Land use coverage in the catchment was identified using aerial imagery and assigned a Manning's 'n' roughness value, as presented in Table 1. The TUFLOW model was used to simulate the catchment rainfall-runoff process, utilising the ensemble storm method outlined in the ARR 2019 guidelines.

Table 1 – Mannings 'n' values used in TUFLOW model

Land Use	n
Urban	0.05
Natural Vegetation	0.12
Roadway	0.02
Quarry	0.04
Sports ground	0.06
Cleared	0.08

A detailed hydraulic model, as presented in Figure 3, was constructed using a 1 m horizontal grid cell resolution. The Z shape functionality was used to enforce the observed channel shape and better represent the channel hydraulics adjacent to the Site. Topographical modifications were also enforced according to available site survey data (2024102 TS1.pdf) to ensure accurate representation of the existing surface within the Site.

Pipe and box culvert sizes were observed during a site inspection, with reasonable assumptions made as to invert levels, and were modelled with 1D elements dynamically linked to the 2D floodplain. The existing bridge within the Site was modelled using a 2D layered flow constriction to represent the bridge opening and bridge deck hydraulics.

Appropriate Mannings 'n' values were used according to Table 1, with additional values of 0.08, 0.06 and 0.04 used to represent varying hydraulic characteristics of the channel within the model area.

The hydraulic model was then modified to represent post-development conditions, and included representation of the modified channel, proposed buildings and earthworks, additional flow capacity at the existing bridge, new pedestrian bridge access from Grey Street, and new vehicular bridge access from Queen Street, as presented in Figure 4.

Hydrologic and Hydraulic Modelling

The TUFLOW model of the catchment was simulated (using the HPC solver) for the full range of design rainfall events for storm durations ranging from 10 minutes to 12 hours. The design rainfall depths were sourced from the BoM IFD (Intensity Frequency Duration) portal. Due to the small size of the catchment area, no Areal Reduction Factor (ARF) was applied.

Design rainfall losses considered the recent NSW-specific guidance. This provided a continuing loss of 1.1 mm/h. Initial losses ranged from around 3 mm to 6 mm. Impervious areas were given an initial loss of 1 mm, with 0 mm/h continuing loss. The urban area was estimated at 50% impervious, with losses interpolated between the pervious and impervious values.

The ensemble method involves the simulation of ten rainfall temporal patterns for each design event magnitude and duration, with the average condition of the ten being adopted for design purposes. The TUFLOW model simulations were analysed at the upstream side of the existing bridge accessing the Site to identify the critical storm duration, i.e., that which produces the peak flood flow for each design event magnitude. The 45-minute duration was identified as being critical for the 20% AEP event, the 30-minute duration was critical for the 10% AEP and 5% AEP, the 25-minute duration was critical for the 2% AEP, 1% AEP and 0.5% AEP, and the 20-minute duration was critical for the 0.2% AEP.

For the simulation of the PMF (Probable Maximum Flood) condition the Generalised Short Duration Method (GSDM) published by the BoM was adopted. Events for the 15-minute to 1-hour durations were simulated to determine the critical conditions. This found the Probable Maximum Precipitation (PMP) for the 15-minute duration to be critical, with a rainfall depth of 180 mm (720 mm/h intensity). The simulated peak design flood flows at the Site are summarised in Table 2.

Table 2 – Modelled Peak Design Flood Flows at the Site

Design Event	Flow (m^3/s)
20% AEP	11.3
10% AEP	13.1
5% AEP	17.2
2% AEP	21.5
1% AEP	27.6
0.5% AEP	32.9
0.2% AEP	40.8
PMF	145

Flood Risk Mapping

Figure 5 shows the existing local catchment flood extents for the 5% AEP, 1% AEP and PMF events, as simulated in the TUFLOW model. The extent of the 1% AEP Williams River flooding, as detailed in the existing flood study, is also indicated. The proposed location of the function centre is also shown for context.

As evident in Figure 5, most of the proposed building footprint is located within the floodplain. Therefore, the proposed development includes a major channel upgrade to better convey flood flows through the Site. The channel modifications, drainage structures, and earthworks proposed for the development will result in a major redistribution of flow across the Site, bearing little resemblance to the existing flood conditions, and so the flood mapping presented in Figure 6, Figure 7, and Figure 8 are presented for the post-development conditions, and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events, respectively.

Figure 9, Figure 10, and Figure 11 present the post-development flood hazard classification at the Site for the 5% AEP, 1% AEP and PMF events, respectively. The flood hazards have been determined in accordance with Guideline 7-3 of the Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017). This produces a six-tier hazard classification, based on modelled flood depths, velocities and velocity-depth product. The hazard classes relate directly to the potential risk posed to people, vehicles, and buildings, as presented in Chart 1.

The flood hazard mapping is useful for providing context to the nature of the modelled flood risk and to identify potential constraints for development of the Site with regards to floodplain risk management.

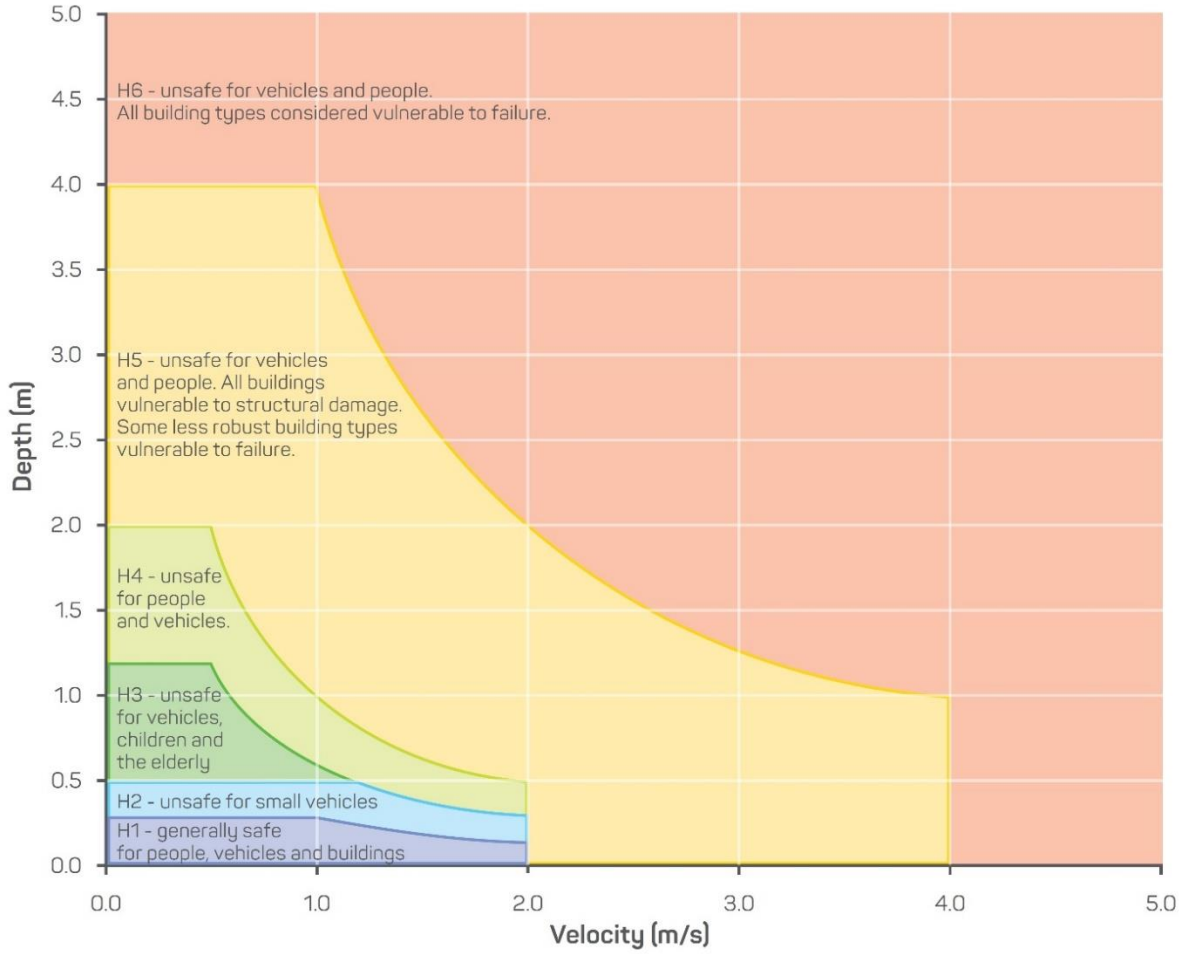


Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

Flood Risk Management

The principal consideration of good practice floodplain risk management is to ensure compatibility of the proposed development with the flood hazard of the land, including the risk to life and risk to property. Requirements within a Council's LEP (Local Environment Plan) and DCP (Development Control Plan) typically consider the management of flood risk, with the application of an FPL (Flood Planning Level) being the principal control measure. The standard FPL for residential development in NSW is the 1% AEP flood level plus a 0.5 m freeboard. However, requirements for non-residential development can vary significantly.

Part C.8 Managing Our Floodplains of the Dungog DCP provides a framework through which potential development is assessed for applicable flood planning requirements. Within this framework, the floodplain is categorised as either a Floodway and/or High Hazard Area, Flood Fringe, or Outer Floodplain. Flood mapping within the Clarence Town Floodplain Risk Management Study (BMT WBM, 2014) indicates that the Site is partly classified as Flood Fringe and Outer Floodplain, with the area along the watercourse being classified as a Floodway.

Schedule 2 of DCP Part C.8 provides a Flood Planning Control Matrix, linking development types to flood planning requirements, based on the floodplain categorisation. For commercial and industrial development, the Outer Floodplain and Flood Fringe area has relevant flood planning controls, with the Floodway area being unsuitable for commercial development.

The proposed location of the function centre will correspond with the existing channel alignment (Floodway) within the Site. Therefore, the proposed development includes redirecting and widening the existing channel, with overbank flow areas partially maintained to minimise upstream impacts. To maintain consistency with the Clarence Town FRMS, the realigned channel should be considered as Floodway, with a Flood Fringe classification appropriate for adjacent floodplain areas below the FPL of 8.6 m AHD. The remainder of the Site is inundated during a PMF event on the Williams River, and so should be considered as Outer Floodplain.

Parts of the proposed function centre will be located within the Outer Floodplain and the Flood Fringe zones, with the relevant flood risk management measures assessed in accordance with the Flood Planning Control Matrix as follows:

- Floor levels (excluding non-habitable residential floorspace) to be equal to or greater than the FPL and other floor levels equal to or greater than the FPL. Construction in Floodway not permitted.
- All structures to have flood compatible building components below or at the FPL
- Engineers certificate to confirm any structure subject to a flood up to and including the 1% AEP or 0.2% AEP (as applicable) flood level can withstand the force of water, debris and buoyancy.
- The impact of the development on flood affection elsewhere to be considered. The development must not obstruct or divert flood waters to or from neighbouring properties.
- Consideration required regarding an appropriate flood evacuation strategy & pedestrian / vehicular access route for both before and during a flood.
- S5.10.7 certificates to notify of applicability of this DCP.
- Applicant to Demonstrate that there is an area where goods may be stored above the FPL during floods.

The modelled local catchment peak flood levels are presented in Table 3 at the upstream and downstream boundaries of the Site for the post-development conditions. The design flood levels for Williams River events are also provided, as derived from the Williams River Flood Study. The peak 1% AEP level for the Site is 8.1 m AHD due to mainstream flooding on the Williams River, with a corresponding FPL of 8.6 m AHD.

The proposed finished floor level (FFL) of the function building is at the Williams River FPL of 8.6 m AHD, and so satisfies the minimum floor level requirements.

Some components of the of the proposed function centre will be constructed below the FPL, and so the construction and finishing materials should be flood compatible and not damaged through prolonged inundation. Electrical infrastructure should also be installed above the FPL.

The building will need to be designed and certified to withstand the expected hydraulic forces of the 1% AEP flood event, which for local catchment flooding includes a flood level up to 7.8 m AHD (post-development) and peak velocities of up to 1.9 m/s, while the Williams River flooding includes a flood level up to 8.1 m AHD and velocities of less than 0.5 m/s.

Table 3 –Peak Design Flood Levels at the Site (m AHD)

Design Event	Local Upstream	Local Downstream	Williams River
20% AEP	7.4	6.8	5.4
10% AEP	7.5	6.9	6.1
5% AEP	7.6	7.0	6.8
2% AEP	7.6	7.1	7.5
1% AEP	7.8	7.2	8.1
0.5% AEP	7.9	7.3	8.8
0.2% AEP	8.1	7.4	N/A
PMF	9.0	8.1	14.1

The impact of the proposed development on flood affectation elsewhere is addressed in the subsequent Flood Impact Assessment section.

The objective of the management of risk to life from flooding is to minimise the likelihood of deaths in the event of a flood and is typically considered for rarer flood events than the 1% AEP, up to the PMF. The rarer flood events produce high hazard flood conditions on Site, presenting a potential risk to life that requires appropriate management. The flood emergency response to manage risk to life typically adopts either a flood evacuation or a shelter-in-place policy.

Flood evacuation is usually the preferable option in large catchments with adequate warning time, whereas a shelter-in-place policy is often required for sites where insufficient warning is available to make flood evacuation a practical option. The Site is affected by both mainstream and local catchment flooding and therefore needs to consider the requirements of both flood evacuation and shelter-in-place.

For local catchment flooding, the PMF event is a very short duration storm with potentially limited warning time available. The peak flood conditions are coincident with the flood-producing rainfall, and evacuation from Site would most likely not be possible. Whilst flood free access is available via the southern access bridge up to a local catchment 1% AEP event, the lack of warning time for a local catchment PMF event makes sheltering in place the only viable option. However, the PMF event is extremely rare (approximately a 1-in-10,000,000 AEP).

Whilst internal flood depths would be less than 0.5 m at the PMF and not present a significant risk to occupants of the building, the structure will be subject to a hazard classification of up to H5, with significant hydraulic forces that could potentially compromise the structural integrity. As such, the building may need to be designed and certified to withstand the expected hydraulic forces of the local catchment PMF event, which includes a flood level up to 9.0 m AHD (post-development) and velocities of up to around 2.6 m/s.

For Williams River flooding there is a sufficient warning time available to not only evacuate the Site but close the Site prior to the flood inundation. The management of Williams River flood events is addressed in the subsequent Flood Emergency Response section.

The applicants should ensure the relevant information is updated within the Online 10.7 Planning Certificate Service to ensure the appropriate flood planning controls for the Site are readily identifiable upon application for a section 10.7 Planning Certificate.

The proposed FFL is at the FPL of 8.6 m AHD, and so storage areas above the FPL are readily available.

Flood Impact Assessment

The TUFLOW model representation of the development, as presented in Figure 4, was simulated for comparison with the modelled pre-development conditions for the purpose of a relative flood impact assessment.

The proposed building occupies a large portion of the existing floodplain within the Site, as shown in Figure 5, with initial simulation of the development resulting in extensive upstream impacts. Therefore, major channel upgrade works were incorporated within the Site. The model topography was modified, enforcing the channel realignment, overbank flow areas, and finished surface levels, with the latest civil design (10880 - C101 to C110 - B.pdf) derived from multiple design iterations to minimise the off-site flood impacts.

Due to loss of part of the floodplain within the Site the channel is proposed to be widened to improve conveyance through a narrower corridor within the eastern side of the Site, with the existing bridge widened to achieve additional capacity through the structure.

Part of the function centre will comprise a suspended slab, which was represented as a 2D Layered FC Shape in TUFLOW to account for the associated blockage and hydraulic losses, with a 20% blockage applied to represent the supporting structure. The remaining part of the building was represented as a solid obstruction to flow, up to the FFL of 8.6 m AHD.

Proposed waterway crossings were represented as 2D layered FC Shapes to represent the bridge openings and bridge deck hydraulics. The proposed channel was modelled with a Manning's 'n' roughness value of 0.05 to represent potential channel vegetation and rock protection works.

The modelled impact to the existing peak flood depths is presented in Figure 12 to Figure 14 for the 5% AEP, 1% AEP and 0.5% AEP events, respectively. The corresponding impact to the existing peak flood velocity is presented in Figure 15 to Figure 17.

Whilst the proposed location of the building results in some localised upstream flood level impacts near the north-east corner of the building, the improved capacity of the channel has resulted in a broader reduction in flood level upstream of the Site, and within the Grey Street road corridor.

The redistribution of flow at the downstream end of the Site has resulted in a localised flood level increase within the footway on the northern side of Queen Street, however, this does not result in an increase to the flood hazard classification in this area and does not change the flood immunity of the road. There is a localised flood level increase within the downstream property, however, more broadly the proposed works result in a reduction of flood extent and level within the property. The modelled flood level impacts are due to local redistribution of flow and do not present a tangible increase to flood risk within the affected areas.

Off-site flood velocity increases of up to 0.8 m/s were modelled adjacent to the upstream and downstream boundaries of the Site for the 1% AEP event, associated with the change in flood flow distribution. Figure 18 and Figure 19 present the modelled 1% AEP velocities for the existing and post-development

conditions, respectively. The mapping shows that the areas of high velocity are relatively localised to the channel and adjacent floodplain.

For Williams River flood events the nature of slow-moving backwater inundation means that any impacts to the existing flood conditions associated with the proposed development will be negligible.

Flood Emergency Response

As discussed previously, a Flood Emergency Response Plan is required to manage residual flood risk below the FPL for the proposed development in relation to Williams River flood events.

A flood warning system is established for the Williams River. The BoM incorporates the Mill Dam Falls gauge into its operational flood warning network. Water level data for the gauge can be accessed at: http://www.bom.gov.au/fwo/IDN60232/IDN60232.061339.plt.shtml. The data presents the current recorded water level at the gauge together with the recorded data over the past five days. The Minor, Moderate and Major flood warning levels are also provided and are summarised in Table 1. The gauge height in metres corresponds to an elevation around 0.8 metres below that of the Australian Height Datum (AHD).

Table 1 – Flood Warning Levels at Mill Dam Falls

Warning Level	Gauge Height (m)	Level (m AHD)
Minor	6.1	6.9
Moderate	7.6	8.4
Major	9.1	9.9

The flood levels at Mill Dam Falls are approximately 6 m higher than those at the Site, with the Major Flood level of 9.9 m AHD representing a design event in the order of a 1-in-4 AEP.

The BoM service level specification nominates a target flood warning time of 12 hours prior to a flood event at Mill Dam Falls. Therefore, sufficient time is available to close the Site prior to the risk of flood inundation.

The owners of the Site should pay attention to any Flood Watch or Flood Warnings issued by the Australian Bureau of Meteorology (BoM). In the event of a flood emergency response being initiated by the SES, occupants of the Site should follow the instructions given accordingly. This may include an order to evacuate to a designated flood evacuation centre, if required. However, during such an event, State emergency services would likely be stretched, and occupants of the Site should be prepared to respond to a flood emergency without assistance.

To ensure timely flood warning in advance of a required evacuation, the owners should set themselves up to receive RSS (Really Simple Syndication) feeds from the BoM New South Wales & ACT Warning service. Alerts are automatically provided to subscribed devices when the feed is updated. This can be set up for both home computers and mobile phones and is customisable (refer http://www.bom.gov.au/rss/rss-guide.shtml). Warnings issued for the Williams River can then be monitored, with real-time gauge data from Mill Dam Falls available for viewing at http://www.bom.gov.au/fwo/IDN60232/IDN60232.061339.plt.shtml

The BoM Twitter feed (https://twitter.com/bom_nsw) offers a simpler and more user-friendly interface for the dissemination of official flood warning information. It also relays SES Flood Evacuation Warning and Flood Evacuation Order information, providing all key flood response advice in a single location. The owners should consider subscribing to the BoM Twitter feed in addition to, or as an alternative to the RSS service. Alternatively, the Floods Near Me (# Floods Near Me #) is a flood warning mobile device application that brings together flood related information in NSW and provides the user with tailored warnings.

If a Major Flood Warning is issued by the BoM for the Williams River at Mill Dam Falls, then closure of the Site should be undertaken. Although a Williams River flood event rarer than a 2% (1-in-50) AEP is required before the Site is affected, the ultimate peak flood level may be unknown at the time the Flood Warning is issued. Closure of the Site and cancellation of any bookings should be communicated to the staff and customers, accordingly. Site closure is expected to occur on average once every four years and provides opportunity to practice an appropriate flood emergency response.

Any valuable building contents susceptible to flood damage can be relocated to areas above the FPL before flooding occurs. However, the protection of property from flooding should always be secondary to the protection of life and so any such activity should be suspended in sufficient time to enable evacuation of people from the Site. Clarence Town offers readily accessible land above the Williams River PMF event.

Business owners in flood-affected areas are encouraged to prepare a Flood Emergency Response Plan (FERP). The Australian Government provides advice and a template for the preparation of an Emergency Management Plan (https://business.gov.au/risk-management/emergency-management/how-to-prepare-an-emergency-management-plan). Most of the content can (and should) be completed by the operator of the business. However, this report provides relevant flood information to support the development of an Emergency Management Plan in relation to flood risk.

Conclusion

The Site at 29, 33, and 35 Grey Street, Clarence Town NSW requires a Flood Assessment to assist in the approval process for the proposed commercial development due to the location of the development within the Williams River floodplain and a local catchment floodplain.

The development is in accordance with the flood planning requirements of Council's DCP, with the flood risk management measures summarised as follows:

- The building will be constructed to the FPL of 8.6 m AHD.
- Development components below the FPL will be constructed with flood-compatible materials.
- The building will need to be designed and certified to withstand the expected hydraulic forces of at least the 1% AEP flood event, which for local catchment flooding includes a flood level up to 7.8 m AHD (post-development) and peak velocities of up to 1.9 m/s.
- Potentially the building may need to be designed and certified to withstand the expected hydraulic forces of the local catchment PMF event to enable safe on-site refuge within the building, which includes a flood level up to 9.0 m AHD (post-development) and velocities of up to around 2.6 m/s.
- A relative flood impact assessment has been undertaken for the development.
- Closure of the Site and relocation of remaining high value building contents above the FPL as part of the flood emergency response in advance of a Williams River flood event.

- The applicants should ensure the relevant information is updated within the Online 10.7 Planning Certificate Service.
- High value building contents susceptible to flood damage will be stored above the FPL.

The development will comprise major earthworks to realign the channel and raise the building to the FPL., with the final design derived from an iterative assessment of the post-development flood conditions to mitigate the off-site impacts.

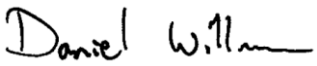
Mitigation measures include widening and straightening of the channel, suspending part of the building above the floodplain to prevent obstruction of overbank flows, and suitable sizing of the channel crossing structures.

Flood impact assessment modelling of the proposed development has been undertaken and shows that the development will result in a broad reduction in flood levels in the local floodplain. Corresponding changes to the flow distribution result in localised increases to flood velocity, however, this does not adversely impact the existing neighbouring development.

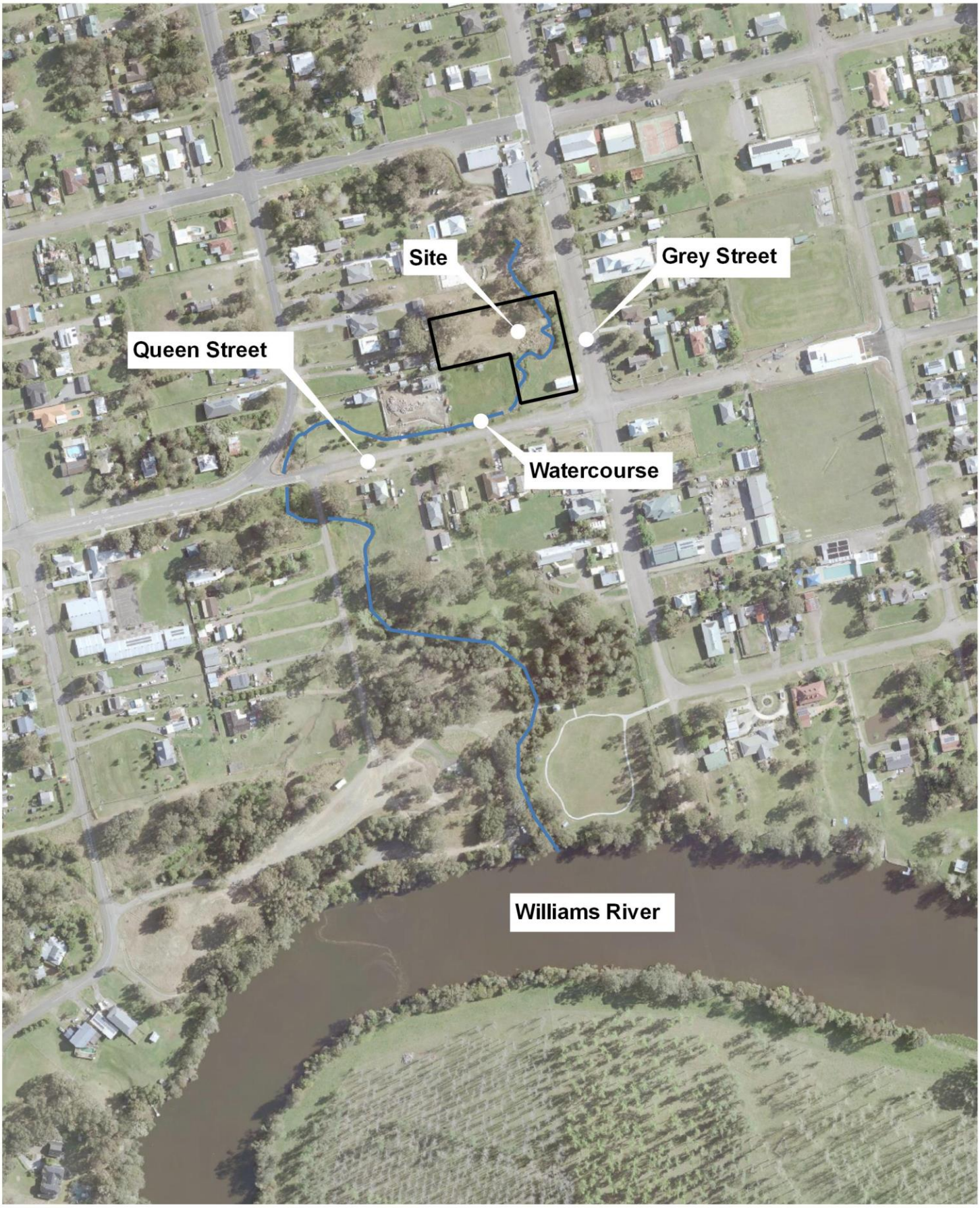
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

Torrent Consulting



Dan Williams
Director



Title:

Study Locality

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approx. scale

Figure: 1

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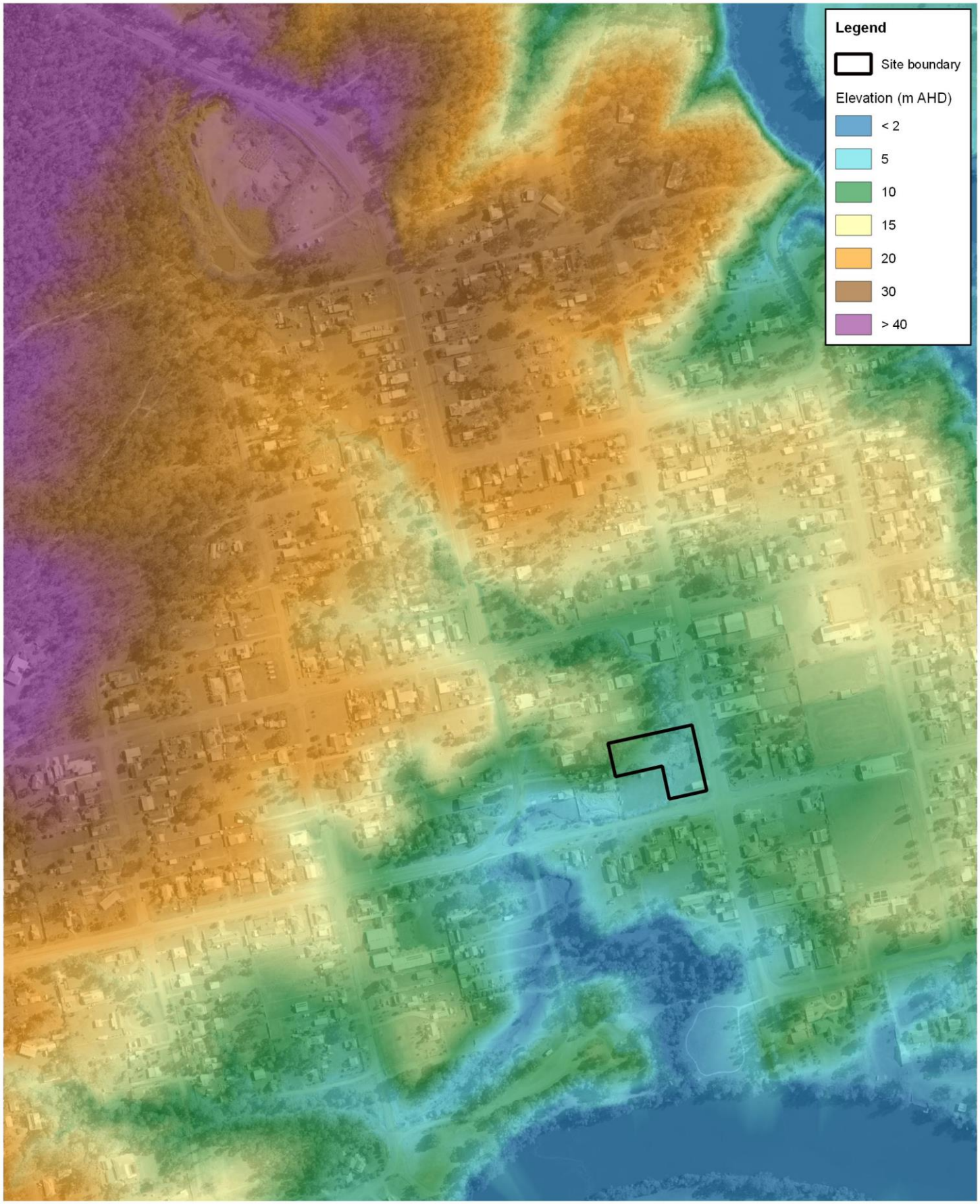

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Local Catchment Topography

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TUFLOW Model Configuration

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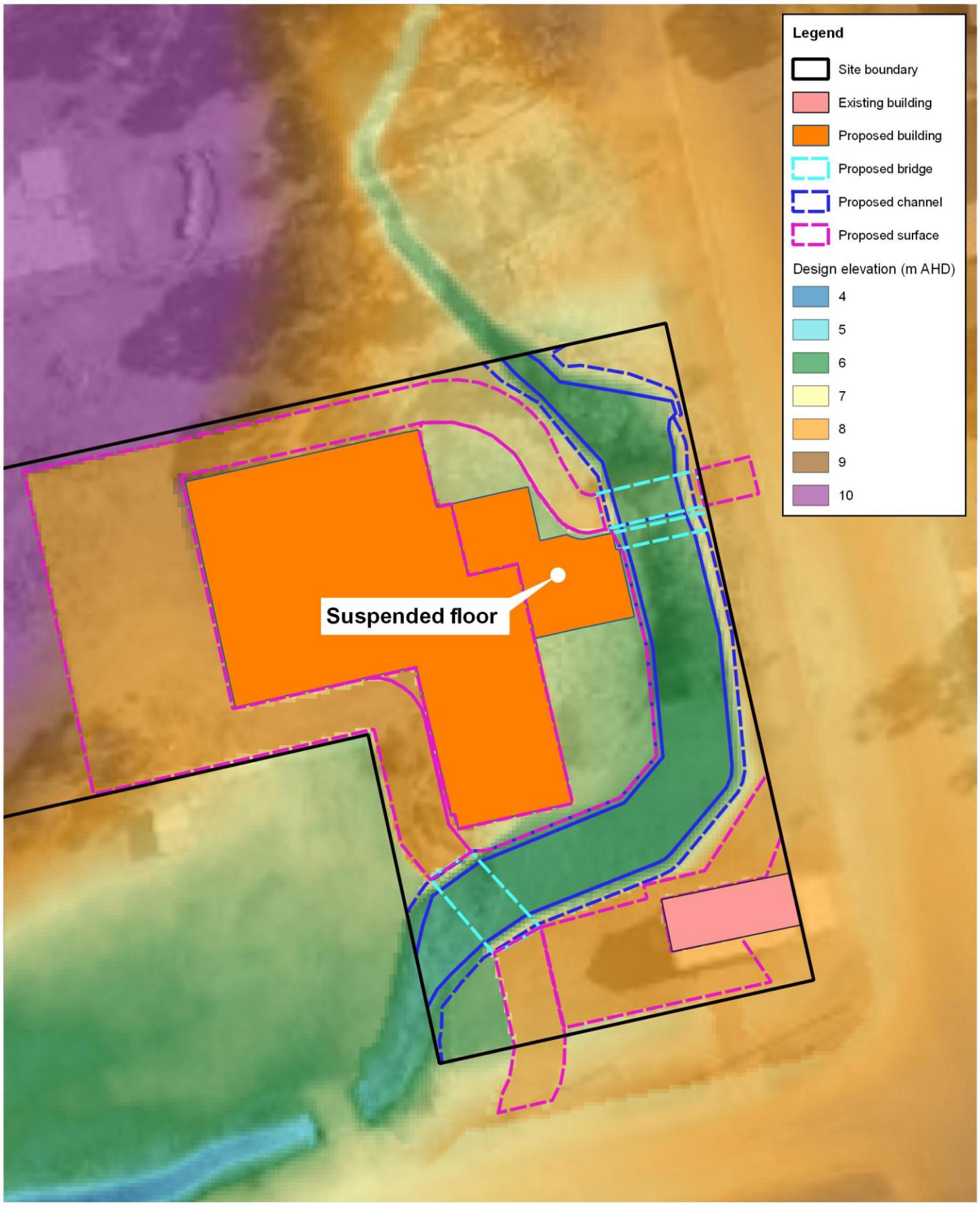

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Proposed Development

0 10 20 m

approx. scale

Figure: 4

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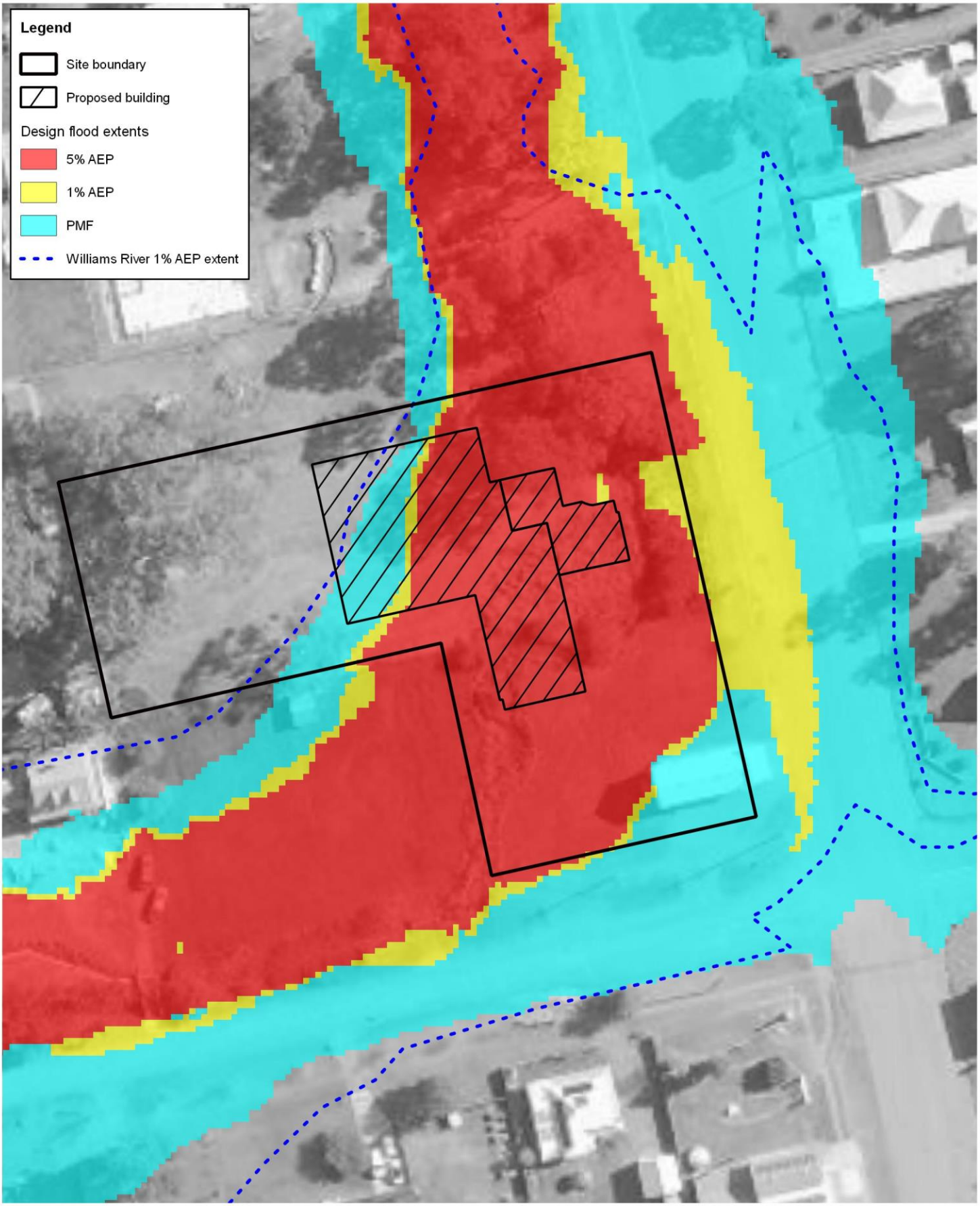

Title:

Modelled Design Flood Extents

0 20 40 m

approx. scale

Figure: 5

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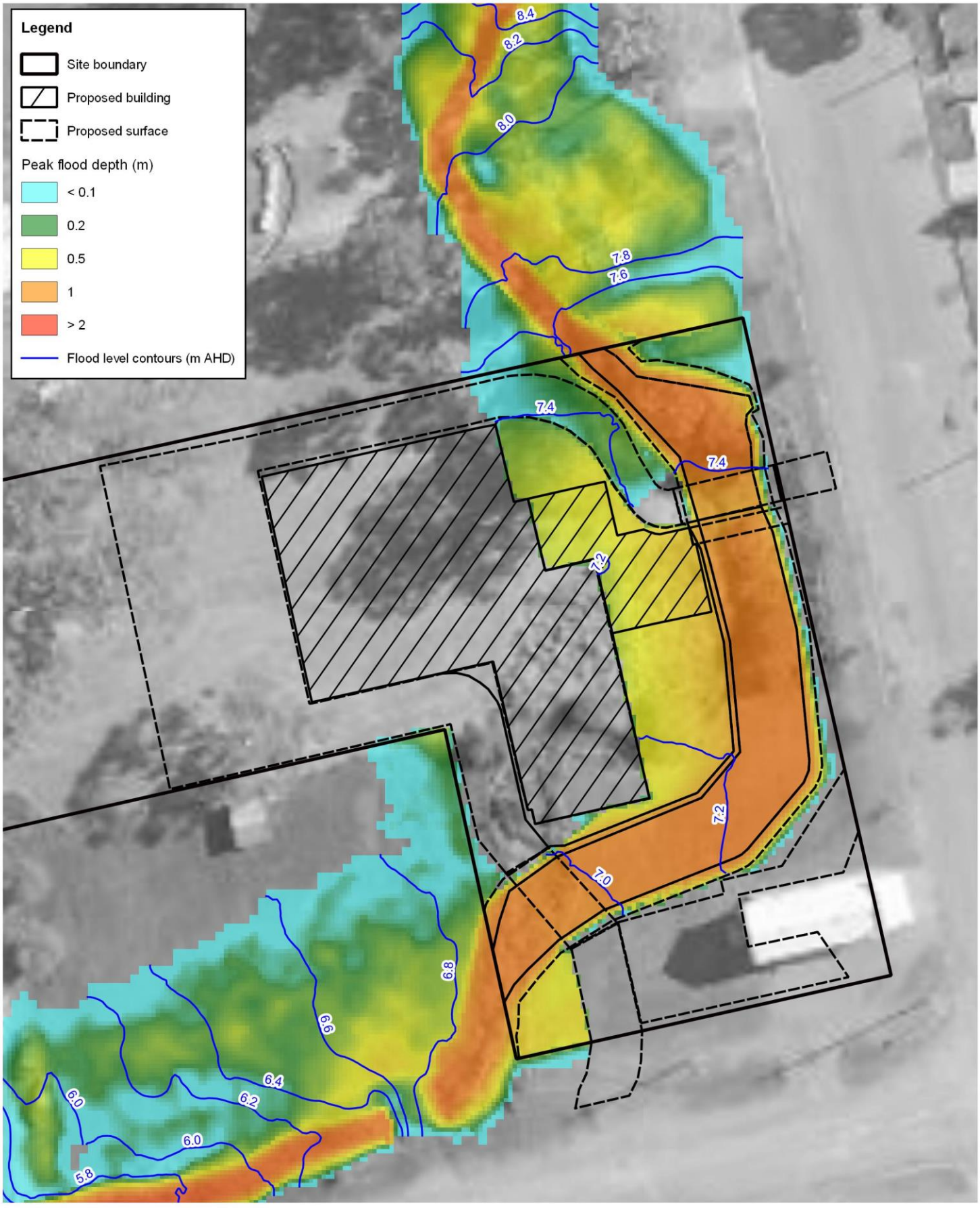

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Modelled 5% AEP Peak Flood Depths and Levels

0 10 20 m

approx. scale

Figure: 6

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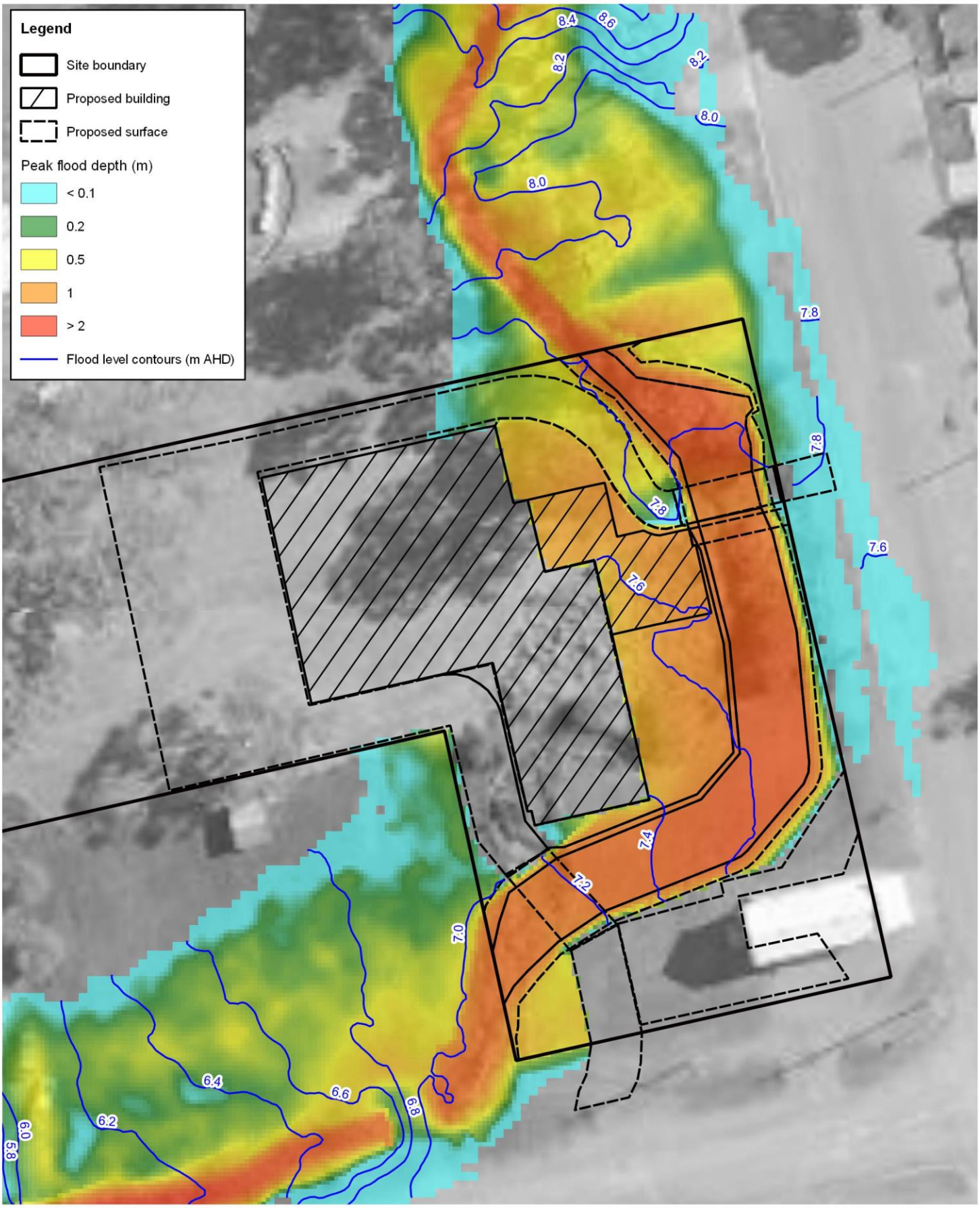

Title:

Modelled 1% AEP Peak Flood Depths and Levels

0 10 20 m

approx. scale

Figure: 7

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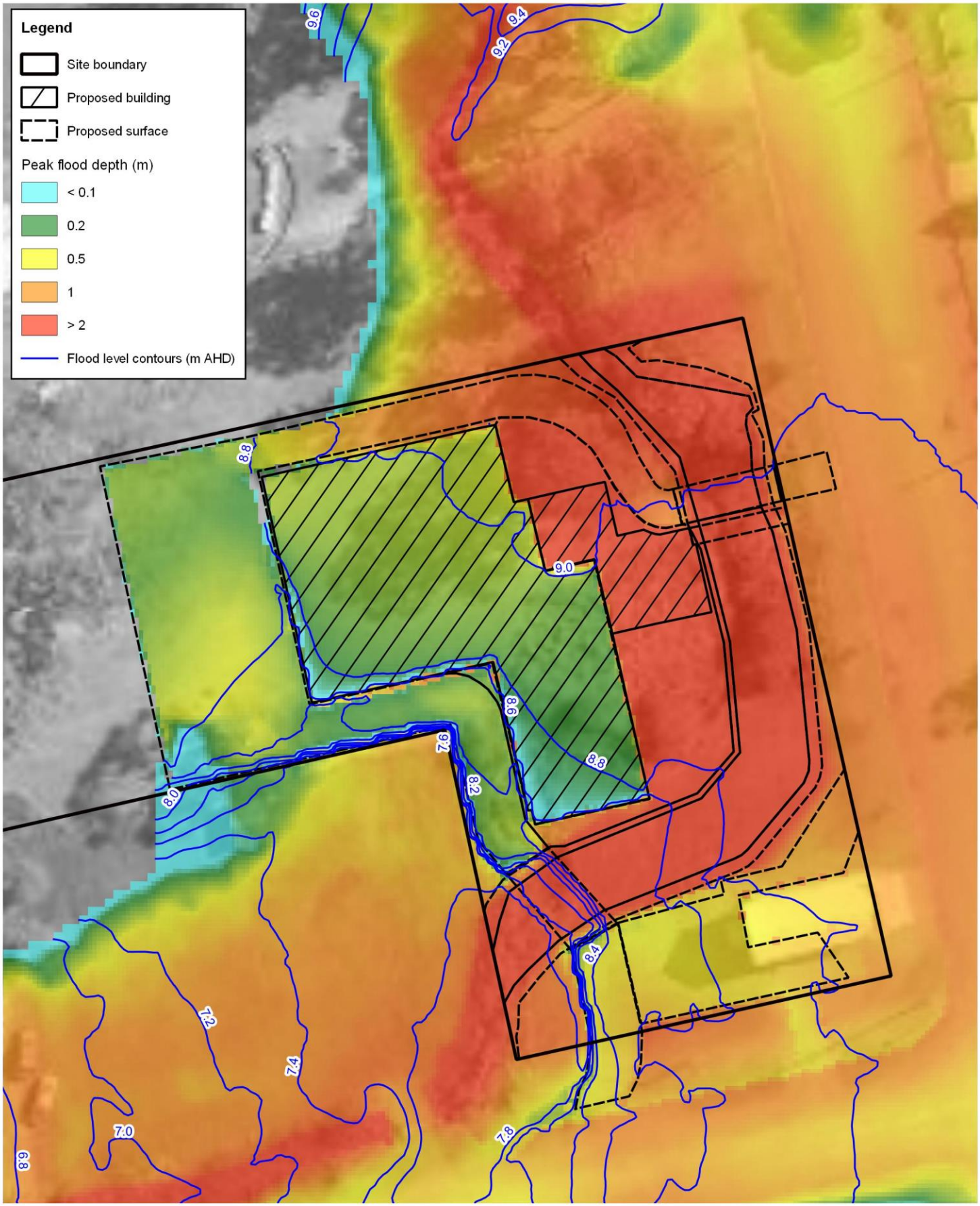

Title:

Modelled PMF Peak Flood Depths and Levels

0 10 20 m

approx. scale

Figure: **8**

Revision: **B**

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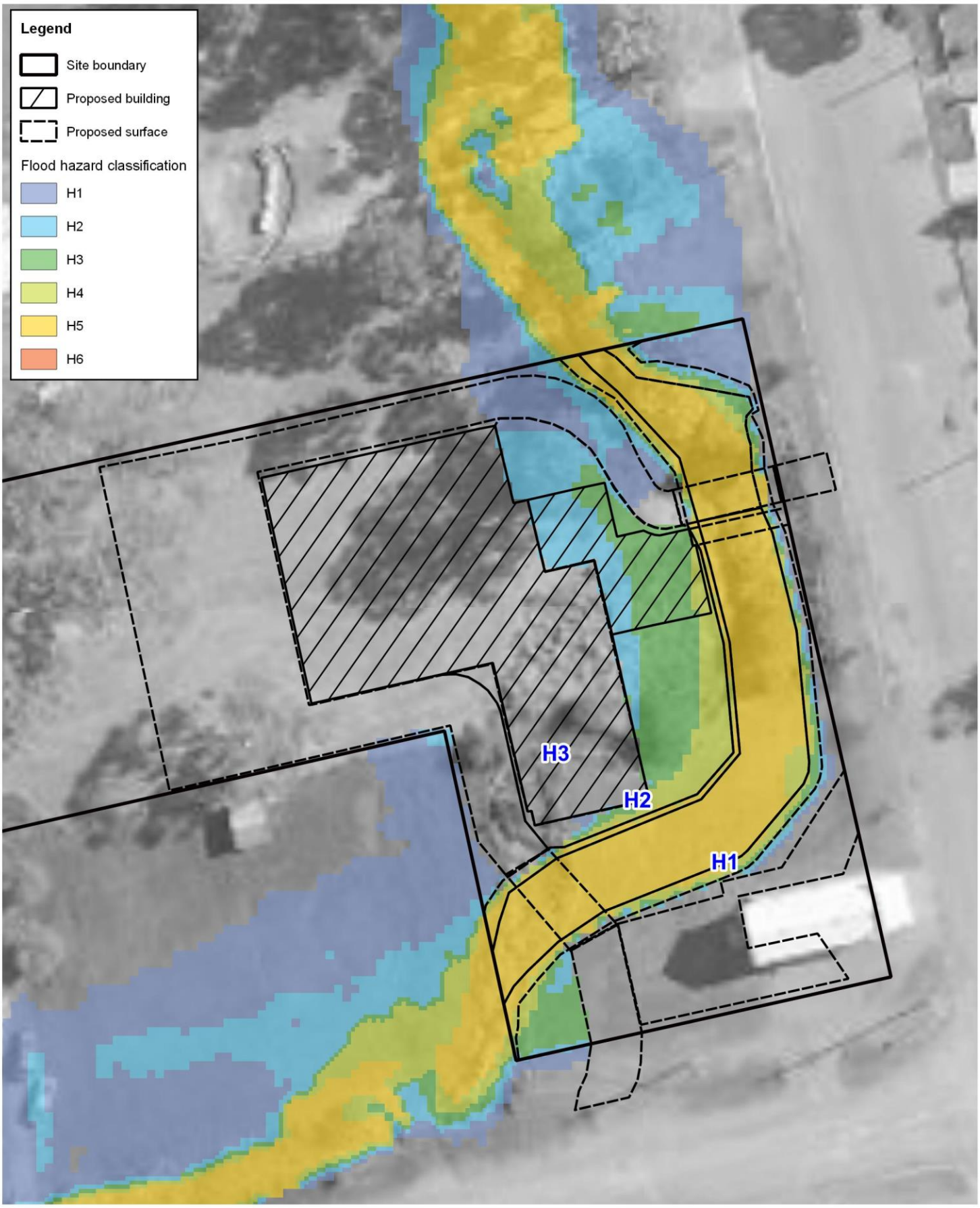

Title:

Modelled 5% AEP Flood Hazard Classification

0 10 20 m

approx. scale

Figure: 9

Revision: B

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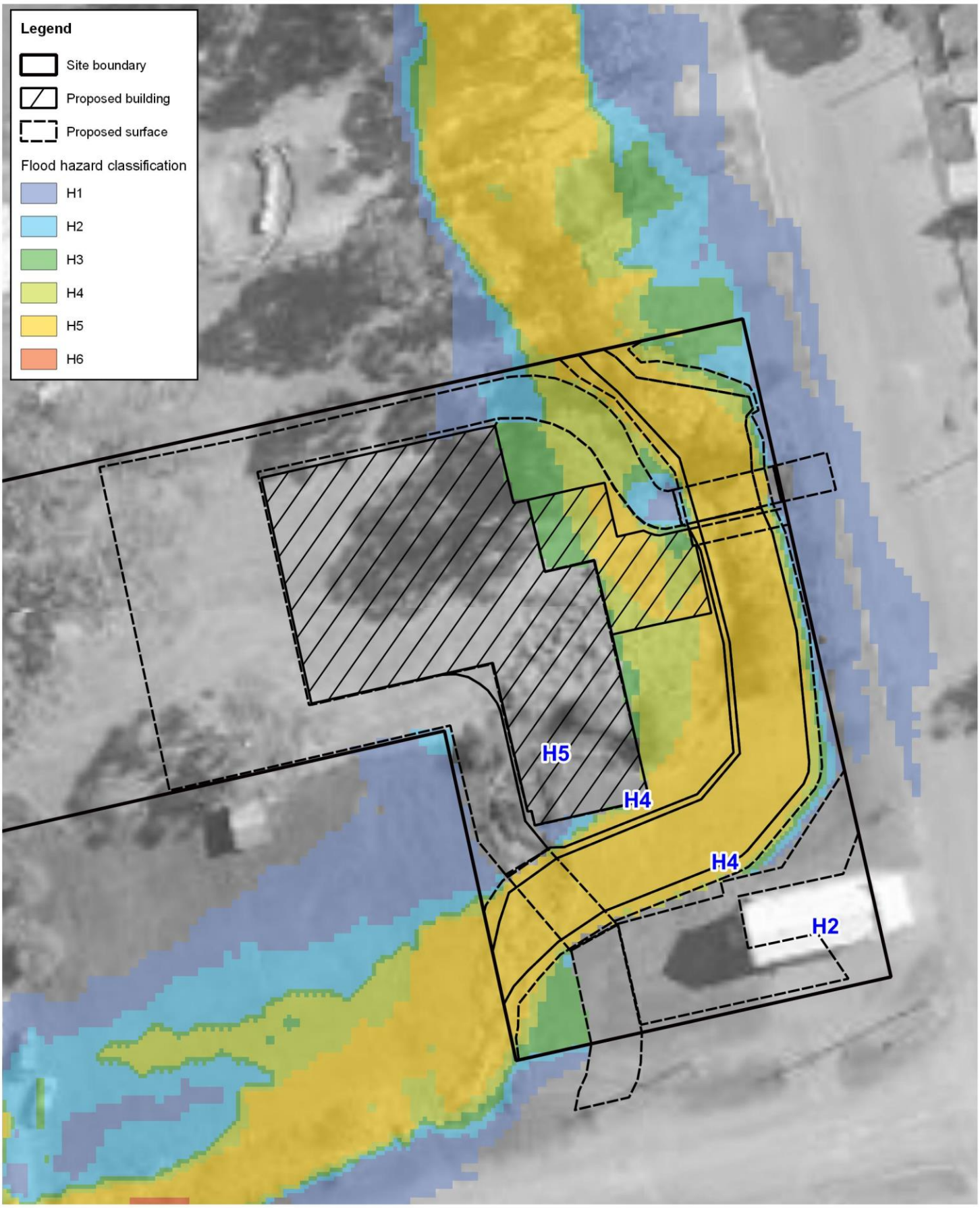

Title:

Modelled 1% AEP Flood Hazard Classification

0 10 20 m

approx. scale

Figure: 10

Revision: B

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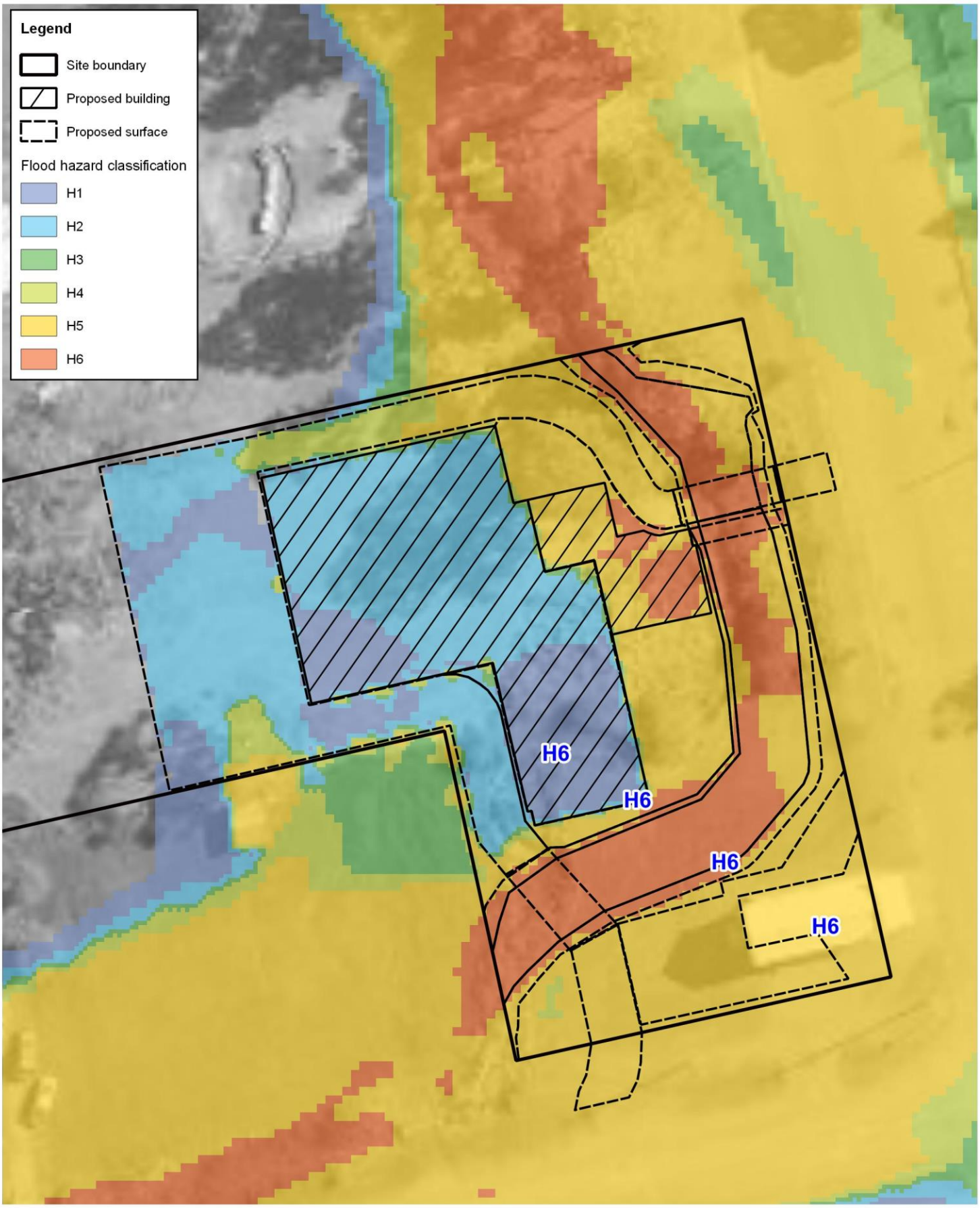

Title:

Modelled PMF Flood Hazard Classification

0 10 20 m

approx. scale

Figure: 11

Revision: B

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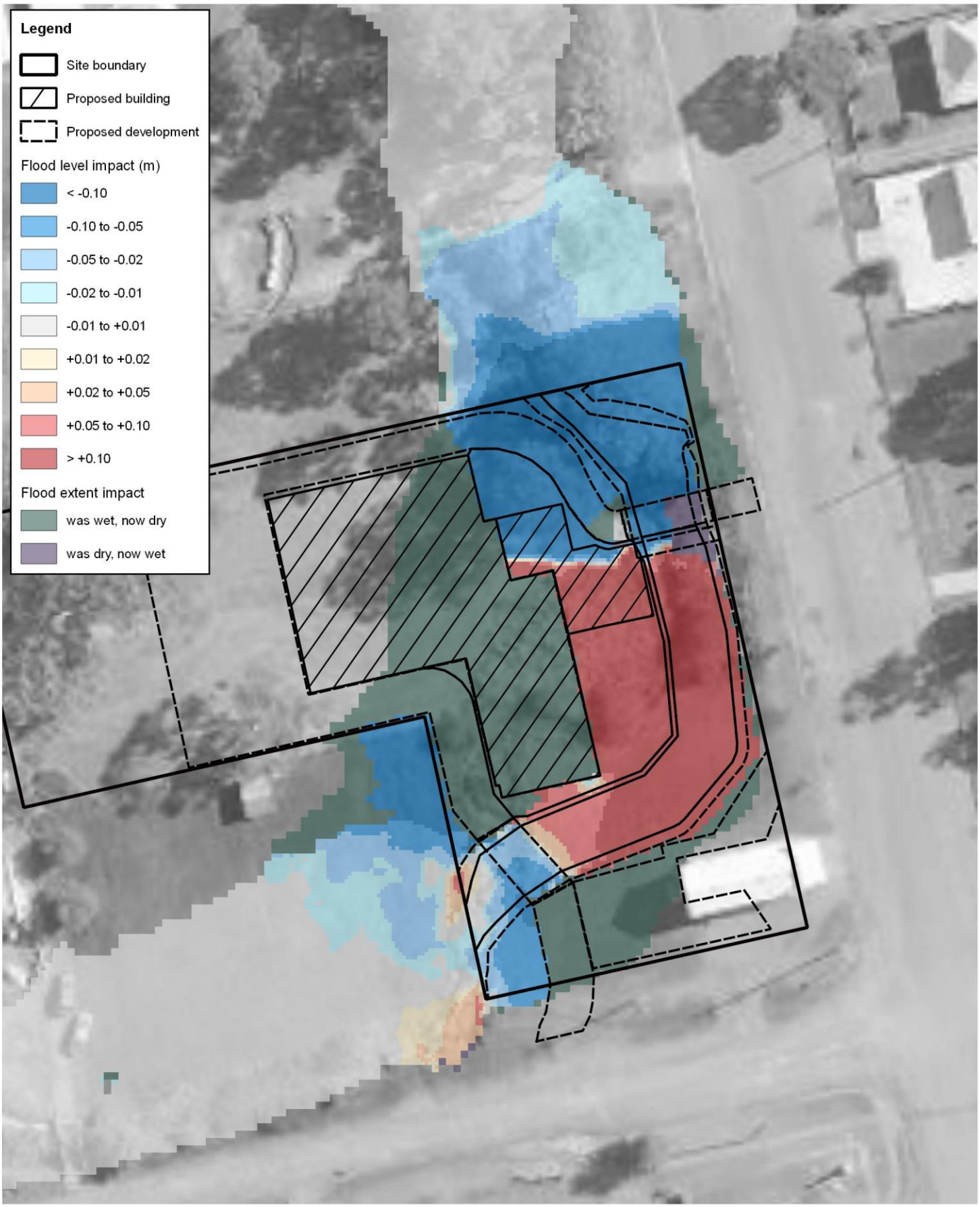

Title:

Modelled 5% AEP Flood Level Impact

0 10 20 m

approx. scale

Figure: 12

Revision: B

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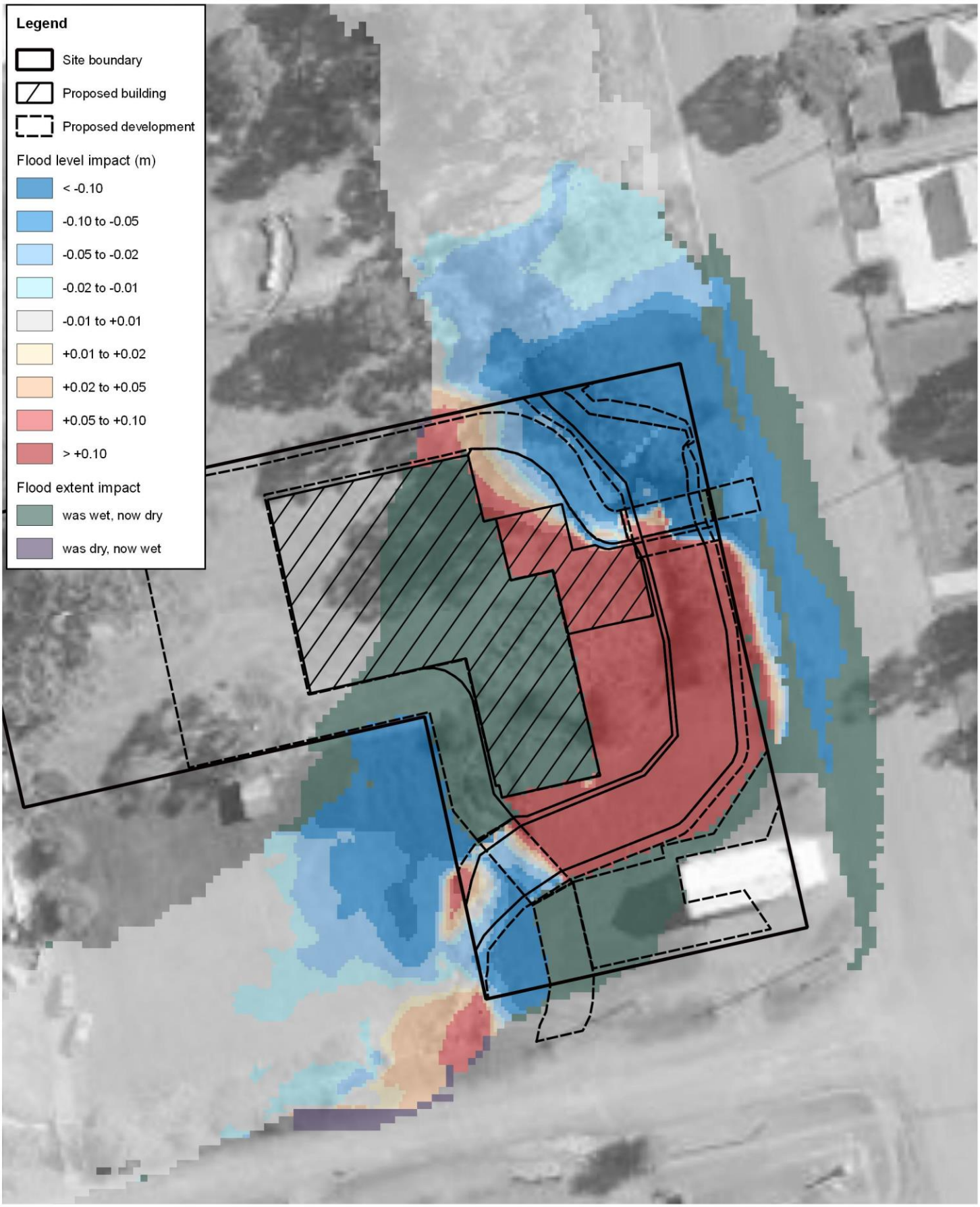

Title:

Modelled 1% AEP Flood Level Impact

0 10 20 m

approx. scale

Figure: **13**

Revision: **B**

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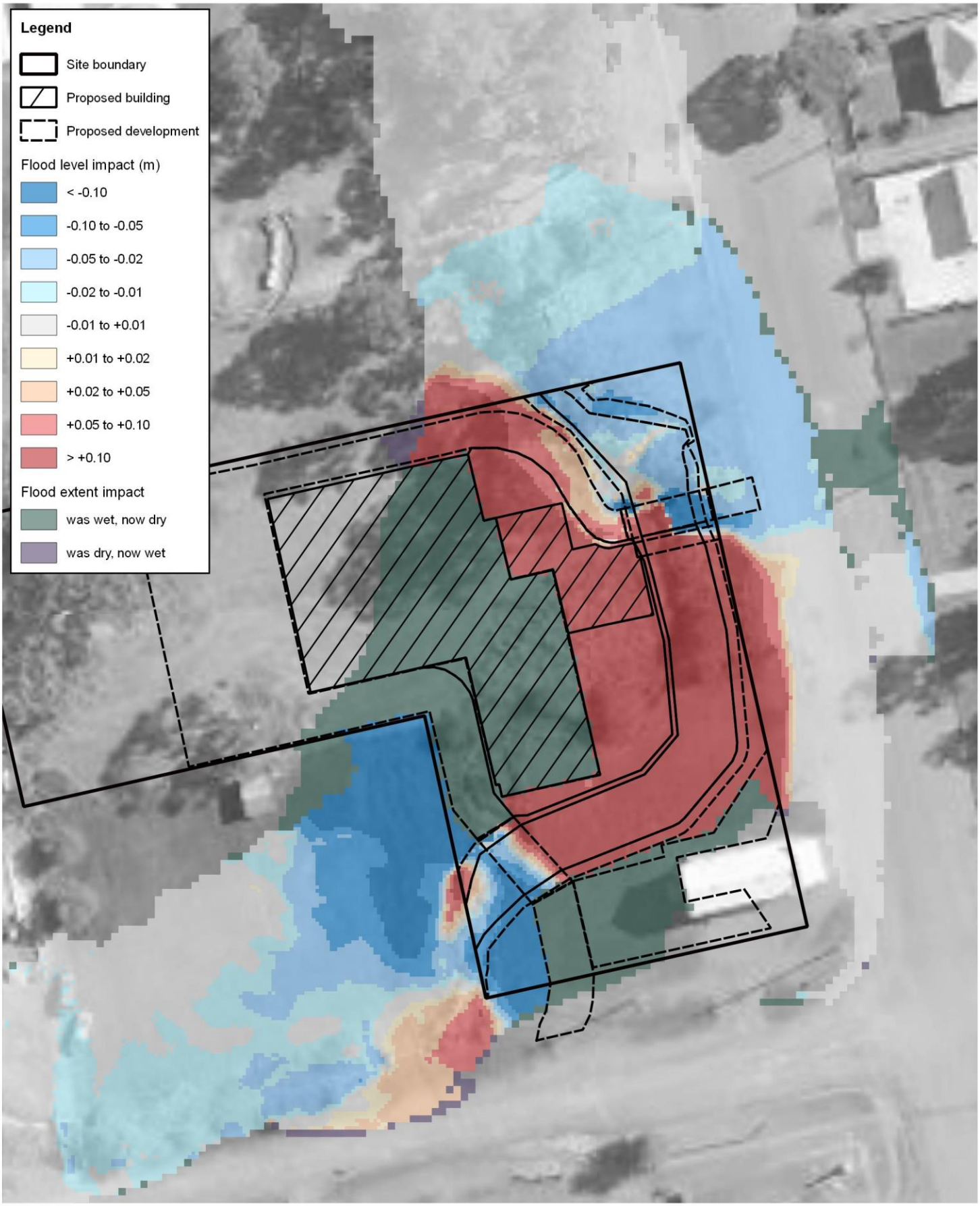

Title:

Modelled 0.5% AEP Flood Level Impact

0 10 20 m

approx. scale

Figure: 14

Revision: A

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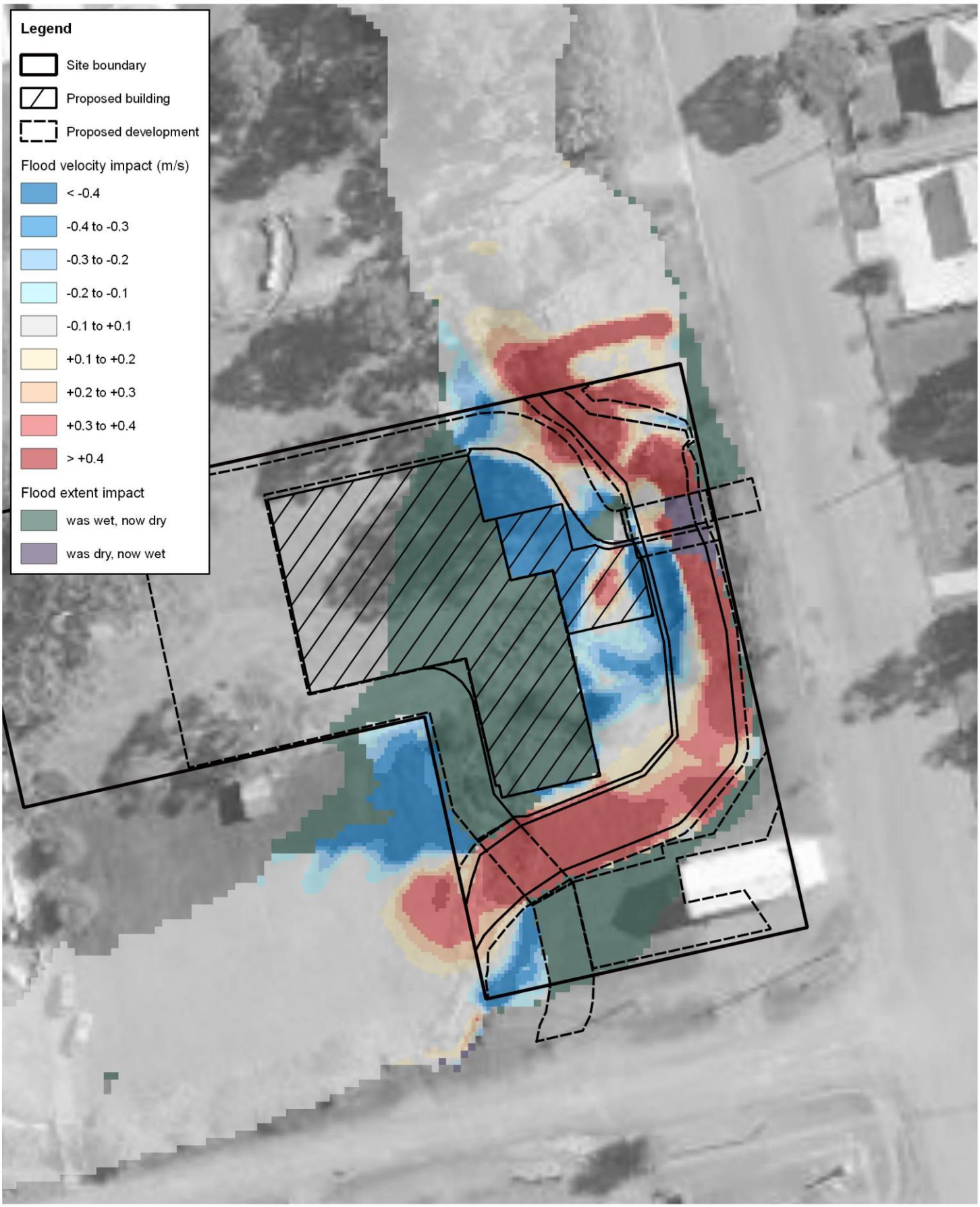

Title:

Modelled 5% AEP Flood Velocity Impact

0 10 20 m

approx. scale

Figure: 15

Revision: B

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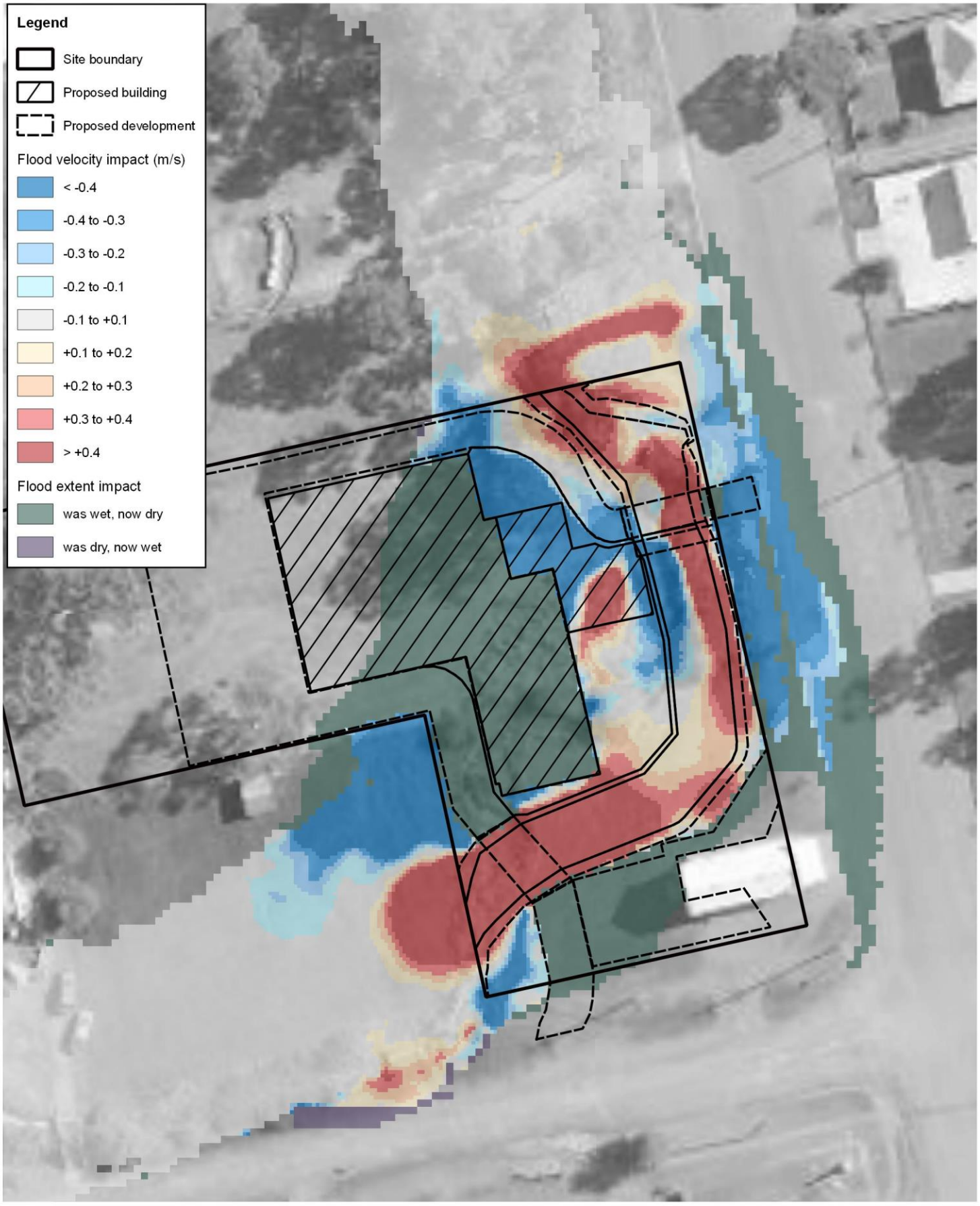

Title:

Modelled 1% AEP Flood Velocity Impact

0 10 20 m

approx. scale

Figure: 16

Revision: B

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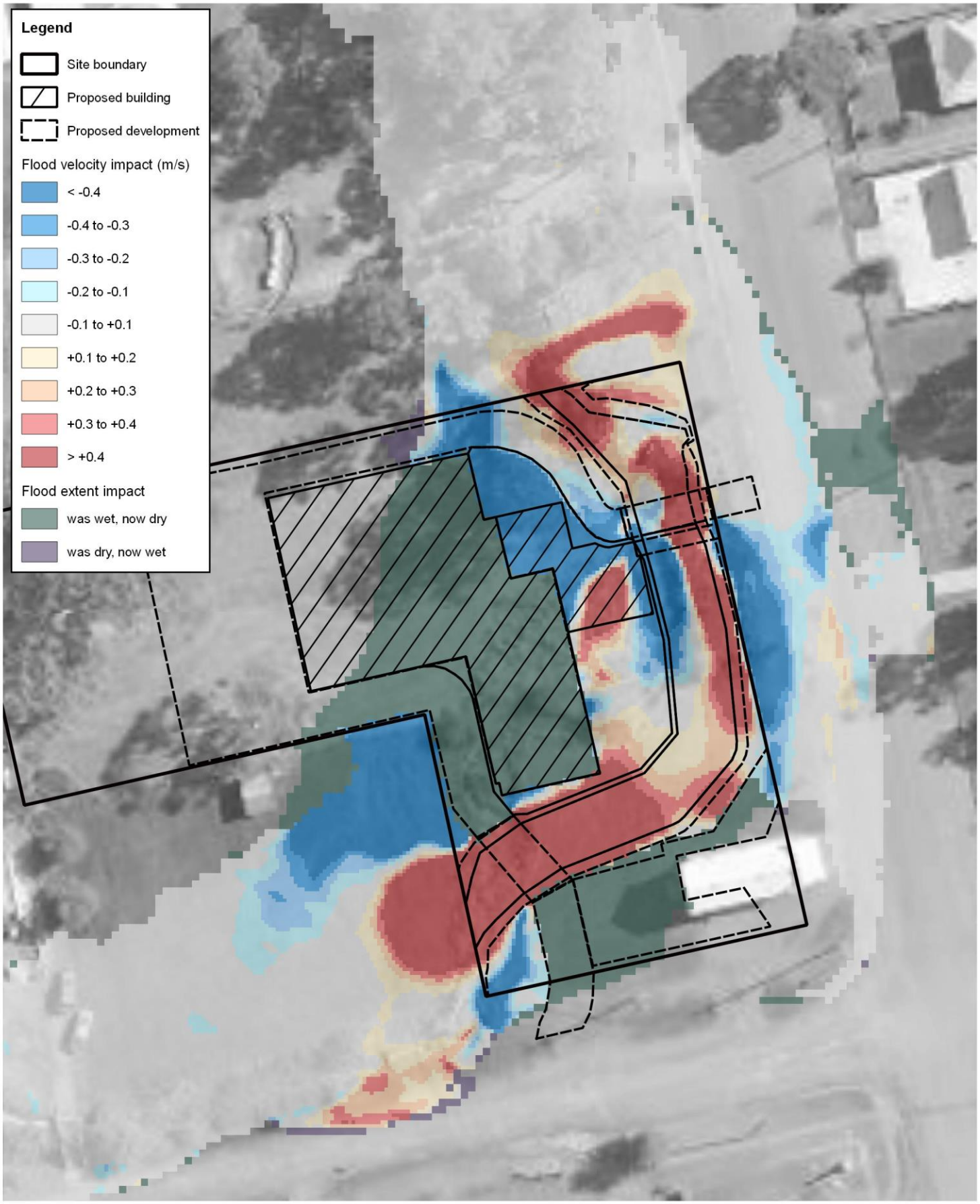

Title:

Modelled 0.5% AEP Flood Velocity Impact

0 10 20 m

approx. scale

Figure: 17

Revision: A

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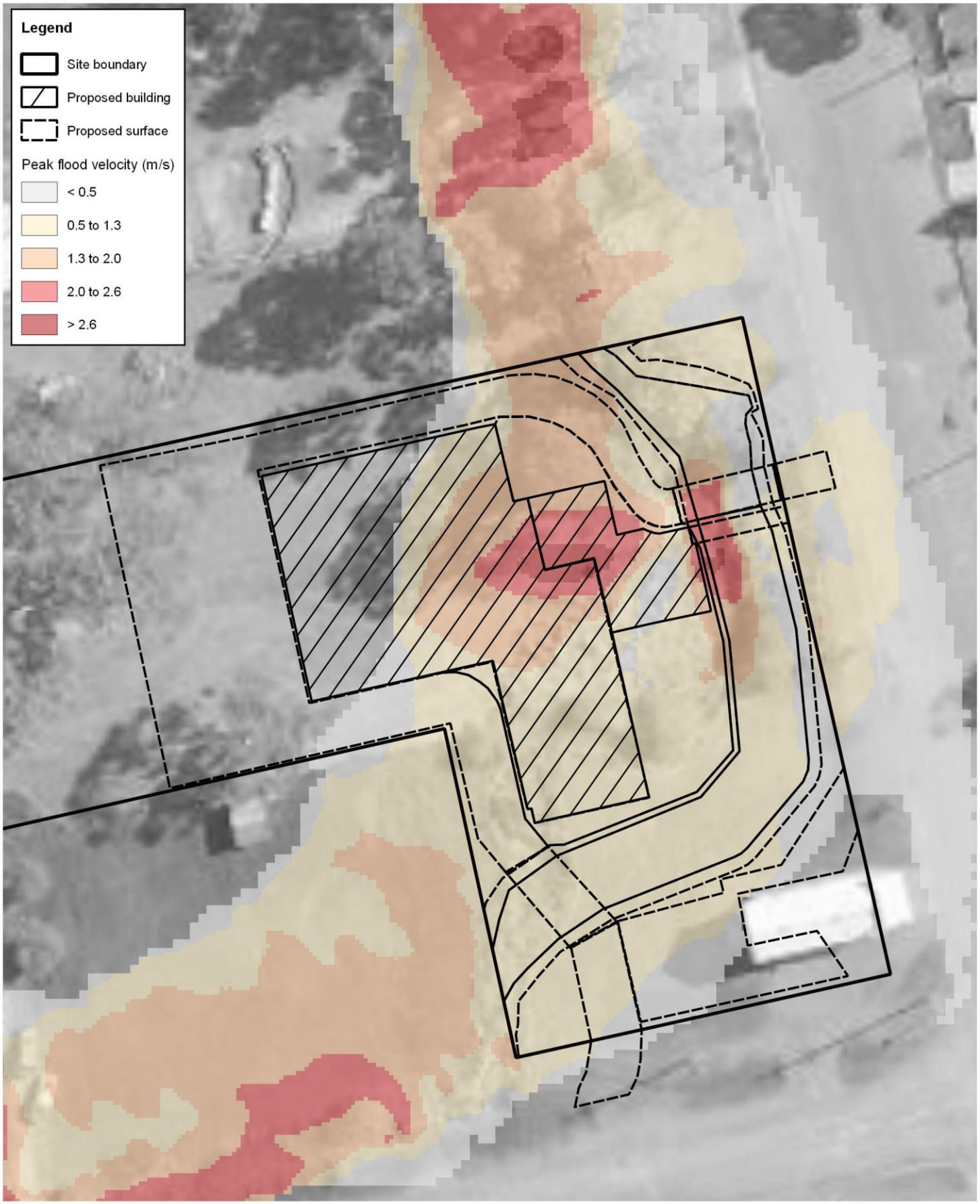

Title:

Modelled 1% AEP Peak Flood Velocity Existing Conditions

0 10 20 m

approx. scale

Figure: 18

Revision: A

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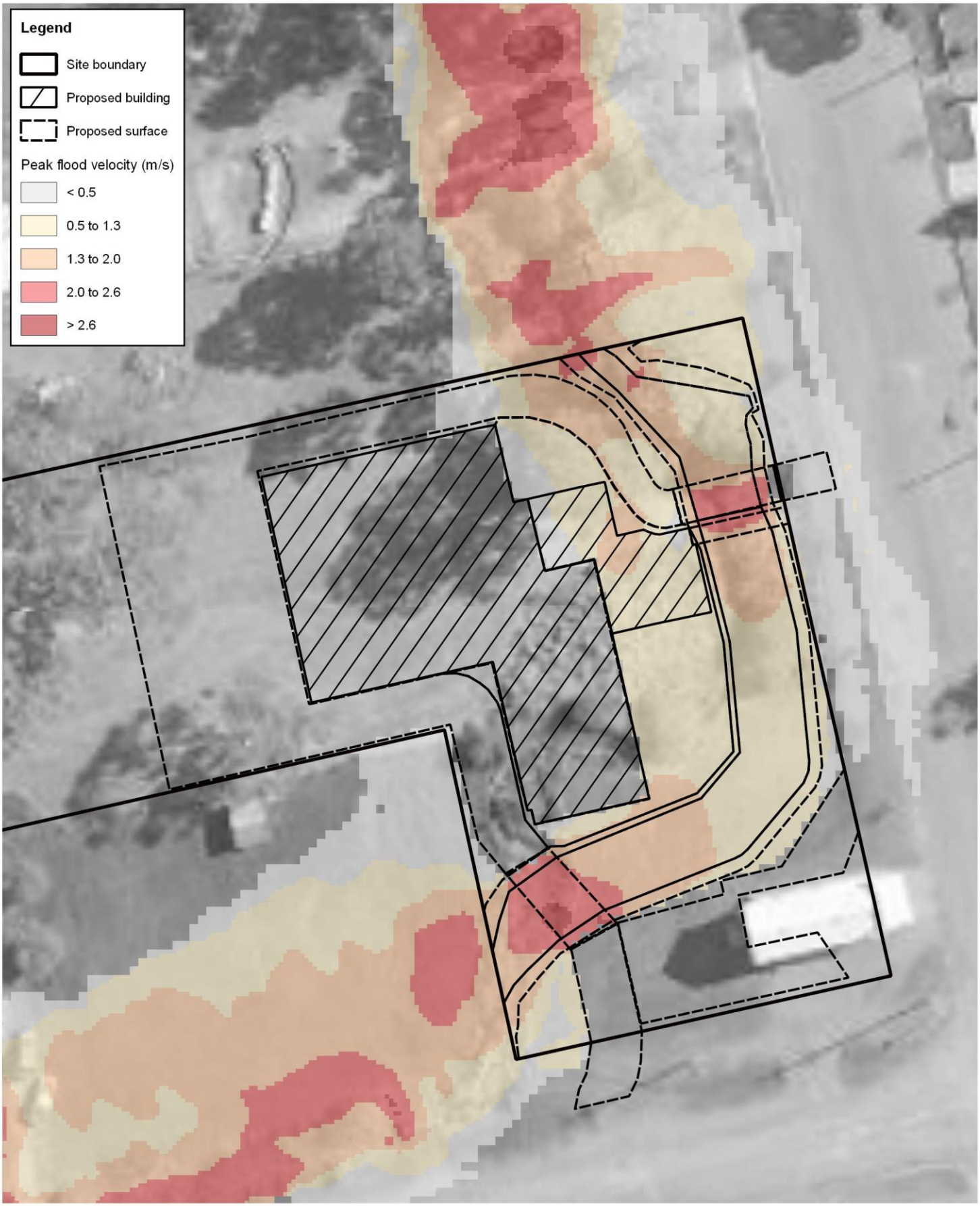

Title:

Modelled 1% AEP Peak Flood Velocity Post-development Conditions

0 10 20 m

approx. scale

Figure: 19

Revision: A

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