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Our Ref: DJW: L.T2345.002.docx

12 September 2023
Williams River Steel
c/o Perception Planning
PO Box 107
Clarence Town NSW 2321
Attention: Graham Bates

Dear Graham

RE: FLOOD IMPACT ASSESSMENT FOR PROPOSED FUNCTION CENTRE AT 29 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 at 29 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.

This Site is located within the floodplain of the Williams River and the tributary watercourse 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 Clarence Town Flood Study (BMT WBM, 2012). Information contained in this study 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 are then incorporated into the TUFLOW model and the design events re-simulated. Comparison of pre- and post-development flood conditions are 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. 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 was modelled using a 2D layered flow constriction to represent the bridge opening and bridge deck hydraulics.

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. Cross drainage was modelled per the hydrologic model, with the addition of Z shape functionality to enforce the observed channel shape and better represent the channel hydraulics adjacent to the Site. 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.

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. An Areal Reduction Factor (ARF) was applied to the East Coast South region design point rainfall using the upstream contributing catchment area of 0.7 km^2. However, given the small catchment size, the impact on point rainfall intensities is effectively negligible.

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

The modelled peak flood extents for the 5% AEP, 1% AEP and PMF events are presented in Figure 4. Figure 5, Figure 6, and Figure 7 are presented for additional flooding context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events, respectively. The extent of Williams River flooding is also indicated.

Figure 8, Figure 9, and Figure 10 present the 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 distribution across the Site for Williams River events has been derived from the corresponding peak flood depth and is presented in text format at four locations.

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.

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 entire Site is classified as Flood Fringe, with the area along the watercourse being classified as a Floodway for local catchment flood events (the entire Site is Flood Fringe for Williams River events).

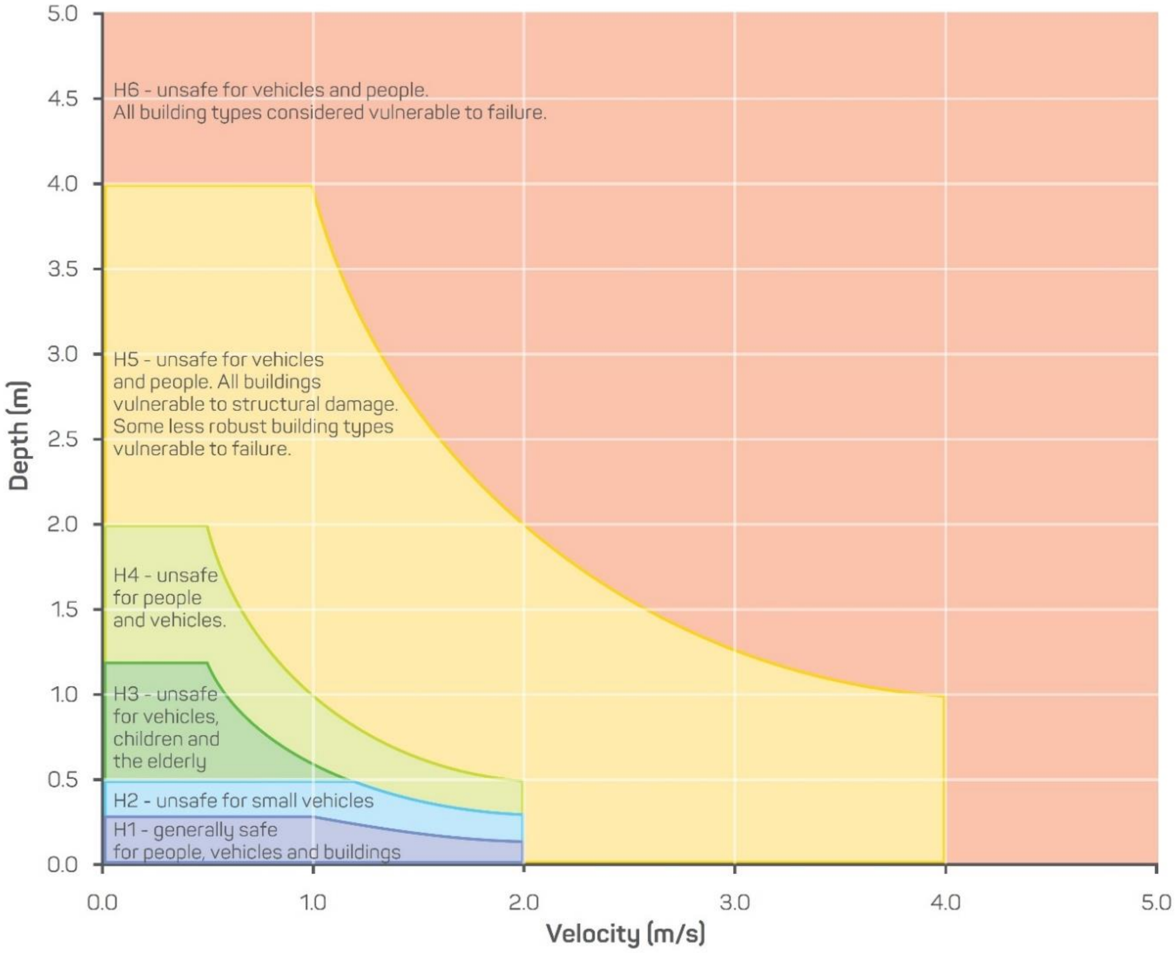

Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

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 Flood Fringe area has relevant flood planning controls, with the Floodway area being unsuitable for commercial development. However, the proposed development is to be suspended above the local catchment 1% AEP flood level and so it will be assessed as per the requirements of the adjacent Flood Fringe areas.

The objective of the management of risk to property is to minimise the damages that would be incurred in the event of a flood. This includes potential damage to future building structures and their contents, and critical infrastructure and services. Risk to property is typically managed to the 1% AEP design flood event. The Dungog Development Control Plan includes the following measures to manage risk to property from flooding:

- a minimum floor level for commercial buildings (excluding shops and offices) of the 1% AEP flood level plus a 0.5 m freeboard (i.e. above the FPL)
- 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 and
- Engineers report required to prove that the development of an existing allotment will not increase flood affectation elsewhere. Flood modelling may be required for significant structures or fill in flood storage areas.

The modelled peak flood levels at the Site are presented in Table 3. These levels represent the peak flood level along the northern boundary of the Site. The design flood levels for Williams River events are also provided, as derived from the Williams River Flood Study (BMT WBM, 2009).

Table 3 –Peak Design Flood Levels at the Site

Design Event	Local (m AHD)	Williams (m AHD)
20% AEP	6.9	5.4
10% AEP	7.0	6.1
5% AEP	7.1	6.8
2% AEP	7.2	7.5
1% AEP	7.3	8.1
0.5% AEP	7.3	8.8
0.2% AEP	7.4	N/A
PMF	8.2	14.1

The finished floor level (FFL) of the proposed function building is 7.9 m AHD. Whilst this satisfies flood planning level requirements for local catchment flood conditions, it is 0.7 m below the FPL for Williams River flooding. While it is better, if possible, for the FFL to be raised above the FPL of 8.6 m AHD, alternative management measures can serve to limit the potential flood damages incurred during a flood event of that magnitude. As a minimum, this would include the construction and finishing materials of the building to be flood compatible and not damaged through prolonged inundation. Electrical infrastructure should also be installed above the FPL. Potential damages to building contents can then be limited by storing them above the FPL or having a Flood Emergency Response Plan that includes relocating contents to an area 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 7.6 m AHD (post-development) and velocities of up to 2.0 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.

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 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 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. Therefore, sheltering in place is the only option. Whilst internal flood depths would be less than 1 m and not present a significant risk to occupants of the building, the structure will be subject to significant hydraulic forces that could potentially compromise the structural integrity. The building will 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 8.8 m AHD (post-development) and velocities of up to around 4 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.

Flood Impact Assessment

The potential impacts of development of the Site, including the proposed filling and suspended slab over the watercourse were simulated using the TUFLOW model developed for this assessment. The model topography was modified, raising the finished surface levels to those provided in the civil design plans (2023 08 17 - 222386 - CIV - DA - A - DRAFT.pdf). The design flood events were re-simulated and compared to the results of the existing conditions in a relative flood impact assessment.

To assess the impacts of the support structure required for the suspended slab construction, a Layered FC shape has been implemented in TUFLOW accounting for the associated blockage and hydraulic losses. A 50% blockage has been applied to account for the likely accumulation of flood debris.

The modelled impact to the existing peak flood depths is presented in Figure 11 to Figure 13 for 5% AEP, 1% AEP and PMF events, respectively. The corresponding impact to the existing peak flood velocity is presented in Figure 14 to Figure 16.

The obstruction associated with the proposed suspended slab development and modelled debris accumulation results in around a 0.3 m increase in peak flood levels upstream of the Site for the 5% AEP and 1% AEP events and a 0.6 m increase at the PMF event. However, the extent of impact does not affect existing development. Even at the PMF event, the impact would not tangibly affect the existing neighbouring dwellings.

The constriction of flows beneath the suspended slab significantly increases the modelled peak flood velocities, by around 0.7 m/s at the 5% AEP event and 0.8 m/s at the 1% AEP event. Increases in velocity of between 1 m/s to 2 m/s are modelled at the PMF event. This needs to be considered in the design of the building structure and potential armouring of the underlying channel and floodplain, with velocities of around 2 m/s at the 1% AEP event and up to around 4 m/s at the PMF event.

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 is 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 Grey Street, Clarence Town NSW requires a Flood Assessment to assist in the approval process for the proposed commercial development.

The finished floor level of the proposed development of 7.9 m AHD is below the required FPL of 8.6 m AHD. Therefore, appropriate measures to manage the flood risk to life and property need to be satisfactorily demonstrated to Council for them to consider approval. This should include:

- Construction and finishing of the proposed building using flood-compatible materials,
- Location of all electrical infrastructure above the FPL,
- Location of high value building contents susceptible to flood damage above the FPL where possible,
- 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,
- Design and certification of the building structure to withstand the expected hydraulic forces of the local catchment PMF event to enable safe on-site refuge within the building.

With the proposed development including a building on a suspended slab above the channel and floodplain, the potential for flood debris accumulation and scour erosion around the building supports needs to be considered in terms of both visual amenity and structural stability.

Flood impact assessment modelling of the proposed development has been undertaken and confirmed that although the suspended slab construction and associated potential debris accumulation results in significant impacts to the existing local peak flood level and velocity conditions, 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

0 100 200 m

approx. scale

Figure:	1
Revision:	A

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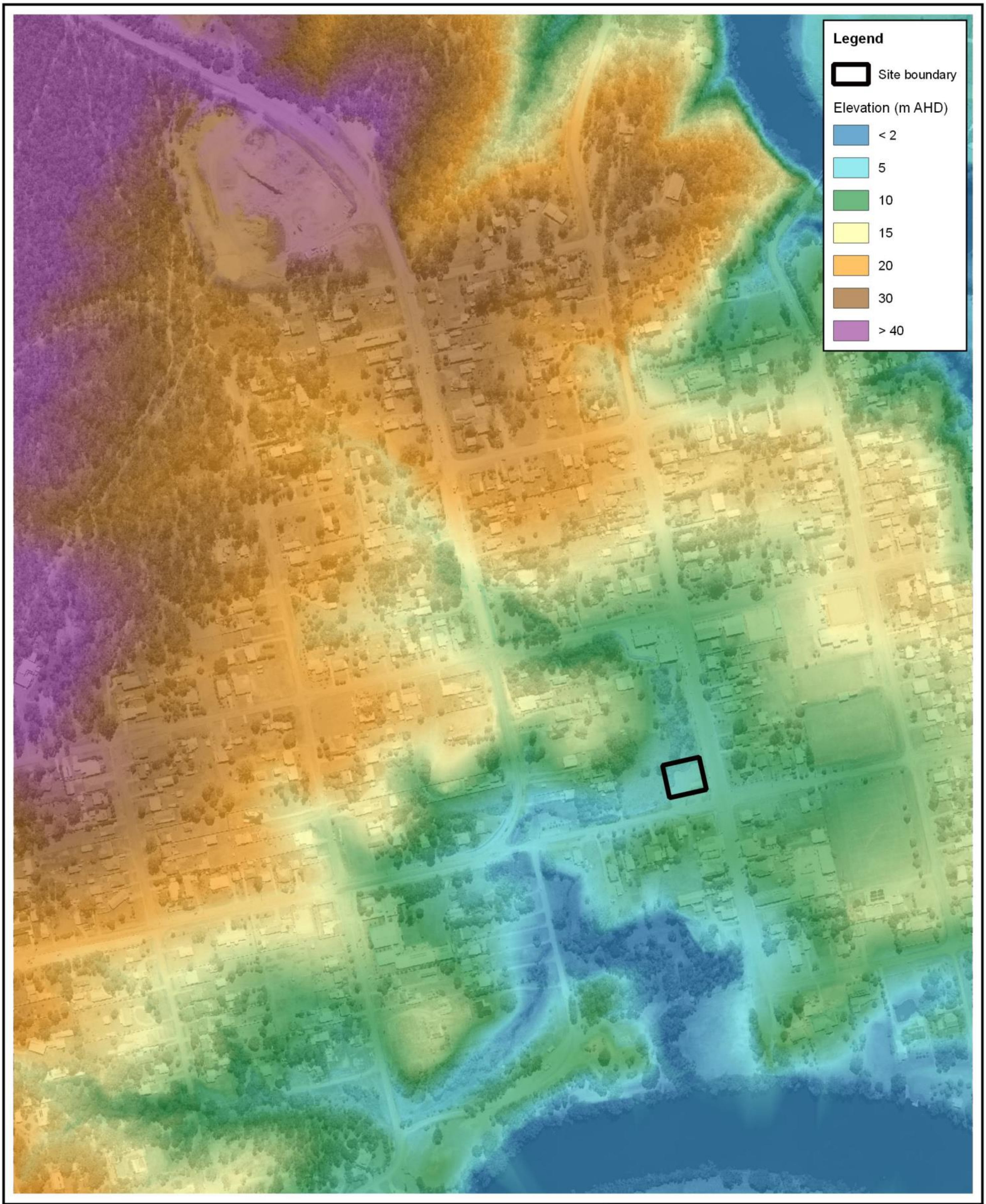

Title:

Local Catchment Topography

Figure: **2**

Revision: **A**

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TUFLOW Model Configuration

0 80 160 m

approx. scale

Figure:	3
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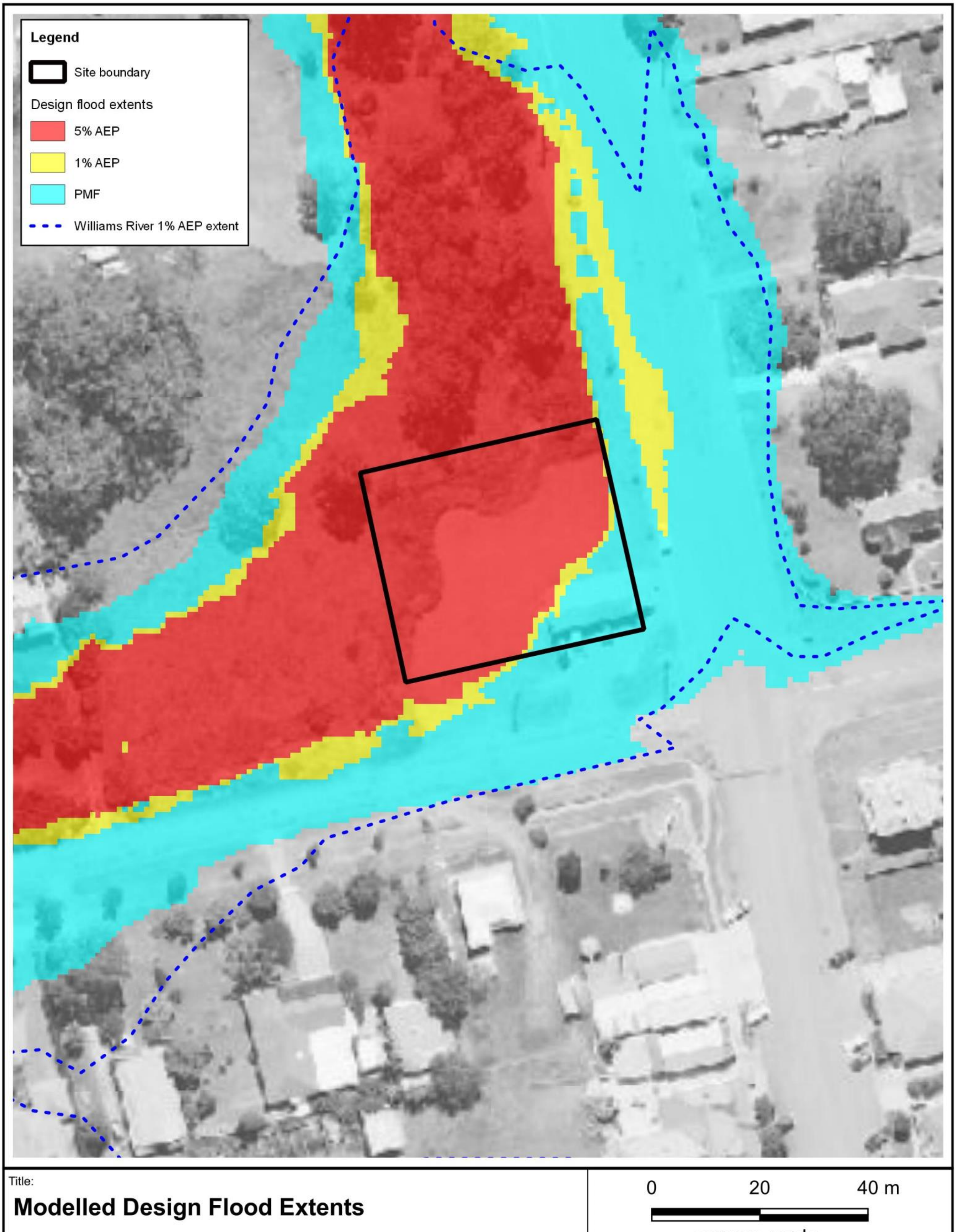

Title:

Modelled Design Flood Extents

Figure: **4**

Revision: **A**

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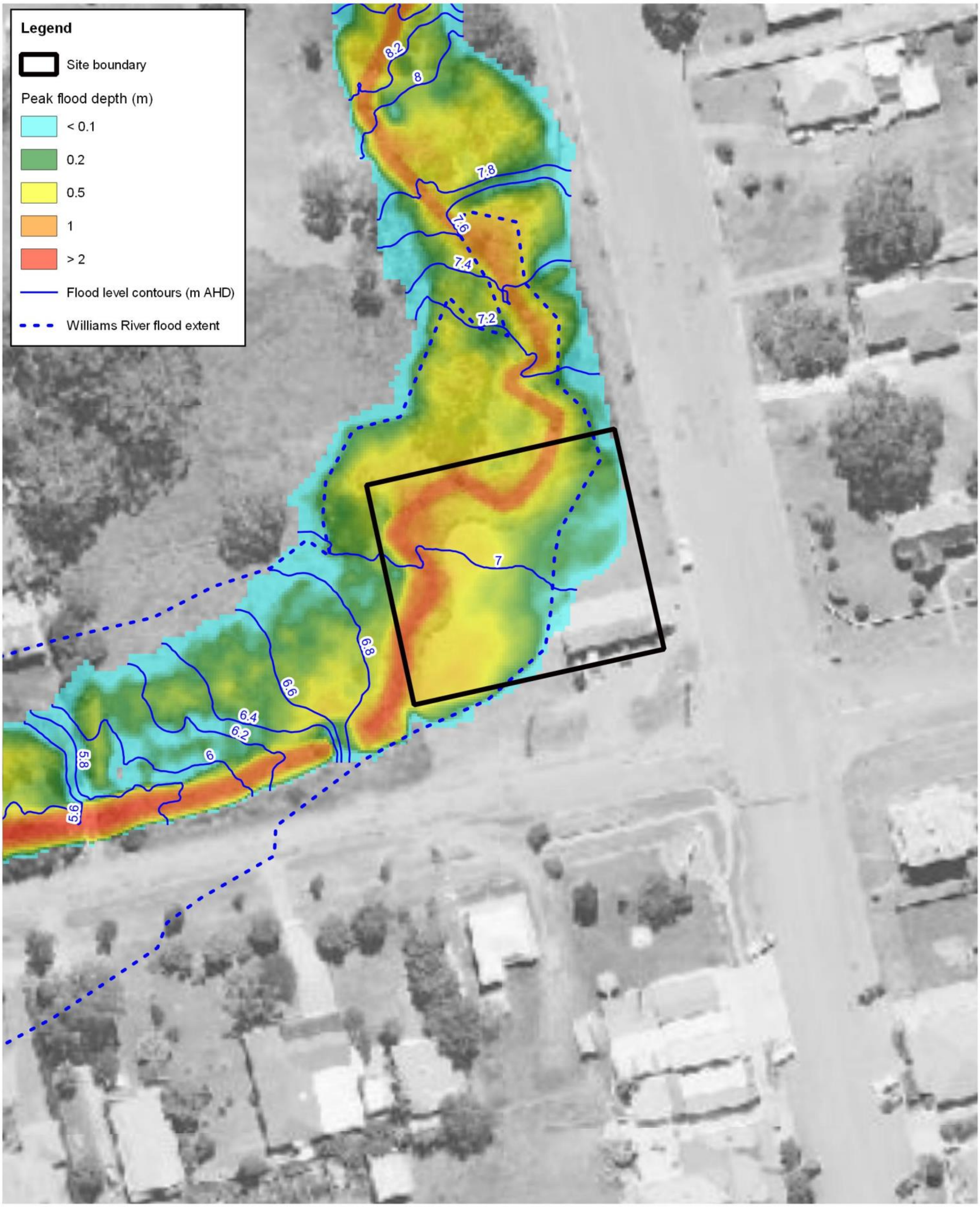

Title:

Modelled 5% AEP Peak Flood Depths and Levels

0 20 40 m

approx. scale

Figure: **5**

Revision: **A**

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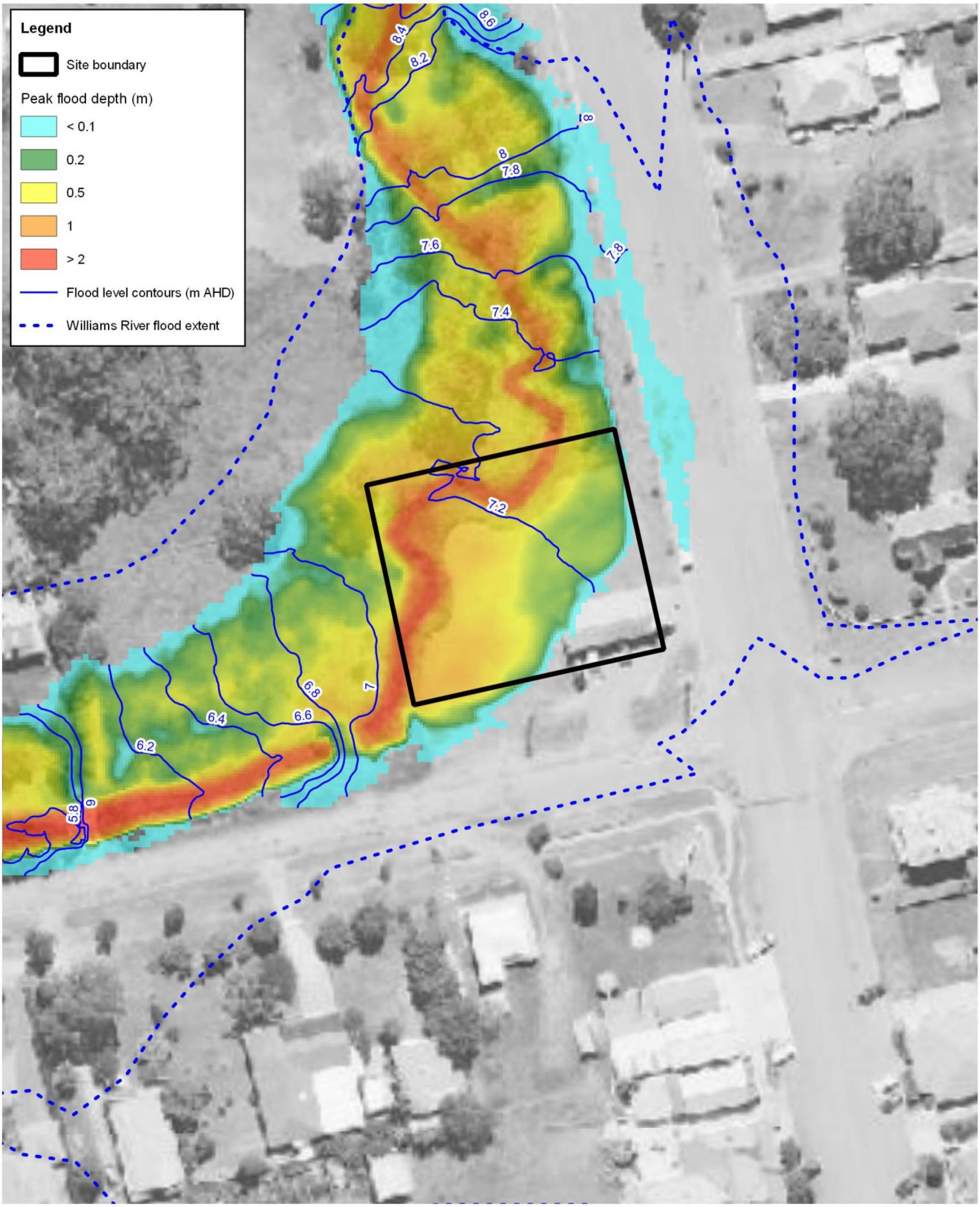

Title:

Modelled 1% AEP Peak Flood Depths and Levels

0 20 40 m

approx. scale

Figure: **6**

Revision: **A**

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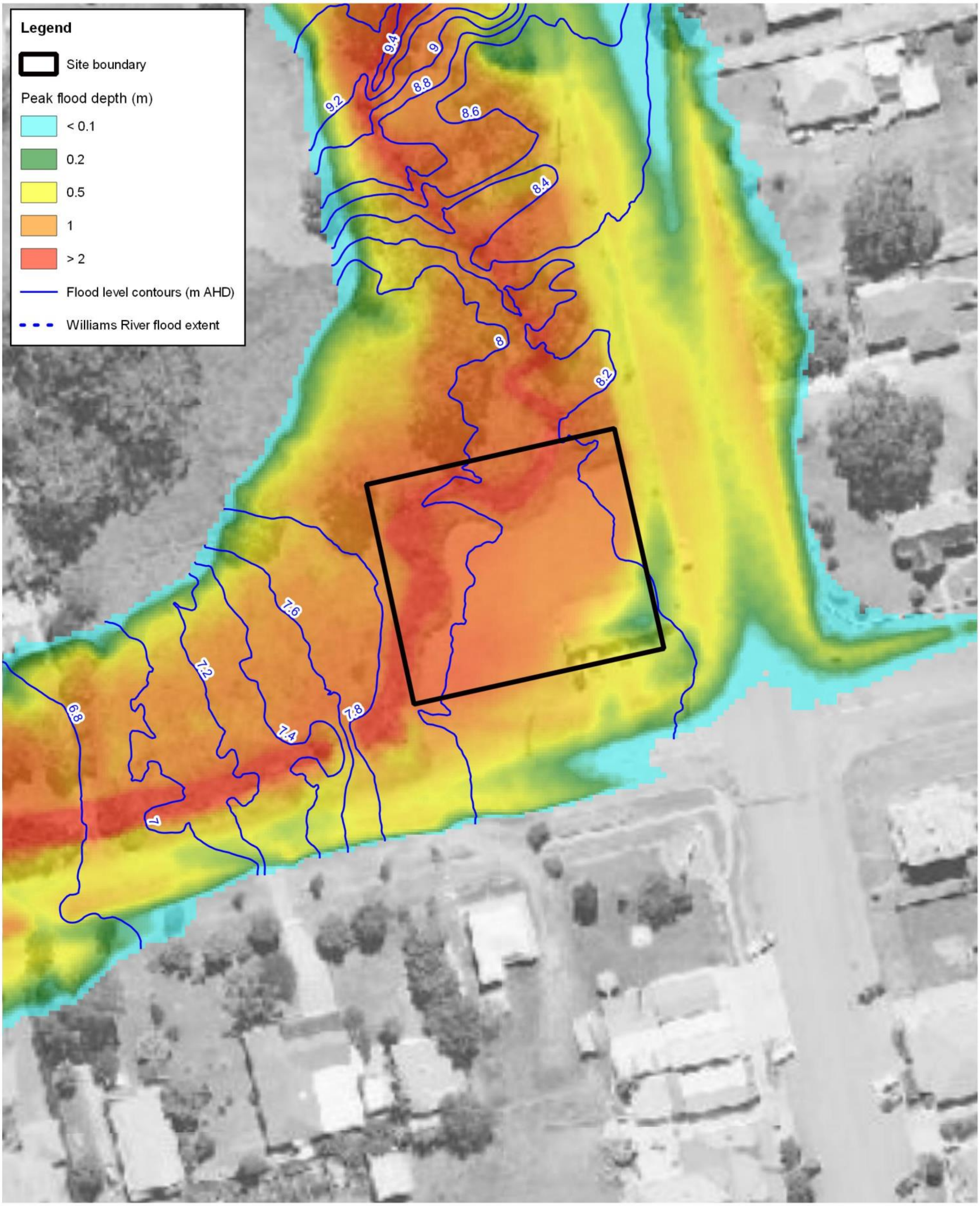

Title:

Modelled PMF Peak Flood Depths and Levels

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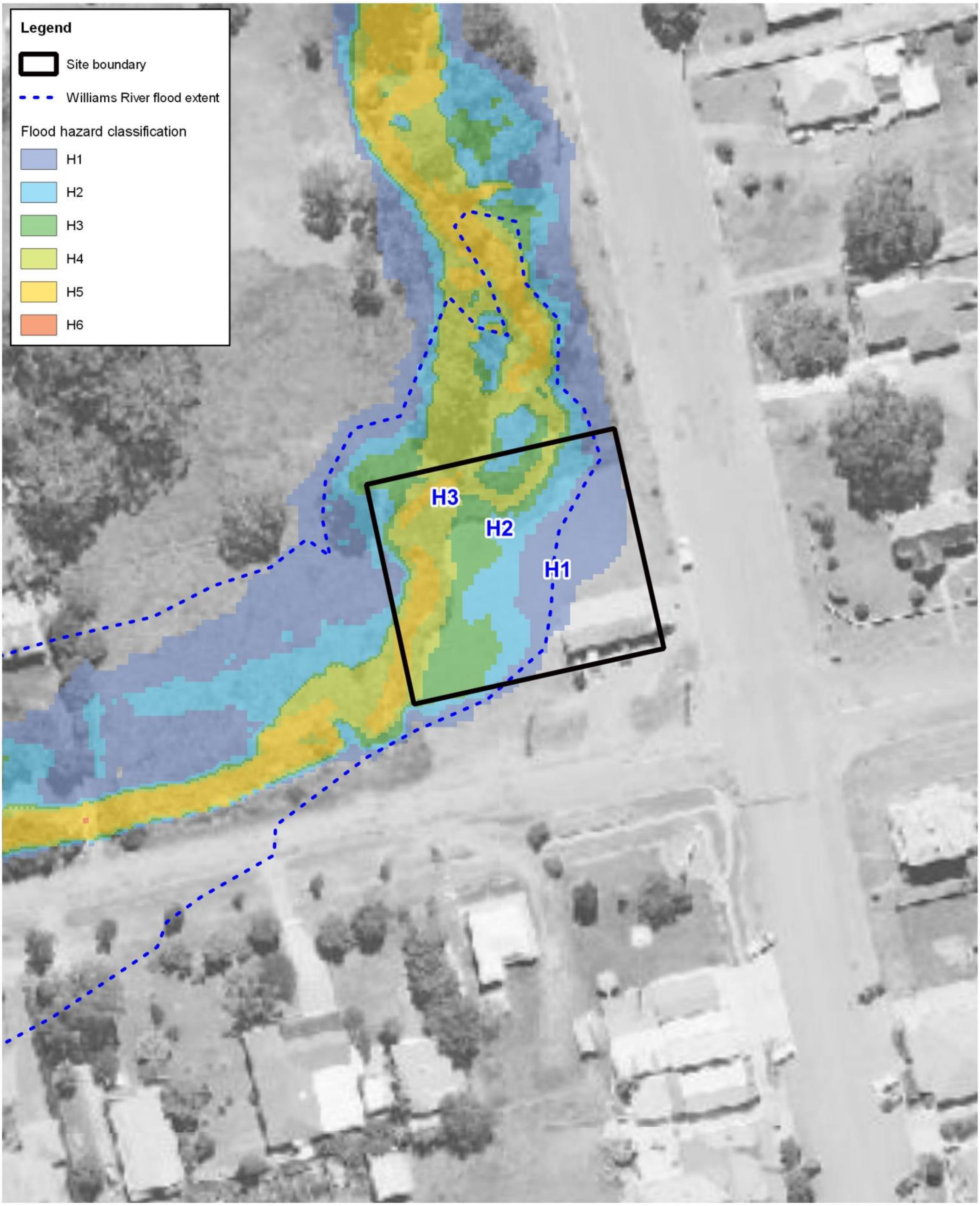

Title:

5% AEP Flood Hazard Classification

Figure: 8

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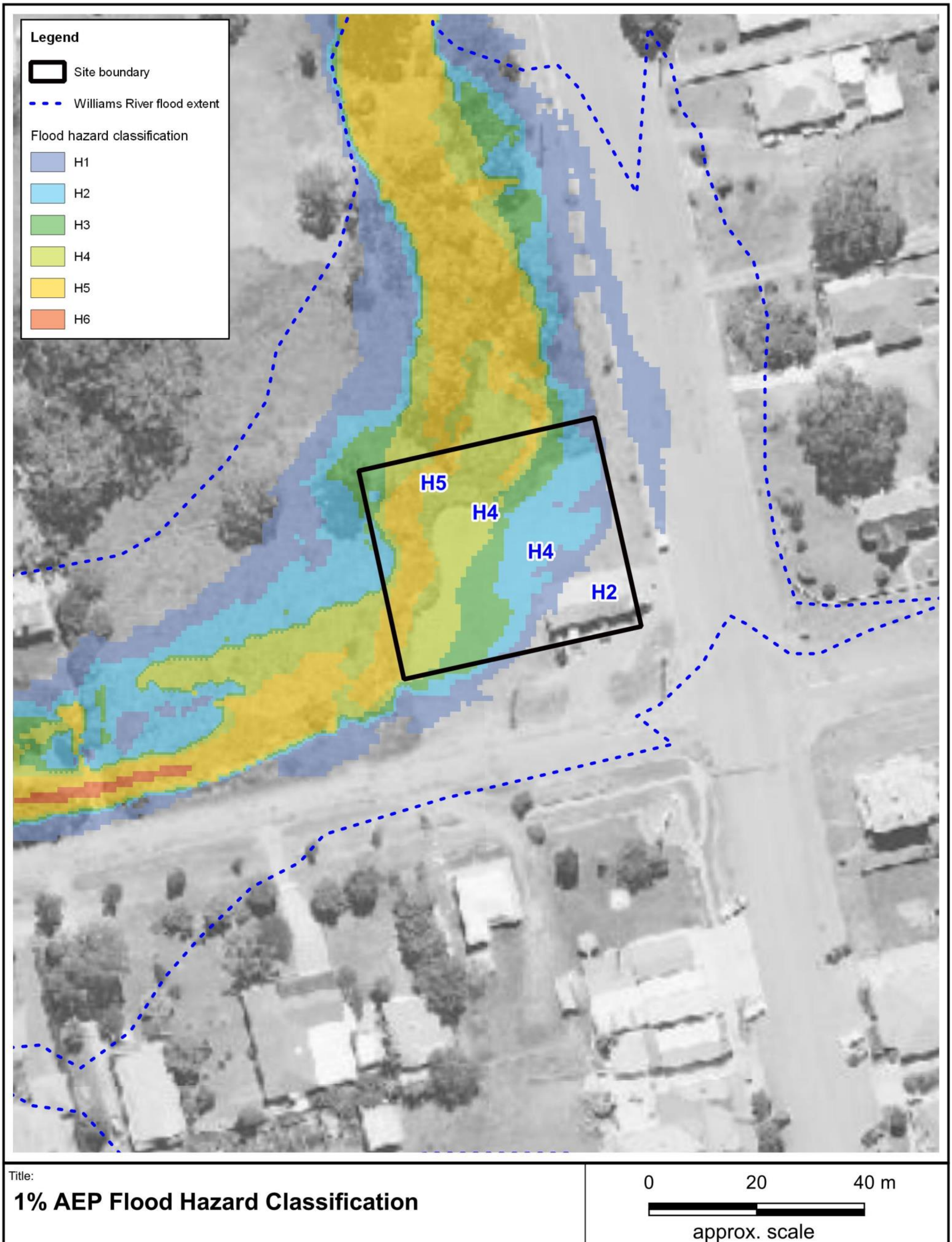

Title:

1% AEP Flood Hazard Classification

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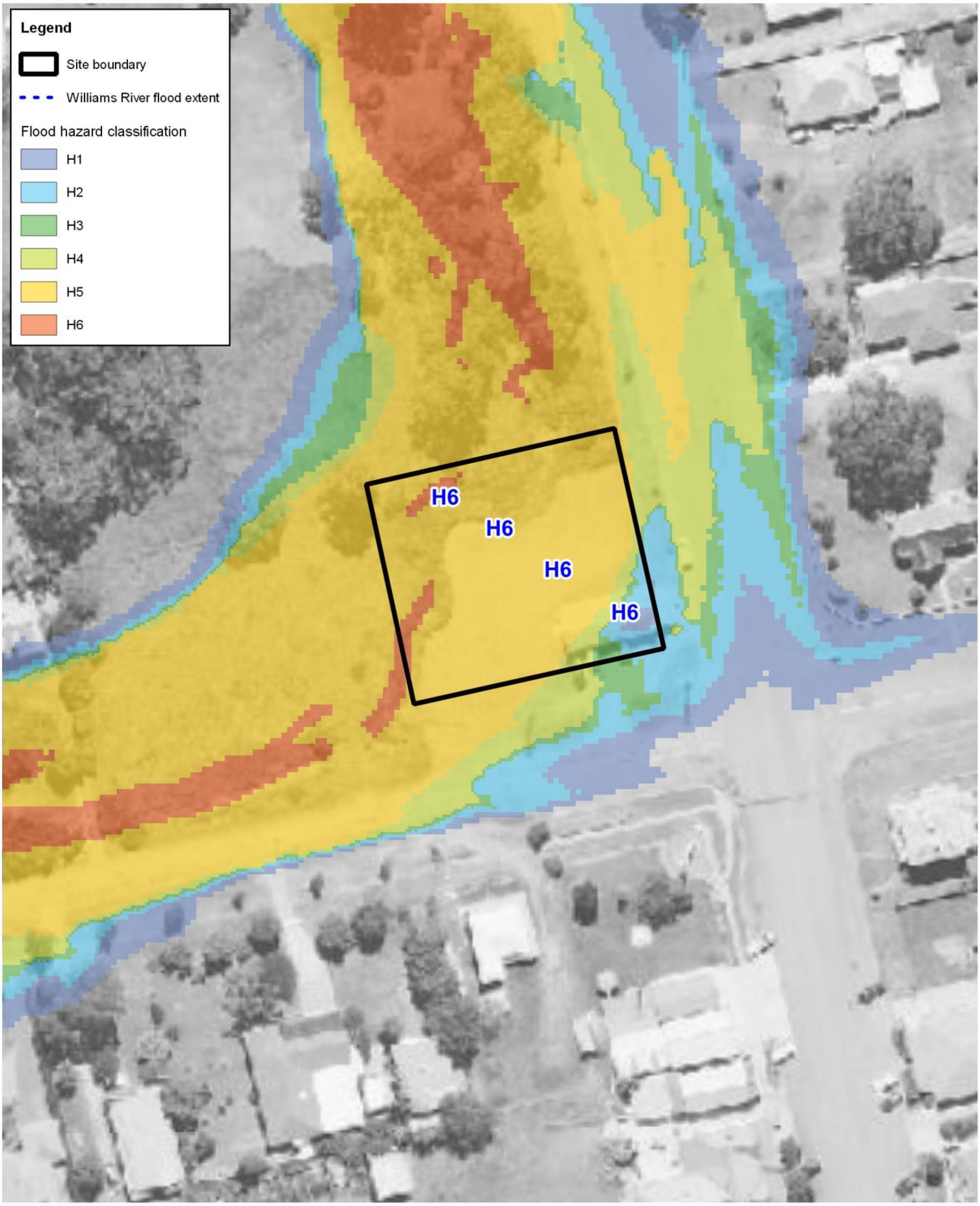

Title:

PMF Flood Hazard Classification

0 20 40 m

approx. scale

Figure: 10

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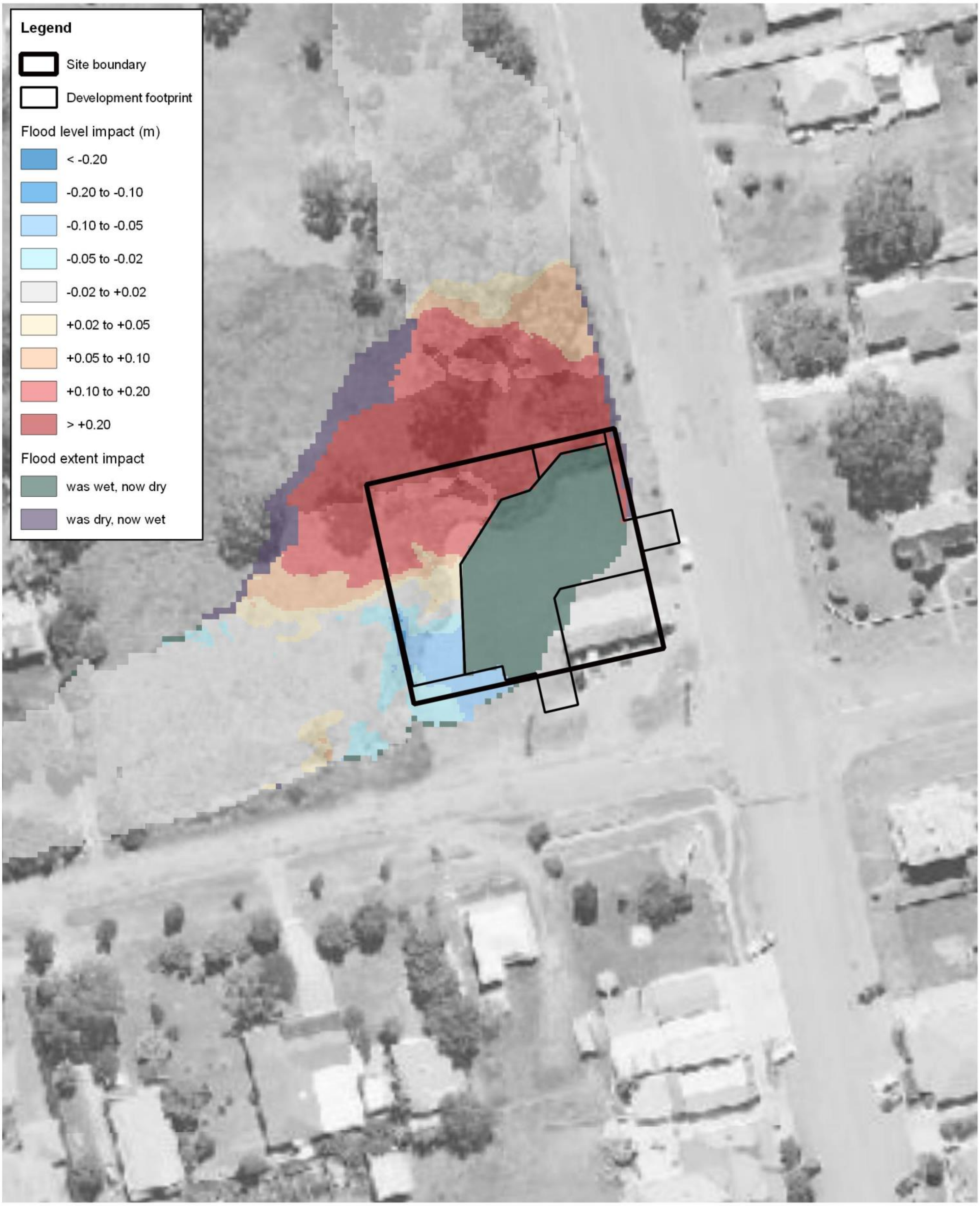

Title:

5% AEP Modelled Peak Flood Level Impact

0 20 40 m

approx. scale

Figure: **11**

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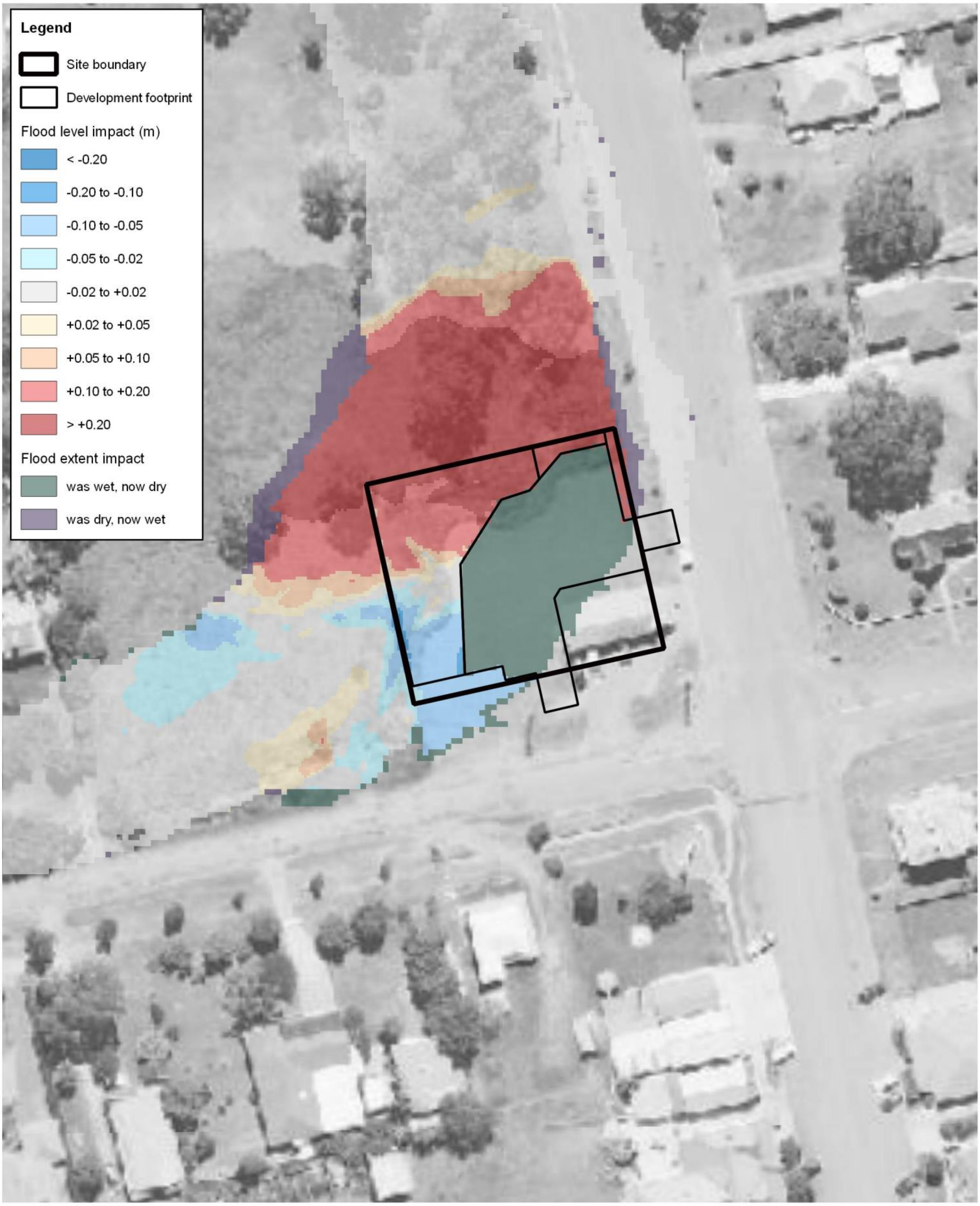

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1% AEP Modelled Peak Flood Level Impact

0 20 40 m

approx. scale

Figure: **12**

Revision: **A**

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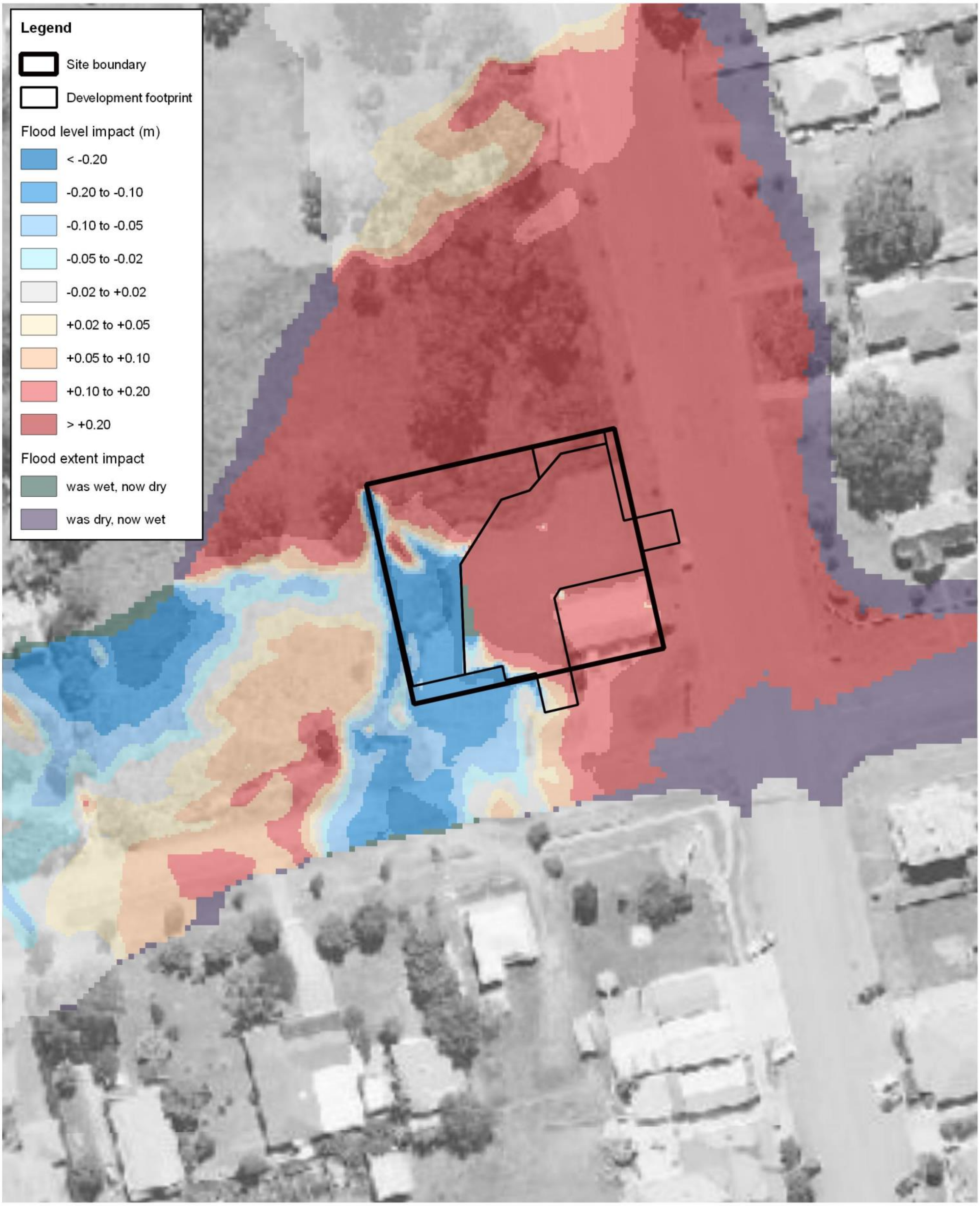
Filepath: Z:\Projects\T2345_Grey_St\GIS\T2345_012_230908_100y_h_impact.qgz



Title:

PMF Modelled Peak Flood Level Impact

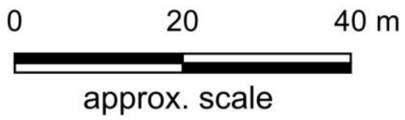


Figure: **13**

Revision: **A**

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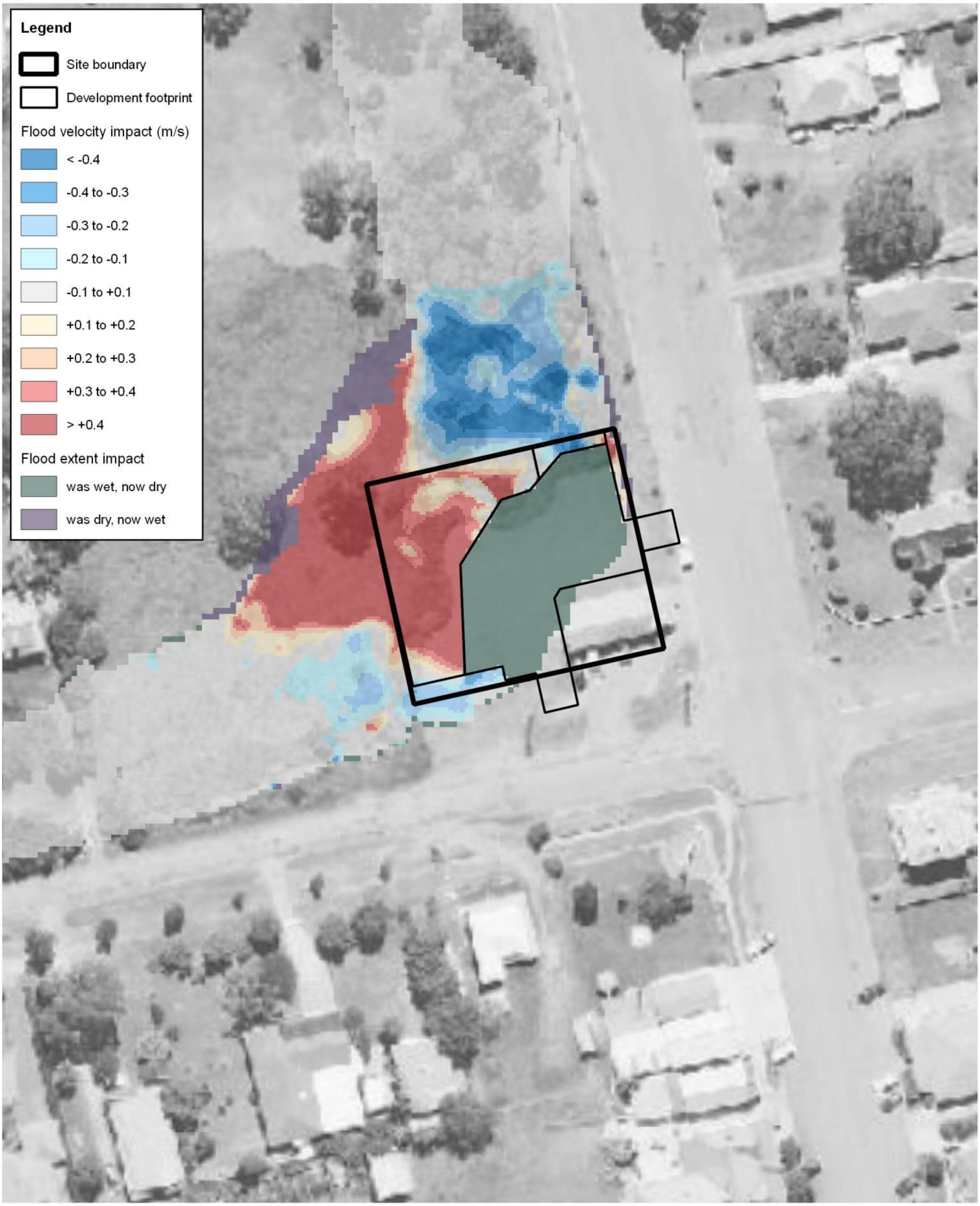

Title:

5% AEP Modelled Peak Flood Velocity Impact

0 20 40 m

approx. scale

Figure: **14**

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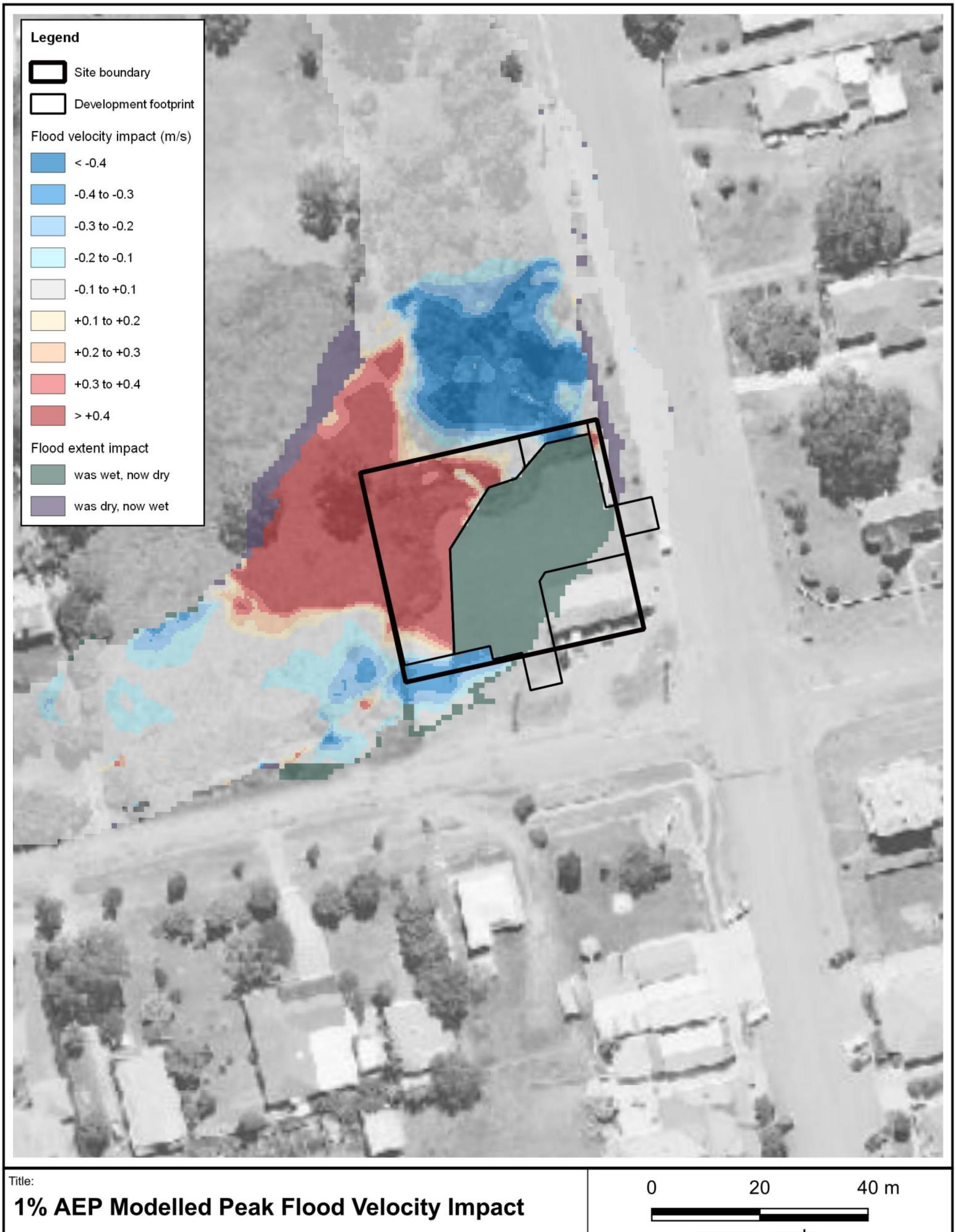

Title:

1% AEP Modelled Peak Flood Velocity Impact

Figure: 15

Revision: A

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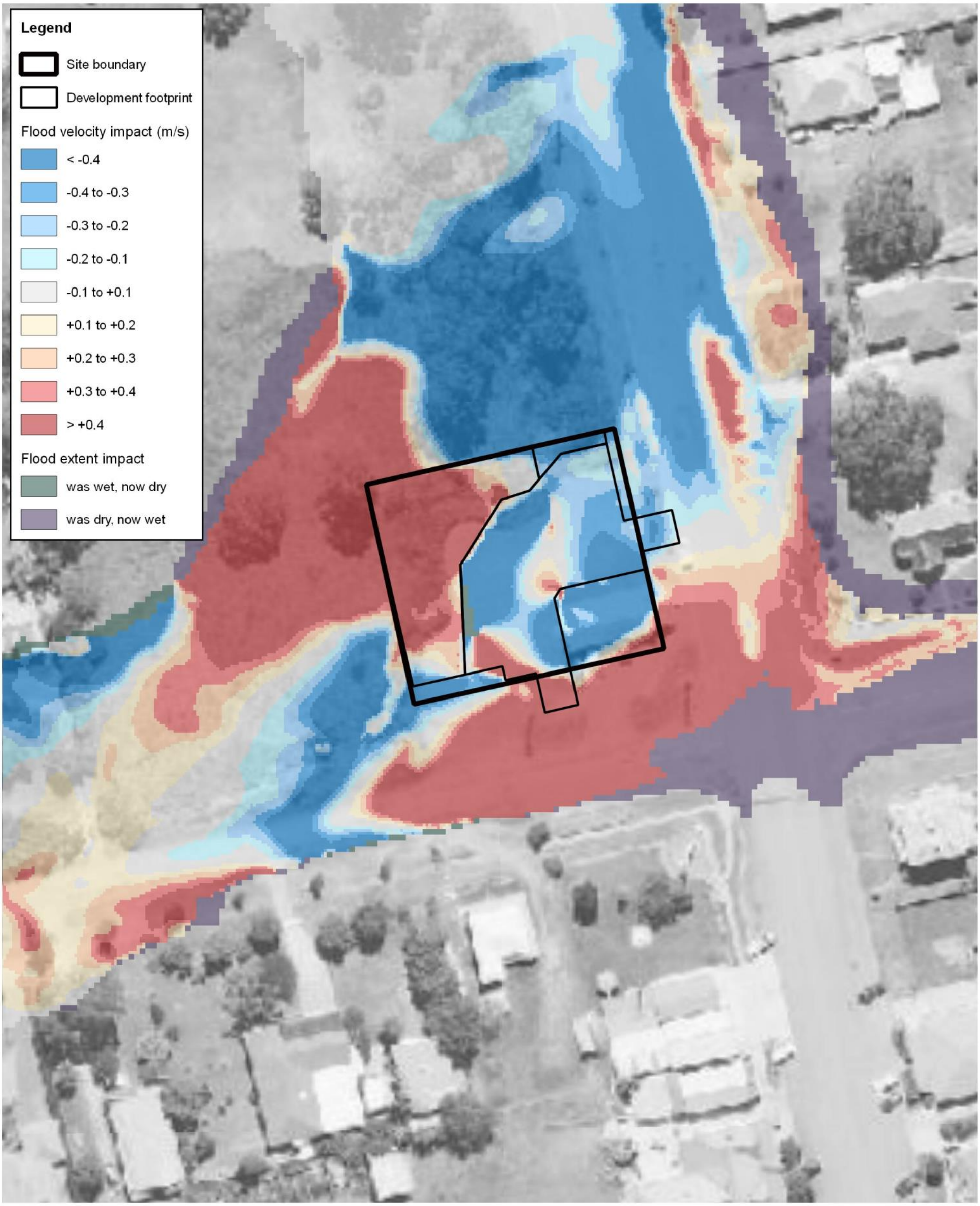

Title:

PMF Modelled Peak Flood Velocity Impact

0 20 40 m

approx. scale

Figure: **16**

Revision: **A**

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