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3 March 2022
Charles David Pty Ltd
c/o Perception Planning
PO Box 107
Clarence Town NSW 2321
Attention: Erin Daniel

Dear Erin

RE: FLOOD IMPACT ASSESSMENT FOR PEPPERTREE ESTATE, GUNDY ROAD, SCONE NSW

Background

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed subdivision of 150 Gundy Road, Scone for the creation of Peppertree Estate (the Site). A review of the Stormwater Management Plan prepared for the proposed development (DA163/2017) was undertaken for Upper Hunter Shire Council (UHSC) by Northrop, dated 19 January 2022. This review found the previous flood assessment for the Site to be of insufficient detail and a flood study including 2D modelling was requested to address this.

This Site is located on the south-eastern edge of Scone, as presented in Figure 1. A second order watercourse traverses the site from east to west, with a first order tributary joining it at the western end of the Site. The local watercourse is a tributary to Parsons Gully, which forms part of the Kingdon Ponds catchment and broader Hunter River system. The total contributing catchment area at the outlet from the Site is around 3.0 km^2, with around half that entering the Site at the eastern end via the existing dam.

LiDAR survey elevation data is available for the study area, with the NSW Spatial Services product being downloaded via the ELVIS Foundation Spatial Data portal. The catchment topography is relatively steep, with typical hillslopes of 5-10% and exceeding 20% towards the peak at the north-east catchment watershed. Sub-catchment delineation for the purposes of flood assessment has been undertaken through the analysis of the LiDAR data using both GIS hydrological tools and hydraulic modelling of runoff using TUFLOW. The sub-catchment delineation is presented in Figure 2 and includes:

- Catchment ‘A’ of 99 ha is the principal catchment draining to the dam at the eastern end of the Site
- Catchment ‘B’ of 29 ha is the secondary catchment draining to the eastern dam
- Catchment ‘C’ of 30 ha drains to Gundy Road at the Bhima Drive intersection
- Catchment ‘D’ of 20 ha drains to Gundy Road at the Kilgallin Close intersection
- Catchment ‘E’ of 72 ha is drained to an open channel along the western boundary of the Site and includes two detention basins for the management of urban stormwater
- Catchment ‘F’ of 51 ha is local hillslope runoff draining to the 2nd order watercourse within the Site
- Catchment ‘G’ of 6 ha is local hillslope runoff draining to a gully line on the western Site boundary
- Catchment ‘H’ of 13 ha is local hillslope runoff draining to the southern and western boundaries of the Site.

Model Development

For this assessment, a TUFLOW hydrologic model was developed covering the area draining to the western boundary of the Site, at which the contributing catchment area is around 3.0 km^2. The additional 19 ha of local catchment runoff from the Site was also included. The model utilised the LiDAR data to define the floodplain topography and was constructed using a 5 m horizontal grid cell resolution.

The LiDAR data was pre-processed using GIS-based terrain analysis techniques to remove sinks within the grid and create a hydrologically corrected DEM. This prevents the initial loss of catchment rainfall to artificial trapped storages within the DEM. The capacity of roadways to convey overland flow was also enforced within the model by lowering the elevations within the road by 0.1 m.

Land use coverage in the catchment was separated into areas of grass, remnant vegetation and impervious surfaces using aerial imagery. Most of the catchment is pastural grassland and was assigned a Manning's 'n' roughness coefficient of 0.05, with the small areas of remnant vegetation being assigned an 'n' value of 0.1. The impervious surface areas of road, driveways and houses were assigned an 'n' value of 0.015.

The downstream boundary of the model was configured as an automatically generated stage-discharge curve with a slope of 1%. Direct rainfall input was applied to the full modelled area to simulate catchment runoff.

A more detailed TUFLOW model was developed covering the Site plus around a 200 m reach upstream of the Site and 600 m reach downstream of the Site, as presented in Figure 3. Catchment 'E' was also modelled from the upper of the two detention basins. The model was constructed using a 2 m horizontal grid cell resolution, sampling elevations from the LiDAR DEM.

The site survey data was provided by MM Hyndes Bailey & Co. and ground survey point levels within the floodplain were compared to the elevations of the LiDAR DEM. This comparison found the LiDAR to be of a high level of accuracy, with an average difference of only +0.05 m to the surveyed levels. Because the LiDAR DEM has a greater spatial density of levels that the ground survey it was used in favour of the latter throughout the Site. However, a -0.05 m adjustment was applied to the LiDAR DEM within TUFLOW to best calibrate the model topography to m AHD.

There were greater levels of difference between the LiDAR and ground survey along some of the surveyed gully lines and so this survey detail was incorporated into the TUFLOW model, enforcing breaklines using the Z shape functionality. The same was also applied to the crest of the dam wall at the eastern end of the Site. The LiDAR DEM and ground survey levels at the western boundary of the Site suggests that the denser vegetation cover within the adjacent power easement is impacting the LiDAR by around a further +0.15 m and so an additional -0.15 m correction was applied to the TUFLOW LiDAR DEM within the easement.

A Manning's 'n' value of 0.05 was adopted for both pastural grassland and the watercourse, with 0.04 being adopted for areas of maintained grass and 0.015 for impervious surfaces. Again, the downstream boundary of the model was configured as an automatically generated stage-discharge curve with a slope of 1%. It is a sufficient distance (and elevation drop) downstream so as not to impact model results within the Site. An initial water level of 221 m AHD was applied within the dam at the eastern end of the Site, which is at the spill level within the survey data.

The stormwater detention basins in catchment 'E' were included in the TUFLOW model, with structure dimensions being measured through site inspection and invert levels estimated from the LiDAR data. The detention basin outlet structures were modelled as 1D elements, with the set of four 2400 mm x 600 mm box culverts under Gundy Road being modelled as a layered FC shape.

The TUFLOW models were used to simulate the catchment rainfall-runoff process, utilising the ensemble storm method outlined in the ARR 2019 guidelines.

Design Flood Hydrology

The TUFLOW model was simulated (using the HPC solver) for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP and 0.2% AEP design rainfall events for storm durations ranging from 15 minutes to three 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 total catchment area of 3.0 km^2. The 1% AEP ARFs calculated in accordance with ARR 2019 range from around 0.90 at the 15-minute duration to around 0.95 at the 3-hour duration. Design rainfall losses considered the recent NSW-specific guidance. This provided a continuing loss of 0.6 mm/h, with 0.0 mm/h being used for impervious surfaces. Initial losses ranged from around 9 mm to 11 mm and were set at 1 mm for impervious surfaces.

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 for catchments ‘A’, ‘C’ and ‘E’ and at the catchment outlet at to identify the critical storm duration, i.e. that which produces the peak flood flow for each design event magnitude. The 60-minute duration was identified as being critical for the 20% AEP and 10% AEP events, with the 45-minute duration being critical for the 5% AEP, 2% AEP and 1% AEP events. The 30-minute duration is critical for the 0.5% AEP and 0.2% AEP events.

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 170 mm (~680 mm/h intensity). The simulated peak design flood flows at the Site are summarised in Table 1. The western boundary flows have been extracted upstream of the catchment ‘E’ contribution.

Table 1 – Modelled Peak Design Flood Flows (m^3/s) at the Site

Design Event	Eastern Boundary	Access Road	Western Boundary
20% AEP 60-min (4577)	7.8	9.0	9.6
10% AEP 60-min (4569)	12.1	14.8	15.6
5% AEP 45-min (4542)	14.7	17.6	18.6
2% AEP 45-min (4533)	19.7	24.7	26.4
1% AEP 45-min (4534)	24.2	31.1	33.5
0.5% AEP 30-min (4498)	27.3	33.2	35.5
0.2% AEP 30-min (4498)	34.3	43.1	46.3
PMF 15-min (GSDM)	294	378	413

Note: contents of parentheses denote the adopted design temporal pattern ID

The modelled peak flow for the 1% AEP event at the western boundary of the Site is around 33.5 m^3/s. This compares to a value of 47.6 m^3/s derived through modelling undertaken for the stormwater management report and 29.8 m^3/s derived by MM Hyndes Bailey & Co. using the ARR RFFE. Northrop provided a 1% AEP peak flow estimate of 28.6 m^3/s from scaling a larger catchment flow derived by GHD in the Scone Bypass Flood Study (2015) by 60%.

The range of estimates between the different methods employed to derive the peak flood flows is relatively large and reflects the uncertainty with such estimations for the study catchment. The stormwater management modelling adopted an impervious fraction of 0.35 for natural catchments, in line with the UHSC guidelines. For a more consistent comparison the TUFLOW hydrologic model was simulated with adjustments to the Manning's 'n', initial loss, and continuing loss values to reflect a 35% impervious area in the natural catchments. The modelled flow hydrographs were then extracted for catchments that match those presented in the stormwater management report. If the flows are then summed for the 'EXTL_A', 'EXTL_B' and 'SITE_A' results with a simple assumed time lag, based on a 1.5 m/s stream velocity, then the peak flow estimate for the 1% AEP event is 38.3 m^3/s.

Most of the increase from the modelled peak 1% AEP flow of 22.8 m^3/s and the modified comparison flow of 38.3 m^3/s is a function of the adopted time lag method. This highlights the significant attenuation of the flood hydrograph that is being modelled in TUFLOW. Whilst the floodplain is relatively contained immediately adjacent the watercourse alignments within the eastern part of the Site, when flowing through the western part of the Site it is dispersive.

With such a small and steep study catchment, the representation of hydrograph attenuation can have a significant impact on the modelled peak flood flow, depending on the modelling approach that is adopted. It is likely that this explains much of the difference between the peak flow estimates using TUFLOW for this flood assessment and DRAINS for the stormwater management assessment. The adoption of a 0.35 impervious fraction for natural catchments in the stormwater assessment is also a significant factor.

Baseline Design Flood Conditions

The TUFLOW hydraulic model was simulated (using the HPC solver) for the adopted design flood hydrology. Figure 4 presents the modelled peak flood extents at the Site for the 5% AEP, 1% AEP and PMF events, with the proposed subdivision layout shown for context. Figure 5, Figure 6 and Figure 7 are presented for additional context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events respectively.

The modelling was originally configured with inflows from catchments 'C' and 'D' input along Gundy Road. However, this resulted in extensive sheet flow from Gundy Road across the Site and the adjacent Strathearn House development. This sheet flow was generally uniform across the landscape, without concentrated pathways of conveyance. The modelled sheet flow was of shallow depth (< 0.1 m) and low hazard (H1) and should be considered as local stormwater runoff rather than mainstream flooding. To improve the clarity of mapping for the mainstream flood conditions through the Site the inflows for catchments 'C' and 'D' were relocated into the mainstream floodplain, as indicated on Figure 3. Potential runoff from Gundy Road through the Site does not present a significant flood risk to the proposed subdivision.

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.

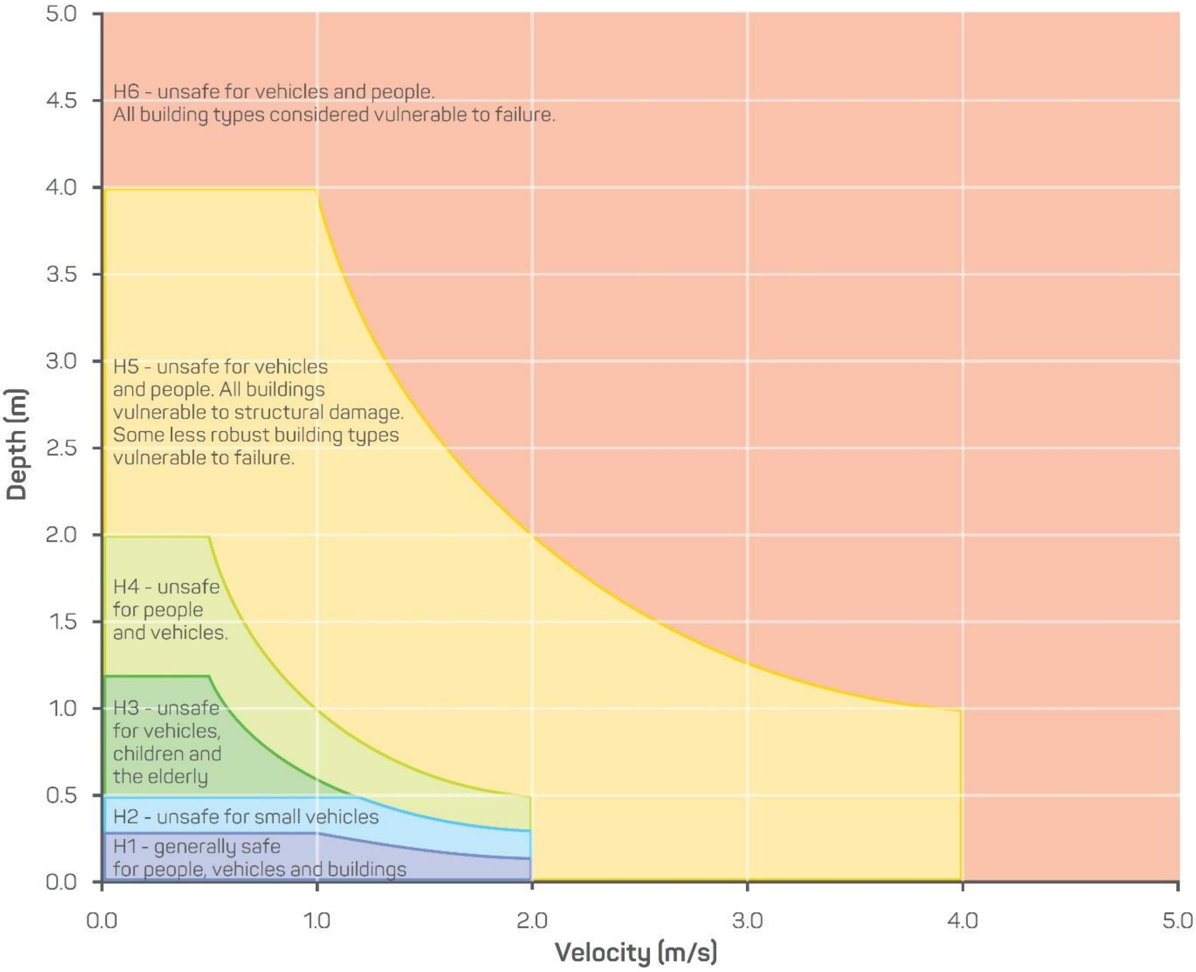

Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

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. 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.

Figure 11 presents the flood function, based on mapping for the 1% AEP event. For the identification of the floodway extent nine cross-sections (refer Figure 11 for locations) were extracted from the modelled VxD product and the area containing 80% of the total peak flood flow distribution was identified. This ranged between a VxD product of around 0.1 at the western boundary of the Site, to over 0.6 at the eastern end of the Site, with an average of around 0.4. A VxD product of 0.4 was used to identify an indicative floodway extent. Flood storage areas were identified as being where the 1% AEP peak flood depth exceeds 0.5 m and is largely limited to the dam and detention basins.

Within the eastern part of the Site the floodway is clearly defined as being 15-20 m wide along the alignment of the watercourse. Another floodway enters the north-western corner of the Site, along the drainage channel which discharges the upstream detention basin outlet into the mainstream floodplain. Between these two floodways there is a broad area of dispersive flow, where there is no readily defined floodway extent and flood flows are more distributed across the floodplain. This is evident in the 1% AEP flood hazard mapping in Figure 9, where the medium hazard (H4) along the floodway dissipates to a largely low hazard (H1 and H2) environment across the western part of the Site.

Post-development Modelling

In addition to the management of flood risk exposure of the proposed development, the potential for off-site flood impacts to the existing baseline flood conditions also need to be considered, to avoid adverse impacts to neighbouring property and infrastructure. There are four key aspects of the proposed subdivision that can impact existing flooding:

- the access road crossing of the floodplain to connect the southern and northern parts of the Site
- land surface regrading to raise flood-affected land above the floodplain
- the construction of stormwater management basins within the floodplain
- increased impervious surfaces resulting in larger runoff volumes from the Site.

To assess the potential impact of the subdivision on flooding, details of the development were incorporated into the TUFLOW model, and the design floods were re-simulated to create post-development flood conditions. These were then compared to the existing flood conditions for the purposes of a relative flood impact assessment.

The access road was modelled at a level of 216.5 m AHD, with a cross-drainage configuration of six 2.4 m x 0.9 m box culverts (modelled as a layered FC shape). The invert level of the culverts was set to 214.85 m AHD at the upstream side, grading to 214.45 m AHD at the downstream side. This maximises the available capacity within the upstream and downstream channel geometry. The concept design for the culverts has been determined through modelling the 1% AEP event to provide the required flow capacity to convey the flood waters and provide a freeboard to the road to allow for potential structure blockages. The difference in assumed cross-drainage structure provision between MM Hyndes Bailey & Co. and Acor is attributable to the difference in estimations of the 1% AEP flood flow. The three different culvert configurations all provide between around 2.4 m^3/s to 2.6 m^3/s of conveyance per m^2 of cross-sectional area and are therefore consistent.

The only area requiring earthworks to raise the proposed subdivision above the floodplain is within Stage 5. Here, a preliminary longitudinal road profile for Road 5 was provided by MM Hyndes Bailey & Co. This profile was used to raise the level of the road and adjacent lots to an indicative post-development condition. These earthworks were then graded down to the natural floodplain level adopting a batter slope of 1-in-5. A high-level concept swale design was then implemented along the toe of the batter being of a ‘V’ profile 10 m wide and around 0.4 m deep. This grades from an invert of 213.3 m AHD at the eastern end of the batter, down to 208.16 m AHD at the western end. The swale will help provide connectivity between local gullies within the existing topography at the upstream and downstream ends, whilst also reducing the risk of erosive hydraulic forces acting on the batter.

For the proposed stormwater management basins, the modelled elevations were graded from the existing ground surface up to a crest level above the floodplain. This provides a conservative assessment of potential flood impacts.

The existing configuration of the dam wall at the eastern end of the Site focusses spills from the dam along an outlet from the southern end, feeding a contoured drainage profile. This is not ideal from a flood risk management perspective, as the spills from the dam are dispersive rather than being focussed within a spillway along the mainstream channel alignment.

A high-level concept design dam wall and spillway profile was derived (refer Chart 2) to provide a formalised spillway discharging to the downstream watercourse channel whilst maintaining post-development discharges consistent with the existing dam configuration. This will better contain floodwaters away from the subdivided lots and reduce the risk of a dam failure from uncontrolled spills. Subsequent design of a formalised dam spillway would likely result in a different spillway profile. However, provided that a revised design maintains existing peak flood flows, then the modelled concept is representative of the resultant flood conditions.

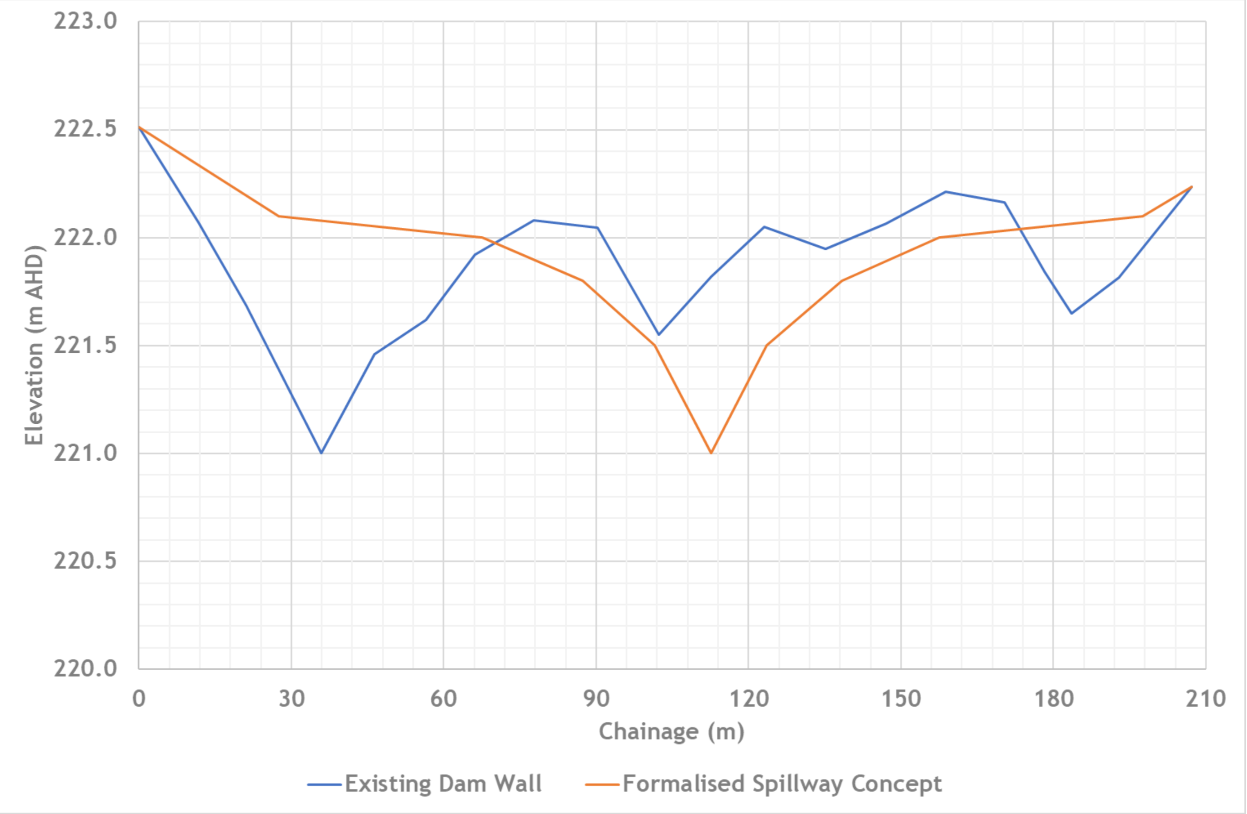

Chart 2 – Modelled Dam Spillway Concept

Flood Impact Assessment

The modelled impacts to the peak flood level are presented in Figure 12, Figure 13 and Figure 14, for the 20% AEP, 5% AEP and 1% AEP events, respectively, with corresponding peak flood velocity impacts presented in Figure 15, Figure 16 and Figure 17.

The results of the relative flood impact assessment show an improved containment of the floodplain downstream of the dam, which is a result of the modelled spillway concept. Elsewhere, the main areas of impact are:

- at the spillway from the dam
- in the vicinity of the access road crossing of the floodplain
- adjacent to the earthworks associated with Stage 5 of the proposed subdivision.

The modelled dam spillway concept results in increased velocities across and downstream of the spillway. The modelled peak flood velocities at the 1% AEP event are up to around 4.2 m/s across the spillway and around 2.0 m/s within the watercourse channel immediately downstream. Future design of a formalised dam spillway should include appropriate scour protection measures.

The access road crossing of the floodplain results in an upstream afflux of around 0.5 m (from around 215.5 m AHD to around 216.0 m AHD) at the 1% AEP event, with impacts extending to around 90 m upstream. The modelled peak flood velocities at the 1% AEP event are up to around 3.2 m/s at the culvert outlet and around 2.6 m/s within the watercourse channel immediately downstream. Future design of the culverts should include appropriate scour protection measures.

The redistribution of flows through the access road culverts, together with the reduction of floodplain width from the Stage 5 earthworks results in a minor increase in modelled peak flood levels at the northern side of the floodplain, with a corresponding reduction at the southern side. These are largely contained within the Site. At the 1% AEP event some localised off-site downstream impacts are modelled, but this does not represent a tangible adverse impact to existing properties. There is a modelled reduction in the peak 1% AEP flood level of around 0.02 m at the location of the dwelling on 5 Bottlebrush Place and a negligible increase (< 0.01 m) further downstream in the floodplain surrounding the electricity substation, which is largely above the 1% AEP floodplain.

There is an increase in the peak flood velocities within the modelled swale along the toe of the Stage 5 earthworks batter. The modelled peak flood velocities at the 1% AEP event are up to around 1.8 m/s within the swale. Future design of a formalised dam spillway should include appropriate scour protection measures.

For the purposes of assessing the potential change in rainfall-runoff from the Site, the TUFLOW hydrological model was modified to represent a 75% impervious surface composition of the proposed subdivision, consistent with the assumptions of the stormwater management report. This was done through reduction of the Manning's' 'n' roughness within the subdivision from 0.05 to 0.021. The continuing loss was reduced from 0.6 mm/h to 0.2 mm/h and the initial losses were also reduced accordingly.

The ARR 2019 ensemble storms were re-simulated for each design event, for both the critical duration and the next duration shorter than the critical. The results of this analysis found that the critical duration for flood flows at the western boundary of the Site remained the same as those of the existing flood conditions. Although the total volume of the modelled flood hydrographs increased, there was also a minor reduction in the modelled peak flows (in the order of -1%). This confirms the findings of the stormwater management report that detention is not required to mitigate flood impacts of the proposed subdivision.

Although the critical flood conditions for the downstream catchment are expected to remain consistent following subdivision of the Site, there will be many storm conditions for which local runoff from the Site is increased. It is expected that short duration rainfall events will result in increased occurrences, peak flows and the duration of local runoff from the Site discharging to the catchment watercourse. Appropriate stormwater management measures should be implemented to mitigate any impacts this might have to the downstream catchment ecology and/or geomorphology, if applicable.

Flood Risk Assessment

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.

The Flood Planning Area (FPA) is the area subject to flood planning controls and is usually defined as the area of land beneath the FPL, although this is not always the case. To define an approximate FPA extent the modelled post-development 1% AEP event peak flood level plus 0.5 m freeboard was intersected with the modelled topography. The modelled post-development peak flood depths and levels are presented in Figure 18, with the resultant FPA extent provided in Figure 19. The post-development flood hazard conditions are presented for the 1% AEP and PMF events in Figure 20 and Figure 21, respectively. The resultant post-development flood function is mapped in Figure 22, following the same method used for the existing flood conditions.

Because of the steep gradients at the Site, the FPL provides a good level of freeboard for both very rare flood events and the potential impacts of future climate change. For example, the modelled peak flood levels for the 0.2% AEP event are typically around 0.1 m higher than those of the 1% AEP. The design rainfall for the 0.2% AEP event is around 28% higher than that of the 1% AEP. For future climate change increases in design rainfall intensity, the ARR data hub provides a range of around 10-20% for the year 2090 horizon. This is less than the difference between the 0.2% AEP and 1% AEP events and so the resultant impact on flood levels will be less than 0.1 m. Therefore, no additional allowance for climate change above the FPL is warranted for the Site.

Almost the entire subdivision is outside of the FPA (i.e. above the FPL). Only subdivided lots 225 and 226 have some minor encroachment within the FPA. However, future dwellings located in these would readily be able to comply with the finished floor level requirements of the FPL. Alternatively, the lower parts of these lots could be filled as part of local regrading earthworks to remove them from the FPA extent. This would have a negligible impact to the existing flood conditions.

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. For large catchments with a relatively long period of advanced flood warning, flood evacuation is the appropriate flood emergency response. However, for small catchments with little to no available flood warning time (including the Site), on-site flood refuge is the appropriate flood emergency response.

Reference to Figure 21 shows that for the PMF event most of the proposed subdivision is outside of the high hazard (H5 and H6) flood areas, albeit for some minor encroachment within subdivided lot 110. Therefore, future residents can safely take refuge from flooding within their homes. Rising access is also readily available from within the subdivision to flood-free land above the PMF level.

The areas identified as public parks within the proposed subdivision layout are largely a low flood hazard (H1 and H2) environment at the 1% AEP event and so this does not represent a significant risk to property for assets located there. The park located adjacent to the Stage 1 and Stage 2 subdivision has the watercourse channel within the south-western corner, but this is only a minor encroachment. The park adjacent to Stage 5 should be moved further east, away from the high hazard area of the swale.

At the PMF event large areas of the parks become a high hazard (H5) flood environment. However, this is not considered a significant risk to life. Firstly, users of the parks can readily walk to the safety of adjacent high ground and secondly, the parks are unlikely to be in use during an extreme rainfall event (or indeed any flood-producing rainfall event)

The potential for an emergency access from the western boundary of the Site through to the New England Highway has been considered. However, this is not necessary as the southern part of the subdivision would only become isolated during flood events rare enough to exceed the design flood immunity of the access road. Because of the short duration of the critical flood conditions at the Site, the access road would only be overtopped for a short period of time (less than one hour).

The subdivided lots of the proposed subdivision are mostly flood-free, with some being flood-affected between the FPL and PMF levels. Therefore, as per the matrix in Table 16 of the Upper Hunter DCP, provision number 4 within the prescriptive criteria of Table 17 need to be satisfied and are addressed below.

Minimum height of building footprints, open car parking areas, driveways and new public roads = 5% AEP flood level plus mine subsidence allowance, if applicable

The public roads and subdivided lots are all outside of the 1% AEP flood extent, as presented in Figure 18.

Low flood hazard access and egress for pedestrians during a 1% AEP flood to an appropriate area of refuge located above the Flood Planning Level.

As presented in Figure 20, all private property within the proposed subdivision will be located outside of the 1% AEP flood extent. Public spaces can readily available low hazard egress to areas outside of the floodplain. The exception is the park adjacent to Stage 5, where low hazard egress could potentially be impacted by the swale. It is recommended that the park be relocated further to the east, where low hazard egress at the 1% AEP event is available.

Low flood hazard emergency vehicle road access (Ambulance, SES, RFS) during a 1% AEP flood event.

As presented in Figure 20, the proposed access road concept provides a flood-free condition at the 1% AEP event. The 1% AEP flood event was also simulated with a 50% blockage applied to the access road culverts. This increases the upstream flood levels, resulting in overtopping of the road. However, the road is overtopped by a depth of less than 0.1 m, with a low hazard (H1) classification. The access road will therefore provide the required emergency vehicle access, even with a 50% blockage of the culverts.

Risk assessment of flood hazard during a PMF flood event; including consideration of changes to flood behaviour, and location of floodways, to ensure that the consequences of the increased flood hazard are acceptable and manageable.

As presented in Figure 21, the proposed subdivision is largely flood-free at the PMF event, with the impacted lost being mostly a low hazard (H1 and H2) flood environment. Most of the proposed subdivision is outside of the high hazard (H5 and H6) flood areas, albeit for some minor encroachment within subdivided lot 110. Therefore, future residents can safely take refuge from flooding within their homes. Rising access is also readily available from within the subdivision to flood-free land above the PMF level.

As presented in Figure 22, the creation of a swale along the toe of the Stage 5 earthworks batter helps to formalise a floodway through the southern side of the floodplain within the area of dispersive flow.

Negligible flood affectation elsewhere in the floodplain for a full range of flood events up to the PMF, having regard to:

a) loss of flood storage,

b) changes in flood levels, flows and velocities upstream, downstream and adjacent to the site,

c) cumulative impact of multiple development in the vicinity.

The flood impact assessment has found the impacts of the proposed subdivision to be almost entirely contained within the Site. The locally increased flood levels upstream of the access road and adjacent to Stage 5 are accounted for within the 1% AEP flood level mapping and FPA extent within Figure 18 and Figure 19, respectively. Locally increased flood velocities are to be managed through appropriate design of the dam spillway, access road culverts and drainage swale adjacent to the Stage 5 earthworks.

At the 1% AEP event some localised off-site downstream impacts are modelled, but this does not represent a tangible adverse impact to existing properties. There is a modelled reduction in the peak 1% AEP flood level of around 0.02 m at the location of the dwelling on 5 Bottlebrush Place and a negligible increase (< 0.01 m) further downstream in the floodplain surrounding the electricity substation, which is largely above the 1% AEP floodplain.

Absolute flood impacts to depth and velocity are not typically assessed at the PMF event. However, Figure 23 presents the modelled PMF hazard classification for the existing and developed conditions. It shows that the impact of the proposed subdivision to the existing PMF conditions is minor. There is a reduced flood hazard from high to medium within Stage 5 because of the associated earthworks, with an increase from H5 to H6 along the adjacent swale. Downstream of the Site there is a minor local reduction in hazard at the southern side of the floodplain, associated with a reduction in modelled flood velocities downstream of the Stage 5 earthworks.

The potential for cumulative impacts for multiple developments in the vicinity is negligible. Because of the steep nature of the catchment, only the impact of developments cannot extend far upstream or downstream. The floodplain within the catchment is largely undeveloped, with the only currently developable areas having already been developed adjacent to the Site.

Conclusion

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed subdivision of 150 Gundy Road, Scone for the creation of Peppertree Estate.

This assessment has included development of TUFLOW models for the local catchment and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology.

Flood hazard mapping has been produced that shows that the Site is of a relatively low flood risk and is suitable for subdivision, as most of the proposed subdivision is outside of the floodplain. The risk to property from flooding is readily managed through application of the FPL requirements to future residential development. The risk to life from flooding is readily managed through seeking on-site flood refuge and access to low hazard egress to high ground. An alternative emergency access should not be required as the access road would only be overtopped for a short period of time (less than one hour) for events rarer than its design standard.

The flood impact assessment has found the impacts of the proposed subdivision to be almost entirely contained within the Site, with off-site impacts being negligible. The relevant provisions of the Upper Hunter DCP have also been satisfied. However, there are a few recommendations to improve flood risk management:

- the removal of Basin 3 from the floodplain
- formalisation of a spillway for the existing dam to better contain flood extents and reduce the risk of a dam failure
- creation of a drainage swale along the toe of the Stage 5 earthworks batter
- the relocation of the park adjacent to Stage 5 further to the east.

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

0 300 600 m

approx. scale

Figure:	1
Revision:	A

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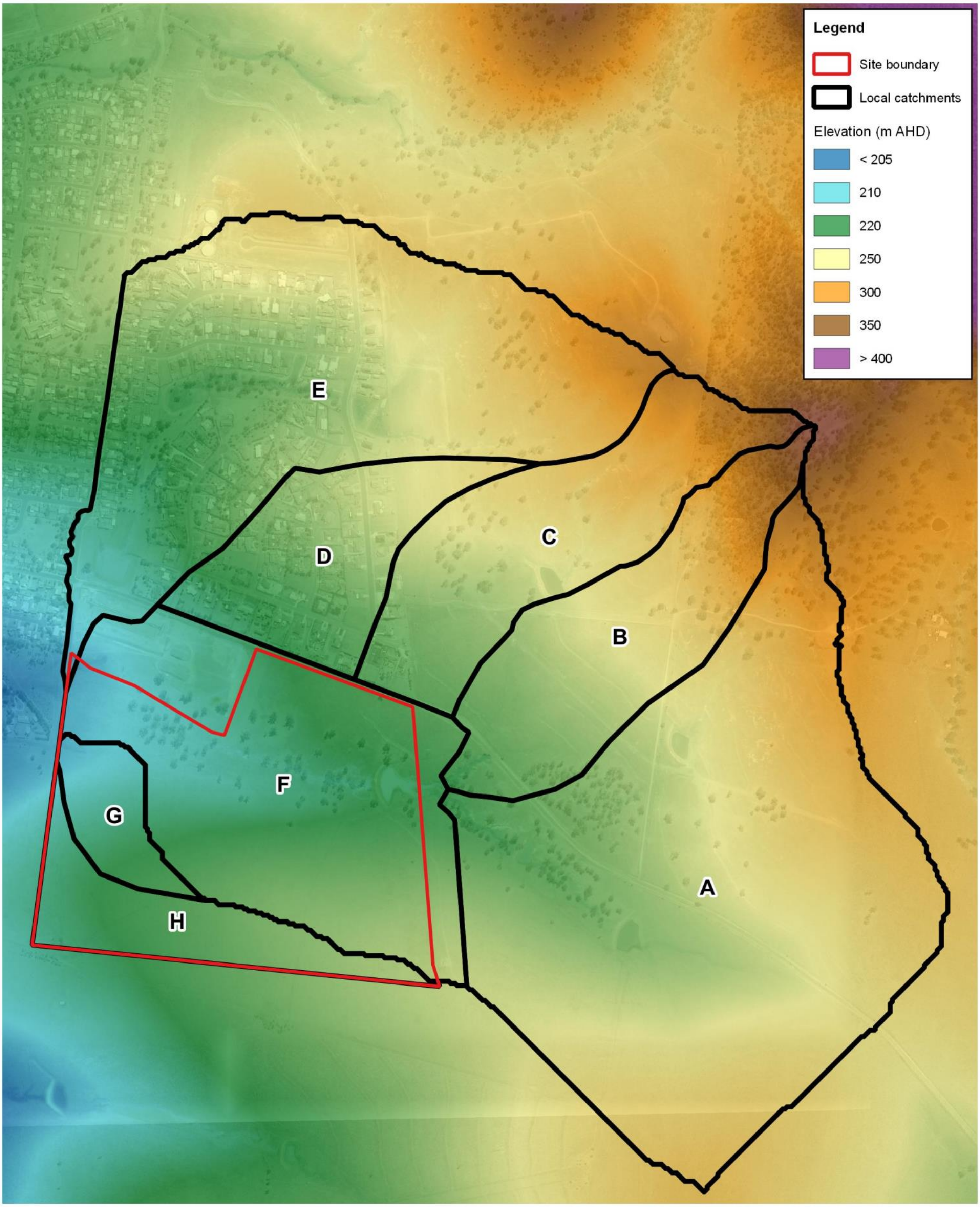

Title:

Local Catchment Topography

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

TUFLOW Model Configuration

0 200 400 m

approx. scale

Figure: 3

Revision: A

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Title:

Design Flood Extents

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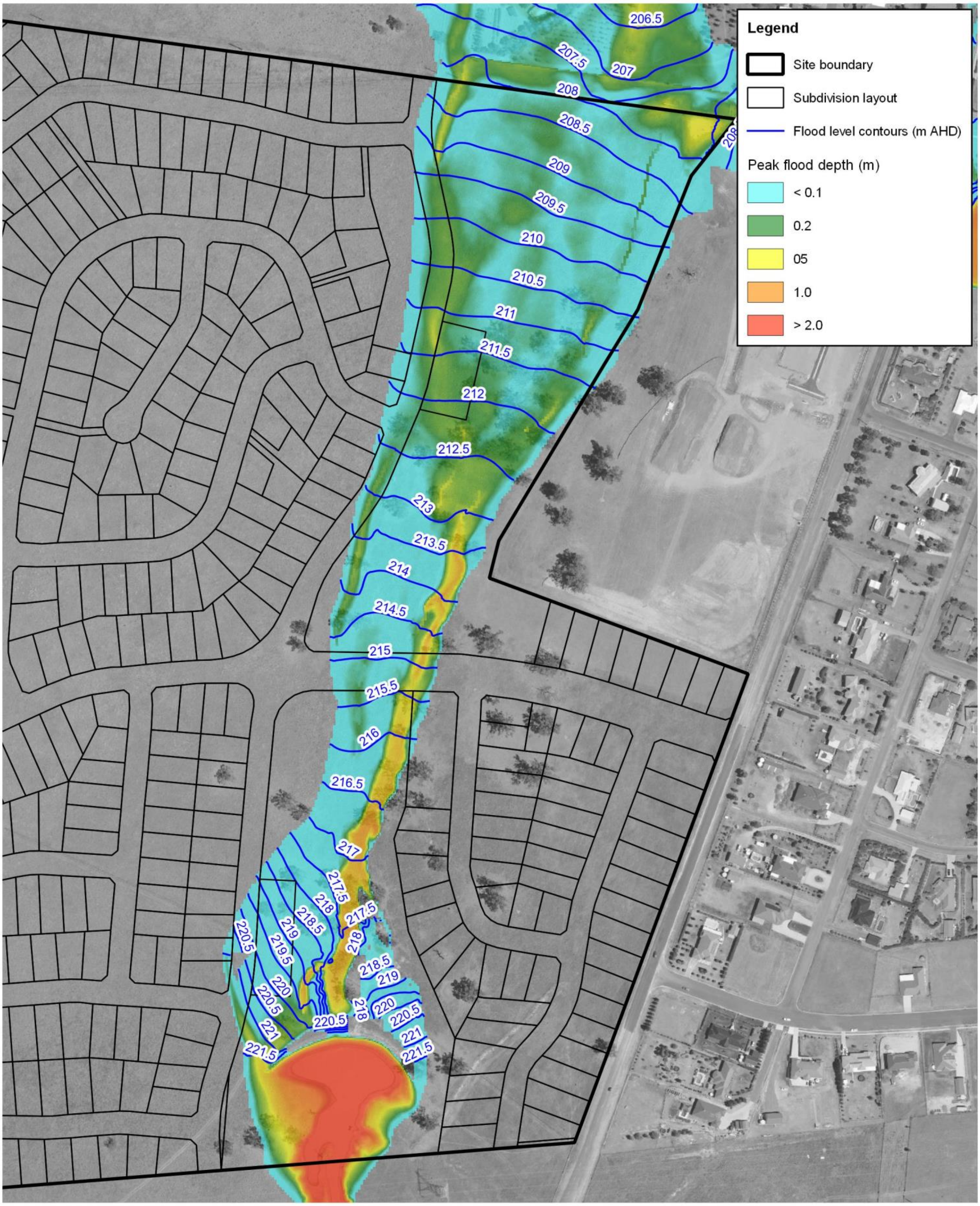

Title:

5% AEP Peak Flood Depths and Levels

0 100 200 m

approx. scale

Figure: 5

Revision: A

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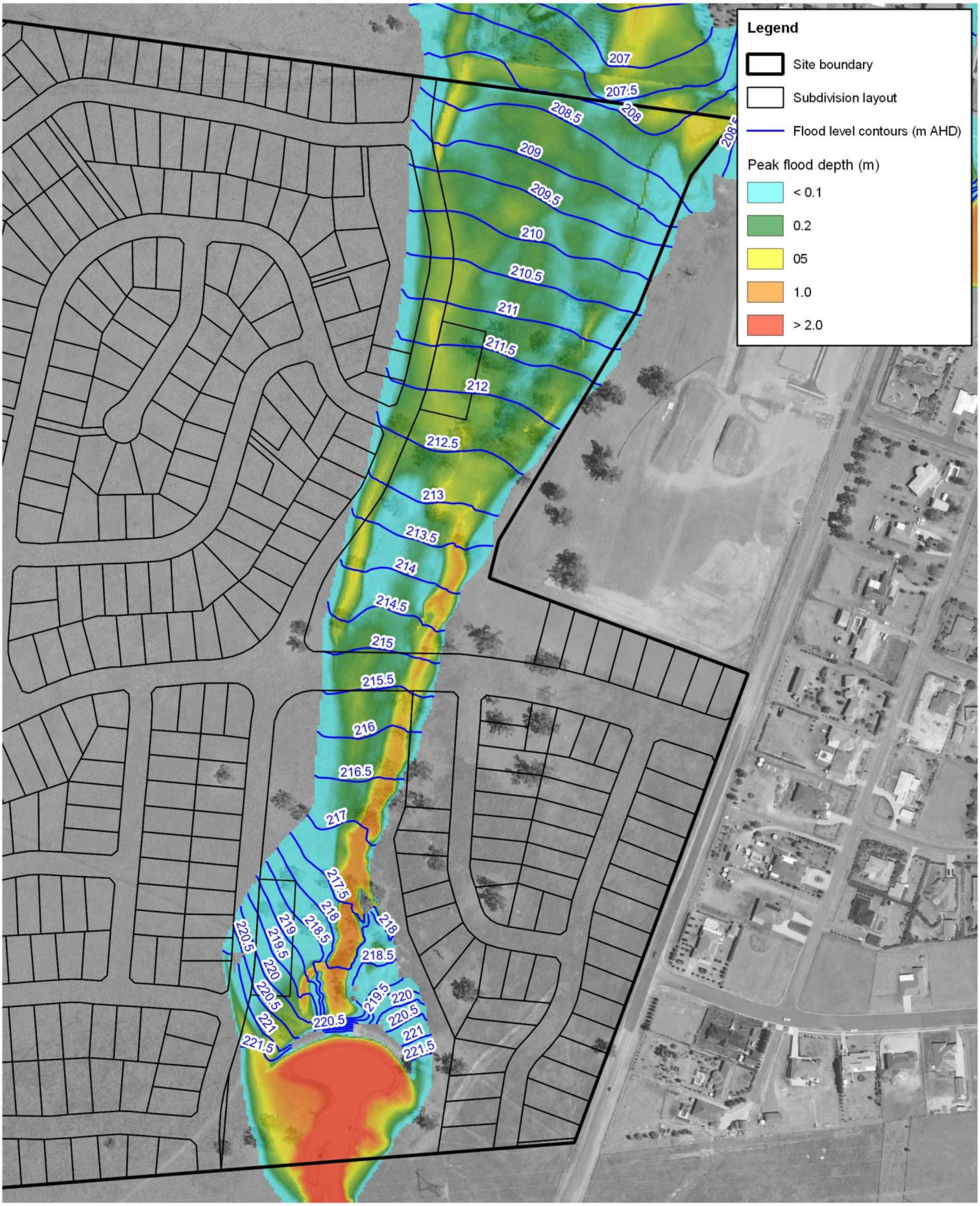

Title:

1% AEP Peak Flood Depths and Levels

0 100 200 m

approx. scale

Figure: 6

Revision: A

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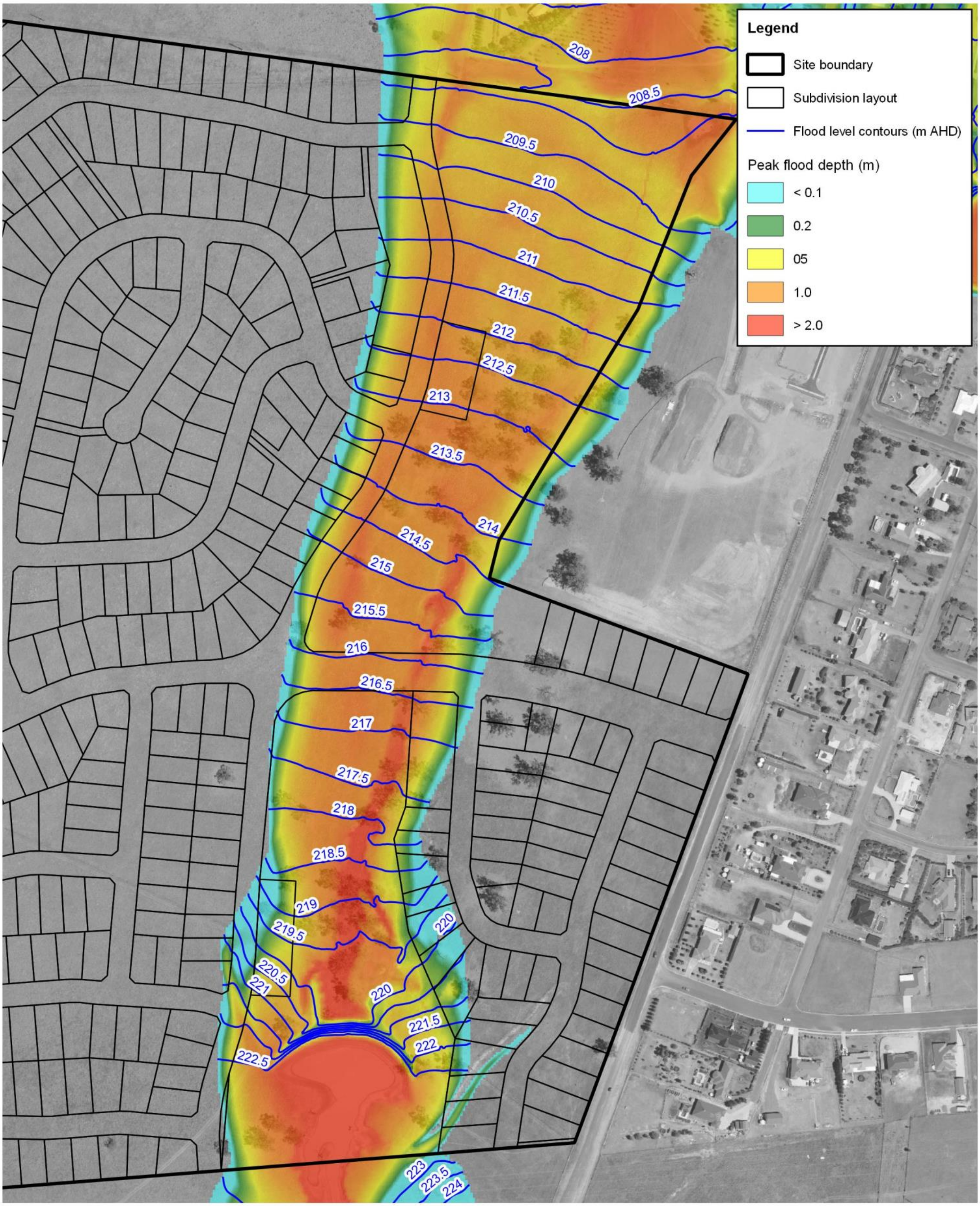

Title:

PMF Peak Flood Depths and Levels

0 100 200 m

approx. scale

Figure: 7

Revision: A

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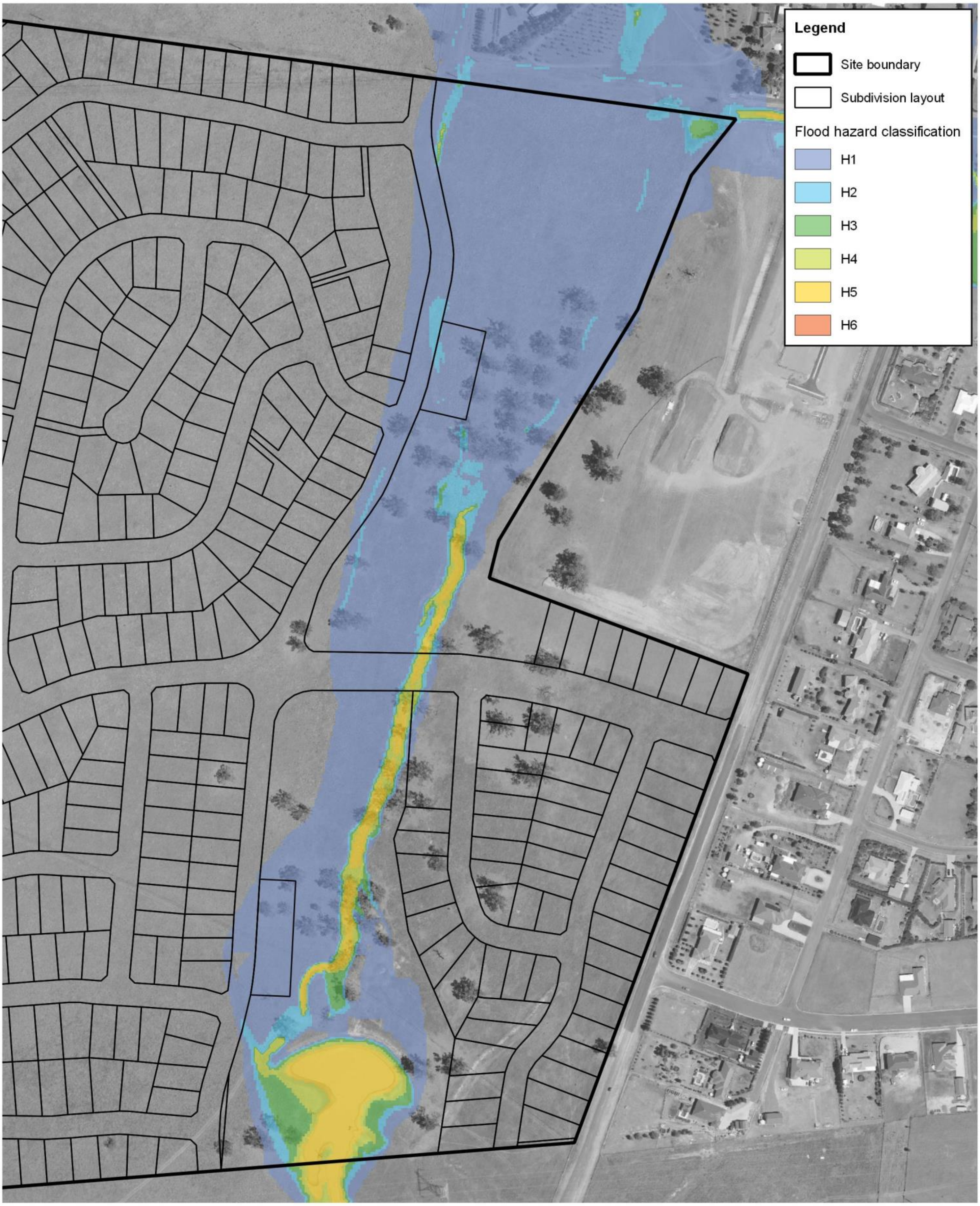

Title:

5% AEP Flood Hazard Classification

0 100 200 m

approx. scale

Figure: 8

Revision: A

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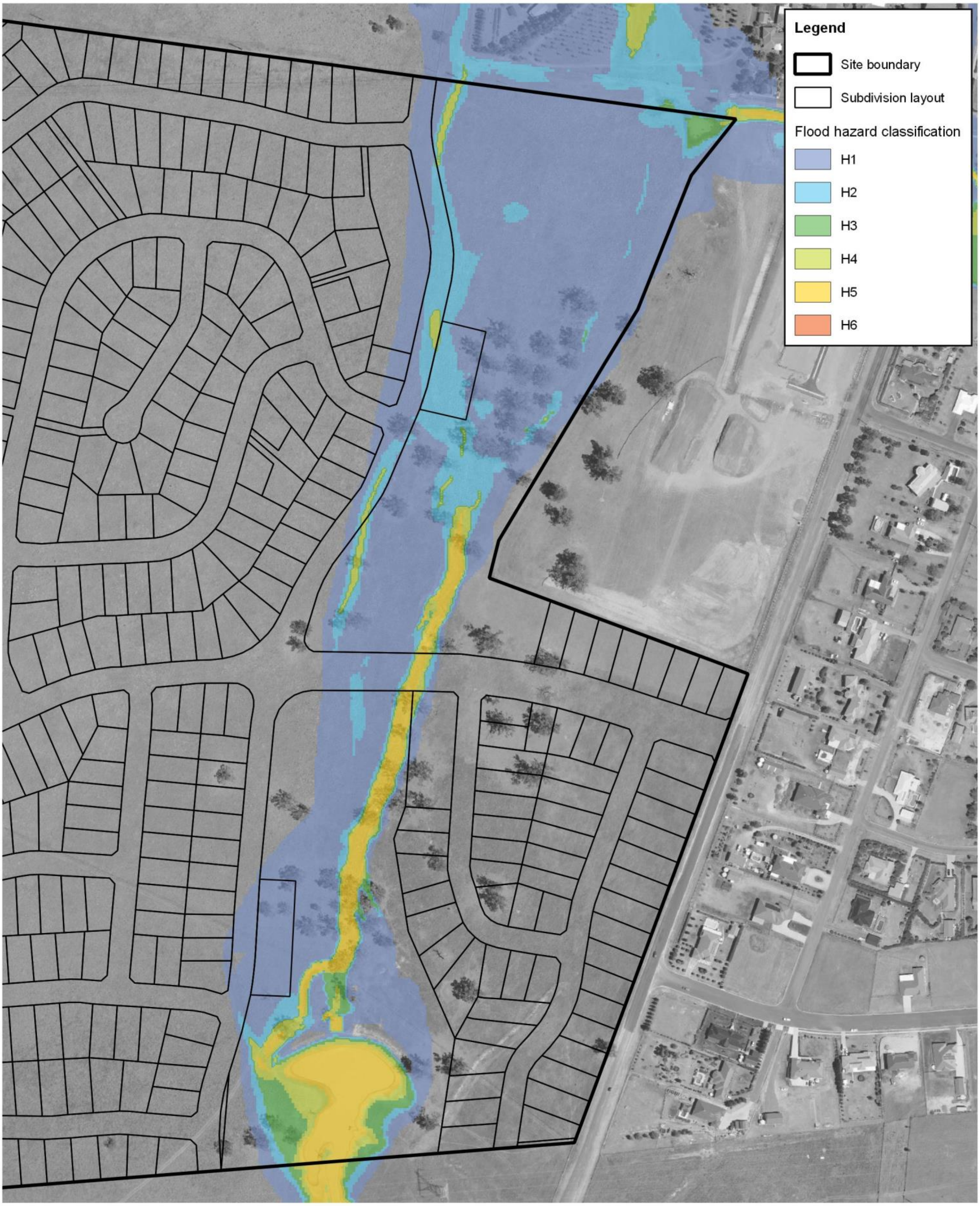

Title:

1% AEP Flood Hazard Classification

0 100 200 m

approx. scale

Figure: 9

Revision: A

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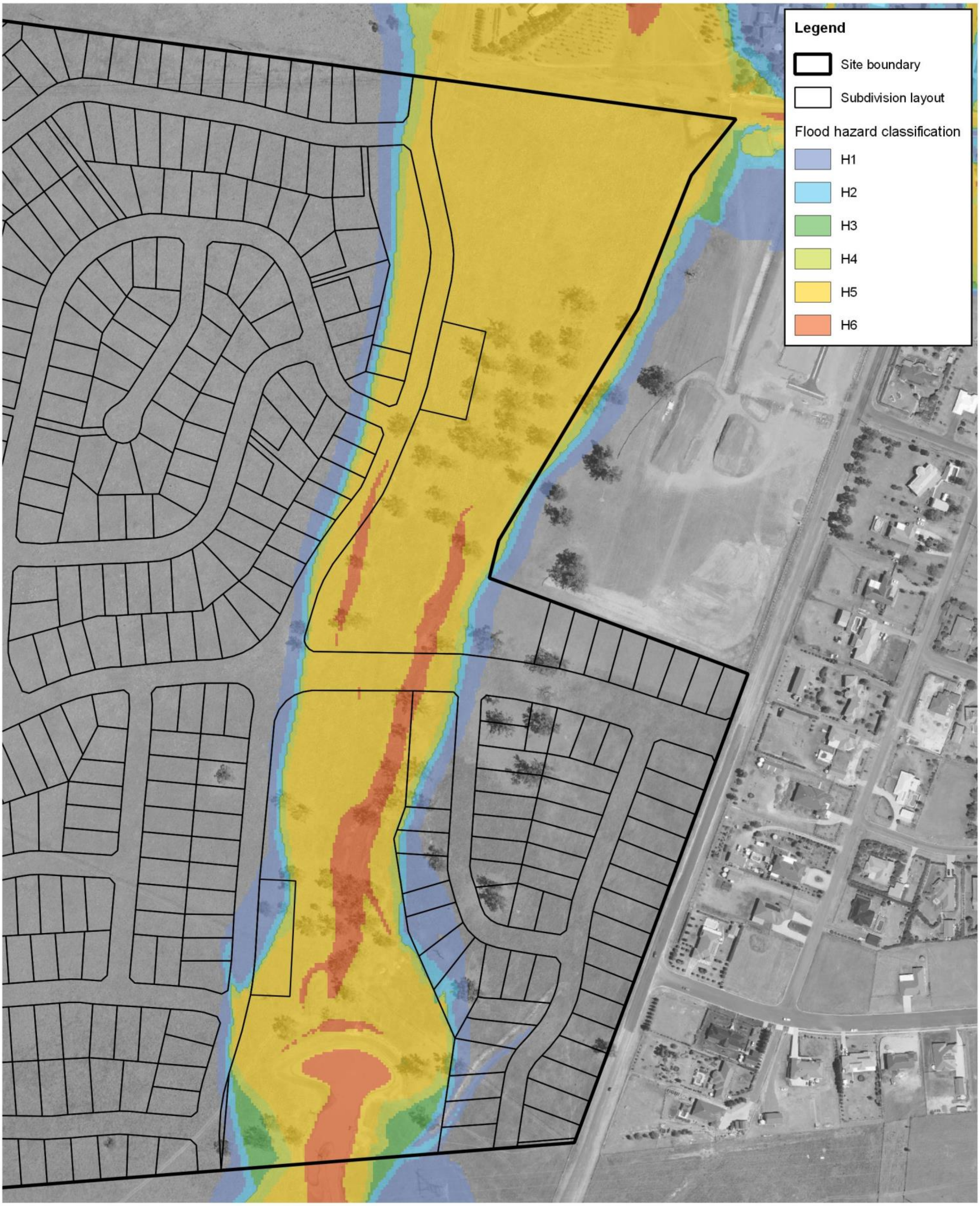

Title:

PMF Flood Hazard Classification

0 100 200 m

approx. scale

Figure:	10
Revision:	A

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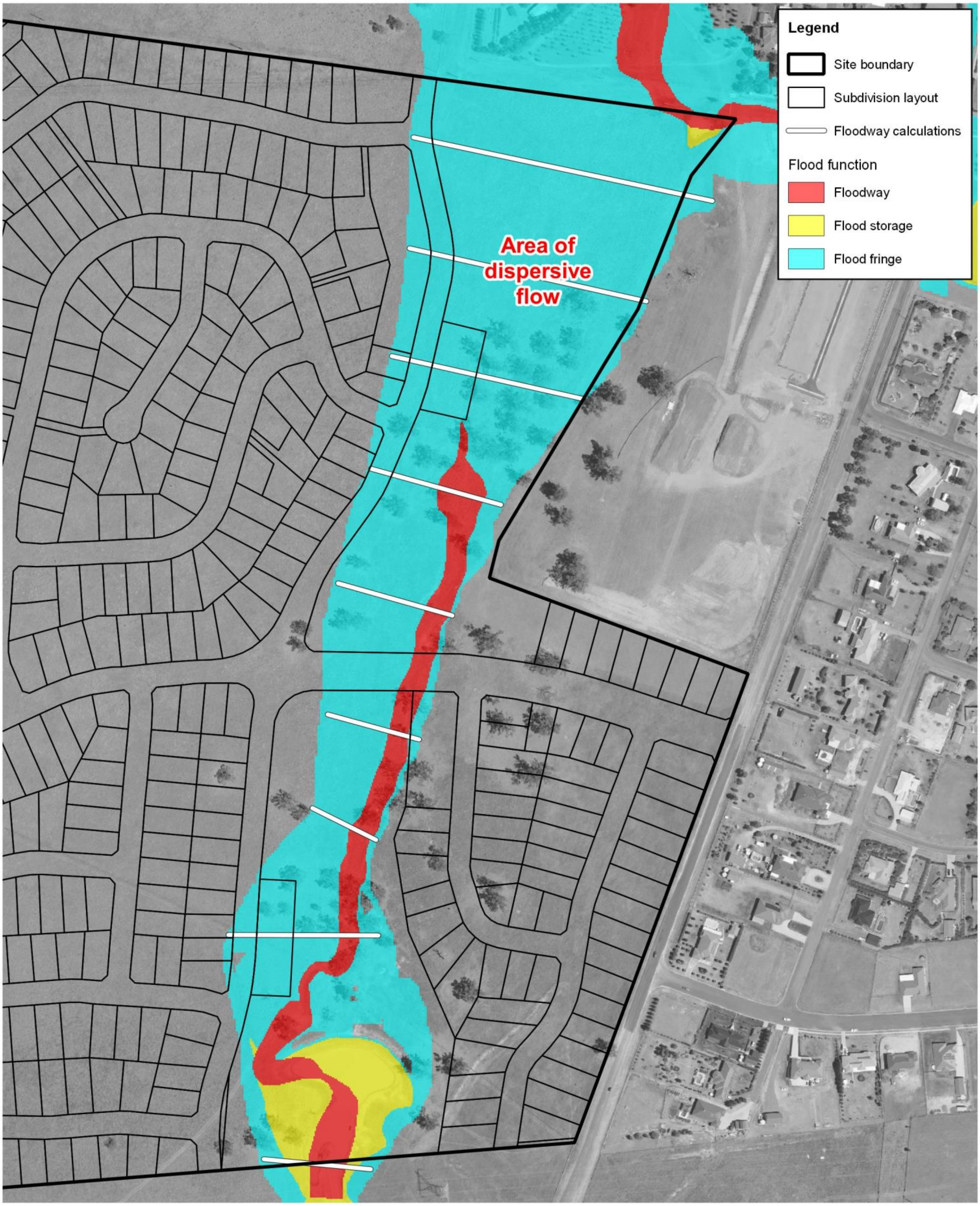

Title:

1% AEP Flood Function

Figure: 11

Revision: A

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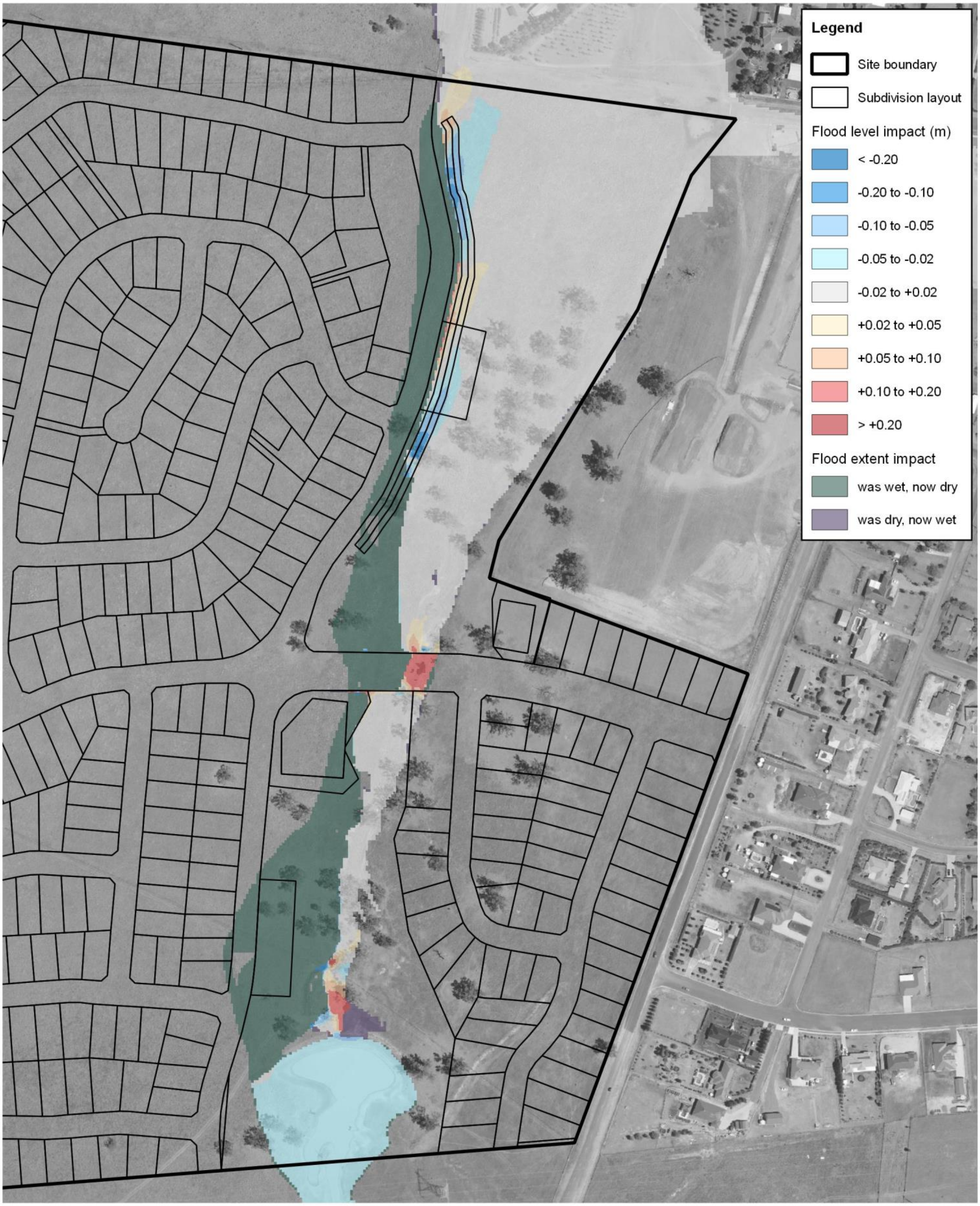

Title:

20% AEP Modelled Peak Flood Level Impact

0 100 200 m

approx. scale

Figure: **12**

Revision: **A**

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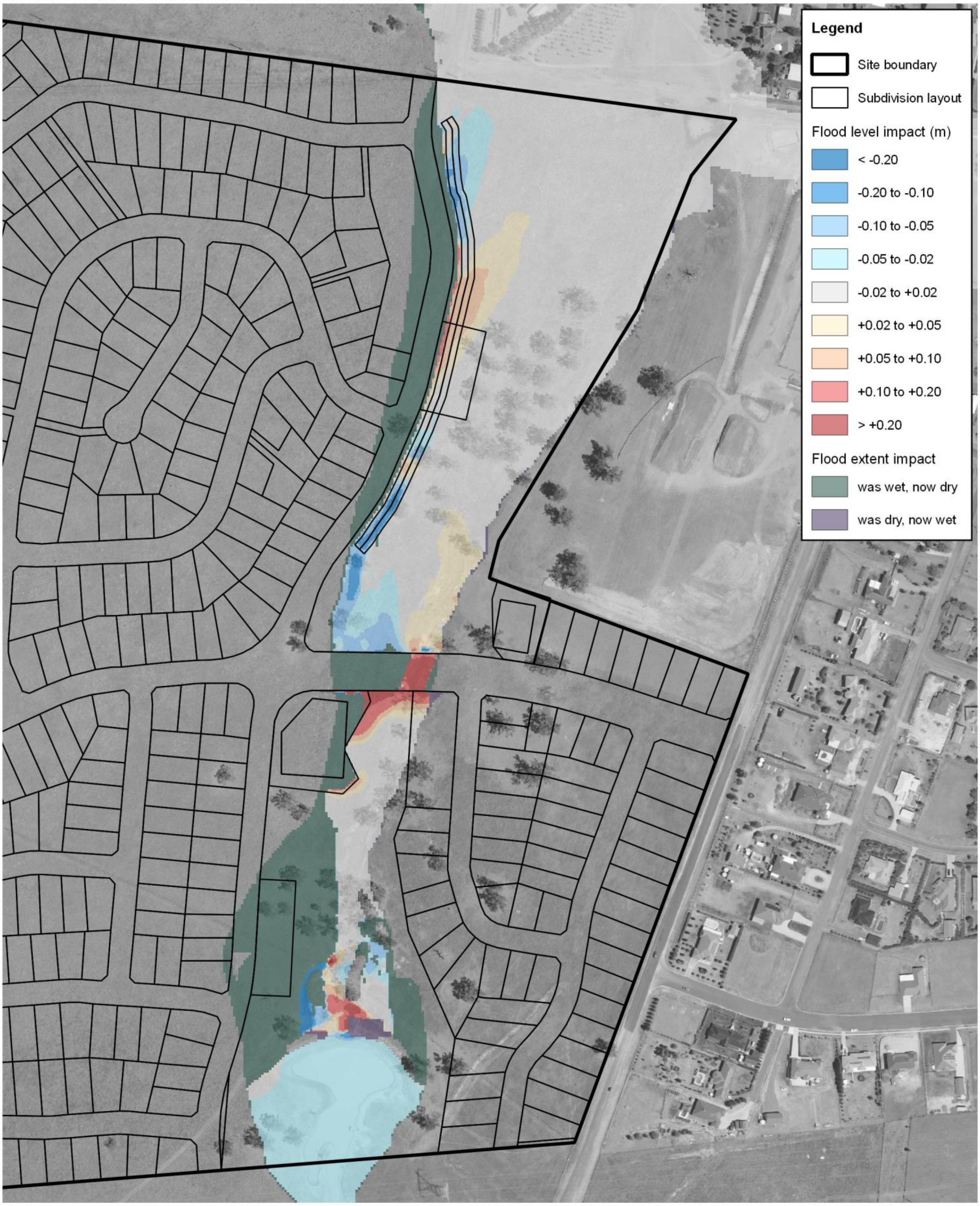

Title:

5% AEP Modelled Peak Flood Level Impact

Figure: 13

Revision: A

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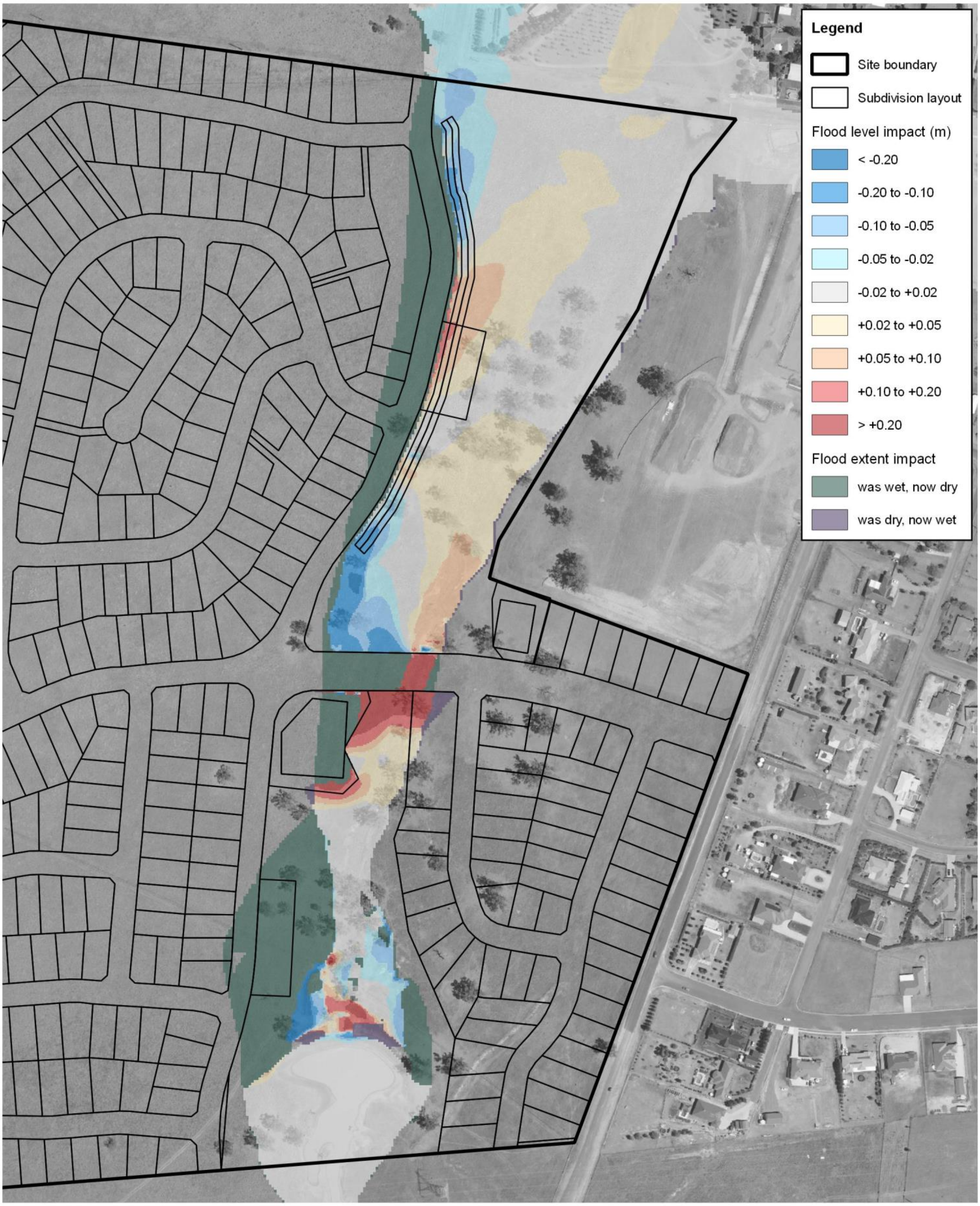

Title:

1% AEP Modelled Peak Flood Level Impact

Figure: 14

Revision: A

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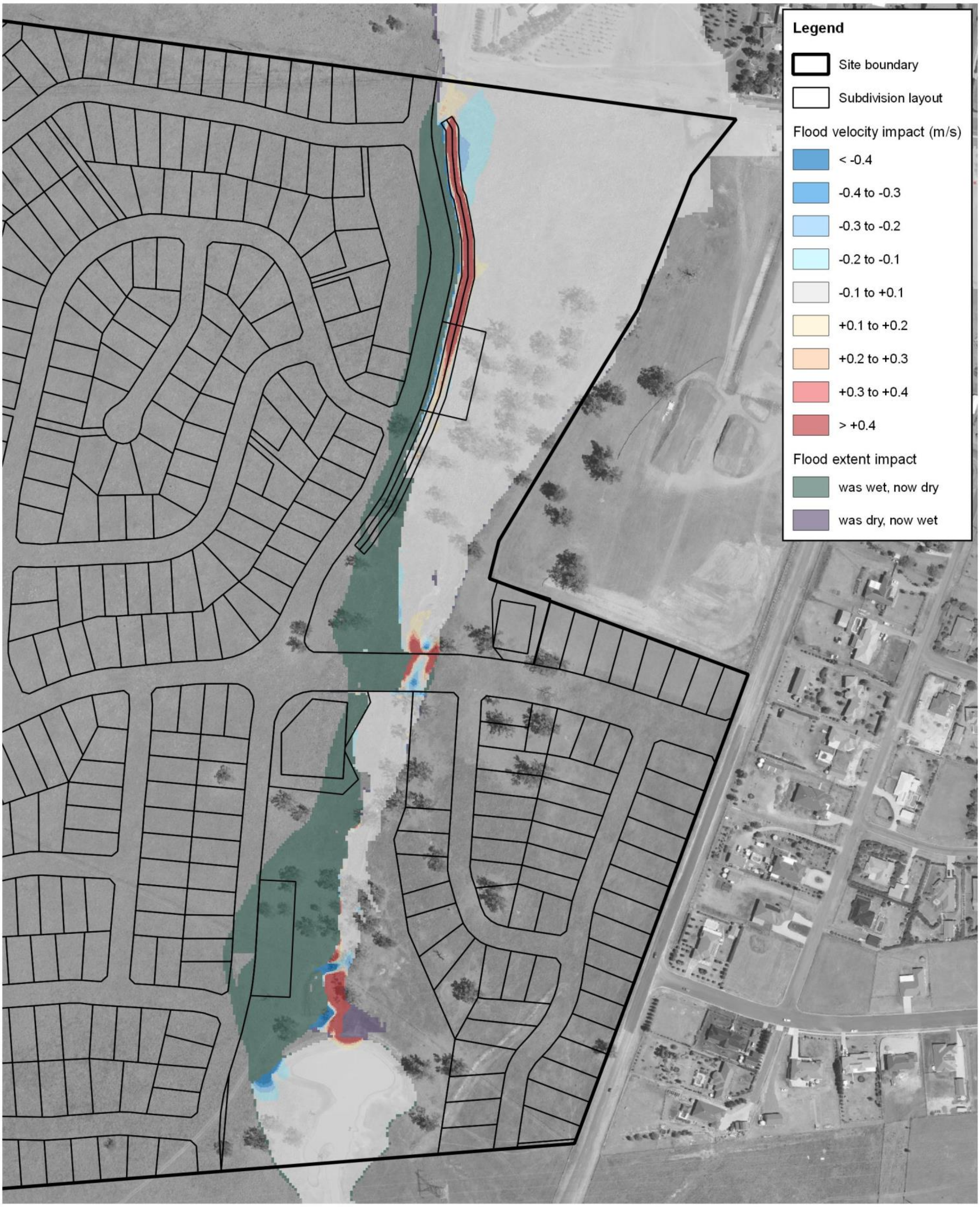

Title:

20% AEP Modelled Peak Flood Velocity Impact

0 100 200 m

approx. scale

Figure: 15

Revision: A

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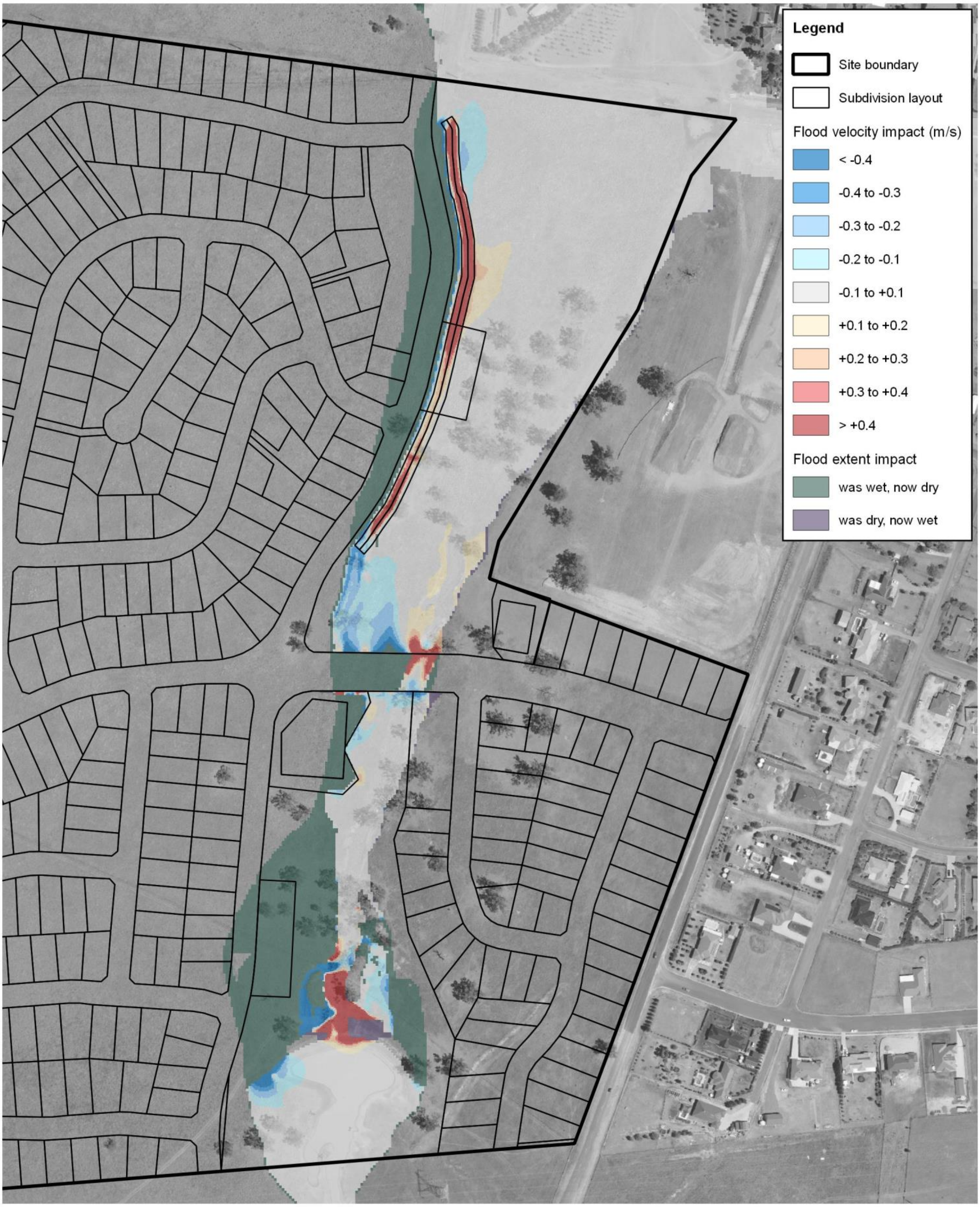

Title:

5% AEP Modelled Peak Flood Velocity Impact

0 100 200 m

approx. scale

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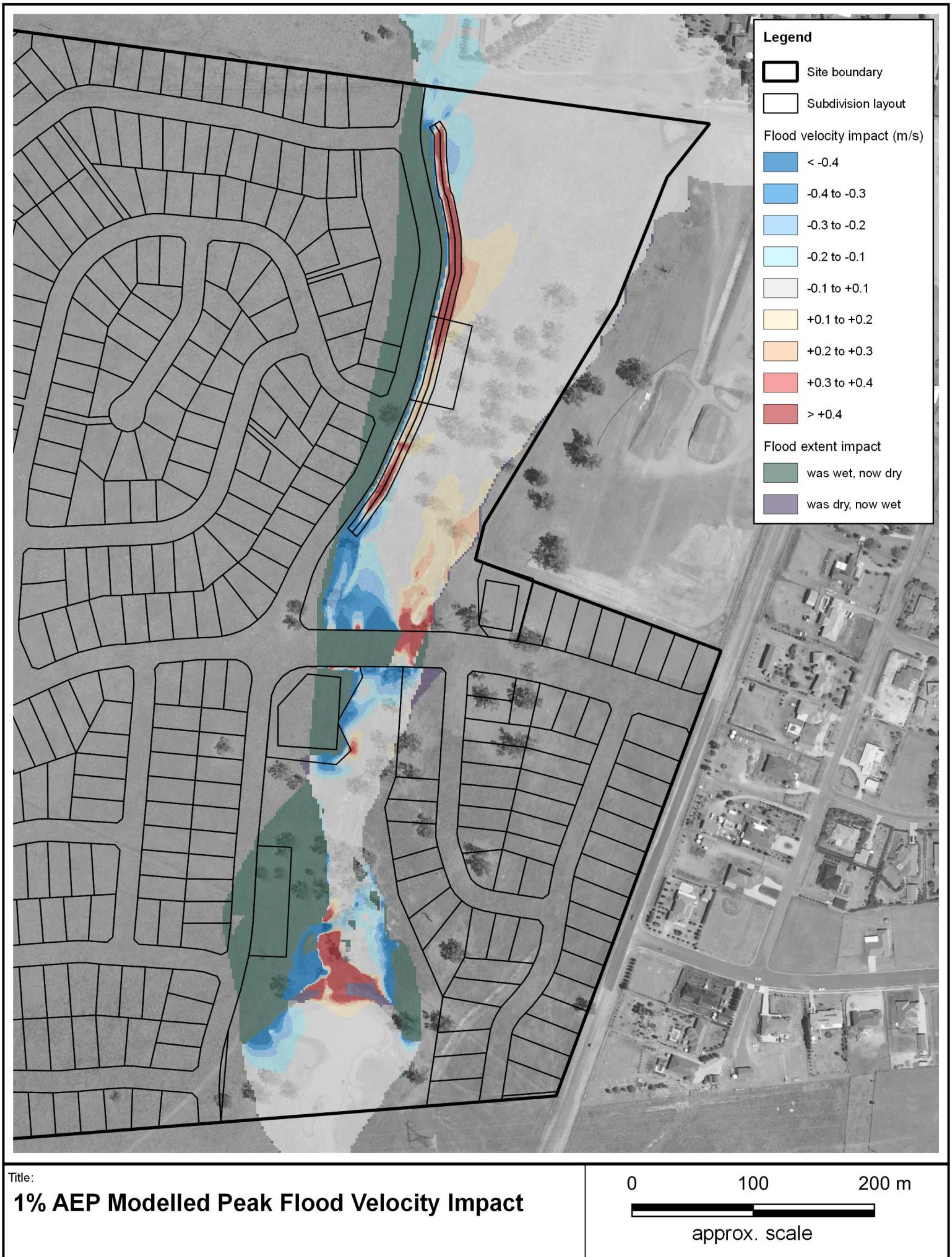

Title:

1% AEP Modelled Peak Flood Velocity Impact

Figure: 17

Revision: A

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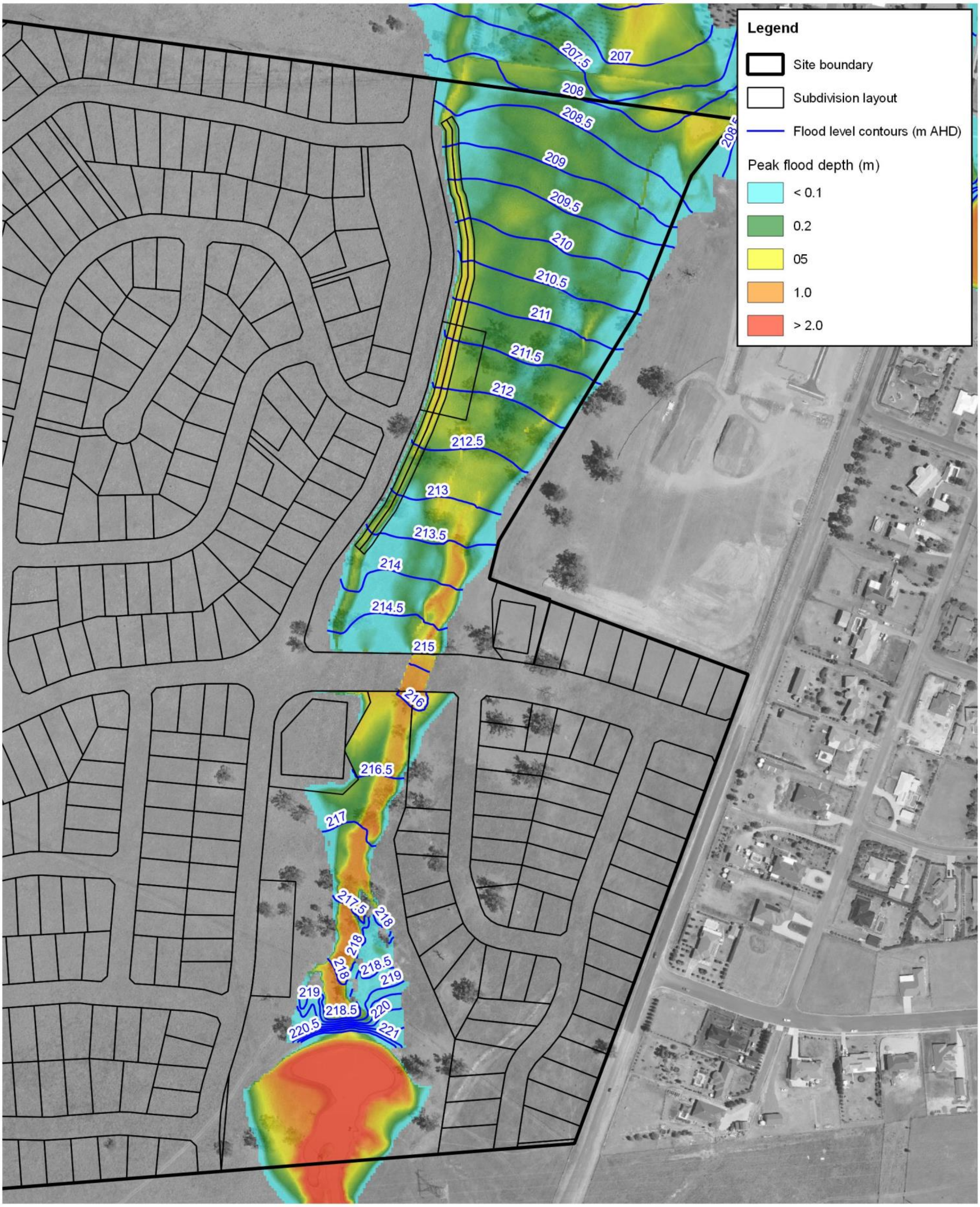

Title:

1% AEP Peak Flood Depths and Levels Post-development Conditions

0 100 200 m

approx. scale

Figure: 18

Revision: A

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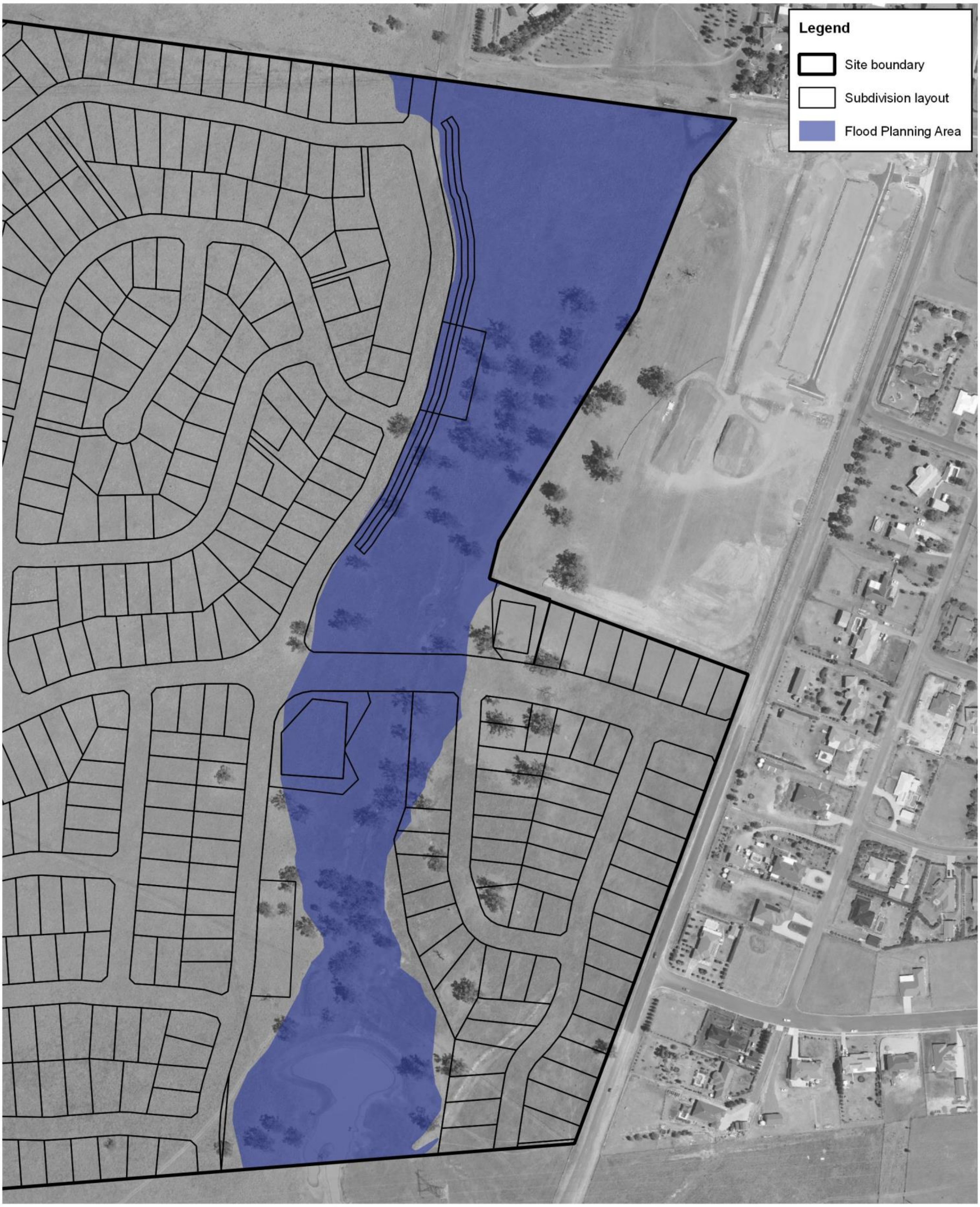

Title:

Flood Planning Area
Post-development Conditions

0 100 200 m

approx. scale

Figure: 19

Revision: A

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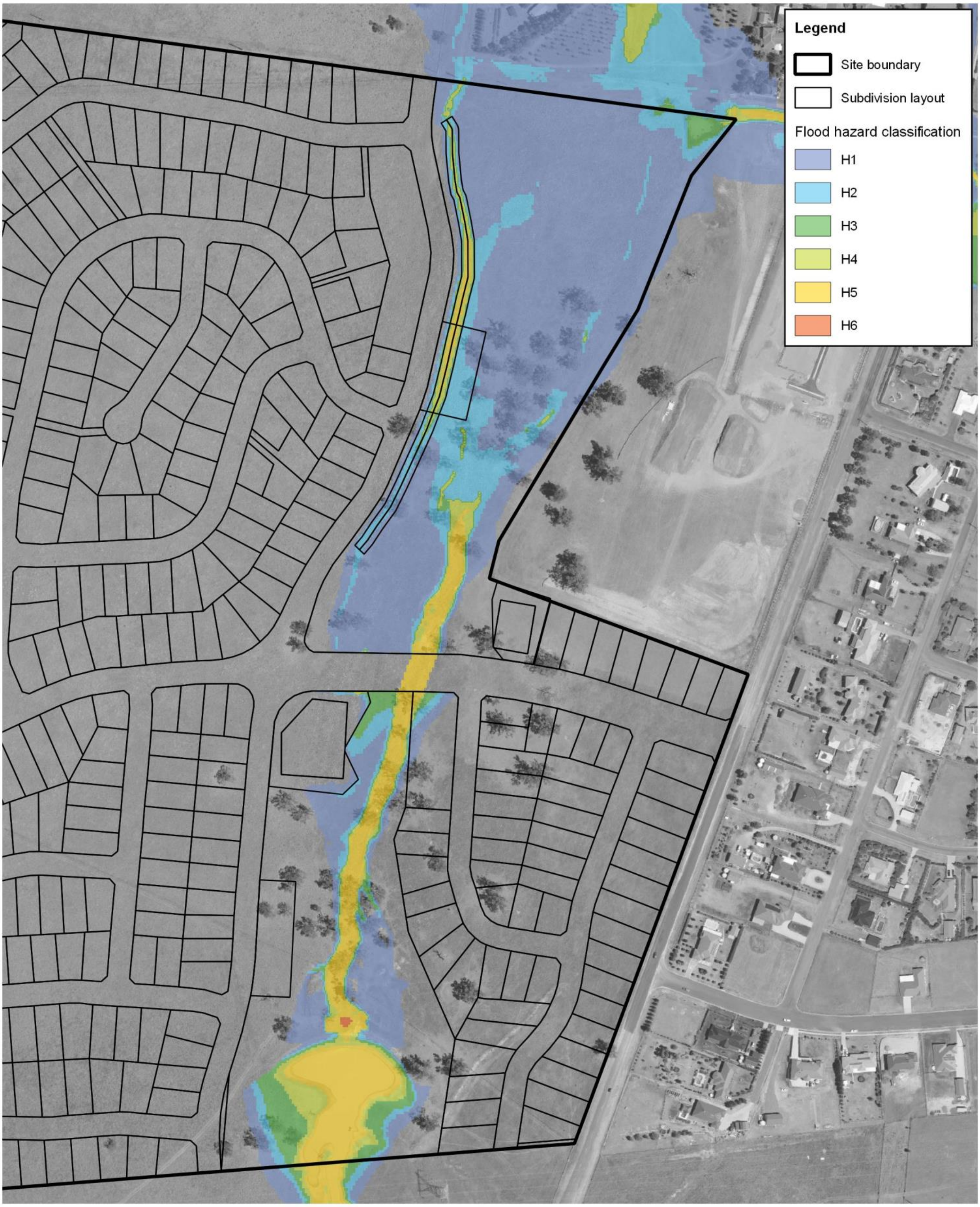

Title:

1% AEP Flood Hazard Classification Post-development Conditions

Figure: 20

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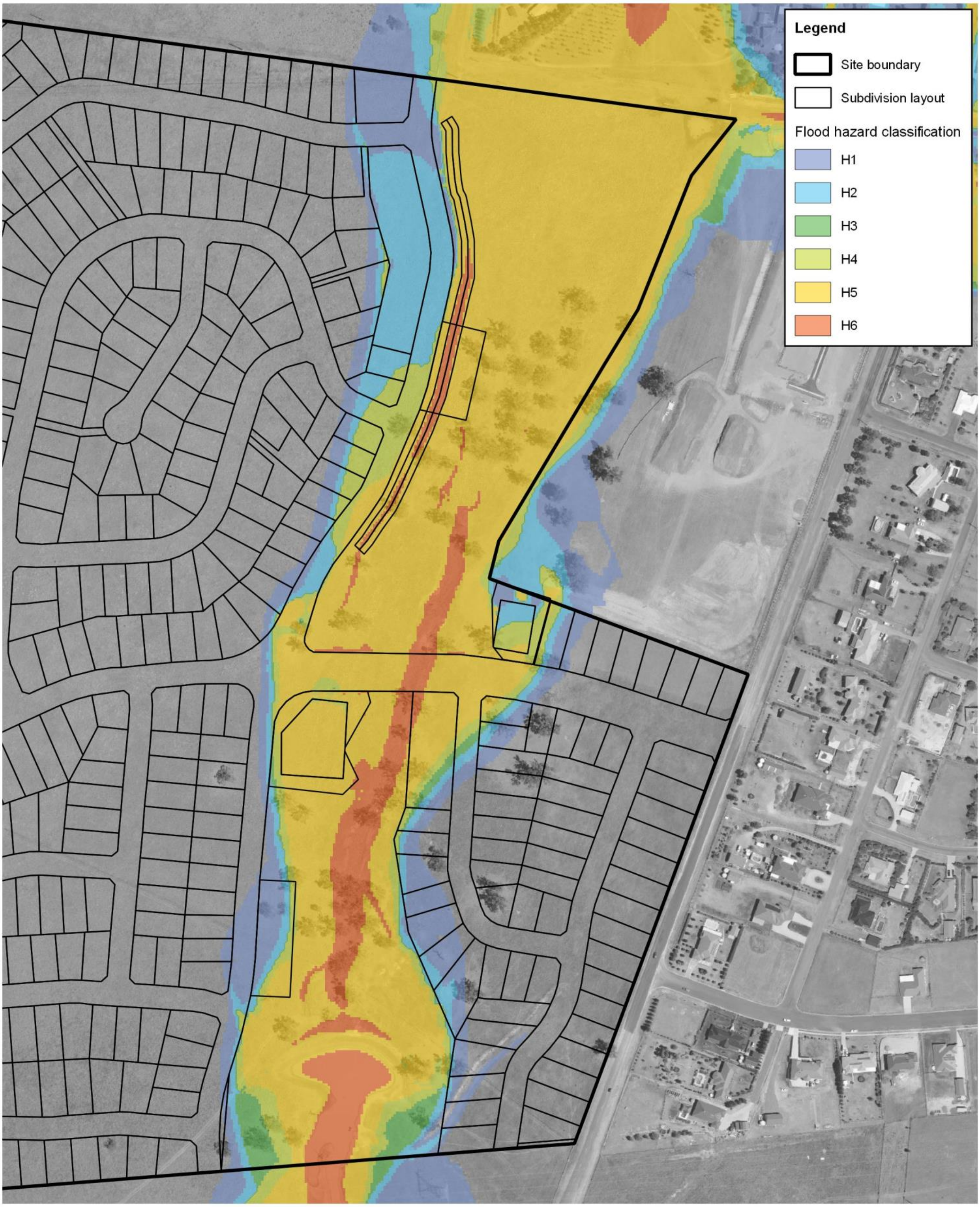

Title:

PMF Flood Hazard Classification
Post-development Conditions

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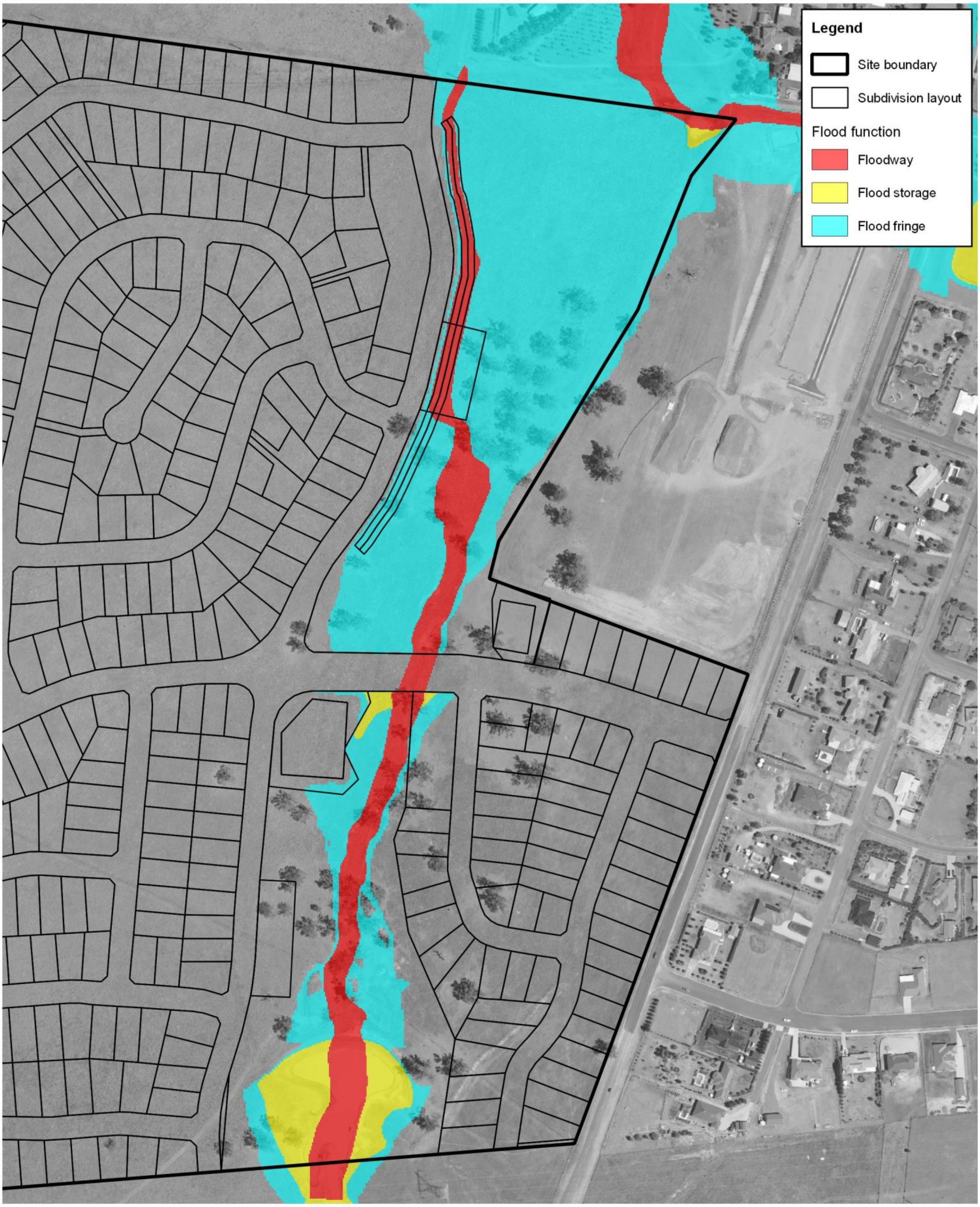

Title:

1% AEP Flood Function
Post-development Conditions

0 100 200 m

approx. scale

Figure: 22

Revision: A

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