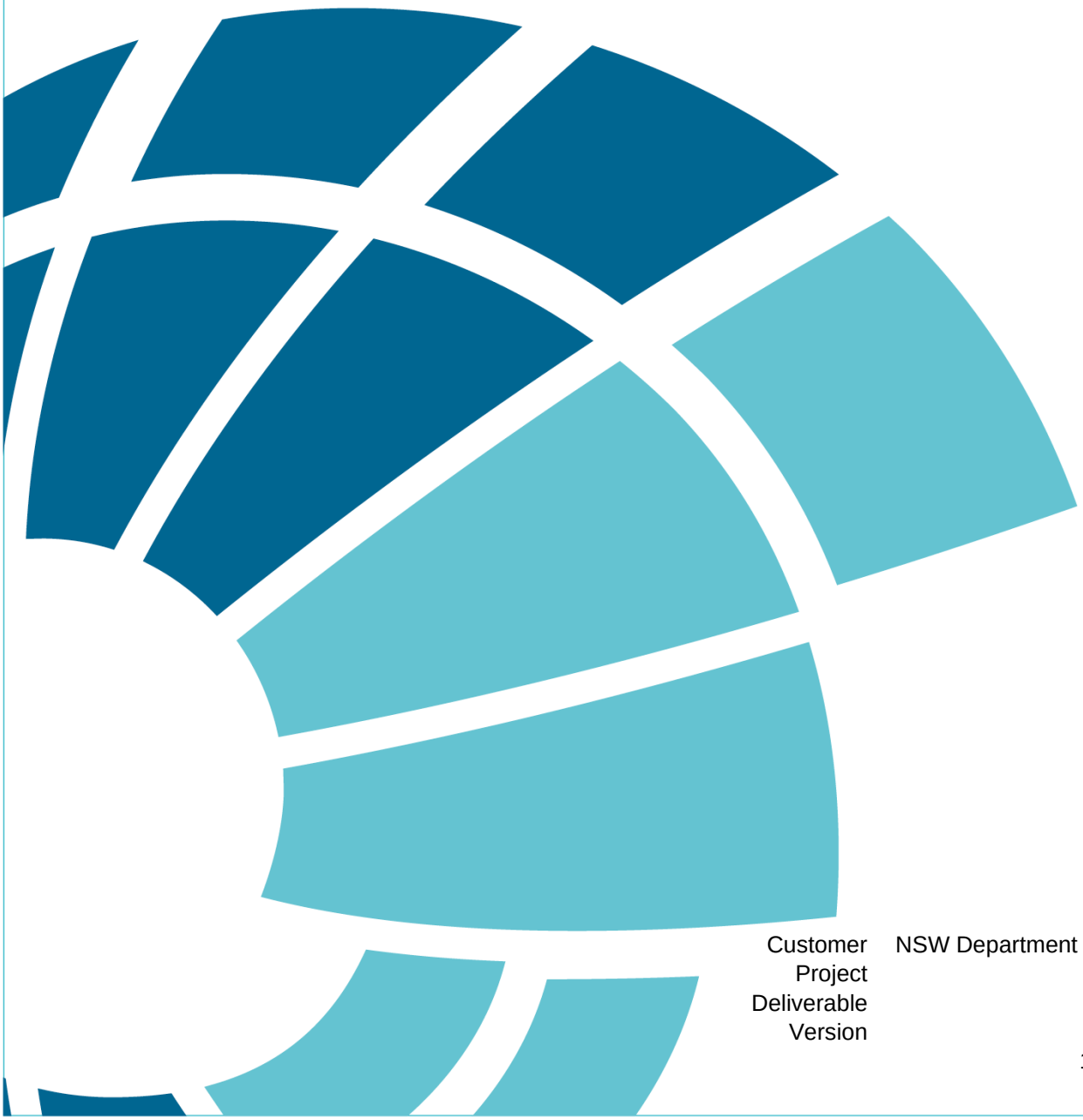
Flood Impact and Risk Assessment - Lennox Head Public School



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1 Introduction

1.1 Project Description

This Flood Impact and Risk Assessment has been prepared by BMT on behalf of the NSW Department of Education (the Applicant) to assess the potential environmental impacts that could arise from the new school development at Montwood Drive, Lennox Head; Lot 5 DP1239938 (the Site). This report has been prepared to identify and address the existing flood risk at the Site and the potential for flood impacts associated with the proposed works.

This report accompanies a Review of Environmental Factors (REF) that seeks approval for the construction and operation of a new primary school at the site, which involves the following works:

- Construction of a new school building, including learning hubs and an administration and library building.
- Construction of a multi-purpose hall.
- Construction and operation of a preschool.
- Construction of car parking, waste storage and loading area.
- Associated site landscaping and open space improvements.
- Associated off-site infrastructure works to support the school, including (but not limited) services, driveways and pedestrian crossings.

For a detailed project description, refer to the Review of Environmental Factors (REF) prepared by EPM Projects.

1.2 Site Description

The Site is located on the corner of Montwood Drive and Snapper Drive with a 170m road frontage to Montwood Drive (western boundary) and 260m road frontage to Snapper Drive (northern boundary). The Site comprises a single allotment, legally described as Lot 5 in deposited plan (DP) 1239938 with an approximate site area of 4.17ha. The Site is approximately 2.5km north of Ballina Airport and 4.5km north of Ballina town centre.

Figure 1.1 Aerial of the Site (NSW Planning Portal Spatial Viewer)

2 Flood Impact and Risk Assessment Overview

The following tasks were completed as part of this flood impact and risk assessment:

- Review of available topographic and flood information for the Site;
- Review of relevant Council flood studies, flood-related planning policies, and flood advice for the Site;
- Identification of on-site flood risk for design flood events, including the 10% AEP, 5% AEP, 1% AEP, 0.2% AEP, the Probable Maximum Flood (PMF), and a climate change scenario (increased rainfall intensity);
- Flood impact assessment comparing post-activity flood behaviour with existing flood conditions across all events.

It is noted that the works completed are not inclusive of a Stormwater Management Plan for the Site.

2.1 Site Description and Topography

The new Public School will be located on a 4.17halot of land bound by Snapper Drive to the north and Montwood Drive to the west, in Lennox Head, NSW 2478. The layout of the new proposed Public School can be found in Figure 2.1.

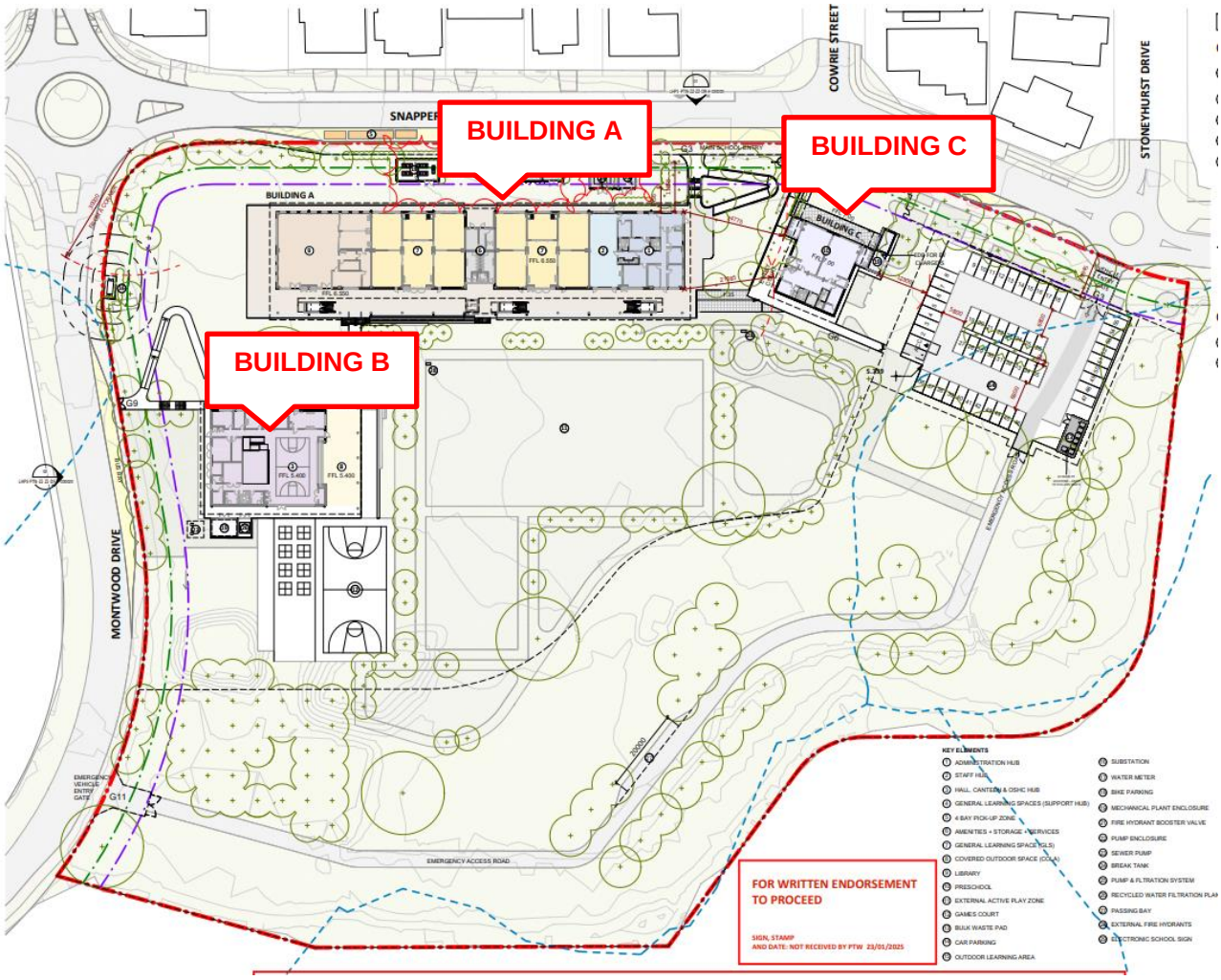
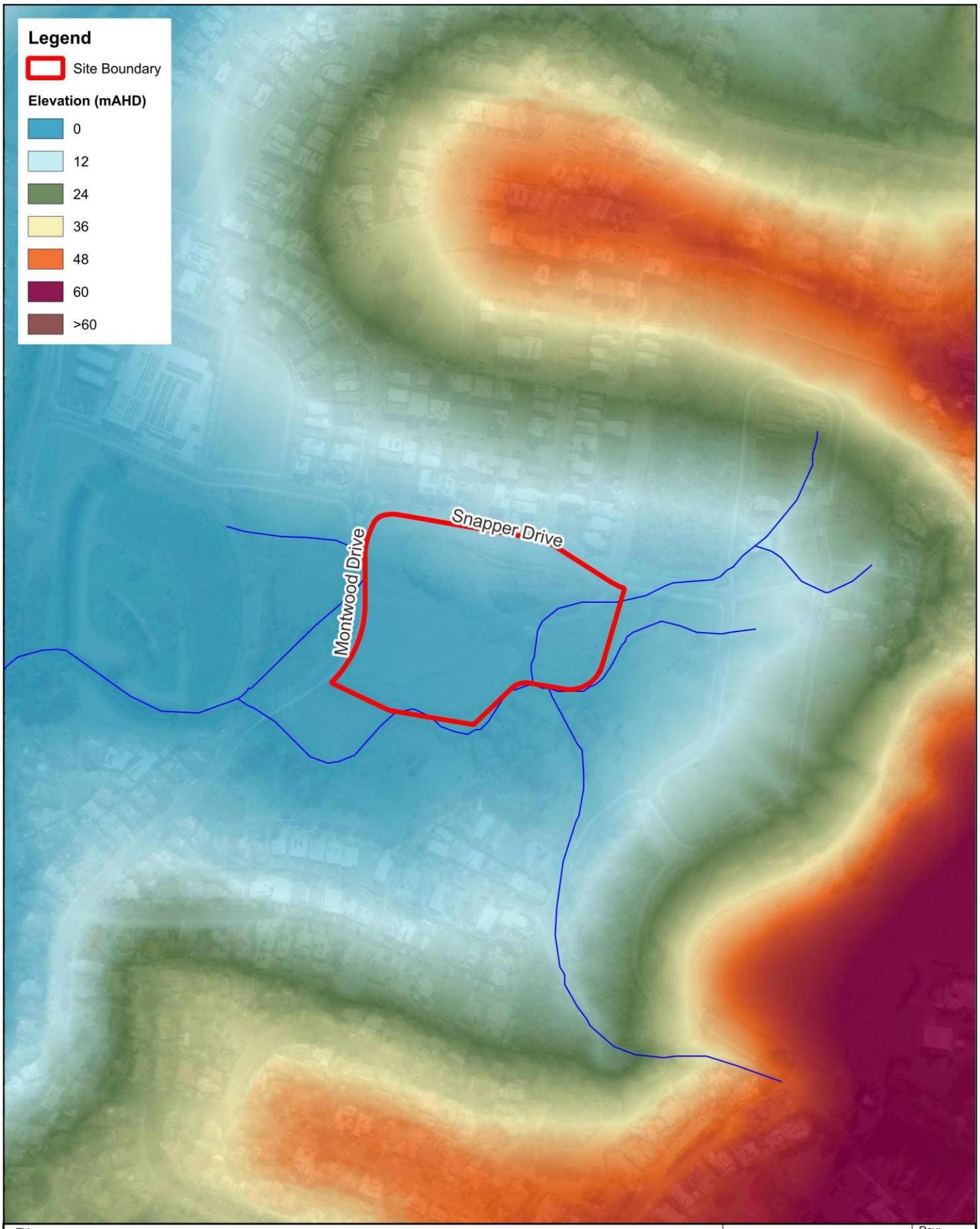


Figure 2.1 Ground Floor Site Plan (PTW Architects, 2025)

REFERENCE: Drawing Number LHPS-PTW-ZZ-GF-DR-A-020001 Rev 06

The Site is predominately undeveloped with mixed vegetation and is currently zoned R3 Medium Density Residential, under the Ballina Shire Council Local Environmental Plan (LEP) 2012. On-site elevations range from approximately 1.5m AHD at the south-western site boundary to above 8.8m AHD along the northern site boundary.

The Site forms part of the North Creek catchment. A tributary of North Creek runs along the Site's southern boundary from east to west. Rainfall-runoff generated from the upstream catchment and on-site is primarily directed overland towards the tributary, which discharges south-west into North Creek, ultimately draining south into the Richmond River prior to discharging into the Pacific Ocean. The extent and topography of the Site is shown in Figure 2.2.



Title:

Site Elevations

Figure: 2.2

Rev: A

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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2.2 Flood Mechanism and Existing Studies

Flooding at the Site is influenced by its position within the North Creek catchment, a major tributary of the Richmond River, and by its topography. An assessment of the existing flood risk at and in the vicinity of the Site is discussed in the following sections and was informed by:

- A desktop assessment of regional flood characteristics from the Ballina Flood Study Update (BMT, In Draft 2024), herein sometimes referred to as the Draft 2024 Ballina Flood Study; and
- A local overland flood model for the catchment draining through the Site into North Creek which has been developed as part of this assessment.

It is noted that the time of project inception and model development, the Ballina Flood Study Update had not been published by Ballina Shire Council. Information from Ballina Shire Council's previous studies, namely:

- Ballina Flood Study Update (BMT WBM, 2008),
- Ballina Floodplain Risk Management Study (BMT WBM, Bewsher, Grech Planners, 2012), and
- Ballina Floodplain Risk Management Plan (BMT WBM, 2015)

have been utilised in the development of the overland flood model. Herein these studies are sometimes collectively referred to as the 2008 Ballina Flood Study.

3 Existing Flood Conditions

3.1 Existing Regional (Mainstream) Flood Conditions

The results of the Draft 2024 Ballina Flood Study indicate that the southern portion of the Site will be affected by backwatering from North Creek from at least the 1 in 20 AEP (5% AEP) event, scaling with event rarity up to the PMF. Peak regional flood levels at the Site are summarised in Table 3.1 below.

Table 3.1 Peak Flood Level at Site predicted by Existing Study

Flood Event	Peak Flood Level (m AHD)
1 in 20 (5% AEP)	2.2
1 in 100 (1%) AEP	2.5
1 in 500 (0.2%) AEP	2.6
PMF	5.4

Modelling of the proposed development (see Section 4) against regional flood conditions has not been undertaken as part of this assessment. It is noted that the proposed development works are not expected to intersect with the predicted regional flood extent for any event up to and including the 1 in 500 AEP event under existing or future climate change conditions and that therefore the works would have a minimal impact on backwater flood conditions.

The PMF extent in the vicinity of the Site has been extracted from the Draft 2024 Ballina Flood Study and is shown in Figure 3.1. As shown in the figure, the regional flooding extent will inundate the majority of the Site to the south and cause complete inundation of Montwood Drive. However, the northern portion of the Site and Snapper Drive are not inundated, providing both potential flood-free locations on Site and rising road access away from the Site.

Figure 3.1 Regional PMF Extent at Site (BMT, In Draft 2024)

3.2 Existing Local (Overland) Flood Conditions

Existing overland peak flood level and extent at the Site is defined by the Overland Flow Flood model developed as part of this assessment. A summary of the model set-up and results is included in the following sections.

3.2.1 Hydrologic Model Setup

A direct rainfall or rainfall-on-grid (ROG) hydraulic model was developed for the catchment draining to North Creek within which the Site is located, and has an approximate catchment area of 2.5km^2. The ROG hydraulic model included 2016 IFD (intensity-frequency-duration) design rainfall estimates developed by the Bureau of Meteorology (BoM) that were adjusted to match present (i.e. current climate) conditions as per the guidance in Book 1, Chapter 6 of ARR 2019. The following formula, extracted from ARR 2019, was used to scale the IFD estimates.

To account for changes since the period represented by the IFD curves in the 2016 IFD portal, it is recommended that IFD information as well as estimates of the PMP should be adjusted using Equation (1.6.1) and the relevant rate of change in Table 1.6.1:

$$I_p = I \times \left(1 + \frac{\alpha}{100}\right)^{\Delta T} \quad (1.6.1)$$

where

- I_p the projected (current or future) design rainfall depth or intensity
- α is the rate of change from Table 1.6.1
- I is the historical design rainfall depth or intensity (e.g. from the 2016 IFD portal or historical PMP estimates)
- ΔT is the most up-to-date estimate of global (land and ocean) temperature projection for the design period of interest and selected climate scenario relative to a baseline time period. When used in conjunction with the 2016 IFD curves the baseline is recommended to be the 1961-1990 period (see Table 1.6.2 and text below).

Figure 3.2 Extract from ARR 2019, Book 1 Chapter 6 (Ball, et al., 2019)

2016 IFD and PMP estimates were scaled up by 18.26% to represent current climate conditions, assuming:

- A rate of change, α, of 15 – the recommended central (median) estimate rate of change for flood durations less than 1 hour (see Table 3.3).
- A temperature projection, ΔT, of 1.2 – the Current and near-term (2021-2040) global mean surface temperature projection for SSP2-4.5.

ARR 2019 also recommends the application of an Areal Reduction Factor (ARF) in the determination of design rainfall estimates for a catchment contributing flows to a point of interest that is larger than 1km^2. The ARF is the ratio between the average rainfall occurring on a specific area and the point rainfall computed for the same duration and AEP. Given that the catchment is relatively small, any areal reduction in rainfall would also be small. A conservative ARF factor of 1 was therefore adopted for the assessment (in other words, no reduction in the rainfall depth was applied).

3.2.2 Hydraulic Model Setup

To facilitate the assessment, the following datasets have been provided by or obtained publicly available sources as follows:

- Aerial imagery of the study area;
- Reports and flood results from the Draft 2024 Ballina Flood Study and 2008 Ballina Flood Study;
- Existing Site survey prepared by Stantec in 2024;
- Proposed Site Plan provided by PTW Architects (ref: “LHPS-PTW-ZZ-GF-DR-A-020001 REV - 06”, issued on 1 April 2025);

- Digital Elevation Model (DEM) in 1 m tiles based on LiDAR aerial survey obtained in 2010 by the NSW Government, available from the ELVIS webpage (https://elevation.fsdf.org.au/);
- Cadastral information and hydrolines (watercourses) from SIX Maps (https://maps.six.nsw.gov.au/clipnship.html);
- Bureau of Meteorology (BoM) 2016 design rainfalls (http://www.bom.gov.au/water/designRainfalls/revised-ifd/);
- Temporal patterns for design rainfalls from ARR Data Hub (https://data.arrsoftware.org/); and
- Storm losses from the Draft 2024 Ballina Flood Study and the ARR Data Hub.
    - The 1% AEP 2-hour Burst Initial Loss of 3.9 mm adopted in the Draft 2024 Ballina Flood Study has been conservatively applied for all events; and
    - The ARR Datahub continuing loss of 0.84 mm/hr has conservatively been applied.

The hydraulic model was developed to cover the portion of the catchment draining to North Creek within which the Site is located. The TUFLOW HPC software package was used to run the simulations, adopting a Quad Tree mesh with:

- A 5m grid cell size applied outside of the Site to balance representation of topographic features and model simulation time; and
- A 1.25 m grid cell size applied on-Site and in immediate surrounds (Montwood Drive and Snapper Drive) to better represent local drainage features.

This setup aimed to provide reasonable run times and enhanced resolution across the model, particularly around the study area.

The Site grades significantly from north-east to the low-lying tributary area in the south-west of the Site, which discharges underneath Montwood Drive and then into North Creek. Overland flow is concentrated along the existing tributary area with shallow affectation present elsewhere.

Hydraulic roughness zones (e.g. urban, forested areas, cleared land or vegetated areas) were informed mainly by inspection of aerial photography. Depth varying Manning's 'n' values were adopted, but matched to those adopted in the 2008 Ballina Flood Study where possible. A summary of the adopted Manning's 'n' hydraulic roughness is provided in Table 3.3.

Table 3.2 Adopted Manning's 'n' Hydraulic Roughness

Catchment Surface Type	Lower Depth (m)	Lower Depth Manning's 'n' Value	Upper Depth (m)	Upper Depth Manning's 'n' Value
Light Vegetation	0.05	0.5	0.1	0.07
Low density residential	0.03	0.1	0.1	0.1
Medium Density residential	0.03	0.1	0.1	0.1
National parks and nature reserves (Very Dense Vegetation)	0.05	0.5	0.1	0.12
Neighbourhood Centre (Low density residential)	0.03	0.1	0.1	0.1
Primary production	0.05	0.5	0.1	0.05
Public Recreation (Grass maintained)	0.05	0.5	0.1	0.035
Rural Landscape	0.05	0.5	0.1	0.05
Infrastructure	N/A	1	N/A	1
Public Road in use	0.05	0.5	0.1	0.025
Private Road	0.05	0.5	0.1	0.025
Buildings	N/A	1	N/A	1
Dams, open water, bare soil, etc	0.05	0.5	0.1	0.05
Pasture (Default)	0.05	0.5	0.1	0.05
Dense Vegetation	0.05	0.5	0.1	0.12

Model inflows include runoff generated as part of the ROG input. A stage discharge boundary (denoted as HQ) was applied at the outlet of the model on North Creek, automatically generated by TUFLOW using the bed slope of the watercourse.

The existing on-site and local stormwater system is conservatively not included within the model, and it is assumed that all rainfall will discharge overland.

3.2.3 Critical Duration Assessment

As per ARR 2019 recommendations, an ensemble of ten temporal patterns for each duration has been modelled for each AEP design flood event as part of the assessment herein. The ten temporal patterns vary in terms of their distribution and variability (comprising front, middle and back loaded storms) and can result in a wide range of flooding behaviour within the catchment.

The procedures for ARR 2019 provide for the selection of the temporal pattern that gives the peak flow closest to the mean of the peak flows from all ten temporal patterns. This method was followed to find the critical temporal pattern for each storm duration. A critical storm duration assessment was then undertaken to establish the critical storm duration that produces the highest mean peak flow at the study area across the modelled storm durations. A summary of the critical storm duration at the Site for each AEP design storm event is presented in Table 3.4.

Local PMF flood conditions were determined based on the procedures outlined in 'The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method' (BoM, 2003).

Table 3.3 Critical Storm Duration

Design Storm (AEP)	Storm Duration (min)
20% (1 in 5)	45
10% (1 in 10)	60
5% (1 in 20)	60
1% (1 in 100)	45
0.2% (1 in 500)	60
PMF	45

3.2.4 Climate Change Scenario

The 2023 Flood Risk Management Manual (FRMM) and Guideline LU01 (Flood Impact and Risk Assessment) recommends including a climate change assessment to understand and mitigate potential future impacts. This assessment uses the SSP2-4.5 climate scenario, a widely recognised moderate scenario developed by the IPCC (Intergovernmental Panel on Climate Change). This scenario assumes moderate emissions reductions, and a long a long-term warming trend that assess future flood risks under anticipated climate conditions in the year 2100.

3.3 Existing Local (Overland) Flood Conditions

The hydraulic model has been used to simulate for the existing flood conditions for the 20% AEP, 10% AEP, 5% AEP, 1% AEP, 0.2% AEP events, the 1% AEP under SSP2 2100 scenario (1% AEP with Climate Change), and the PMF event. Flood depths below 100 mm have been filtered from the final results.

The existing local flood modelling results for the 10% AEP, 5% AEP, 1% AEP, 0.2% AEP, 1% AEP with Climate Change and PMF events are attached in Annex A and presented as follows:

- Peak flood depths and level contours for existing conditions – Figures A-01 to A-05;
- Peak flood velocities for existing conditions – Figures A-06 to A-10; and
- Peak flood hazard for existing conditions – Figures A-11 to A-15.

The Site grades significantly from elevated areas in the north-east to low lying areas along the tributary of North Creek in the south-east. Flood depths and high flow areas are concentrated along the southern boundary and within the existing on-site pond. Some ponding is also present in the centre-east of the Site, although is likely the result of survey data picking up previous landscaping works.

Overtopping of Snapper Drive, along the north-eastern boundary of the Site, results in the discharge of flow from the north-eastern corner through the Site and minor ponding in this area.

4 Post Activity Flood Conditions

4.1 Proposed Activity

The proposed development for the Public School is presented in Figure 2.1. Proposed works include the construction of a new school building, a multi-purpose hall, a pre-school building, car parking area, associate site landscaping and associated off-site infrastructure works including gutter upgrades along Snapper Driver.

4.2 Post-Activity Regional (Mainstream) Flood Conditions

Additional modelling for post-activity regional (mainstream) flood conditions has not been assessed at the Site because the proposed activities do not significantly alter the floodplain or affect the flow characteristics of the regional flood conditions for all events up to and including the 1 in 500 AEP flood event (see Section 3.1).

A comparison of the predicted maximum peak PMF level on Site of 5.4 mAHD against proposed finished floor levels (FFL) for the development (see Figure 2.1) is included in Table 4.1 below.

Table 4.1 Comparison of Proposed Building FFLs with PMF

Proposed Building	Proposed Building FFL (mAHD)	Commentary
Building A	6.55	Building would be elevated several metres above regional PMF
Building B	5.4	Building would be elevated at or just above regional PMF
Building C	7	Building would be elevated over one metre above regional PMF
Carpark	5.739 (lowest point)	Carpark would be elevated above regional PMF

On the basis of the above, proposed Buildings A, B and C would be elevated above the maximum predicted PMF level. Evacuation from the Site during regional flood events would also be available along Snapper Drive in a north-easterly direction. Consideration of flood emergency response to a very rare or extreme regional flood event at the Site is outlined in the *Lennox Head Public School Flood Emergency Response Plan* (BMT, 2025).

It is noted that the Draft 2024 Ballina Flood Study is currently on public exhibition and has not yet been formerly adopted or endorsed by Ballina Shire Council. It is considered that the study represents the best current available information for the Site.

4.3 Post-activity Local (Overland) Flood Model

The proposed activities were incorporated into the TUFLOW hydraulic model as part of the post-activity scenario modelling whereby:

- Proposed earthworks were incorporated into the post-activity scenario modelling as per the design provided by Enstruct issued on 4 April 2025.
- The hydraulic roughness and associated rainfall losses were adjusted to match the change in surface.

- Proposed finished floor levels for buildings and outdoor areas were incorporated as terrain modifications set to nominated levels.

This hydraulic model has been used to simulate for the post-activity flood conditions for the 20% AEP, 10% AEP, 5% AEP, 1% AEP, 0.2% AEP events, 1% AEP with Climate Change and the PMF event. A flood depth filter of less than 100mm has been applied to all results. The flood impact assessment results are discussed in the following section.

It is assumed that rainfall falling on the proposed development area will be managed via the site stormwater management plan, where as the focus of this assessment is on potential local catchment flood impacts associated with the activity works.

As noted in Section 3.2.2, the flood model conservatively does not include on-site or local stormwater systems under either scenario.

4.4 Post-Activity Local (Overland) Flood Conditions

The post-activity local flood modelling results for the 20% AEP, 10% AEP, 5% AEP, 1% AEP, 0.2% AEP, 1% AEP with Climate Change and PMF events are attached in Annex B and presented as follows:

- Peak flood depths and level contours for post-development conditions – Figures B-01 to B-05;
- Peak flood velocities for post-activity conditions – Figures B-06 to B-10 (Annex C); and
- Peak flood hazard for post-activity conditions – Figures B-11 to B-15 (Annex C);

The proposed landscaping works at the Site primarily involve a decrease in gutter depths on Snapper Drive and an increase in elevations along the northern boundary of the Site. As a result, higher concentrations of flow are maintained within the Snapper Drive Road verge when compared to existing conditions. A partial overland flowpath discharges to the north of the carpark area and proposed Building C before heading south to the west of both features.

Peak flood levels along the path are below 7 mAHD for all events up to and including both the 0.2% AEP and 1% Climate Change events and therefore below the proposed finished floor level for Building C. The Peak PMF level at Building C is 7.1 mAHD, which would result in minor overtopping in that event.

5 Predicted Changes in Peak Flood Condition

The proposed activity has been considered in terms of potential adverse impacts on existing (baseline) local (overland) flood behaviour. Modelling results were used to assess and map the relative flood impacts of the proposed activity (i.e. peak flood levels from the post-activity scenario minus peak flood levels from the existing scenarios). Peak flood impacts for 20% AEP, 10% AEP, 5% AEP, 1% AEP and 0.2% AEP event and 1% AEP Event with Climate Change. The local (overland) flood impact mapping is shown in Annex C, as follows:

- Peak flood level impacts for post-activity conditions – Figures C-01 to C-05; and
- Peak flood velocity impacts for post-activity conditions – Figure C-06 to C-10.

The maps identify areas where:

- Flooding previously occurred in the existing scenario model but no longer occurs in the post-activity scenario model (referenced “was wet now dry”);
- Flooding now occurs in the post-activity scenario model which was previously not flooded in the existing scenario model (referenced “was dry now wet”); and
- Extent and degree of change in the peak water levels / velocities.

A summary of the impacts are as follows:

5.1 Peak Flood Depth and Level Impacts

The existing flood conditions indicate that the proposed development area is affected primarily by shallow overland flooding, broadly unaffected by flooding or with depths broadly below 100 mm for all modelled flood events. The flood impact results indicate that the proposed new buildings will be free from local overland flooding for all modelled events up to the PMF, but will experience minor overtopping in that event (see Section 4.4).

The proposed decrease in gutter depths on Snapper Drive and an increase in elevations along the northern boundary of the Site result in a larger portion of flow concentrations along Snapper Drive and Montwood Drive under post development conditions when compared to existing. Along the Snapper Drive roadway itself, these increases are largely localised to the gutter, and would be expected to have a negligible impact on road trafficability for all modelled events. However, due in particular to the rise in elevations along the northern boundary, previous flowpaths which discharged through the Site at the north-east corner are partially blocked resulting in localised increases at the property boundary of sites along Stoneyhurst Drive (up to 50mm).

It is noted that the flood modelling undertaken for this assessment does not include the existing or proposed drainage network. The inclusion of this information with the flood modelling, would likely impact on the flow of water through the Site, reducing levels locally and therefore potentially allowing additional overflow onto the Site (potentially reducing levels further upstream). It is recommended that this information be included in future modelling during detailed design to confirm the behaviour shown at the corner of Stoneyhurst Drive. If, following the inclusion of the local stormwater network, peak flood impacts are still shown at the property, it is recommended that additional inflow into the Site is included in order to carry flow away from the corner and reduce potential impacts (See Section 7.1).

5.2 Peak Flood Velocity Impacts

The existing flood conditions show that the Site is generally impacted by low flood velocities, with only slight variations observed across the Site. However, higher velocities are present along the internal roads on the southern portion of the overall Site. These higher velocities are limited to the southern section and do not significantly impact the rest of the Site.

In the post-activity flood conditions, similar low velocities are expected across the Site.

5.3 Peak Flood Hazards

The best practice flood risk management approach to flood hazard mapping (Australian Institute for Disaster Resilience, 2017) classifies the floodplain into the six distinct hazard classifications (H1 to H6) shown in Figure 5.1. These hazard classifications are based on adopted thresholds of flood depth, velocity and depth-velocity product that identify when flood conditions are likely to present a risk to people, vehicles and buildings. A description of each hazard threshold is provided in Table 5.1.

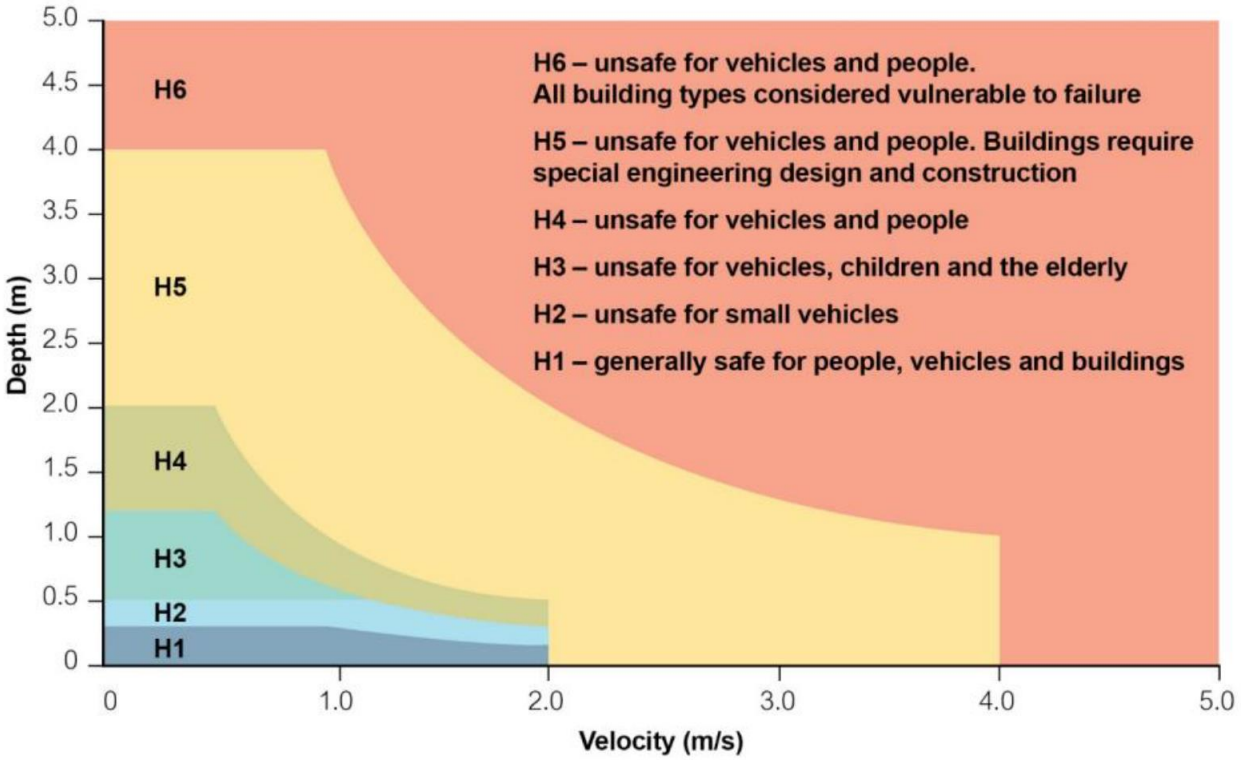

Figure 5.1 AIDR Flood Hazard Classification System

Table 5.1 Combined hazard curves – vulnerability threshold classification limits (AIDR, 2017)

Hazard Classification	Description	Classification limit (D and V in combination) m2/s	Limiting still water depth (D) m	Limiting velocity (V) m/s
H1	Generally safe for vehicles, people and buildings	D*V ≤ 0.3	0.3	2.0
H2	Unsafe for small vehicles	D*V ≤ 0.6	0.5	2.0
H3	Unsafe for vehicles, children and the elderly	D*V ≤ 0.6	1.2	2.0
H4	Unsafe for vehicles and people	D*V ≤ 1.0	2.0	2.0
H5	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure	D*V ≤ 4.0	4.0	4.0
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure	D*V ≤ 4.0	-	-

Peak existing and post-development flood hazards at the Site are shown in Annex A and Annex B. Figure B-21 shows post-development PMF hazards on the Site. The map indicates high hazards (up to H5 classification) along the low-lying tributary that runs from the north-east corner through the south of the Site, and along Montwood Drive downstream (west) of the Site. However, in proposed development areas and locations where the school is proposed hazards are predominantly low (H1 or H2 classifications). Some intermediate hazards (up to H3 classification) are present along the path between the carpark and Building C and in south-east areas of the school – but this classification is driven by the extremity of the PMF and the areas are below an H2 classification for all other events.

The results indicate that while low-lying areas of the Site are subject to high-hazard development, the proposed school site itself is subject to low or no flood hazards.

6 Compliance with Flood Management Guidelines

This section provides a review of NSW flood-related development controls and guidelines that have been considered in the preparation of the flood risk and impact assessment.

6.1 Ballina Local Environment Plan requirements

Specific flood-related requirements from the Ballina Local Environment Plan (LEP) 2012 are listed in Table 6.1, along with commentary regarding the development.

Table 6.1 Ballina LEP Clause 5.21 Flood Planning

LEP Requirement	Comment
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development— (a) is compatible with the flood function and behaviour on the land, and (b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and (c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and (d) incorporates appropriate measures to manage risk to life in the event of a flood, and (e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	a) The proposed works are located in low-hazard, predominantly flood fringe areas for all events up to and including the overland PMF. The proposed development will be located above the regional PMF level. b) The proposed development may result in minor flood level increases to properties at the corner of Snapper Drive and Stoneyhurst Drive due to blockage of existing minor flowpath through the north of the Site. Investigation of these impacts should be undertaken as part of detailed design, inclusive of incorporation of on-site drainage design if required. If necessary, mitigation of these impacts could likely be achieved through provision of an additional overflow at the north-east corner of the Site. c) Proposed building finished floor levels for A, B and C are located above the regional Probable Maximum Flood. Rising Road Access is available from the Site along Snapper Drive. A Flood Emergency Response plan has been prepared for the Site. d) As per c) e) The development will not result in any changes along waterways.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters— (a) the impact of the development on projected changes to flood behaviour as a result of climate change, (b) the intended design and scale of buildings resulting from the development, (c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood, (d) the potential to modify, relocate or remove buildings resulting from development if the	a) A climate change assessment under SSP2-4.5 with a 2100 planning horizon has been undertaken. The results indicate peak flood level increases of up to 10 mm when compared to the results for the 1% AEP event. b) The proposed buildings will not be located within the regional PMF flood extent. c) Proposed building finished floor levels for A, B and C are located above the regional Probable Maximum Flood. Rising Road Access is available from the Site along Snapper Drive. A Flood Emergency Response plan has been prepared for the Site. The Site is impacted by low hazard flooding.

LEP Requirement	Comment
surrounding area is impacted by flooding or coastal erosion.	d) Noted

6.2 Ballina Development Control Plan requirements

Specific flood-related requirements for the Ballina Development Control Plan (DCP) 2012 are included in Chapter 2b Flood Management. While the DCP identifies Council's requirements relating to development in the floodplain, and on other flood prone land, in Ballina Shire it also includes the follow definition of local drainage.

*"**Local drainage** refers to small scale overland flow including areas generally where depths are less than approximately 0.3m and are beyond the floodplains of original watercourses (which may now be piped, channelised or diverted). There is little risk to personal safety or property damage in these areas. This type of inundation is not referred to as 'flooding' and normal building controls are used to manage the inundation risks in these areas rather than the flood-related controls in this Plan."*

Local overland flows impacting on the proposed new buildings fall below the 0.3 m depth threshold identified in the DCP and are beyond the floodplains or original watercourses across the catchment (this better describes the tributary which runs north-east to south-west along the Sites southern boundary). Therefore, it is not considered that the prescriptive controls outlined in the DCP are relevant to local catchment flooding at the Site.

As outlined in Section 3.1, all proposed buildings will be elevated above the regional PMF level at the Site. Off-site evacuation is available via Snapper Drive for regional flood affectation. A Flood Emergency Response Plan has been developed for the Site.

6.3 Planning Circular PS-24-001

Planning Circular PS-24-001 *Update on addressing flood risk in planning decision* (Department of Planning, Housing and Infrastructure, 2024), provides information to planning authorities in relation to addressing flood risk in land use planning. The circular notes that assessment of a proposed development against LEP clause 5.21 Flood Planning should be undertaken prior to determination of a Development Application (assessed in Section 6.1). The circular also includes a recommendation that planning authorities provide a risk-based approach to the assessment of flood-affected proposals, taking into account the risk profile of the proposal and with consideration of flooding at the location. These considerations are included in Table 6.2 below along with commentary in regard to the development.

Table 6.2 Planning Circular - Flood Risk Profile

Matters to consider when determining the flood risk profile should include: 1. whether the proposal is in a high-risk catchment 2. the location of the proposal in relation to flood behaviour and constraints including: a. floodway, flood storage area or flood fringe area b. the hazard vulnerability classification of the land	1. Lennox Head is within the Northern Rivers catchment which is identified as high risk. However the Site is elevated well above the Richmond River, the proposed development is above the regional PMF and off-site evacuation to flood-free areas to the north-east is available 2. a. The proposed development area is located in a low hazard flood fringe area for all local catchment flood events and

c. frequency of inundation 3. whether the proposal provides for safe occupation and efficient and effective evacuation in flood events and how it is to be achieved 4. in high-risk catchments, whether the proposal is likely to result in a significant increase to the risk to life in other parts of the catchment in a PMF flood event 5. any known evacuation constraints such as the flood emergency response classification for the area and available warning times (including rate of rise and when the evacuation route is cut off by floodwater) 6. whether the proposal is for a sensitive or hazardous land uses , or other higher risk uses and what mitigation strategies (if any) are proposed to reduce any identified risks 7. whether there may be adverse flooding impacts on surrounding properties 8. potential impacts of cut and fill and other building works on flood behaviour 9. ability of proposed development to withstand flood impacts.	outside of the extent of regional flooding. b. The proposed development area is located in a low hazard flood fringe area c. The development is elevated above the regional PMF level. Partial inundation may occur at Building C during a local overland PMF. 3. A Flood Emergency Response Plan has been prepared for the development. 4. The development will not impact on the flood emergency response arrangements for other sites 5. Off-site evacuation is available for all regional flood events at the Site. Shelter-in-place may be employed in response to flash flooding. See FERP for more detail. 6. The proposal is for a school development. Building floor levels for the new learning centre (Building A) and school Hall (Building B) will be above the PMF for all local catchment flood events. All 3 new buildings will be above the regional PMF level. A FERP has been undertaken for the Site for the management of residual risks. 7. Minor impacts are shown at the corner of Snapper Drive and Stoneyhurst Drive. Mitigation of these impacts is discussed in Section 7.1. 8. Flood Impacts are discussed in Section 5 9. The development is not expected to experience significant flood affectation for all events up to and including the PMF (for both regional and local catchment flooding).
The above matters should be considered across a range of flood scenarios for high risk proposals. The typical events examined may include the 10% Annual Exceedance Probability (AEP), 5% AEP, 1% AEP, 0.5% or 0.2% AEP, the PMF event, and in relation to the flood planning level (if available).	This study has included modelling and assessment of the 20% AEP, 10% AEP, 5% AEP, 1% AEP, 0.2% AEP, 1% AEP under climate change and PMF events.

6.4 Flood Risk Management Guideline LU01

The Flood Impact and Risk Assessment Flood Risk Management Guideline LU01 provides advice on the scope and scale of a flood impact and risk assessment. The LU01 guideline outlines that the primary aim of a Flood Impact and Risk Assessment (FIRA) is to *"identify and analyse:*

- *the impacts of the proposed development on the flood risk to the existing community*
- *the impacts and risks of flooding on the development and its users*

- *how these impacts can be managed to minimise the growth in risk to the community due to the development."*

General considerations for a flood risk and impact assessment, provided in Section 2.3 of the guideline, are copied below with reference to this assessment.

For a FIRA to meet the aims outlined [above] *it requires an understanding of:*

the full range of flood risk. To achieve this, flood behaviour would be examined for a range of events. Typical events examined may include the 10%, 5%, 1%, 0.5% or 0.2% AEP and probable maximum flood (PMF)

This assessment has considered flooding for the 20%, 10%, 5%, 1% and 0.2% AEP and PMF events.

the potential for coincidence with downstream tailwater levels or ocean inundation levels where the area is influenced by backwater flooding from downstream waterways or the ocean

The Site is located in a steep upstream catchment area for a tributary of North Creek, a minor tributary of the Richmond River. Local catchment affectation is dominated by intense short duration storms, while regional flooding is heavily influenced by long duration, high volume events. As a result the likelihood of significant coincident flooding is unlikely. The Site is elevated above the regional PMF..

the constraints that flood places on the land (floodways, flood storage, flood hazard and emergency response issues) determined for a number of events, typically 5%, 1%, 0.2% or 0.5% AEP and PMF

Under existing conditions, the proposed development areas are predominantly elevated and flood-free. Under post development conditions, the development areas will be further raised above the floodplain.

the appropriateness of the development or development types for the location based on the flood constraints on the land

The proposed development areas are predominantly flood-free or subject to low hazard flooding for all events up to and including the PMF.

the adequacy of management measures and controls to: - effectively address these constraints to ensure the flood risks to the proposed development and its users are acceptable - manage flood and associated emergency management (EM) impacts to the existing community due to the development

Proposed development works are placed in elevated areas of the catchment, several metres above regional flood levels and subject to no or very low hazard flooding for all events up to the PMF.

Potential flood impacts associated with the development can be managed via:

- Design and installation of local drainage (conservatively not included in the modelling).
- Design and incorporation of an overflow in the north-eastern corner to encourage excess water on Snapper Drive into the existing tributary to allow the natural flow regime to be maintained following infill works.

the choice of Australian Rainfall and Runoff (ARR) data version to use.

climate change impacts. Both existing and post development flood behaviour needs to consider climate change impacts on flood behaviour so the robustness of decisions over time can be understood. Climate change impacts can influence outcomes and requirements for developments.

ARR 2019 version 4.2 methodologies have been used in this assessment. ARR 2016 IFDs have been used for the assessment, but scaled to meet current (2025) and future climate change projections in line with the requirements of ARR 2019 Book 1 Chapter 6.

7 Planning Consideration

7.1 Mitigation Measures

7.1.1 Off-Site Flood Impacts

The proposed works would result in the partial blockage of existing overland flowpaths which discharge from Snapper Drive through the Site under pre-development conditions. The results of this assessment indicate that the retention of these flows on Snapper Drive would have the potential to cause localised off-site impacts to properties beyond the Site boundary under post-development conditions. It is noted that the impacts shown in this assessment are highly localised and relatively minor, and may be partially reflective of the conservative nature of the modelling assumptions in this assessment.

It is anticipated that additional flood modelling will be completed as part of detailed design development. Should it be necessary, any off-site impacts associated with the detailed design – particularly to properties along Snapper Drive to the north of the Site – can be mitigated via amendments to the design at this time. This will ensure post-development conditions do not worsen flood affectation from pre-development levels, and can be confirmed by modelling prior to construction.

7.1.2 Finished Floor Levels

The nominated finished floor level for Building C, 7.0mAHD , is below the local catchment PMF level of 7.1 mAHD. Mapping provided in Annex B indicates that during a local catchment PMF event, Building C would experience minor overfloor flooding.

A path is available from Building C to Building A via Snapper Drive which is not affected by local catchment flooding for any event. Given the extreme rarity of the PMF event, the low affectation at Building C and the availability of a flood-free path to a flood-free refuge in a neighbouring building, the overland flood risk at the Site is considered low and with no further mitigation required.

7.2 Evaluation of Environmental Impacts

The evaluation of environmental impacts considers the potential effects of the proposed activities on the Site and surrounding areas, with a focus on flood behaviour and long-term environmental sustainability. This assessment has assessed for both the existing and post-activity conditions, factoring in local overland flooding and potential climate change impacts.

Based on the findings, the proposed activities are not expected to significantly alter flood behaviour or lead to adverse environmental consequences off-site. Overall, the proposed activities align with sustainable environmental management practices, with minimal disruption to existing conditions and flood regimes.

8 Recommendations

This report documents the Flood Impact and Risk Assessment (FIRA) prepared to support the Review of Environmental Factors (REF) for the construction and operation of Lennox Head Public School on behalf of the NSW Department of Education.

For regional (mainstream) flooding, additional modelling for post-activity conditions was not conducted as the proposed development will be elevated above regional PMF flooding.

BMT developed a flood model to assess overland flooding in the catchment draining to North Creek, following the ARR 2019 guidelines and consistent with Draft Ballina Flood Study methodologies. Local (overland) model results show that the Site's elevated location minimises flood impacts across most areas, with only shallow localised flood depths of approximately 0.15m occurring in isolated low lying zones during the 1% AEP event. The majority of the development area Site falls within an H1 hazard classification, indicating low risk to people and property.

Under post-activity flood conditions, minor off-site impacts are predicted for the neighbouring property at the corner of Snapper Drive and Stoneyhurst Drive. Discussion of potential mitigation options is included in the report, and it is concluded that the minor nature of the impacts and the conservative assumptions within this report will mean these can alleviated as part of detailed design. The report also compares the proposed activity with flood management guidelines and outlines relevant planning considerations. The findings indicate that the proposed activity is not expected to significantly alter flood behaviour or cause adverse environmental impacts off-site.

As part of the mitigation measures, a Flood Emergency Response Plan (FERP) has been prepared for the school, outlining the actions to be taken in the event of flooding. The FERP focusing on minimising risks to the safety of occupants and ensuring a timely response to extreme flood events.

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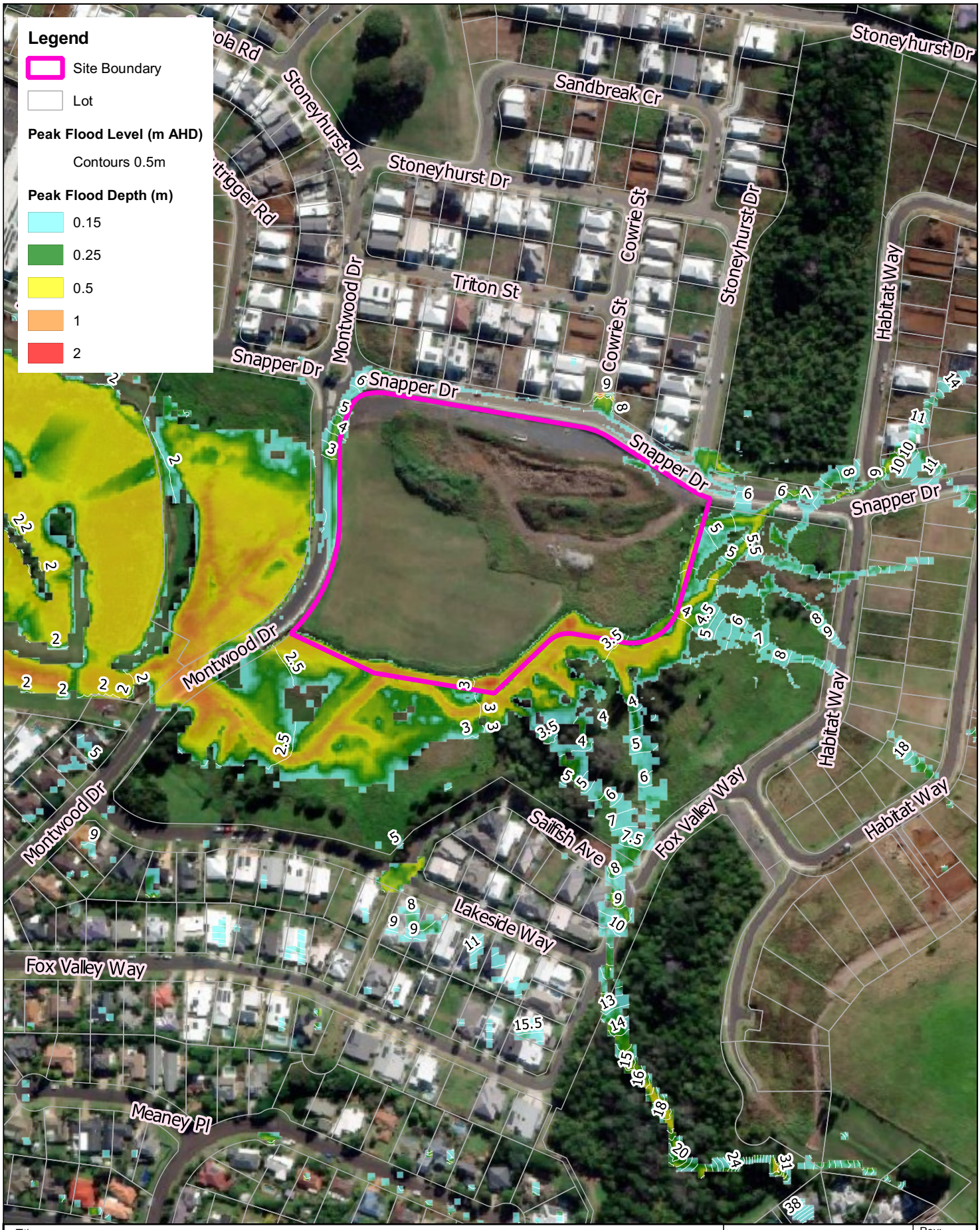
Annex A Existing Scenario Flood Maps



Peak Flood Depths and Levels - Existing Conditions - 20% AEP Event

Figure: A-01

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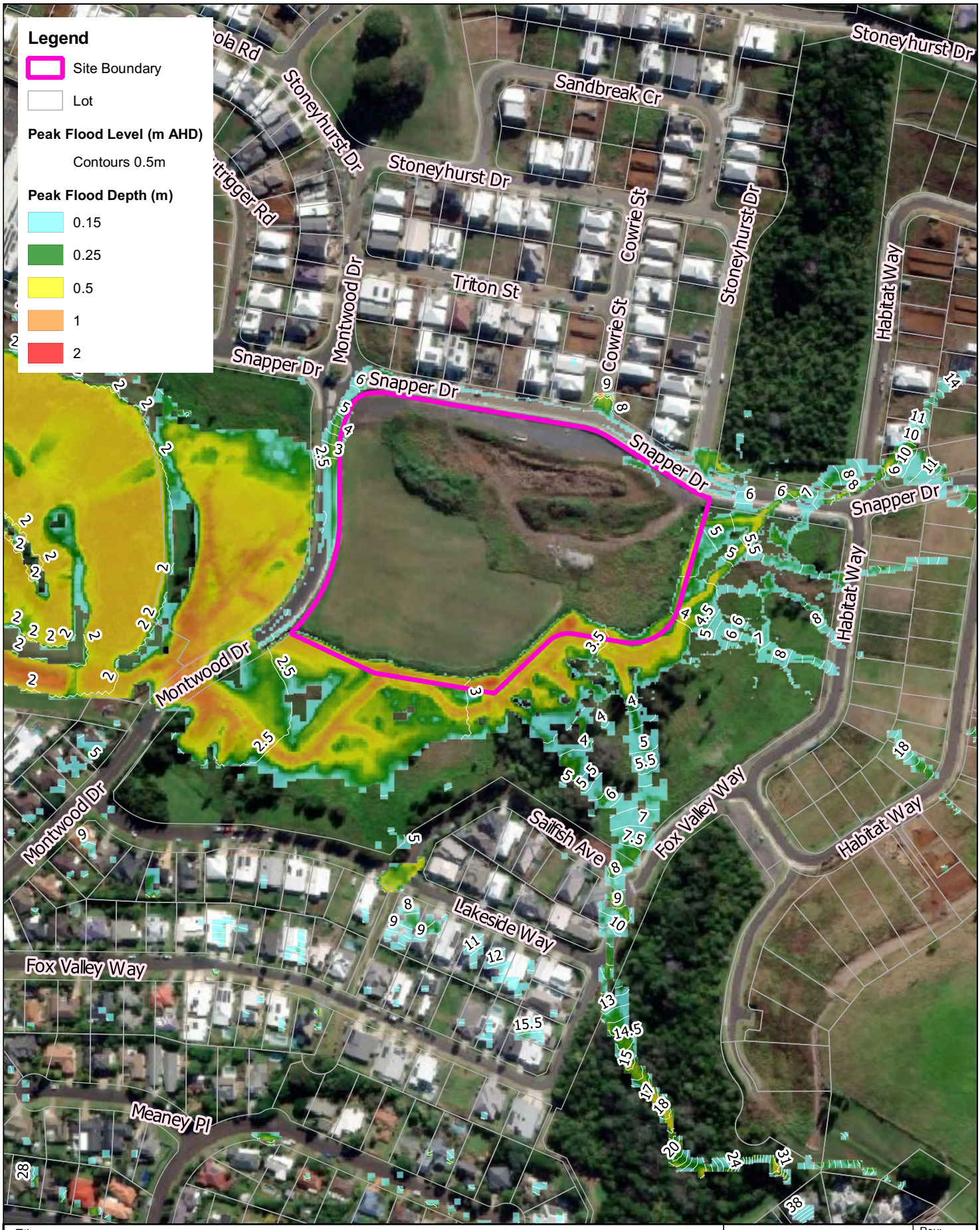

Title:

Peak Flood Depths and Levels - Existing Conditions - 10% AEP Event

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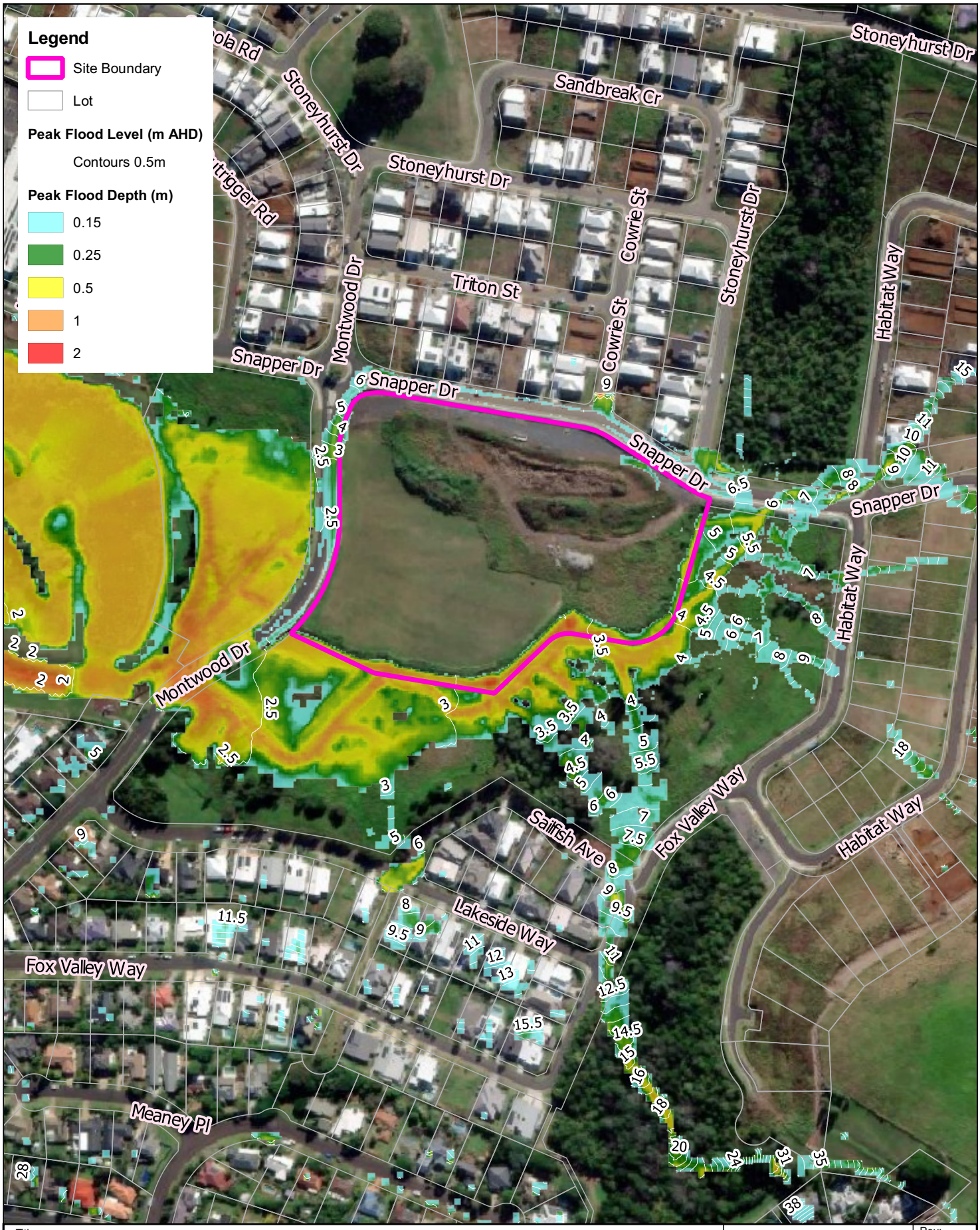

Title:

Peak Flood Depths and Levels - Existing Conditions - 5% AEP Event

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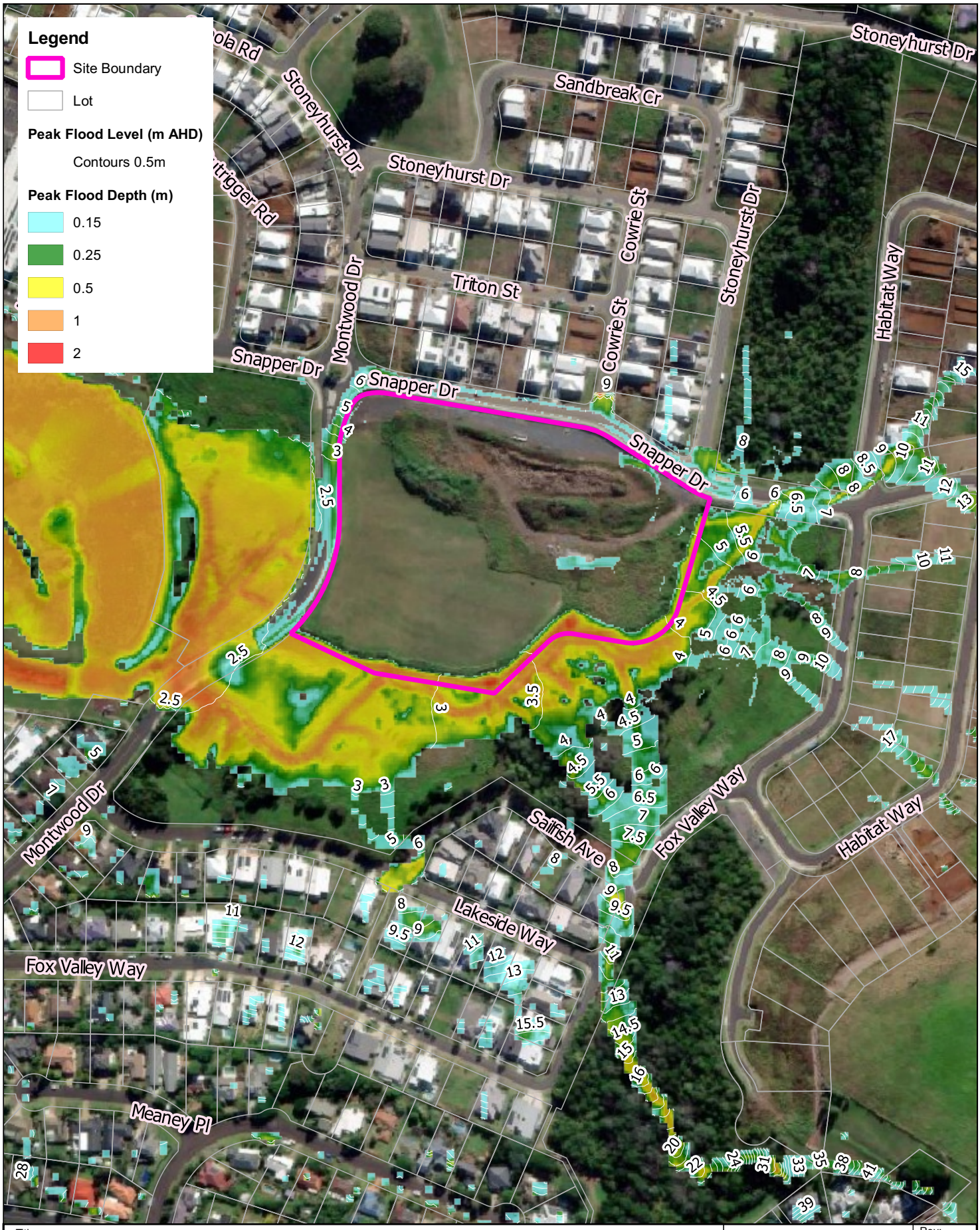

Title:

Peak Flood Depths and Levels - Existing Conditions - 1% AEP Event

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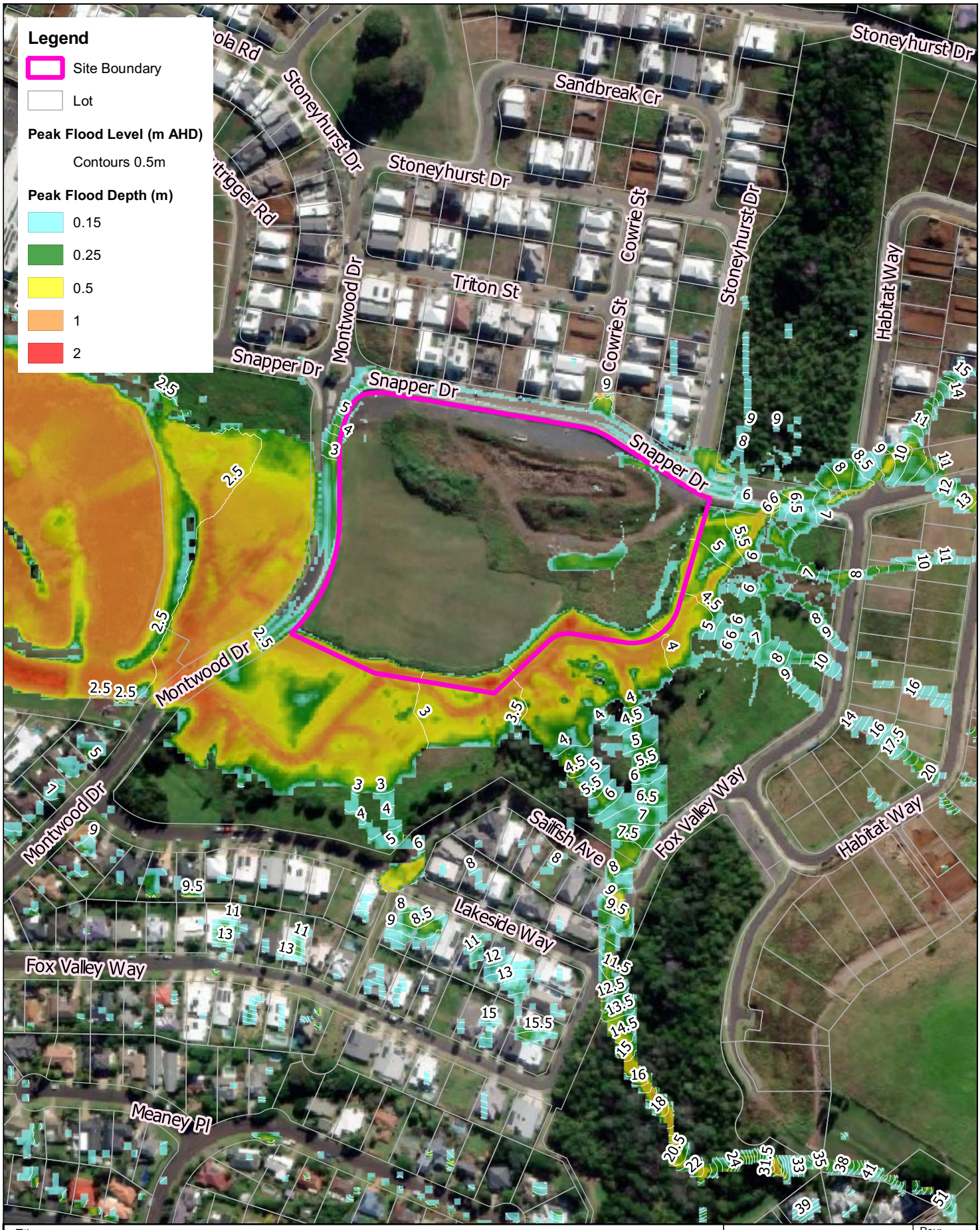

Title:

Peak Flood Depths and Levels - Existing Conditions - 0.2% AEP Event

Figure: A-05

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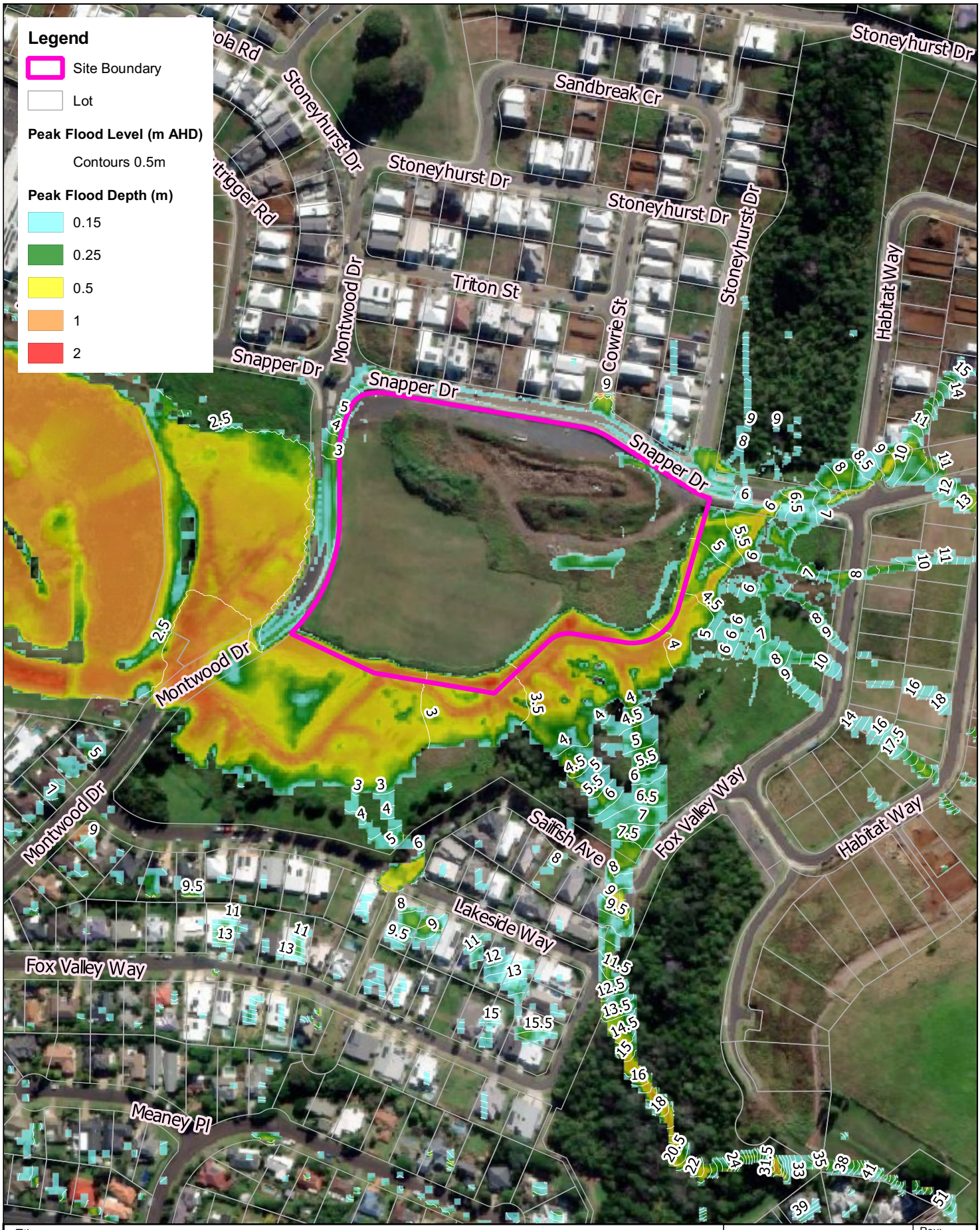

Title:

Peak Flood Depths and Levels - Existing Conditions - 1% AEP Event with Climate Change

Figure: A-06

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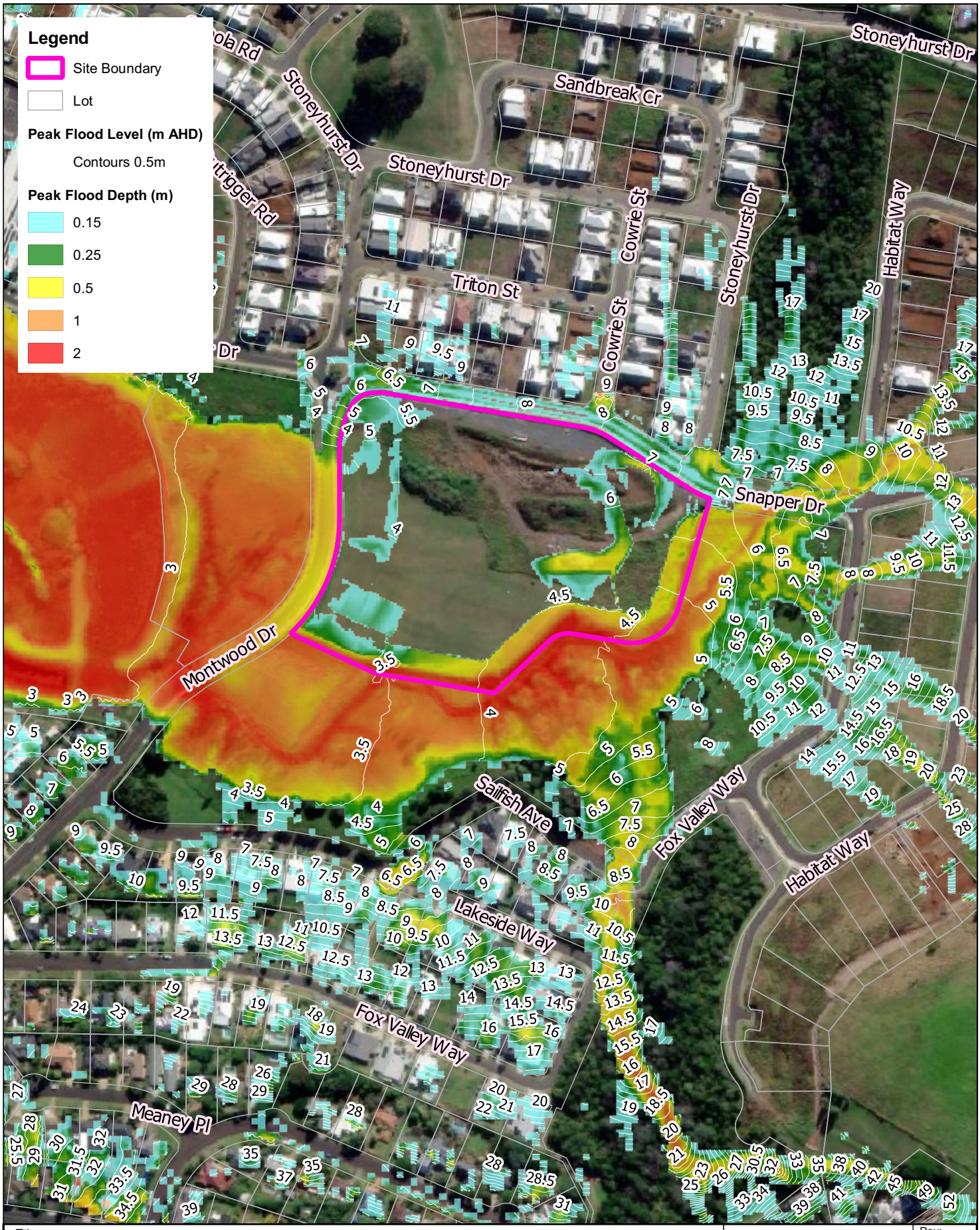

Title:

Peak Flood Depths and Levels - Existing Conditions - PMF Event

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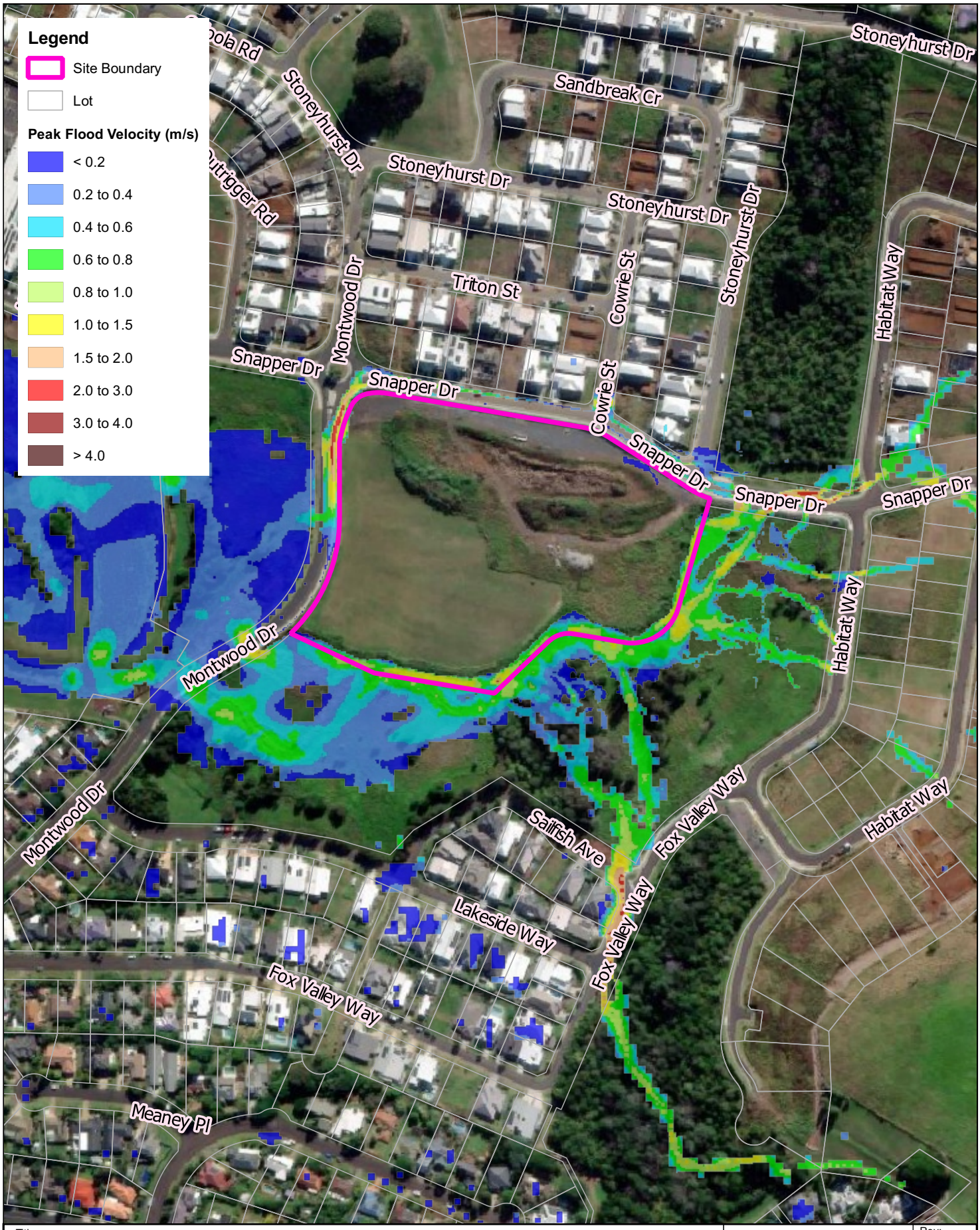

Title:

Peak Flood Velocities - Existing Conditions - 20% AEP Event

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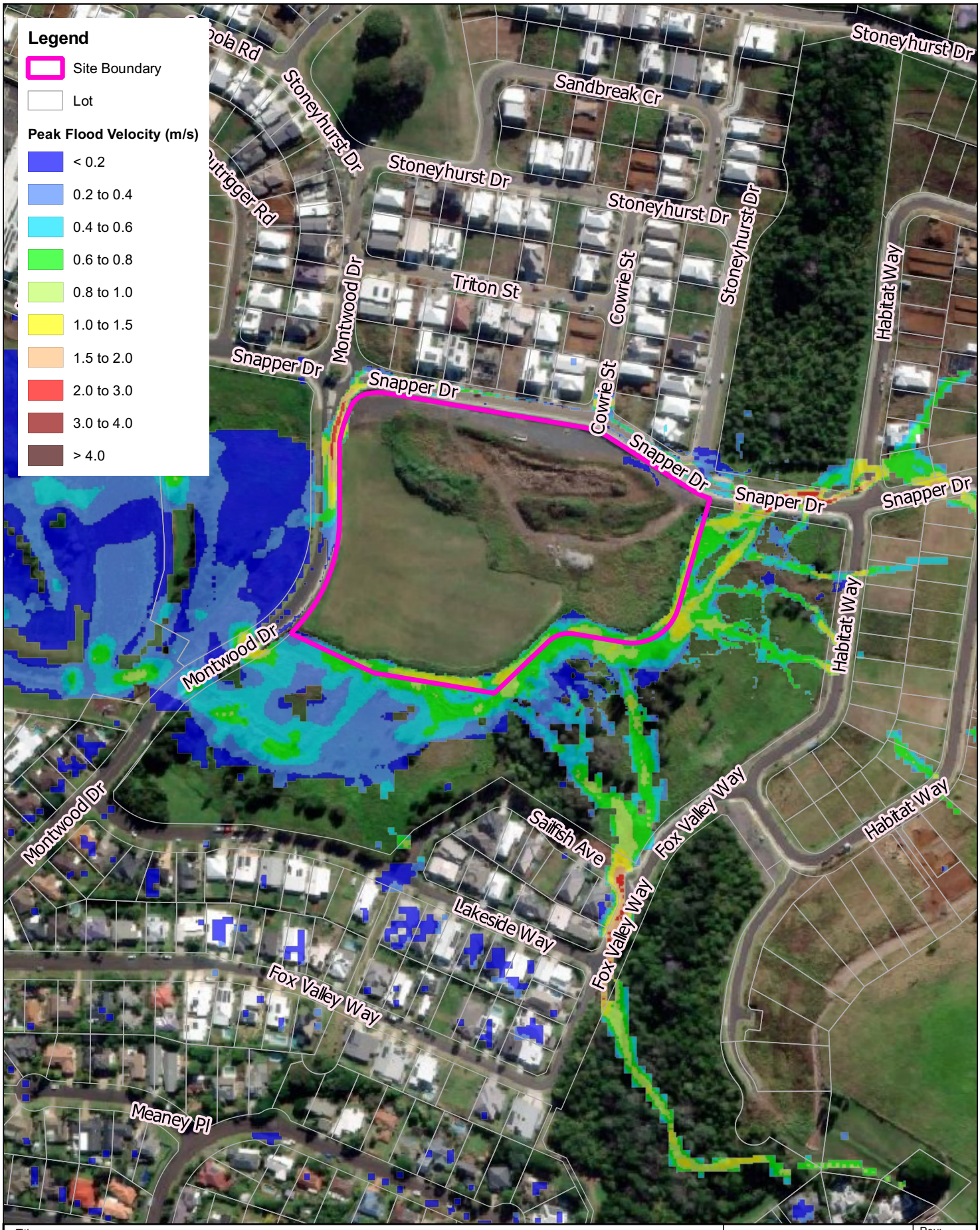

Title:

Peak Flood Velocities - Existing Conditions - 10% AEP Event

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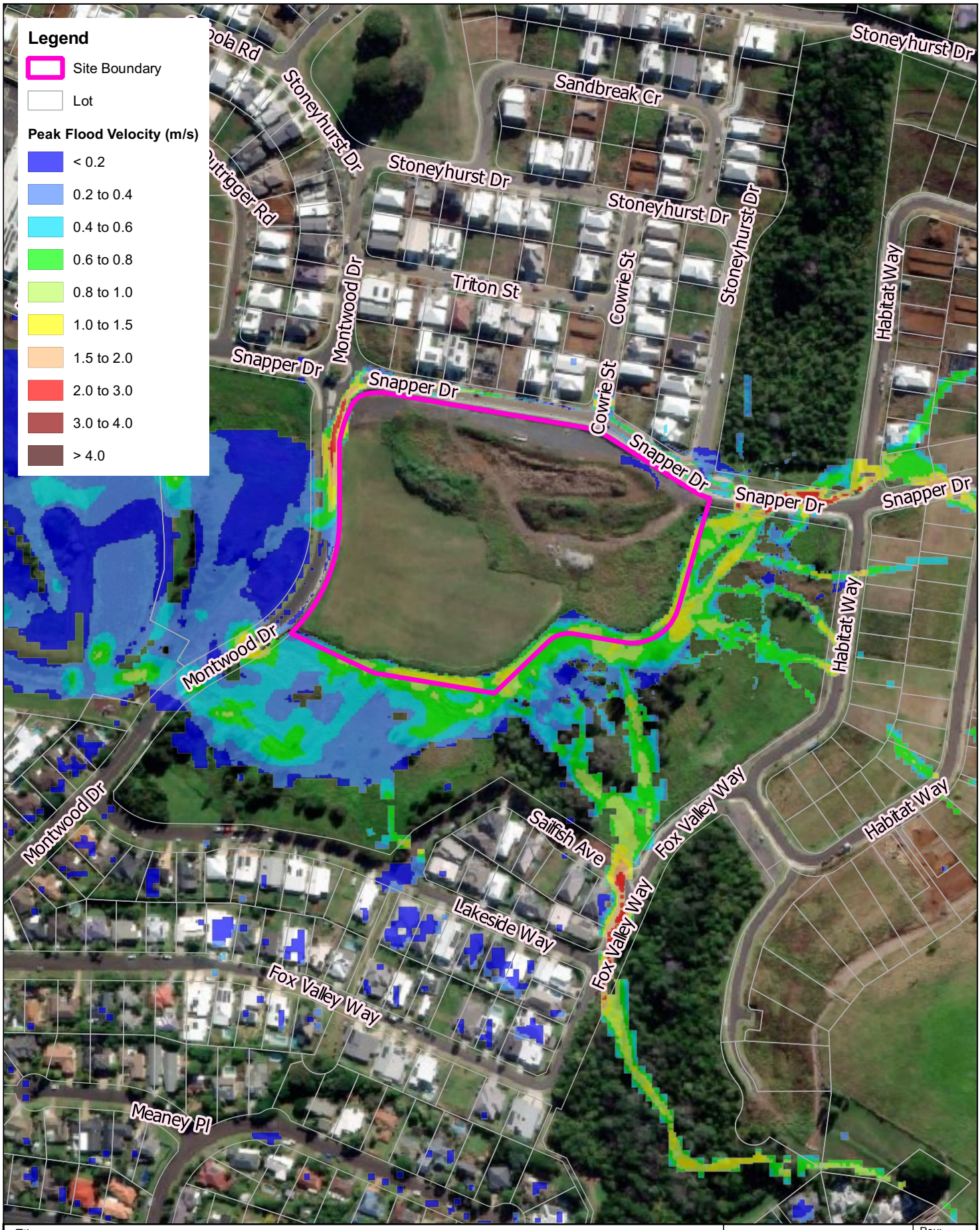

Title:

Peak Flood Velocities - Existing Conditions - 5% AEP Event

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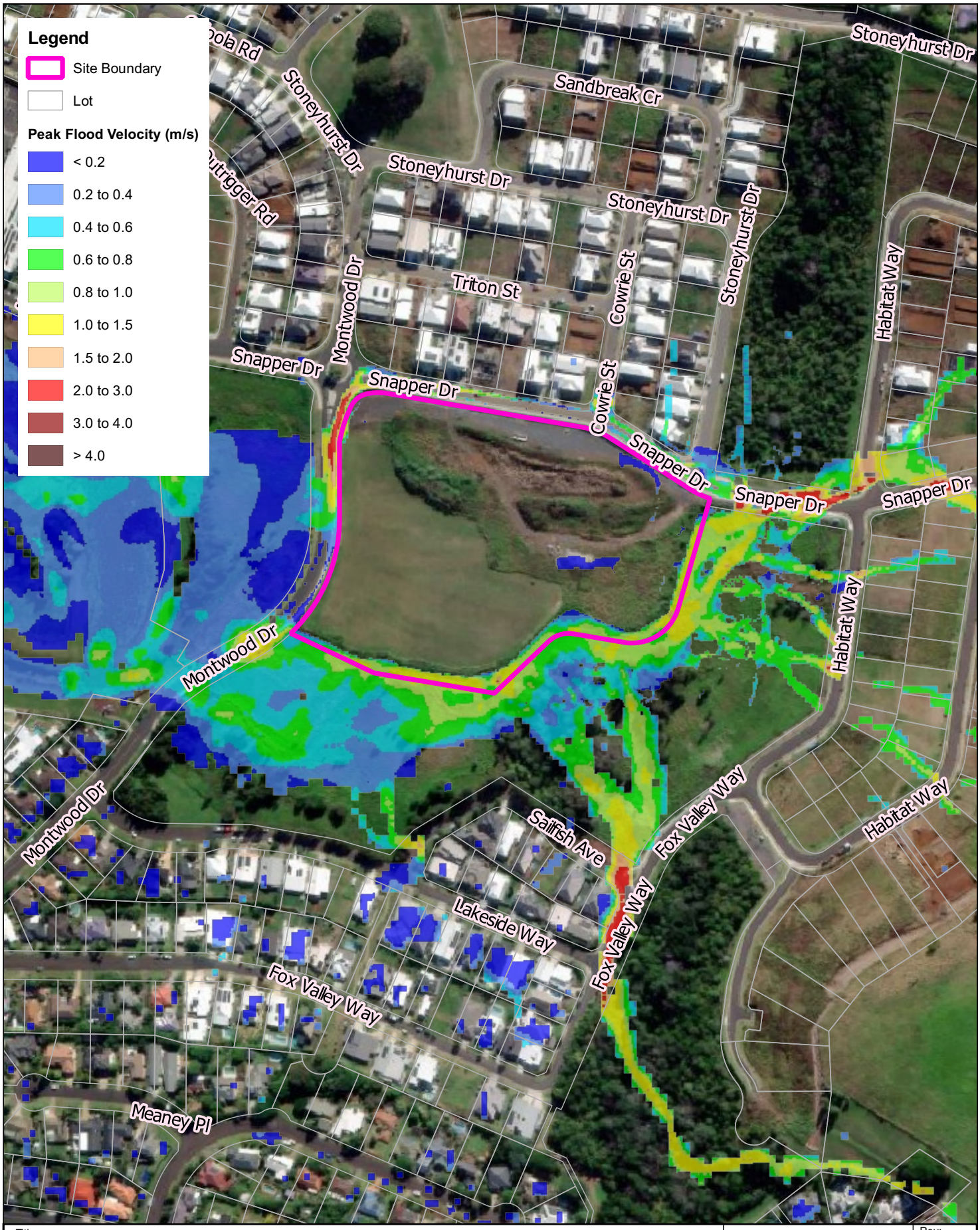

Title:

Peak Flood Velocities - Existing Conditions - 1% AEP Event

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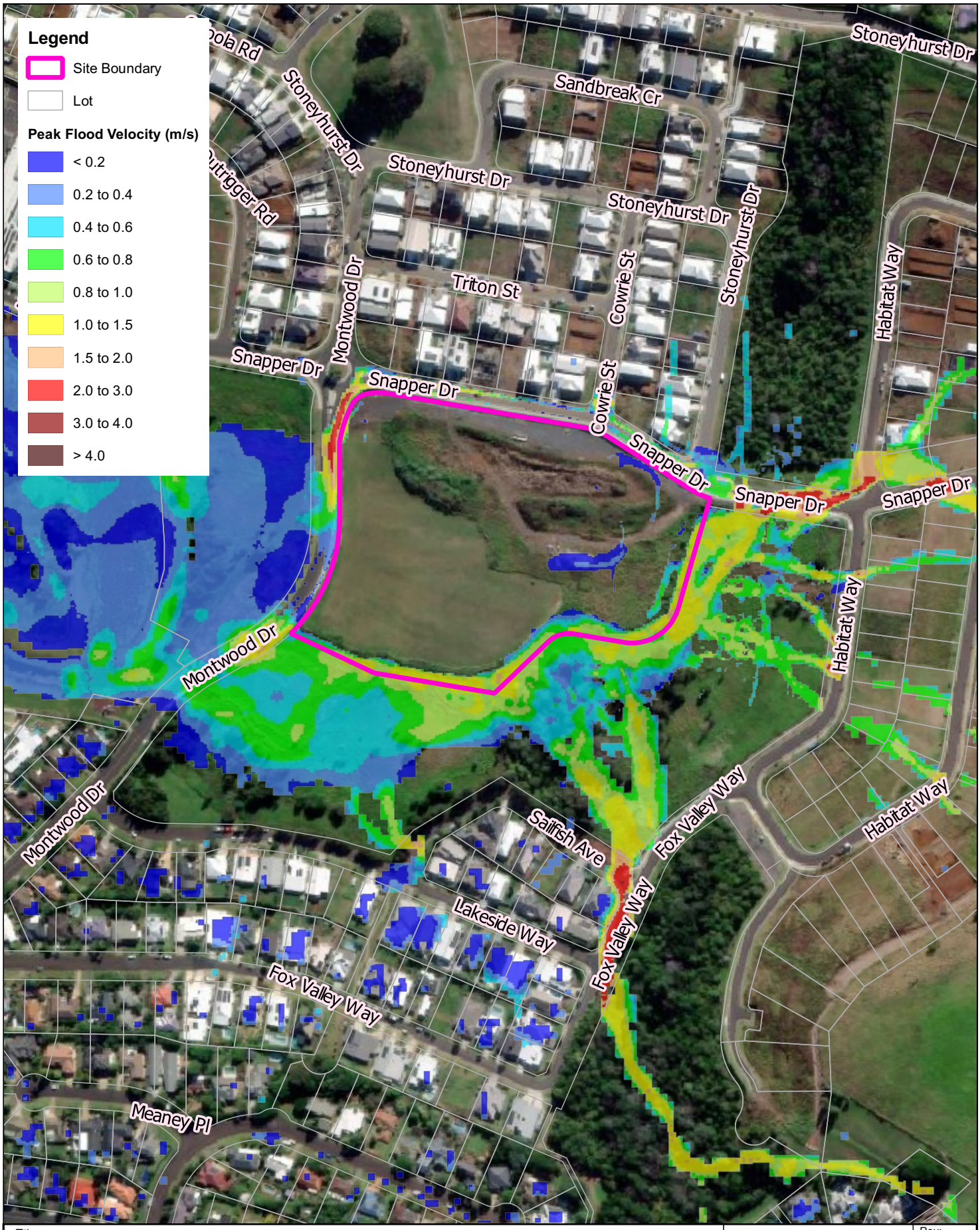

Title:

Peak Flood Velocities - Existing Conditions - 0.2% AEP Event

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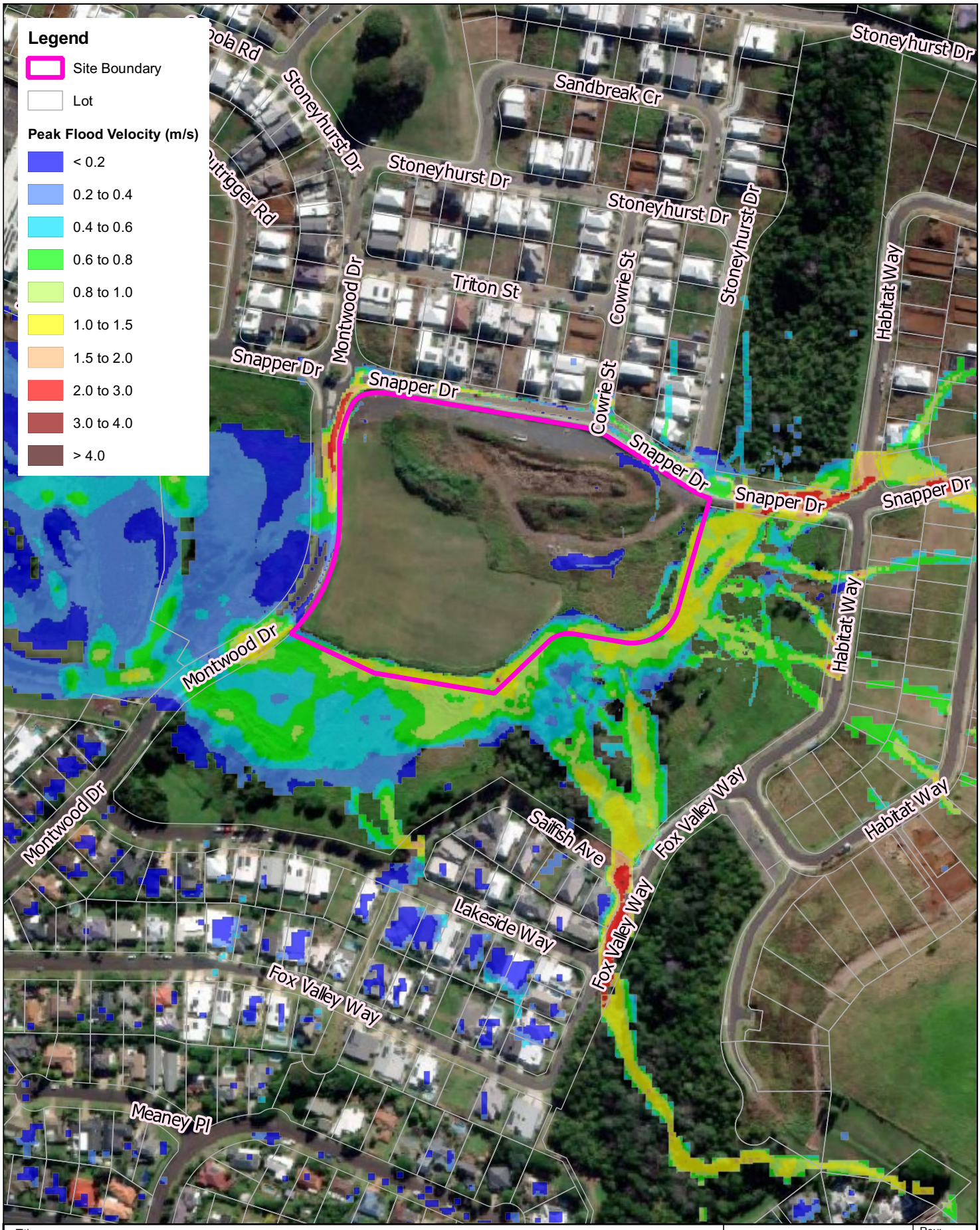

Title:

Peak Flood Velocities - Existing Conditions - 1% AEP Event with Climate Change

Figure: A-13

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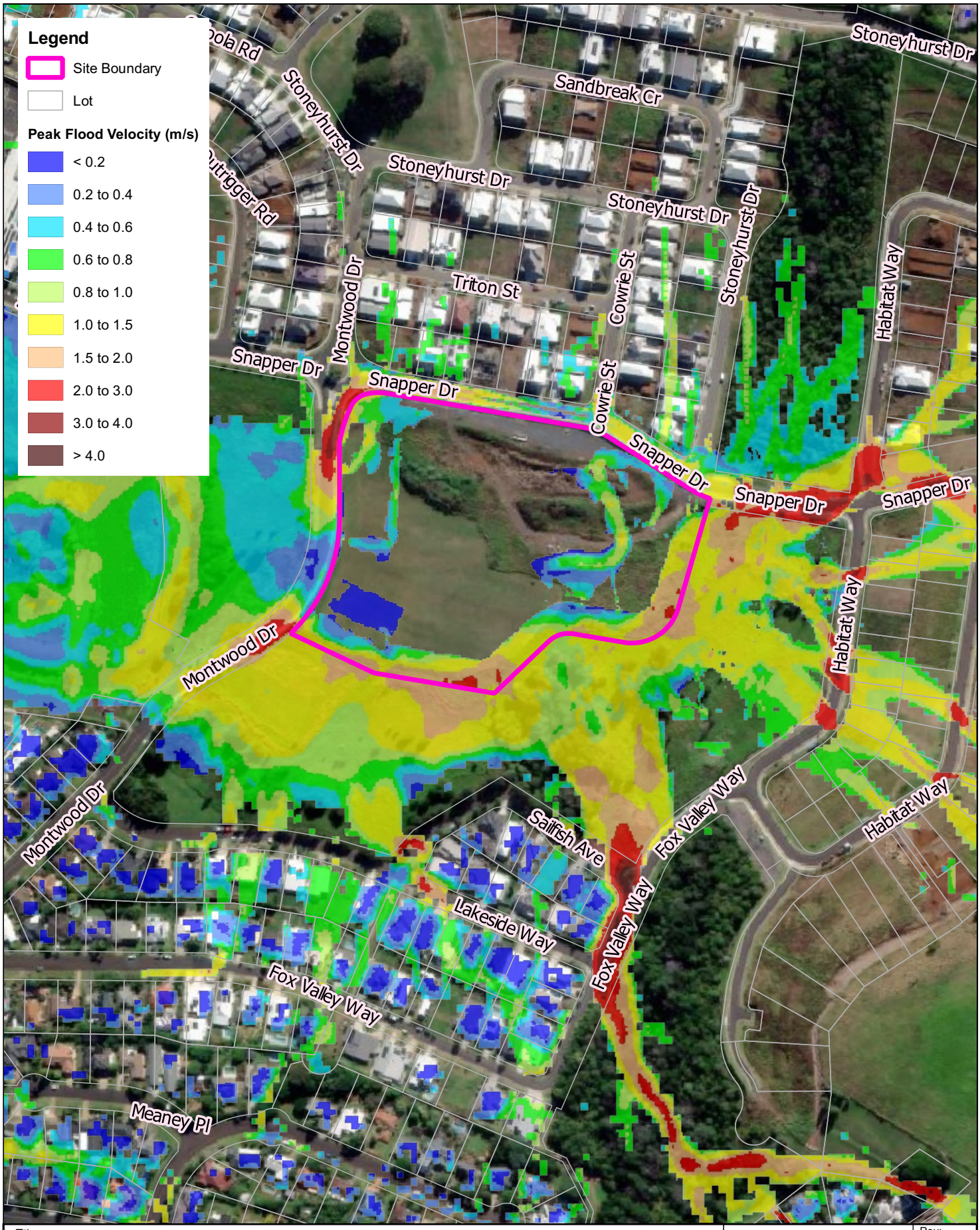

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Peak Flood Velocities- Existing Conditions - PMF Event

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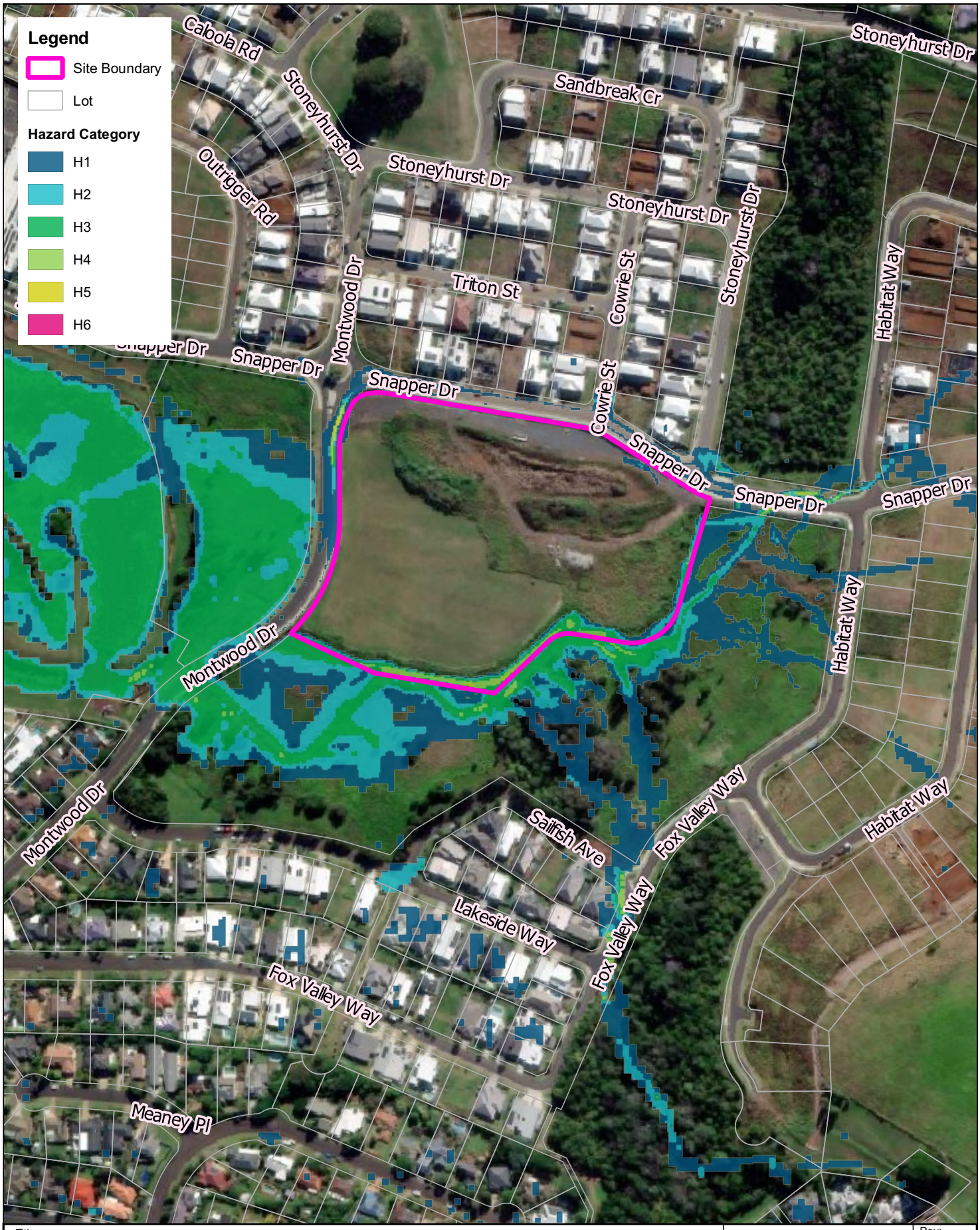

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Peak Flood Hazard - Existing Conditions - 20% AEP Event

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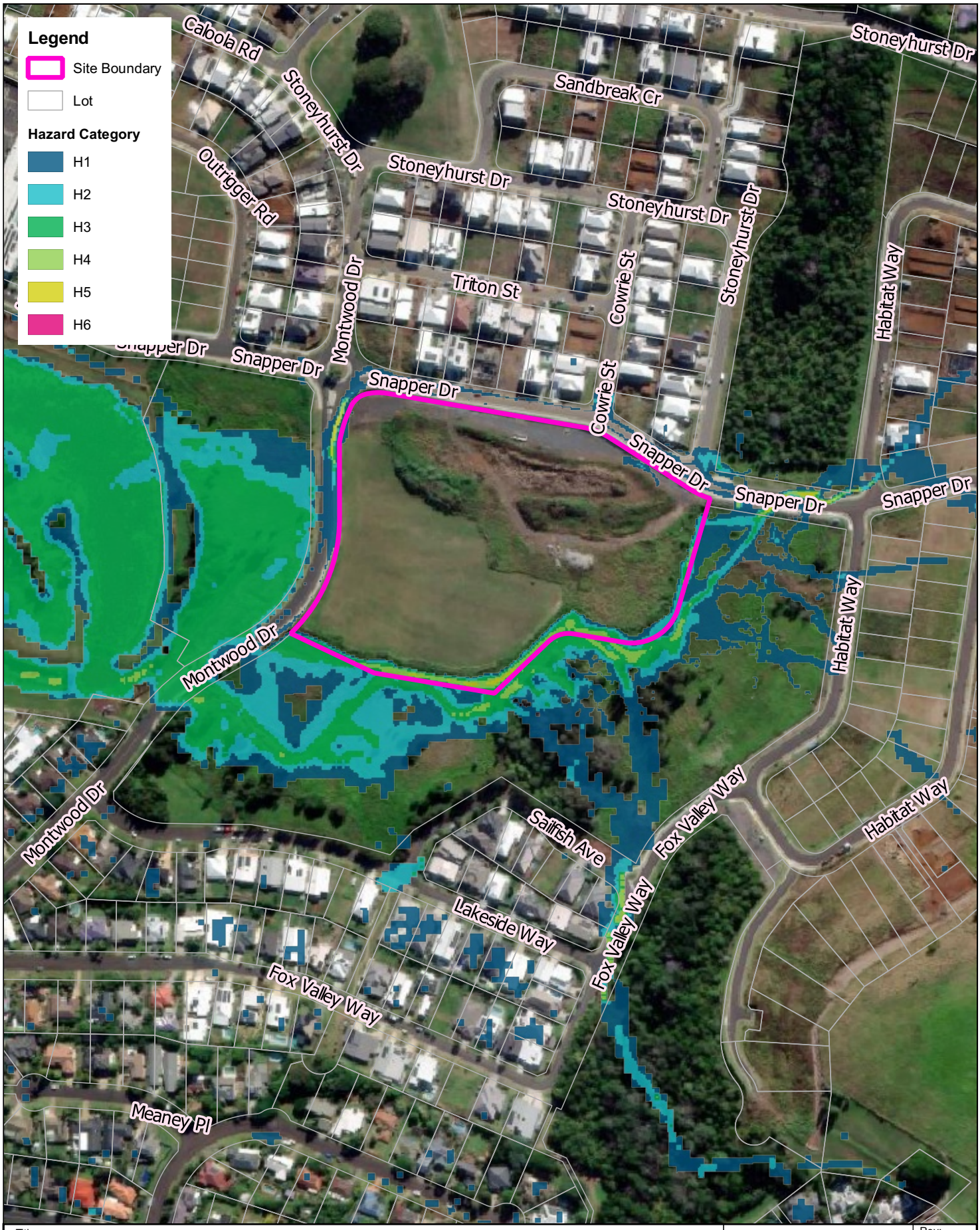

Title:

Peak Flood Hazard - Existing Conditions - 10% AEP Event

Figure: A-16

Rev: A

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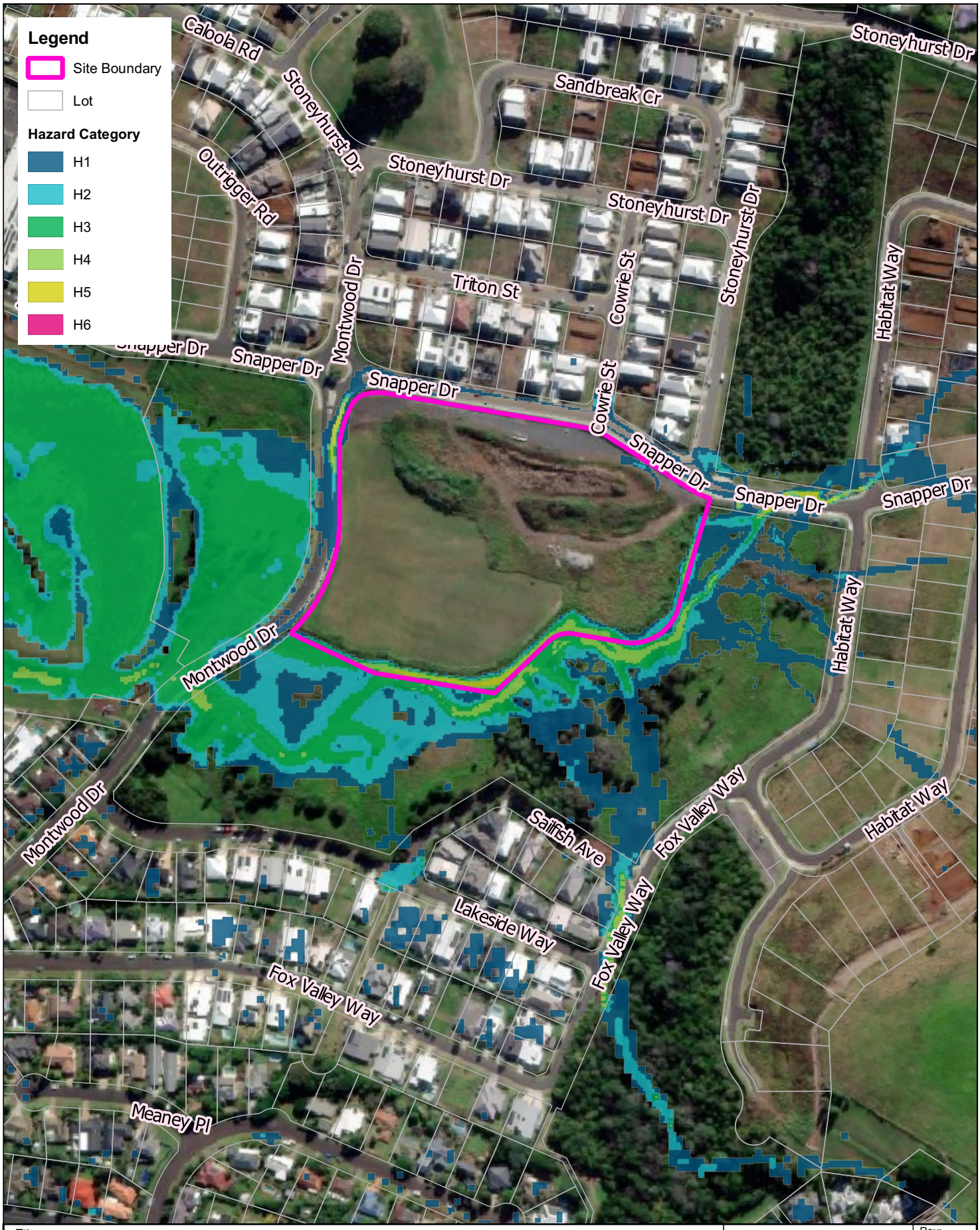

Title:

Peak Flood Hazard - Existing Conditions - 5% AEP Event

Figure: A-17

Rev: A

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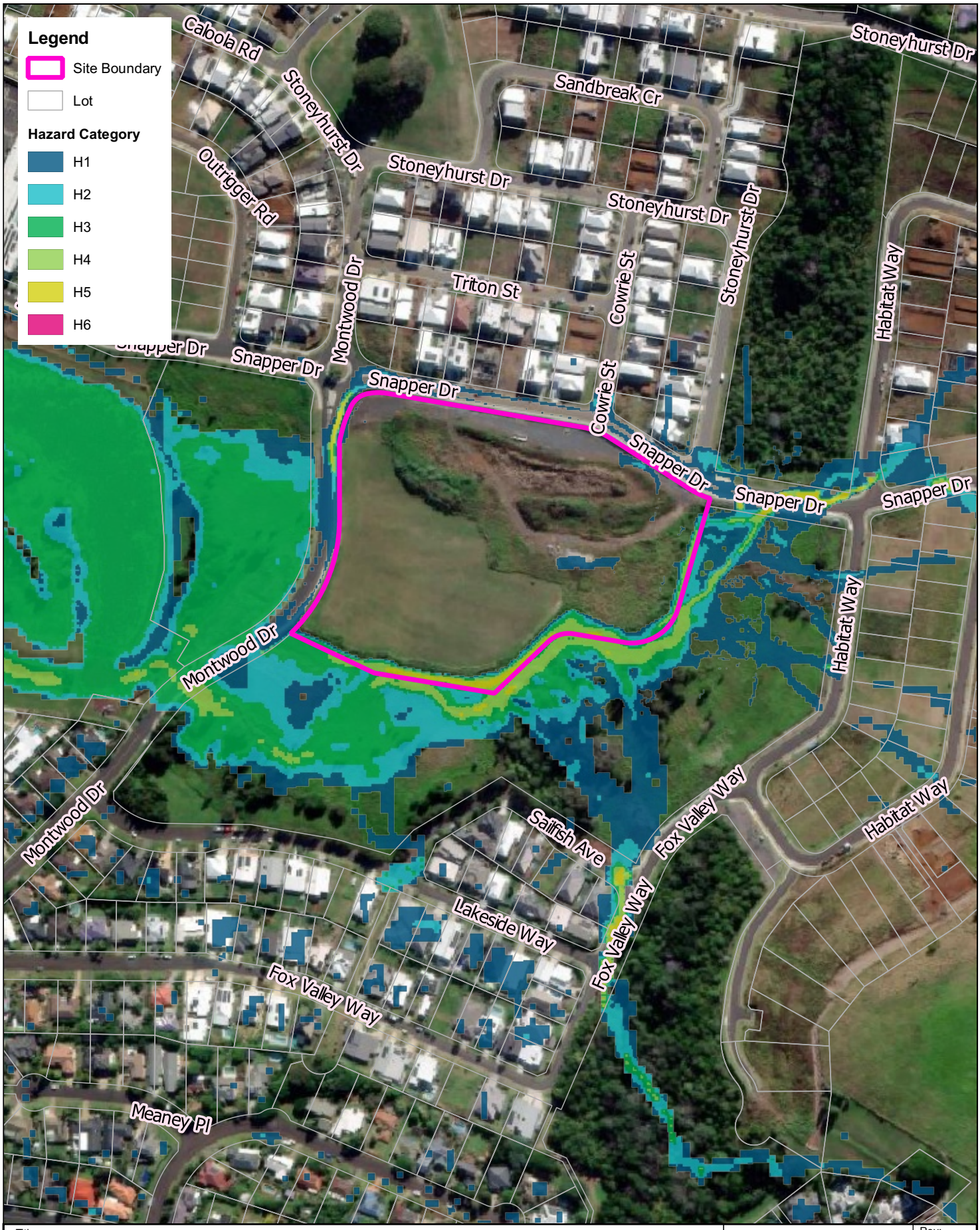

Title:

Peak Flood Hazard - Existing Conditions - 1% AEP Event

Figure: A-18

Rev: A

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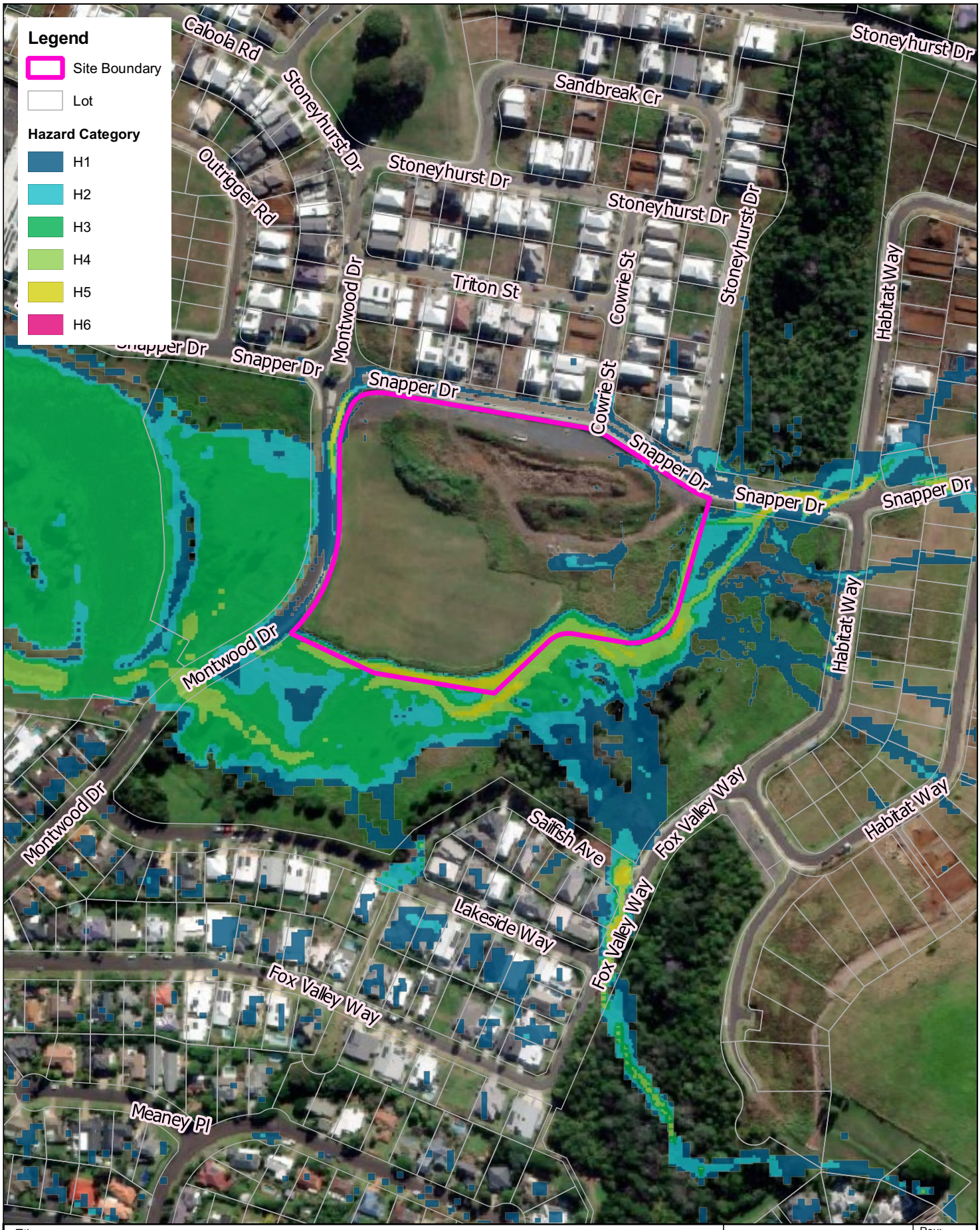

Title:

Peak Flood Hazard - Existing Conditions - 0.2% AEP Event

Figure: A-19

Rev: A

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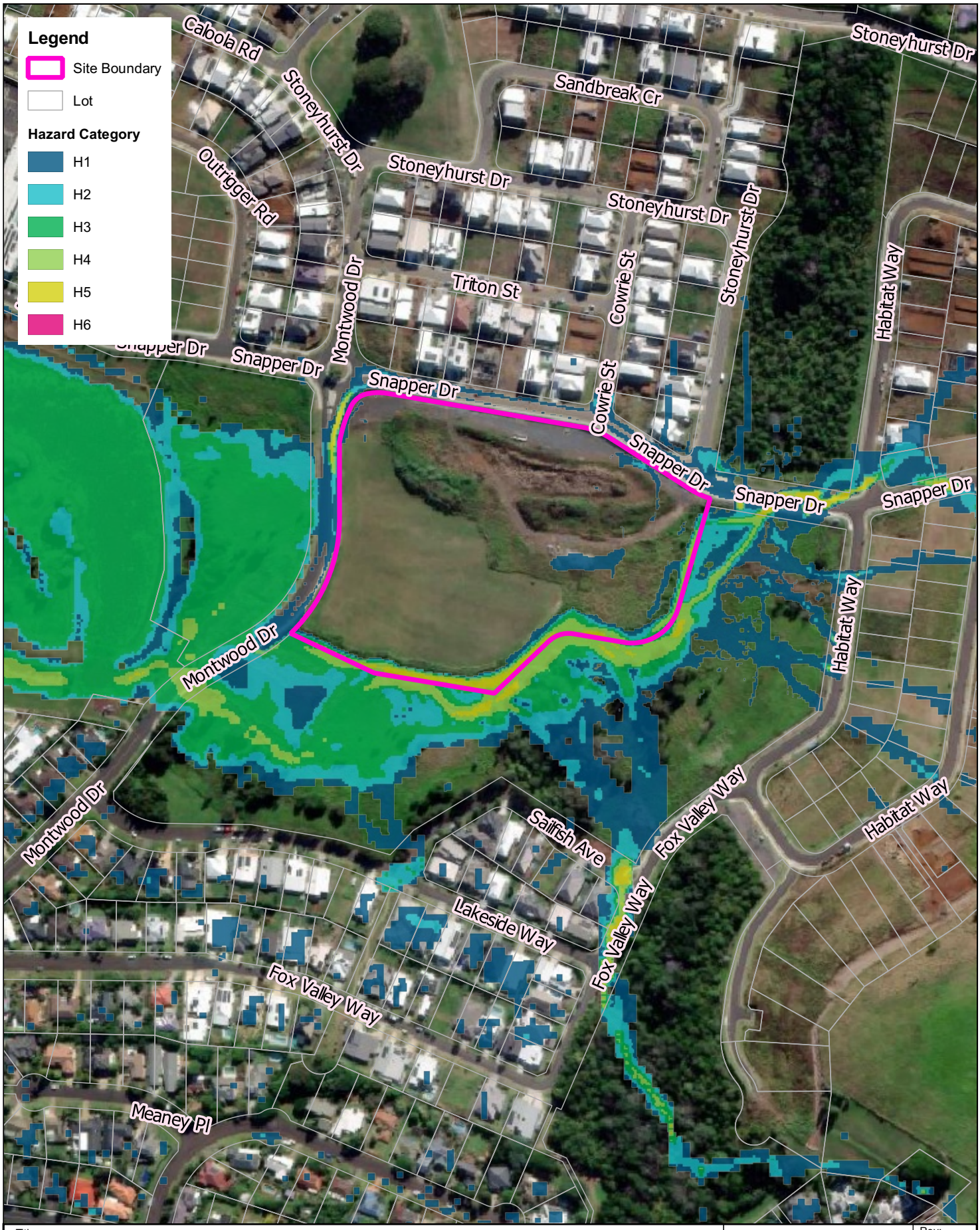

Title:

Peak Flood Hazard - Existing Conditions - 1% AEP Event with Climate Change

Figure: A-20

Rev: A

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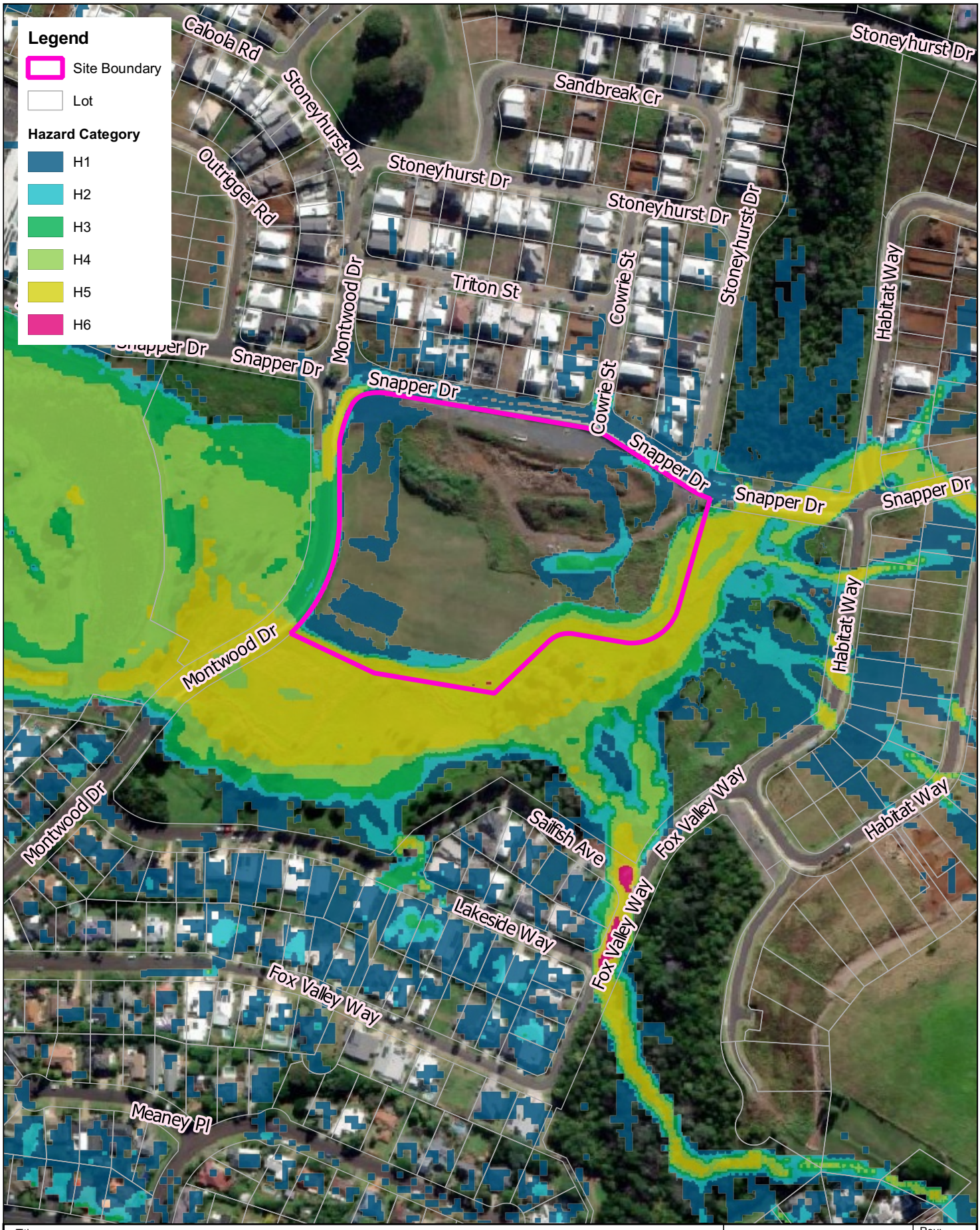

Title:

Peak Flood Hazard - Existing Conditions - PMF Event

Figure: A-21

Rev: A

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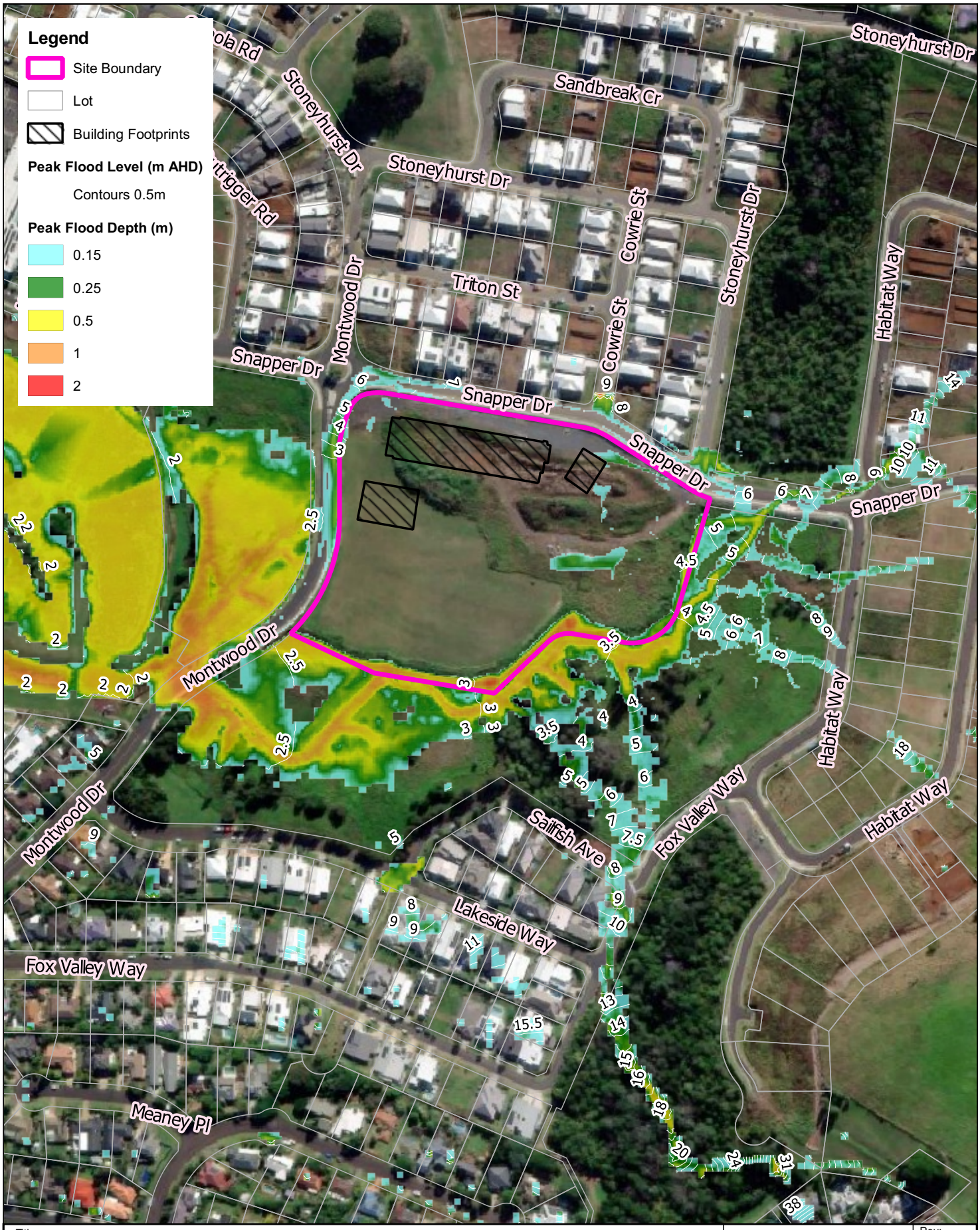
Annex B Post-Activity Flood Maps



Title:

Peak Flood Depths and Levels - Post-Development Conditions - 20% AEP Event

Figure: B-01

Rev: A

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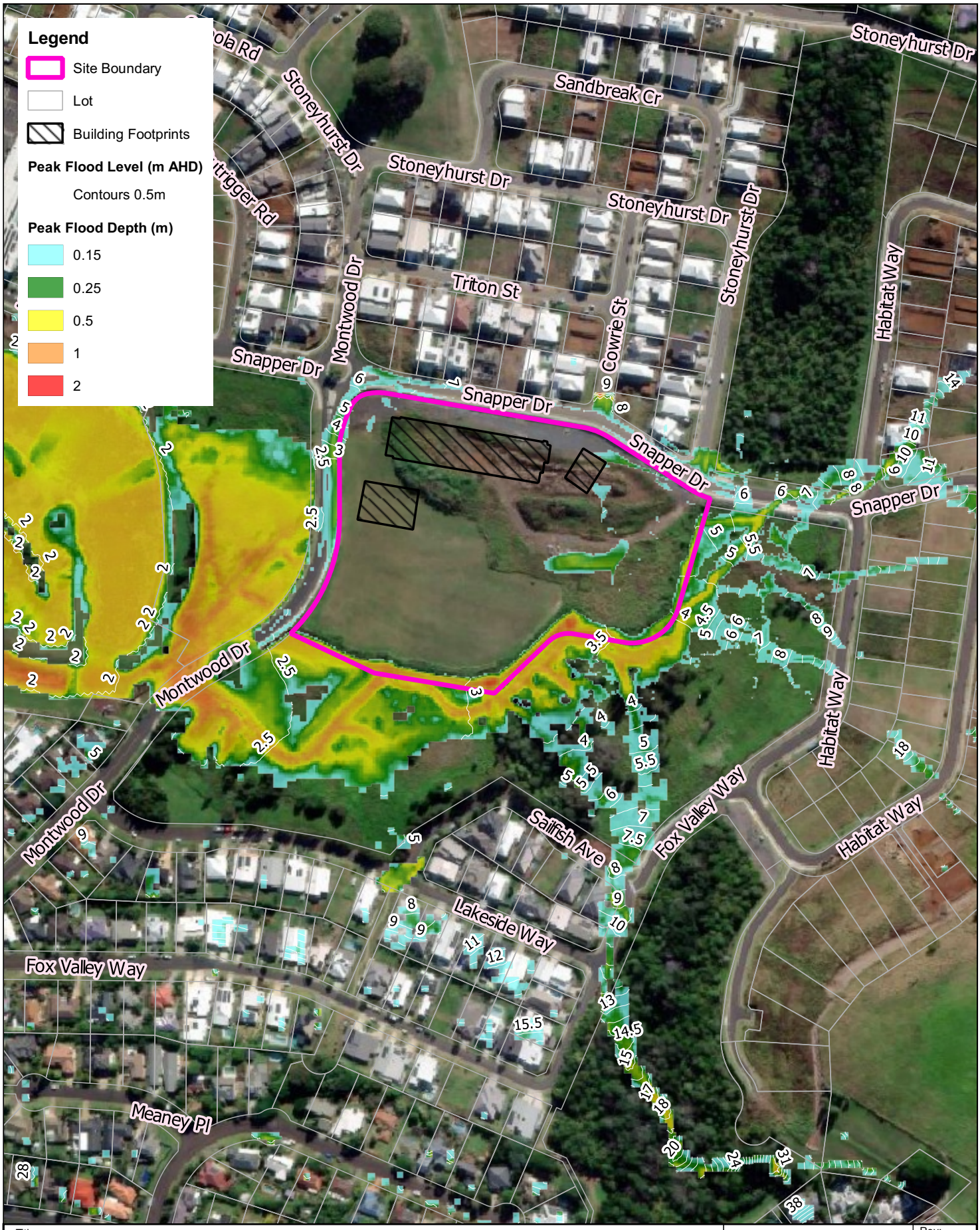

Title:

Peak Flood Depths and Levels - Post-Development Conditions - 10% AEP Event

Figure: B-02

Rev: A

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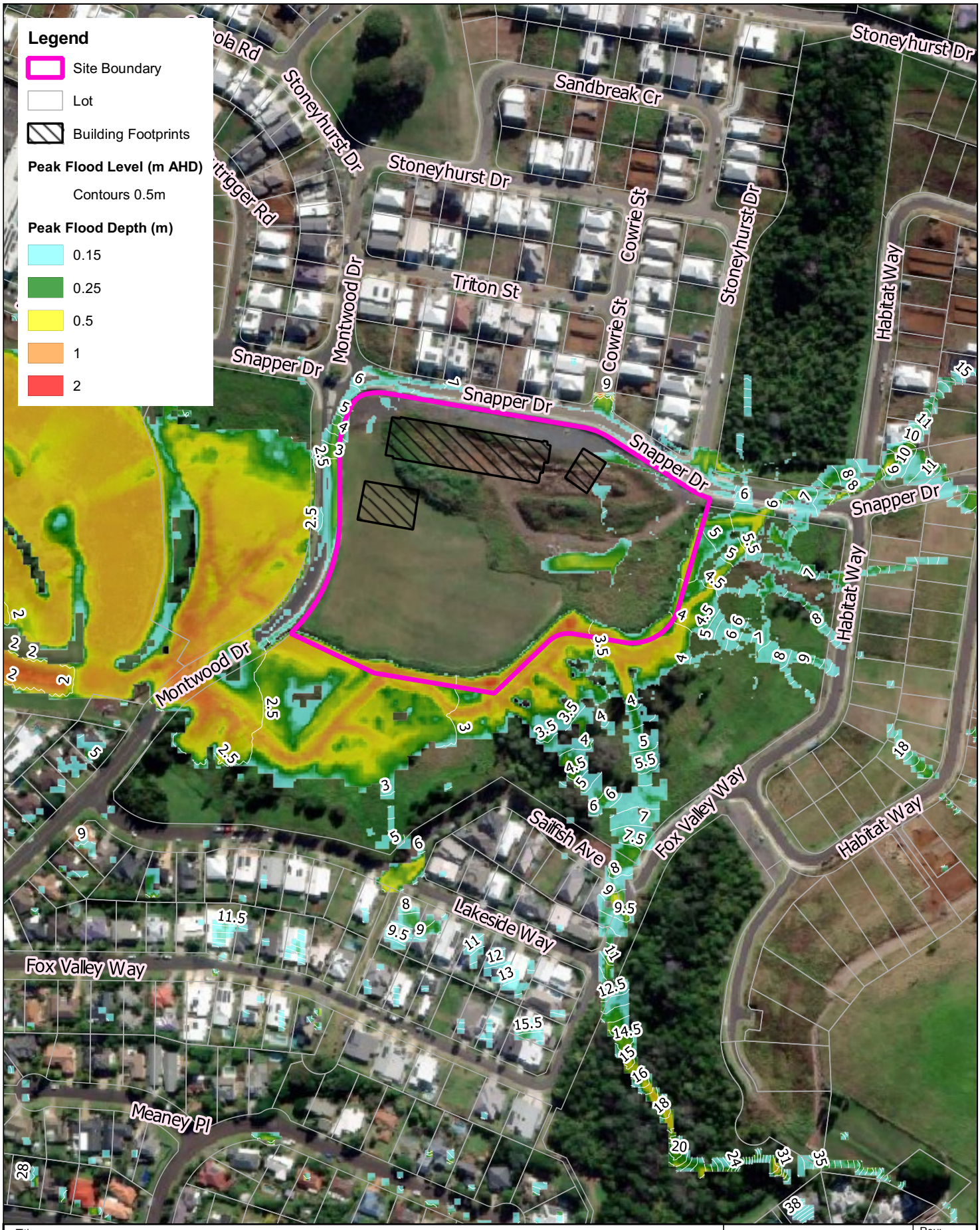

Title:

Peak Flood Depths and Levels - Post-Development Conditions - 5% AEP Event

Figure: B-03

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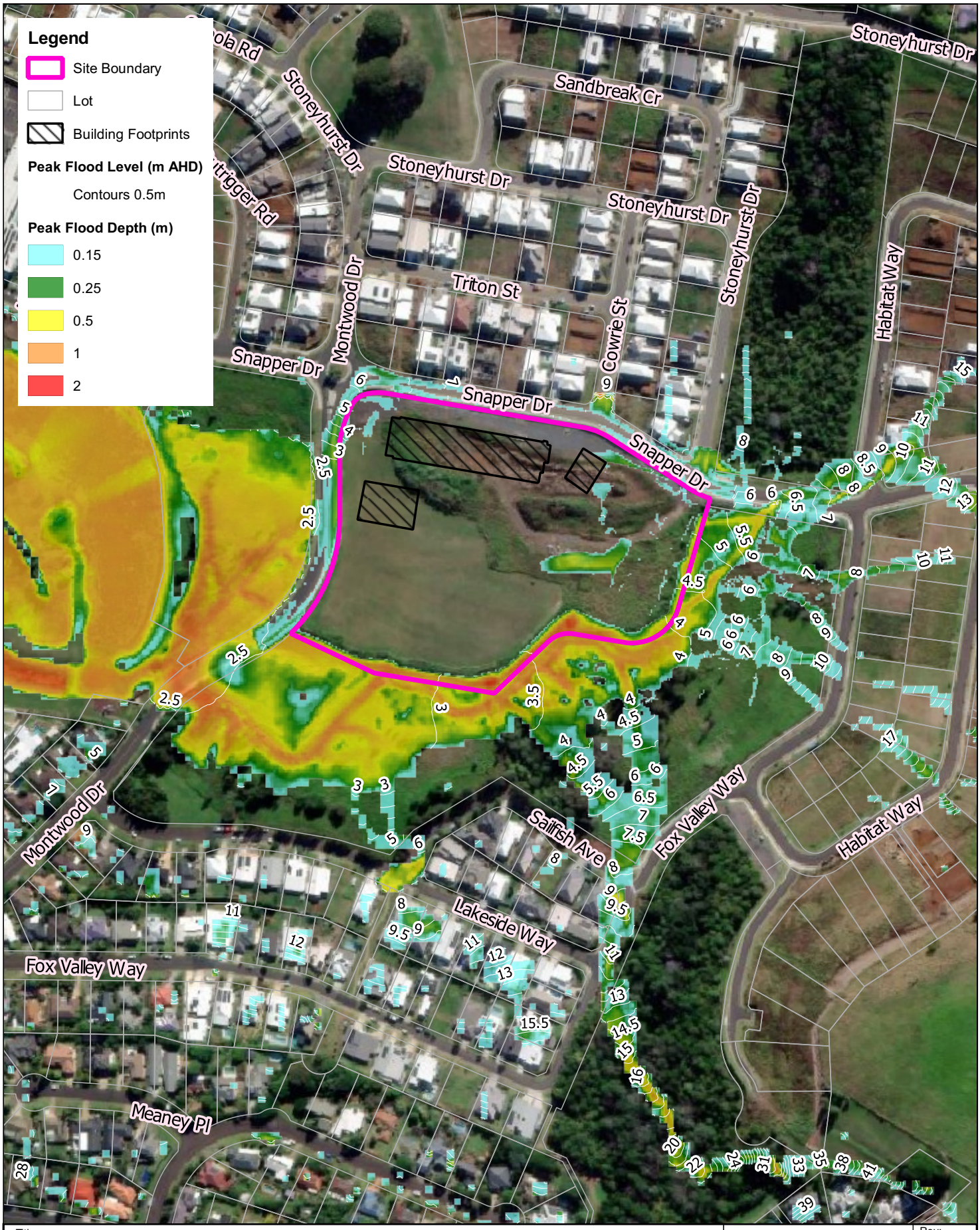

Title:

Peak Flood Depths and Levels - Post-Development Conditions - 1% AEP Event

Figure: B-04

Rev: A

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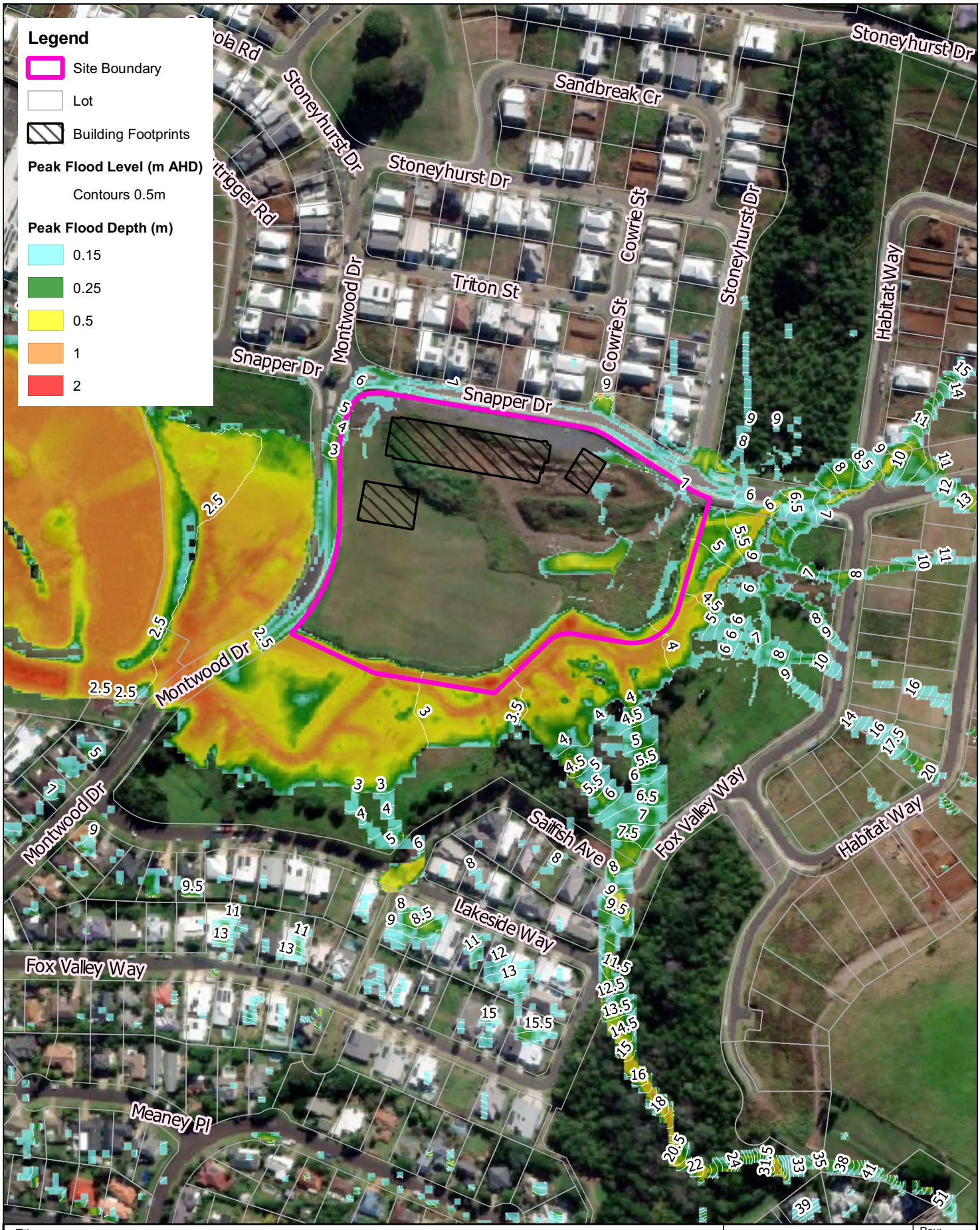

Title:

Peak Flood Depths and Levels - Post-Development Conditions - 0.2% AEP Event

Figure: B-05

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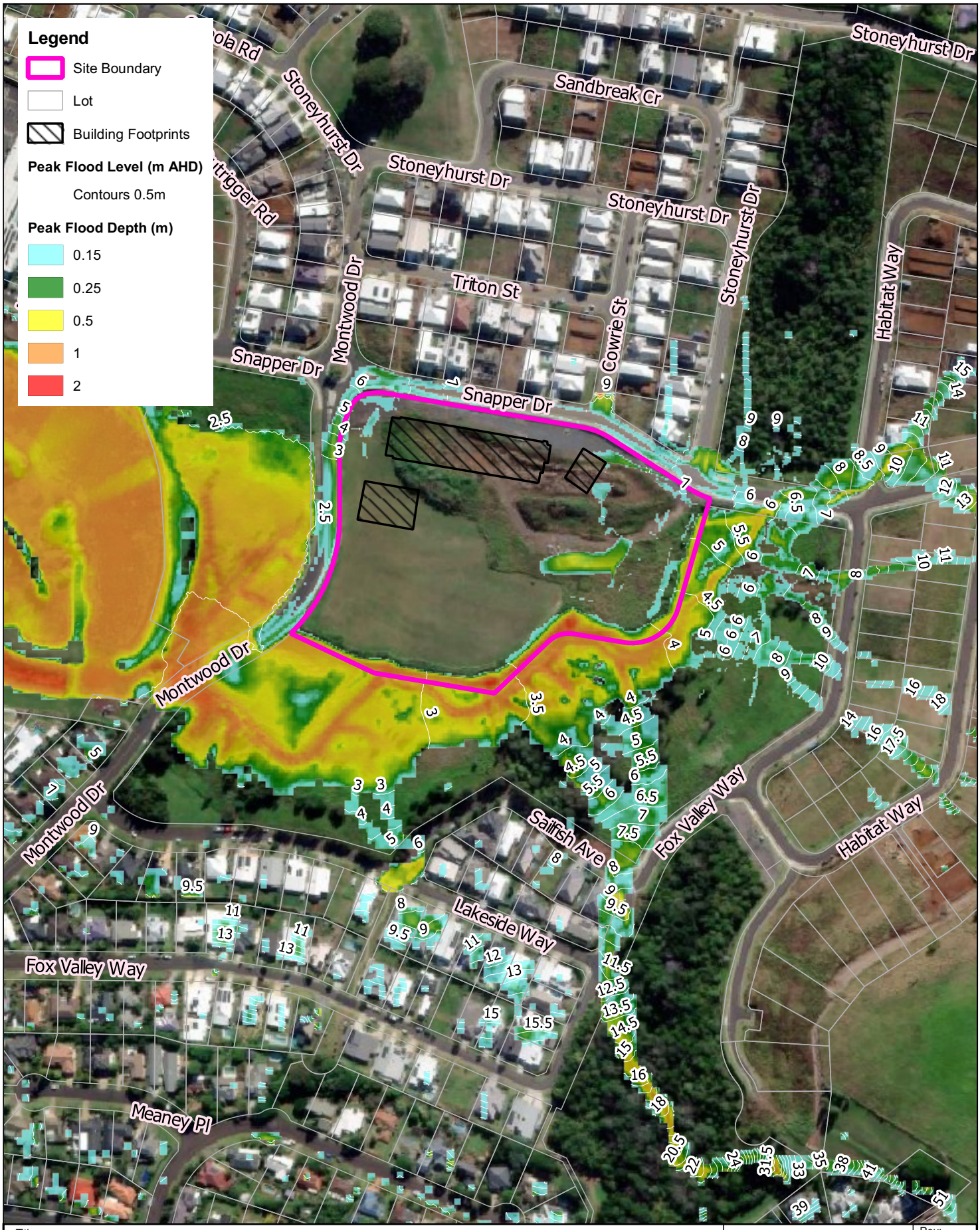

Title:

Peak Flood Depths and Levels - Post-Development Conditions - 1% AEP Event with Climate Change

Figure: B-06

Rev: A

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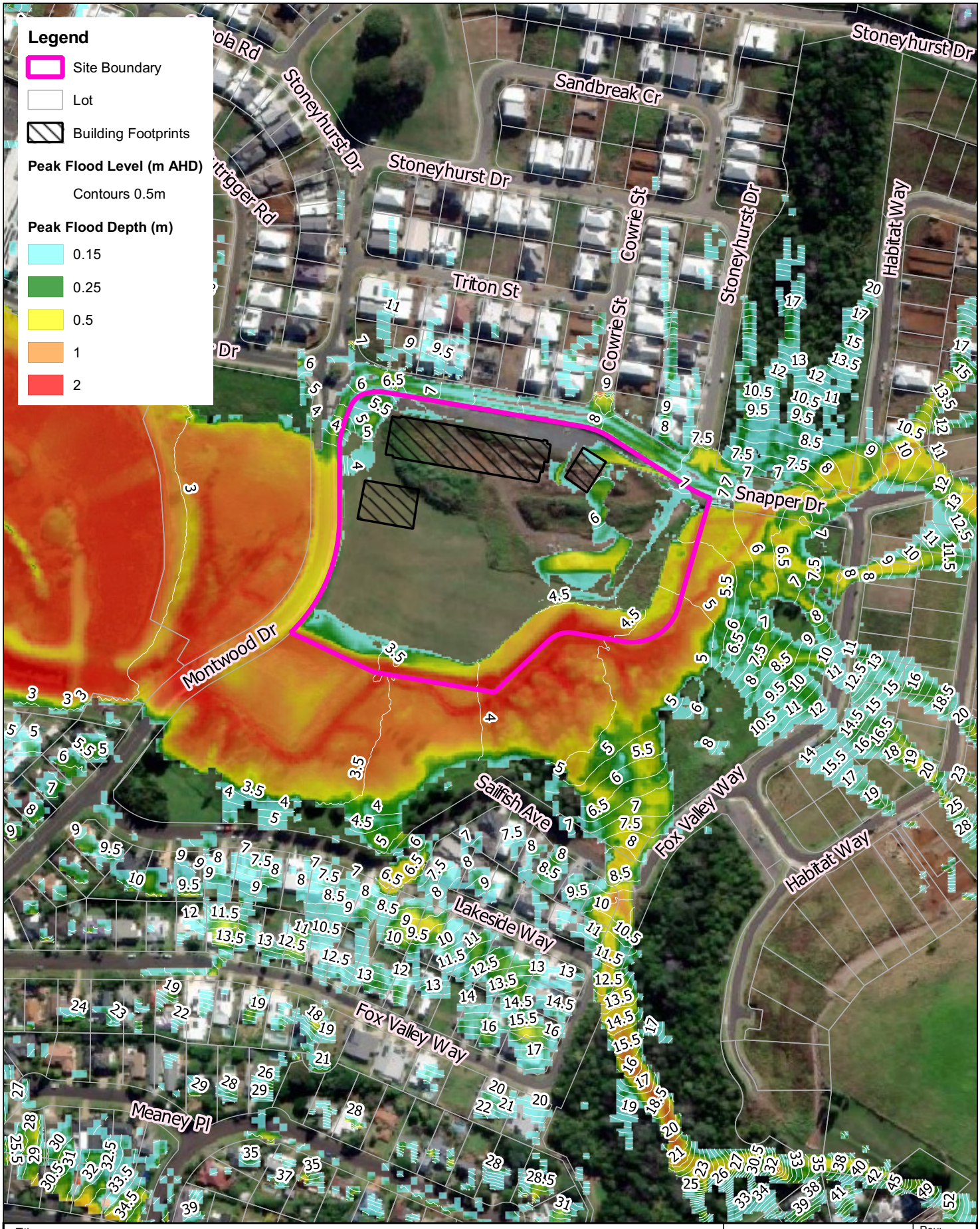

Title:

Peak Flood Depths and Levels - Post-Development Conditions - PMF Event

Figure: B-07

Rev: A

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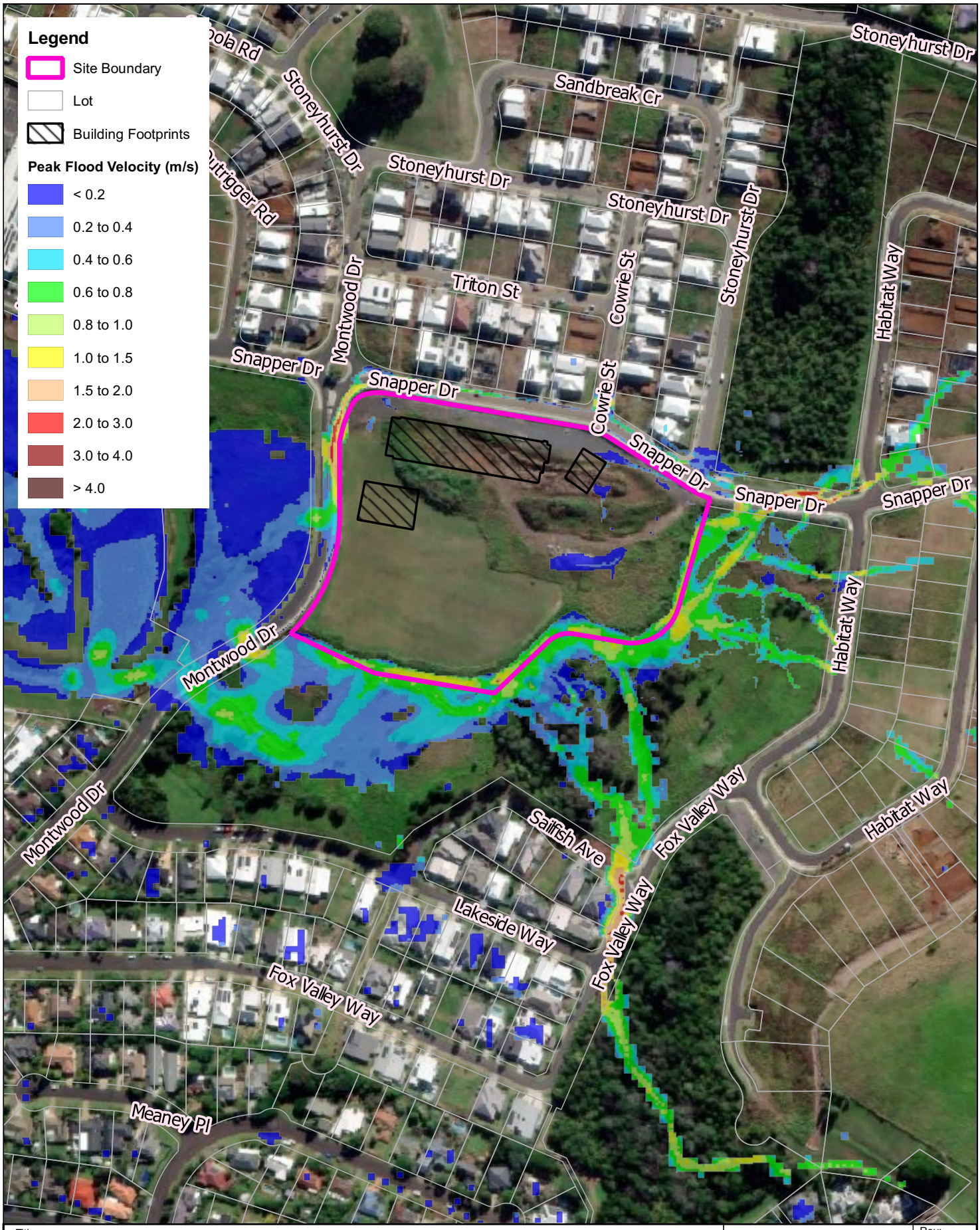

Title:

Peak Flood Velocities - Post-Development Conditions - 20% AEP Event

Figure: **B-08**

Rev: **A**

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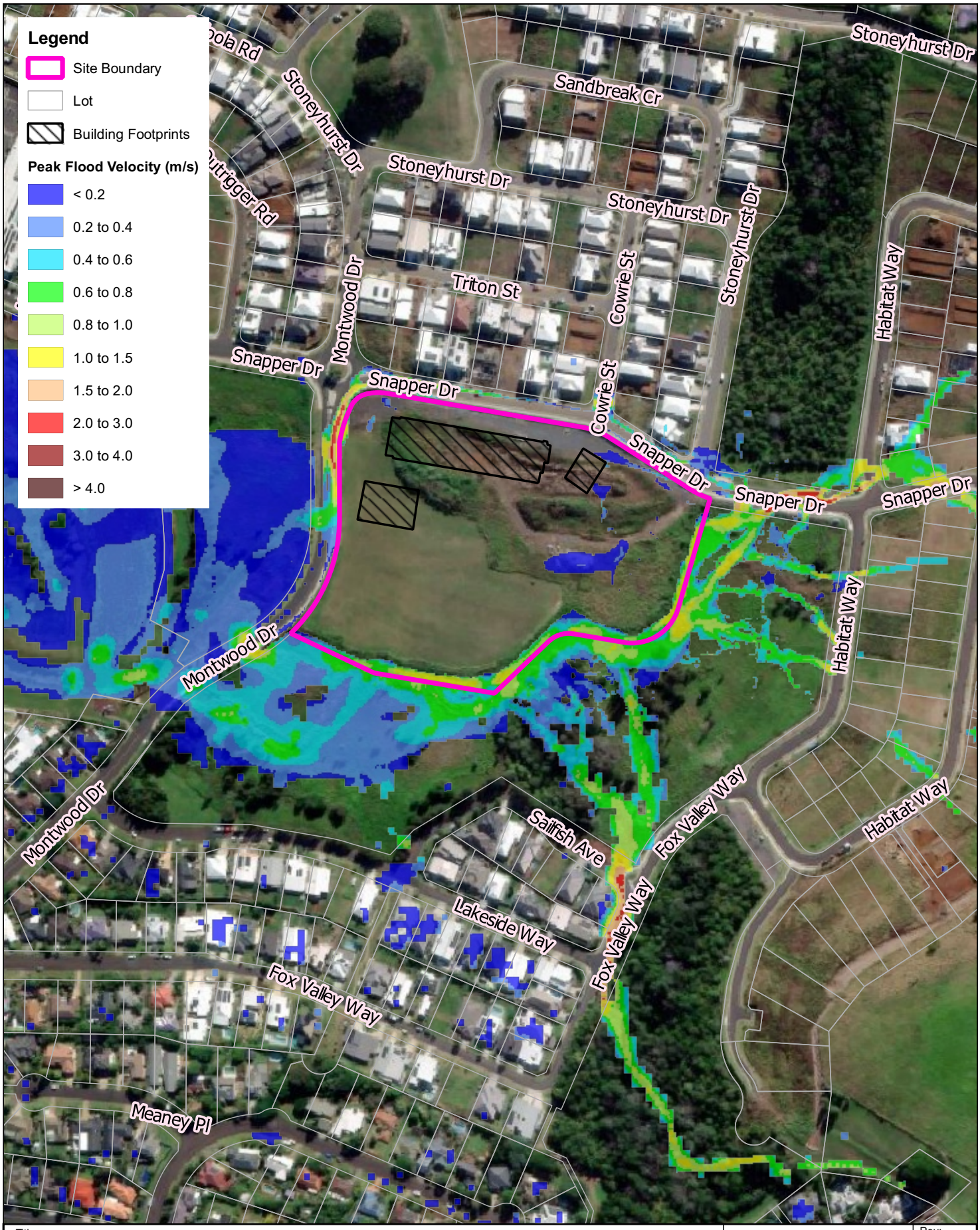

Title:

Peak Flood Velocities - Post-Development Conditions - 10% AEP Event

Figure: B-09

Rev: A

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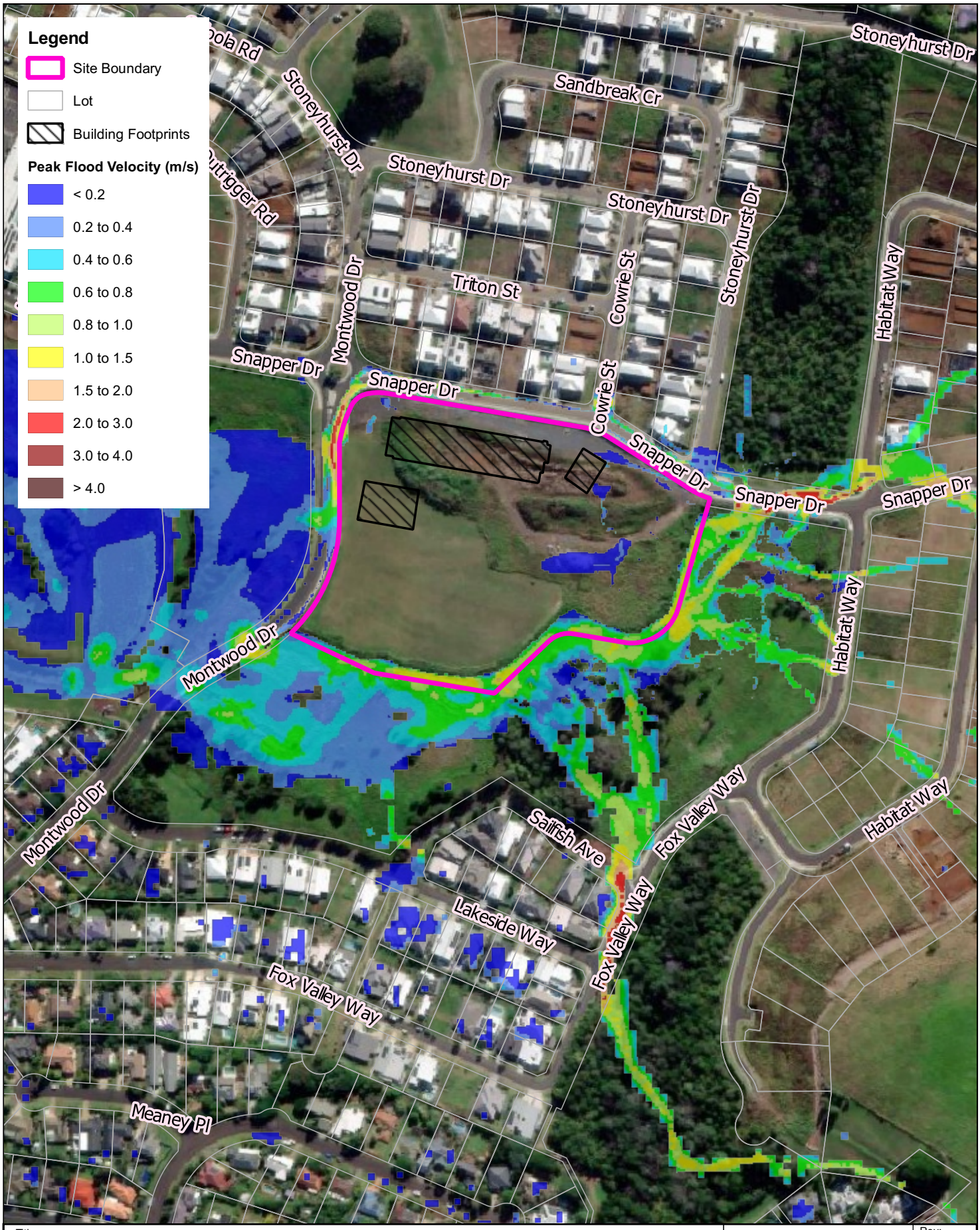

Title:

Peak Flood Velocities - Post-Development Conditions - 5% AEP Event

Figure: B-10

Rev: A

0 80 160 m

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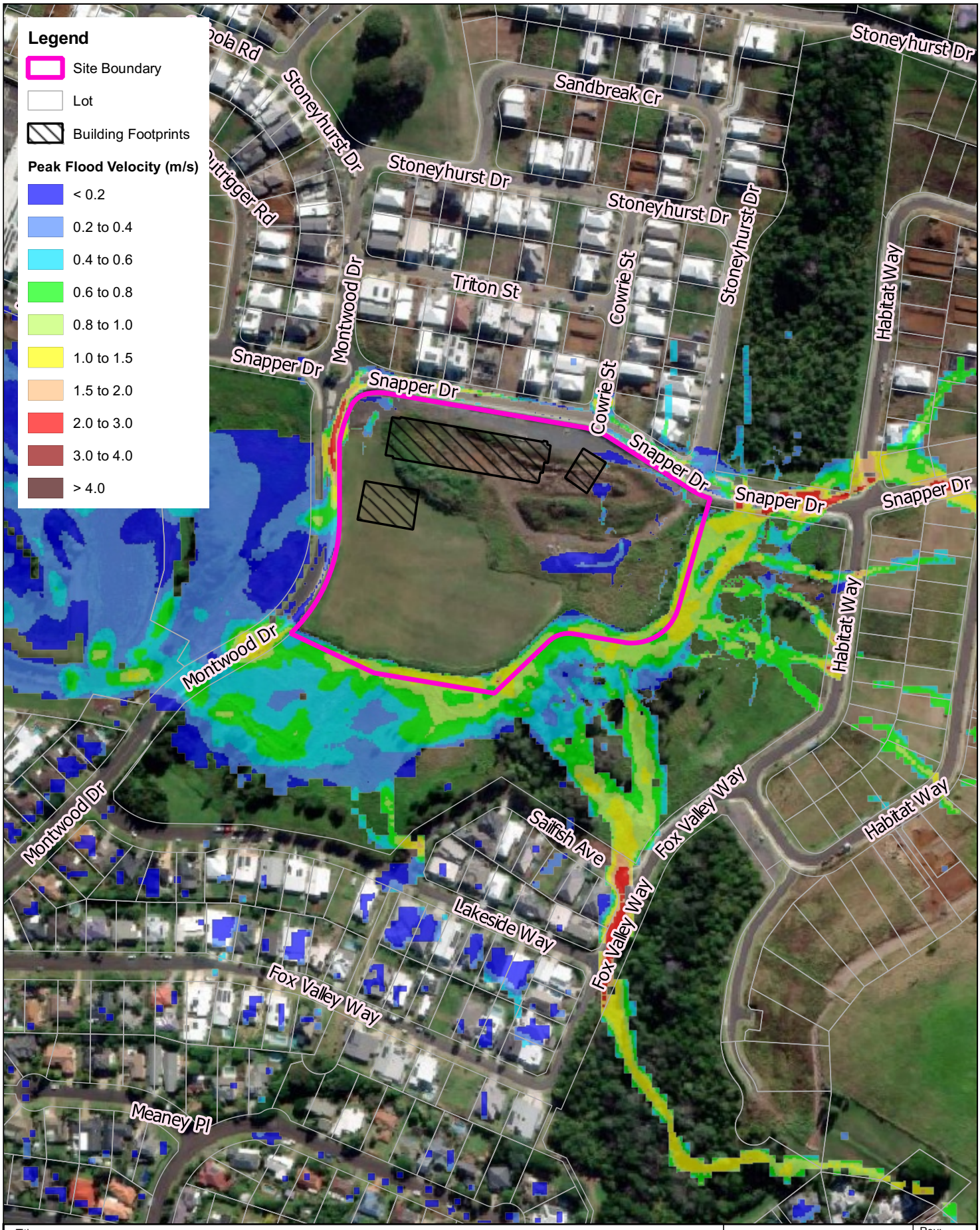

Title:

Peak Flood Velocities - Post-Development Conditions - 1% AEP Event

Figure: B-11

Rev: A

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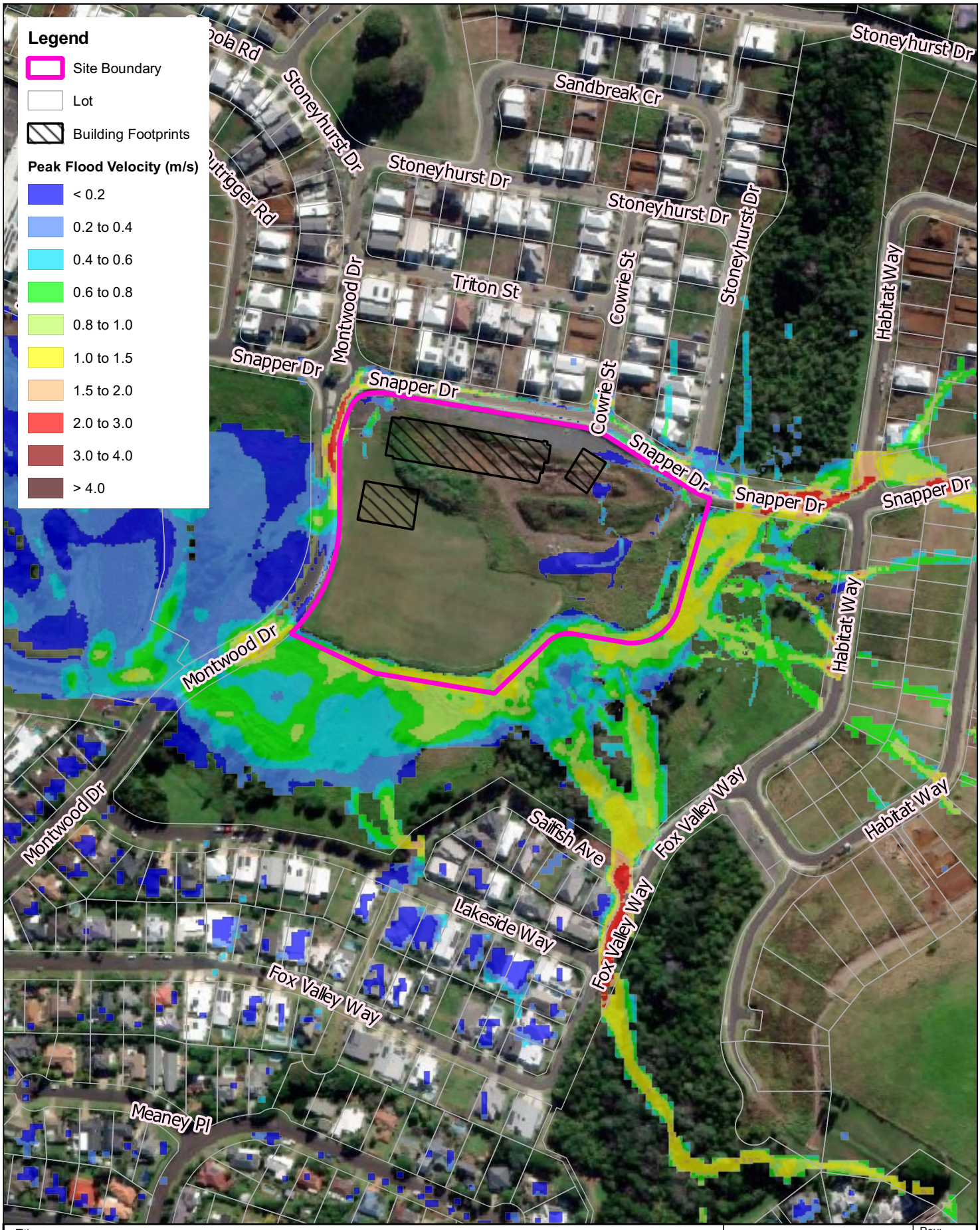

Title:

Peak Flood Velocities - Post-Development Conditions - 0.2% AEP Event

Figure: B-12

Rev: A

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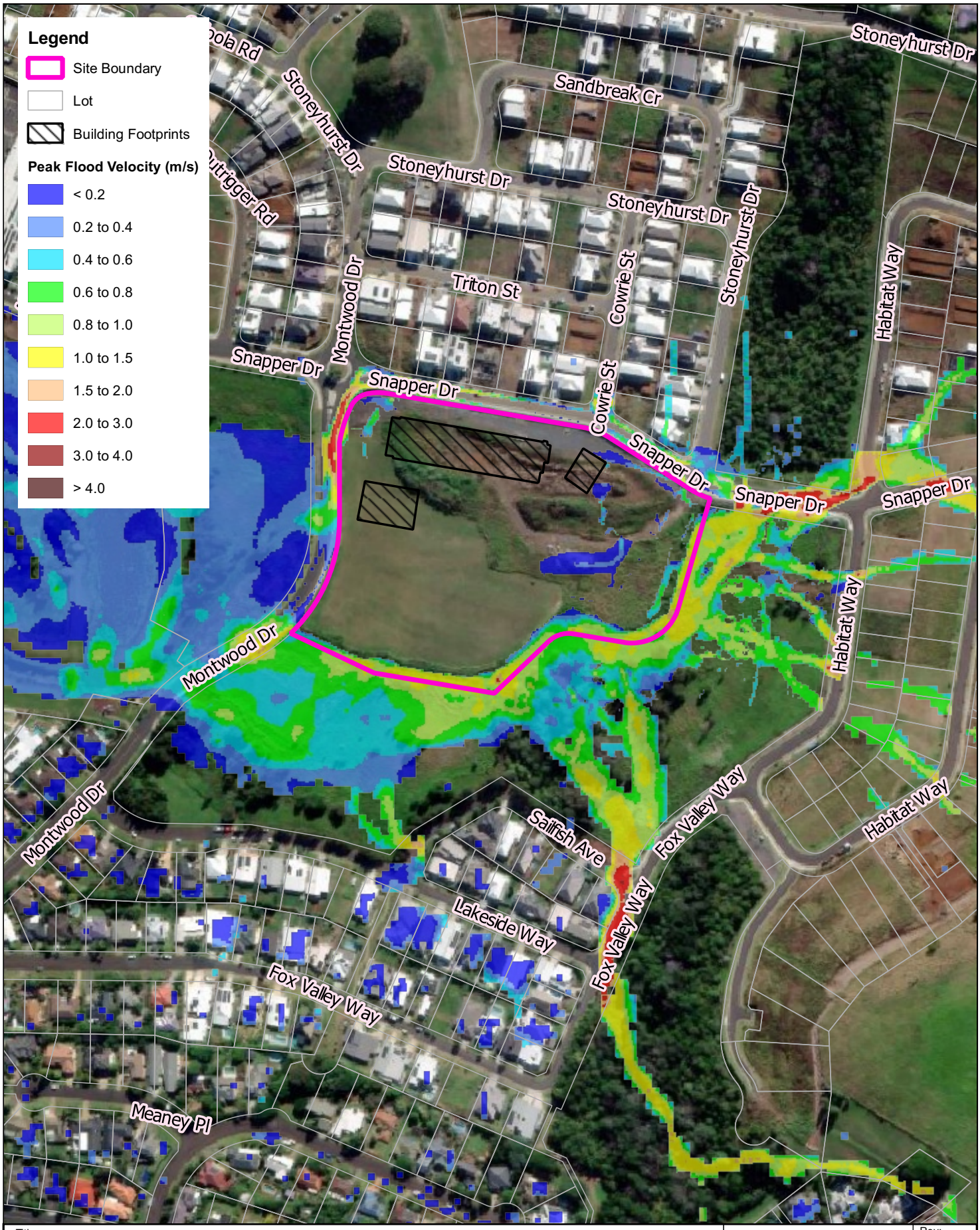

Title:

Peak Flood Velocities - Post-Development Conditions - 1% AEP Event with Climate Change

Figure: B-13

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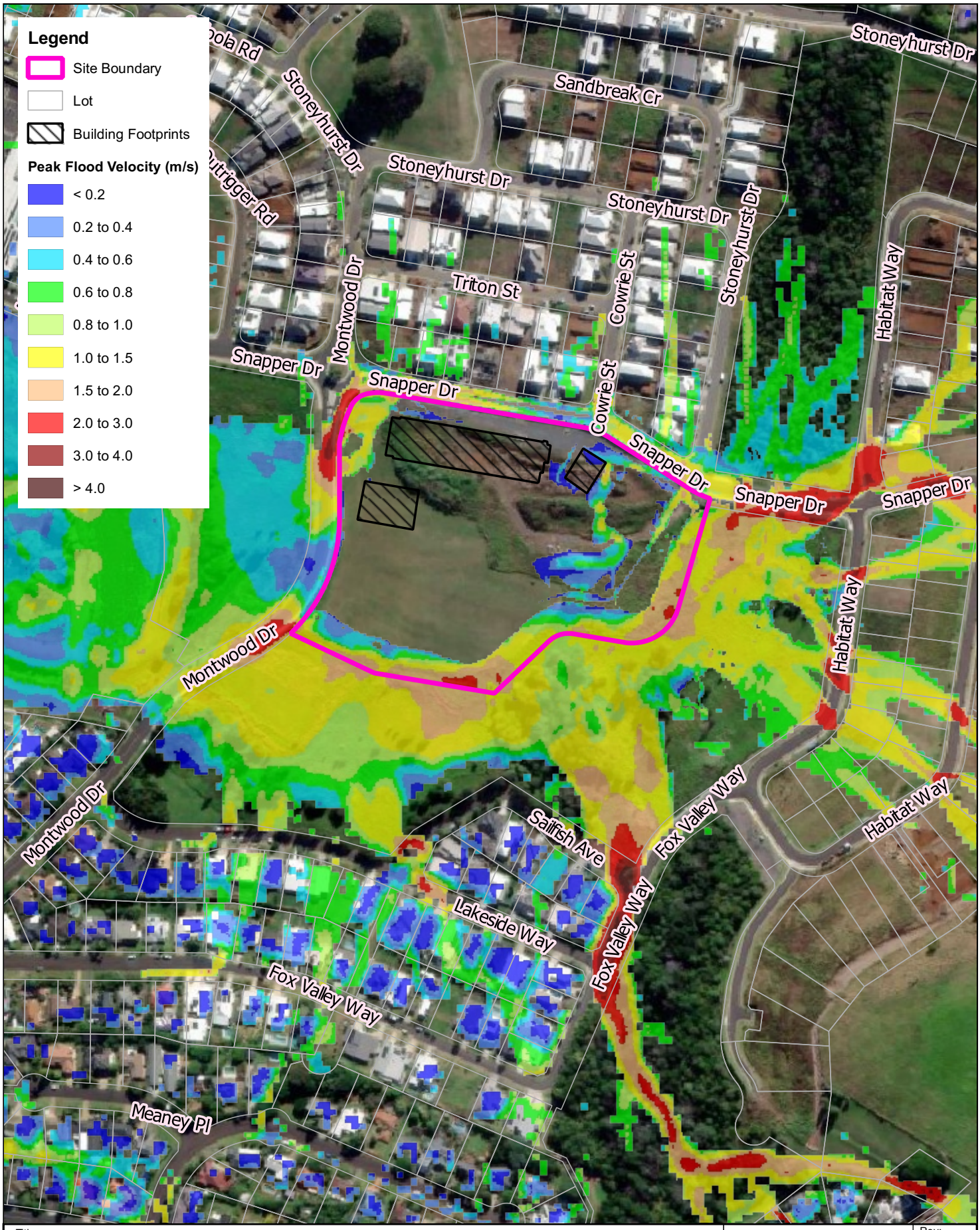

Title:

Peak Flood Velocities- Post-Development Conditions - PMF Event

Figure: B-14

Rev: A

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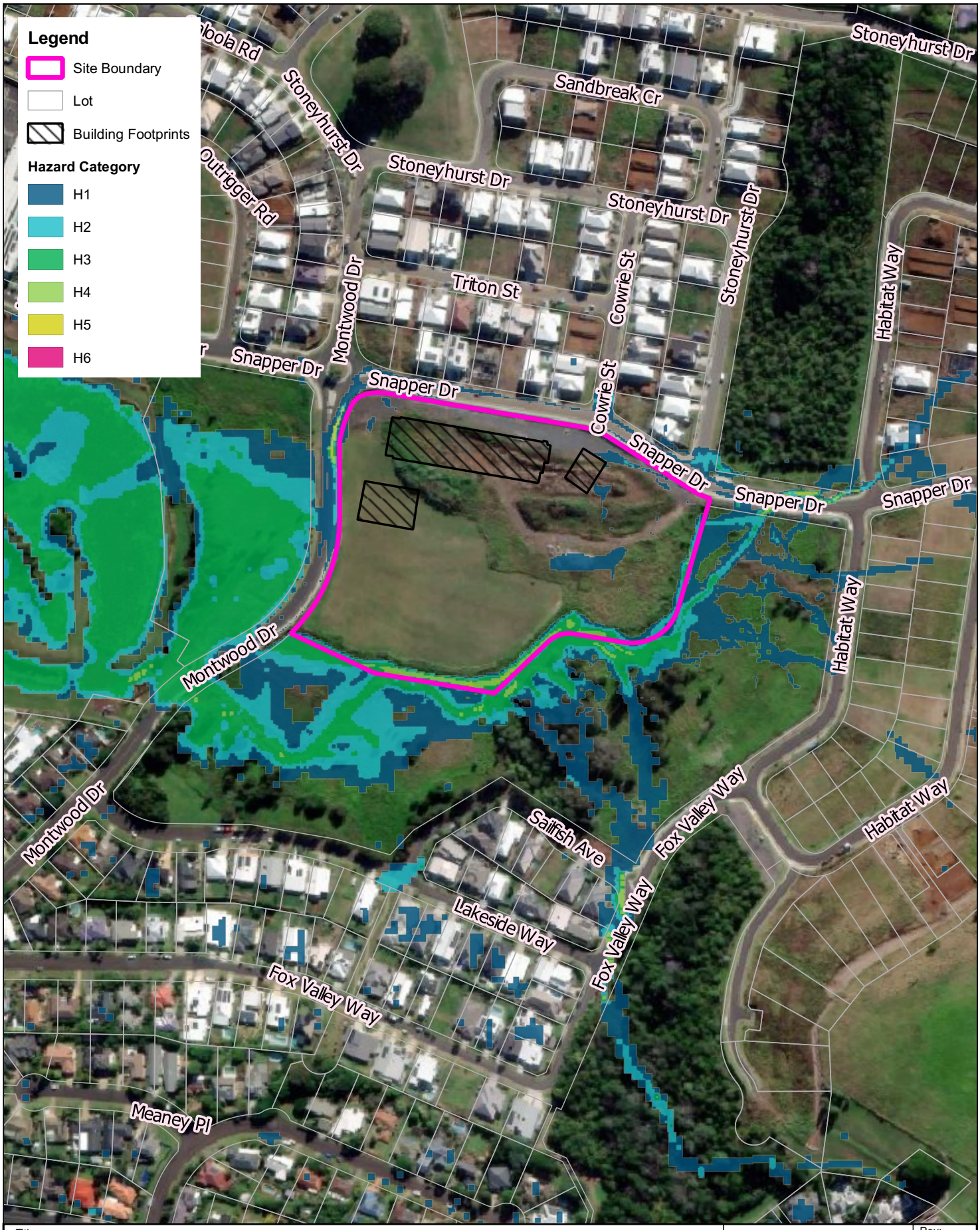

Title:

Peak Flood Hazard - Post-Development Conditions - 20% AEP Event

Figure: B-15

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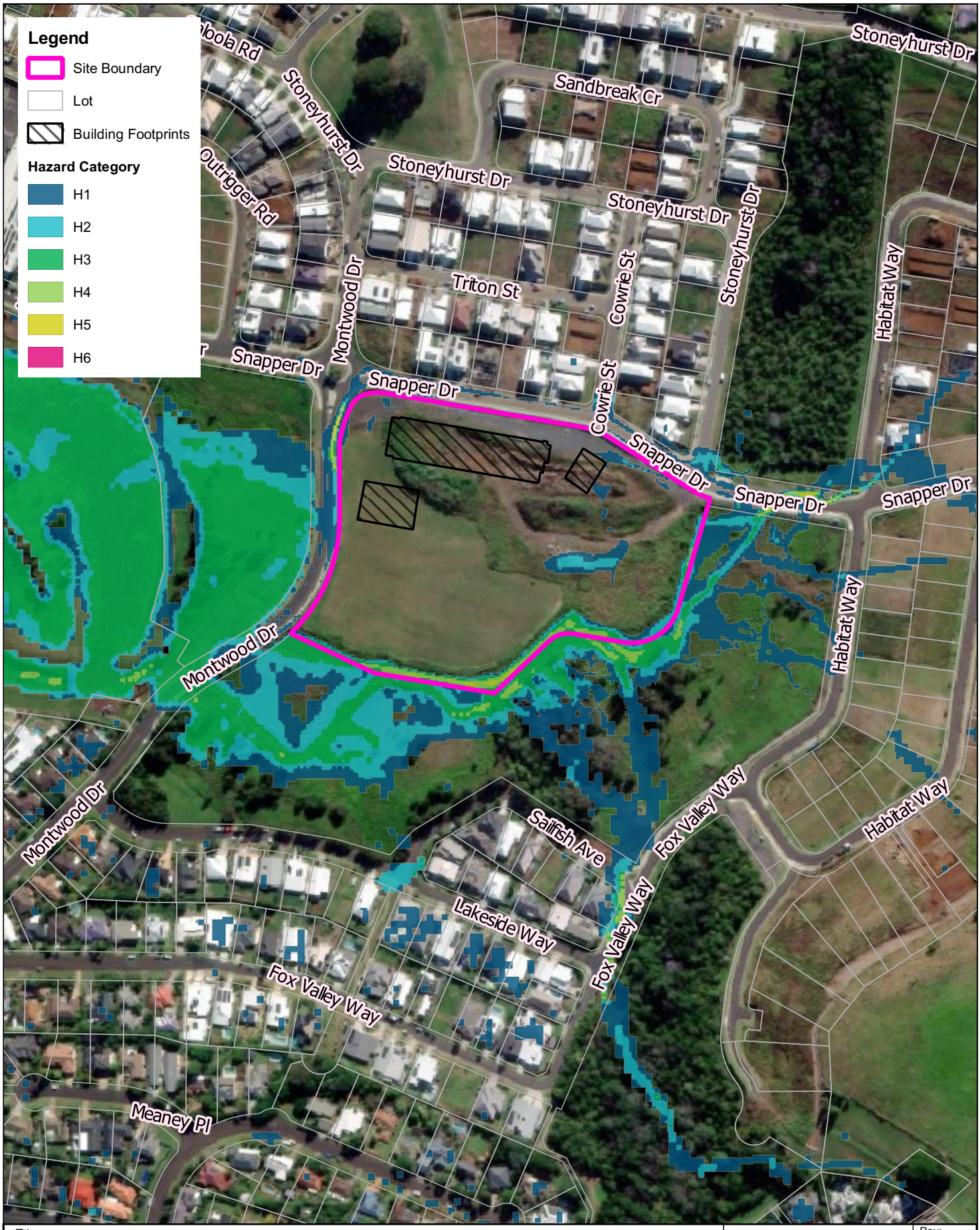

Title:

Peak Flood Hazard - Post-Development Conditions - 10% AEP Event

Figure: B-16

Rev: A

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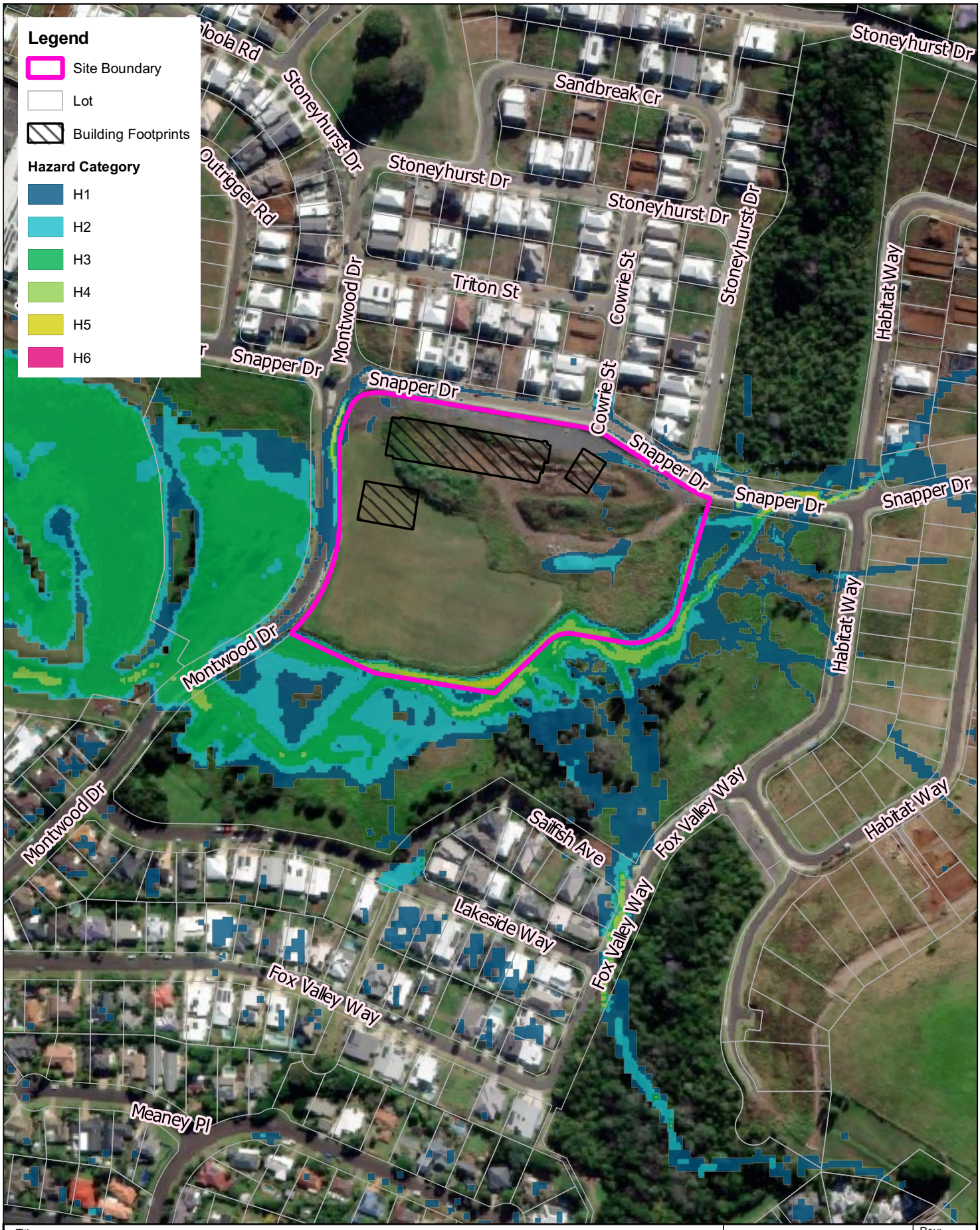

Title:

Peak Flood Hazard - Post-Development Conditions - 5% AEP Event

Figure: B-17

Rev: A

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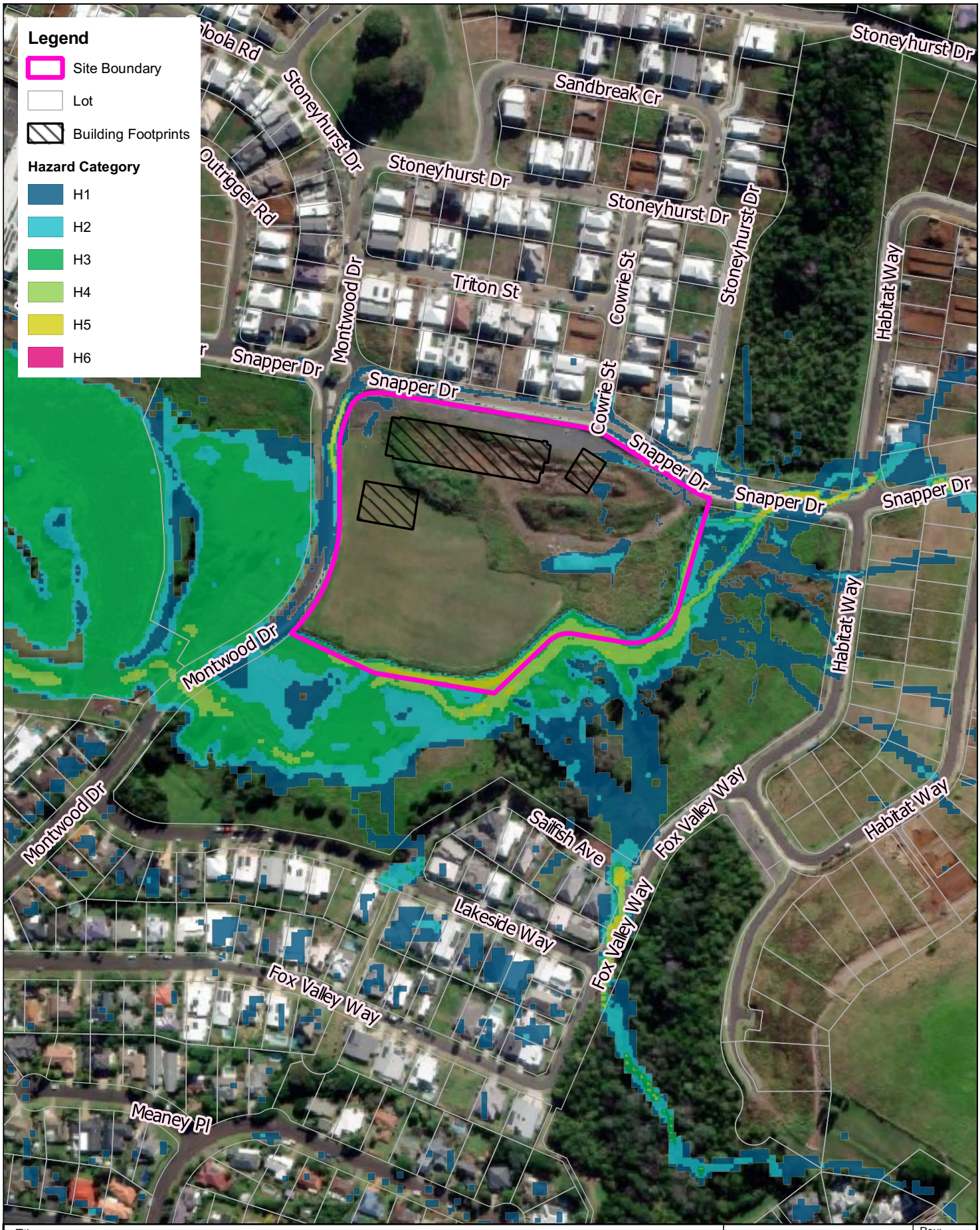

Title:

Peak Flood Hazard - Post-Development Conditions - 1% AEP Event

Figure: B-18

Rev: A

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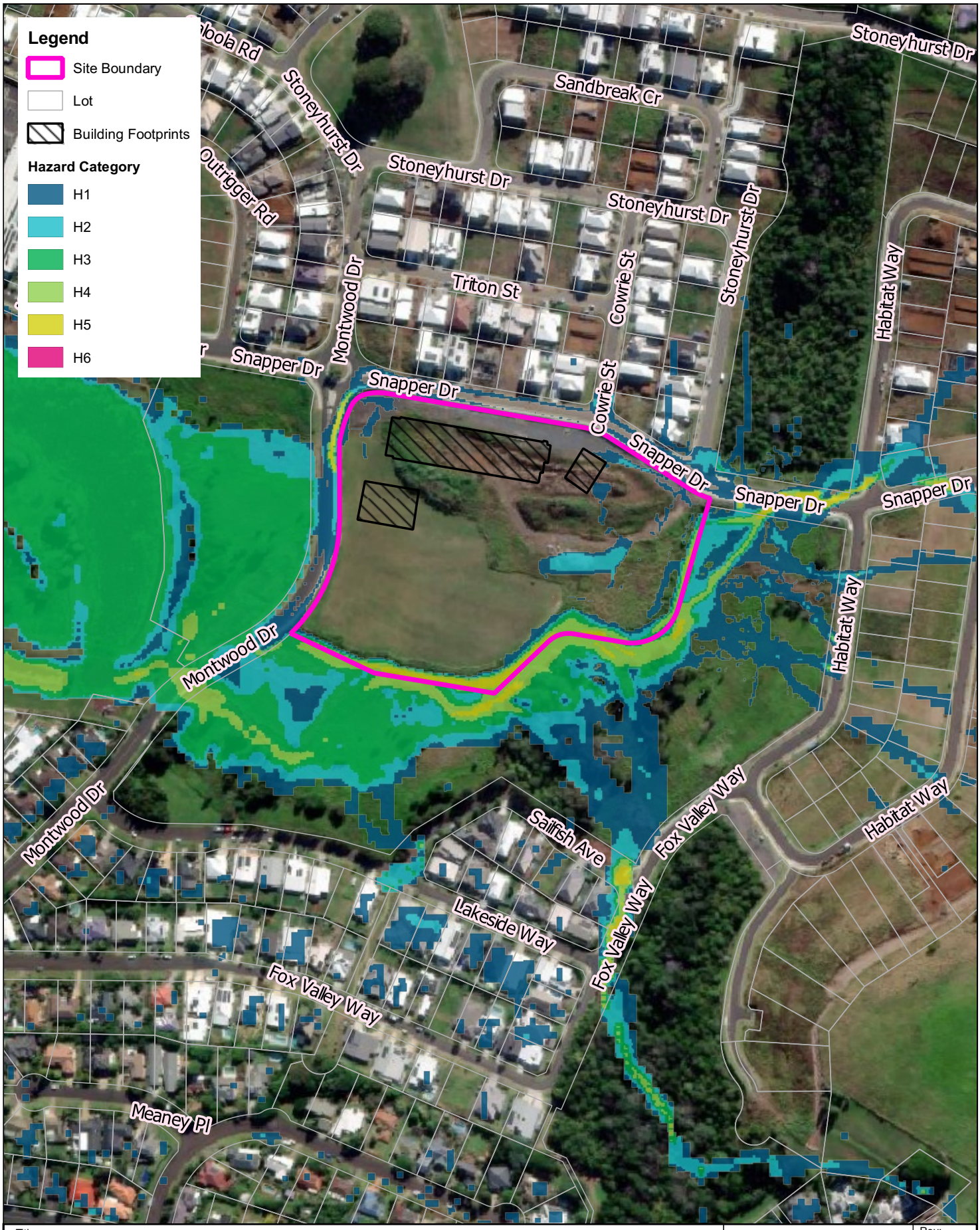

Title:

Peak Flood Hazard - Post-Development Conditions - 0.2% AEP Event

Figure: B-19

Rev: A

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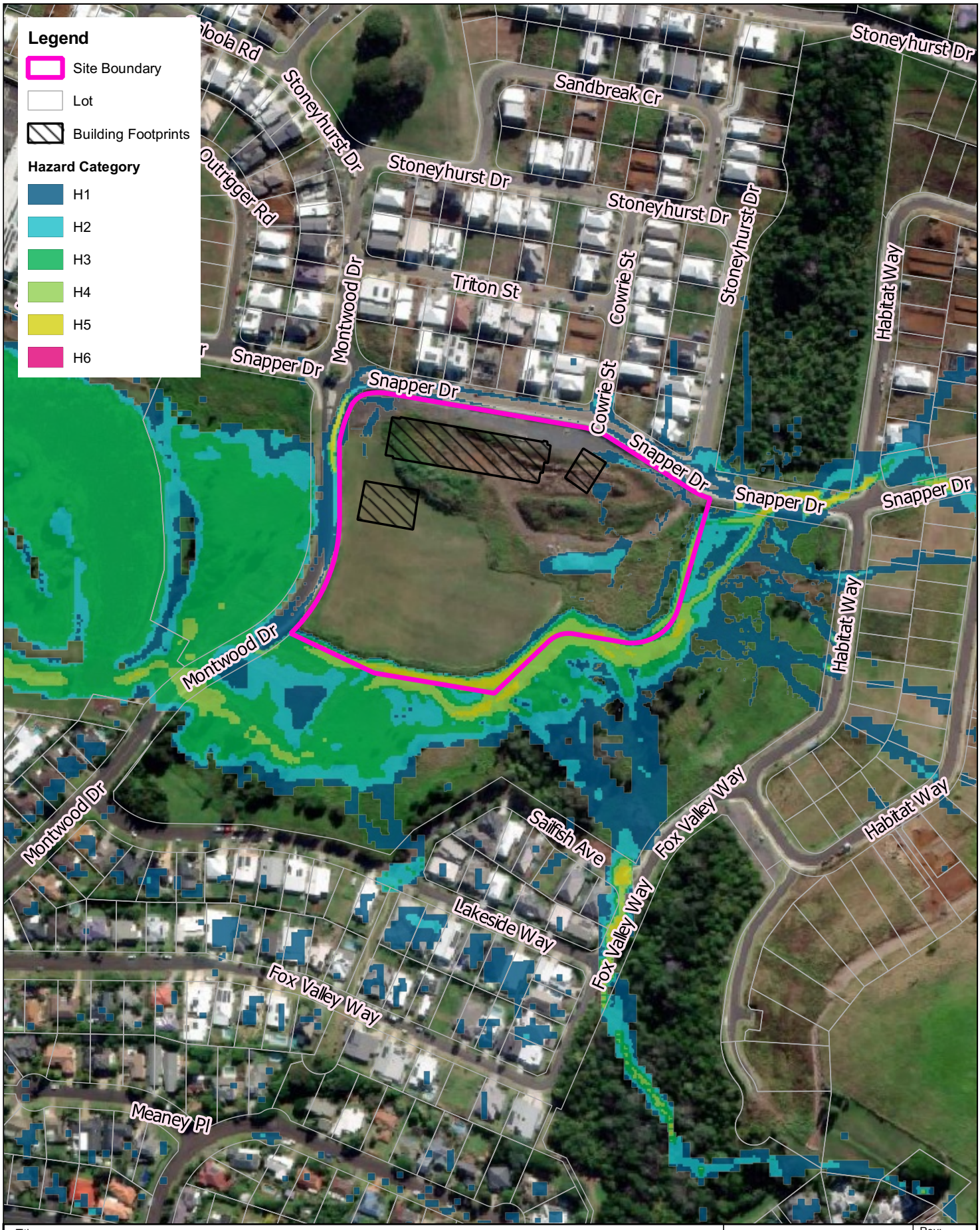

Title:

Peak Flood Hazard - Post-Development Conditions - 1% AEP Event with Climate Change

Figure: B-20

Rev: A

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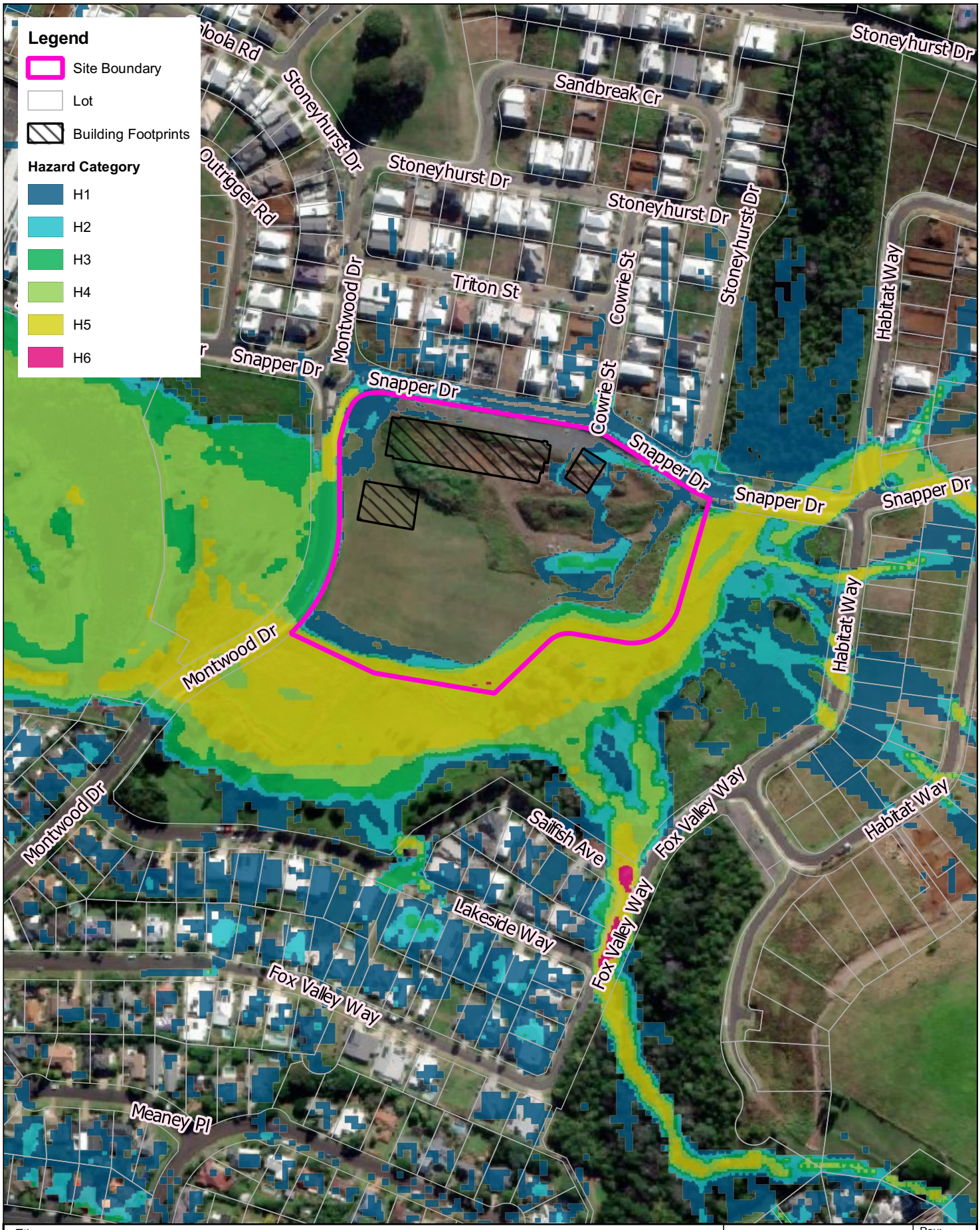

Title:

Peak Flood Hazard - Post-Development Conditions - PMF Event

Figure: B-21

Rev: A

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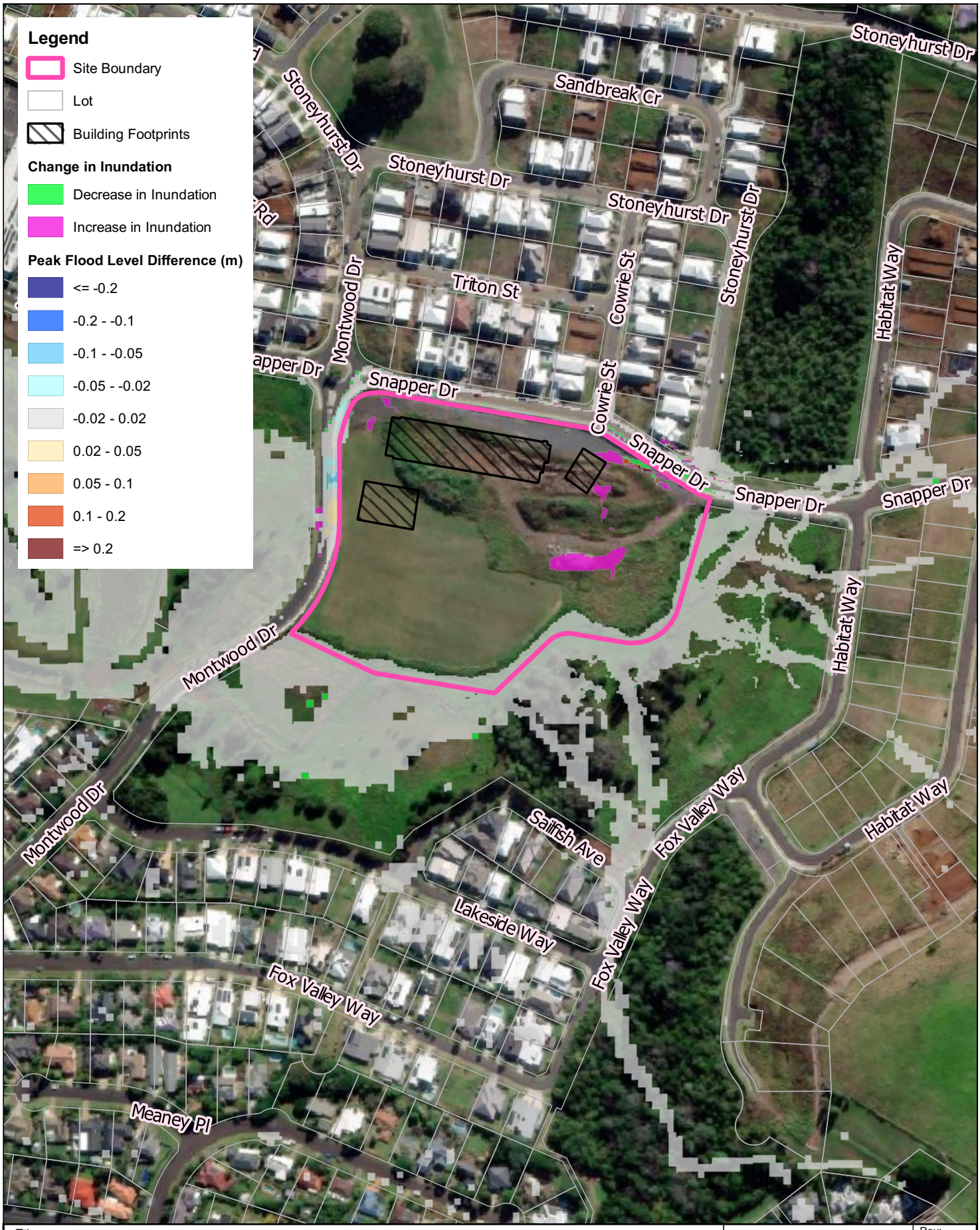
Annex C Flood Impact Mapping



Title:

Peak Flood Level Impact - 20% AEP Event

Figure: C-01

Rev: A

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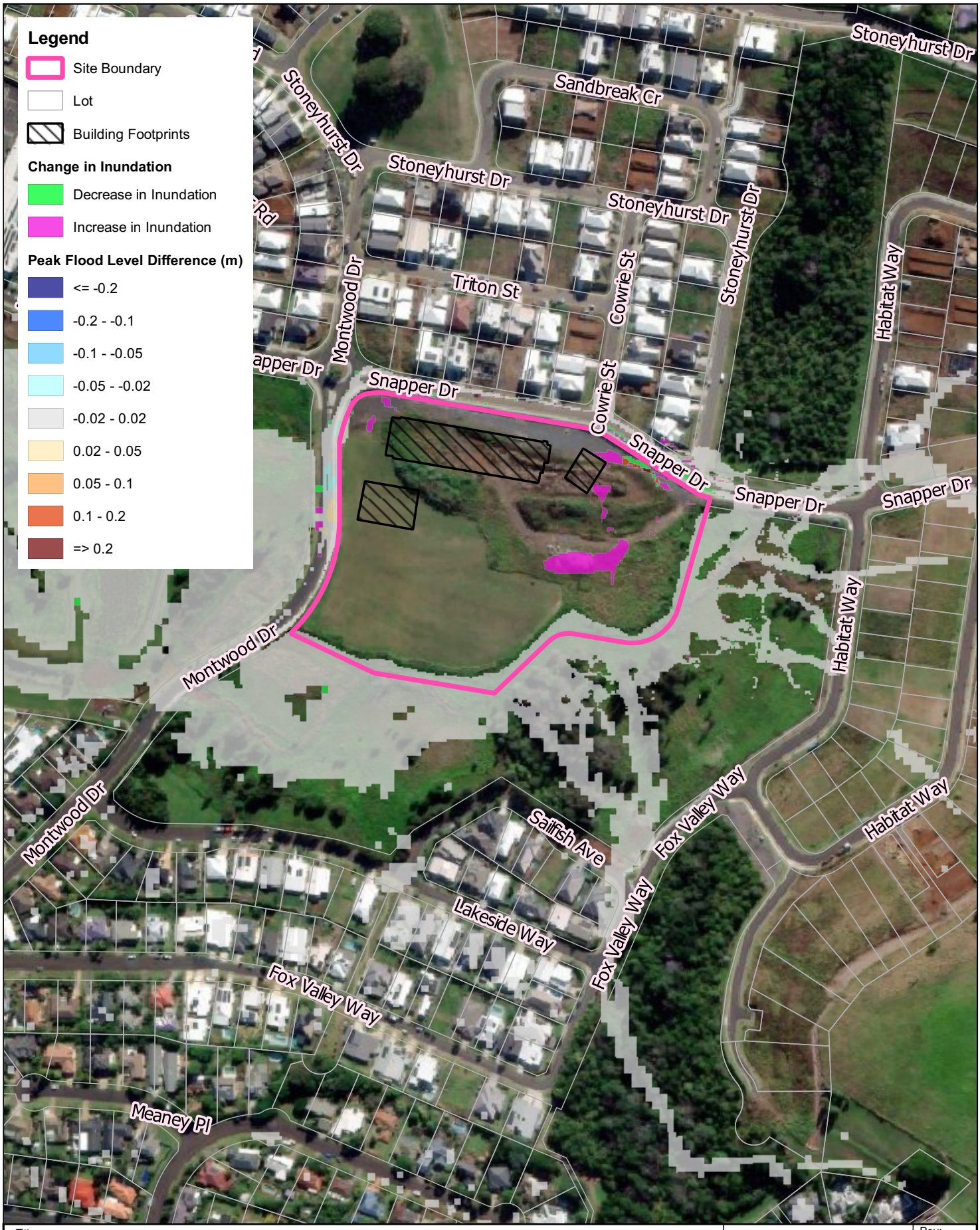

Title:

Peak Flood Level Impact - 10% AEP Event

Figure: C-02

Rev: A

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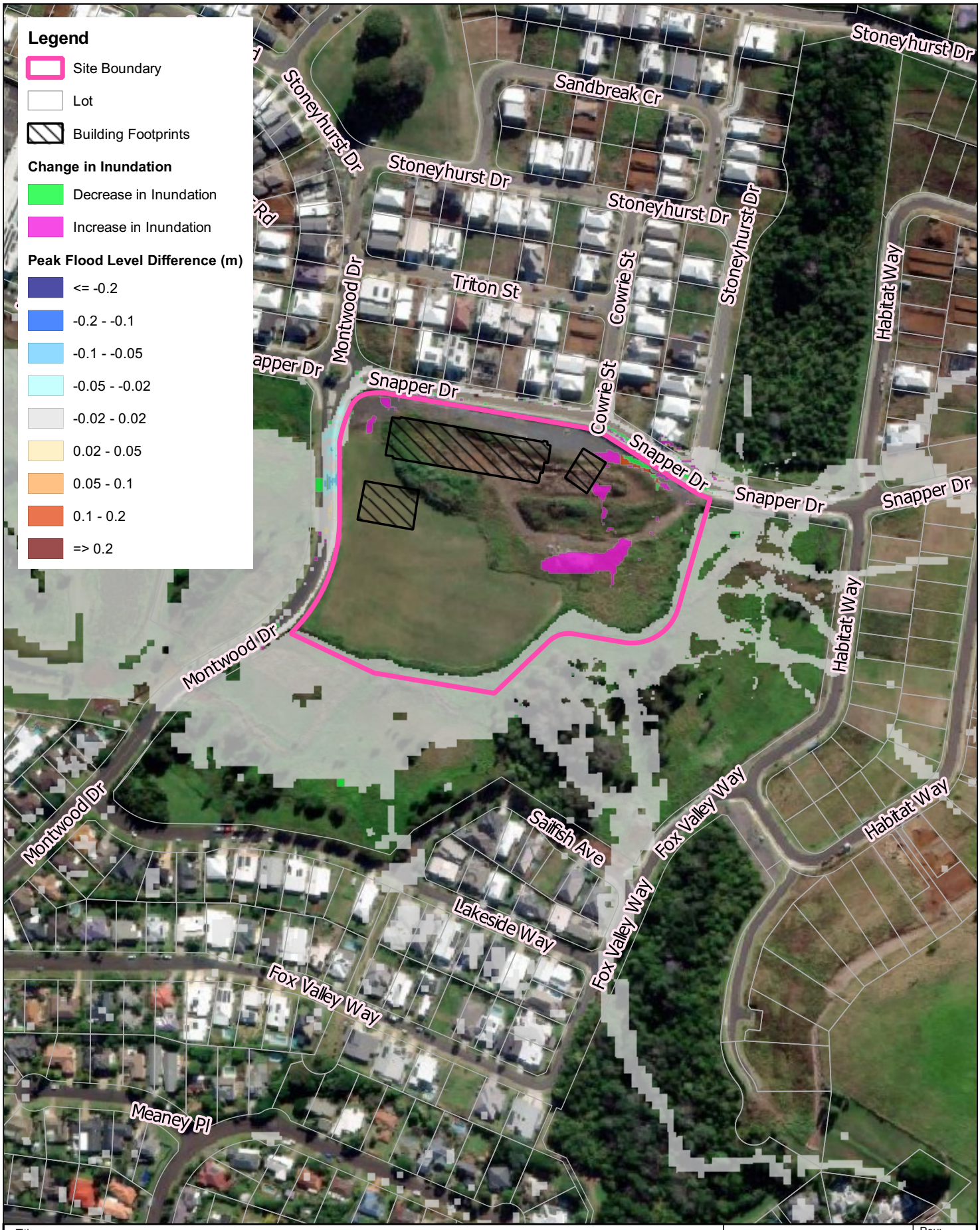

Title:

Peak Flood Level Impact - 5% AEP Event

Figure: C-03

Rev: A

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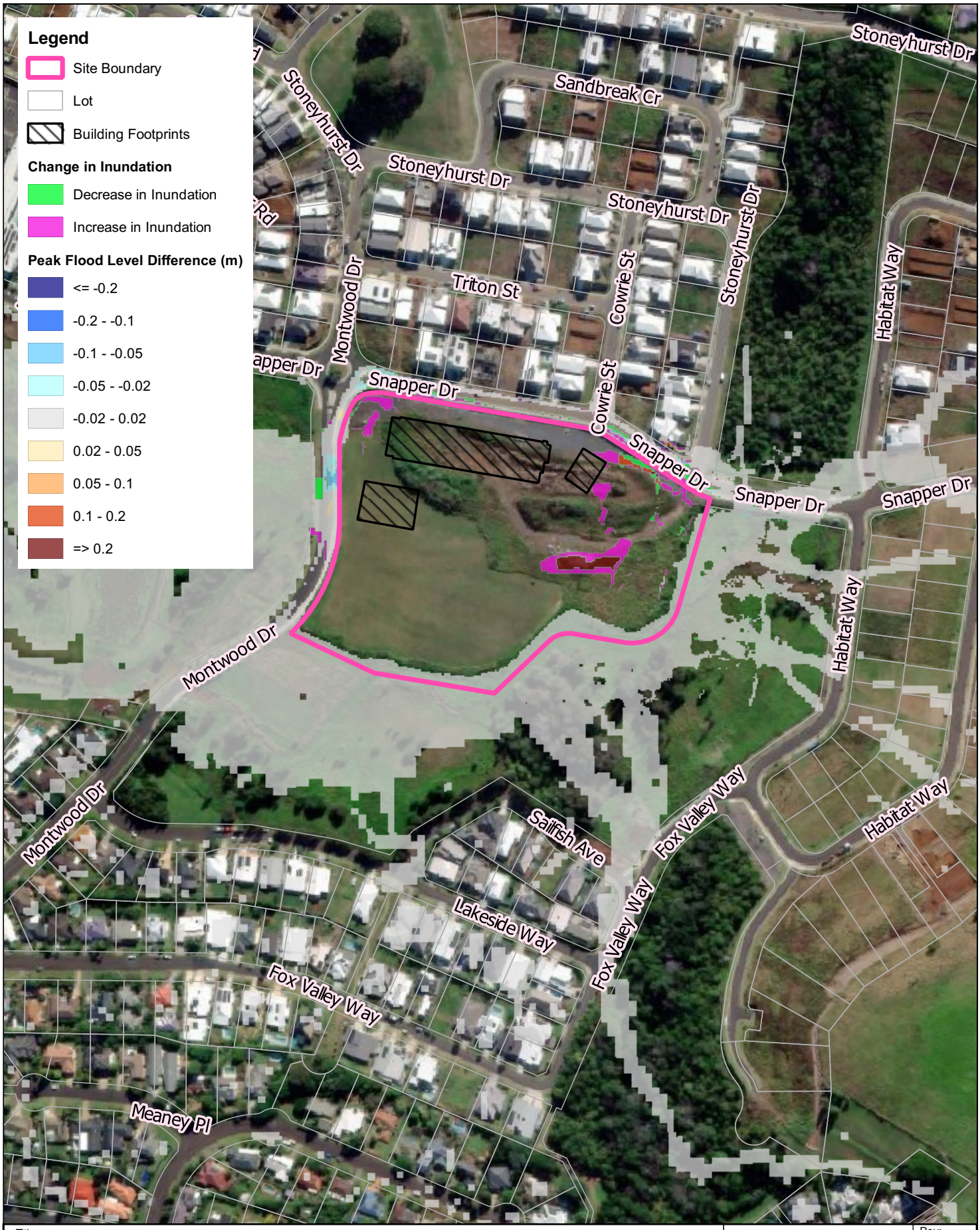

Title:

Peak Flood Level Impact - 1% AEP Event

Figure: C-04

Rev: A

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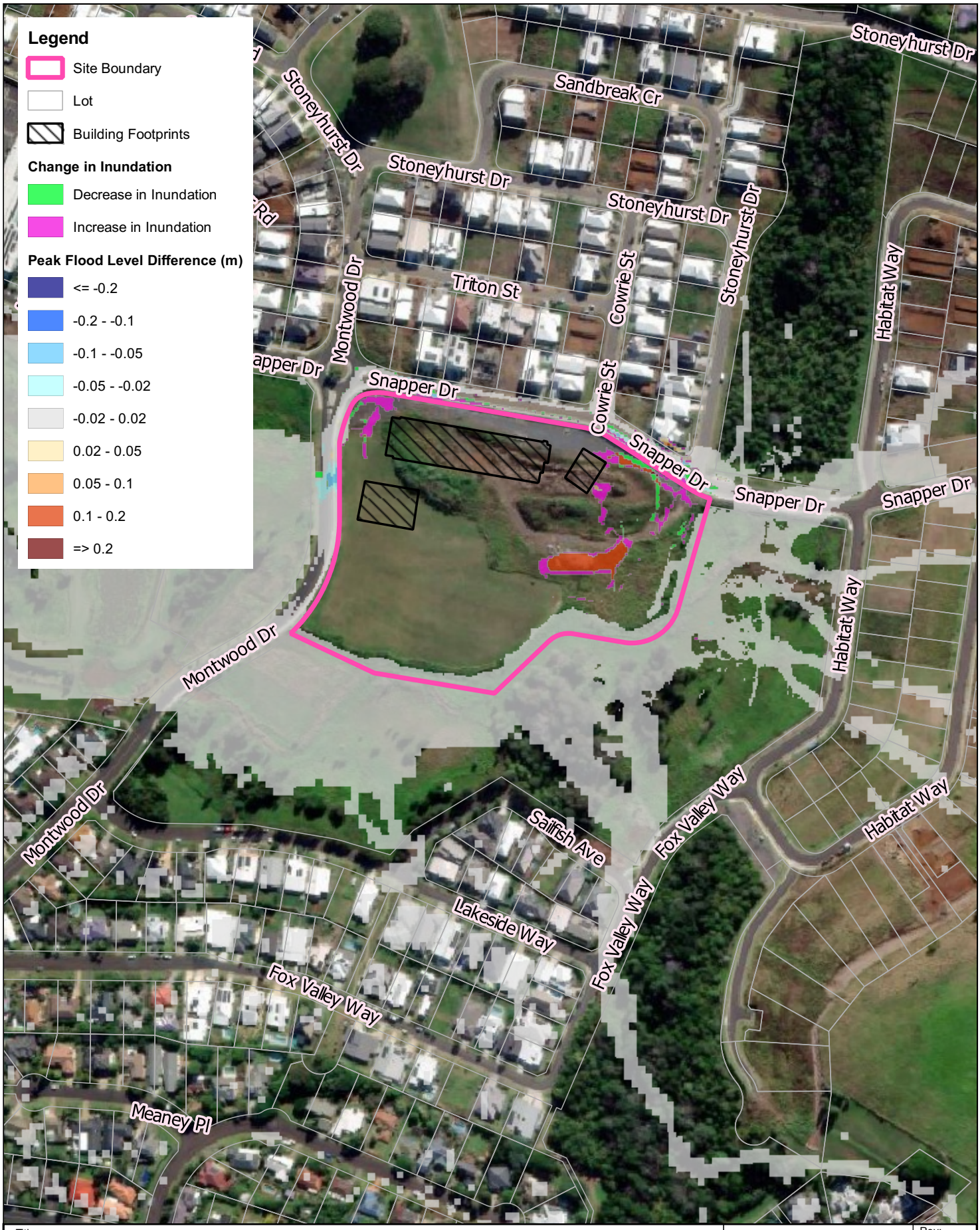

Title:

Peak Flood Level Impact - 0.2% AEP Event

Figure: C-05

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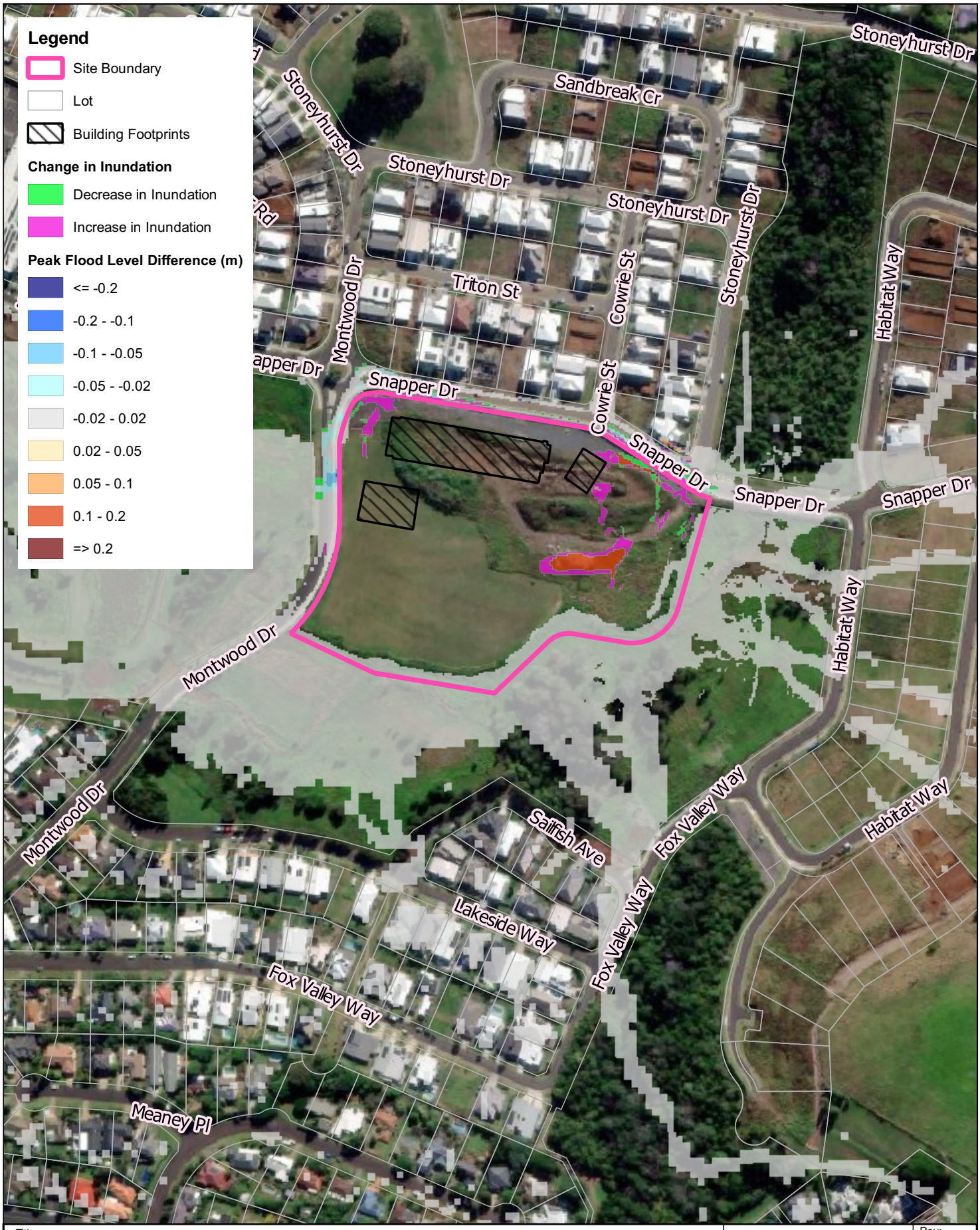

Title:

Peak Flood Level Impact - 1% AEP Event with Climate Change

Figure: C-06

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Title:

Peak Flood Velocity Impact - 20% AEP Event

Figure: C-07

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Title:

Peak Flood Velocity Impact - 10% AEP Event

Figure: C-08

Rev: A

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Title:

Peak Flood Velocity Impact - 5% AEP Event

Figure: C-09

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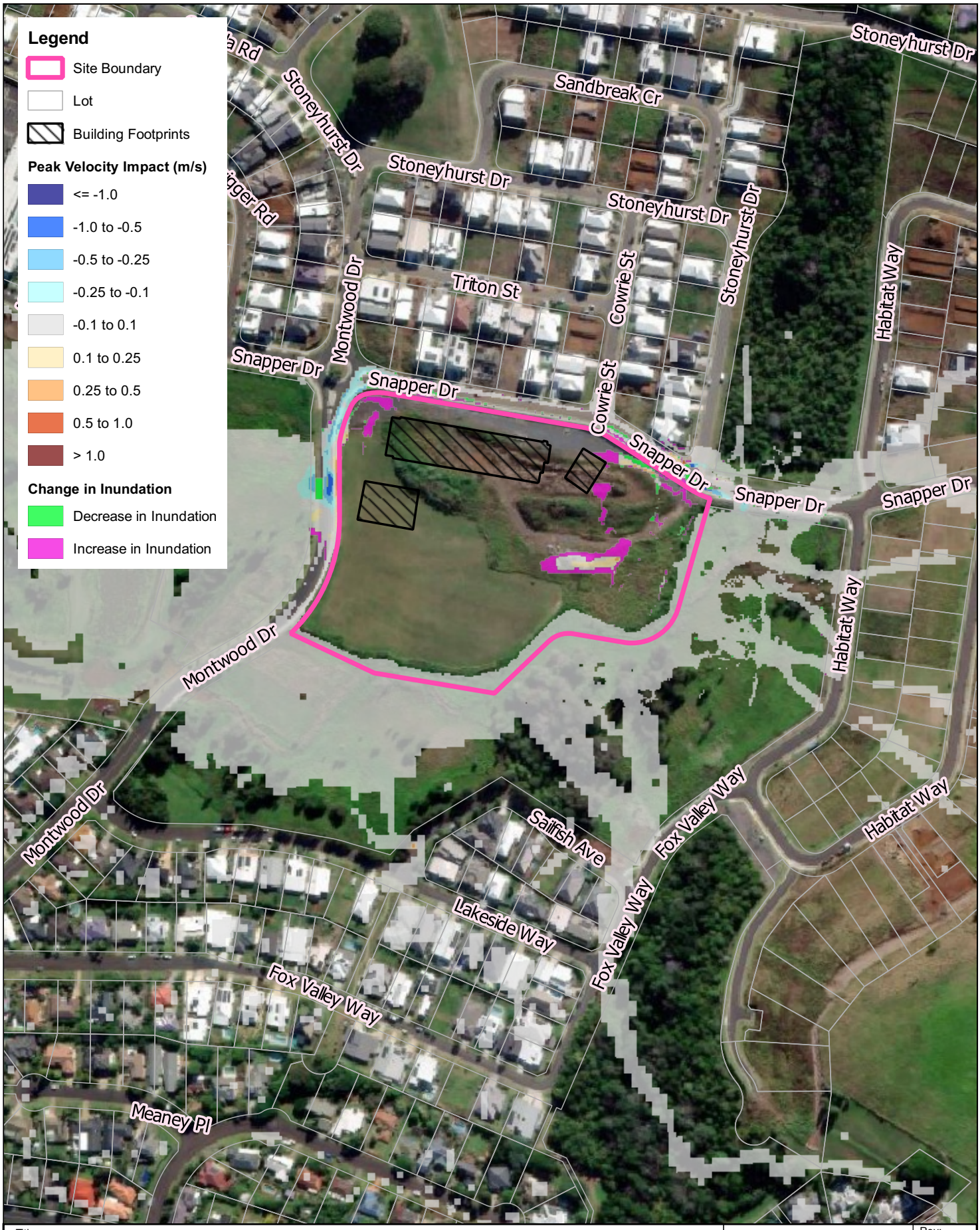

Title:

Peak Flood Velocity Impact - 1% AEP Event

Figure: C-10

Rev: A

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Title:

Peak Flood Velocity Impact - 0.2% AEP Event

Figure: C-11

Rev: A

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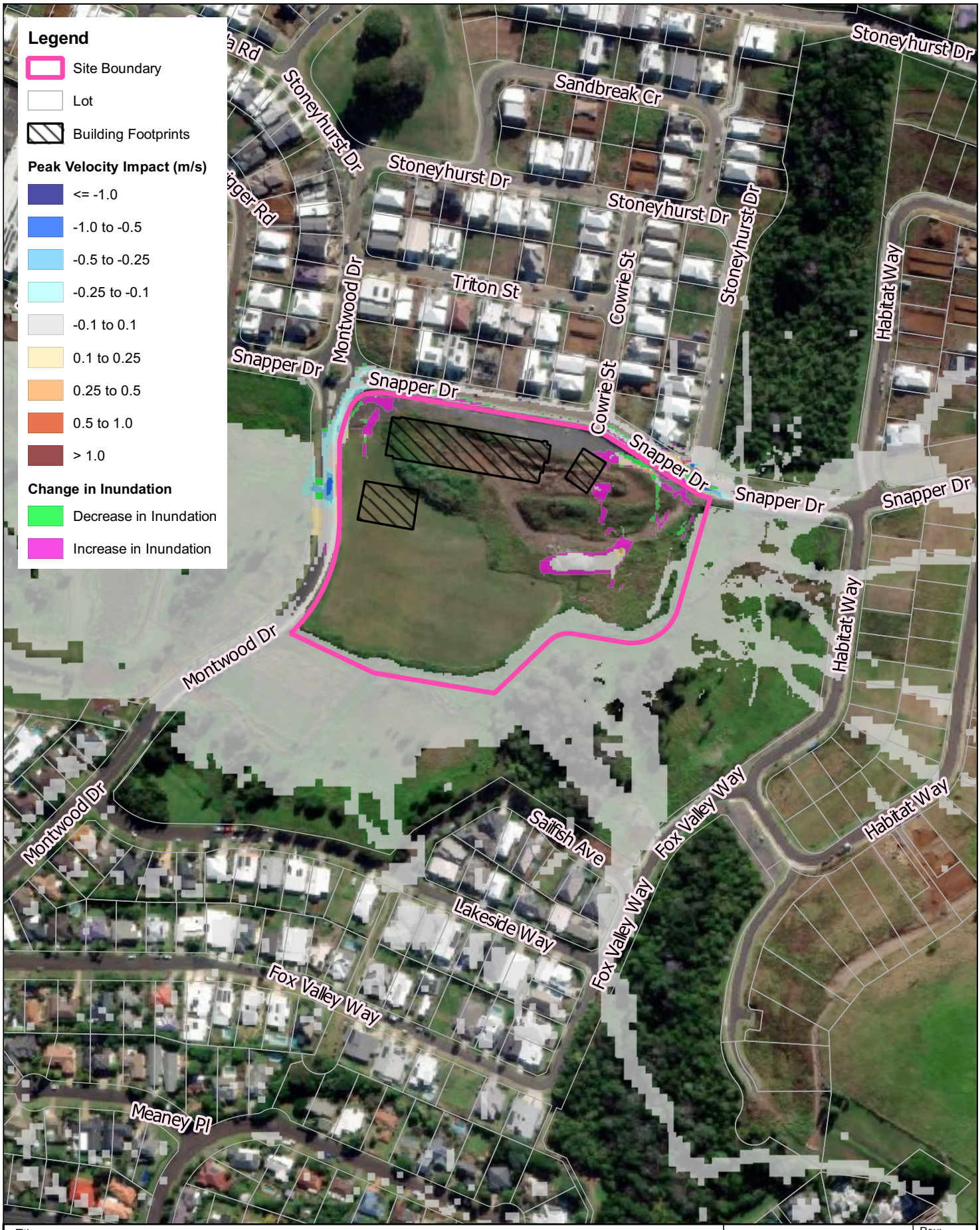

Title:

Peak Flood Velocity Impact - 1% AEP Event with Climate Change

Figure: C-12

Rev: A

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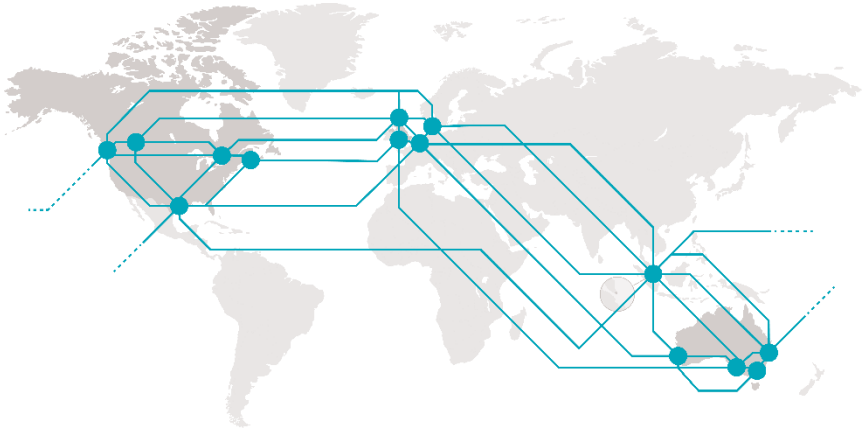

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