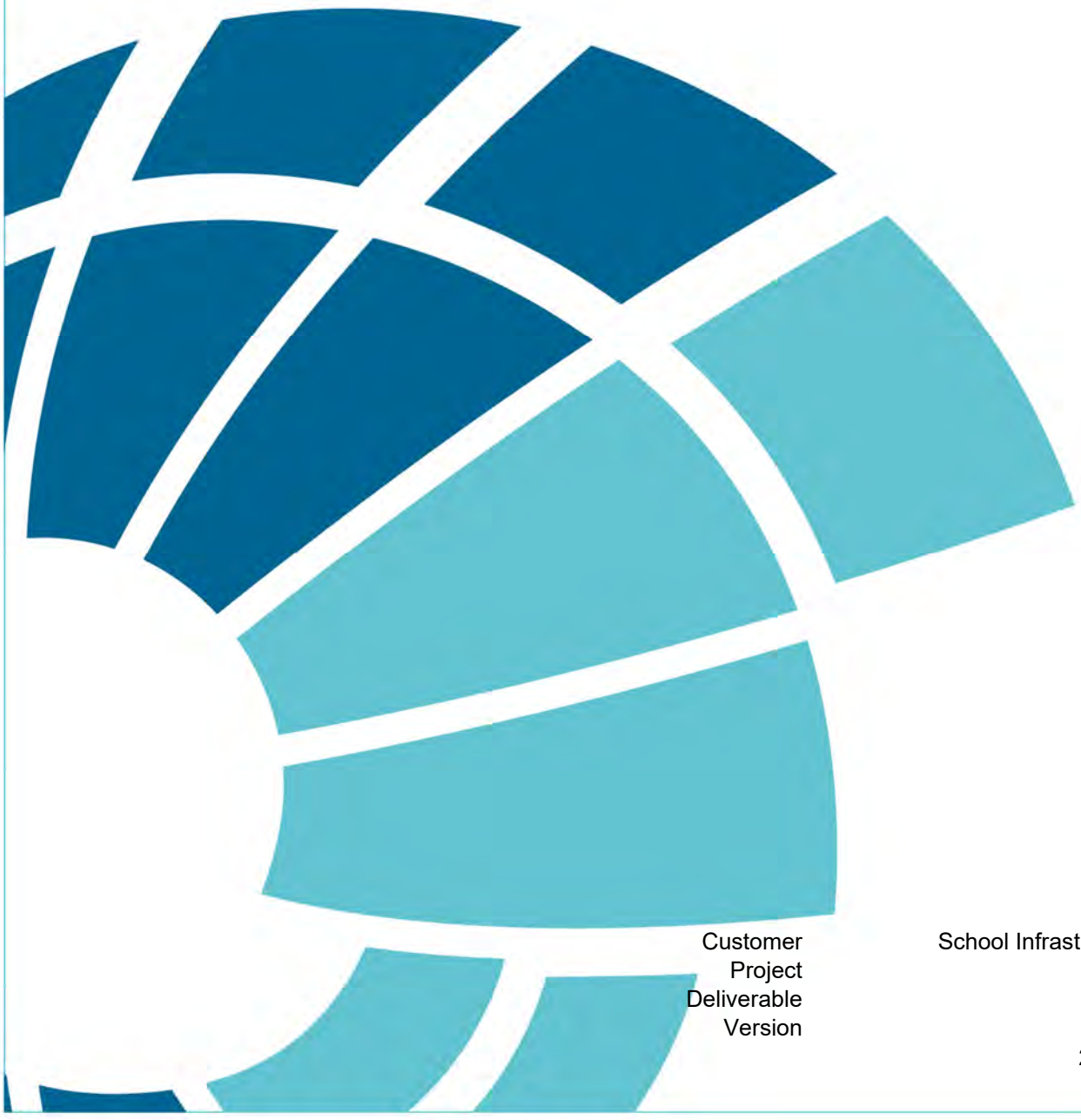
Hunter River High School - Flood Impact Assessment



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1 Introduction

1.1 Purpose of this Report

School Infrastructure NSW (SINSW) propose development at Hunter River High School (hereafter referred to as "HRHS" or the "Site") located at 36 Elkin Avenue, Heatherbrae (Lot DP 540114, Lot DP 579025 and Lot DP 540114). The school is located within Port Stephens Local Government Area (LGA) in the Hunter Region of NSW.

In 2023, BMT was engaged by SINSW to investigate the existing flood risk in relation to Council's planning policies and to assess the suitability of the HRHS development. BMT previously completed the following Flood Impact Assessment (FIA) and Flood Emergency Response Plan (FERP) for the site based on the original proposed design of works:

- 'Flood Impact Assessment - Hunter River High School' (BMT, 2023) (hereafter referred to as the "2023 FIA")
- 'Hunter River High School Flood Emergency Response Plan' (BMT, 2023) (hereafter referred to as the "2023 FERP")

Since the completion of these assessments, the design has been revised to raise new building floor levels to provide immunity up to the Probable Maximum Flood (PMF) level. As such, an updated FIA and FERP are required to assess the revised proposed design. Please note that the FERP is documented within a separate report.

This FIA report has been prepared to accompany:

- A Part 5 Activity Approval, development permitted without consent, for the construction of a new administration building (Block X), student learning hub (Block Z) and provision of essential services.
- A Part 5 Activity Approval, development permitted without consent, for the construction of a new linking road and kiss and drop bay between Adelaide Street and Elkin Avenue.

In February 2024, a Development Application for the Site was approved for various works. These works included the construction of a gymnasium (Block Y), consisting of a basketball court, equipment storage, canteen kitchen, staff room, first aid room and change room amenities, construction of hardstand civic space north of the gymnasium, construction of full-size rugby field, construction of new carpark consisting of sixty-five (65) parking spaces (including 6 accessible parking spaces), and construction and connection of a reticulated sewer pipe. For the purposes of this Flood Impact Assessment, the design works forming part of the Development Application have been incorporated into the flood modelling, however there is no commentary provided on the existing, post-development or change in post-flood conditions associated for these works.

The proposed Site Plan is enclosed in Annex A to this report.

1.2 Description of the Site

HRHS covers an approximate area of 9.2ha and is bounded by Adelaide Street and the Pacific Highway to the south-east, residential properties to the north-east and south-west, and open grassed land to the north-west. It is located about 800m east of the Hunter River and 500m south-west of the junction of Grahams Town Drain and Windeyers Creek. The locality of HRHS and its terrain is shown in Figure 1.1, which varies between 1.4 and 7.0mAHD across the Site. Notably, there is a steep rise in ground elevations in the northwest corner of the site where ground levels rise from around 2.5mAHD to 6.7mAHD.

Figure 1.1 Hunter River High School Locality and Existing Terrain

The Site includes the following three lots:

- Lot DP 540114
- Lot DP 579025
- Lot DP 120189

Port Stephens Council Flood Information Certificates for these three lots (reference: Certificate numbers 83-2022-1025-1,83-2022-1026-1,83-2022-1027-1 dated 18 July 2022 and enclosed in Annex B) indicate that the majority of the Site is located in the category of “Minimal Risk Flood Prone Land”. However, the North-West corner of Lot 1 DP 120189 and most of Lot 1 DP 579025 are within a “High Hazard Floodway Area”. It is noted that Port Stephens Council adopts the 1% AEP with 2100 future planning horizon scenario as the Defined Flood Event (the flood event selected as a general standard for the management of flooding to development (Considering flooding in land use planning (DCEEW 2021))).

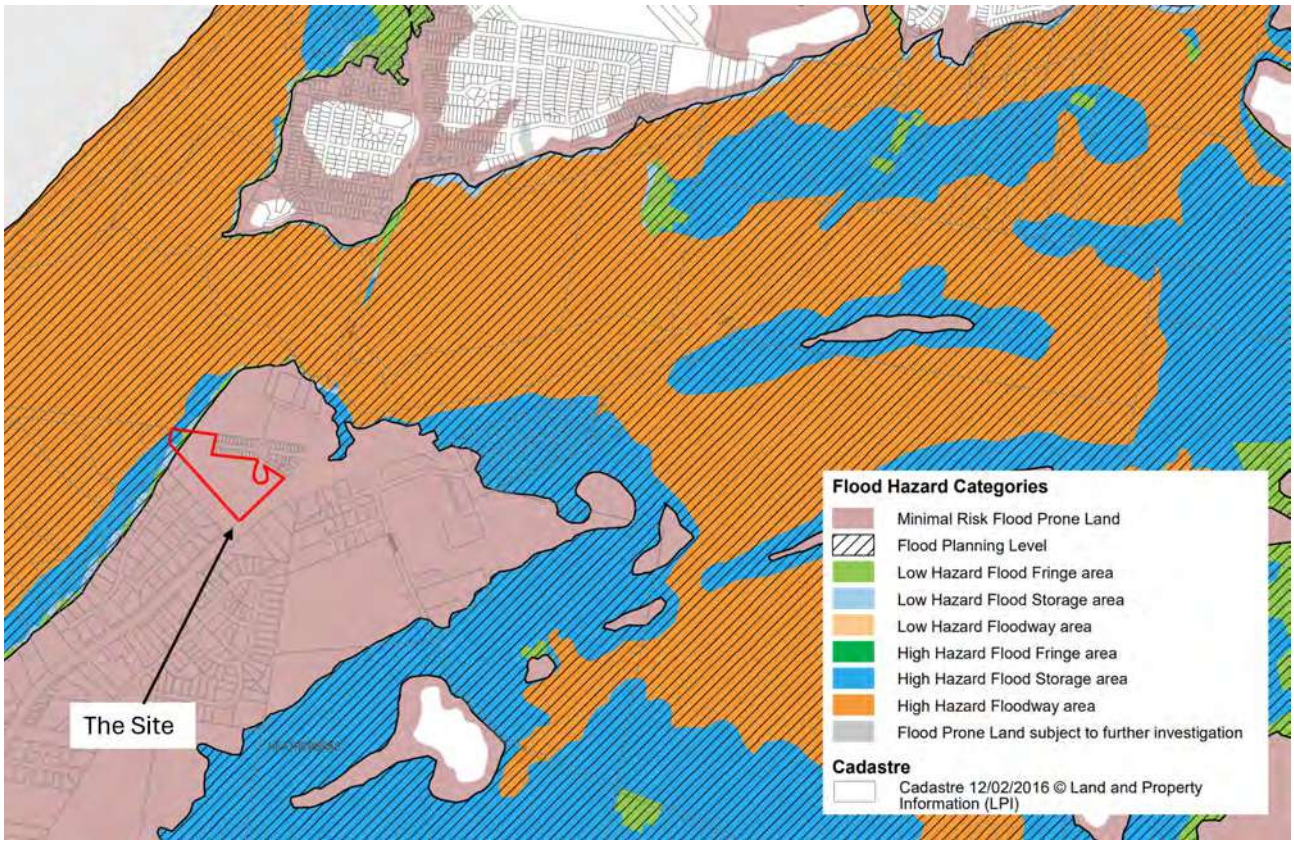


Figure 1.2 Extract of the 2016 Port Stephens Council Flood Hazard Mapping (Source: Sheet FHZ_002C from the Floodplain Risk Management Policy and Flood Hazard Maps (Port Stephens Council, 2016))

1.3 Flooding Mechanisms

HRHS is located within the Hunter River catchment, in the Williamtown / Salt Ash district that is situated adjacent to the lower reaches of the Hunter River. The Hunter River drains a catchment area of approximately 21,000 km^2, nearly all of which lies upstream of Raymond Terrace. The Hunter River catchment is identified as a high-risk catchment in the 2022 Flood Inquiry Volume 2 Full Report (NSW Government, 2022). As such, Hunter River flooding is the dominant flood mechanism at the Site.

There are also other considerations including local catchment flooding. Windeyers Creek is a small tributary of the Hunter River located around 400m north of the site and has a catchment area of approximately 20km^2. Flow generated by Windeyers Creek would not be expected to affect the Site as to do so its runoff would effectively have to fill the Hunter River floodplain. Windeyers Creek has the potential to be subject to backwater inundation from the Hunter River. This flood mechanism is accounted for in the modelling undertaken for this assessment although was shown to not affect the Site due to the Site being separated from Windeyers Creek by higher ground (as shown in Figure 1.1).

Due to the elevated location of the Site and the physical barrier to flow represented by the Pacific highway running along the south Site boundary, it is not expected that there is any flood risk associated with runoff originating from the south of the Site. Any on-site runoff would be managed as part of a stormwater management plan.

Therefore, the only source of flooding that is relevant for this assessment is mainstream flooding from the Hunter River.

2 Available Flood Studies and Modelling

HRHS lies within the Hunter River catchment. Regional (mainstream) Hunter River flooding within this part of the Hunter River catchment has previously been defined by the following Port Stephens Council ("Council") studies:

- 'Williamtown Salt Ash Flood Study' (BMT WBM, 2005)
- 'Williamtown Salt Ash Flood Study Review' (BMT WBM, 2012)
- 'Updated Williams River Flood Study' (BMT WBM, 2016)
- 'Williamtown Salt Ash Floodplain Risk Management Study and Plan' (BMT WBM, 2017)

The 'Williamtown Salt Ash Floodplain Risk Management Study and Plan' (BMT WBM, 2017) (referred to hereafter as the "Williamtown FRMS&P") is the most recent flood study and has been adopted by Council to define the flood behaviour in this region. The study area covers approximately 400 km² that comprises the townships of Williamtown, Salt Ash, part of Raymond Terrace and the floodplain areas separating these towns. . The Williamtown FRMS&P has two sources of inflow:

- Application of Hunter River and Williams River hydrographs (flow vs time): These represent Hunter River inflows which are the dominant source of flooding across the Hunter River floodplain. These flows are based on a Flood Frequency Analysis (FFA) approach using the historical flood records at Raymond Terrace Gauge.
- Local catchments inflows: 10% AEP local catchment inflows were applied to all design events (excluding PMF) using inflows derived from a calibrated XP-RAFTS model using AR&R 1987 data and modelling methodologies. The impact of these local catchment inflows on the overall flood behaviour in the study area is minimal in comparison to the Hunter River inflows.

The Williamtown FRMS&P also includes climate change scenarios for the 2050 and 2100 planning horizons under the 1% AEP event which are based on the outcomes and findings of the 'Williamtown Salt Ash Flood Study Review' (BMT WBM, 2012).

The Williamtown FRMS&P TUFLOW model does not include local catchment and overland flow flooding in the surrounding area of the HRHS. However, basing on a review of the catchment area draining to Site, surrounding topography and land-use, it is not expected that there is an overland flow flood risk within the HRHS Site (for further discussion, refer to Section 1.3).

Therefore, the regional Williamtown FRMS&P TUFLOW model was considered suitable to be used as basis for this assessment.

3 Existing Flood Conditions

3.1 Existing Scenario Modelling

The Williamtown FRMS&P TUFLOW model was updated to represent local, contemporary floodplain conditions on-Site more reliably. This included the following updates:

- Ground surface elevations within the model were updated based on detailed Site survey data provided to BMT by Stantec on 31 October 2022 (reference: 220310A_02.dwg). This Digital Elevation Model (DEM) is shown in Figure 3.1.
- The land use layers used to define the Manning's n roughness values within the Site were refined to better represent the existing surface conditions on-Site.
- Following the same approach used for the entire model, existing buildings within the Site are represented as areas of high roughness (Manning's n value = 2.0) to provide high obstruction to the flow while accounting for the flood storage capacity within each building. The outline of the existing buildings were refined on the basis of the survey data provided.

The updated version of the model is referred to as the "Existing Scenario TUFLOW model" and has been used as a baseline for the assessment of the proposed design in Section 4.1.

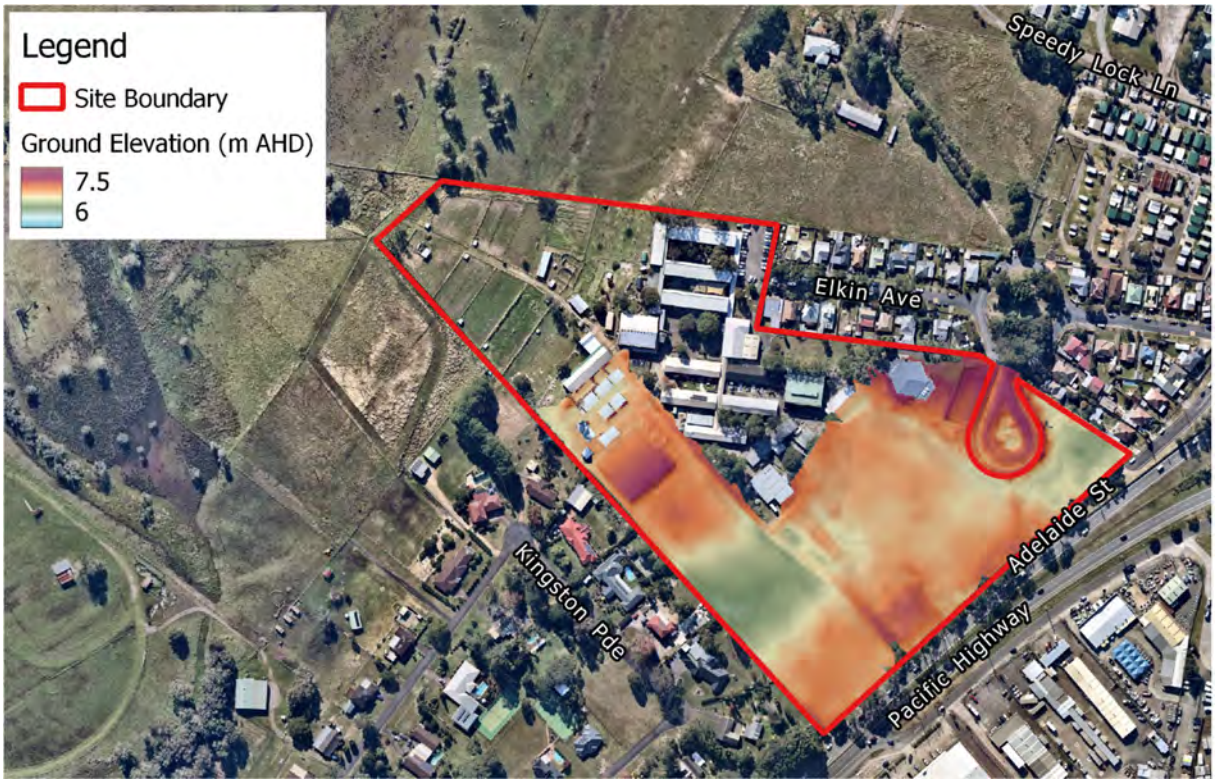


Figure 3.1 Existing Conditions DEM

The Existing Scenario TUFLOW model was used to simulate existing flood conditions for a range of design events including the 10%, 5%, 2%, 1%, 0.2% and 0.02% Annual Exceedance Probability (AEP) and the Probable Maximum Flood (PMF) events.

It is noted that the Williamtown FRMS&P did not simulate the 0.2% AEP (1 in 500 AEP) and 0.02% AEP (1 in 5000 AEP) flood events. As such, the inputs for these events were derived for this assessment in order to estimate peak 0.2% and 0.02% AEP flood conditions within the Site. Refer to Annex C for the adopted modelling inputs.

Furthermore, in line with the Port Stephens Development Control Plan (DCP) 2014 and in order to assess the potential impact of future climate conditions on the existing flood behaviour, the 1% AEP flood event was also simulated under future (year 2100) conditions (herein referred to as the "1% AEP Future Climate (2100 Planning Conditions)"). This event includes a projected sea level rise of 900mm relative to the 1990 Mean Sea Level and increased design flows and design rainfall intensities by 20% in accordance with the Williamtown FRMS&P.

The results of these design event simulations were used as the basis for defining and mapping existing design flood conditions, as outlined further below.

3.2 Existing Flood Conditions

Existing flood modelling results for the full range of design events has been provided for peak flood depths and flood level contours, velocities, flood hazard and flood function. This mapping is provided in Annex D.

3.2.1 Existing Flood Behaviour

Existing flood conditions in the vicinity of the Site are characterised by deep slow-moving water from the Hunter River. From the most frequent design event simulated (10% AEP flood), floodwater inundation on-Site is contained to lower-lying areas in the north-west of the Site. In a 1% AEP flood, the peak flood depth reaches 3.5m in the north-west corner (which equates to a peak flood level of 4.7mAHD). The peak flood level for the 1% AEP Future Climate (2100 Planning Conditions) flood is 5.2mAHD, although there is minimal change to the peak flood extent compared to the 1% AEP flood.

During a 0.02% AEP flood, the entire Site is inundated by floodwaters, with a peak flood level of 7.60mAHD and depths ranging between 0.4m and 6.45m. At the location of the proposed buildings on-Site, the peak flood depth is approximately 0.7m. The entire site is flooded during the PMF, and the peak flood level on-Site is 8.51mAHD with depths ranging between 1.4m to 7.0m. At the location of the proposed buildings (Block X and Z), the maximum peak flood level is 8.5m AHD and a peak flood depth of approximately 1.6m in the PMF.

3.2.2 Floodplain Development Manual (2005) Flood Hazard

Port Stephens Council DCP 2014 adopts the NSW Floodplain Development Manual (FDM) (NSW Government, 2005) flood hazard categorization to identify flood conditions that are likely to present a risk to people, vehicles, and buildings. Flood hazard is based on a combination of flood depths, velocity and depth-velocity product thresholds as shown in Figure 3.2.

Provisional hazard mapping based on FDM (2005) classifications has been prepared based on peak depth, velocity and velocity-depth product outputs from the TUFLOW modelling, and is provided for the Site in Annex D for all modelled floods.

In the 0.02% AEP flood, the flood hazard varies from low to intermediate at the location of the proposed buildings (Block X and Z) and intermediate to high hazard at the existing buildings (buildings G, H, I, J and K).

In the PMF, the entire Site is classified as High Hazard.

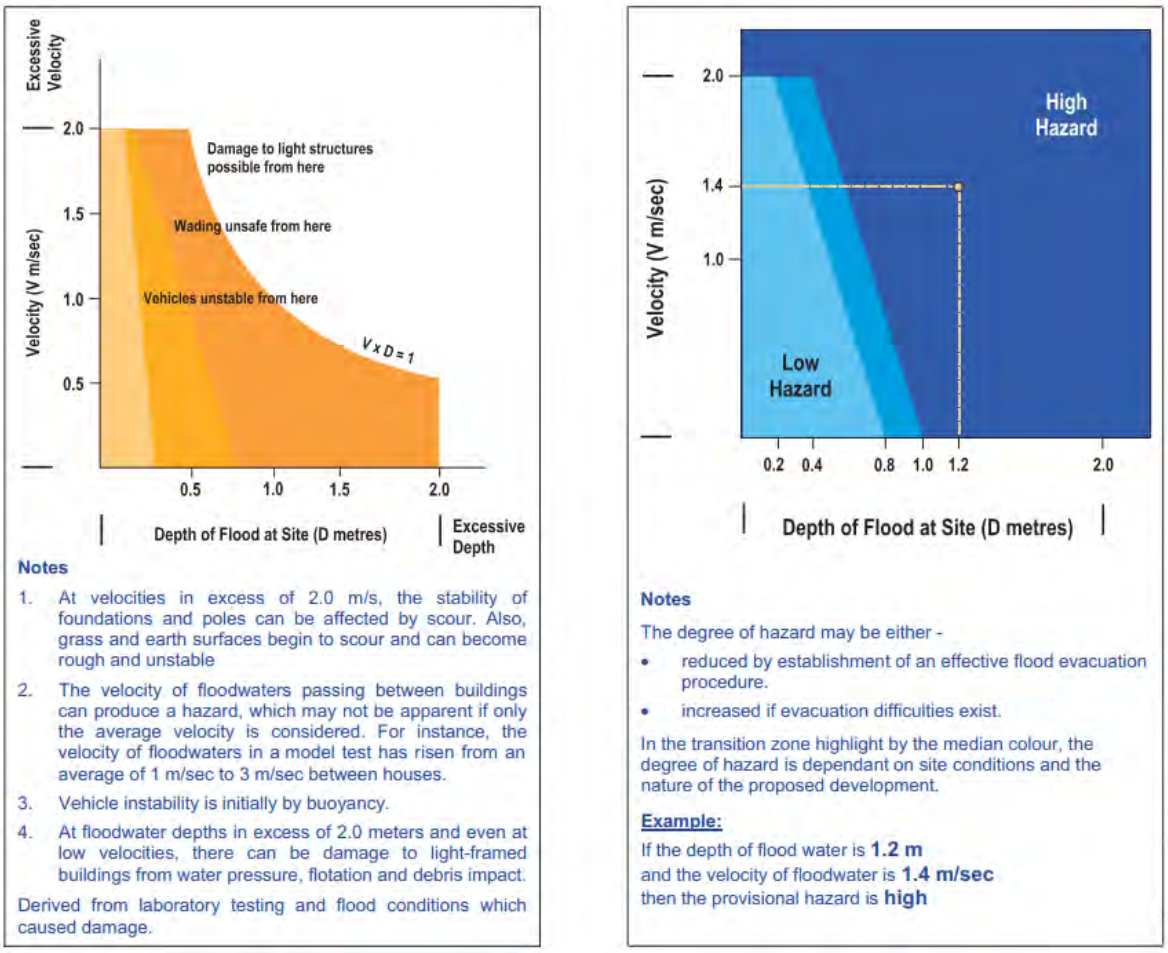


Figure 3.2 Provisional Flood Hazard Categorisation (Source: NSW Government, 2005)

3.2.3 Flood Risk Management Guideline FB03 (2023) / AIDR (2017) Flood Hazard

In AIDR (2017) and most recently in 'Flood Hazard – Flood Risk Management Guideline FB03' (NSW DPE, 2023) (companion guideline to the 'Flood Risk Management Manual' (NSW DPE, 2023)) (herein FRMM (2023)), the variation in flood hazard is characterised based on the composite six-tiered hazard classification that corresponds to the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters. The six classifications are summarised in Table 3.1 and shown in Figure 3.3.

The use of these hazard classifications represents current best practice. Therefore, provisional hazard mapping based on these classifications has been prepared based on peak depth, velocity and velocity-depth product outputs from the TUFLOW modelling, and is provided for the Site in Annex D for all modelled events.

In the 0.02% AEP, the flood hazard classification varies from H1 to H6 across the Site. The location of the proposed buildings (Block X and Z) and the existing buildings (buildings G, H, I, J and K) are categorised as H3.

In the PMF, the Site is classified by an H6 categorisation at the north-west of the lot, and an H5 categorisation across the remainder of the Site (including existing buildings (buildings G, H, I, J and K) and the location of the proposed buildings (Block X and Z)).

Table 3.1 Best Practice Provisional Flood Hazards (AIDR, 2017)/ FRMM (2023)

Hazard	Criteria	Description
H1	Depth < 0.3 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.3 m^2/s	Generally safe for vehicles, people and buildings.
H2	Depth < 0.5 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.6 m^2/s	Unsafe for small vehicles.
H3	Depth < 1.2 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 0.6 m^2/s	Unsafe for small vehicles , children and the elderly.
H4	Depth < 2.0 m and Velocity < 2.0 m/s and Velocity*Depth ≤ 1.0 m^2/s	Unsafe for vehicles and people.
H5	Depth < 4.0 m and Velocity < 4.0 m/s and Velocity*Depth ≤ 4.0 m^2/s	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
H6	Depth > 4.0 m OR Velocity > 4.0 m/s OR Velocity*Depth > 4.0 m^2/s	Unsafe for vehicles and people. All building types considered vulnerable to failure.

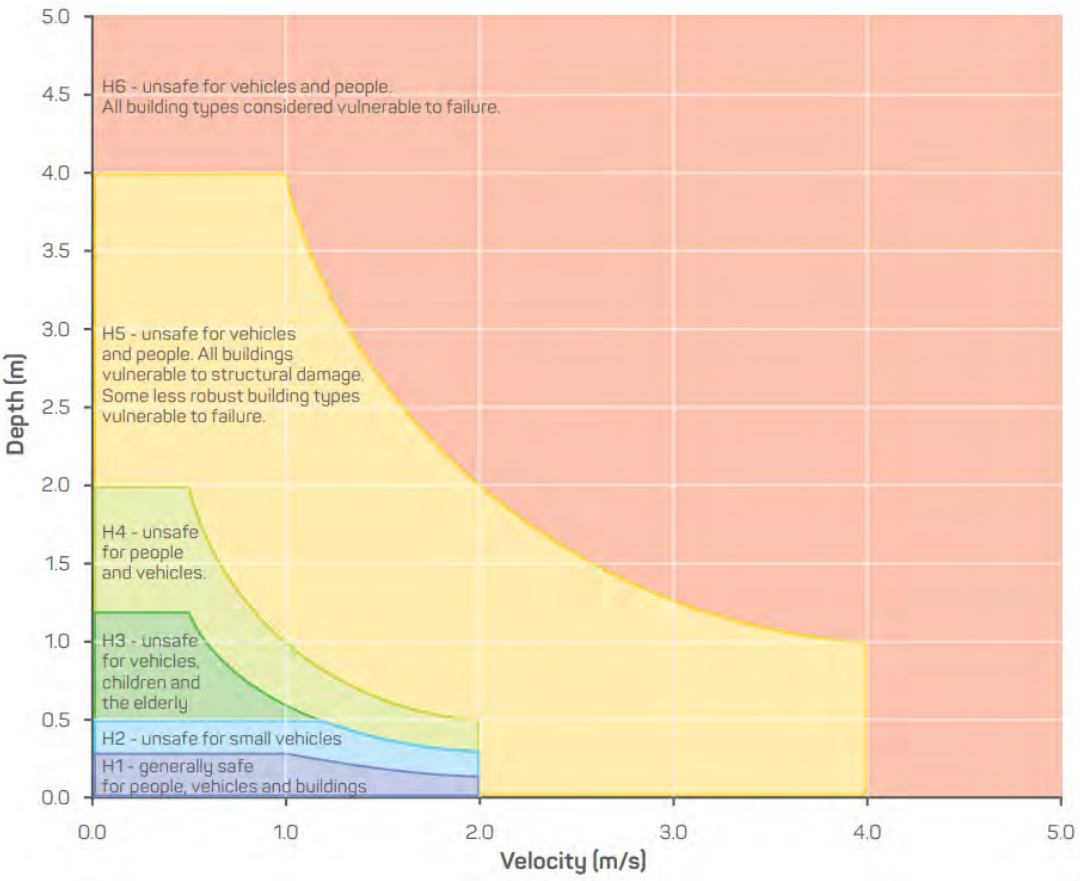


Figure 3.3 Combined Flood Hazard Curves

3.2.4 Flood Function

Flood function categories (also referred to as hydraulic categorisation) identify areas performing different natural hydraulic functions of conveying and storing water within the floodplain. Flood function mapping was prepared for this assessment based on outputs from the TUFLOW modelling, and the flood function criteria defined within the Williamtown FRMS&P reproduced in Table 3.2.

Table 3.2 Flood Function Criteria

Building	Criteria	Definition
Floodway	Velocity * Depth > 0.3	Areas and flow paths where a significant portion of floodwaters are conveyed (including all bank-to-bank creek sections).
Flood Storage	Velocity* Depth < 0.3 and Depth > 0.5m	Areas where floodwaters accumulate before being conveyed downstream. These areas are important for detention and attenuation of flood peaks.
Flood Fringe	Velocity* Depth < 0.3 and Depth < 0.5m	Areas that are low-velocity backwaters within the floodplain. Filling of these areas generally has little consequence to overall flood behaviour.

Flood Function Mapping is provided in Annex D for the 0.02% AEP (1 in 5000 AEP) flood and PMF.

In the 0.02% AEP, the Site is classified as flood storage at both the existing buildings (buildings G, H, I, J and K) and the location of the proposed buildings (Block X and Z) with some isolated areas of flood fringe across the Site.

In the PMF, the Site is predominately classified as a floodway with some isolated areas of flood storage.

4 Post-development Flood Conditions

4.1 Post-development Scenario Modelling

Development works within a floodplain can potentially impact flood behaviour and modify predicted flood levels, velocities, extent and timing of inundation, hazard, etc. Accordingly, post-development flood conditions associated with the HRHS development have been modelled and assessed as part of this project.

In March 2024, Richard Crookes supplied BMT with the proposed Site plan (reference: Building Height Exercise - Option B (SINSW_RCC Review).pdf), as enclosed in Annex A. Stantec also supplied BMT with the 90% design terrain data associated with the proposed development (reference: HRHS-STNC-XX-XX-M3-C-065101.dwg). This data has informed the following modifications to the Existing Scenario TUFLOW model to form the "Post-development Scenario TUFLOW model" for this assessment:

- Ground surface elevations within the model were updated based on a DEM developed from the design terrain data. This information includes the full-size rugby field, hardstand civic space north of Block Y (gymnasium), and a new linking road and kiss and drop bay between Adelaide Street and Elkin Avenue. This DEM is shown in Figure 3.1. It is noted that there is no change to ground levels below 6.78m AHD.
- Land use layers used to define hydraulic roughness were updated to reflect proposed land uses and associated surface roughness types.
- The footprints of the proposed buildings; Block X (administration building), Block Y (gymnasium) and Block Z (student learning hub) were all raised to their proposed finished floor levels assuming blockwork underneath (completely impermeable below floor level). Block X (administration building) and Block Z (student learning hub) were raised to 8.5m AHD and Block Y (gymnasium) was raised to 7.3m AHD.
- The proposed ramp was incorporated into the model using the proposed ground levels specified in the proposed Site plan. The underneath of the ramp was assumed to be blockwork underneath (completely impermeable below floor level).

A review of proposed ground levels indicate that the proposed works are situated outside the flood extents of all events up to and including the 0.2% AEP flood (including both the 1% AEP and 1% AEP Future Climate (2100 Planning Conditions) floods).Given this, there would be no expected flood impacts associated with the proposed development during these events and therefore, only the 0.02% AEP flood and PMF were simulated for post-development conditions.

The results of these design event simulations were used as the basis for defining and mapping post-development flood conditions, as outlined further below.

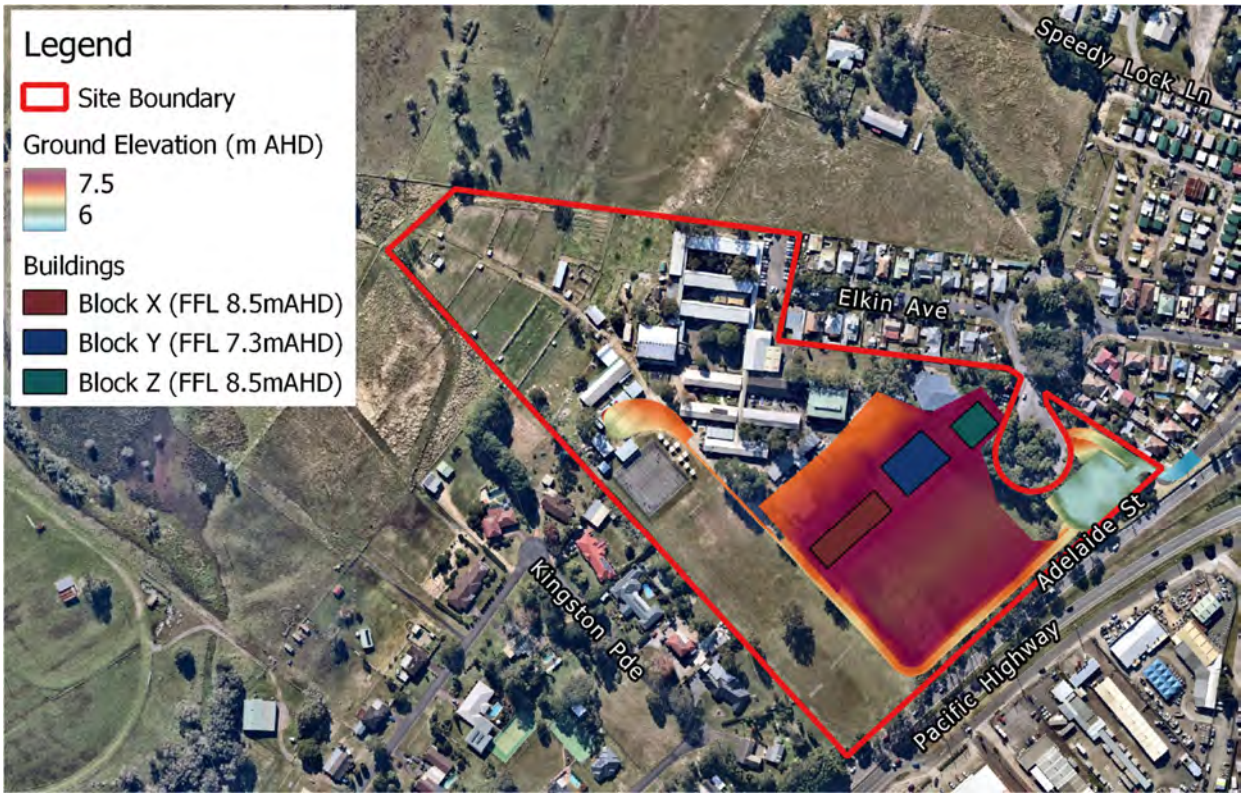


Figure 4.1 Post-development Conditions DEM

4.2 Post-development Flood Conditions

Post-development flood conditions, including peak flood depths and flood level contours, velocities, flood hazard and flood function, have been mapped for the 0.02% AEP flood and PMF. This mapping is provided in Annex E.

It is noted that flood behaviour for post-development conditions are similar to the existing flood conditions discussed in Section 3.2. A summary of the post-development flood conditions relevant to the post-development works includes:

- There is no over floor inundation of Block X and Block Z as they are proposed to be set to the PMF Level.
- The peak flood velocities predicted at the proposed buildings (Block X and Z) are:
  - Block X – 0.10m/s and 1.05m/s in the 0.02% AEP flood and PMF respectively. It is noted that the 1.05m/s is highly localised at the south-west corner of the footprint, and the velocities predicted along the remaining footprint are less than 0.6m/s.
  - Block Z – 0.22m/s and 0.47m/s in the 0.02% AEP flood and PMF respectively.
- The peak flood hazards predicted at the proposed buildings (Block X and Z) using the hazards approach defined in the Floodplain Development Manual (2005) is low hazard in the 0.02% AEP flood and high hazard in the PMF.
- The peak flood function predicted at the proposed buildings (Block X and Z) using the hazards approach defined in the AIDR (2017) / FRMM (2023) is H1, H2 and H3 in the 0.02% AEP flood and H5 in the PMF.
- The peak flood function predicted at the proposed buildings (Block X and Z) is flood fringe in the 0.02% AEP flood and floodway and flood storage in the PMF.

5 Flood Impact Assessment

5.1 Overview

The proposed development has been assessed in terms of potential impacts on existing flood behaviour. Flood impact mapping was prepared by subtracting peak level or velocity for existing conditions from post-development conditions, and indicate the magnitude and location of changes associated with the proposed works. The resulting impact maps for the 0.02% AEP flood and PMF (noting these are the only modelled design floods where the proposed works are within the predicted peak flood extent).

Commentary of the predicted changes to on-Site and off-Site flood behaviour is summarised below. Within the Site, there is a focus on what the potential changes in flood behaviour would be expected for the existing buildings considered for sheltering-in-place (buildings G, H, I, J and K).

5.2 Predicted Change in Peak Flood Conditions

5.2.1 Flood Levels

There are no predicted changes in flood levels resulting from the proposed development in the 0.02% AEP (1 in 5000 AEP) event (nor any smaller magnitude design floods).

There are predicted changes in PMF levels both within the Site and off-Site resulting from the proposed development. These changes are outlined below and are predicted to result when Hunter River floodwaters draining from the north-west are impeded by proposed building footprints and floodwaters are redistributed.

- Within the Site, this results in an increase in flood levels on the upstream side of the building footprints (centre of the Site where existing buildings are located – increases of up to 20mm are predicted) and a decrease in flood levels on the downstream side of the proposed buildings extending to the southern boundary of up to 30mm.
- Off-site, there are a localised predicted increases of up to 10mm affecting four lots between 28 to 34 Elkin Avenue. The predicted increases occur along the southern boundaries of the lots with an ingress of up to 10m. The peak flood depth in this area is approximately 2m.

5.2.2 Velocities

During both the 0.02% AEP flood and PMF, there are predicted changes in flood velocities as a result of the proposed works. It noted that these changes in velocities occur in areas where existing velocities are already low. Specifically:

- In the 0.02% AEP flood, there are changes in flood velocities around the proposed building footprints as a result of the redistribution of flows. This generally results in a decrease in flood levels with a maximum decrease of 0.4m/s predicted. The resulting velocities around the building footprints are less than 0.5m/s. Along the south-eastern boundary (fronting Pacific Highway), there is a maximum increase of up to 0.75m/s with the resulting velocities remaining less than 1.0m/s. Off-site, there are increases in velocities within Elkin Avenue and private properties along Elkin Avenue. Whilst the resulting velocities are generally less than 0.65m/s, there a localised velocities of up to 1.0m/s. A maximum localised increase of 0.36m/s occurs resulting in a velocity of 1.01m/s occurs within 12 Elkin Avenue.

- In the PMF event, there are off-site increases in velocities located to the north-east and south-west of the Site within private properties. To the south of the Site, localised increases of up to 0.12m/s result in a post-development velocity of up to 0.44m/s. To the north-east, the largest increases in velocities are located within the proposed new linking road and kiss and drop bay between Adelaide Street and Elkin Avenue. The maximum resulting velocity is predicted to be 1.3m/s located within the kiss and drop bay road corridor, whilst the maximum resulting velocity within private property was found to 1.2m/s within 12 Elkin Avenue (an increase of 0.60m/s). Within the Site, there are predicted increases in flow velocities around existing buildings G, I, J and K, however the resulting velocities will remain below 0.65m/s, whilst building H has a resulting velocity of 0.80m/s in the post-development scenario.

5.2.3 Flood Hazard

Floodplain Development Manual (2005)

In the 0.02% AEP flood, there are no increases in flood hazard categorisation. There are highly localised decreases in the hazard categorisation to the south-west of the Site. This is associated with localised impacts on peak flood levels and flow velocities that results in a decrease in the resultant flood hazard categorisation.

In the PMF, there are highly localised increases and decreases in the hazard categorisation. On the Pacific Highway (near the north-eastern boundary of the Site), there is a decrease from High Hazard to Intermediate Hazard.

FRRM (2023) / AIDR (2017) Flood Hazard

In the 0.02% AEP flood, there are no increases to flood hazard categorisation within the Site or off-Site. Within the Site, there is a decrease in the flood categorisation from H3 to H1 and H2 at the location of the proposed buildings and rugby field.

In the PMF, there is no increase in flood hazard categorisation within the Site or off-Site.

5.2.4 Flood Function

There are no predicted changes to the peak flood function during the 0.02% AEP flood and PMF as a result of the proposed development.

5.3 Summary of flood impacts

A summary of predicted flood impacts associated with the proposed development is provided below:

- No flood impacts are predicted to occur in modelled events less than the 0.02% AEP flood.
- Within the Site and relevant to existing buildings (buildings G, H, I, J and K)
  - In the PMF, there are predicted increases of up to 20mm although peak flood depths at existing buildings considered for sheltering-in-place (buildings G, H, I, J and K) occur in locations where the existing peak flood depth is less than 2m (from ground level, not floor level).
  - Whilst there are predicted increases in velocities in the PMF, the resulting velocities will remain below 0.65m/s for existing buildings G, I, J and K. Building H has a resulting velocity of 0.80m/s in the post-development scenario.

- Off-site
  - There are a localised increases of up to 10mm predicted in the PMF that affects four between 28 to 34 Elkin Avenue. The predicted increases occur along the southern boundaries of the lots with an ingress of up to 10m. It is noted that under existing conditions, the peak flood depth in this area is approximately 2m and these properties are already exposed to high flood hazard and flood risk. As such, there is no change to the existing flood risk at these properties as a result of the post-development conditions. Therefore, these off-Site impacts of less than 10 mm are not predicted to result in an appreciable increase in flood risk across these areas.
  - The maximum peak velocity impact of 0.60m/s that results in a peak flow velocity of 1.2m/s within 12 Elkin Avenue occurs in an area subjected to depths of up to 1.5m and high hazard and floodway classifications under existing conditions. As such, there is no change to the existing flood risk at this property under the post-development conditions since it is already exposed to high flood risk under existing conditions.

Overall, the proposed development does not result in increased flood risk to other private properties or public roads outside the boundaries of the Site.

6 Assessment of Council DCP Requirement

Table 6.1 sets out the compliance of the proposed development with Port Stephens DCP 2014.

Table 6.1 Response to Port Stephens Council DCP Requirements

Requirement	Response
Site Selection	
B5.1 If multiple flood hazard categories are specified for a site on a flood certificate, the proposed development must be located on the land with the lowest flood risk	Flood Certificates received from Council on 18 July 2022 show the following hazard categories for the three lots that form the Subject Site as follows: • Lot DP 540114: entirely classified as “Minimum risk flood prone land” • Lot DP 579025: mostly classified as “High hazard floodway area” with some portions at the south-east end classified as “Low hazard flood storage area” and “Low hazard flood fringe areas” • Lot DP 120189: mostly classified as “Minimum risk flood prone land” with small portions at the north-west corner classified as “Low hazard flood storage areas”. Proposed works encompass all the three lots but only occupy areas classified as “Minimum risk flood prone land”.
Finished Floor Level (FFL)	
B5.2 Development must meet the minimum FFL as specified in Figure BJ	Flood Information Certificates received from Council on 18 July 2022 show the adopted minimum floor level being equal to 5.7mAHD. This equates to the 1% AEP Future Climate (2100 Planning Conditions) flood level plus 500mm allowance for freeboard. shows the adopted FFL for the proposed buildings which are consistently higher than the nominated minimum floor level. As noted by a Council representative in the pre-DA meeting, Control B5.2 of Port Stephens DCP requires the FFL for a vulnerable development to be at the PMF level which, in this instance, is equal to 8.5mAHD. Both Block X (Admin Building) and Block Z (Learning Hub) are proposed to be set to 8.5mAHD which is equal to the PMF level.
Flood Compatible Design	
B5.3 Development for a building (and/or an associated driveway or access) must be of a flood compatible design and construction and shall meet the relevant requirements in the construction of Buildings in Flood Hazard Areas (Australian Building Codes Board). Council may also require structural certification for development proposed on land which becomes a floodway in the PMF.	Proposed buildings must be constructed using flood compatible materials and according to flood compatible design. The Site is classified as “floodway” during PMF. The structural integrity of the proposed buildings (Block X and Z) has been confirmed by a structural engineer that considers depths of water up to 2m

Requirement	Response
	and velocities up to 1.0m/s, which would be suitable based on the predicted flood behaviour in a PMF event. In addition, the structural integrity of the existing buildings G, H, I, J and K has been confirmed by a structural engineer that considers depths of water up to 2m and velocities up to 1.0m/s (suitable for a PMF event). Please refer to Annex H or a copy of the structural integrity letter for both existing and proposed buildings.
B5.4 Fencing on flood prone land should be stable in events up to the current day 1% AEP flood event and not obstruct the flow of floodwater.	Fencing is not part of the proposed works.
B5.5 All incoming main power service equipment, including all metering equipment, and all electrical fixtures, such as power points, light fittings, switches, heating, ventilation and other service facilities must be located above the FPL, or where possible above the PMF. Where the above cannot be achieved, the following features shall be used: • Electrical cabling is not to be installed within walls, or chased into walls; and • Any circuit containing switches, power points or any other electrical fitting that are located below the FPL, shall connect to the power supply through an individual Residual Current Device (RCD), located in the meter box.	All electrical services to be located above PMF level of 8.5mAHD for Block X and Block Z.
B5.6 The storage of hazardous or potentially hazardous materials, potentially polluting material or material that could be washed from site and cause harm downstream must be stored above the FPL with appropriate bunding.	No hazardous or polluting material is expected to be stored on Site. Gas cylinders to be located above the FPL of 5.7mAHD and appropriately anchored.
B5.7 Items that may wash away during flood events (e.g. rainwater tanks, hot water tanks, gas cylinders, shipping containers) must be elevated above the 1% AEP flood event level in the year 2100 (without freeboard) or anchored to resist buoyancy and impact forces.	All movable items to be stored away from the 1% AEP Future Climate (2100 Planning Horizon) flood extent, which equates to the peak flood level of 5.2m AHD.

Requirement	Response
Flood impact and risk assessment	
B5.8 A flood impact and risk assessment is required for: • Any fill on land identified as floodway. • Any fill located in a flood storage area, unless: - The net volume of fill does not exceed the lesser of 20% or 2000m³ of the flood volume of the lot in the 1% AEP flood event in the year 2100 (this includes consideration of previous fill volumes); and - It is demonstrated that the fill does not adversely affect local drainage patterns of all events up to the 1% AEP flood event in the year 2100. Note: Fill in flood storage areas greater than the abovementioned volume can be offset by flood storage. Offsetting can be achieved through consolidation of lots and/or assigning an 'easement to flood land' on the compensatory lot/s. Compensatory lots must be located within the zone of influence of the proposed fill (as demonstrated by the flood impact and risk assessment) or adjacent to the proposed fill and be of the same hazard category of the subject site. • Any fill for the purposes of a livestock flood refuge mound, unless the livestock flood refuge mound is located in an identified flood fringe area: - The volume/size and location of the livestock flood refuge mound meets the criteria in Figure BK; and - The size of the mound must have regard to the agricultural capacity of the land. The design and size of the mound shall be determined by reference to the NSW Department of Primary Industries – Agriculture. 2009, 'Primefacts: Livestock flood refuge mounds'; and • Where the proposed development could change flood behaviour, affect existing flood risk, or expose people to flood risks that require management or; • If Council determines a flood impact and risk assessment is necessary for any other reason.	No fill is proposed in areas identified as floodway and/or flood storage in the 1% AEP Future Climate (2100 Planning Horizon) event. A flood impact and risk assessment has been conducted following Council's request (documented herein).

Requirement	Response
B5.9 For residential accommodation, subdivision, commercial premises, industrial premises, garages, open car parking spaces and carports, a reduced planning horizon of 50 years from the date of determination will be accepted where the design facilitates ongoing flood adaptation (i.e. the future raising of the building).	N/A for vulnerable development
B5.10 Where proposed alterations and additions to existing residential accommodation is less than 40% of the gross floor area of the existing residential accommodation, and does not involve a net increase in the number of bedrooms, Council will consider a FFL lower than the flood planning level (FPL), but not lower than the existing floor level. Any additional flood risk must include mitigation measures to reduce the overall flood risk of the development.	N/A
B5.11 Access from the building envelope to the public road is to have a minimum finished access level of: • The flood immunity of the connecting public road; or • The current day 1% AEP flood event level for the site.	Dual access to the Site is proposed via Adelaide Street and Elkin Avenue. Both accesses are flood free in the 1% AEP flood.
5.12 Earthworks for driveways and access must satisfy the objectives of B3.D of the DCP and LEP. Note: Impacts on local drainage and localised flooding should be considered and addressed. Driveways should be designed and constructed in accordance with Councils standard design drawings.	Due to the elevated location of the Site and the physical barrier to flow resulting from the Pacific Highway along the southern boundary of the Site, it is expected that local flow would be minimal. Proposed driveway and access roads works do not involve considerable cut and fill volumes and are not considered to have the potential to impact localised flood behaviour. Proposed roadworks are not within 40m of the top bank of a riparian corridor and do not represent a potential hazard to the environment. Please refer to other consultant report(s) for local drainage considerations relevant to this development (i.e. not part of BMT's scope of work for this assessment).
5.13 Subdivision that creates the ability to erect additional dwellings is to indicate building envelopes above the FPL and comply with the requirements of B5.11, B5.12 and B5.14 of this Part.	No Subdivision is proposed at the Site.
5.14 If evacuation egress from residential accommodation, a commercial premises, an industrial premises, fill or development vulnerable to emergency response and critical infrastructure to flood free areas cannot be achieved via a route that is flood free in the current day 1% AEP flood event	Site egress locations are not flooded in the 1% AEP or the 1% AEP Future Climate (2100 Planning Horizon) events. However, in the 2% AEP, all evacuation routes from the Site are cut by floodwaters at several points. The northern route via Adelaide Street is first cut off by floodwaters at

Requirement	Response
or is a low hazard flood area, an onsite flood refuge must be provided meeting the following criteria: • Is located above the PMF level; • Is intrinsically accessible to all people on the site, plainly evident and self-directing; • Is accessible in sufficient time for all occupants with fail safe access and no reliance on elevators; • Has unobstructed external access for emergency boats during flooding; • Caters for the number of persons that could reasonably be expected on-site at any one time (approx. 2m² per person); • Provides adequate shelter from the storm and has natural lighting and ventilation; and • Contains sufficient clean water, a first aid kit, portable radio with spare batteries and a torch with spare batteries. Note: If a flood refuge is required, the DA must be accompanied by structural certification.	Windeyers Creek in a 2% AEP. The Pacific Highway that runs in a south-west to north-east direction is interrupted both north at Windeyers Creek Bridge (cut-off in a 2% AEP event) and south by Hunter River flooding at the Hunter Region Botanic Gardens (cut-off in a 10% AEP event). In the south, Masonite Road is also not trafficable in a 2% AEP event. Should floodwaters rise above the 1% AEP flood level (in the 0.02% AEP and PMF event for instance), the Site would be flooded. From a flood emergency response perspective, the Site is classified as a Low Flood Island (LFI). A Flood Emergency Response Plan that complies with Council's requirements has been drafted for the Site (reference: 'R.A12187.001.05_HRHS_FERP').
B.15 A site based overland flow report must be submitted for development located within a designated overland flow path. The purpose of this report is to demonstrate that the development: • Will not result in material increase in flood level or flood hazard upstream, downstream or surrounding properties; and • Will provide acceptable management of flood risk with appropriate development levels to ensure the safety of people.	The Site is not located in a designated flow path. Refer to Figure 3.1 for discussion about local overland flow.
Development on land identified as floodway	
B5.16 Development other than farm buildings and/or fill is not supported on land identified as either low hazard floodway or high hazard floodway.	No development is proposed in areas classified as floodways during the 1% AEP event and the 1% AEP Future Climate (2100 Planning Horizon).
B5.17 Fencing in a floodway should not include non-permeable materials or fencing types that could restrict or redirect flood waters.	No fencing in floodway is proposed.
Application of performance-based solutions	
B5.18 The proposed land use is consistent with Figure BI, which shows suitable land uses by flood hazard category (as identified on a flood certificate) and the proposed development incorporates adequate measures to manage risk to human life from flooding, including:	Development is suitable with the flood hazard category designated by Council for the Site ("Minimal Risk Flood Prone Lands", as shown in the Flood Information Certificates in Annex B). A Site-specific Flood Emergency Response Plan (reference: 'R.A12187.001.05_HRHS_FERP') has

Requirement	Response
Evacuation access from an area affected by flooding to an area free of risk from flooding, taking into account any potential access restrictions; Warning times and procedures to make people aware of the need to evacuate; Consideration of the current and potential future occupants; and Consistency with the most recent Council adopted flood study or floodplain risk management study that has been undertaken for the site.	been drafted and demonstrates compliance with Council's flood emergency requirements.
B5.19 The proposed development will not increase the potential individual or cumulative flood impacts on other development or properties that are likely to occur in the same floodplain. In determining any potential increase in flood impacts, Council will consider: • Future (in the year 2100) flood levels and/or velocities including, but not limited to the 5% AEP flood event, 1% AEP flood event and probable maximum flood (PMF) events; • Loss of flood storage in the immediate floodplain; and • Consistency with the most recent, Council adopted flood study or floodplain risk management study that has been undertaken for the site.	A Flood Impact Assessment has been completed for the Site. Flood modelling shows that the location of the proposed works are not flood affected up to and including the 0.2% AEP and 1% AEP Future Climate (2100 Planning Horizon) floods. Flood modelling for the 0.02% AEP flood and PMF indicate that the proposed development will result in no predicted changes to flood levels during the 0.02% AEP event, and only minor increases of up to 10mm occurring at four lots (28 to 34 Elkin Avenue) in the PMF. It is noted that the peak flood depth in locations where afflux is predicted is approximately 2m under existing conditions, and there is no change to the predicted flood hazard categorisation (High Hazard) or flood function (floodway) associated with the predicted afflux. As such, it is considered that there is no increase in flood risk at this location, and therefore negligible flood impact, as a result of the proposed works. In both the 0.02% AEP flood and PMF, there are some peak velocity changes predicted on-Site and off-Site, however these impacts are not predicted to result in any adverse impacts on existing flood risk across roads or adjoining properties. Further information regarding velocity impacts are discussed in Section 5.2.2.
B5.20 The proposed development must be compatible with the flood hazard category of the land (as identified on a flood certificate) or include mitigation measures or offsets to reduce the flood risk. In determining compatibility, Council will consider: • Whether there is other land on the site with lower flood risks where the development could be located; • Depth of flood inundation on the site and the adjacent land;	The development is compatible with the flood hazard category of the land ("Minimal Risk Flood Prone Lands", as shown in the Flood Information Certificates in Annex B). No development works is proposed for the portions of Lots with different (more severe) flood hazard categorisation.

Requirement	Response
• Flow velocity on the site as well as upstream and downstream from the site; • Suitability of design so that the development does not become isolated by high hazard floodwaters; and • Consistency with the most recent, Council adopted flood study or floodplain risk management study that has been undertaken for the site.	

Table 6.2 Flood Planning Level and Proposed Floor Levels

Building	1% AEP year 2100 Flood Level (mAHD)	Flood Planning Level (mAHD)	Proposed Finished Floor Level (mAHD)
Block X – Admin Building	NF	5.7	8.5
Block Z – Learning Hub	NF	5.7	8.5

Note: NF = Building Not Flooded

BMT responses to Council's pre-DA meeting are provided in Annex G and are based on the 2023 FIA and 2023 FERP. Whilst some of the responses are no longer relevant due the changes in the proposed design, there are some items which are still applicable.

7 Conclusion

On behalf of SINSW, BMT has undertaken a site-specific flood impact assessment for the proposed works for the Hunter River High School. The proposed works include the construction of a full-sized rugby field, new carpark, new linking road and kiss and drop bay between Adelaide Street and Elkin Avenue and the buildings. The proposed buildings include Block X (administration building) and Block Z (student learning hub). The finished floor levels of Block X and Z are set to the Probable Maximum Flood (PMF) level.

Flood modelling was completed for the existing and post-development mainstream Hunter River flood conditions based on flood models from the Williamtown Salt Ash Floodplain Risk Management Study and Plan (BMT WBM, 2017). An impact assessment was also completed by comparing peak flood conditions under existing (baseline) conditions and proposed (post-development) conditions.

The results of the flood modelling demonstrate that all proposed works are located outside the Hunter River flood extent for all events up to and including the 0.5% AEP event and 1% AEP Climate Change (2100 Planning Horizon) and therefore, only the 0.02% AEP flood and PMF have the potential to impact the site of proposed works and be impacted by changes in flood conditions as a result of the proposed development within the floodplain. Under existing conditions, flood behaviour on-Site is characterised by slow, deep moving water, with peak PMF depths ranging from 1.4m to 7.0m depending on ground levels.

Under post-development conditions, similar flood conditions are predicted for both the 0.02% AEP flood and PMF. Modelling results indicate that the proposed development will not result in predicted changes to flood levels and only minor increases in flow velocity during the 0.02% AEP event. Whilst there are some peak PMF level and velocity increases off-Site, these increases are not predicted to result in any significant changes to existing flood risk across adjoining property and roads which are already exposed to high hazard and floodway categorisation under existing conditions.

The flood modelling showed that the Site was classified by floodway in the PMF Event. It is noted that the flood function mapping presented in this FIA assessment is based on the methods and threshold criteria prescribed in the Williamtown FRMS&P, for which flood function is defined up to and including the PMF. Port Stephens Council's Flood Certificate for the Site defines flood hazards and flood function for all events up to the Defined Flood Event (the flood event selected as a general standard for the management of flooding to development (Considering flooding in land use planning, DCEEW 2021)) of the 1% AEP Climate Change Scenario only, with rarer events (including the PMF) defined only as "Minimal Risk Flood Prone Land".

Whilst the Site is flood free in the 1% AEP event (and 1% AEP Climate Change (Planning Horizon 2100), the Site is completely inundated from the 0.02% AEP flood. A Flood Emergency Response Plan has also been prepared for the proposed development and is documented in a separate report (reference: ‘R.A12187.001.05_HRHS_FERP’). It provides information on flood risk to occupants of the proposed development for events up to and including the PMF, potential for site evacuation, shelter-in-place considerations and guidance on how to respond in the event of a flood.

Overall, the assessment documented in this report, and specifically the responses provided in Table 6.1, demonstrate that the development satisfies Council’s flood-related DCP requirements.

8 References

Babister M and Barton C (eds) 2012, Australian Rainfall and Runoff Revision Project 15: Two-dimensional modelling in urban and rural floodplains, report P15/S1/009, Engineers Australia, Canberra.

BMT (2005). Williamtown- Salt Ash Flood Study, prepared for Port Stephens Council.

BMT (2017). Williamtown- Salt Ash Floodplain Risk Management Study & Plan, prepared for Port Stephens Council.

Port Stephens Council (2014) Development Control Plan.

Port Stephens Council (2022) Development Control Plan Section B5 Flooding.

2022 Flood Inquiry Volume 2 Full Report (NSW Government, 2022).

New South Wales Department of Planning and Environment (NSW DPE) (2023) Flood Hazard - Flood Risk Management Guideline FB03.

Australian Institute for Disaster Resilience (AIDR) (2017), Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia.

Australian Institute for Disaster Resilience (AIDR) (2017) Guideline 7-2 Flood Emergency Response Classification of the Floodplain.

DCEEW. Considering flooding in land use planning Guideline (2021)

Annex A Proposed Site Plan

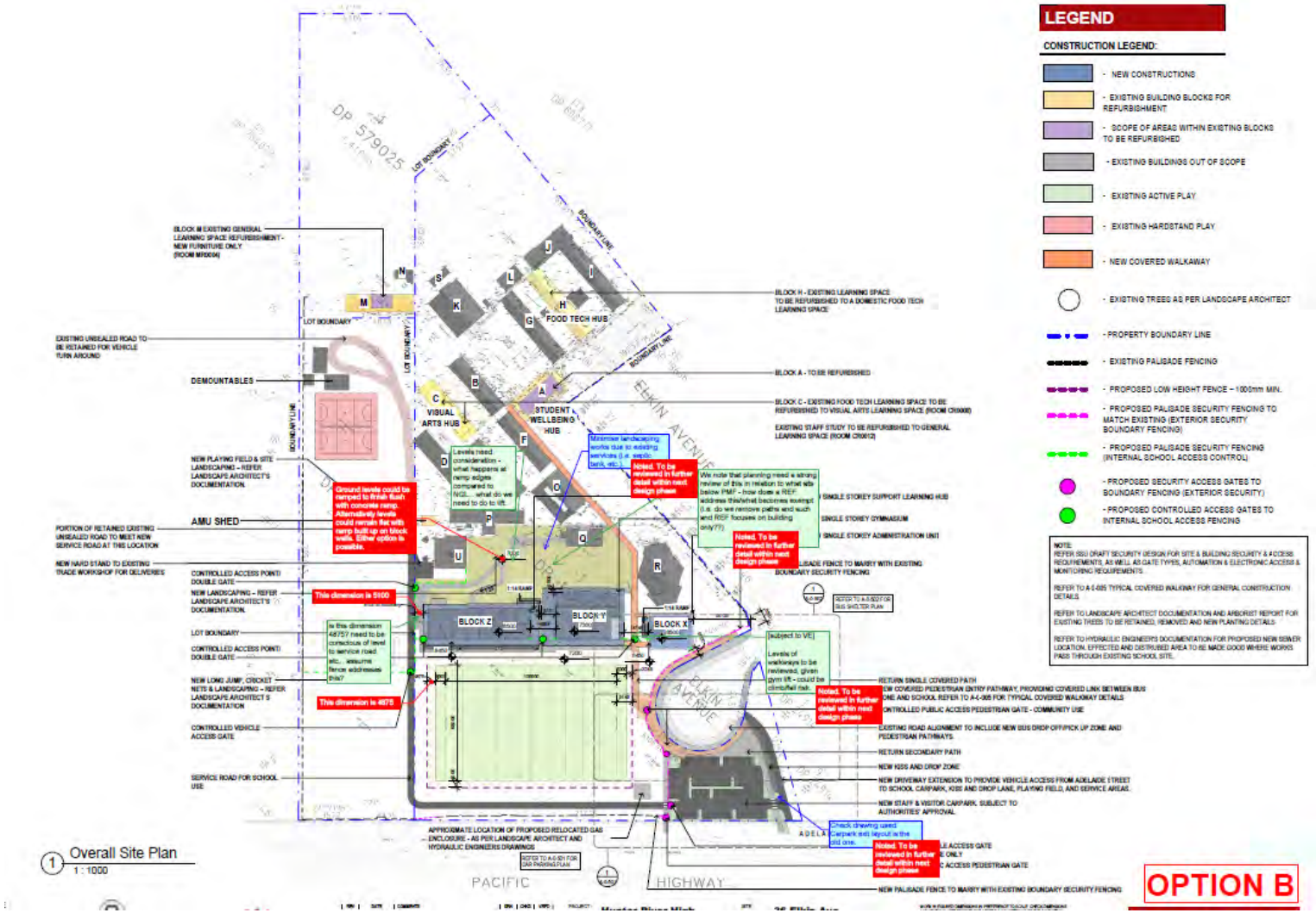


Figure 1 Overall Site Plan (Extract from Drawing A-0-001 of the proposed Site plan (reference: Building Height Exercise - Option B (SINSW_RCC Review).pdf)

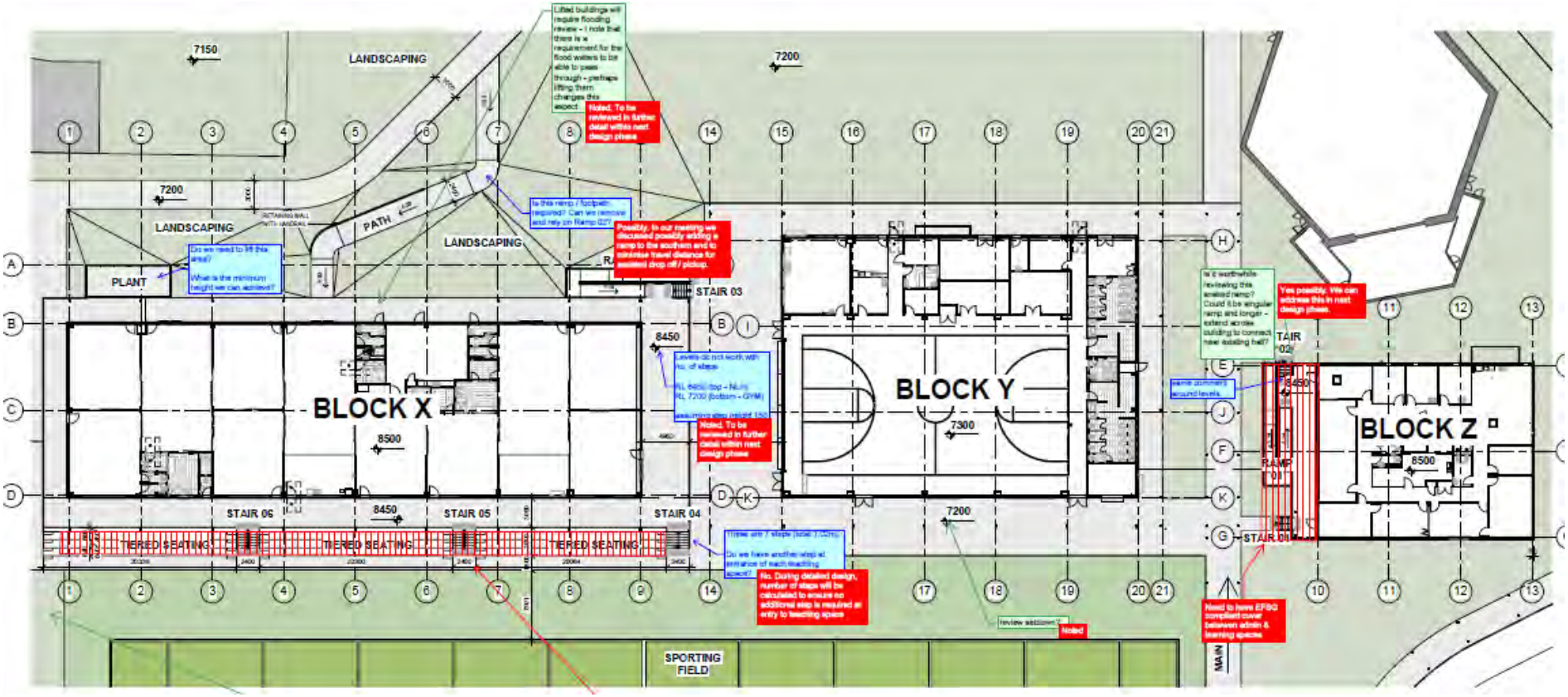


Figure 2 Detailed Site Plan (Extract from Drawing A-0-600 of the proposed Site plan (reference: Building Height Exercise - Option B (SINSW_RCC Review).pdf)

Annex B Port Stephens Council Flood Information Certificates

FLOOD CERTIFICATE

File No: PSC2013-05401
Issue date: 18-Jul-22
Property ID: 20943

Barr Planning
92 Young St
Carrington NSW 2294

Certificate number: 83-2022-1027-1

Property details: 40 Elkin Avenue HEATHERBRAE LOT: 1 DP: 540114

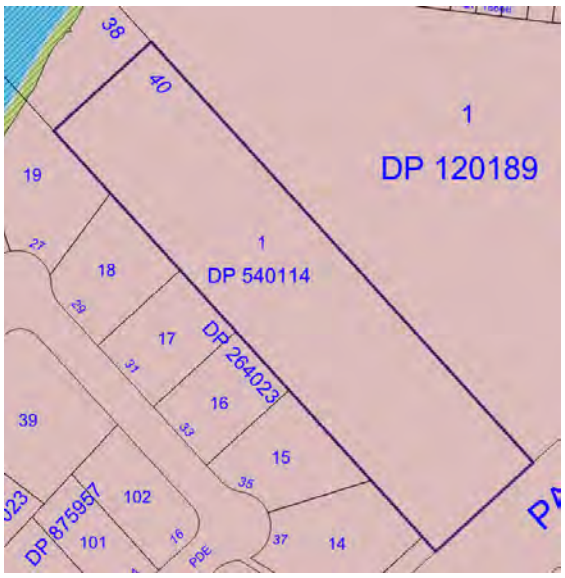
Thank you for your recent flood enquiry regarding the above property. This certificate confirms that this property **is** located in a **flood prone** area. This **is not** a "flood control lot" for the purposes of the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.

Flood Planning Level	**NA**	(This level defines the minimum floor level for habitable rooms and land that is subject to flood-related development controls (refer to Port Stephens DCP Section B5).
Highest Hazard Category	**Minimal Risk Flood Prone Land**	

Flood levels that may be useful are:

Probable maximum flood level	8.5 metres AHD (velocity = 0.6 m/s)	(The highest flood level that could conceivably occur at this location. If required, onsite flood refuges are built at or above this level, refer to the Port Stephens Development Control Plan B5.2)
Current day 1% AEP flood level	4.8 metres AHD	(This level is useful for insurance purposes, refer to your insurance policy and the Insurance Contracts Regulation 1985 (Cwealth).)
Minimum onsite wastewater level	NA	(The 5% AEP level 50 years from now, refer to the Port Stephens On-site Sewage Management Development Assessment Framework and AS/NZS 1547:2012 5.5 land application system design.)

Flooding extent on subject lot, categorised by hazard



Crown © NSW Land and Property Information, © Port Stephens Council

Flood Hazard Categories

- Flood Prone Land
- Flood Planning Level
- Low Hazard Flood Fringe area
- Low Hazard Flood Storage area
- Low Hazard Overland Flow Path area
- Low Hazard Floodway area
- High Hazard Flood Fringe area
- High Hazard Flood Storage area
- High Hazard Overland Flow Path area
- High Hazard Floodway area
- Flood Prone Land subject to further investigation

Information derived from Port Stephens Council 2012, *Williamtown / Salt Ash Flood Study Review*, BMT WBM, Newcastle and Port Stephens Council 2017, *Williamtown / Salt Ash Floodplain Risk Management Study & Plan*, BMT WBM, Newcastle

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ABN 16 744 377 876

IMPORTANT INFORMATION

This Certificate is provided in good faith and in accordance with the provisions of section 733 of the Local Government Act 1993. This certificate provides an estimate of real flood characteristics. Any particular flood may be different to the conditions that were assumed to determine the information shown in this certificate.

The provided flood information has been compiled from information provided by external consultants and flood studies completed by Council in accordance with the NSW Floodplain Development Manual. The information has not been independently verified or checked beyond the agreed scope of work and Council does not accept liability in connection with unverified information.

Council acknowledges that its flood information may be incomplete and varying in accuracy, however it is the best information available to Council at the time of issue.

The information is provided to give the applicant an understanding as to the extent of flooding affecting the property as well as assist in the preparation of a Floodplain Risk Management Report. The information is subject to change if more accurate data becomes available to Council. Accordingly the information in this certificate is not warranted after the day of issue.

Council is not responsible for updating flood data when site conditions have change from the time of the original flood study and does not accept responsibility arising from any change in site conditions.

Where the relevant information is available, Council's Flood Planning Levels include the estimated impact of climate change.

Council recommends that the information contained in this Certificate be interpreted by a suitably qualified professional. It is the responsibility of the applicant to obtain survey level data (in metres AHD) for the site.

Council disclaims responsibilities to any other person other than the person nominated on the Flood Certificate arising from or in connection with the information provided.

The floor level survey for the property (if available) is based on the conditions on the date of the survey. Any changes to buildings since the survey may alter the appropriate floor level. Refer to the Port Stephens LEP 2013 Section 5.21 and Port Stephens Development Control Plan Section B5 for details on development controls on flood prone land.

For information, the insurance industry uses its own estimates of flood risk and its own definitions for flooding, which may differ when compared with Council's information and the NSW Floodplain Development Manual. You should contact your insurance company to find out if a flood certificate may influence your insurance premium.

The information provided may contain personal information as defined under the Privacy and Personal Information Protection Act 1998. The purpose of collecting this information is to enable Council to consider matters under related legislation, issue related documentation where required and other associated matters as provided by law and will be utilised by Council officers in assessing the proposal and other associated activities. The information may also be made available to other persons in accordance with the relevant Acts and regulations, such as the Government Information (Public Access) Act 2009 and will be stored in Council's record system.

DEFINITIONS

"Flood Planning Level" defines the area of land below the 1% AEP flood event in the year 2100 plus freeboard and is the area of land subject to flood-related development controls (refer to Port Stephens Development Control Plan Section B5). The Flood Planning Level defines the minimum floor level for habitable rooms.

"Freeboard" is a safety margin applied to the estimation of flood levels to compensate for uncertainties due to factors such as wave action, localised hydraulic behaviour (eg flow path blockages caused by natural and urban debris such as trees, 'wheelie' bins, cars, containers) and changes in rainfall patterns and ocean water levels as a result of the changing climate (refer Flood Manual Section 4).

"Habitable room" in a residential situation is a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom; in an industrial or commercial situation is an area used for offices or to store valuable possessions susceptible to flood damage (refer Flood Manual Section 4).

"Adaptable minimum floor level" is the reduced flood planning level allowed in Council's Development Control Plan where the proposed development facilitates ongoing flood adaptation (for example, where the design facilitates building raising in the future, such as a pier and beam housing design).

"Probable maximum flood level" is the flood level that arises from the largest flood that could conceivably occur at a particular location (the "PMF" or extreme design event). This level does not include any freeboard and provides an upper limit of flooding and associated consequences for the problem being investigated. It is used for emergency response planning purposes to address the safety of people and defines the floodplain and identifies "Flood Prone" land.

"AEP" (Annual Exceedance Probability) is the chance of a flood of a given or larger size occurring in any one year (for example, the 1% AEP event has a 1% chance of occurring every year; the 5% AEP event has a 5% chance of occurring every year).

"Surveyed floor level" is the surveyed level at the entrance to the residence, usually measured as part of the floodplain risk management plan undertaken for the area.

"AHD" (Australian Height Datum) a common national survey level datum, approximately corresponding to mean sea level set in the mid to late 1960s.

Hazard Categories

"High hazard" flood area is the area of flood which poses a possible danger to personal safety, where the evacuation of trucks would be difficult, where able-bodied adults would have difficulty wading to safety or where there is a potential for significant damage to buildings (refer Flood Manual Appendix L).

"Low hazard" flood area is the area of flood where, should it be necessary, a truck could evacuate people and their possessions or an able-bodied adult would have little difficulty in wading to safety (refer Flood Manual Appendix L).

Hydraulic Categories

"Floodways" are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of flood flow, which may in turn adversely affect other areas (refer Flood Manual Section 4).

"Overland flow path" is land inundated by local runoff on its way to a waterway, rather than overbank flow from a stream, river, estuary, lake or dam (refer Flood Manual Section 4).

"Flood Storage" areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The loss of storage areas may increase the severity of flood impacts by reducing natural flood attenuation (refer Flood Manual Section 4).

"Flood Fringe" is the remaining land in the Flood Planning Area after the Floodway area and Flood Storage area have been defined (refer Flood Manual Section 4).

"Flood Prone Land subject to further investigation" refers to the area of land susceptible to flooding where a comprehensive technical investigation of flood behaviour (to define the variation over time of flood levels, extent, velocity, flood hazard and the Flood Planning Level up to and including the probable maximum flood) has not yet been carried out (refer Flood Manual Appendix F).

"Minimal Risk Flood Prone Land" is land on the floodplain that is above the Flood Planning Level. This means that there are no flood-related development controls that apply to residential development, but critical emergency response and recovery facilities, such as evacuation centres and vulnerable development types, such as aged care and child care facilities, may not be appropriate in this location.

FLOOD CERTIFICATE

File No: PSC2013-05401
Issue date: 18-Jul-22
Property ID: 27244

Barr Planning
92 Young St
Carrington NSW 2294

Certificate number: 83-2022-1026-1

Property details: 38 Elkin Avenue HEATHERBRAE LOT: 1 DP: 579025

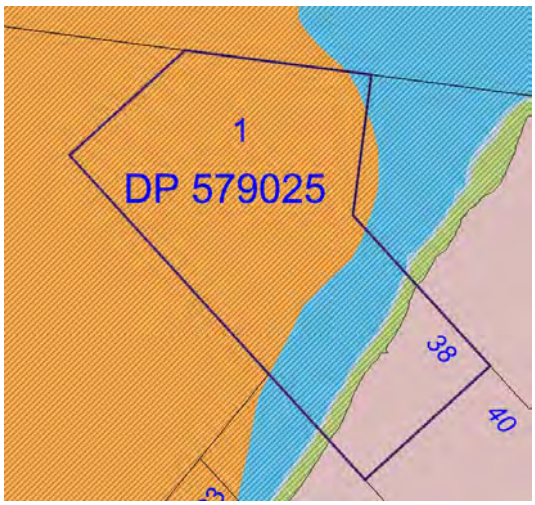
Thank you for your recent flood enquiry regarding the above property. This certificate confirms that this property **is** located in a **flood prone** area. This **is** a "flood control lot" for the purposes of the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.

Flood Planning Level	**5.7 metres AHD** (velocity = 0.3 m/s)	(This level defines the minimum floor level for habitable rooms and land that is subject to flood-related development controls (refer to Port Stephens DCP Section B5).
Highest Hazard Category	**High Hazard Floodway area**	

Flood levels that may be useful are:

Probable maximum flood level	8.5 metres AHD (velocity = 0.6 m/s)	(The highest flood level that could conceivably occur at this location. If required, onsite flood refuges are built at or above this level, refer to the Port Stephens Development Control Plan B5.2)
Current day 1% AEP flood level	4.8 metres AHD	(This level is useful for insurance purposes, refer to your insurance policy and the Insurance Contracts Regulation 1985 (Cwealth).)
Adaptable minimum floor level	5.7 metres AHD	(The 1% AEP flood level plus 0.5m, 50 years from now, refer to the Port Stephens Development Control Plan B5.2.)
Minimum onsite wastewater level	3.4 metres AHD	(The 5% AEP level 50 years from now, refer to the Port Stephens On-site Sewage Management Development Assessment Framework and AS/NZS 1547:2012 5.5 land application system design.)

Flooding extent on subject lot, categorised by hazard



Flood Hazard Categories

- Flood Prone Land
- Flood Planning Level
- Low Hazard Flood Fringe area
- Low Hazard Flood Storage area
- Low Hazard Overland Flow Path area
- Low Hazard Floodway area
- High Hazard Flood Fringe area
- High Hazard Flood Storage area
- High Hazard Overland Flow Path area
- High Hazard Floodway area
- Flood Prone Land subject to further investigation

Information derived from Port Stephens Council 2012, *Williamtown / Salt Ash Flood Study Review*, BMT WBM, Newcastle and Port Stephens Council 2017, *Williamtown / Salt Ash Floodplain Risk Management Study & Plan*, BMT WBM, Newcastle

PORT STEPHENS COUNCIL
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Raymond Terrace NSW 2324
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www.portstephens.nsw.gov.au
ABN 16 744 377 876

IMPORTANT INFORMATION

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DEFINITIONS

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"AHD" (Australian Height Datum) a common national survey level datum, approximately corresponding to mean sea level set in the mid to late 1960s.

Hazard Categories

"High hazard" flood area is the area of flood which poses a possible danger to personal safety, where the evacuation of trucks would be difficult, where able-bodied adults would have difficulty wading to safety or where there is a potential for significant damage to buildings (refer Flood Manual Appendix L).

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Hydraulic Categories

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FLOOD CERTIFICATE

File No: PSC2013-05401
Issue date: 18-Jul-22
Property ID: 23840

Barr Planning
92 Young St
Carrington NSW 2294

Certificate number: 83-2022-1025-1

Property details: 36 Elkin Avenue HEATHERBRAE LOT: 1 DP: 120189

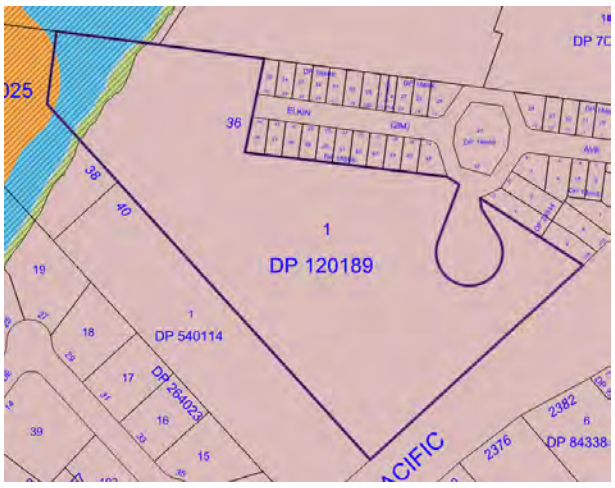
Thank you for your recent flood enquiry regarding the above property. This certificate confirms that this property **is** located in a **flood prone** area. This **is** a "flood control lot" for the purposes of the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.

Flood Planning Level	**5.7 metres AHD** (velocity = 0.3 m/s)	(This level defines the minimum floor level for habitable rooms and land that is subject to flood-related development controls (refer to Port Stephens DCP Section B5).
Highest Hazard Category	**High Hazard Floodway area**	

Flood levels that may be useful are:

Probable maximum flood level	8.5 metres AHD (velocity = 0.7 m/s)	(The highest flood level that could conceivably occur at this location. If required, onsite flood refuges are built at or above this level, refer to the Port Stephens Development Control Plan B5.2)
Current day 1% AEP flood level	4.8 metres AHD	(This level is useful for insurance purposes, refer to your insurance policy and the Insurance Contracts Regulation 1985 (Cwealth).)
Adaptable minimum floor level	5.7 metres AHD	(The 1% AEP flood level plus 0.5m, 50 years from now, refer to the Port Stephens Development Control Plan B5.2.)
Minimum onsite wastewater level	3.4 metres AHD	(The 5% AEP level 50 years from now, refer to the Port Stephens On-site Sewage Management Development Assessment Framework and AS/NZS 1547:2012 5.5 land application system design.)

Flooding extent on subject lot, categorised by hazard



Flood Hazard Categories

- Flood Prone Land
- Flood Planning Level
- Low Hazard Flood Fringe area
- Low Hazard Flood Storage area
- Low Hazard Overland Flow Path area
- Low Hazard Floodway area
- High Hazard Flood Fringe area
- High Hazard Flood Storage area
- High Hazard Overland Flow Path area
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Annex C Deriving Modelling inputs for 0.2% AEP and 0.02% AEP flood events

The Williamtown / Salt Ash district is located adjacent to the lower reaches of the Hunter River. The Hunter River drains a catchment area of approximately 21,000 km^2, nearly all of which lies upstream of Raymond Terrace. As such, the Hunter River is the dominant mechanism of flooding. There are also other considerations including local catchment flooding and tidal flooding. The modelling approaches adopted for the Williamtown FRMS&P include:

- Application of Hunter River and Williams River hydrographs which represent Hunter River inflows. These inflows match the design peak flood levels estimated using FFA for Raymond Terrace Gauge.
- Local catchments inflows: 10% AEP local catchment inflows were applied to all design events (excluding PMF).
- Tidal Conditions: 50% AEP Newcastle Harbour and Port Stephens flood levels were applied to all design events (excluding PMF).

As part of the work completed for the Williamtown FRMS&P, a revised Flood Frequency Analysis (FFA) was undertaken for peak flood levels at the Raymond Terrace Water Level Gauge. This updated FFA formed the basis of the design flood estimates used in the Williamtown FRMS&P (and this assessment). It is noted that no design estimates were provided for the 0.2% and 0.02% AEP events. There are inherent uncertainties regarding the estimation of design flood flows, particularly for the large magnitude events and particularly at the Raymond Terrace gauge which is less reliable due to a shorter continuous record period and the absence of a rating curve and a shorter continuous record, with the most significant flood events predating this period. However, in order to provide a best-estimate for a suitable design flood level at the Site, the following was completed:

- Interpolated design peak flood levels between the 0.5% AEP (1 in 200 year) and the PMF (assuming a 1 in 10,000 year event which is a conservative approach)
- Extrapolated design peak flood levels using the gradient between the 1% and 0.5% AEP events.

Figure C.1below shows this for both the Raymond Terrace design flood levels and Hexham Bridge design flood levels. The inflow hydrographs were scaled up from the 0.5% AEP (1 in 200 year) event and simulated through TUFLOW until the resulting flood level at both Raymond Terrace and Hexham Gauge fell within the estimated design flood level ranges. The same local catchment and tidal conditions were adopted as per the Williamtown FRMS&P design event modelling. A summary of the adopted values are:

- A 1.2 factor was applied to the design hydrograph which resulted in a flood level of 5.73mAHD and 4.74mAHD Raymond Terrace at Hexham Gauge which was found to fall within the estimated range for the 0.2% AEP (1 in 500 year).
- A 2.2 factor was applied to the design hydrograph which resulted in a flood level of 7.72mAHD and 6.77mAHD Raymond Terrace at Hexham Gauge which was found to fall within the estimated range for the 0.02% AEP (1 in 5000 year).

It is noted that the ‘Flood Impact Assessment for Proposed Mound and Shed Construction at 28 Alnwick Road, Millers Forest NSW’ (Torrent Consulting, 2022) estimated the peak flood level at Raymond Terrace to be 5.8mAHD in the 0.2% AEP (1 in 500 AEP) which is a good match to the adopted design flow used in this assessment. It is noted that the 0.02% AEP (1 in 5000 AEP) was not simulated for Torrent (2022). A review of publicly available documents found no assessments or studies that have simulated the 0.02% AEP (1 in 5000 AEP).

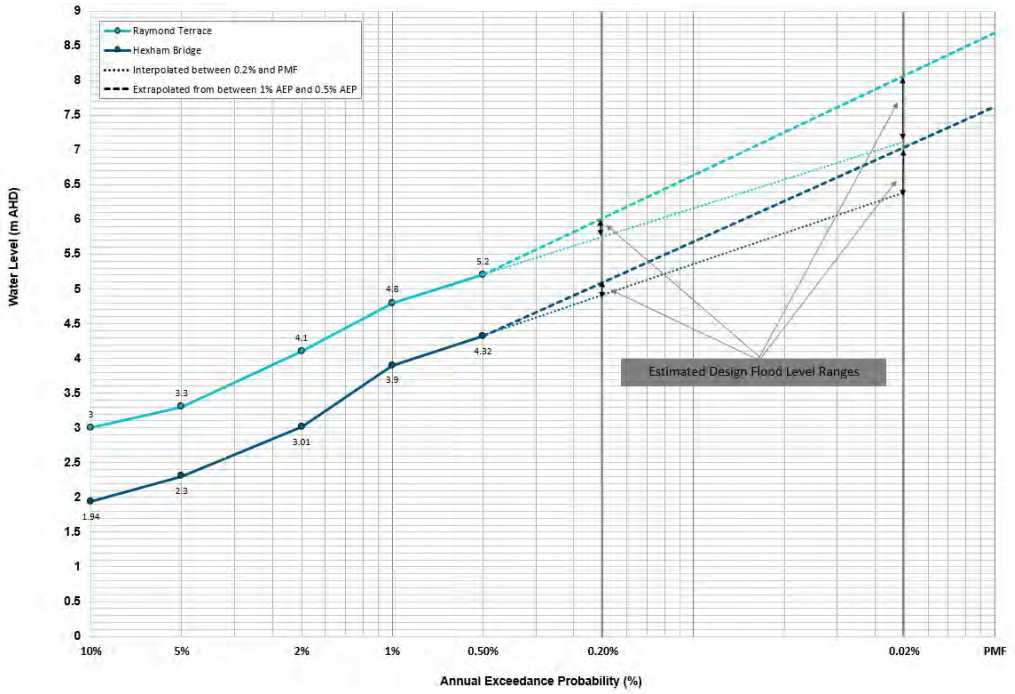

Figure C.1 Design Flood Level Estimates for Raymond Terrace and Hexham Bridge

Annex D Existing Flood Conditions Mapping

LEGEND

Site Boundary

Lot

Peak Flood Level (m AHD)

Peak Flood Level Contour 0.05m

Peak Flood Depth (m)

0.5
1
3
3.5
4
4.5
5

MILLERS FOREST
RAYMOND TERRACE
HEATHERBRAE
WOODBERRY
Hunter River
Elizabeth Ave
Grahams Town Drain
Adelaide St
Windeyers Creek
Pacific Highway
Kingston Pde
Motto Ln
Giggins Rd
Masonite Rd

Title:
Peak Flood Depth - Existing Scenario - 10% AEP Flood

Figure: **D-01**

Rev: **A**

N

0 300 600 m

BMT

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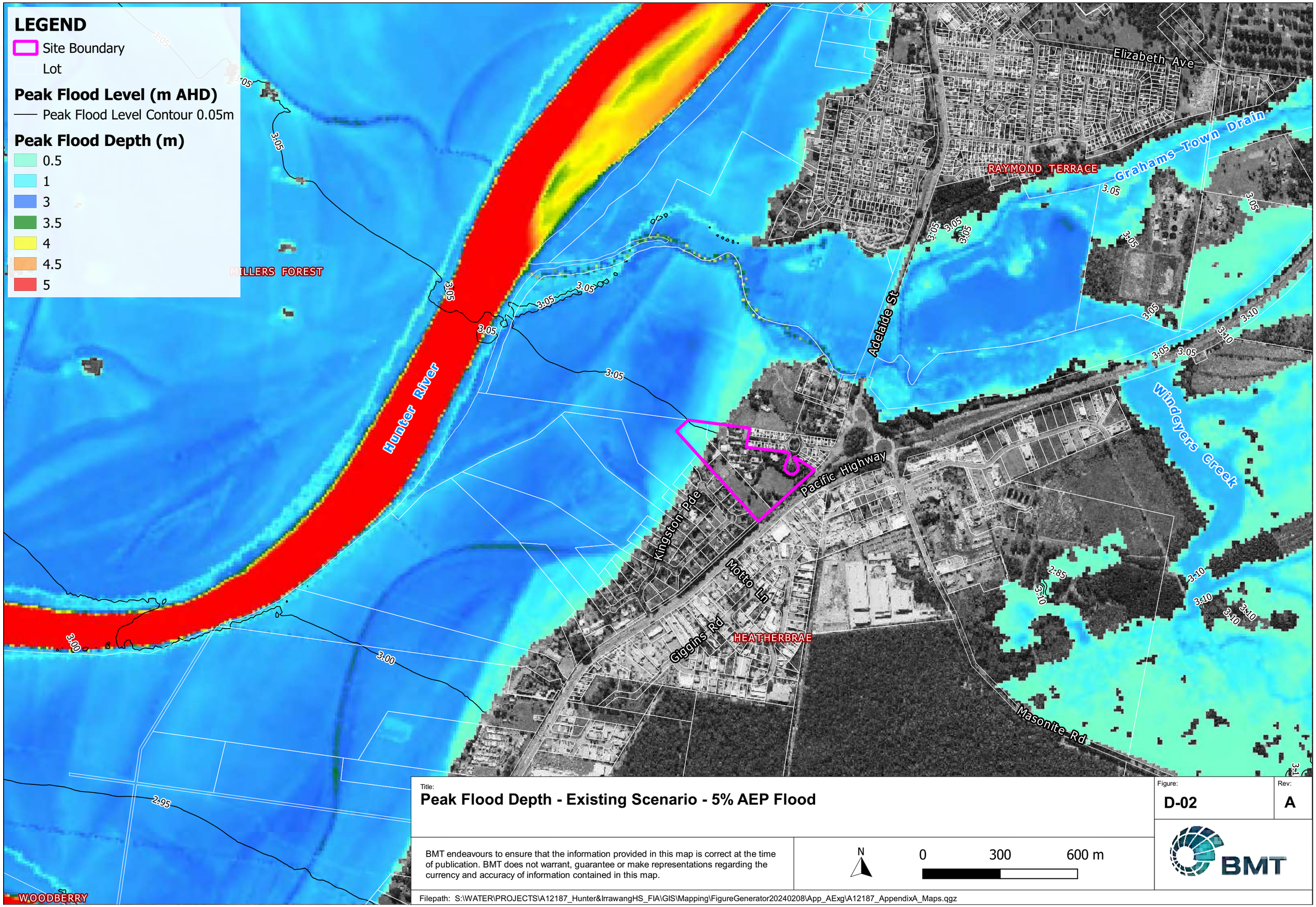

Title:

Peak Flood Depth - Existing Scenario - 5% AEP Flood

Figure: D-02

Rev: A

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LEGEND

Site Boundary

Lot

Peak Flood Level (m AHD)

Peak Flood Level Contour 0.05m

Peak Flood Depth (m)

0.5

1

3

3.5

4

4.5

5

Elizabeth Ave

RAYMOND TERRACE

Adelaide St

Grahams Town Drain

MILLERS FOREST

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

4.00

3.95

3.90

3.85

3.80

3.55

Title:

Peak Flood Depth - Existing Scenario - 2% AEP Flood

Figure: **D-03**

Rev: **A**

N

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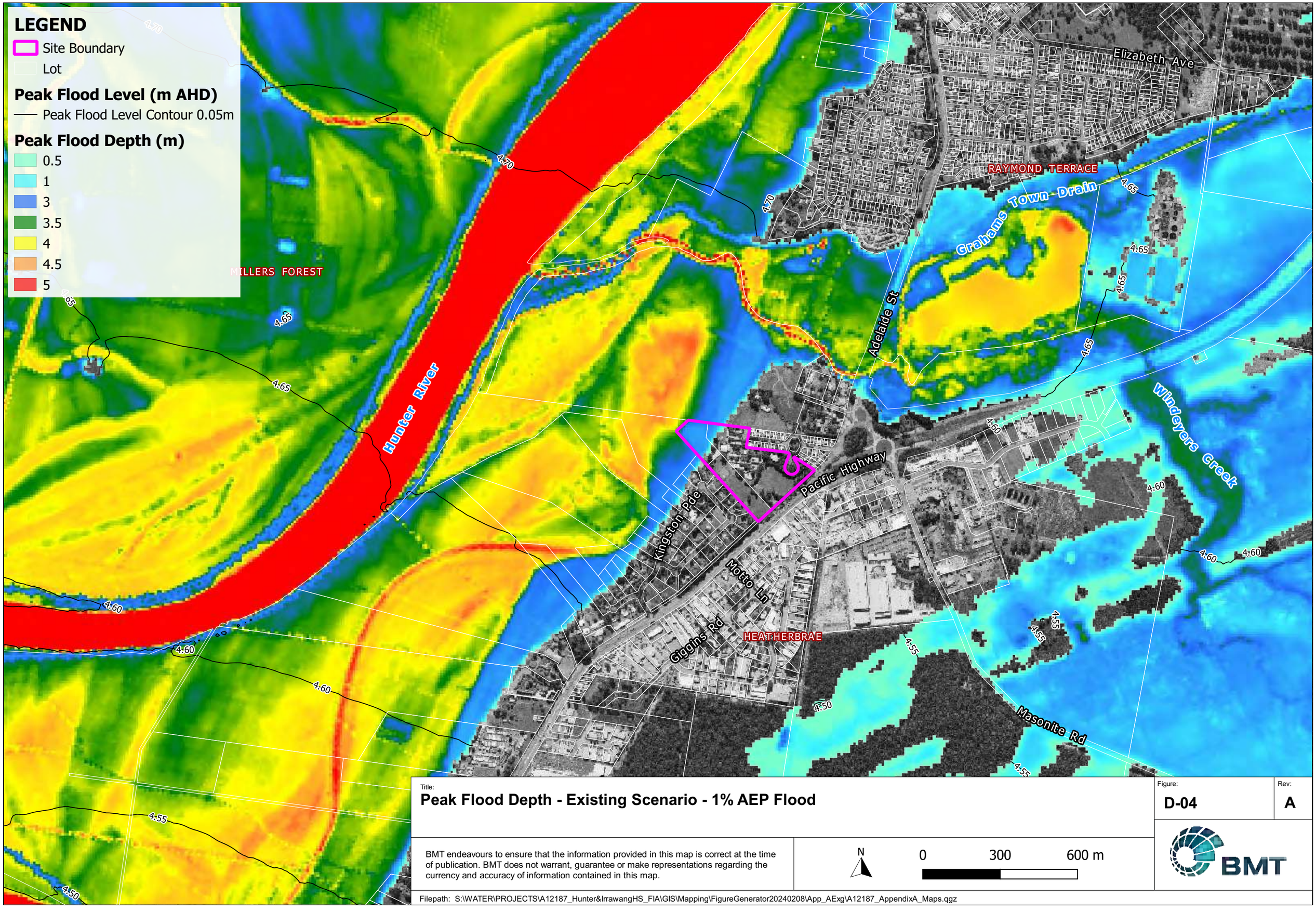

Title:

Peak Flood Depth - Existing Scenario - 1% AEP Flood

Figure: D-04

Rev: A

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BMT

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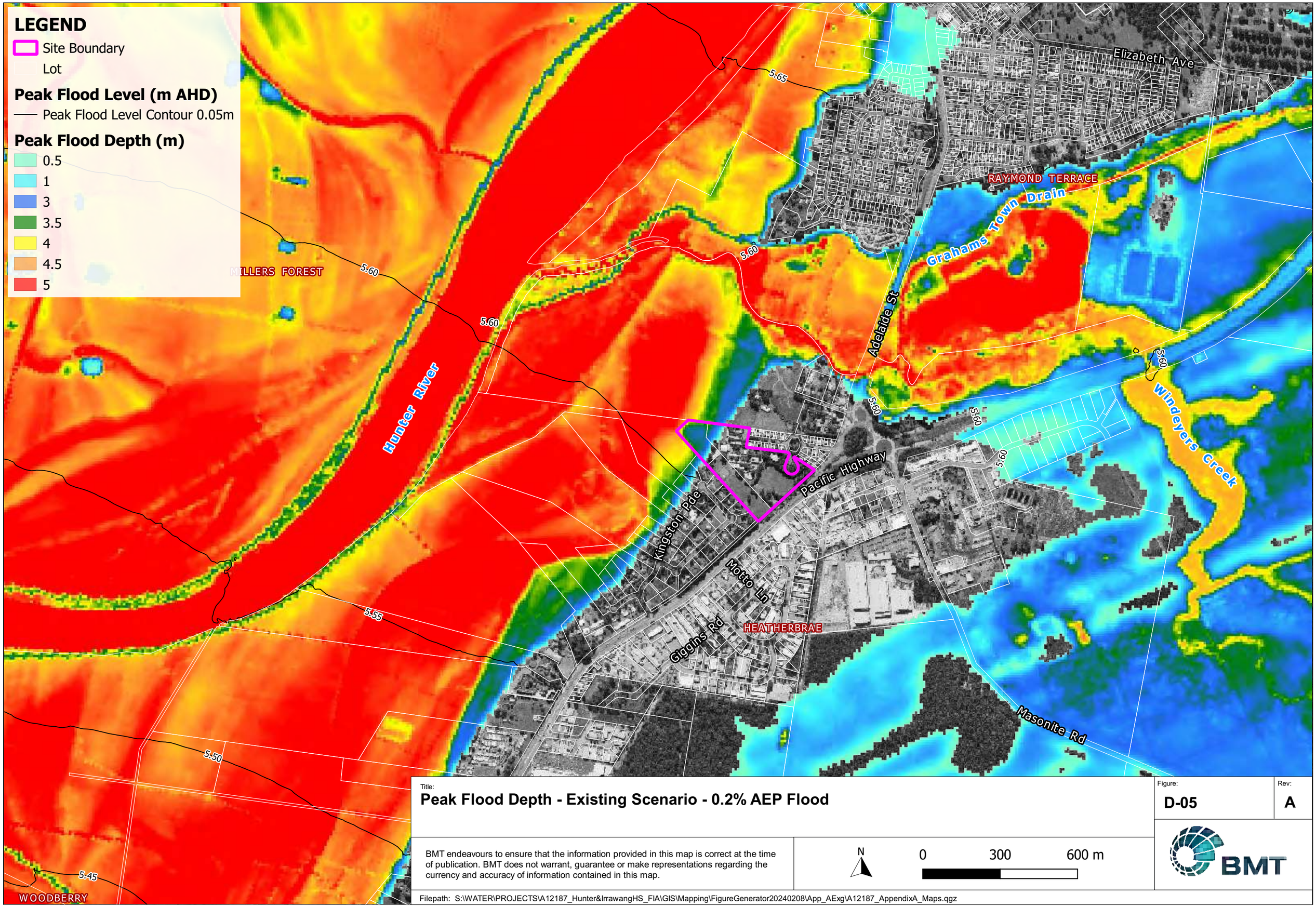

Title:
Peak Flood Depth - Existing Scenario - 0.2% AEP Flood

Figure: **D-05**

Rev: **A**

N

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BMT

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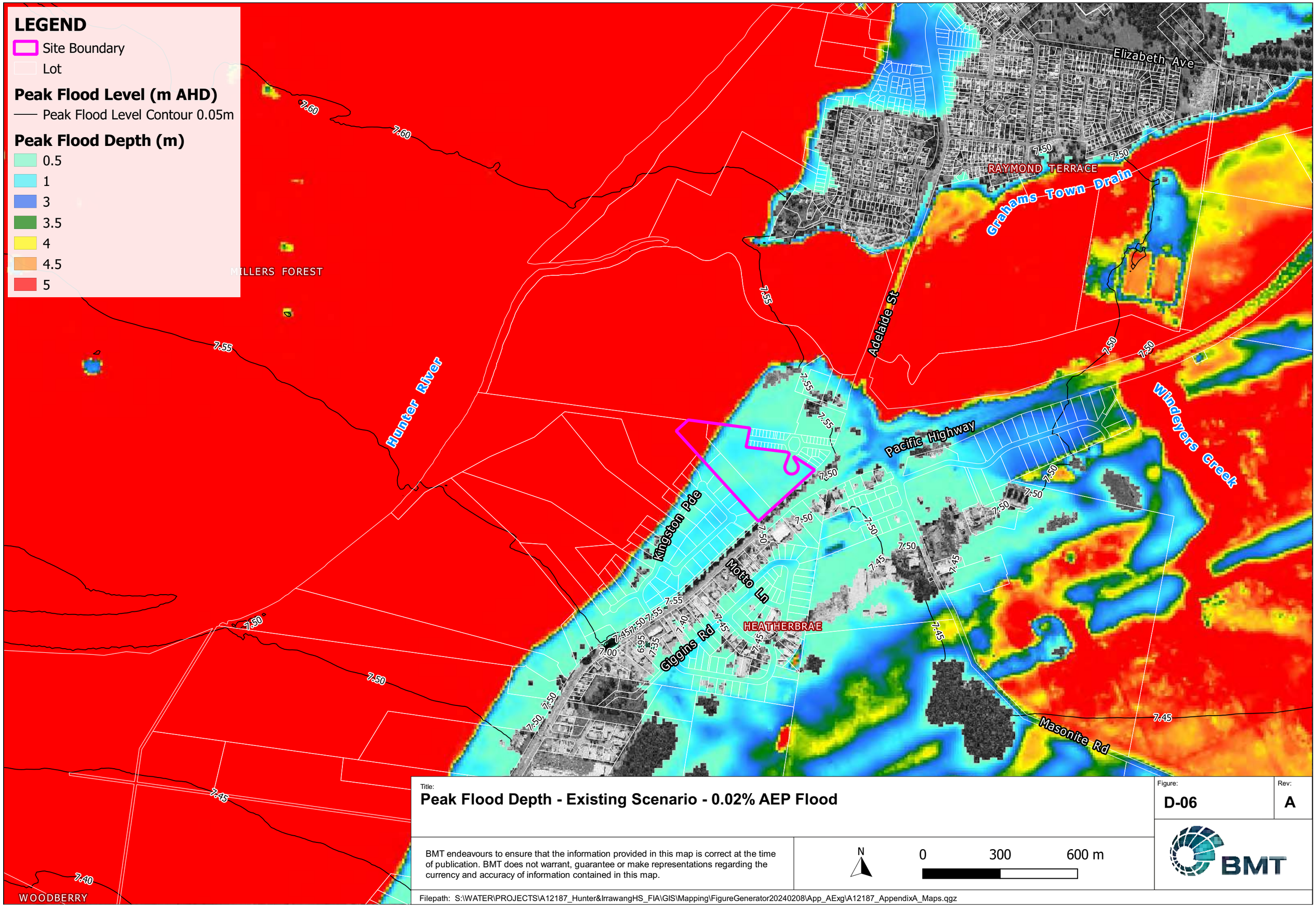

Title:

Peak Flood Depth - Existing Scenario - 0.02% AEP Flood

Figure: D-06

Rev: A

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LEGEND

- Site Boundary
- Lot

Peak Flood Level (m AHD)

- Peak Flood Level Contour 0.05m

Peak Flood Depth (m)

- 0.5
- 1
- 3
- 3.5
- 4
- 4.5
- 5

RAYMOND TERRACE
MILLERS FOREST
HEATHERBRAE
WOODBERRY
Elizabeth Ave
Grahams Town Drain
Hunter River
Adelaide St
Pacific Highway
Windeyers Creek
Kingston Pde
Motto Ln
Heather St
Giggins Rd
Masonite Rd

Title:
Peak Flood Depth - Existing Scenario - Probable Maximum Flood (PMF)

Figure: D-07

Rev: A

N

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LEGEND

Site Boundary

Lot

Peak Flood Level (m AHD)

Peak Flood Level Contour 0.05m

Peak Flood Depth (m)

- 0.5
- 1
- 3
- 3.5
- 4
- 4.5
- 5

5-25
5-20
5.15
5.10
5.05
MILLERS FOREST
Hunter River
RAYMOND TERRACE
Elizabeth Ave
Grahams Town Drain
Adelade St
Windeyers Creek
Pacific Highway
Kingston Pde
Motto Ln
Giggins Rd
HEATHERBRAE
Masonite Rd

Title:

Peak Flood Depth - Existing Scenario - 1% AEP Climate Change (2100)

Figure: D-08

Rev: A

N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

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Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Existing Scenario - 10% AEP Flood

Figure: **D-09**

Rev: **A**

N

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BMT

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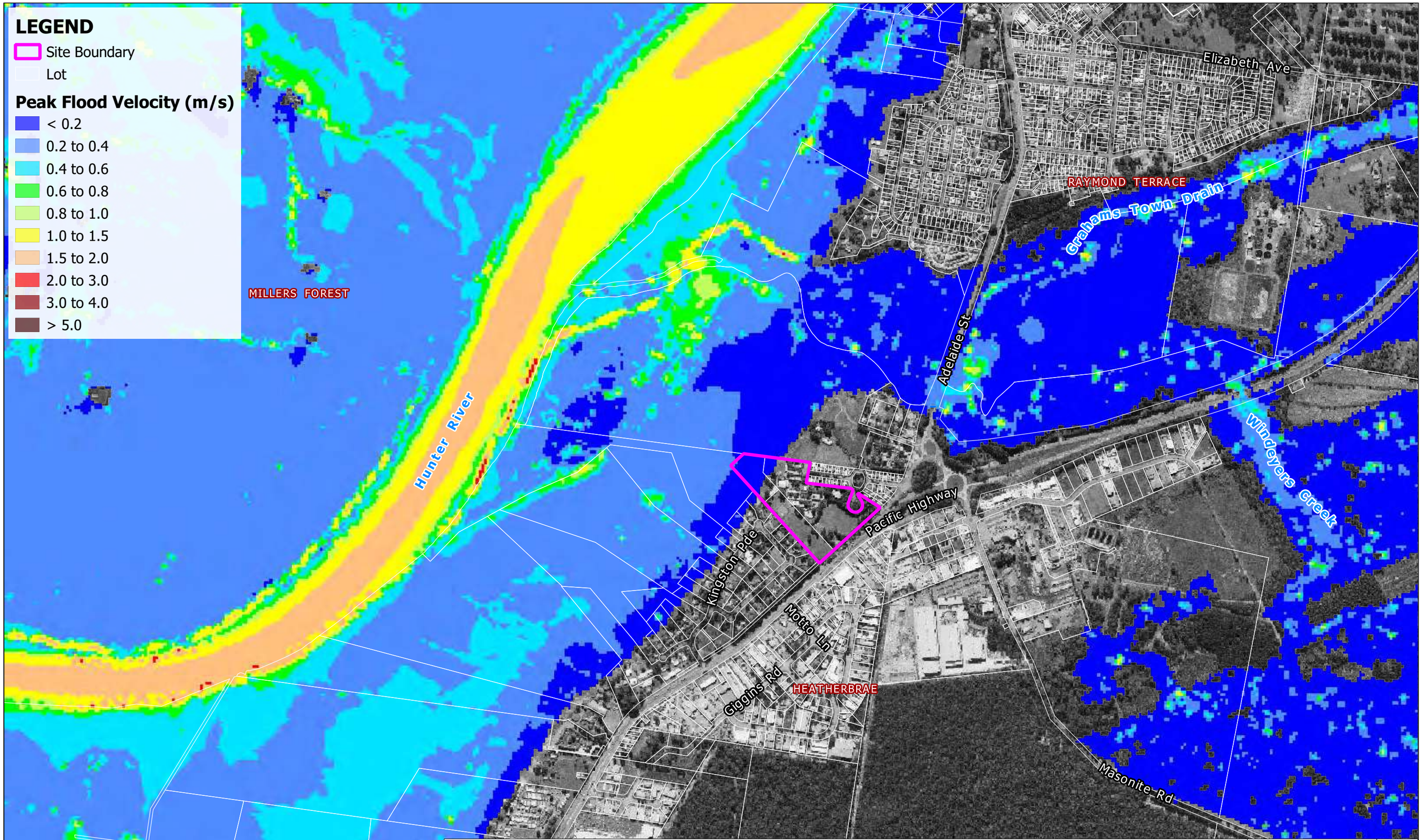

Title:
Peak Flood Velocity - Existing Scenario - 5% AEP Flood

Figure: **D-10**

Rev: **A**

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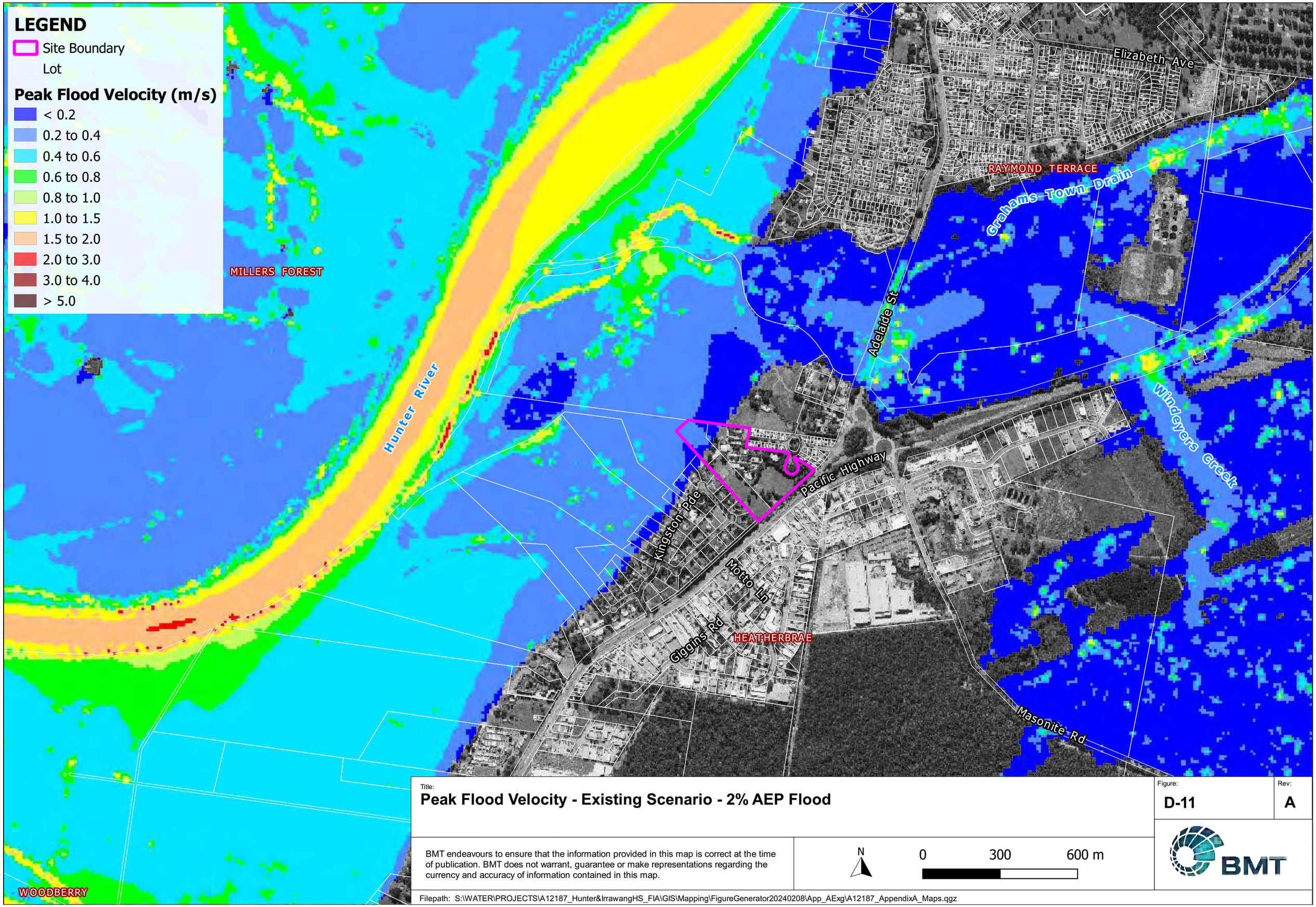

Title:
Peak Flood Velocity - Existing Scenario - 2% AEP Flood

Figure: **D-11**

Rev: **A**

N

0 300 600 m

BMT

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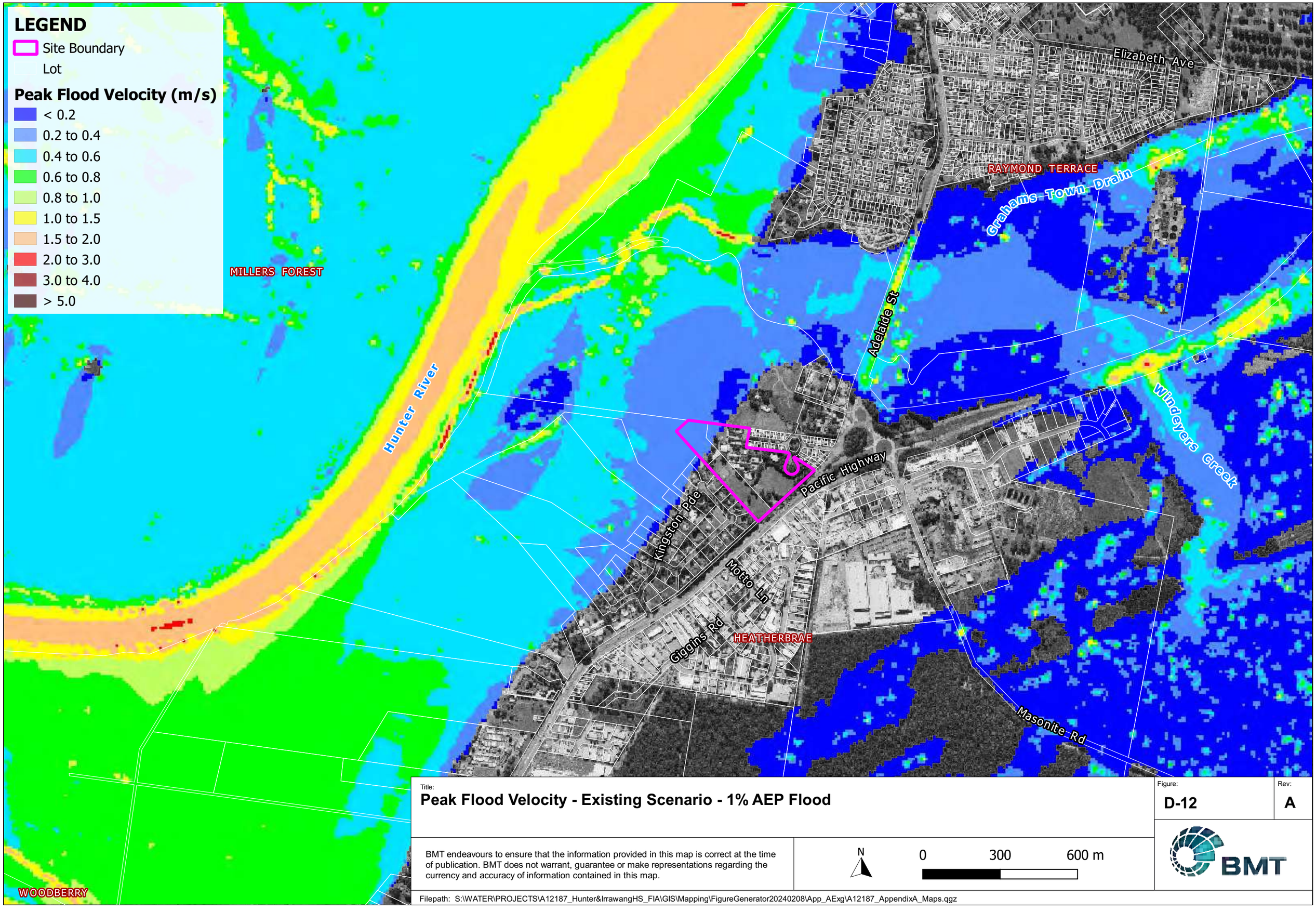

Title:
Peak Flood Velocity - Existing Scenario - 1% AEP Flood

Figure: D-12

Rev: A

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N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Existing Scenario - 0.2% AEP Flood

Figure: **D-13**

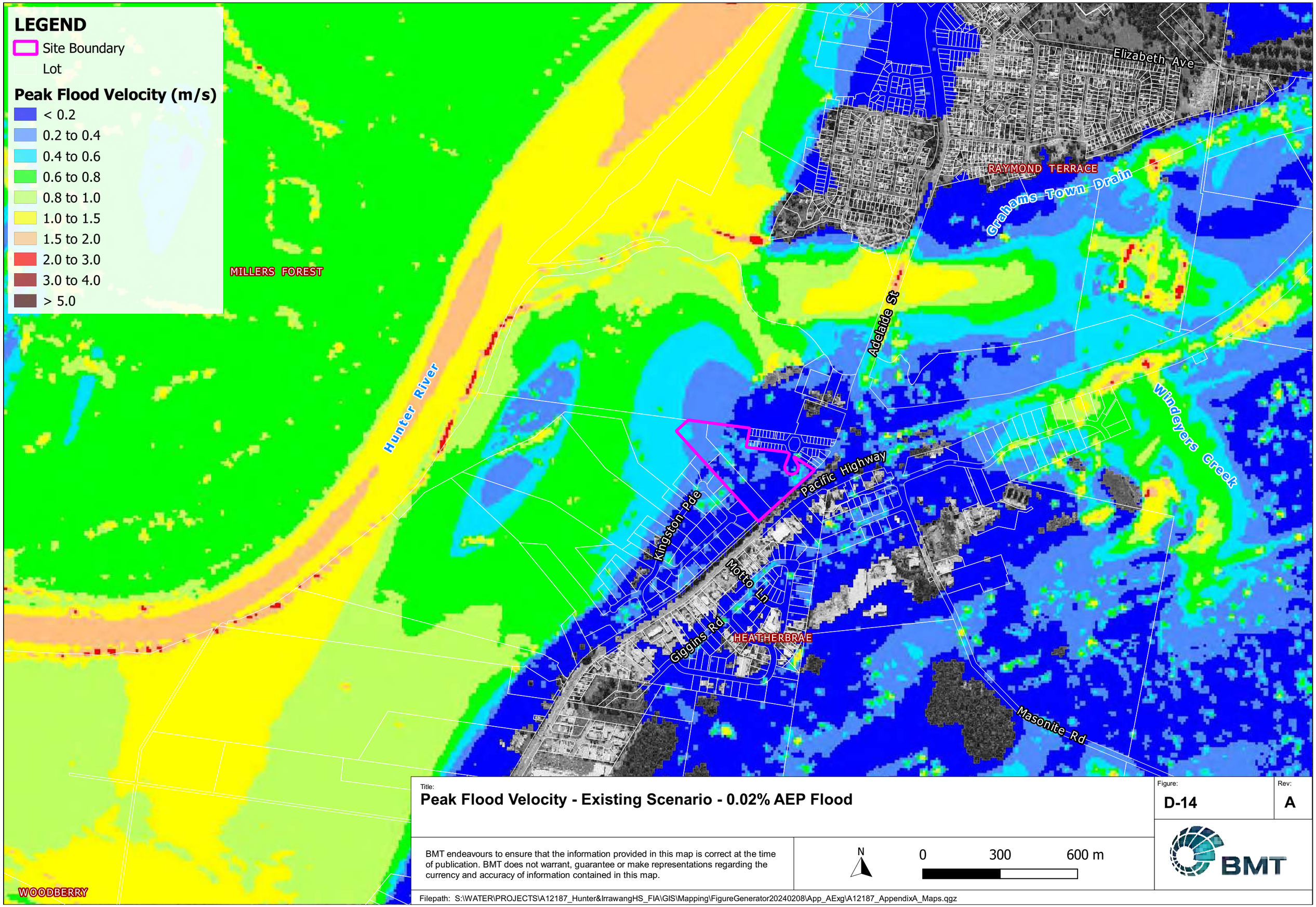
Rev: **A**

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz



Title:

Peak Flood Velocity - Existing Scenario - 0.02% AEP Flood

Figure: D-14

Rev: A

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N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Existing Scenario - Probable Maximum Flood (PMF)

Figure: D-15

Rev: A

N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Existing Scenario - 1% AEP Climate Change (2100)

Figure: D-17

Rev: A

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelade St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Existing Scenario - 10% AEP Flood

Figure: D-18

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelade St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Existing Scenario - 5% AEP Flood

Figure: D-19

Rev: A

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

WOODBERRY

RAYMOND TERRACE

HEATHERBRAE

Elizabeth Ave

Adelade St

Grahams Town Drain

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

Masonite Rd

Title:

FDM (2005) Flood Hazard - Existing Scenario - 2% AEP Flood

Figure: D-20

Rev: A

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N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

WOODBERRY

RAYMOND TERRACE

HEATHERBRAE

Elizabeth Ave

Graham's Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

Masonite Rd

Title:

FDM (2005) Flood Hazard - Existing Scenario - 1% AEP Flood

Figure: D-21

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Existing Scenario - 0.2% AEP Flood

Figure: D-22

Rev: A

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Existing Scenario - 0.02% AEP Flood

Figure: D-23

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Existing Scenario - Probable Maximum Flood (PMF)

Figure: D-24

Rev: A

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

WOODBERRY

RAYMOND TERRACE

HEATHERBRAE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

Masonite Rd

Title:

FDM (2005) Flood Hazard - Existing Scenario - 1% AEP Climate Change (2100)

Figure: D-25

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

Site Boundary

Lot

Peak Flood Hazard

H1

H2

H3

H4

H5

H6

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

AIDR Flood Hazard (2017) - Existing Scenario - 5% AEP Flood

Figure: D-26

Rev: A

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

AIDR Flood Hazard (2017) - Existing Scenario - 2% AEP Flood

Figure: D-27

Rev: A

N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Hazard

H1

H2

H3

H4

H5

H6

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

AIDR Flood Hazard (2017) - Existing Scenario - 1% AEP Flood

Figure: D-28

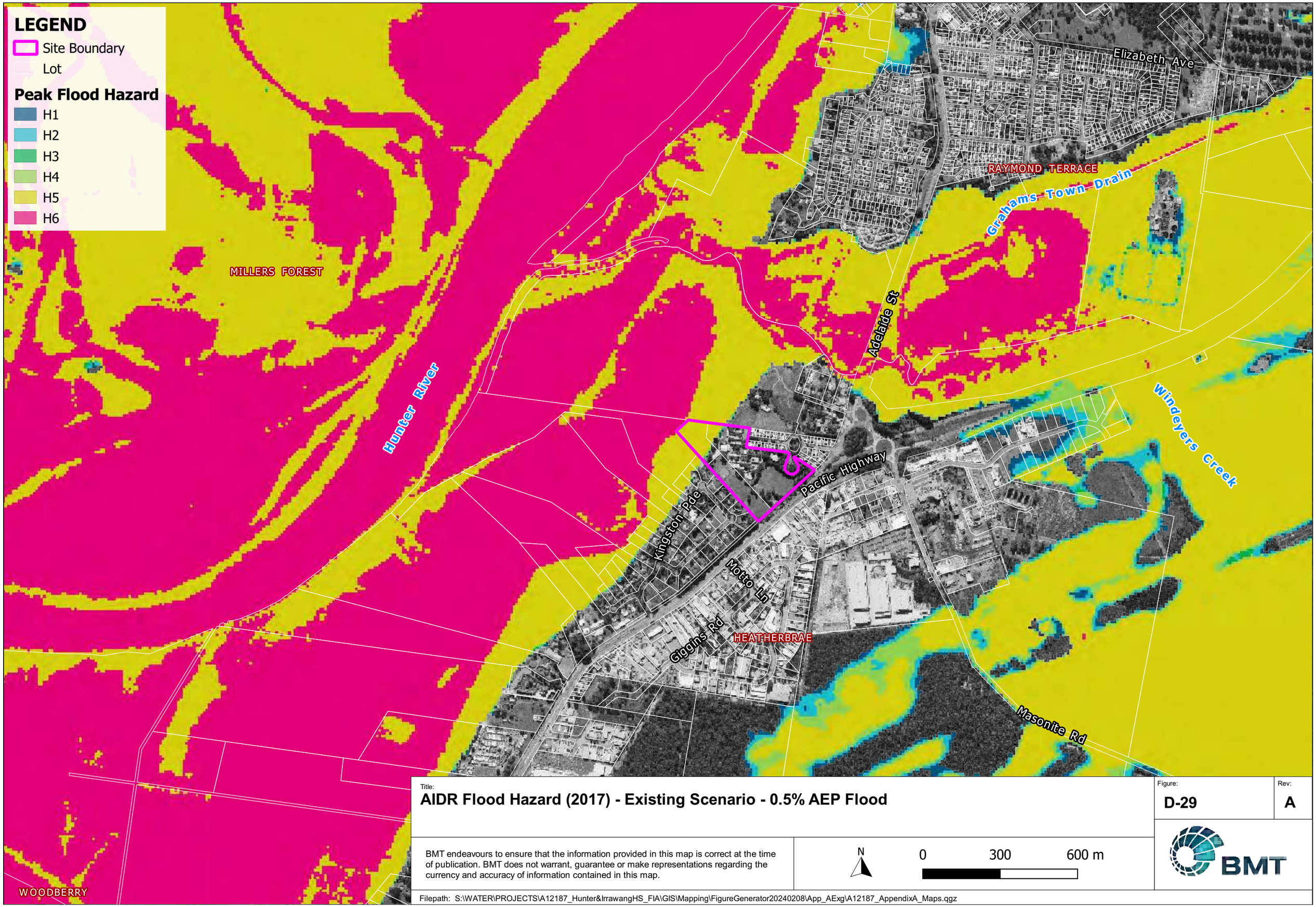
Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz



Title:

AIDR Flood Hazard (2017) - Existing Scenario - 0.5% AEP Flood

Figure: D-29

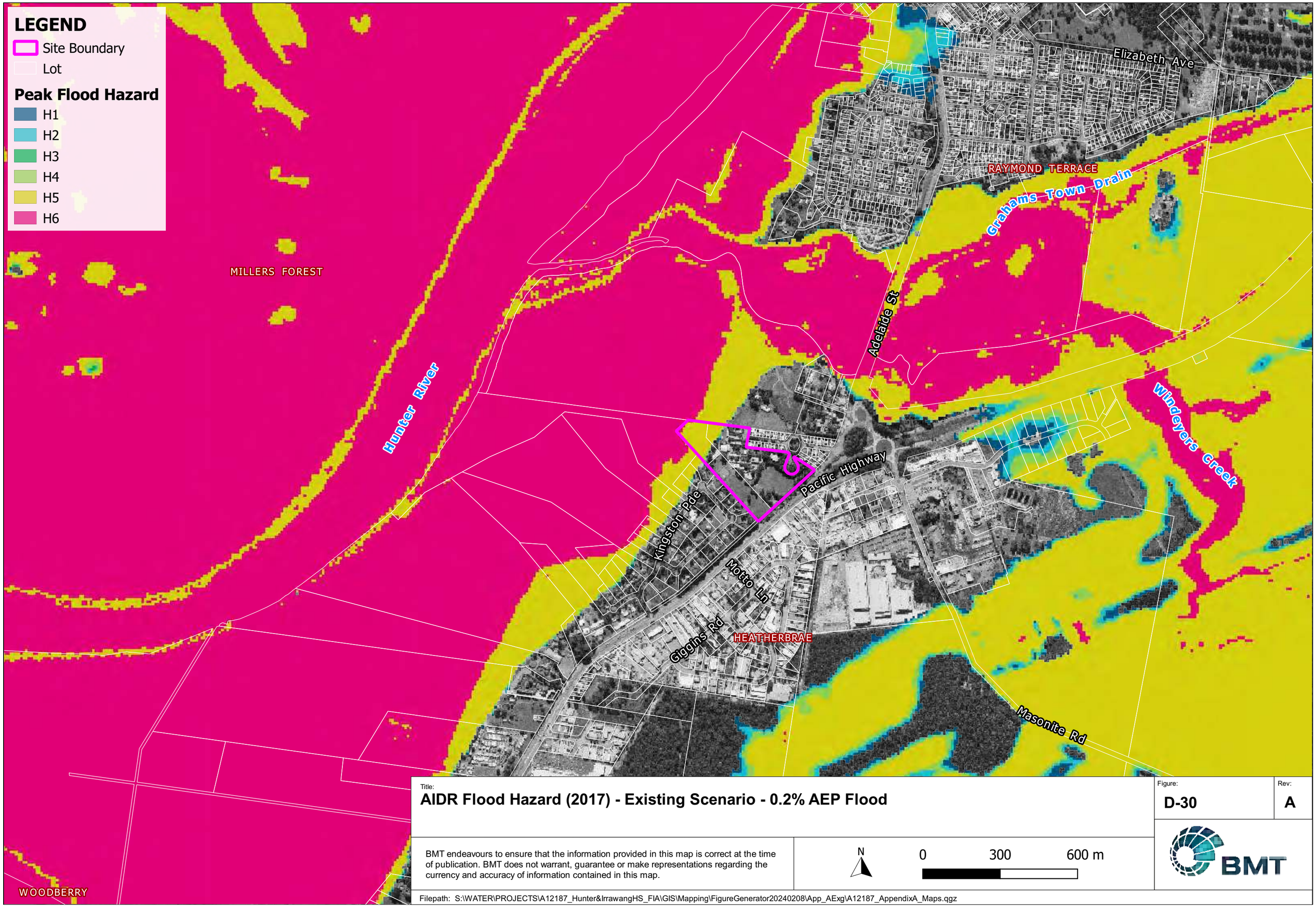
Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz



Title:

AIDR Flood Hazard (2017) - Existing Scenario - 0.2% AEP Flood

Figure: D-30

Rev: A

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N

0 300 600 m

BMT

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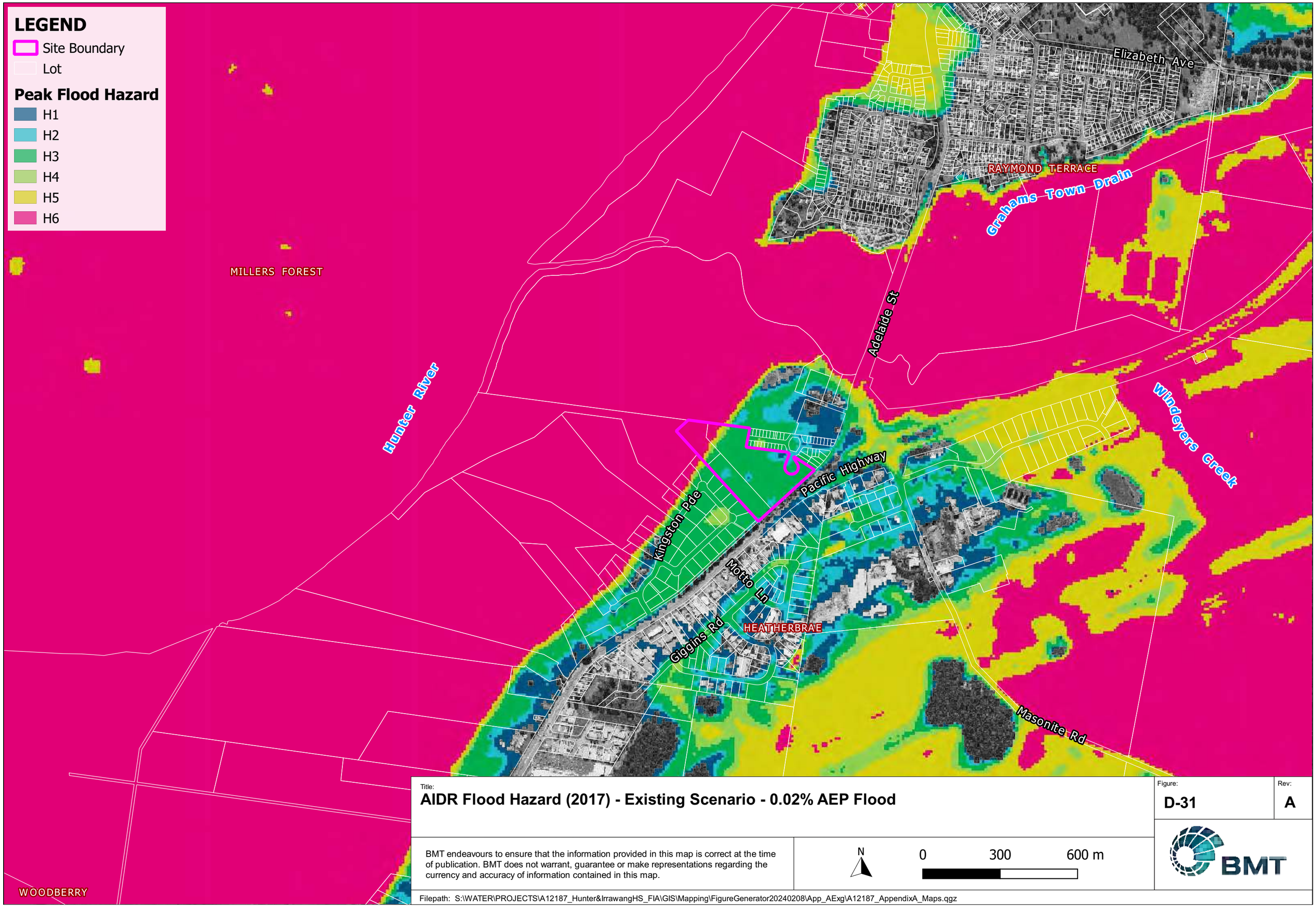

Title:
AIDR Flood Hazard (2017) - Existing Scenario - 0.02% AEP Flood

Figure: **D-31**

Rev: **A**

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N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

AIDR Flood Hazard (2017) - Existing Scenario - Probable Maximum Flood (PMF)

Figure: D-32

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

MILLERS FOREST

RAYMOND TERRACE

HEATHERBRAE

WOODBERRY

Elizabeth Ave

Grahams Town Drain

Adelade St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

Masonite Rd

Title:

AIDR Flood Hazard (2017) - Existing Scenario - 1% AEP Climate Change (2100)

Figure: **D-33**

Rev: **A**

N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Flood Functions

- Flood Fringe
- Flood Storage
- Floodway

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Function - Existing Scenario - 0.02% AEP Flood

Figure: D-34

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\App_AExg\A12187_AppendixA_Maps.qgz

LEGEND

- Site Boundary
- Lot

Flood Functions

- Flood Fringe
- Flood Storage
- Floodway

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Function - Existing Scenario - Probable Maximum Flood (PMF)

Figure: D-35

Rev: A

N

0 300 600 m

BMT

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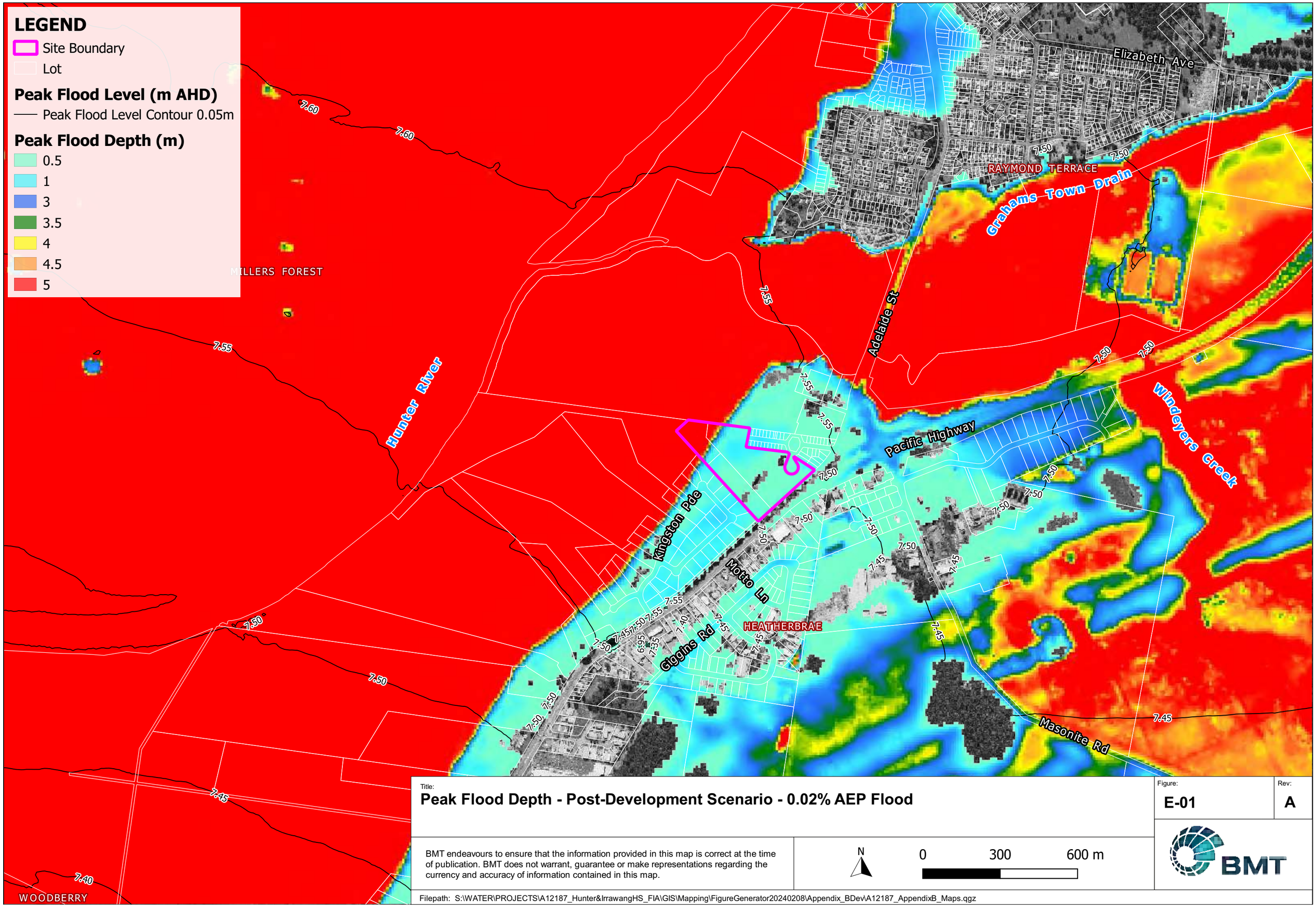
Annex E Post-development Flood Conditions Mapping



Title:

Peak Flood Depth - Post-Development Scenario - 0.02% AEP Flood

Figure: E-01

Rev: A

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N

0 300 600 m

BMT

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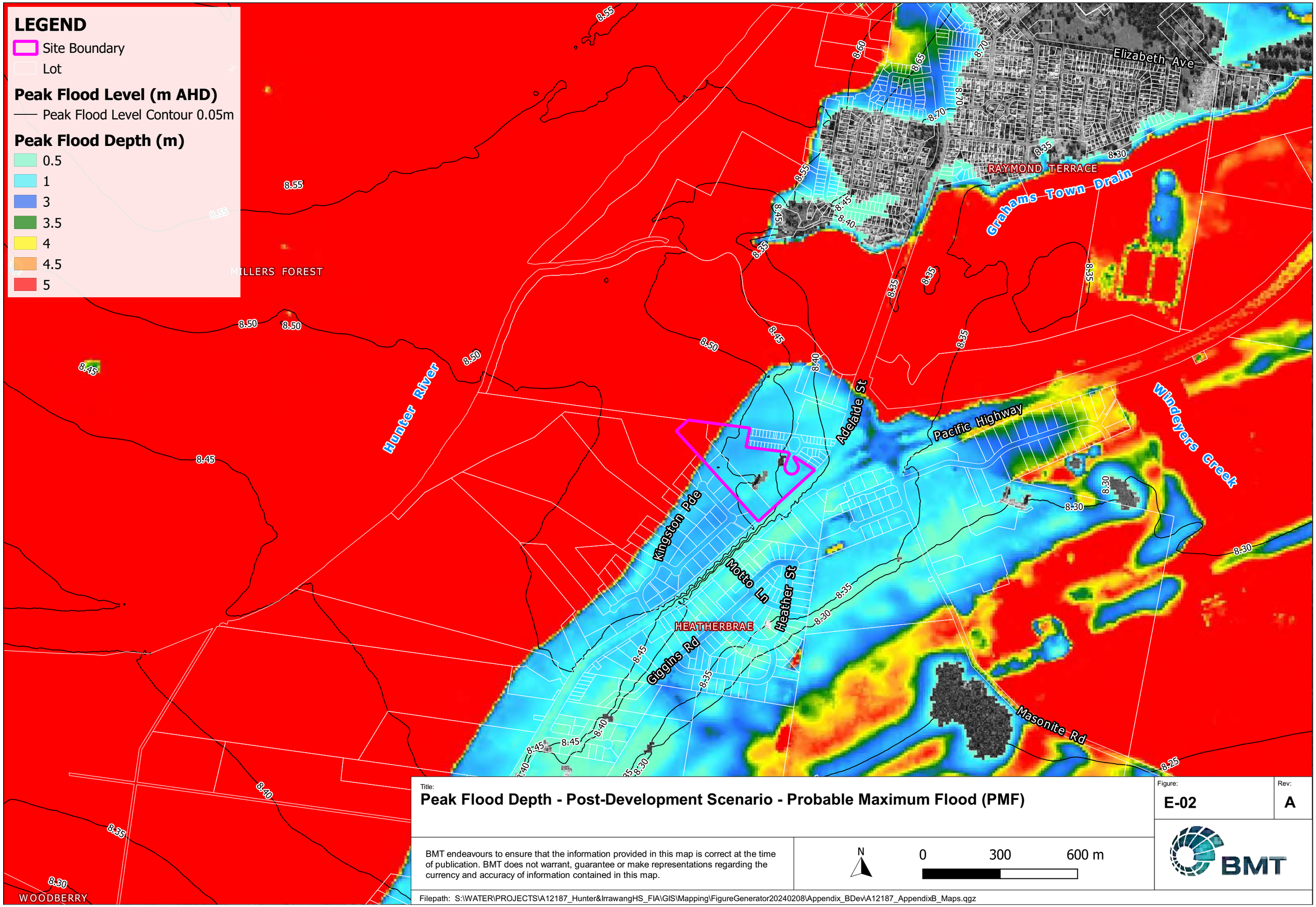

Title:

Peak Flood Depth - Post-Development Scenario - Probable Maximum Flood (PMF)

Figure: E-02

Rev: A

N

0 300 600 m

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_BDev\A12187_AppendixB_Maps.qgz

LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Post-Development Scenario - 0.02% AEP Flood

Figure: **E-03**

Rev: **A**

N

0 300 600 m

BMT

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LEGEND

Site Boundary

Lot

Peak Flood Velocity (m/s)

- < 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- > 5.0

MILLERS FOREST

Hunter River

Elizabeth Ave

RAYMOND TERRACE

Grahams Town Drain

Adelaide St

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Velocity - Post-Development Scenario - Probable Maximum Flood (PMF)

Figure: E-04

Rev: A

N

0 300 600 m

BMT

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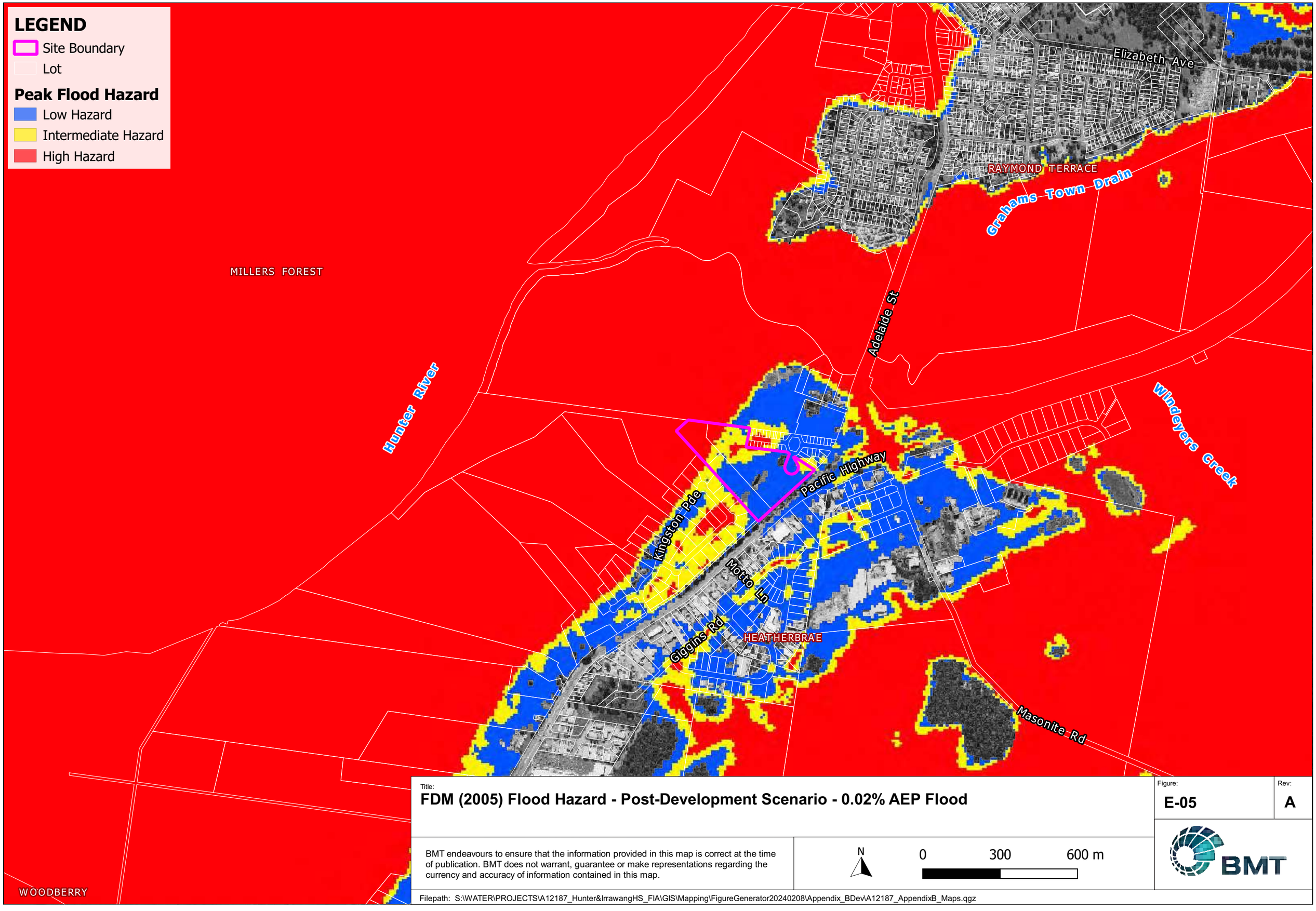

Title:

FDM (2005) Flood Hazard - Post-Development Scenario - 0.02% AEP Flood

Figure: E-05

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_BDev\A12187_AppendixB_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- Low Hazard
- Intermediate Hazard
- High Hazard

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

FDM (2005) Flood Hazard - Post-Development Scenario - Probable Maximum Flood (PMF)

Figure: E-06

Rev: A

N

0 300 600 m

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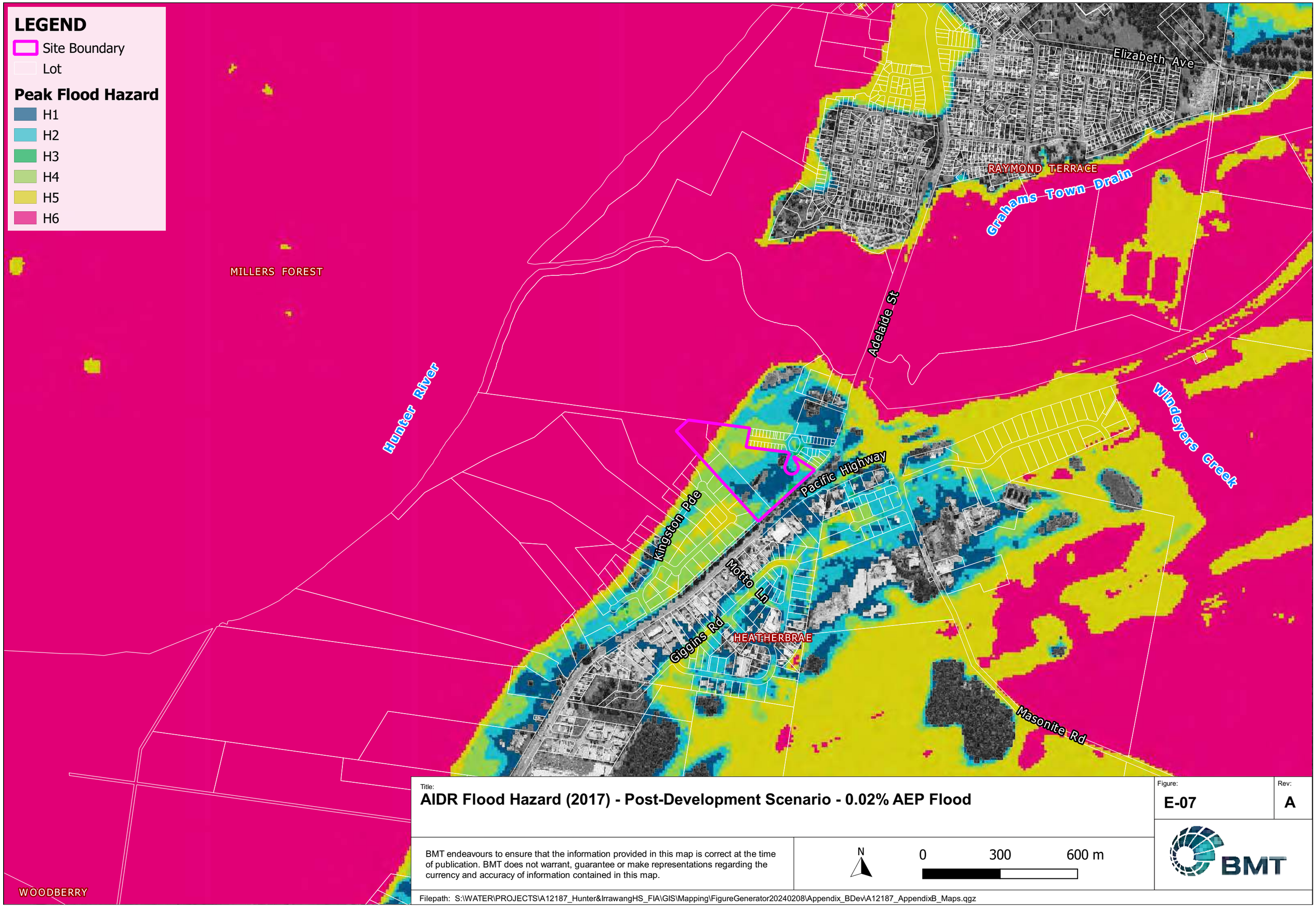

Title:

AIDR Flood Hazard (2017) - Post-Development Scenario - 0.02% AEP Flood

Figure: E-07

Rev: A

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N

0 300 600 m

BMT

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LEGEND

- Site Boundary
- Lot

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

AIDR Flood Hazard (2017) - Post-Development Scenario - Probable Maximum Flood (PMF)

Figure: E-08

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_BDev\A12187_AppendixB_Maps.qgz

LEGEND

- Site Boundary
- Lot

Flood Functions

- Flood Fringe
- Flood Storage
- Floodway

MILLERS FOREST

RAYMOND TERRACE

HEATHERBRAE

WOODBERRY

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

Masonite Rd

Title:

Peak Flood Function - Post-Development Scenario - 0.02% AEP Flood

Figure: E-09

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_BDev\A12187_AppendixB_Maps.qgz

LEGEND

- Site Boundary
- Lot

Flood Functions

- Flood Fringe
- Flood Storage
- Floodway

MILLERS FOREST

RAYMOND TERRACE

Elizabeth Ave

Grahams Town Drain

Adelaide St

Hunter River

Windeyers Creek

Pacific Highway

Kingston Pde

Motto Ln

Giggins Rd

HEATHERBRAE

Masonite Rd

WOODBERRY

Title:

Peak Flood Function - Post-Development Scenario - Probable Maximum Flood (PMF)

Figure: E-10

Rev: A

N

0 300 600 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_BDev\A12187_AppendixB_Maps.qgz

Annex F Flood Impact Assessment Mapping

LEGEND

- Site Boundary
- Lot

Change in Flood Level Extent

- Was Wet Now Dry
- Was Dry Now Wet

Peak Flood Impact (m)

- <= -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - -0.02
- No Significant Impact
- 0.02 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- >= 0.20

RAYMOND TERRACE
Grahams Town Drain
Windeyers Creek
Adelaide St
MILLERS FOREST
Hunter River
Speedy Lock Ln
Elkin Ave
Pacific Highway
Kingston Pde
HEATHERBRAE
Motto Ln
Heather St
Masonite Rd
Giggins Rd

Title:
Change in Peak Flood Level - 0.02% AEP Flood

Figure: **F-01**

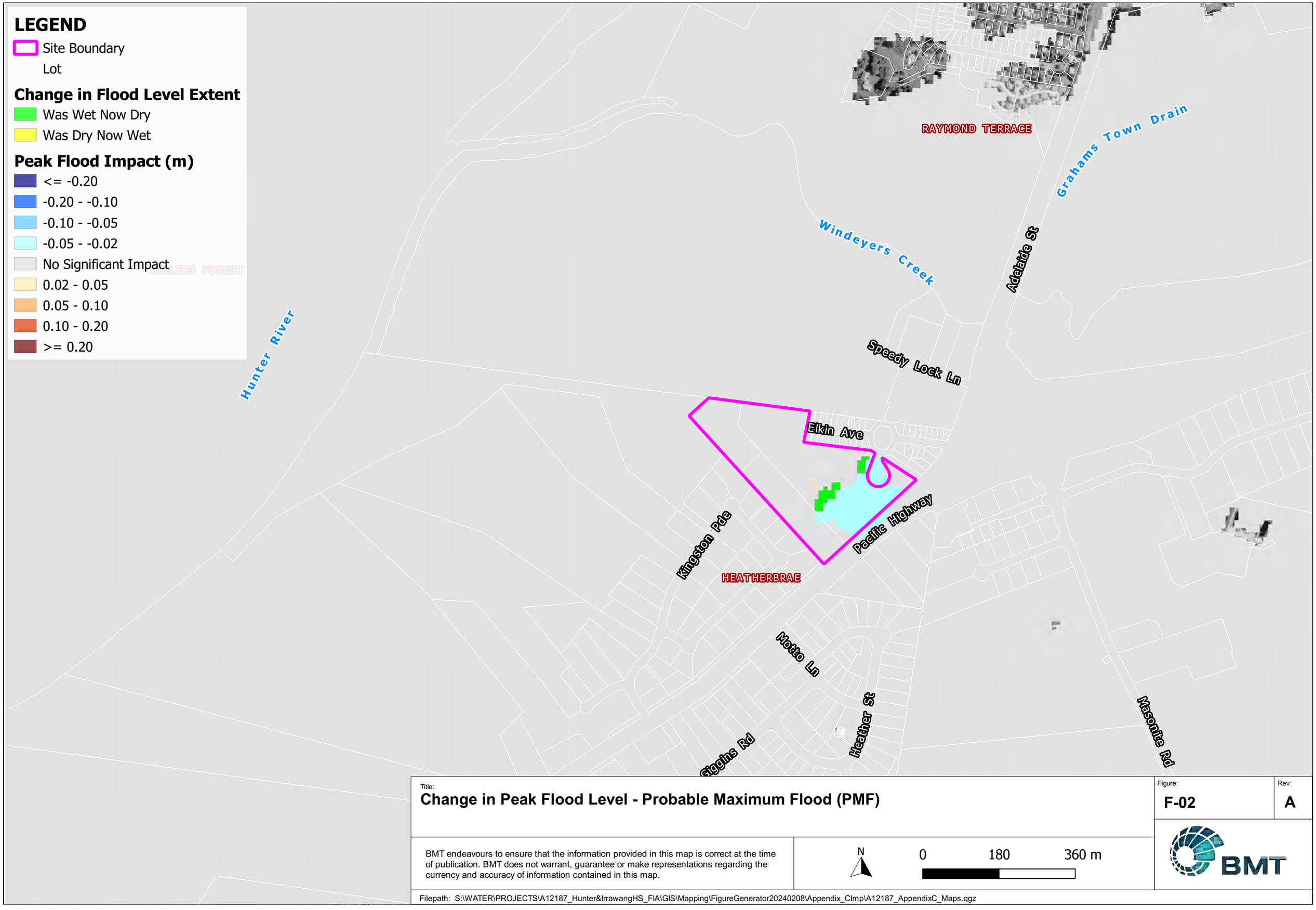
Rev: **A**

N

0 180 360 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_CImp\A12187_AppendixC_Maps.qgz



Title:
Change in Peak Flood Level - Probable Maximum Flood (PMF)

Figure: **F-02**

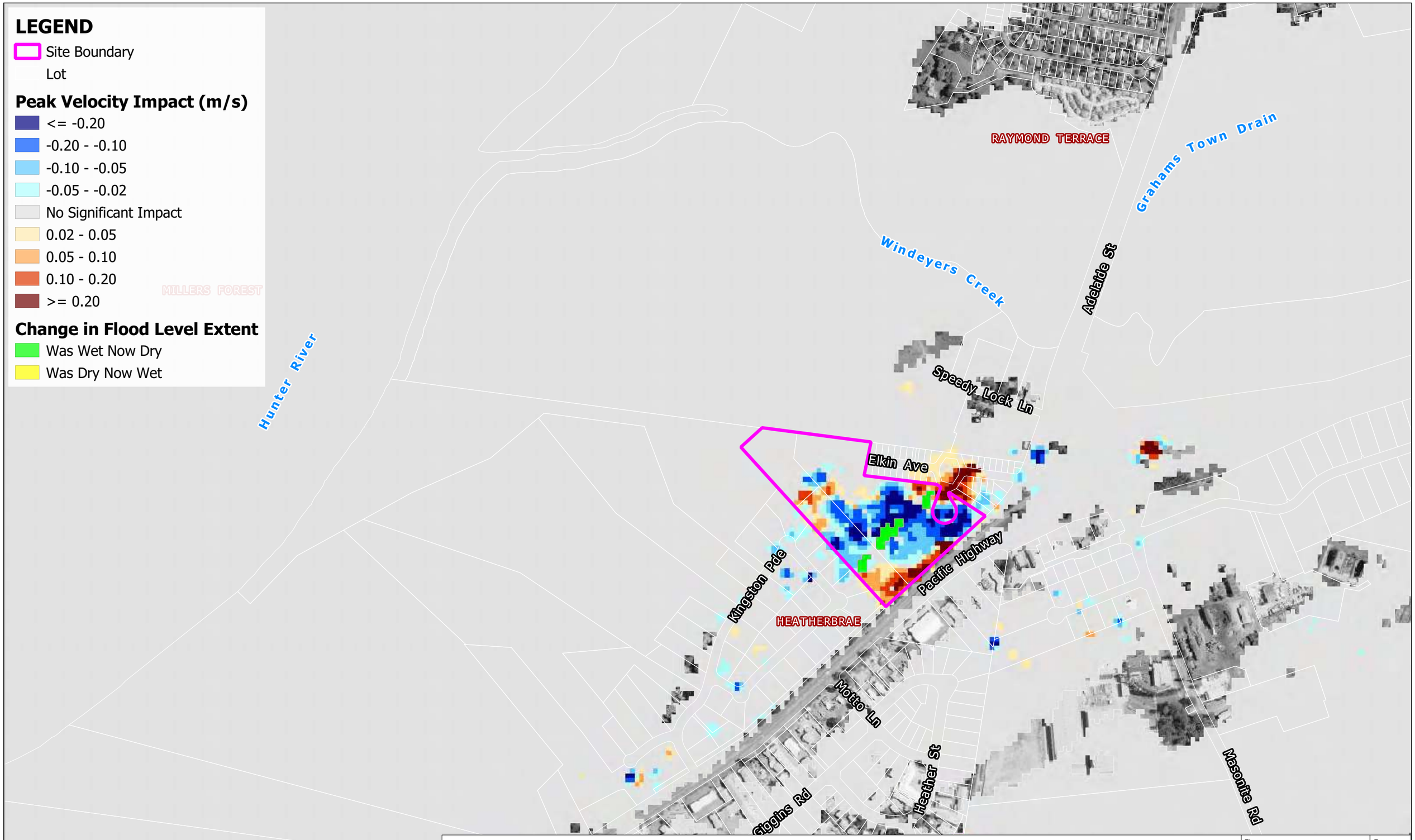
Rev: **A**

N

0 180 360 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_CImp\A12187_AppendixC_Maps.qgz



Title:
Change in Peak Flood Velocity - 0.02% AEP Flood

Figure: **F-03**

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.

N

0 180 360 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_CImp\A12187_AppendixC_Maps.qgz

LEGEND

- Site Boundary
- Lot

Peak Velocity Impact (m/s)

- <= -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - -0.02
- No Significant Impact
- 0.02 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- >= 0.20

Change in Flood Level Extent

- Was Wet Now Dry
- Was Dry Now Wet

RAYMOND TERRACE
MILLERS FOREST
HEATHERBRAE
Hunter River
Windeyers Creek
Grahams Town Drain
Adelaide St
Speedy Lock Ln
Elkin Ave
Pacific Highway
Kingston Pde
Motto Ln
Heather St
Giggins Rd
Masonite Rd

Title:
Change in Peak Flood Velocity - Probable Maximum Flood (PMF)

Figure: **F-04**

Rev: **A**

N

0 180 360 m

BMT

Filepath: S:\WATER\PROJECTS\A12187_Hunter&IrrawangHS_FIA\GIS\Mapping\FigureGenerator20240208\Appendix_CImp\A12187_AppendixC_Maps.qgz

Annex G Response to Comments raised by Council in the Pre-DA meeting.

Item	BMT Response
General: General Update for Currency	
PSCC Comment / Town Planner Advice: Firstly, in accordance with the flood certificate and council pre-DA minutes, it is agreed that the development is considered vulnerable. In relation to the Figure BI, I note on the flood certificate that the area that the buildings sit within is in the Flood Prone Category which has an associated minimal risk as identified on the flood certificate for Lot 1 DP540114 and figure 1.2 of the FIA. As such, it is justified that the development is suitable provided the development meets the development **controls**. In strict accordance with the DCP, the title for Figure BI states suitable land uses by flood hazard category (as identified on a flood certificate). The flood certificate for Lot 1 DP 120189 has the highest hazard category – High hazard flood way area however this limited the north west corner of the allotment. Council raise that the departure, based on the flood certificate, however the justification is provided that the development is on the lowest flood risk area. This is noted in BMTs part 4 assessment against the DCP.	As noted by Council, the FIA documents that the development is proposed on the part of the subject site that is subject to the lowest flood risk.
Town Planner Advice: In relation to FFLs control B5.2 requires the FFL for a vulnerable development to be at the PMF level, in this instance, this is 8.5mAHD. The departure from the DCP should be justified by BMT in their response. I believe that they have used the adoptable minimum floor level of 5.7m AHD for residential development. Please have BMT review this assessment against Figure BJ	The Flood Impact Assessment (R.A12187.001.02_HRHS_FIA) and Flood Emergency Response Plan (R.A12187.001.02_HRHS_FERP) prepared by BMT for the Hunter River High School take into consideration the Site's high level of flood immunity (higher than the 1%AEP+CC flood level for the portion of the Site subject to development), as well as the presence of flood-free evacuation routes in the 1%AEP event. The proposal is for addition of building structures to an existing school complex, which does not introduce additional people into the floodplain Data provided by SINSW states the projected number of Site occupants is expected to remain relatively stable over time. The current maximum number of site occupants is 931, and School Infrastructure NSW is expecting only a slight increase (less than 5%) in the number of students in the next couple of years, followed by a subsequent decrease that will bring the number of occupants back to levels similar to the current ones. As part of the FERP, careful consideration has been given to the existing on-site available space above the PMF level. Specifically, the plan ensures that the upper storeys of existing buildings G,H,I,J and K are suitable and sufficient to accommodate the maximum number of people reasonably expected to be on site. This means that in the event of a flood, the occupants of the

Item	BMT Response
	site will be able to shelter at a safe height above the floodwaters. It is important to consider that the SES (State Emergency Service) does not endorse development plans that involve deliberate isolation or sheltering in buildings surrounded by floodwater. These strategies do not offer the same level of risk management as evacuation. The SES stresses that sheltering in a building within the flood extent is not safe, as larger floods can result in entrances and exits becoming flooded and potentially isolating children without food or water for several hours or more. This increases the risk of fire or medical emergencies and the likelihood of caregivers entering floodwater to reach the children. As a school complex, HRHS does not have any permanent residents on the site. Therefore, the emergency strategy preferred by the school is early closure, ideally before the start of the school day, with a trigger based on a severe weather warning. However, in case of severe weather conditions that arise while people are already on site, the FERP proposes to evacuate the site. To ensure timely evacuation, an on-site flood warning signal will be installed: this will allow flood warning redundancy if the BoM gauge of Raymond Terrace fails to warn. The FERP demonstrates that, in the 1%AEP event there would be no less than 10 hours available to evacuate after the order is issued. Similarly, in the unlikely event of a PMF (Probable Maximum Flood) occurrence, there would be around 5 hours available for evacuation after the warning is issued. Based on the information provided, the proposal is seeking consent to set the Finished Floor Level (FFL) of the proposed buildings at 7.3mAHD, which is 1.6 metres higher than the Flood Planning Level (FPL) of 5.7mAHD as indicated in the council's flood certificate.
Town Planner Advice As detailed at the front end of the BMT report, the location of the development is on the lowest flood risk area and noted in Figure 1.2 of the BMT report to be of minimal flood risk, however the flood modelling for the PMF event in Figures C-23 -C27 identify the area as High Hazard Flood Way. I curious in the significant change in flood hazard mapping against Figure 2 and the Modelling. In relation to risk and addressing suitability of the site for development and	While the Williamtown Salt Ash Flood Study did not consider any design flood events between the 0.5% Annual Exceedance Probability (AEP) and the Probable Maximum Flood (PMF), it is still possible to provide an estimate of flood levels for these rare events by using a log-normal interpolation. This involves considering the design flood levels for AEPs up to 0.5% and

Item	BMT Response
justification against a reduction in FFL, I consider BMT need to provide clarification and additional justification. To this extent, I then question the level of construction to address Control B5.3.	the PMF event, assuming that the PMF has an AEP of 1:1,000,000. Based on this analysis, it has been determined that flood levels of 7.3mAHD will be exceeded for events with a rarity of approximately 1:5,000 AEP which would be classed as an 'extreme' flood under the ARR 2019 guideline. Therefore, it is clear that the proposed development will have a very high level of flood immunity that supports the proposed FFL. With regards to Control B5.3 of Port Stephens DCP, a certified structural engineer shall confirm that Existing Buildings designated for sheltering in place, are able to withstand the PMF hydraulic force. Buildings' structures will need to be checked considering depths of water up to 2m and velocities up to 0.6m/s (conservatively highest depth and velocity values sampled around the polygons of the existing buildings G,H,I,J and K)
Town Planner Advice: I note Control B5.6 which relates to hazardous or potentially hazardous materials. Whilst it has been noted within the SEE that the gas cylinders do not meet the threshold for potentially hazardous materials, the statement that 'no hazardous or polluting material is expected to be stored on Site' should be revised to note the relocation of the LPG cylinders. BMT should assess whether the relocation needs to be above the FPL of 5.7mAHD and appropriately anchored to meet the flood hazard to avoid displacement during a flood event.	An addition has been made to the response of Control B.5.6 in Table 4.1 of the report with regards to gas cylinders, their appropriate storage, and anchoring.
Town Planner Advice: Control B5.9 Should be not applicable for the vulnerable development.	Noted and response to DCP control has been edited.
Town Planner Advice: Control 5.10 pertains to alts and adds to residential accommodation. This should be N/A	Noted and response to DCP control has been edited.
Town Planner Advice: Table 4.2 should be considered to be updated in relation control B5.2 and justification for the departure provided.	Based on the observations made in support of adopting a Flood Freeboard Level (FFL) lower than the PMF level, it is requested to retain the existing table 4.2
Town Planner Advice: See the link here for Clause 5.22 under the SI for BMT to include in the amended report: https://legislation.nsw.gov.au/view/html/inforce/current/epi-2006-155a#sec.5.22	According to Clause 5.22 of the 2022 Principal Local Environmental Plan, any development on land subject to this clause must meet the following requirements: (a) Ensure the safety of occupants and enable efficient evacuation during a flood event. (b) Include measures to manage the risk to life in the event of a flood. (c) Avoid any adverse effects on the environment during a flood event.

Item	BMT Response
	After reviewing the proposed measures, we are satisfied that the development meets the necessary criteria. To address point (a), SINSW projections have confirmed that the proposed development will not result in an increase in the current number of people in the floodplain. Therefore, even in the post-development scenario, the existing available space in buildings suitable for emergency sheltering in place will be sufficient. This ensures that the flood safety of the site will not be affected. To manage the risk to life in the event of a flood, point (b), a Flood Emergency Response Plan (FERP) has been drafted for the site. The FERP includes school closure before the start of the day in the event of a severe flood warning. Given that a Probable Maximum Flood (PMF) event is an extremely rare occurrence, early forecast is likely to be available, and therefore it is highly likely that no occupants will be on site during a PMF event due to the early closure. Additionally, an on-site flood alarm system has been installed and it has been demonstrated that timely evacuation is possible via a flood-free route. The residual flood risk will be managed with the provision for sheltering in place in the existing 2-storey buildings on site should timely evacuation not be possible. Furthermore, it is important to note that the FFL for the proposed buildings is significantly higher than the 1%AEP+CC+freeboard level, providing additional safety margins against flooding. Together, these measures offer a robust approach to managing flood risk for the proposed development. According to the flood impact maps presented as part of the FIA, afflux caused by the proposed works is negligible. Therefore, from a flooding perspective, the development will not have an adverse effect on the environment during a flood event, addressing point (c). Based on the above, we believe that the proposed measures are appropriate for managing the risk to life in the event of a flood, and therefore we request a reduced Flood Planning Level (FPL) for the proposed development.

Annex H Structural Assessment for Flood Refuge for Existing Buildings

Level 1, 215 Pacific Highway
Charlestown NSW 2290
02 4943 1777
newcastle@northrop.com.au
ABN 81 094 433 100

13 May 2024

NL201218

Richard Crookes Constructions
Dylan Cross
Suite 18, Level 2, 50 Glebe Road
The Junction NSW 2291

Dear Dylan,

Re: Hunter River High School – Flood Refuge Block X and Z

We understand that to be considered appropriate for flood refuge, select buildings at Hunter River School the buildings will need to be remain structurally adequate when subjected to the PMF parameters of 2 metres of water depth at a velocity of up to 1 metres per second.

Block X and Z are new structures which are designed by Northrop. The structural concept consists of reinforced core-filled masonry subfloor walls, with a suspended concrete slab and steel framed structure over.

Based on the design presented, the structural integrity of these buildings would not be detrimentally affected if subjected to the structural loads commensurate with a PMF event of 2 metres of water depth at a maximum velocity of 1m/s.

We trust this meets your requirements, however, do not hesitate to contact us to discuss further.

Yours sincerely,

Matthew Allen
Principal | Structural Engineer
BEng (Civil) MIEAust CPEng NER (Structural)

		Date
Prepared by	MA	13/05/2024
Checked by	CK	13/05/2024
Admin	HB	13/05/2024

Level 1, 215 Pacific Highway
Charlestown NSW 2290
02 4943 1777
newcastle@northrop.com.au
ABN 81 094 433 100

3 April 2024

NL201218

Richard Crookes Constructions
Dylan Cross
Suite 18, Level 2, 50 Glebe Road
The Junction NSW 2291

Dear Dylan,

Re: Hunter River High School – Flood Refuge

Northrop Consulting Engineers have been engaged by Richard Crookes Constructions to review the suitability of the existing buildings G, H, I, J and K at Hunter River High School to be used as flood refuge during the probable maximum flood (PMF) event as defined in the flood emergency response plan.

We understand that to be considered appropriate for flood refuge the buildings will need to be remain structurally adequate when subjected to the PMF parameters of 2 metres of water depth at a velocity of up to 1 metres per second.

Based on observations on site, Buildings G, H, I, J and K buildings were typically observed to consist of primary structural frames of steel and concrete. We are of the opinion that the structural integrity of these buildings would not be detrimentally affected if subjected to the structural loads commensurate with a PMF event of 2 metres of water depth at a maximum velocity of 1m/s.

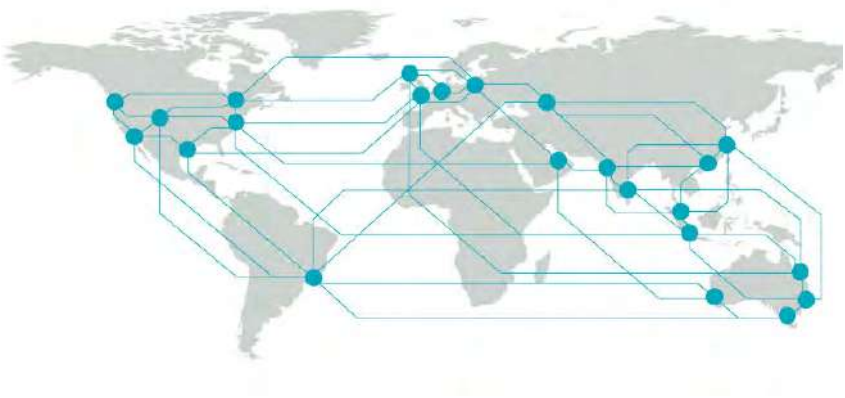
We advise that it is likely the non-structural elements such as windows, doors and non-load bearing façade walls would be compromised due to the moving water and/or hydrostatic loads associated with the flood, however these are not part of the primary structure and any damage would not cause a structural adequacy failure.

We trust this meets your requirements, however, do not hesitate to contact us to discuss further.

Yours sincerely,

Matthew Allen
Principal | Structural Engineer
BEng (Civil) MIEAust CPEng NER (Structural)

		Date
Prepared by	MA	03/04/2024
Checked by	CK	03/04/2024
Admin	HB	03/04/2024



BMT is a leading design, engineering, science and management consultancy with a reputation for engineering excellence. We are driven by a belief that things can always be better, safer, faster and more efficient. BMT is an independent organisation held in trust for its employees.

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