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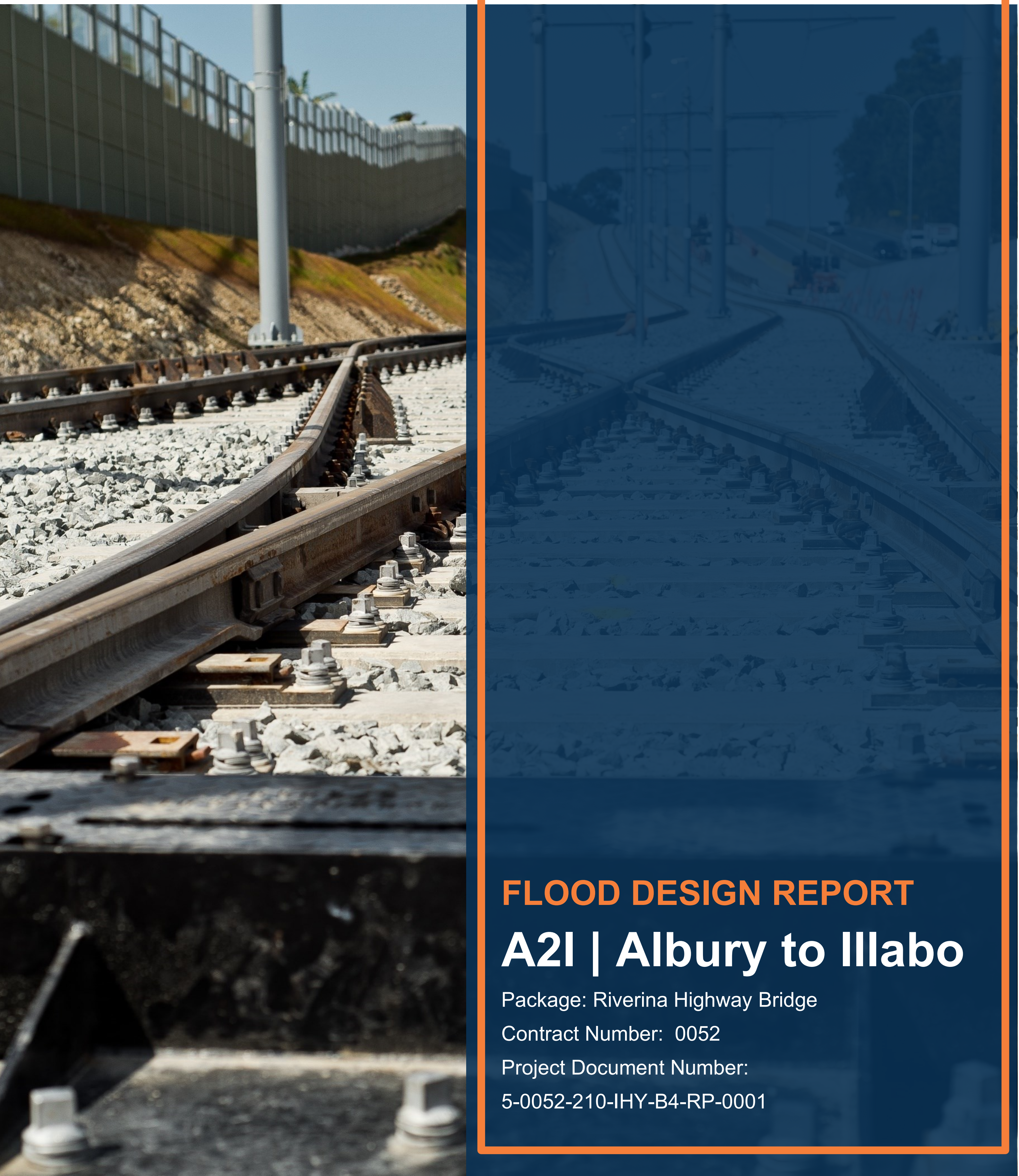

# FLOOD DESIGN REPORT

# A2I | Albury to Illabo

Package: Riverina Highway Bridge

Contract Number: 0052

Project Document Number:

5-0052-210-IHY-B4-RP-0001

## Document Control

| DOCUMENT TITLE: | Flood Design Report – Riverina Highway Bridge | | |
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## Revision History

| REVISION | REVISION DATE | AMENDMENT | DATE TO CLIENT |
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| A | 23/07/2024 | PDR Issue for review | 23/07/2024 |
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| 0 | 09/07/2025 | IFC Issue for use | 10/07/2025 |

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# GLOSSARY

Specific terms and acronyms used throughout this plan and sub-plans are listed and described in Table 0- 1 below.

**Table 0- 1: Definitions**

| Term | Definition |
|---|---|
| A2I | Albury to Illabo |
| A2P | Albury to Parkes Enhancement Project |
| AEP | Annual Exceedance Probability |
| ADC | Assumptions, Dependencies and Constraints |
| AHD | Australian Height Datum |
| ALCAM | Australian Level Crossing Assessment Model |
| ARF | Areal Reduction Factor |
| ARI | Average Recurrence Interval |
| ARR | Australian Rainfall and Runoff |
| ARTC | Australian Railway Track Corporation |
| BoD | Basis of Design |
| BoM | Bureau of Meteorology |
| CIZ | Construction Impact Zone |
| CO | Construct Only |
| CRS | Coordination Reference System |
| CSSI | Critical State Significant Infrastructure |
| D&C | Design and Construct |
| DCN | Design Change Notice |
| DDR | Detailed Design Review |
| EMC | Electromagnetic compatibility |
| EDPM | Engineering, Design and Project Management |
| ECMP | Electromagnetic compatibility management plan |
| EIS | Environmental Impact Statement |
| FDR | Feasibility Design Review |
| FS | Finish-Start constraint type |
| FSL | Finished Surface Level |
| GDA | Geocentric Datum of Australia |
| GIR | Geotechnical Interpretative Report |
| HF | Human Factors |
| I2S | Illabo to Stockinbingal |
| IFC | Issued for Construction |
| IR | Inland Rail |
| ITC | Incentivised Target Cost |
| IV | Independent Verifier |
| Km | Kilometres |

| Term | Definition |
|---|---|
| LPA | Licensed Project Area |
| LiDAR | Light Detection and Ranging |
| MGA | Map Grid of Australia |
| MIRDA | Master Inland Rail Development Agreement |
| NCR | Non-Conformance Report |
| NLPA | Non-Licensed Project Area |
| NtP | Notice to Proceed |
| PDR | Preliminary Design Review |
| PMF | Probable Maximum Flood |
| PSR | Project Scope and Requirements |
| QDL | Quantitative Design Limits |
| REF | Review of Environmental Factors |
| RFI | Request for Information |
| RMAR | Rail Maintenance Access Road |
| S2P | Stockinbingal to Parkes |
| SAQP | Sampling, Analysis and Quality Plan |
| SDR | Systems Definition Review |
| SEMP | System Engineering Management Plan |
| TfNSW | Transport for New South Wales |
| TWL | Tail Water Level |
| V & V | Verification and Validation |
| WAD | Works Authorisation Deed |
| WAE | Work-as-Executed |

# 1 A2P PROJECT INTRODUCTION

## 1.1 Albury to Parkes (A2P)

As part of the Inland Rail program of projects, the Australian Rail Track Corporation (ARTC) has appointed Martinus as the delivery contractor for the Albury to Parkes (A2P) project, which comprises the brownfield sections between Albury and Illabo (A2I) and Stockinbingal to Parkes (S2P). The greenfield portion between Illabo to Stockinbingal (I2S) is not a part of the A2P project scope.

## 1.2 Project Scope

The S2P section will be delivered under an REF and as such construction works associated with the two (2) Construct Only packages can commence at Contract Award. The Design and Construct for the other seven (7) projects sites will also commence at Contract Award.

The A2I section will be delivered under an EIS and requires a Notice to Proceed from ARTC before works can commence on site. Design for A2I will however commence at Contract Award. The project received State Planning approval on 8th Oct 2024, and Martinus received the Notice to Proceed from IRPL on 18 Oct 2024.

Within the A2I section there are twenty (20) locations with twenty-nine (29) Design and Construct (D&C) projects of varying degrees of design gate development:

- Murray River bridge (Structure modifications)
- Albury Station Yard (Track slews, track reconfigurations)
- Albury Station Yard Track Slews (retained 3-track alignment)
- Albury Station Yard Footbridge (footbridge replacement), both pre- and post- SDRP-response
- Riverina Highway bridge (Track lowering)
- Billy Hughes bridge (Track lowering)
- Tabletop Yard (Structure modification)
- Culcairn Station Yard (Track slews and bridge removal)
- Henty Yard (Track slews)
- Yerong Creek Yard (Track slews)
- The Rock Yard (Structure modification)
- Uranquinty Yard (Track slews)
- Pearson Street bridge (Track lowering)
- Cassidy Parade footbridge (Bridge replacement), both pre- and post- SDRP-response
- Edmondson Street Bridge (stand-alone road bridge)
- Edmondson Street Footbridge (stand-alone road bridge)
- Edmondson Street bridge and footbridge (combined Bridge replacement), post- SDRP-response
- Wagga Wagga Station Yard (Track slews)
- Wagga Wagga Footbridge (footbridge replacement), both pre- and post- SDRP-response
- Bomen Yard (Track slews)
- Harefield Yard (Track slews)
- Kemp Street Bridge (stand-alone road bridge)
- Kemp Street Footbridge (stand-along footbridge)
- Kemp Street bridge and footbridge (combined Bridge replacement)
- Junee Station Yard (Track slews and bridge removal)
- Olympic Highway Underbridge (Track reconfiguration and Structure modification)
- Junee to I2S dual track section (Track slews)
- LX605 & LX1472 Activations
- LX605 relocation and LX1472 closure, both 16m and 4m slew options

Within the S2P section, there are two (2) Construct only projects:

- Daroobalgie New Loop
- Wyndham Avenue (Track lowering)

and seven (7) Design and Construct (D&C) projects:

- Milvale Yard (Structure modification)

- Bribbaree Yard (Track slews)
- Quandialla Yard (Structure modification)
- Caragabal Yard (Track slews)
- Wirrinya Yard (Track slews)
- Lachlan River bridge (Structure modifications)
- Forbes Station (Track slews and awning modifications)

The D&C scope typically includes works associated with route clearance to accommodate the new F2M clearance envelope, necessary to accommodate the double-stacked freight container trains and this includes.

- Structure modifications
- Track reconfigurations
- Bridge replacements
- Track lowering
- Track slews and level crossing upgrades
- Bridge removal

## 1.3 Site Description

This study conducts a flood assessment for the Riverina Highway bridge (refer to Figure 1-1 for site location). The background and previous studies for the site are listed below.


**Figure 1-1: Site Locations**

### 1.3.1 Background

The Riverina Highway bridge (Site) forms part of the Albury to Illabo Section, with works between the Main Line's Chainage Ch 644.819km and Ch 645.400km. It is located within the Albury City Local Government Area, with the existing bridge passing over the existing railway tracks. The Riverina Highway bridge only caters to vehicle traffic and will be retained without any changes. The project scope involves lowering the existing railway track, which crosses beneath the bridge, for a vertical clearance of 7.1m over the Main line to allow the passage of double-stack rail traffic underneath the bridge.

## 1.4 Objectives

This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Issued for Construction (IFC) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary.

This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001).

## 1.5 Scopes

The scope of this study includes:

- Review the changes in design between IFC and DDR.
- Carrying out the flood assessment for the design in the DDR stage for the design events of 10%, 5%, 2%, 1%AEPs and 1% AEP with climate change and PMF (Probable Maximum Flood).
- Checking flood assessment results against the criteria, including flood impact and flood immunity.
- Proposing any mitigation measures if required.

## 1.6 Previous Studies

### 1.6.1 Flood Studies

The table below summarises the flood studies associated with the Riverina Highway bridge site.

**Table 1-1: Summary of the Previous Studies**

| Item No. | Flood Study | Description | Comments |
|---|---|---|---|
| 1 | Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) | This flood study defines flood behaviour under the conditions of the model that was built in 2011. The hydrologic models were developed in RAFTS and DRAINS software packages and the 2D hydraulic model was developed using the TUFLOW software. The hydrologic model was calibrated using historical flood data. The TUFLOW model was simulated for design rainfall events ranging between the 20% and 0.2% AEPs based on the Australian Rainfall and Runoff 1987 (ARR87). | - |
| 2 | Albury Floodplain Risk Management Study (FRMS) and Plan (WMA Water, 2016) | This report assessed flood behaviour, flood risk, and flood management issues in the Albury LGA. It used the Lyall & Associates (2011) model and updated it to consider the elevated water levels in the Murray River and the terrain changes for recently developed land throughout the catchment. | The TUFLOW model from this FRMS has been adopted to be updated and used for flood assessment in this current assessment. A summary of the TUFLOW model parameters is provided in Table 4-2. |
| 3 | Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Wagga Wagga (June 2022) | No detailed flood modelling is documented in the Reference Design report. The Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) was adopted to inform the flooding across the site. It indicated that a minor 1% AEP overland flow (0.4m$^3$/s) would occur upstream of the rail box culvert (3/ 1.2mWx0.9mH) crossing located at CH644770 and adjacent to the Scots School. Shallow overland flow then traverses the rail corridor southwards. There is a localised low point below the Riverina Highway overbridge and limited storage occurs prior to overtopping the railway track with continued overland flow towards Wilson Street.<br>A DRAINS model was built to estimate the peak flows associated with the Reference Design and this indicated that the track could achieve 1% AEP flood immunity | - |

| Item No. | Flood Study | Description | Comments |
|---|---|---|---|
| | | resulting from the design and is not expected to produce an increase in downstream flood levels of more than 100 mm. | |
| 4 | Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, Flooding and Water quality (July 2022) | No detailed flood modelling is documented in the EIS report. The Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) was adopted to inform the flooding across the site. Four design events, including the 20%, 5%, 1% AEP events and the Probable Maximum Flood (PMF) event were assessed and modelling demonstrated that the three box culverts (CH644+770) do not have sufficient capacity to convey the upstream runoff. As a consequence, water spills into the rail corridor during the 20% AEP and greater events. The portion of overland flow that spills into the rail corridor proceeds in a south-west direction, following the terrain slope.<br>A DRAINS model was developed to assess rail flood immunity. Modelling confirmed that the railway line can achieve 1% AEP flood immunity with the proposed drainage system and that there were no adverse flood impacts associated with the proposed works. | - |

### 1.6.2 Reference Design

The below report was produced by Others, as part of the Reference Design.

- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Albury (June 2022)

The site is located within the South Albury catchment which is the smallest of the subject catchments discharging to the Murray River. The flood study predicts a minor 1% AEP overland flow (0.4 $m^3/s$) will occur into the rail upstream of the 3x 1.2Wx0.9H transverse box culvert crossing arrangement located at Ch 644.770km and adjacent to The Scots School. Shallow overland flow then traverses the rail corridor southwards. There is a localised low point below the Riverina Highway overbridge and limited storage occurs prior to overspilling with continued overland flow towards Wilson St. This flow path will be impacted by the proposed track lowering and there are no watercourses within the project site.

### 1.6.3 Environmental Impact Statement

The below report was produced by Others, as part of the Environmental Impact Assessment.

- Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (July 2022)

There is no detailed flood modelling within this report. A qualitative assessment was undertaken to assess the overland flood condition of the site based on the Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) and regional floods condition based on the Albury Floodplain Risk Management Study and Plan (WMA Water, 2016). The site is not affected by regional flooding from Murray River (refer to Figure 1-2) but is affected by local overland flooding during the 20 % AEP, 5% AEP, 1% AEP and PMF flood events (refer to Figure 1-3).

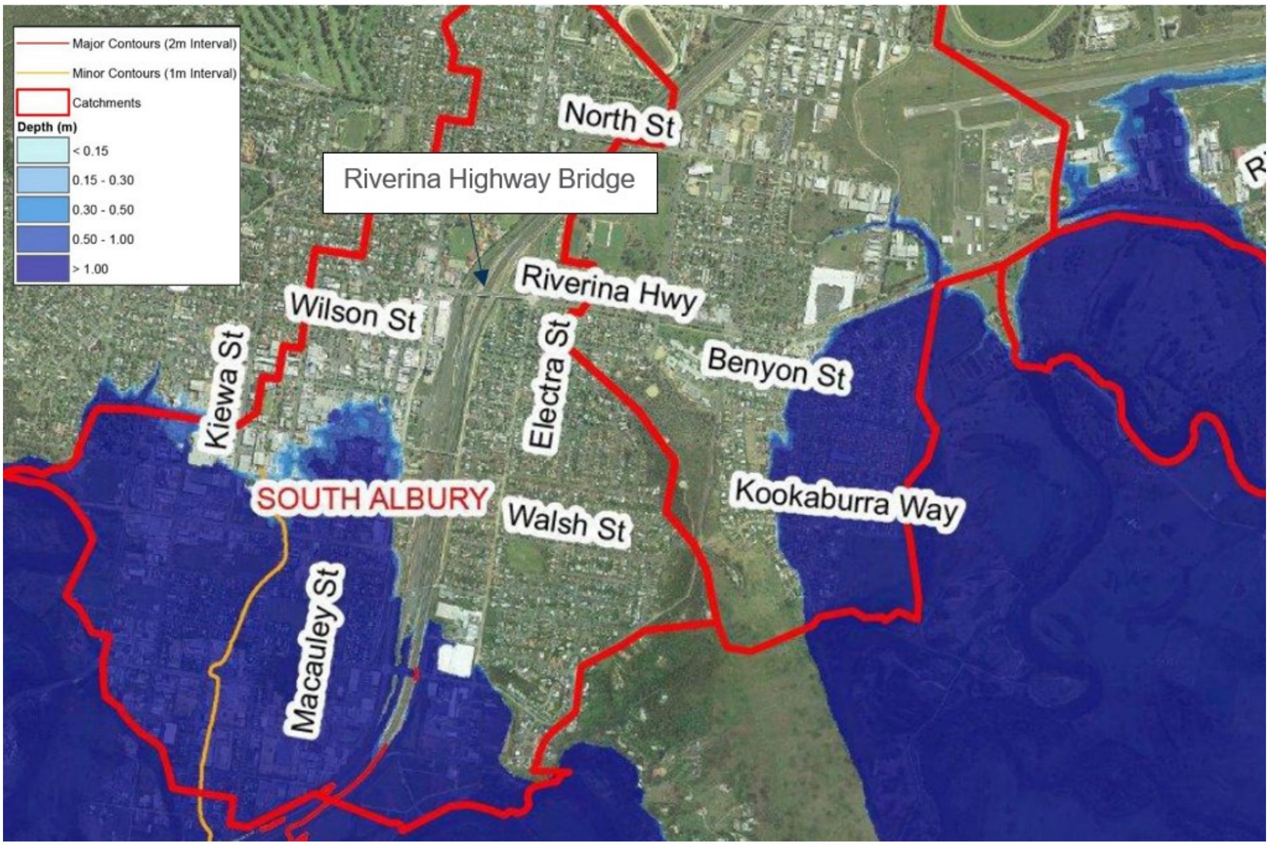


**Figure 1-2: PMF Murray Catchment Regional Flooding (Image source: Albury to Illabo EIS Technical Paper 11, July 2022)**

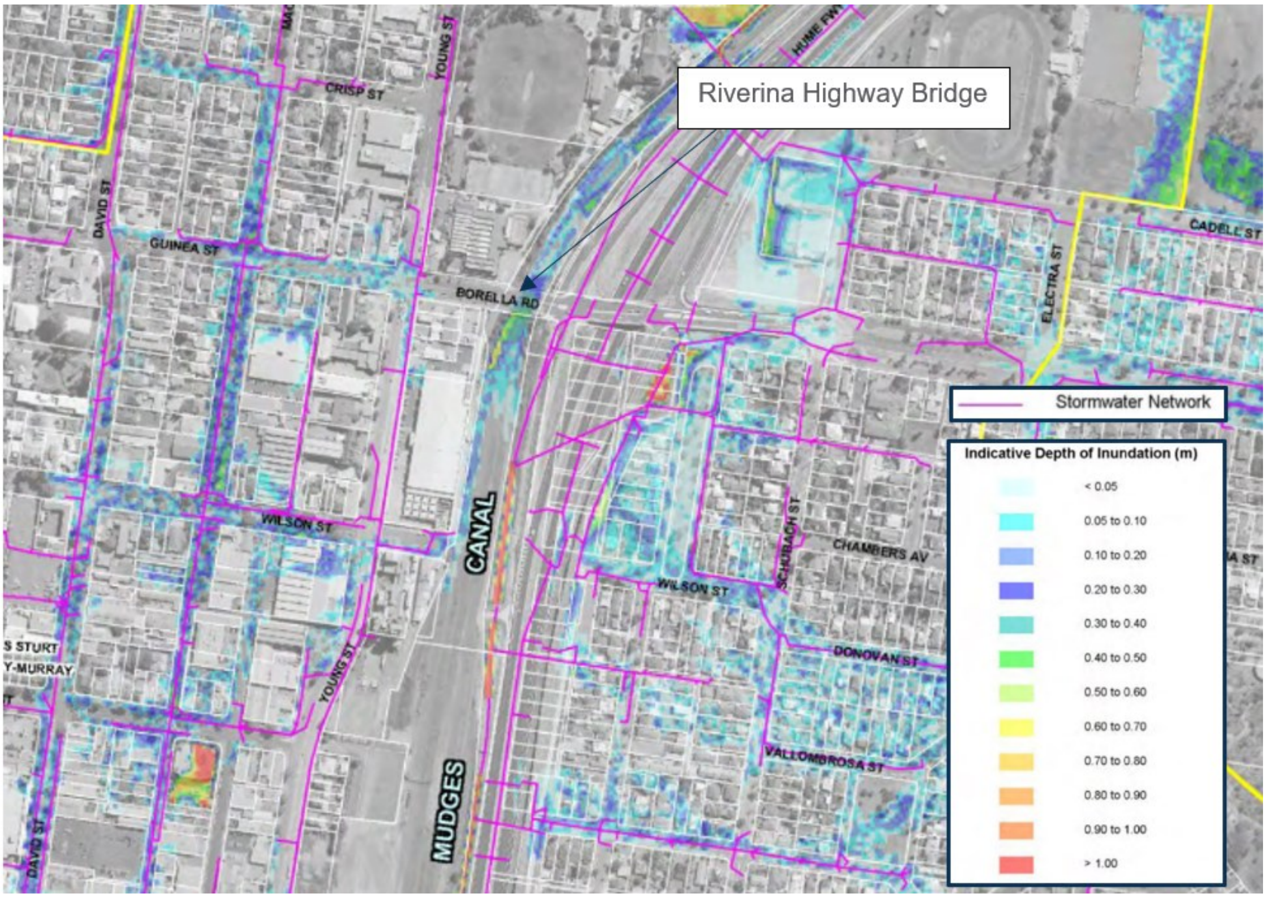


**Figure 1-3: 1% AEP Local Flooding (Image source: Albury to Illabo EIS Technical Paper 11 (July 2022))**

## 1.7 Purpose and Requirements

The primary purpose of this IFC flood design report is to investigate the flood behaviour and its potential flood impact.

The secondary purpose of this report is to provide evidentiary documentation on consultation with external stakeholders, and review conducted by the independent suitably-qualified flood consultant, in demonstrating compliance with the CSSI conditions of approval. Refer to Appendix D for the ARTC review and Appendix E for the Independent Flood Consultant Review.

## 1.8 Information Documents

The following documents have been provided 'For Information' and have been referenced/reviewed as part of the design development:

- Albury Floodplain Risk Management Study (FRMS) and Plan, WMA Water, 2016
- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Albury (WSP, June 2022), 2-0008-210-PEN-03-RP-0002
- Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (WSP, July 2022), 2-0008-210-EAP-00-RP-0010

## 1.9 Inputs

The inputs to this flood assessment report include:

- Australian Standards and Guidelines: AS 7637 Railway Infrastructure – Hydrology and Hydraulics
- Australian Rainfall and Runoff: A Guide to Flood Estimation 2019
- Austroads Guide to Bridge Technology – Part 8: Hydraulic Design of Waterway Structures
- Inland Rail Climate Change Risk Assessment Framework

### 1.9.1 Input Data

The table below outlines the available information relevant to the site and used for flood modelling.

**Table 1-2: Available Information**

| Item | Information | Type | Description / Comments |
|---|---|---|---|
| 1 | Flood model used in Albury Floodplain Risk Management Study and Plan (WMA water, 2016) | TUFLOW model | Received from Martinus on 29/08/2023 |
| 2 | LiDAR 2020<br>(The data used to create this DEM has an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal) | TIF format in 1m resolution | Downloaded from https://elevation.fsdf.org.au/ on 08/09/2023 |
| 3 | 1m 2015 LiDAR and High-Resolution Aerial Imagery. The data derived points have an accuracy of 0.15m (68% confidence interval) ARTC LiDAR | TIF format in GDA94 | The existing 1m LiDAR (flown by ARTC in 2015) was received from Martinus on 12/11/2024.<br>However, the LiDAR2020 (item 2) is newer and in GDA2020. Therefore, only LiDAR 2020 (item 2) is used. |
| 4 | V2 DR RIVE NET EX | 12da | Existing drainage system<br>Received from DJV Drainage team on 18/09/2023 |
| 5 | A2P RVR RAIL EXT GDA20Z55.12da<br>A2P RVR ROAD EXT GDA20Z55.12da | 12da | Point cloud survey<br>Received from DJV civil team on 15/04/2024 |
| 6 | A2P RVR EXT GDA20Z55 COMBINED 241202.dxf<br>A2P RVR EXT GDA20Z55 COMBINED 241202.12da | 12da and dxf file in GDA2020 projection | Detailed topography survey and existing track levels<br>Received from DJV Civil team on 02/12/2024 |

| Item | Information | Type | Description / Comments |
|---|---|---|---|
| 7 | 5-0052-210-CAL-B4-MD-0004-RIVERINA_HWY_3D_RAIL_DESIGN_STRINGS_DWG.dwg | Dwg file in GDA2020 projection | Rail Design Strings<br>Received from DJV Rail team on 06/12/2024 |
| 8 | BALLAST 21 B4 MR21B4001.dem<br>CAPPING 21 B4 MR21B4001.dem<br>DESIGN MD21B4501.dem<br>RMAR MC21B4201.dem<br>OPTION - DRAIN MD21B4505 -3m CHANNEL.dem<br>5-0052-210-CCW-B4-MD-0002-RIVERINA_HWY_3D_CIVIL_DESIGN_STRINGS_DWG.dwg | Dem Grid file (0.05m grid) in GDA2020 projection | Civil Design for ballast, capping, RMAR and associated channels in the GDA2020 projection<br>Received from DJV Civil team on 11/02/2025 |
| 9 | B4 EXIS DRAINAGE.12daz<br>B4 Existing Pit Schedule.xlsx | 12Da file and Excel file | Existing drainage data.<br>Received from DJV Drainage team on 21/01/2025 |
| 10 | A2P - Riverina Pump Sump - Design Calculations V1.xlsm<br>Riverina Pump Station - Check print for page turn.pdf | PDF file and Excel file | DDR Pump design specifications<br>Received from DJV Pump team on 29/01/2025 |
| 11 | B4 DRAINAGE STRINGS.12daz<br><br>5-0052-210-CDR-B4-SC-0001-RIVERINA_DRAINAGE PIT SCHEDULE.xlsx | 12Da file and Excel file | Drainage design system<br>Received from DJV Drainage team on 31/01/2025 |
| 12 | Riverina U-drain to overland flow channel detail draft | Sketch and PDF | Draft details on channel transition design details for the IFC stage<br>Received from DJV Drainage team on 09/05/2025 |
| 13 | Proposed rock mattress extent sketch | JPG file | Details on the proposed rock mattress sketch for the IFC stage<br>Received from DJV Drainage team on 24/06/2025 |

## 1.10 IFC Design

Minor design changes to the drainage elements were made in the IFC stage, including:

- Two localised channel smoothing transitions between the U-drain and overland flow channel (at around CH645050 and CH645175) which will be implemented in IFC Design. The cross-sections of the U-drain and overland flow channel remain the same with the DDR stage design. As the overall channel conveyance remains unchanged, the changes in flood results will be negligible.
- 6m of channel section next to the pump station to be lined with rock mattress. Manning's roughness of the channel will increase from 0.03 (Grass lining) to 0.04, while the cross-section remains the same. This is only anticipated to cause a negligible flood level increase locally within the channel.

Overall, the above changes are not anticipated to affect the overall flooding behaviour or results, nor to lead to any significant impacts. Apart from these, there have been no alterations to the civil, track, and pump designs since the DDR stage (refer to Section 3.4)

Given that the changes in the IFC are minimal compared to the DDR, the flood assessment will not result in any non-compliance. Therefore, the flood assessment results from the DDR stage will be utilised to inform the IFC flood assessment from Section 2 onwards.

## 1.11 Outputs

The list of flood maps and the flood maps are included in Appendix A.

## 1.12 Limitations and Assumptions

The hydrologic and hydraulic modelling assumptions and constraints are listed below:

- An assessment of temporary works and staging has not been undertaken as it is out of the flooding scope.
- According to Clause 5.4.2 and Clause 5.4.3 in Annexure B of PSR (Table 2-1), the highest flood event shall be the one stipulated by the ARTC Safety Management System (SMS). As per Section 10.1.3 of Track and Civil Code of Practice Section 10 Flooding, the 1% AEP shall be used. The flood impact would be assessed up to the 1% AEP for the project.
- Blockage assessment is carried out for the 1% AEP design scenario as per the guidance set out in ARR2019 for the culverts within the project boundary while 20% blockage is adopted for all the other culverts, pits and pipes outside the project boundary (Refer to 5-0052-210-IHY-99-ME-0001)

# 2 COMPLIANCE WITH REQUIREMENTS

## 2.1 Project Scope and Requirements

Assessment of the detailed design to see if it meets the Project Scope and Requirements (PSRs) has been undertaken. This is demonstrated throughout the flood assessment, with Table 2-1 below summarising the Riverina Overbridge track lowering Design's Compliance with the PSRs.

**Table 2-1: Flooding Criteria within PSR Annexure B Technical Requirements**

| Requirement | Identifier | A2P Technical Requirements Description | Compliance Evidence Reference |
|---|---|---|---|
| Project Wide | 5.4.10 | Without limiting the environmental management requirements in Annexure F, section 6.1.1, all D&C Works in watercourses shall comply with the NSW Department of Primary Industries Standards:<br>Policy and Guidelines for Fish Friendly Waterway Crossings; Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings; and Policy and Guidelines for Fish Habitat Conservation and Management Update. | N/A (structure modifications do not affect waterway flow) |
| Project Wide | 5.4.2 | Where existing flood immunity is lower than ARTC SMS minimum requirements, the functional requirements for flood immunity take precedence over the ARTC SMS. | The ARTC minimum requirement is 1% AEP. The top of the track is overtopped in the 1% AEP in the existing scenario. Thus, the existing track does not achieve immunity in 1% AEP.<br>The existing immunity is maintained under design conditions. Refer to Section 5.3. |
| Project Wide | 5.4.3 | Where existing flood immunity is higher than ARTC SMS minimum requirements, the ARTC SMS requirements for flood immunity take precedence over the functional requirements. | The ARTC minimum requirement is 1% AEP. The top of the track is overtopped in the 1% AEP in the existing scenario. Thus, the existing track does not achieve immunity in 1% AEP.<br>The existing immunity is maintained under design conditions. Refer to Section 5.3. |
| Project Wide | 5.4.5 | Bridge and culvert hydraulics shall comply with Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures. | There are no bridge structures or Waterway structures within the Riverina Highway bridge Scope. |
| A2I Technical Requirements | IR-SR-A2I-116 | The System shall comply with 0-0000-900-ESS-00-ST-0001 Inland Rail Climate Change Risk Assessment Framework. | Climate change assessment was carried out by running the 1% AEP + 2090 RCP 8.5 and identifying potential flood behaviour.<br>Refer to Section 5.5.2. |
| A2I Technical Requirements | IR-SR-A2I-349 | The Corridor System for Enhancement Corridors shall have a flood immunity of no worse than existing. | The existing immunity is maintained under design conditions.<br>Refer to Section 5.3. |
| A2I Technical Requirements | IR-SR-A2I-350 | The Corridor System, where the existing track is lowered, shall maintain the existing flood immunity. | The existing immunity is maintained under design conditions.<br>Refer to Section 5.3. |

| Requirement | Identifier | A2P Technical Requirements Description | Compliance Evidence Reference |
|---|---|---|---|
| A2I Technical Requirements | IR-SR-A2I-352 | The Corridor System shall prevent damage of the formation due to ponding of water. | No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site.<br>Refer to Sections 5.2 & 5.3. |
| A2I Technical Requirements | IR-SR-A2I-458 | The Corridor System shall prevent ponding in longitudinal open channels. | The proposed channels have grading that prevents ponding.<br>Refer to Section 4.5 (Drainage Design) on the Riverina Highway Bridge Design Report (5-0052-210-PEN-B4-RP-0001) |
| A2I Technical Requirements | IR-SR-A2I-459 | The Corridor System for Enhancement Corridors shall provide mitigation for flood impacts no worse than existing condition. | Existing condition is maintained. Flood impacts are no worse than existing conditions.<br>Refer to Section 5.4. |
| A2I Technical Requirements | IR-SR-A2I-464 | The Corridor System shall cause no adverse impacts either inside or outside the rail corridor when diverting water away from the track. | Existing condition is maintained. Flood impacts no worse than existing condition.<br>Refer to Section 5.4. |
| A2I Technical Requirements | IR-SR-A2I-465 | The Corridor System shall minimise changes to the existing or natural flow patterns. | The corridor system has minimised changes to the existing flow patterns. Flood impacts no worse than existing condition.<br>Refer to Section 5.4. |
| A2I Technical Requirements | IR-SR-A2I-541 | The Structures System new underbridges shall withstand the 0.05% annual exceedance probability design flood event. | N/A. There is no new underbridge structure change. |
| A2I Technical Requirements | IR-SR-A2I-735 | The Third-Party System private roads shall have flood immunity no worse than existing. | No third-party private roads are impacted.<br>Refer to Section 5.4.1. |
| A2I (Annexure F) | 6.1.1 | Without limiting clauses 8 and 14 of the Deed, the Contractor shall ensure that the Contractor's Activities and the Works comply with the following for A2I, the Conditions of Approval and the environmental assessment reports available on:<br>https://www.planningportal.nsw.gov.au/major-projects/projects/inland-rail-albury-illabo" | Refer to Table 2-2 |

*A2I Technical requirements are used in A2P as A2P is a part of A2I.

## 2.2 Conditions of Approval – Flooding

The Conditions of Approval (CoA) have been provided as part of the CSSI approval and Inland Rail Deed of Variation. The detailed design has been assessed to check if it meets the CoA and the compliance is presented in Table 2-2 below.

**Table 2-2: Conditions of Approval Compliance Table – Flooding**

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| E38 | All practicable measures must be implemented to ensure the design, construction and operation of the CSSI will not adversely affect flood behaviour, or adversely affect the environment or cause avoidable erosion, siltation, | Compliant.<br>Refer to Section 5. |

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| | destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses. | |
| E39 | The CSSI must be designed with the objective to meet or improve upon the flood performance identified in the documents listed in **Condition A1**. Variation consistent with the requirements of this approval at the rail corridor is permitted to effect minor changes to the design with the intent of improving the flood performance of the CSSI. | Compliant.<br>Refer to Section 5. |
| E40 | Updated flood modelling of the project's detailed design must be undertaken for the full range of flood events, including blockage of culverts and flowpaths, considered in the documents listed in **Condition A1**. This modelling must include: | Compliant.<br>Refer to Sections 0 and 5. |
| E40 | a) Hydrologic and hydraulic assessments consistent with *Australian Rainfall and Runoff – A Guide to Flood Estimation* (GeoScience Australia, 2019); | Compliant.<br>Refer to Section 0. |
| E40 | b) Use of modelling software appropriate to the relevant modelling task; | Compliant.<br>Section 0 shows that the appropriate software (TUFLOW) was used |
| E40 | c) Field survey of the existing rail formation and rail levels, should be included within the models; and | Compliant.<br>The existing rail level was used to inform the flood immunity.<br>Refer to Section 5.1 and 5.2. |
| E40 | d) Confirmation of predicted afflux at industrial properties adjacent to Railway Street, Wagga Wagga based on field survey. | N/A.<br>This criterion is related to the Wagga Wagga Yard enhancement site but not the Riverina Highway track lowering site, which is the subject of this report. |
| E40 | Updated flood modelling must be made publicly available in accordance with **Condition B18**. | Flood design report and independent review of the flood design report shall be provided to IR, through this submission, for IR to upload on the IR website, as per CoA B18 responsibility allocation. |
| E41 | The Proponent's response to the requirements of **Conditions E38** and **E40** must be reviewed and endorsed by a suitably qualified flood consultant, who is independent of the project's design and construction and approved in accordance with **Condition A16,** in consultation with directly affected landowners, DCCEEW Water Group, TfNSW, DPI Fisheries, BCS, NSW State Emergency Service (SES) and relevant Councils. | Independent review of the flood modelling, model and Flood Design Report is undertaken by the Proof Engineer's specialist contractor, who satisfies and complies with the requirements of A16.<br>Consultation with the council and other stakeholders is being undertaken through a formal review of this Flood Design Report. |
| E42 | The CSSI must be designed and constructed to limit impacts on flooding characteristics in areas outside the project boundary during any flood event up to and including the 1% AEP flood event, to the following: | See items below |
| E42 | (a) a maximum increase in inundation time of one hour, or 10%, whichever is greater; | Compliant.<br>Refer to Section 5.4.4. |

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| E42 | (b) a maximum increase of 10 mm in above-floor inundation to habitable rooms where floor levels are currently exceeded; | Compliant.<br>No flood level increase of 10mm in above-floor inundation on any properties.<br>Refer Section 5.4.1. |
| E42 | (c) no above-floor inundation of habitable rooms which are currently not inundated; | Compliant.<br>No increase for above floor inundation of habitable rooms on any properties.<br>Refer Section 5.4.1. |
| E42 | (d) a maximum increase of 50 mm in inundation of land zoned as residential, industrial or commercial; | Compliant.<br>No flood level increase of more than 50mm in residential, industrial and commercial areas.<br>Refer Section 5.4.1. |
| E42 | (e) a maximum increase of 100 mm in inundation of land zoned as environment zone or public recreation; | Compliant.<br>No flood level increase of more than 100mm in the environment zone or public recreation.<br>Refer to Section 5.4.1. |
| E42 | (f) a maximum increase of 200 mm in inundation of land zoned as rural or primary production, environment zone or public recreation; | Compliant.<br>No flood level increase of more than 200mm in rural or primary production, environment zone or public recreation.<br>Refer to Section 5.4.1. |
| E42 | (g) no increase in the flood hazard category or risk to life; and | Compliant<br>Refer to Section 5.4.3. |
| E42 | (h) maximum relative increase in velocity of 10%, or to 0.5m/s, whichever is greater, unless adequate scour protection measures are implemented and/or the velocity increases do not exacerbate erosion as demonstrated through site-specific risk of scour or geomorphological assessments | Compliant<br>Refer to Section 5.4.2 |
| E42 | Where the requirements set out in clauses (d) to (f) inclusive cannot be met alternative flood levels or mitigation measures must be agreed to with the affected landowner. | N/A, Clause (d) to (f) are compliant |
| E43 | A **Flood Design Report** confirming the: | |
| E43 | a) final design of the CSSI meets the requirements of **Condition E42;** and | Compliant<br>Refer to Section 5. |
| E43 | b) the results of consultation with the relevant council in accordance with **Condition E46** | Refer to E46 |
| E43 | must be submitted to and approved by the Planning Secretary prior to the commencement of permanent works that would impact on flooding. | This report will be submitted to the Planning Secretary for approval prior to the commencement of permanent works that would impact on flooding. |

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| E44 | The **Flood Design Report** required by **Condition E43** must be approved by the Planning Secretary prior to works that may impact on flooding or the relevant council's stormwater network. | This report will be submitted to the Planning Secretary for approval prior to the commencement of permanent works that would impact on flooding. |
| E45 | Flood information including flood reports, models and geographic information system outputs, and work as executed information from a registered surveyor certifying finished ground levels and the dimensions and finished levels of all structures within the flood prone land, must be provided to the relevant Council, BCS and the SES in order to assist in preparing relevant documents and to reflect changes in flood behaviour as a result of the CSSI. The Council, BCS and the SES must be notified in writing that the information is available no later than one (1) month following the completion of construction. Information requested by the relevant Council, BCS or the SES must be provided no later than six (6) months following the completion of construction or within another timeframe agreed with the relevant Council, BCS or the SES. | Flood information will be provided to the relevant Council, BCS and the SES in order to assist in preparing relevant documents and to reflect changes in flood behaviour as a result of the CSSI in accordance with the requirements of CoA E45 |
| E46 | The design, operation and maintenance of pumping stations and storage tanks and discharges to council's stormwater network must be developed in consultation with the relevant council. The results of the consultation are to be included in the report required in **Condition E47.** | Although the flow balance has been changed, (i.e. more flow down Mudges Canal and less towards Wilson Street), the overall catchment area and imperviousness remain the same as per the existing condition, there is no additional flow towards the existing Council's stormwater network. The design has not worsened the existing condition.<br>Albury City Council has been consulted through design review process in accordance with the Master Inland Rail Deed Agreement.<br>Refer to Section 4.5 (Drainage Design) in the Riverina Highway Bridge Design Report (5-0052-210-PEN-B4-RP-0001). |

## 2.3 Updated Mitigation Measures - Flooding

The Updated Mitigation Measures (UMM) have been provided, and the detailed design has been assessed to meet the UMM and the compliance is presented in Table 2-3 below.

**Table 2-3: Updated Mitigation Measures Compliance Table - Flooding**

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| HFWQ3 | Further consultation will be undertaken with local councils and other relevant authorities to identify opportunities to coordinate the proposal with flood mitigation works committed to as part of the council's flood management plans, or other strategies. | Consultation with the Council and other relevant authorities will be undertaken through a formal review of this Flood Design Report. |
| HFWQ4 | At Wagga Wagga Yard enhancement site, flood modelling would be carried out during detailed design to confirm predicted afflux at industrial properties located at Railway Street and compliance with the Quantitative Design Limits for Inland Rail.<br>This would be informed by topographic and building floor surveys and a review of localised drainage structures (as required). | This criterion is related to the Wagga Wagga Yard enhancement site lowering site but not the Riverina Highway track, which is the subject of this report. |

| Condition | Condition or Criteria | Compliance Evidence Reference |
|---|---|---|
| | Quantitative assessment of the sites of low and moderate hydraulic complexity will be carried out during detailed design and will consider the impact of the Possible Maximum Flood event at built-up areas (where information is available) and the tenure of the upstream areas that are impacted by drainage and/or flooding. The outcomes of the assessment are to be provided to DCCEW– BCS | Compliant.<br>Quantitative assessment has been undertaken. Refer to Section 4.3 & 5. |
| HFWQ5 | At Riverina Highway bridge enhancement site, flood and drainage network modelling (including capacity and operation of the stormwater storage and pump system) will be carried out during detailed design to confirm predicted compliance with the Quantitative Design Limits (QDLs)* for Inland Rail. The modelling would be undertaken in consultation with Albury City Council. | The flood model included the proposed stormwater drainage and Pump design and storage. Refer to Section 4.3.2.<br>The flood assessment results comply with CoA E42. Refer to Section 5.4 |

* QDL is superseded by CoA E42.

# 3 CHANGE MANAGEMENT

This section summarises the changes made to this design package due to changes in the project scope and/or evolution of the design.

## 3.1 Concept Design to SDR

Key design changes between the Concept Design and the SDR Design are listed in Table 3-1.

**Table 3-1: Design Differences Between Concept and SDR**

| Item | Difference | Reason for Change |
|---|---|---|
| 1 | Incorporation of LiDAR survey | An existing condition topography |
| 2 | Incorporation of Design Drainage | New drainage design |
| 3 | Incorporation of Civil Design | New civil design |
| 4 | Incorporation of Railway track Design | New rail design for the site |

## 3.2 SDR to PDR

Key design changes between the SDR and the PDR Design are listed in Table 3-2.

**Table 3-2: Design Differences Between SDR and PDR**

| Item | Difference | Reason for Change |
|---|---|---|
| 1 | Updated hydrology from ARR 1987 to ARR 2019. | Project requirements for PDR. Additional information is provided in Section 4.2. |
| 2 | Incorporation of the latest existing condition survey (Point cloud data) | A new existing condition survey was provided |
| 3 | Incorporation of Design Drainage | New drainage design for the site |
| 4 | Incorporation of Civil Design | New civil design for the site |
| 5 | Incorporation of Railway track Design | New rail design for the site |

## 3.3 PDR to DDR

Key design changes between the PDR and the DDR Design are listed in Table 3-3.

**Table 3-3: Design Differences Between PDR and DDR**

| Item | Difference | Reason for Change |
|---|---|---|
| 1 | Incorporation of the latest existing condition survey | A new detailed topography survey was provided |
| 2 | Incorporation of Design Drainage and Pump design | Updated drainage and pump design for the site |
| 3 | Incorporation of Civil Design | Updated civil design for the site |
| 4 | Incorporation of Railway track Design | Updated rail design for the site |

## 3.4 DDR to IFC

Key design changes between the DDR and the IFC Design are listed in Table 3-4.

**Table 3-4: Design Differences Between DDR and IFC**

| Item | Difference | Reason for Change |
|---|---|---|
| 1 | Updating sections and text throughout the report | To address the ARTC / IR / PE / TfNSW review comments. Text at E41 was amended to correct cross-referencing to other CoA numbers, and text to E41 and E46 was amended to reflect that ACC has been consulted through the process of design and report review. |

| Item | Difference | Reason for Change |
|---|---|---|
| 2 | Design addition only at the tie-in sections of the U-drain and overland flow channel for a smoother channel transition, while the cross-sections of both the U-drain and overland flow channel remain the same with the DDR stage design at the western overland channel. | IFC stage design update |
| 3 | 6m of channel section next to pump station to be lined with rock mattress | IFC stage design update |

# 4 MODELLING METHODOLOGY

Detailed hydraulic modelling using TUFLOW was undertaken for this flood and impact assessment. The study area is the track area under the Riverina Highway bridge.

The overall approaches for flood modelling are listed below:

- Update the Hydrology from ARR 1987 to ARR 2019 and produce inflows to be used in the hydraulic model.
- Updating the received TUFLOW model by incorporating the latest LiDAR (2020) and survey data (Items 2, 5 and 6 from Table 1-2).
- Comparison of the existing case TUFLOW against the flood study around the site area.
- Using the updated TUFLOW model to predict existing hydraulic behaviour, which forms the existing case against which the implementation of the design works is assessed.
- Updating the TUFLOW model from existing conditions to design conditions by incorporating the design into the existing case model.
- The Riverina Highway bridge deck is not included but the bridge abutment and embankments are captured as per the detailed survey in the flood assessment. This is because the bridge does not have a pier which would impact the flooding characteristics within the railway corridor, and the bridge deck is too high to be an obstruction to flooding characteristics within the railway corridor,
- Conducting a climate change sensitivity test for the 1% AEP to inform the potential impact on the railway track flood immunity.
- Conduct a blockage assessment as per ARR 2019 procedures.

## 4.1 Catchment Description

The Riverina Highway bridge site is located within the urban area of Albury and away from Murray River. Thus, it is not subject to regional flooding. However, the site is affected by overland flooding. The flood water coming from the northern catchment of The Scots School Albury runs along the rail corridor in a south-east direction. This surface runoff flows through a 3-cell box culvert (CH644770 in Figure 4-4) into an open channel on the eastern side of the railway, followed by a piped section connecting with Mudges Canal. Mudges Canal continues about 1.5km to the south before discharging into the Murray River.

## 4.2 Hydrologic Modelling

### 4.2.1 ARR2019 Approach

The hydrology models (DRAINS-RAFTS and DRAINS-ILSAX) related to Albury FRMSP (WMAwater, 2016) and Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Lyall & Associates, 2011) were originally built based on ARR1987, by Others. An excerpt from the study report is shown in the Figure below.

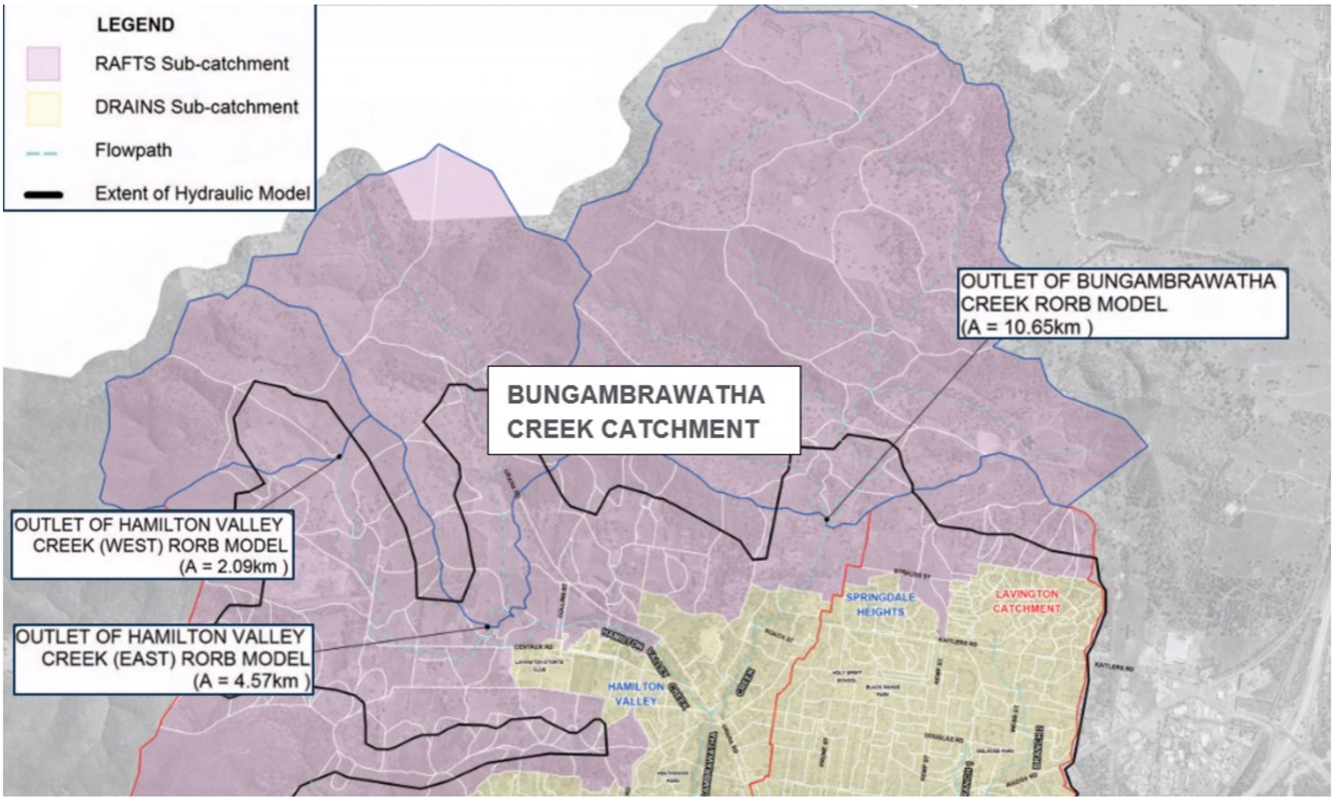


**Figure 4-1 Sub-catchment Plan from Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Source: Figure 3.1-1 of Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study, Lyall & Associates, 2011).**

Figure 4-1 describes that a RAFTS model was used for the upstream catchment while the DRAINS model was used for the densely populated catchment within the Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study. These hydrology models were not received from the Council and consequently, hydrology models have been built adopting ARR2019 to provide inflows to TUFLOW as part of the detailed design engagement. The sub-catchments delineation is shown in Figure 4-2. The DRAINS-RAFTS model was used to provide the SA inflow for the upstream catchment and the catchment within the study area but does not contain any drainage network (this inflow approach is consistent with the one adopted by the hydraulic model from Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study). Instead of DRAINS-ILSAX (ARR2019 recommended initial loss and continue losses cannot be used in DRAINS-ILSAX), Rainfall Excess was calculated to be applied to the urbanised catchment with drainage network. The parameters for the two types of models were summarised in Table 4-1. The PMF Hydrology model was based on the ARR1987 guidelines. This was then updated as per ARR2019 guidelines incorporating an ensemble of 11 temporal patterns for GSDM PMF from 15 minutes to 180 minutes.

**Table 4-1: Hydrology Models Parameters**

| Parameters | Hydrology model for upstream catchment and the catchment within the study area but does not contain any drainage network | Hydrology approach for urbanised catchment |
|---|---|---|
| Model Type | DRAINS-RAFTS[1] | Rainfall Excess only |
| Areal Reduction Factor | Not Applied (As per Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study) | |
| Temporal Patterns | ARR2019 Temporal patterns (refer to Appendix B) | |
| Rainfall Losses | Refer to Section 4.2.3 and Appendix B | |
| Rainfall Depth | Refer to Appendix C | |
| Output | Routed hydrograph | Rainfall excess |
| Design Events | 10% AEP, 5% AEP, 2% AEP, 1%AEP, 1%AEP with Climate Change, PMF | |

Drains software with Rafts storage routing module, enables detailed simulation of the storage and routing of stormwater through various catchment elements. It also supports the latest guidelines and methodologies outlined in the Australian Rainfall and Runoff 2019 (ARR2019).

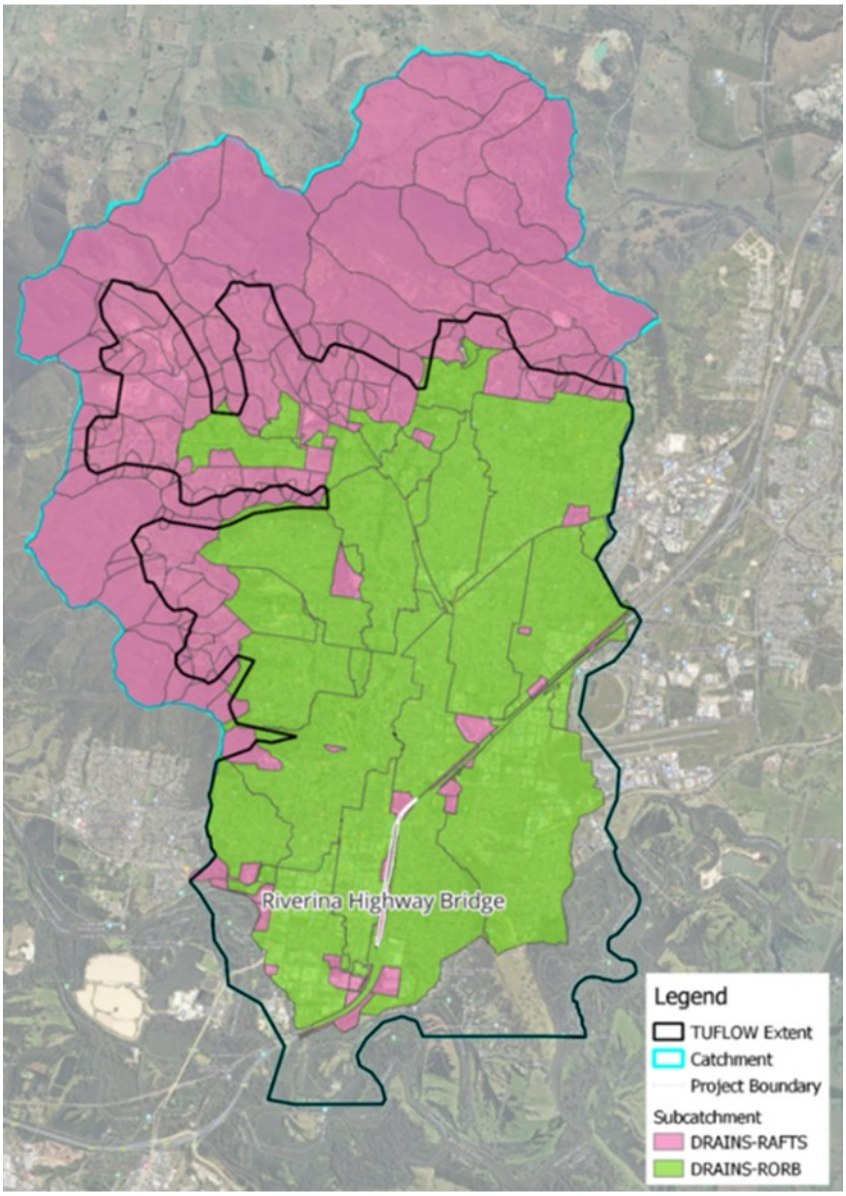


**Figure 4-2 Excerpt from the flood study showing sub-catchments**

### 4.2.2 Climate Change

An assessment was conducted to evaluate the influence of climate change on flooding to anticipate future climate change flood risk. As per the EIS report (Section 3.3.5 of Albury to Illabo Environmental Impact Statement Technical Paper 11), 2090 RCP8.5 interim climate change factor sourced from the ARR Data Hub (https://data.arr-software.org/) was adopted.

Sea level rise will not affect the site as it is far away from the sea. In addition, as per FRMS (Figure 9), the site is outside of the Murray River PMF extent. Therefore, the water level resulting from climate change in the Murray River will not affect the site.

### 4.2.3 Input Data for Design Flood Estimation

This study adopted the ARR 2019 procedure for NSW Specific Data to run the hydrological model. Probability Neutral Burst Initial Loss and storm continuing losses times 0.4 (1.8 mm/h) were used for pervious area. An initial loss of 1mm and continuing losses of 0 mm/h were adopted for impervious area. The design events of 10%, 5%, 2%, 1% AEPs, PMF and 1% AEP with Climate Change were selected to run.

Flow hydrographs were generated for input to the hydraulic model for the 10% AEP, 5% AEP, 2% AEP, 1% AEP, PMF and 1% AEP + Climate Change events to perform critical duration analysis (Refer to Section 4.3.1).

## 4.3 Hydraulic Modelling

### 4.3.1 Existing TUFLOW Model Update

The TUFLOW hydraulic model was updated with modelling based on the received Albury FRMSP (WMAwater, 2016) detailed in Section 1.9.1. A summary of the received Albury FRMSP 2016 TUFLOW Model (item 1 from Table 1-2) and updated DDR model parameters can be found in Table 4-2. The model extent encompasses Bungambrawatha Creek, South Albury and Lavington catchments (Figure 4-3).

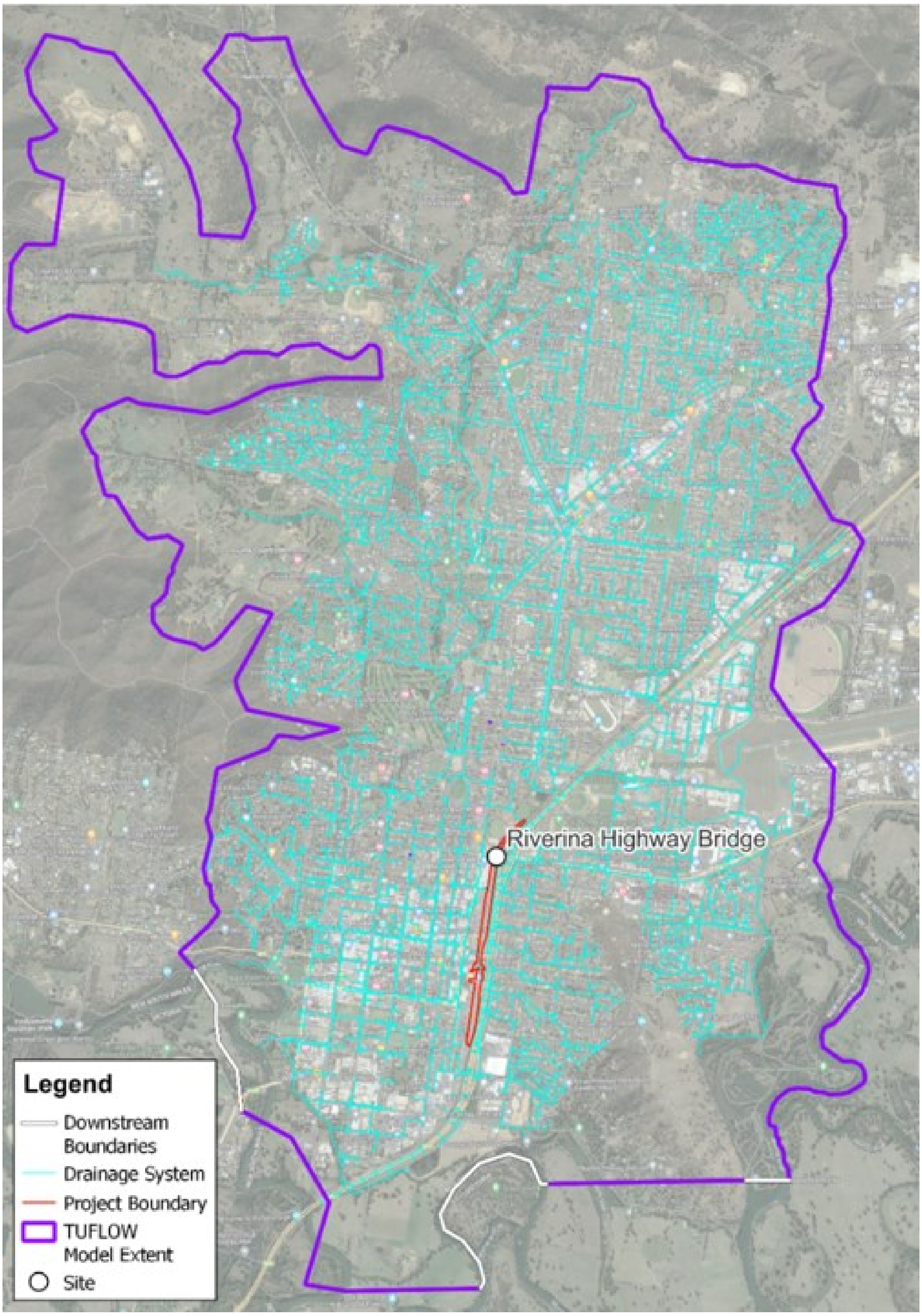


**Figure 4-3: TUFLOW Model Extent**

**Table 4-2: Model Parameters in the Albury FRMSP 2016 TUFLOW Model and the Updated DDR Existing Case TUFLOW Model**

| Parameters | Albury FRMSP 2016 TUFLOW Model | Updated DDR TUFLOW Model (Existing Case) |
|---|---|---|
| Software Version | TUFLOW 2012-05-AB-w64 Classic | TUFLOW.2020-10-AF HPC |
| Coordination Reference System (CRS) | GDA94 MGA 55 | GDA2020 MGA 55<br>Refer to the following Section 4.3.1.3 for more details. |
| Grid Size | 5m | 0.625m within the quadtree area (Site area) and 5m outside of the quadtree area (refer to Figure 4-4) |
| Hydrology | DRAINS-RAFTS and DRAINS-ILSAX (ARR1987) | DRAINS-RAFTS and DRAINS-RORB (ARR2019) |
| Inflow type | External inflow and SA Polygons | External inflow, Rainfall Excess, and SA Polygons<br>Refer to the following Section 4.3.1.4 for updating details |
| Key Features | Existing railway track was not defined | Surveyed existing railway track was included |
| Extent | Bungambrawatha Creek, South Albury and Lavington catchments | Bungambrawatha Creek, South Albury and Lavington catchments |
| Downstream Boundary | Constant downstream water boundary | Constant downstream water boundary |
| Timestep | 0.5s | Dynamic |
| Building Representation | High Manning's (10) | High Manning's (10) |
| Topography | DTM (5m resolution) based on Airborne Laser Scanning (ALS) survey in May 2005. The accuracy is ±100mm for urban area and ±250mm for wider Albury LGA.<br>Cross section data for major trunk infrastructure | DTM (5m resolution) based on Airborne Laser Scanning (ALS) survey in May 2005. The accuracy is ±100mm for urban area and ±250mm for wider Albury LGA.<br>Cross section data for major trunk infrastructure<br>2020 LiDAR for sites<br>Point cloud survey and detailed survey for Riverina Highway bridge and railway corridor (Items 4 and 5 in Table 1-2 respectively) |
| Roughness | Asphalt or concrete road surface: 0.02<br>Concrete Surfaces: 0.015<br>Well Maintained Grassed Cover e.g. sporting oval: 0.03<br>Grass or Lawns: 0.045<br>Macrophytes: 0.06<br>Lightly Vegetated Areas: 0.07<br>Trees: 0.08<br>Trees and Shrub: 0.09<br>Mildly Dense Vegetation: 0.12<br>Dense vegetation: 0.135<br>Buildings: 10<br>Water Bodies/Wetlands: 0.035<br>Pastoral Grass, Tough Scrub Grass: 0.05<br>Rock Riprap: 0.06<br>Selected Roads in the Bungambrawatha Creek catchment: 0.06 | Asphalt or concrete road surface: 0.02<br>Concrete Surfaces: 0.015<br>Well Maintained Grassed Cover e.g. sporting oval: 0.03<br>Grass or Lawns: 0.045<br>Macrophytes: 0.06<br>Lightly Vegetated Areas: 0.07<br>Trees: 0.08<br>Trees and Shrub: 0.09<br>Mildly Dense Vegetation: 0.12<br>Dense vegetation: 0.135<br>Buildings: 10<br>Water Bodies/Wetlands: 0.035<br>Pastoral Grass, Tough Scrub Grass: 0.05<br>Rock Riprap: 0.06<br>Selected Roads in the Bungambrawatha Creek catchment: 0.06 |

| Parameters | Albury FRMSP 2016 TUFLOW Model | Updated DDR TUFLOW Model (Existing Case) |
|---|---|---|
| | Allotments where fences and outbuildings are present: 0.1 | Allotments where fences and outbuildings are present: 0.1<br>Concrete Open channel: 0.02 (adapted to be in line with the drainage design)<br>Proposed Channel: 0.03 |
| Design Events | PMF, 0.2% AEP, 0.5% AEP, 1%AEP, 2% AEP, 5% AEP, 10% AEP, 20% AEP | PMF, 1% AEP with climate change, 1% AEP, 2% AEP, 5% AEP, 10% AEP |

#### 4.3.1.1 GDA2020 conversion

The conversion to GDA2020 of the Tuflow data received from Albury Council, represents a crucial update to modernise and align the model with the latest geodetic standards and reference systems and to meet project requirements on the CRS. The model layers and the rasters were converted into GDA2020 MGA 55 from GDA94 MGA 55.

#### 4.3.1.2 Topography

The model topography was updated by incorporating the 2020 LiDAR, point cloud survey and detailed survey. This update was performed to enhance the accuracy of the model, ensuring a proper representation of the most recent topography within the study area (Refer to Figure 4-4).

#### 4.3.1.3 TUFLOW Model Version and Grid Size

To capture the design including railway track, cess drain, and open channel in the model, a fine grid was required. Therefore, a newer TUFLOW model version needed to be adopted to provide a finer grid for the required area (this function is called “quadtree” and is available in TUFLOW versions from 2020 onwards). For this purpose, a finer resolution of 0.625m was adopted for the site and 5m outside the site to enable detailed representation and assessment of the design.

The model is set up using point terrain data (*.mid) instead of the grid (ASCII) for topography outside the LiDAR extent (as per the original received model). The latest TUFLOW version 2023-03-AC does not support when using quadtree with point terrain data. Therefore, TUFLOW release 2023 onwards cannot be used.  However, the version before the 2023 release would run without any issues (as long as the quadtree extent does not extend into the point terrain data - refer to Figure 4-4). Thus, TUFLOW 2020-10-AF HPC (the latest version prior to the 2023 release) was selected to conduct this flood assessment.

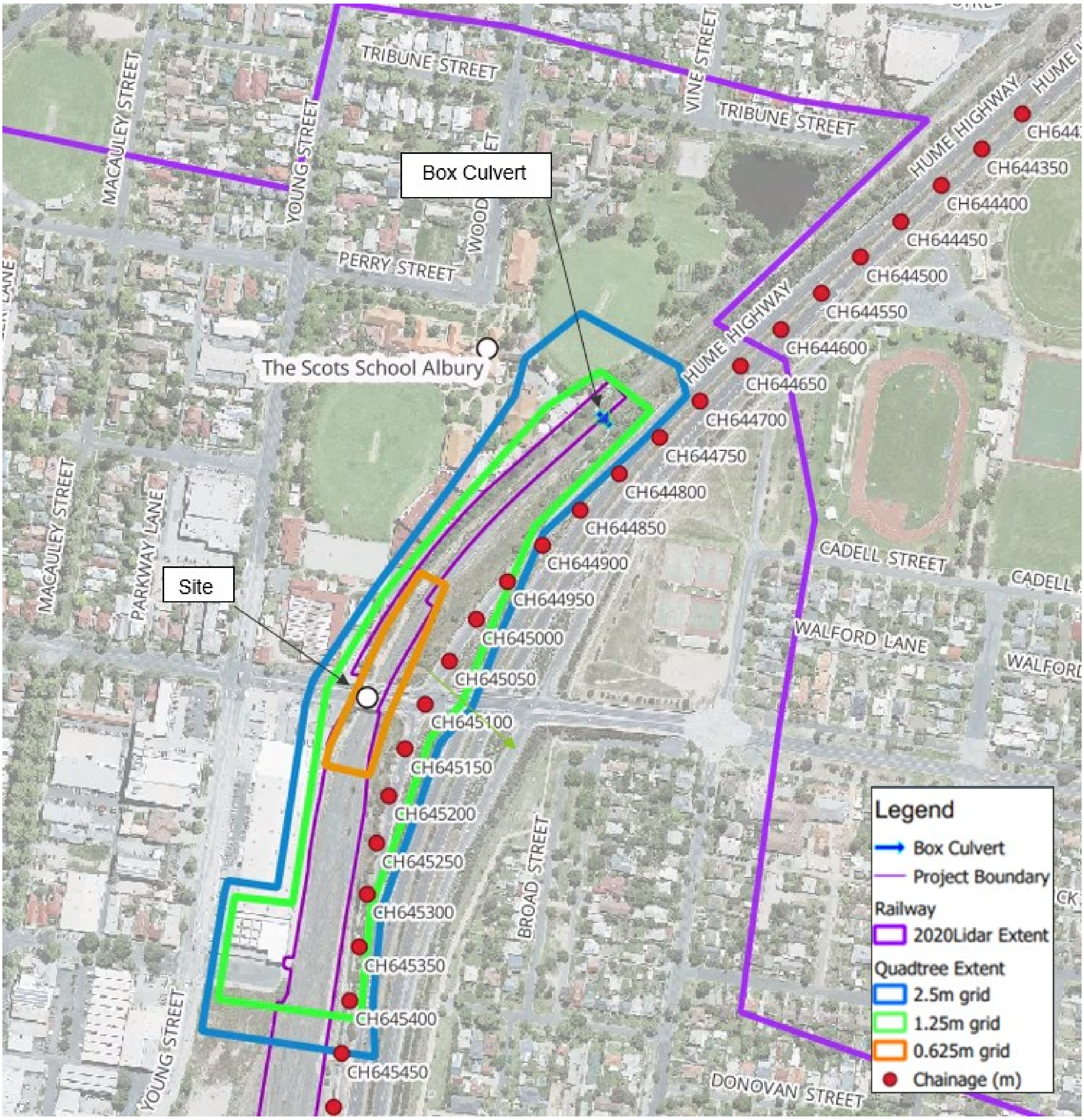


**Figure 4-4: Adopted LiDAR 2020 Extent and Grid Size Extent**

#### 4.3.1.4 Inflows

The inflow polygons (CH644800 to CH645100) covering the railway corridor upstream of the Riverina Highway bridge were updated based on the review of the LiDAR 2020. As is shown in Figure 4-5, the original inflow polygon covers the whole railway corridor then all the inflow is assumed to be assigned to the location indicated by the red arrow on the western side of the railway. However, this does not reflect the real situation as within the green polygon area in Figure 4-5 there should be two drainage lines on either side of the rail line (cyan dash lines in the right panel of Figure 4-5), capturing the water from the east and west catchment of the railway. To reproduce the realistic flood behaviour, the original inflow polygon was split into two.

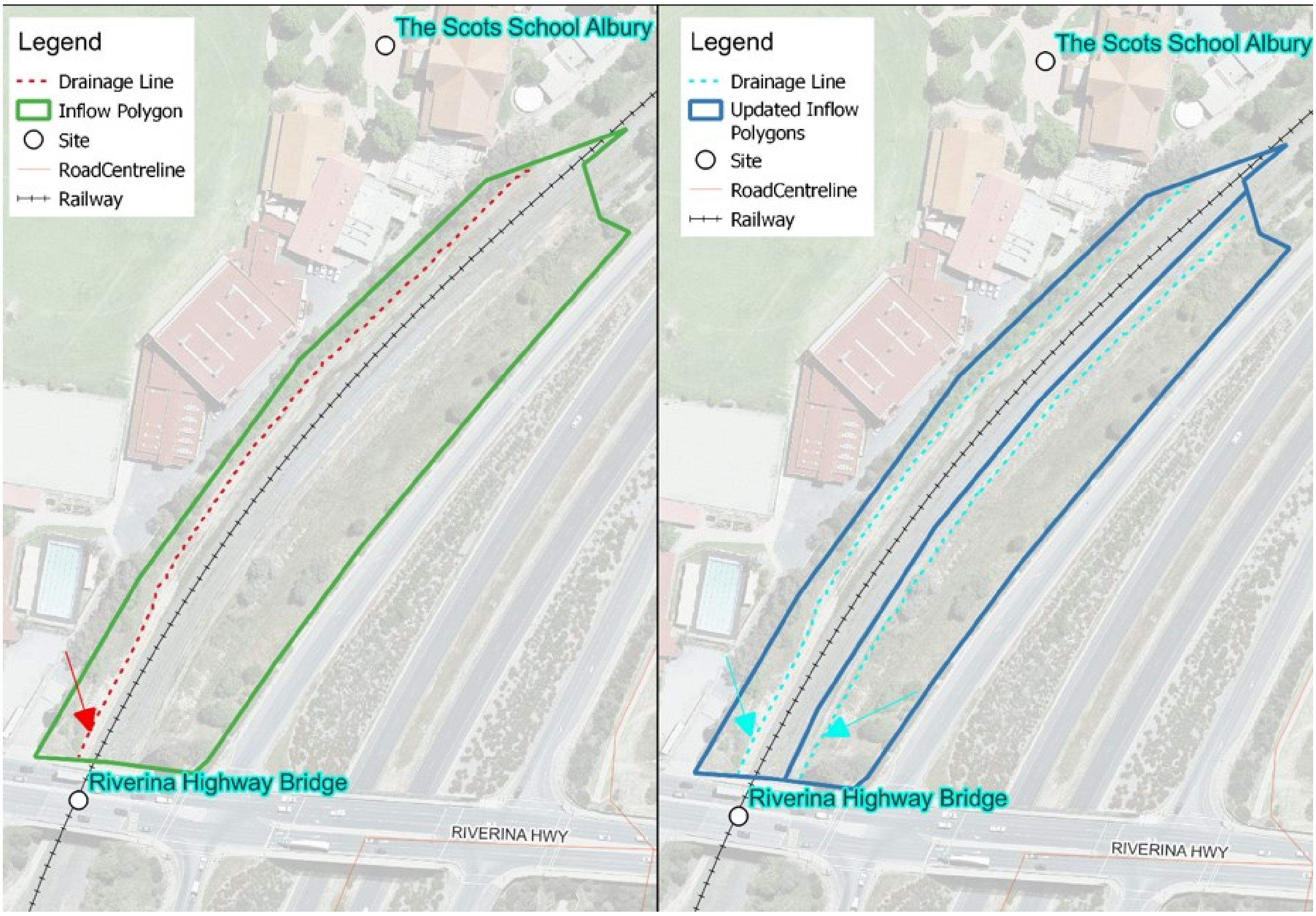


**Figure 4-5: Inflow Polygons Update (Left: Original Inflow Location; Right: Updated Inflow Location)**

#### 4.3.1.5 Key Features

The Albury FRMPS TUFLOW model did not model the railway track line within the study area. As the key feature, ignoring the railway track will result in inaccurate results. As such, the existing railway track around the Riverina Highway bridge (CH644750 to CH645650) was included in the updated existing case TUFLOW model (refer to Item 6 in Table 1-2).

#### 4.3.1.6 Drainage Network

The drainage data based on detailed survey was incorporated into the updated DDR TUFLOW model (refer to Item 9 in Table 1-2). The Albury FRMPS TUFLOW model drainage data is used outside the site and updated in relation to the 2020 LiDAR.

#### 4.3.1.7 Design Events

The storm durations of 30min, 45min, 60min, 90min, 120min, 180min, 270min, 360min, 540min and 720min were modelled. An ensemble of 10 temporal patterns was run for each duration as recommended in ARR2019. The critical durations were determined based on the maximum envelope method across the selected durations. The model was run for the design events of 10%, 5%, 2%, 1% and 1% AEP with climate change. The critical duration and temporal patterns determined and elaborated below in Table 4-3 summarise the information of the design events.

**Table 4-3: Summary of Events and Critical Durations Run in TUFLOW –Riverina Highway Bridge.**

| Design Events | Master Design Critical Duration and Temporal Pattern | Temporal Pattern |
|---|---|---|
| 10% AEP | 30minutes, 45minutes, 120minutes, 180minutes, 540minutes | All 10 temporal patterns for each duration |
| 5% AEP | 30 minutes, 45 minutes, 60 minutes, 120 minutes | |
| 2% AEP | 30 minutes, 60 minutes, 270 minutes | |
| 1% AEP | 30 minutes, 90 minutes, 120 minutes, 270 minutes | |

| | | |
|---|---|---|
| 1% AEP + Climate Change | 30 minutes, 90 minutes, 120 minutes | |
| PMF | 180 minutes | All 11 temporal patterns for each duration |

## 4.3.2 Design TUFLOW Model Update

### 4.3.2.1 Key Features

To establish the model for design condition, updates were undertaken to incorporate the Inland Rail Project Works as part of the DDR stage. Table 4-4 and Figure 4-6 include proposed work details.

**Table 4-4: Design Condition Key Features**

| Item | Design | Details |
|---|---|---|
| 1 | Track | The railway tracks within the site underwent a significant modification by lowering them to an approximate depth of up to 1.1 metres from the existing track level under the Riverina Highway bridge. (Refer to Section 4.2 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding track design changes) |
| 2 | Drainage | • A 450mm diameter pipe network connecting to a new pump. (Refer to Section 4.5 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding Drainage design)<br>• Inclusion of western overland flow channel. A crest was created near CH644920 to produce a storage area with an approximate height of 0.6m towards the Mudges Canal. The channel is used as a Rail Maintenance Access Road at the southern side of the Riverina Highway bridge.<br>• Inclusion of a cess drain between the western overland flow channel and the railway track.<br>• Inclusion of eastern overland flow channel parallel to the Loop Railway line<br>(Refer to Drawing 5-0052-210-CDR-B4-DR-0015 and 5-0052-210-CDR-B4-DR-0201 for channel schedule and long section respectively. The drainage channels and earthworks design incorporate positive grades, preventing any trapped low points that could cause ponding within the proposed work area. Between two cross-sections, there will be no localised depressions between adjacent cross-sections). |
| 3 | Civil | Rail Maintenance Access Road at the south-eastern side of the Riverina Highway bridge.<br>(Refer to Section 4.3 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding civil design) |
| 4 | Pump System | Inclusion of pump system and associated storage.<br>In the design scenario, flow from the 450mm pipe located upstream of the pumps will be channelled into a storage tank, from which the water will subsequently be pumped out.<br>Two identical pumps were included in the model and they were modelled in dynamic ways with 0.075 $m^3/s$ pumping out flow during higher head. To be specific, the first pump will be activated when the water level reaches 156.726mAHD, while the second pump will engage when the water level rises to 158.310mAHD. Both pumps are designed to convey water to Mudges Canal, through a 225 mm diameter pipe (Refer to Figure 4-6). This operation rule is based on DJV pump team input. For details of the pump refer to Section 4.10 of the Design Report 5-0052-210-PEN-B4-RP-0001. |

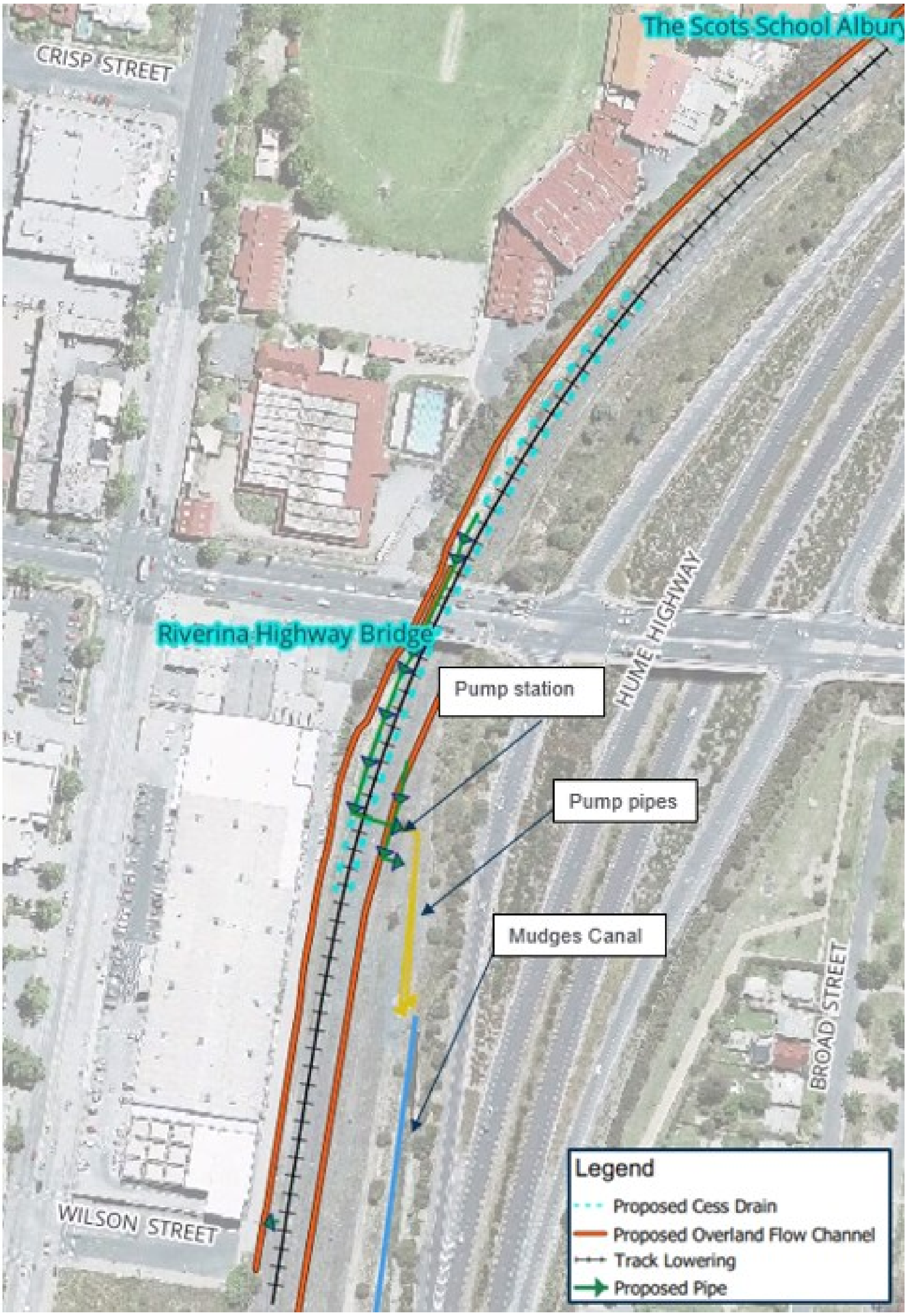


**Figure 4-6: Proposed Designs Included in the Model**

#### 4.3.2.2 Catchment area Inflows

As shown in Figure 4-7, compared with the existing model inflow locations (Figure 4-5, right panel), the western catchment was divided into three sub catchments: one for railway corridor catchment draining to the new proposed cess drain (cyan arrow); one for western catchment draining to the proposed overland flow channel (red arrow) and the upper small catchment will flow towards Mudges Canal (blue arrow). The eastern catchment remained unchanged (black arrow).

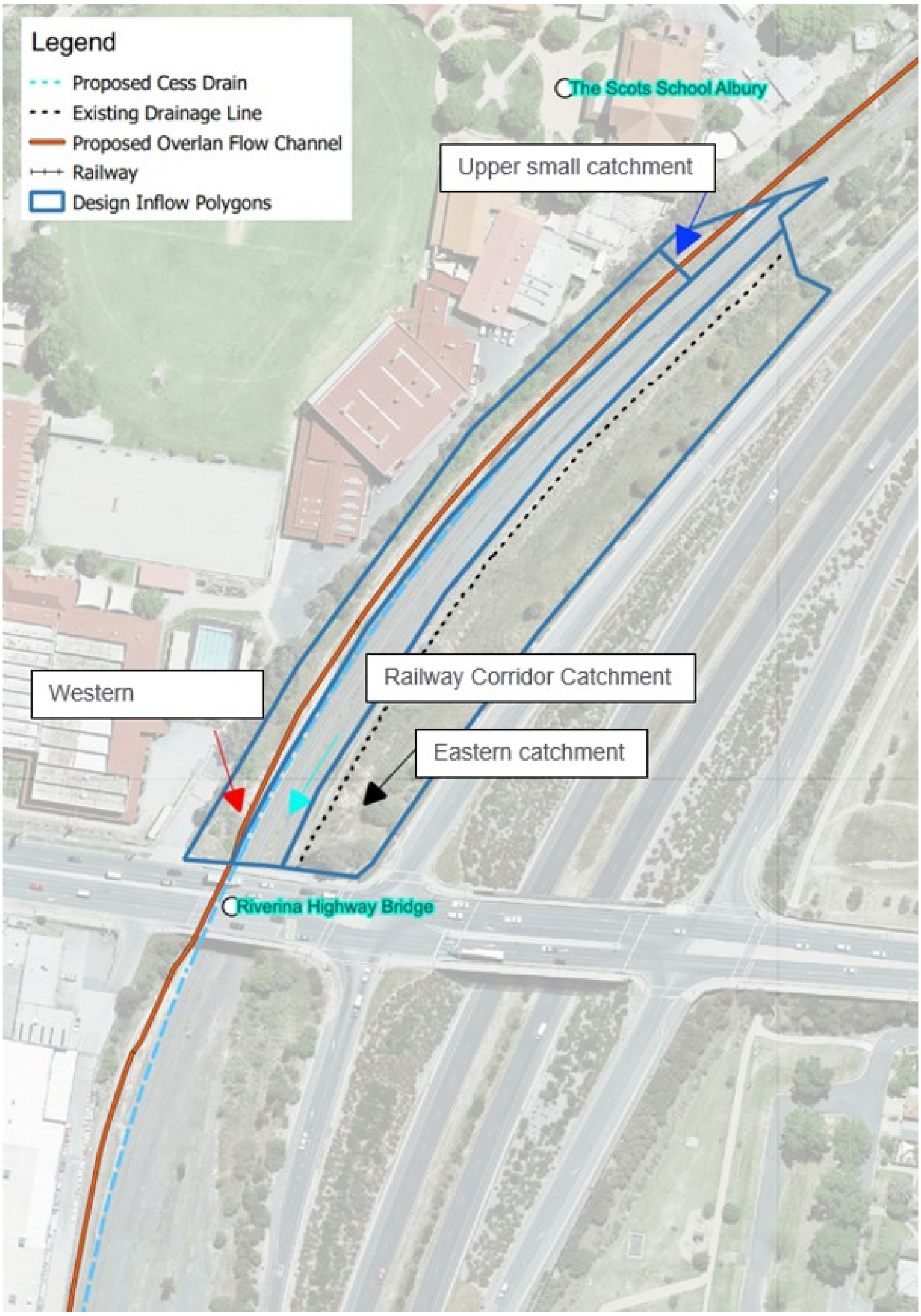


Figure 4-7: Design Inflow Polygons

### 4.3.3 Existing Flow Comparison between ARR2019 and ARR1987 at Key Location

The updated existing case TUFLOW model with ARR2019 was compared against the information provided in Table E3 of Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011). As a key inflow into the study area, the 1% AEP flow breaking out from the 3-cell culvert (Ch644.770km) into the railway corridor from the updated model (ARR2019) was compared with the flows reported in the flood study (indicated in Figure 4-8). The flood study indicates that the flow is around 0.4m3/s (1% AEP) while the flow from the updated existing model in this assessment is around 0.87m3/s (1% AEP, critical duration 120 min Temporal pattern 10). This indicated that at around the site area (purple polygon in Figure 4-8), ARR2019 will produce a higher flow than ARR1987 for the 1% AEP event.

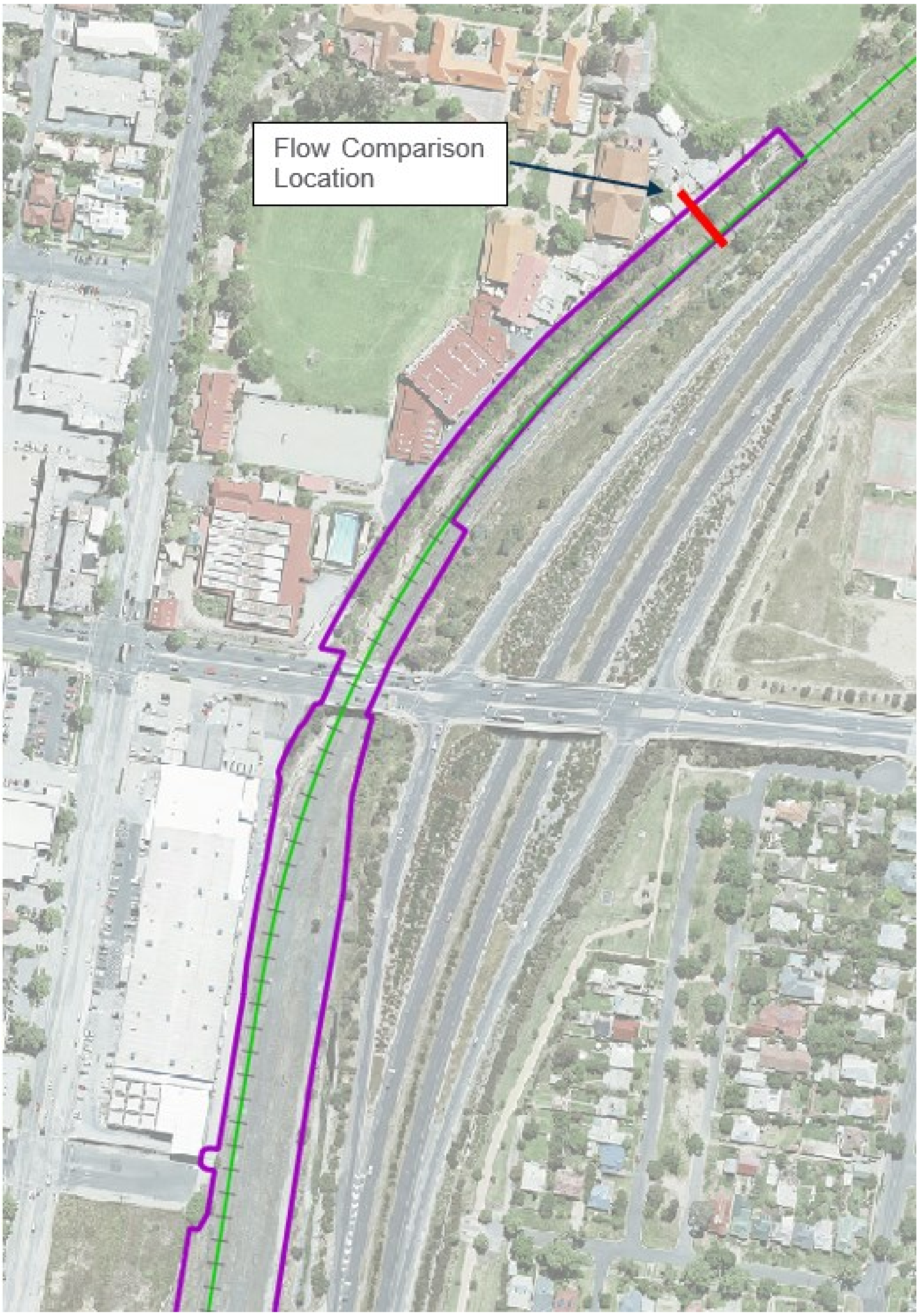


**Figure 4-8: Flow Comparison Location**

# 5 FLOOD ASSESSMENT

## 5.1 Existing Condition

Existing flood maps presenting peak flood depths and level contours, peak velocities, and flood hazard for the events modelled are provided in Appendix A.

The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert (Figure 4-4) positioned to the north of the site (CH644.770km). The existing open channel at the western side of the Main railway track collects this excess flooding water and redirects it towards the south (refer to

Figure 5-1). The primary existing drainage network in the site flows towards to the Mudges Canal and secondary drainage network flows towards Wilson Street (refer to Figure 5-2).

According to the Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (July 2022), the Albury FRMSP 2016 TUFLOW Model indicated that the existing railway line experienced overtopping in 20% AEP event. The updated modelling of this project now demonstrates that the existing rail level remains immune to overtopping up to the 2% AEP event under the Riverina Highway bridge area. This is due to:

- The existing railway track was not represented in the Albury FRMSP 2016 TUFLOW Model. Subsequent updates to the TUFLOW model, which included incorporating data from an existing rail survey and employing a finer grid size within the site, have improved the accuracy of the TUFLOW model and the presentation of the actual rail line levels.
- As discussed in Section 4.3.1, the initial model utilised a single SA polygon that covered two channels, directing water to the lowest point of one channel. SA polygon was now divided into two separate polygons, each designed to direct flows into its respective channel. This modification corrected the flooding situation downstream of the channels because the flow was now correctly divided into two distinct pathways, aligning with the natural drainage patterns.
- The railway corridor under the Riverina Highway bridge was not properly represented in the Albury FRMSP 2016 TUFLOW Model. The railway corridor levels underneath the Riverina Highway bridge were 0.5m lower than the surrounding area, which was created artificially by implementing a terrain modification and was not real. This was corrected in the updated TUFLOW model by using LiDAR 2020 and survey data.
- Points of interest in the site are indicated below (Refer to

Figure 5-1)

- Point 1 - Located at western overland channel north of the crest
- Point 2 - Located at western overland channel south of the crest
- Point 3 - Located at western overland channel North of Riverina Highway Bridge
- Point 4 - Located at railway corridor channel
- Point 5 - Located at main railway track line
- Point 6 - Located at railway corridor channel
- Point 7 - Located east to the railway track lines
- Point 8 - Located at western overland channel North of Wilson Street
- Point 9 - Located at western overland channel near Wilson Street

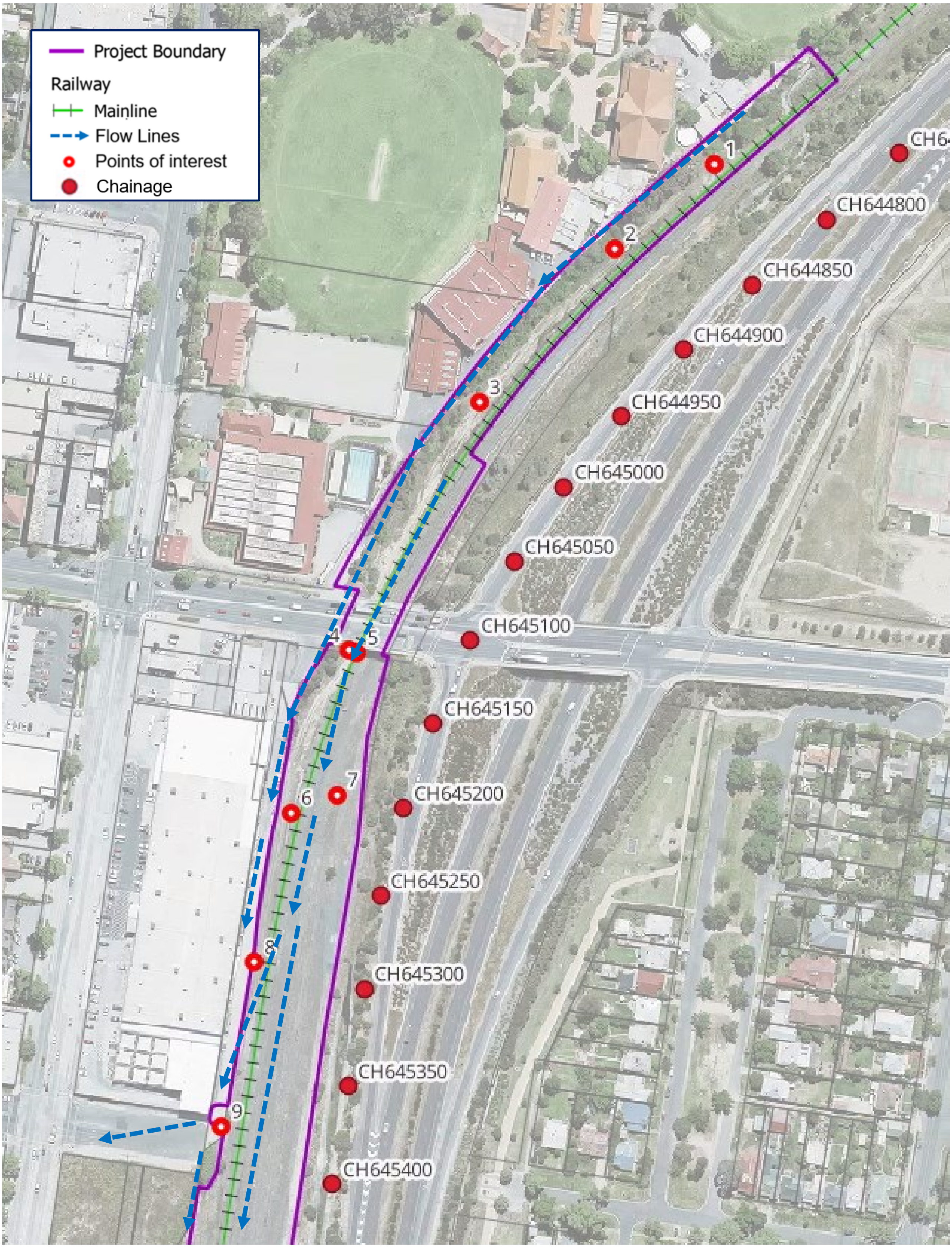


Figure 5-1: Riverina Highway Site Existing Scenario Overland Flow Paths for 1% AEP

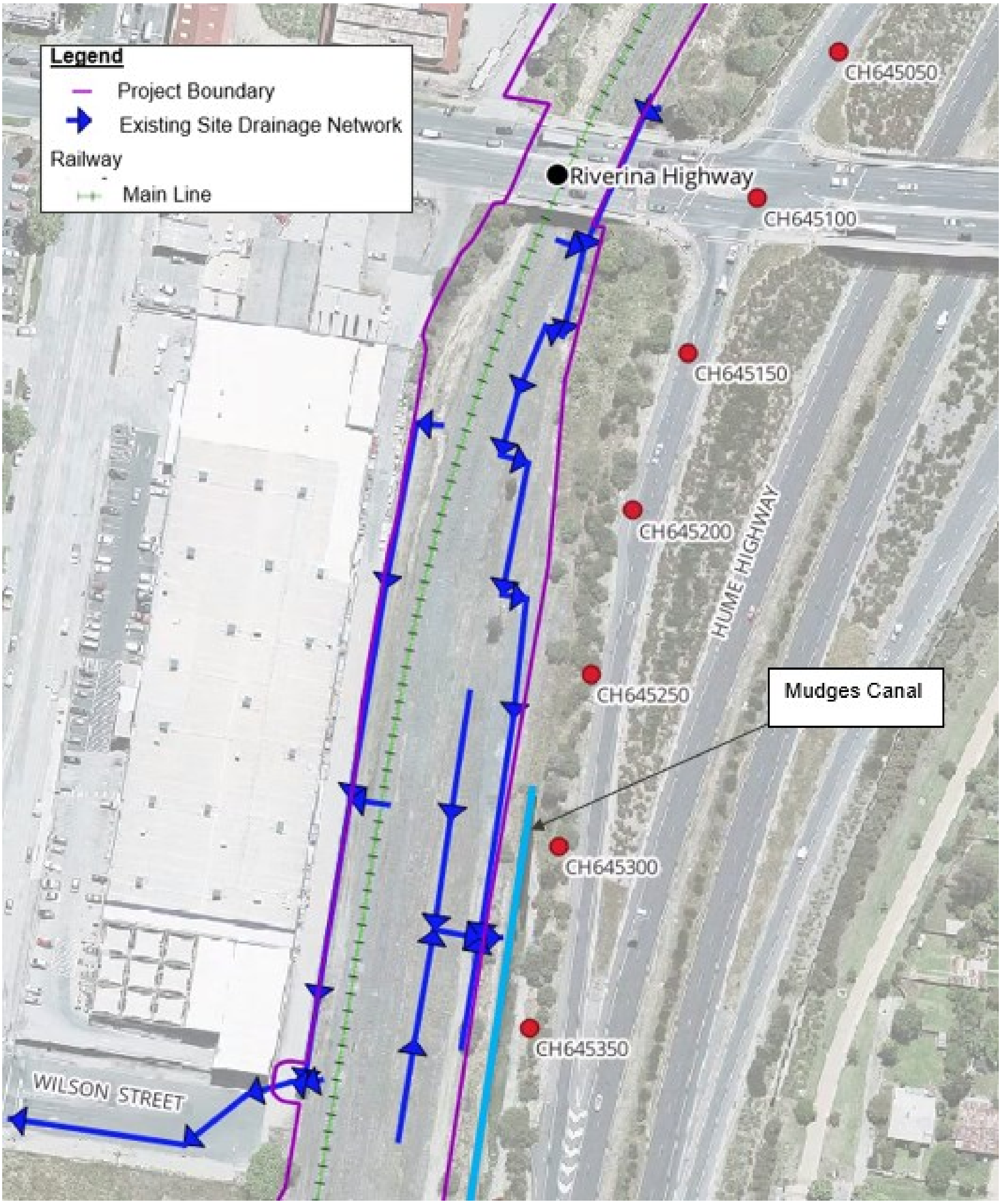


Figure 5-2: Riverina Highway Site Drainage

Table 5-1 summarise the peak flood level results for the existing condition in the study area and points of interest (refer to Figure 5-1 for the location).

**Table 5-1: Peak Flood Levels – Existing Condition**

| Design Events | Flood Levels |
|---|---|
| 10% AEP | The flood waters do not overtop the existing railway tracks. (Refer to Figure A1 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.40 m. |
| 5% AEP | The flood waters do not overtop the existing railway tracks. (Refer to Figure A2 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.55 m. |
| 2% AEP | The flood waters do not overtop the existing railway tracks. (Refer to Figure A3 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.60 m. |
| 1% AEP | The flood waters overtop the top of rail levels between CH645250 - CH645350, generally with a depth of less than 50mm (Refer to Figure A4 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.70 m. |
| 1% AEP + Climate Change | The flood waters overtop at multiple locations over the existing railway tracks south of the Riverina Highway bridge, generally with a depth of less than 200mm. (Refer to Figure A5 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 0.2 - 0.9 m. |
| PMF | The flood waters overtop at multiple locations over the existing railway tracks south to Riverina Highway bridge generally with a depth of less than 2.5 – 4m. (Refer to Figure A6 in Appendix A).<br>The flood depth along the existing rail corridor is generally in a range of about 2 - 3 m. |

**Table 5-2: Points of Interest Data – Peak Flood Levels (mAHD) – Existing Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | Not flooded | 163.15 | 163.16 | 163.31 | 163.49 | 166.20 |
| Point 2 | 162.98 | 162.99 | 162.99 | 163.09 | 163.22 | 165.78 |
| Point 3 | 161.91 | 161.91 | 161.92 | 162.03 | 162.21 | 165.31 |
| Point 4 | 161.36 | 161.37 | 161.38 | 161.56 | 161.77 | 163.76 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | 161.74 | 163.81 |
| Point 6 | 161.08 | 161.11 | 161.14 | 161.43 | 161.59 | 163.73 |
| Point 7 | 161.30 | 161.34 | 161.37 | 161.39 | 161.54 | 163.74 |
| Point 8 | 160.98 | 160.99 | 161.00 | 161.32 | 161.49 | 163.40 |
| Point 9 | Not flooded | Not flooded | Not flooded | 160.89 | 160.95 | 161.78 |

Table 5-3 summarises the Peak flood velocity results and Table 5-4 summarises Peak flood velocity at points of interest for the existing condition in the study area.

**Table 5-3: Peak Flood Velocity – Existing Condition**

| Design Events | Flood Velocity |
|---|---|
| 10% AEP | The peak velocity below the Riverina Highway bridge generally ranges up to 0.4 m/s. (Refer to Figure A7 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 0.4 m/s |

| Design Events | Flood Velocity |
|---|---|
| 5% AEP | The peak velocity below the Riverina Highway bridge generally ranges up to 0.5 m/s. (Refer to Figure A8 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 0.5 m/s |
| 2% AEP | The peak velocity below the Riverina Highway bridge generally ranges up to 0.5 m/s. (Refer to Figure A9 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 0.6 m/s |
| 1% AEP | The peak velocity below the Riverina Highway bridge generally ranges up to 0.8m/s. (Refer to Figure A10 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 0.9 m/s |
| 1% AEP + Climate Change | The peak velocity below the Riverina Highway bridge generally ranges up to 1.0m/s. (Refer to Figure A11 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 1.1 m/s |
| PMF | The peak velocity below the Riverina Highway bridge generally ranges up to 4 m/s. (Refer to Figure A12 in Appendix A).<br>The peak velocity along the rail corridor open channel is generally less than 3 m/s |

**Table 5-4: Points of Interest Data – Peak Flood Velocity (m/s) – Existing Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | Not flooded | 0.1 | 0.1 | 0.5 | 0.7 | 1.5 |
| Point 2 | 0.3 | 0.3 | 0.4 | 0.7 | 0.9 | 2.5 |
| Point 3 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 1.8 |
| Point 4 | 0.4 | 0.4 | 0.4 | 0.7 | 0.8 | 3.8 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | < 0.1 | 4.1 |
| Point 6 | 0.1 | 0.2 | 0.2 | 0.4 | 0.8 | 2.1 |
| Point 7 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 0.1 | 2.2 |
| Point 8 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 2.1 |
| Point 9 | Not flooded | Not flooded | Not flooded | 0.3 | 0.8 | 4.0 |

The flood hazard assessment is based on the general flood hazard classification set by the Australian Institute for Disaster Resilience in Australian Disaster Resilience Handbook Collection - Flood Hazard, 2017. Figure 5-3 and the tables below describe the hazards.

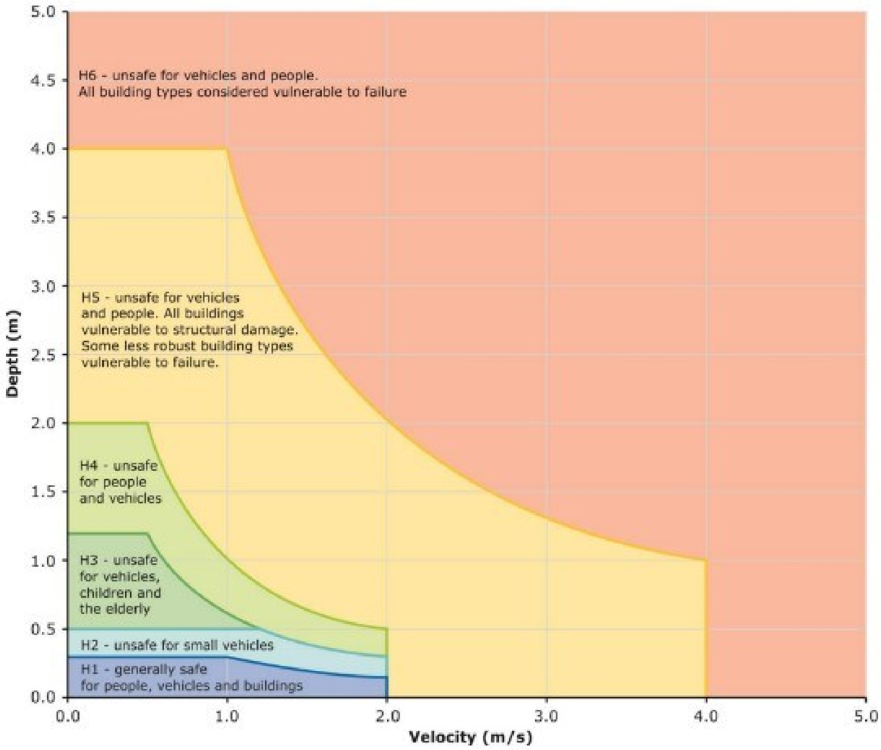


**Figure 5-3: Hazard Category Classification**

Table 5-5 summarises the Peak flood hazard results and Table 5-6 summarises Peak flood hazard at points of interest for existing condition in the study area.

**Table 5-5: Flood Hazard – Existing Condition**

| Design Events | Flood Hazard |
|---|---|
| 10% AEP | The flood hazard along the rail corridor open channel is generally H1. (Refer to Figure A13, Figure A14 and Figure A15 respectively in Appendix A). |
| 5% AEP | |
| 2% AEP | |
| 1% AEP | The flood hazard along the rail corridor open channel is generally H1 and H2. (Refer to Figure A16 in Appendix A). |
| 1% AEP + Climate Change | The flood hazard along the rail corridor open channel is generally less than H3. (Refer to Figure A17 in Appendix A). |
| PMF | The flood hazard along the rail corridor open channel is H6. (Refer to Figure A17 in Appendix A). |

**Table 5-6: Points of Interest Data – Peak Flood Hazard – Existing Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | Not flooded | H1 | H1 | H1 | H2 | H6 |
| Point 2 | H1 | H1 | H1 | H1 | H1 | H6 |
| Point 3 | H1 | H1 | H1 | H1 | H2 | H6 |
| Point 4 | H1 | H1 | H1 | H2 | H3 | H6 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | H1 | H6 |
| Point 6 | H2 | H2 | H2 | H3 | H4 | H6 |
| Point 7 | H1 | H1 | H1 | H1 | H1 | H6 |
| Point 8 | H1 | H1 | H1 | H2 | H3 | H6 |

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 9 | Not flooded | Not flooded | Not flooded | H1 | H1 | H5 |

## 5.2 Design Condition

Design condition flood maps, including peak flood depths and level contours, peak velocities, and flood hazard for the events modelled are provided in Appendix A.

Table 5-7 summarises the peak flood level results for design condition within the study area.

The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert positioned to the north of the site. The raised crest near Point 2 prevents the water from flowing south during small storm events up to the 2% AEP. However, in large storm events from the 1% AEP, the crest is overtopped, and water is flowing south along the overland flow channel (refer to Figure 5-3). The raised crest at point 2 will divert the water back into the Mudges Canal.

Point 1 experiences a greater flood depth under design conditions compared to existing conditions. This is due to the reduction in topographic levels near the Mudges Canal, which forces more water to flow into Point 1. The changes in flood levels at point 1 between the existing and design scenarios will be greater due to alterations in topography, particularly when compared to the upstream areas of the Mudges Canal.

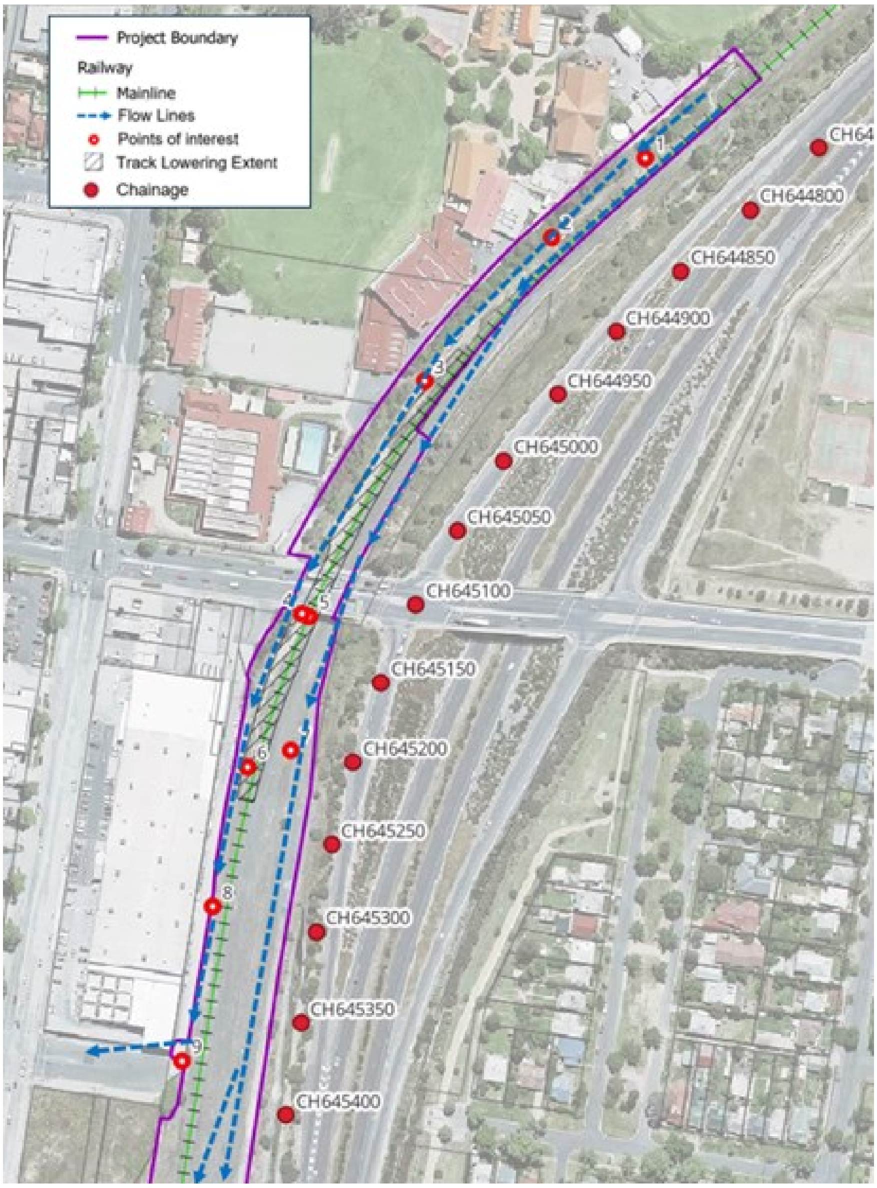


Figure 5-4: Riverina Highway Site Design Scenario Overland Flow Paths for 1% AEP

**Table 5-7: Peak Flood Levels – Design Condition**

| Design Events | Flood Levels |
|---|---|
| 10% AEP | The flood waters do not overtop the proposed railway tracks. (Refer to Figure A19 in Appendix A).<br>The flood depth along the proposed overland flow channel is generally less than 0.09 m. |
| 5% AEP | The flood waters do not overtop the proposed railway tracks. (Refer to Figure A20 in Appendix A).<br>The flood depth along the proposed overland flow channel is generally less than 0.1 m. |
| 2% AEP | The flood waters do not overtop the proposed railway tracks. (Refer to Figure A21 in Appendix A).<br>The flood depth along the proposed overland flow channel is generally less than 0.2 m. |
| 1% AEP | The flood waters do not overtop the proposed railway tracks. (Refer to Figure A22 in Appendix A).<br>The flood depth along the proposed overland flow channel is generally less than 0.5 m. |
| 1% AEP + Climate Change | The flood waters overtop the proposed railway tracks at multiple locations with overtopping depths up to approximately 0.9m. (Refer to Figure A24 in Appendix A).<br>The railway corridor is significantly flooded, with flood depth reaching up to 1.75m. |
| PMF | The flood waters overtop the proposed railway tracks at multiple locations with overtopping depths up to approximately 2.5 to 4m. (Refer to Figure A25 in Appendix A).<br>The railway corridor is significantly flooded, with flood depth reaching up to 4m. |

**Table 5-8: Points of Interest Data – Peak Flood Levels (mAHD) – Design Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | 162.98 | 163.13 | 163.21 | 163.55 | 163.70 | 166.16 |
| Point 2 | Not flooded | Not flooded | Not flooded | 162.50 | 162.68 | 165.59 |
| Point 3 | Not flooded | Not flooded | Not flooded | 162.10 | 162.36 | 165.03 |
| Point 4 | 159.71 | 159.71 | 159.72 | 159.73 | 161.48 | 163.71 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | 161.48 | 163.73 |
| Point 6 | Not flooded | Not flooded | Not flooded | Not flooded | 161.47 | 163.77 |
| Point 7 | Not flooded | 161.27 | 161.28 | 161.32 | 161.47 | 163.77 |
| Point 8 | 161.12 | 161.12 | 161.13 | 161.24 | 161.34 | 163.37 |
| Point 9 | Not flooded | Not flooded | Not flooded | Not flooded | 160.92 | 161.76 |

Table 5-9 summarises the peak flood velocity results for design condition within the study area.

**Table 5-9: Peak Flood Velocity – Design Condition**

| Design Events | Flood Velocity |
|---|---|
| 10% AEP | The flood velocity along the proposed overland flow channel is generally less than 0.15m/s. (Refer to Figure A26 in Appendix A). |
| 5% AEP | The flood velocity along the proposed overland flow channel is generally less than 0.1m/s. (Refer to Figure A27 in Appendix A). |
| 2% AEP | The flood velocity along the proposed overland flow channel is generally less than 0.3 m/s. (Refer to Figure A28 in Appendix A). |
| 1% AEP | The flood velocity along the proposed overland flow channel is generally less than 0.6 m/s. (Refer to Figure A29 in Appendix A). |
| 1% AEP + Climate Change | The flood velocity along the proposed overland flow channel is generally less than 1 m/s. (Refer to Figure A31 in Appendix A). |

| Design Events | Flood Velocity |
|---|---|
| PMF | The flood velocity along the proposed overland flow channel is generally less than 4 m/s. (Refer to Figure A32 in Appendix A). |

**Table 5-10: Points of Interest Data – Peak Flood Velocity (m/s) – Design Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 1.6 |
| Point 2 | Not flooded | Not flooded | Not flooded | 0.6 | 1.0 | 2.7 |
| Point 3 | Not flooded | Not flooded | Not flooded | 0.7 | 0.8 | 2.1 |
| Point 4 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 0.9 | 3.8 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | 0.3 | 3.9 |
| Point 6 | Not flooded | Not flooded | Not flooded | Not flooded | 0.2 | 2.1 |
| Point 7 | Not flooded | 0.0 | 0.1 | 0.1 | 0.1 | 2.1 |
| Point 8 | 0.1 | 0.1 | 0.1 | 0.5 | 0.6 | 2.2 |
| Point 9 | Not flooded | Not flooded | Not flooded | Not flooded | 0.6 | 4.2 |

The flood hazard for the design condition at the Riverina Highway bridge study area is presented in Table 5-11 and the maps are presented in Appendix A.

**Table 5-11: Flood Hazard – Design Condition**

| Design Events | Flood Hazard |
|---|---|
| 10% AEP<br>5% AEP<br>2% AEP | ▪ The flood hazard along the rail corridor open channel is generally H1. (Refer to Figures A33, A34 and A35 in Appendix A). |
| 1% AEP | ▪ The flood hazard along the rail corridor open channel is generally H1 and H2. (Refer to Figure A36 in Appendix A). |
| 1% AEP + Climate Change | ▪ The flood hazard along the rail corridor open channel is generally less than H4. (Refer to Figure A38 in Appendix A). |
| PMF | ▪ The flood hazard along the rail corridor open channel is generally less than H6. (Refer to Figure A39 in Appendix A). |

**Table 5-12: Points of Interest Data – Peak Flood Hazard – Design Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 1 | H3 | H3 | H3 | H3 | H4 | H6 |
| Point 2 | Not flooded | Not flooded | Not flooded | H1 | H2 | H6 |
| Point 3 | Not flooded | Not flooded | Not flooded | H1 | H2 | H6 |
| Point 4 | H1 | H1 | H1 | H1 | H4 | H6 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded | H3 | H6 |

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 1% AEP + Climate Change | PMF |
|---|---|---|---|---|---|---|
| Point 6 | Not flooded | Not flooded | Not flooded | Not flooded | H3 | H6 |
| Point 7 | Not flooded | H1 | H1 | H1 | H1 | H6 |
| Point 8 | H1 | H1 | H1 | H1 | H1 | H6 |
| Point 9 | Not flooded | Not flooded | Not flooded | Not flooded | H1 | H6 |

In the design condition, track flood immunity is up to the 1% AEP. The design condition velocities are generally less than 1m/s and with low hazard values.

## 5.3 Flood Immunity and Scour Protection

During the existing scenario, the top of rail is overtopped in 1% AEP. However, the flood immunity is improved in design scenario where the top of rail is not overtopped at 1% AEP. Immunity improvement is attributed to the introduction of the 2 proposed channels and the crest in the western proposed channel. Scour protection is applied on the ends of the proposed channels. The channels are also grass lined with jute-mesh which provides local scour protection to the channel (refer to Drainage Design at Section 4.5 on Riverina Highway Bridge Report (5-0052-210-PEN-B4-RP-0001)). The proposed design results in an improvement of the immunity of the rail in terms of overtopping, which complies with the criteria in PSRs and CoA.

**Table 5-13: Comparison of Flood Immunity at Overtopping Locations**

| Overtopping Location | Existing Condition Overtopping AEP | Design Condition Overtopping AEP |
|---|---|---|
| Ch645.275 | 1% AEP event | 1% AEP event with climate change |
| Ch645.125 | 1% AEP event with climate change | 1% AEP event with climate change |

An assessment of the flood immunity at the noted locations of overtopping along the rail is seen in Table 5-14 and Table 5-15 for CH645275 and CH645125 where overtopping of the rail occurs.

**Table 5-14: Overtopping Details at CH645275**

| Chainage | Top of the Rail Level (mAHD) | | Top of the Formation Level (mAHD) | | 1% AEP Flood Level (mAHD) | | 1% AEP with climate change Flood Level (mAHD) | |
|---|---|---|---|---|---|---|---|---|
| | Existing | Design | Existing | Design | Existing | Design | Existing | Design |
| **CH645275** | 161.30 | 161.33 | 160.63* | 160.66* | 161.34 | 161.07 | 161.50 | 161.44 |

*Note that the existing top of the formation level has been assumed to be 667mm below the existing top of the rail level

**Table 5-15: Overtopping Details at CH645125**

| Chainage | Top of the Rail Level (mAHD) | | Top of the Formation Level (mAHD) | | 1% AEP Flood Level (mAHD) | | 1% AEP with climate change Flood Level (mAHD) | |
|---|---|---|---|---|---|---|---|---|
| | Existing | Design | Existing | Design | Existing | Design | Existing | Design |
| **CH645125** | 161.76 | 160.65 | 161.10** | 159.98** | 161.57 | 159.73 | 161.74 | 161.48 |

**Note that the existing top of the formation level has been assumed to be 667mm below the existing top of the rail level

Furthermore, in the design condition, the flood velocity along the proposed road design outside the project boundary complied with the CoA Scour/Erosion potential criteria (less than 10% increase or less than 0.5m/s changes in velocity) (refer to Clause E42 (h) in Table 2-2) up to the 1% AEP storm event. Hence, there is no need for scour protection measures outside the project boundary.

## 5.4 Flood Impact Assessment

The flood level generally decreases within the project boundary from CH644750 to CH645450 due to the lowered track. An increase in flood depths generally within 100 – 250 mm during the 1% AEP event occurs within the project boundary spanning from CH644900 to CH645050 due to a raised crest. Mudges Canal experiences additional afflux due to the proposed pump outflow and raised crest, but the afflux is well confined within the channel.

Water is discharged from the site at 2 locations, which include an overland flow path towards Wilson St, and a pumped discharge to Mudges Canal. Overland flows to Wilson St maintain the existing flow pattern with no adverse impacts. The flow regime is maintained as per the existing condition (Refer to Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001). Pumped discharge to Mudges Canal is minimal relative to the available capacity with less than 20mm afflux within the canal during the 1% AEP event.

The proposed design is compliant with PSR Annexure B items IR-SR-A2I-459 (no worse than existing), IR-SR-A2I-464 (no adverse impacts), IR-SR-A2I-465 (maintain existing/natural flow paths). Additionally, consultation with the Council has been undertaken at each design stage, and no objections have been raised to date with the proposed design.

### 5.4.1 Changes in Peak Flood Level

Table 5-16 details the changes in peak flood levels that occur and are associated with the proposed works.

**Table 5-16: Flood Level Impact Assessment**

| Design Events | Changes in Peak Flood Levels |
|---|---|
| 10% AEP | The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A40 in Appendix A)<br>The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use.<br>Less than 25 mm of afflux within the Mudges Canal. |
| 5% AEP | The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A41 in Appendix A)<br>The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use.<br>Less than 25 mm of afflux within the Mudges Canal. |
| 2% AEP | The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A42 in Appendix A)<br>The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use.<br>Less than 30 mm of afflux within the Mudges Canal. |
| 1% AEP | The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A43 in Appendix A)<br>The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use.<br>Changes in water levels less than 200m occur outside the project boundary within the railway corridor due to overflowing water from the Mudes canal at CH644800. Although it is outside the boundary, it is classified as ARTC land. Therefore, this afflux is deemed compliant.<br>Less than 25 mm of afflux within the Mudges Canal. |

The changes in flood level outside the project boundary comply with the PSR and CoA clause E42 (b), (c), (d), (e) & (f) project requirements.

**Table 5-17: Points of Interest Data – Changes in Peak Flood Level (m) – Design Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP |
|---|---|---|---|---|
| Point 1 | 0.51 (Newly inundated) | -0.02 | 0.05 | 0.24 |
| Point 2 | No more inundated | No more inundated | No more inundated | -0.59 |
| Point 3 | No more inundated | No more inundated | No more inundated | 0.07 |
| Point 4 | -1.65 | -1.66 | -1.66 | -1.82 |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded |

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP |
|---|---|---|---|---|
| Point 6 | No more inundated | No more inundated | No more inundated | No more inundated |
| Point 7 | No more inundated | -0.08 | -0.09 | -0.07 |
| Point 8 | 0.14 | 0.14 | 0.12 | -0.08 |
| Point 9 | Not flooded | Not flooded | Not flooded | No more inundated |

### 5.4.2 Changes in Peak Flood Velocity

Table 5-18 provides details of changes in peak flood velocity for the design condition.

**Table 5-18: Flood Velocity Impact Assessment**

| Design Events | Changes in Peak Flood Velocity |
|---|---|
| 10% AEP | The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A46 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s. |
| 5% AEP | The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A47 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s. |
| 2% AEP | The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A48 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s. |
| 1% AEP | The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A49 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s. |

Points 1 to 9 experience less than 0.5m/s of velocity increase for events 10% AEP, 5% AEP, 2% AEP and 1% AEP. The changes in flood velocity outside the project boundary comply with the PSR and CoA clause E42 (h) project requirements.

### 5.4.3 Changes in Flood Hazard

Table 5-19 details the changes in peak flood hazard for the design scenario.

**Table 5-19: Flood Hazard Impact Assessment**

| Design Events | Changes in Peak Flood Hazard |
|---|---|
| 10% AEP | There is no increase in hazard outside the project boundary. (Refer to Figure A51 in Appendix A). |
| 5% AEP | Generally, no increase in hazard outside the project boundary. (Refer to Figure A52 in Appendix A). The newly inundated area to the south of Wilson Street at CH645450 experiences H1 Hazard which is generally safe for people, vehicles and buildings. |
| 2% AEP | Generally, no increase in hazard outside the project boundary. (Refer to Figure A53 in Appendix A). The newly inundated area to the south of Wilson Street at CH645450 experiences H1 Hazard which is generally safe for people, vehicles and buildings. |
| 1% AEP | Generally, no increase in hazard outside the project boundary. (Refer to Figure A54 in Appendix A). |

Changed in hazard for the points of interest is provided in Table 5-20.

**Table 5-20: Points of Interest Data – Changes in Hazard (m) – Design Condition**

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP |
|---|---|---|---|---|
| Point 1 | Increased 3 Classes (Newly inundated) | Increased 2 Classes | Increased 2 Classes | Increased 2 Classes |
| Point 2 | No more inundated | No more inundated | No more inundated | No change in hazard |
| Point 3 | No more inundated | No more inundated | No more inundated | No change in hazard |
| Point 4 | No change in hazard | No change in hazard | No change in hazard | Reduced 1 Class |
| Point 5 | Not flooded | Not flooded | Not flooded | Not flooded |
| Point 6 | No more inundated | No more inundated | No more inundated | No more inundated |

| Locations | 10% AEP | 5% AEP | 2% AEP | 1% AEP |
|---|---|---|---|---|
| Point 7 | No more inundated | No change in hazard | No change in hazard | No change in hazard |
| Point 8 | No change in hazard | No change in hazard | No change in hazard | Reduced 1 Class |
| Point 9 | Not flooded | Not flooded | Not flooded | No more inundated |

The changes in flood hazard outside the project boundary comply with the PSR and CoA clause E42 (g) project requirements.

### 5.4.4 Changes in Duration of Inundation

The analysis around the changes in the duration of inundation was undertaken by comparing the existing and design flood level vs time in selected locations. The locations adopted for the comparison are shown in the Figure below.


**Figure 5-5: Reporting Location 1 and 2 for the Changes in Duration of Inundation, noting that the flood water flow direction is perpendicular to Location 1**

Figure 5-6 and Figure 5-7 shows the comparison of flood level vs time for Reporting Locations 1 and 2. Both the existing and design flood level vs time are mostly similar for Location 1 and 2. These demonstrate that the design will not create an extra duration of inundation upstream and downstream outside the project boundary. Consequently, the changes in the duration of inundation comply with the CoA E42(a).

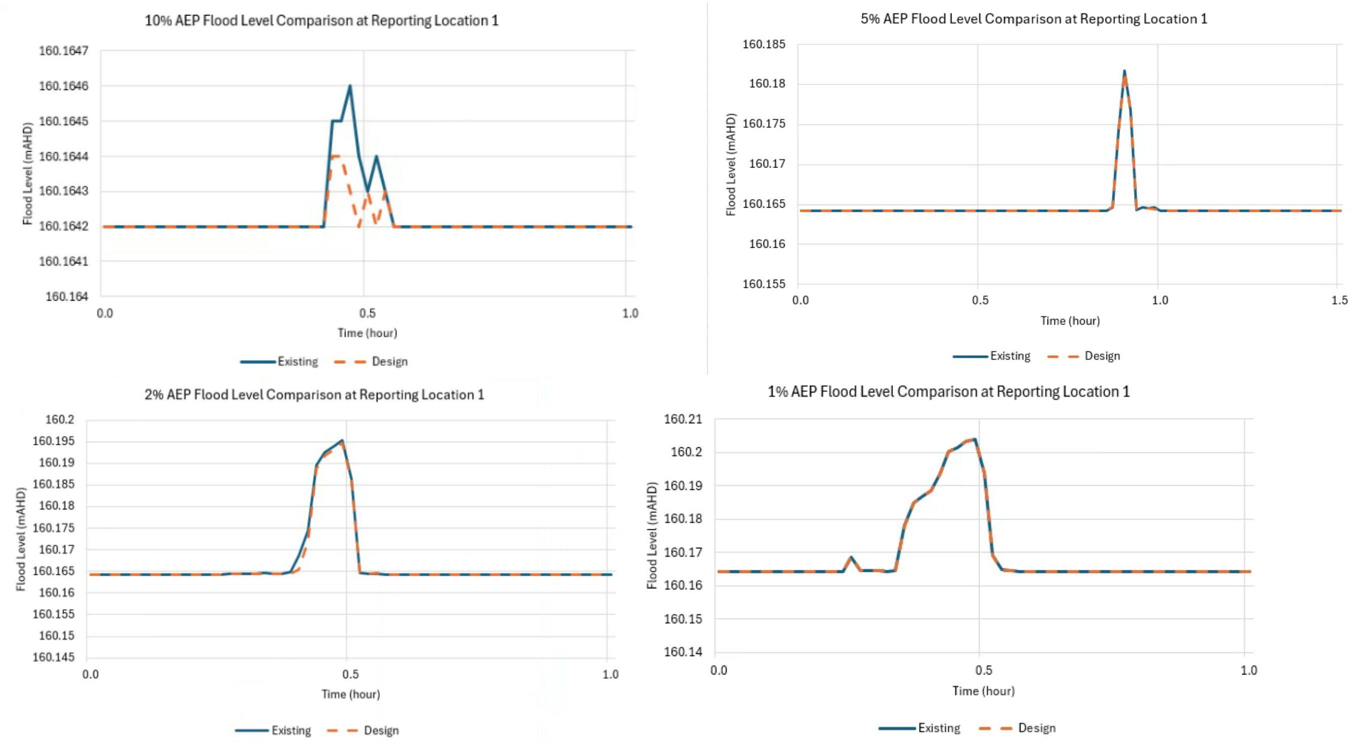


Figure 5-6: Comparison of Flood Level vs. Time at Reporting Location 1

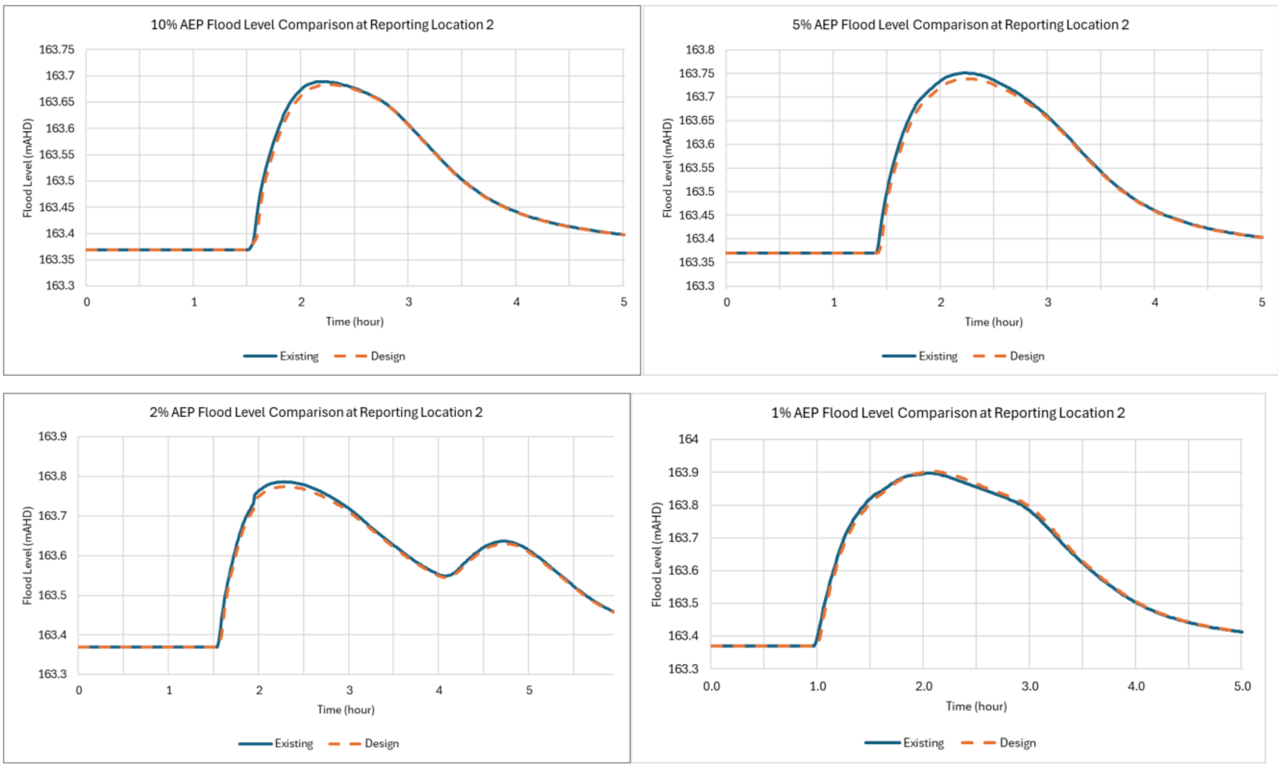


**Figure 5-7: Comparison of Flood Level vs. Time at Reporting Location 2**

## 5.5 Sensitivity Test

### 5.5.1 Blockage Assessment

A hydraulic blockage assessment was carried out for the 1% AEP design scenario as per the guidance set out in ARR2019. The assessment involved assessing the site area for debris availability, mobility and transportability and this, in conjunction with culvert size was used to determine the relevant blockage factors shown in Table 5-21 and Table 5-22. 25% blockage was adopted for all pipes within the site and 20% blockage was adopted for all the other culverts, pits and pipes outside the project boundary (Refer to Figure 5-8).

The above methodology was adopted by considering the following:

- ARR2019 does not require blockage assessments in all design runs. ARR Book 6 Sections 6.4.3 and 6.4.5 allow for an "All Clear" condition when there is no long-term history of blockage at a particular structure. There is no reporting of long-term historical blockage around the site to cause major flooding risk. Therefore, only 1% AEP design was run as a sensitivity test.
- The approach matches the Environmental Impact Statement (EIS) report as per CoA Condition E40, ensuring consistency and reliability.
- For detailed information, refer to the memo 5-0052-210-IHY-99-ME-0001

A flood level comparison between the blockage design scenario and the design is shown in Figure 5-8. The overall flood behaviour at the site is influenced by the blockage of the Mudges Canal box culvert (SA12335), which results in a change in water level of up to 0.17m in the western overland channel. This causes flood water to overflow the channel bund and flow into the railway corridor channel. Nevertheless, the mainline railway track remains unaffected by overtopping. But the loop line is overtopped by additional water entering the site from the Mudges Canal. The north-eastern part of the site experiences an increase in water level of approximately 0.1m, while the south-eastern part sees an increase of less than 0.03m. Far south of the site is not significantly influenced by the blockage, where the change in water level is within +-10mm.

**Table 5-21: Culvert Blockage Percentage**

| Culvert | Blockage Percentage (1%AEP) | Comments |
|---|---|---|
| SA12335 (3 cell 1.2m (W) x 0.9m (H)) | 25% | Inside the project boundary |
| B4-E1-01 to B4-E1-02 (1 cell 0.3m in diameter) | 25% | Inside the project boundary |
| B4-E2-01 to B4-E1-02 (1 cell 0.3m in diameter) | 25% | Inside the project boundary |
| All other pipes (Stormwater pipes) | 25% | Inside the project boundary |
| All other pits | 20% (on grade pit), 50% (Sag pits) | Inside the project boundary |
| All others (culvert, pit and pipe) | 20% | Outside of the project boundary |

**Table 5-22: Culvert Blockage Parameters**

| Culvert | Debris Availability | Debris Mobility | Debris Transportability | AEP Adjusted Debris Potential |
|---|---|---|---|---|
| SA12335 | Low | Medium | Medium | Low |
| B4-E1-01 to B4-E1-02 | Low | Medium | Medium | Low |
| B4-E2-01 to B4-E1-02 | Low | Medium | Medium | Low |

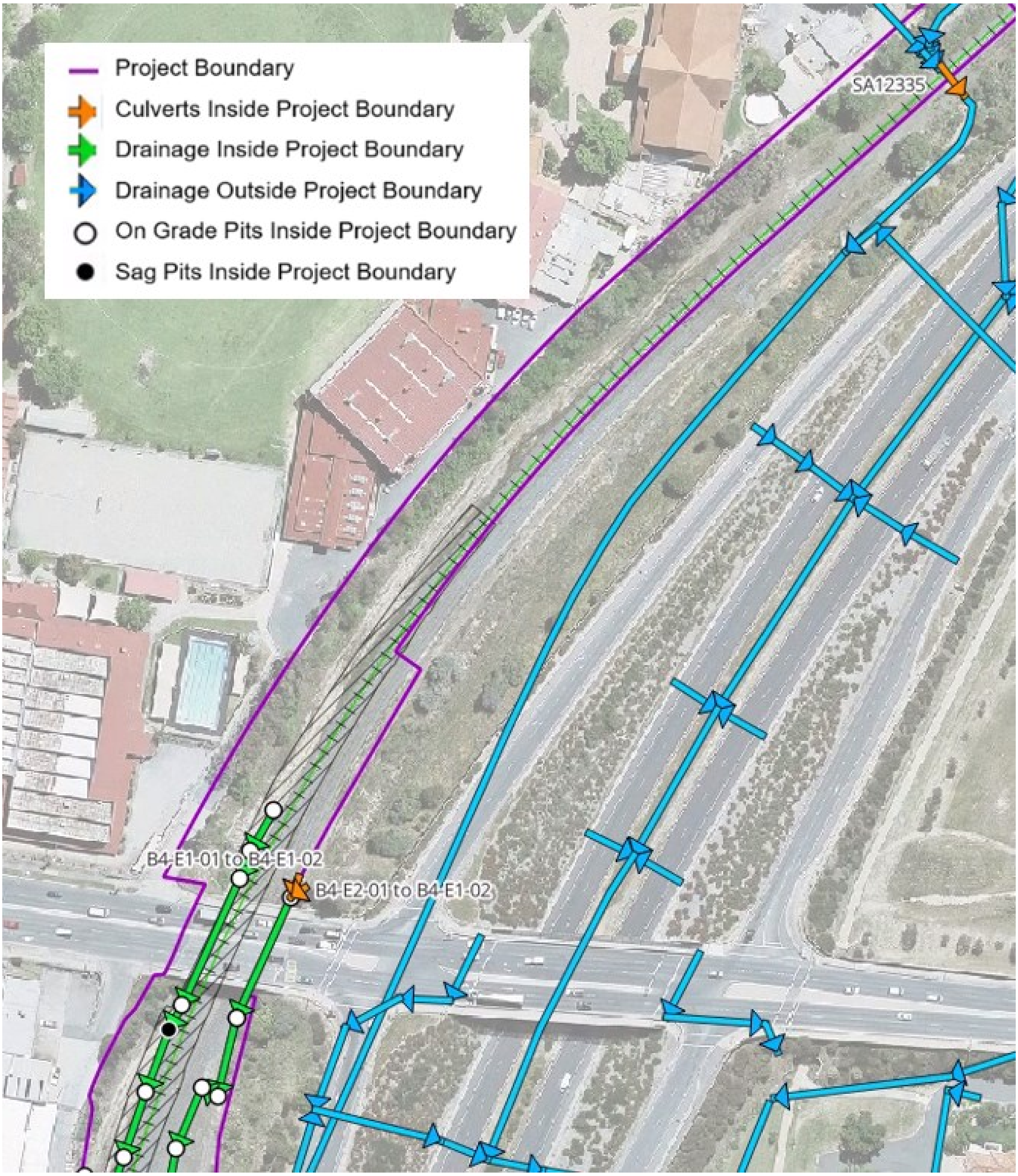


**Figure 5-8: Culverts at Riverina Highway Bridge Site**

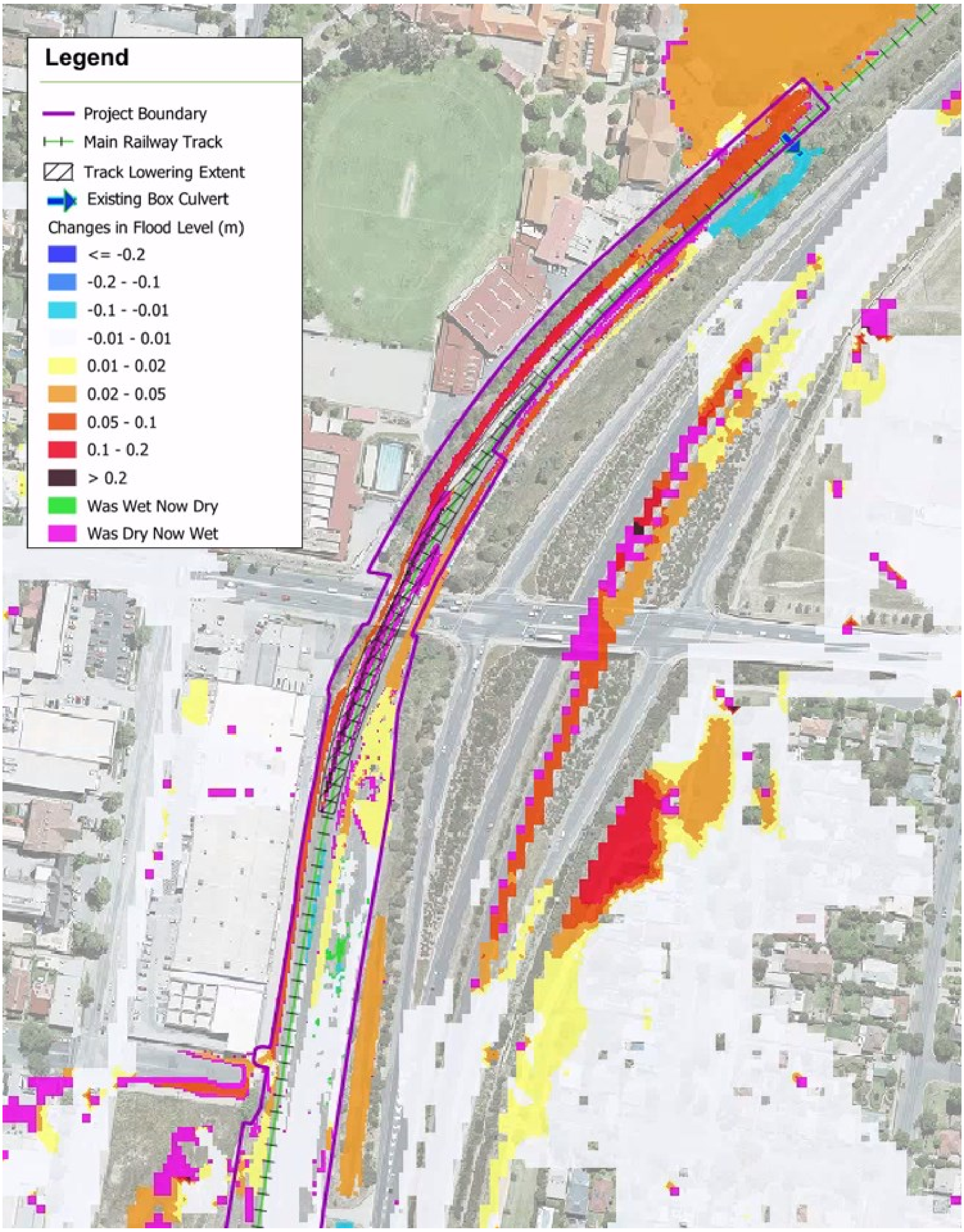


**Figure 5-9: Flood Level Comparison for 1% AEP Design Condition – Blockage vs Design**

### 5.5.2 Climate Change Risk Assessment

As discussed in Section 4.2.2, climate change risk assessment was carried out by running the 1% AEP design event with the use of the Year 2090 RCP8.5 interim climate change factor and the associated 20.2% increase in rainfall (refer to Section 4.2.2 for details of the approach and section 5.1 and 5.2 for the results). Flood depth, flood velocity and flood hazard and corresponding flood maps can be found in Appendix A. The assessment is summarised below:

- Within the study area, both the existing railway track and lowered railway track cannot achieve flood immunity in climate change condition.
- Within the study area, the flood velocity in climate change condition increased by generally 0.3 m/s compared with 1% AEP.
- The site experiences up to the H4 flood hazard were classified as a significant hazard in climate change condition.

# 6 MITIGATION MEASURES

No other instances of non-compliance in terms of flood impact were documented. Therefore, no additional mitigation measures are necessary unless the design changes.

# 7 RECOMMENDATIONS AND NEXT STAGE

This is the final IFC stage of the report, and the following are finalised:

- No instances of non-compliance have been identified through the assessment.
- All comments raised by relevant parties have been resolved (refer to Appendices D, E and F)

Consequently, there are no further recommendations.

# APPENDICES

# APPENDIX A

## Flood Maps

Table A- 1: List of Maps in Appendix A

| Map ID | Map description |
|---|---|
| Figure A01 | 10% AEP Peak Flood Depth and Levels - Existing Condition |
| Figure A02 | 5% AEP Peak Flood Depth and Levels - Existing Condition |
| Figure A03 | 2% AEP Peak Flood Depth and Levels - Existing Condition |
| Figure A04 | 1% AEP Peak Flood Depth and Levels - Existing Condition |
| Figure A05 | 1% AEP Climate Change Peak Flood Depth and Levels - Existing Condition |
| Figure A06 | PMF Peak Flood Depth and Levels - Existing Condition |
| Figure A07 | 10% AEP Peak Flood Velocity - Existing Condition |
| Figure A08 | 5% AEP Peak Flood Velocity - Existing Condition |
| Figure A09 | 2% AEP Peak Flood Velocity - Existing Condition |
| Figure A10 | 1% AEP Peak Flood Velocity - Existing Condition |
| Figure A11 | 1% AEP Climate Change Peak Flood Velocity - Existing Condition |
| Figure A12 | PMF Peak Flood Velocity - Existing Condition |
| Figure A13 | 10% AEP Peak Flood Hazard - Existing Condition |
| Figure A14 | 5% AEP Peak Flood Hazard - Existing Condition |
| Figure A15 | 2% AEP Peak Flood Hazard - Existing Condition |
| Figure A16 | 1% AEP Peak Flood Hazard - Existing Condition |
| Figure A17 | 1% AEP Climate Change Peak Flood Hazard - Existing Condition |
| Figure A18 | PMF Peak Flood Hazard - Existing Condition |
| Figure A19 | 10% AEP Peak Flood Depth and Levels - Design Condition |
| Figure A20 | 5% AEP Peak Flood Depth and Levels - Design Condition |
| Figure A21 | 2% AEP Peak Flood Depth and Levels - Design Condition |
| Figure A22 | 1% AEP Peak Flood Depth and Levels - Design Condition |
| Figure A23 | 1% AEP Peak Flood Depth and Levels - Design Blockage Condition |
| Figure A24 | 1% AEP Climate Change Peak Flood Depth and Levels - Design Condition |
| Figure A25 | PMF Peak Flood Depth and Levels - Design Condition |
| Figure A26 | 10% AEP Peak Flood Velocity - Design Condition |
| Figure A27 | 5% AEP Peak Flood Velocity - Design Condition |
| Figure A28 | 2% AEP Peak Flood Velocity - Design Condition |
| Figure A29 | 1% AEP Peak Flood Velocity - Design Condition |
| Figure A30 | 1% AEP Peak Flood Velocity - Design Blockage Condition |
| Figure A31 | 1% AEP Climate Change Peak Flood Velocity - Design Condition |
| Figure A32 | PMF Peak Flood Velocity - Design Condition |
| Figure A33 | 10% AEP Peak Flood Hazard - Design Condition |
| Figure A34 | 5% AEP Peak Flood Hazard - Design Condition |
| Figure A35 | 2% AEP Peak Flood Hazard - Design Condition |
| Figure A36 | 1% AEP Peak Flood Hazard - Design Condition |
| Figure A37 | 1% AEP Peak Flood Hazard - Design Blockage Condition |
| Figure A38 | 1% AEP Climate Change Peak Flood Hazard - Design Condition |
| Figure A39 | PMF Peak Flood Hazard - Design Condition |

| Map ID | Map description |
|---|---|
| Figure A40 | Changes in Peak Flood Levels for 10% AEP - Design Condition vs Existing Condition |
| Figure A41 | Changes in Peak Flood Levels for 5% AEP - Design Condition vs Existing Condition |
| Figure A42 | Changes in Peak Flood Levels for 2% AEP - Design Condition vs Existing Condition |
| Figure A43 | Changes in Peak Flood Levels for 1% AEP - Design Condition vs Existing Condition |
| Figure A44 | Changes in Peak Flood Levels for 1% AEP Climate Change - Design Condition vs Existing |
| Figure A45 | Changes in Peak Flood Velocity for 10% AEP - Design Condition vs Existing Condition |
| Figure A46 | Changes in Peak Flood Velocity for 5% AEP - Design Condition vs Existing Condition |
| Figure A47 | Changes in Peak Flood Velocity for 2% AEP - Design Condition vs Existing Condition |
| Figure A48 | Changes in Peak Flood Velocity for 1% AEP - Design Condition vs Existing Condition |
| Figure A49 | Changes in Peak Flood Velocity for 1% AEP Climate Change - Design Condition vs Existing |
| Figure A50 | Changes in Peak Flood Hazard for 10% AEP - Design Condition vs Existing Condition |
| Figure A51 | Changes in Peak Flood Hazard for 5% AEP - Design Condition vs Existing Condition |
| Figure A52 | Changes in Peak Flood Hazard for 2% AEP - Design Condition vs Existing Condition |
| Figure A53 | Changes in Peak Flood Hazard for 1% AEP - Design Condition vs Existing Condition |
| Figure A54 | Changes in Peak Flood Hazard for 1% AEP Climate Change - Design Condition vs Existing |

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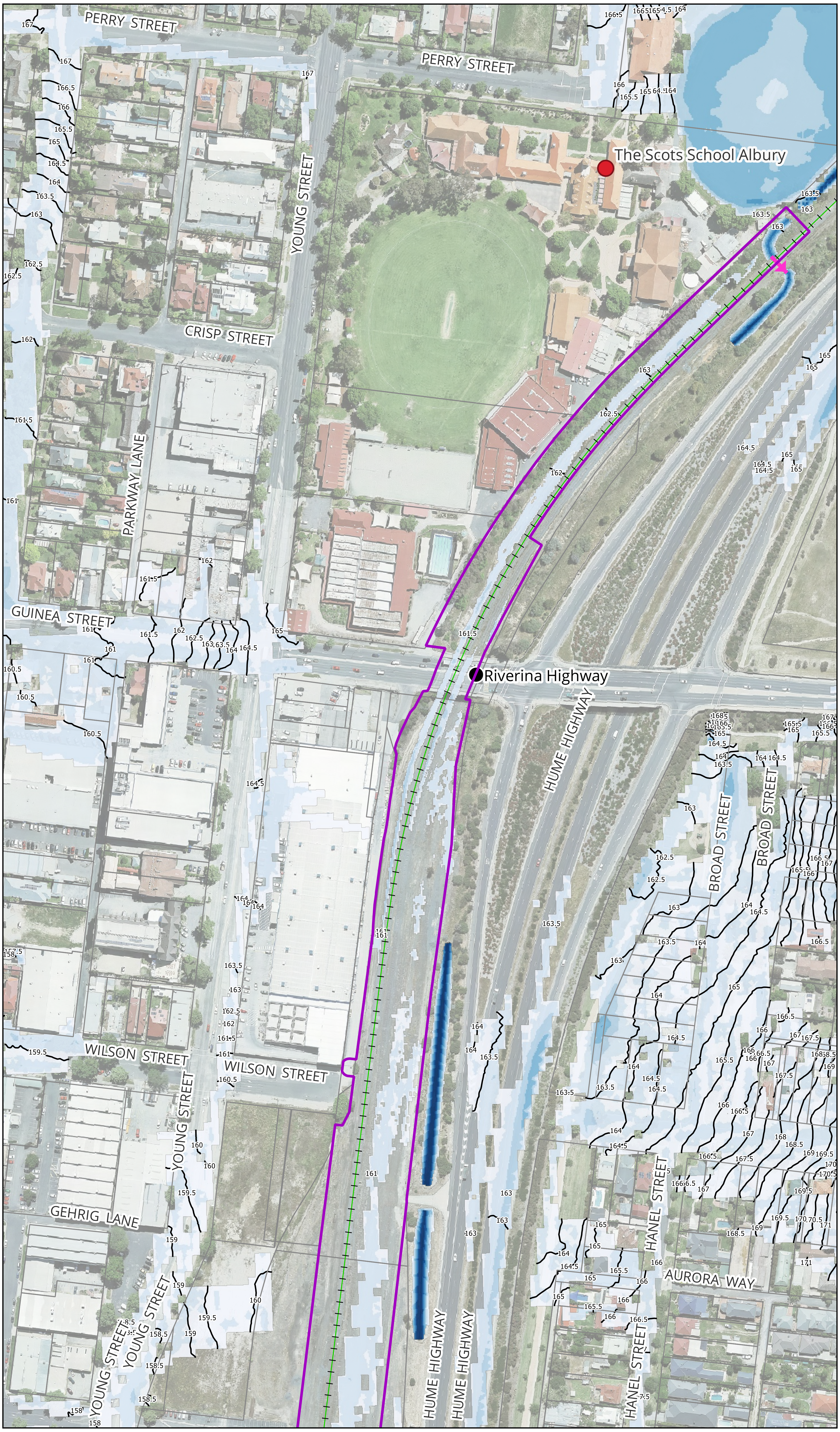
## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2




Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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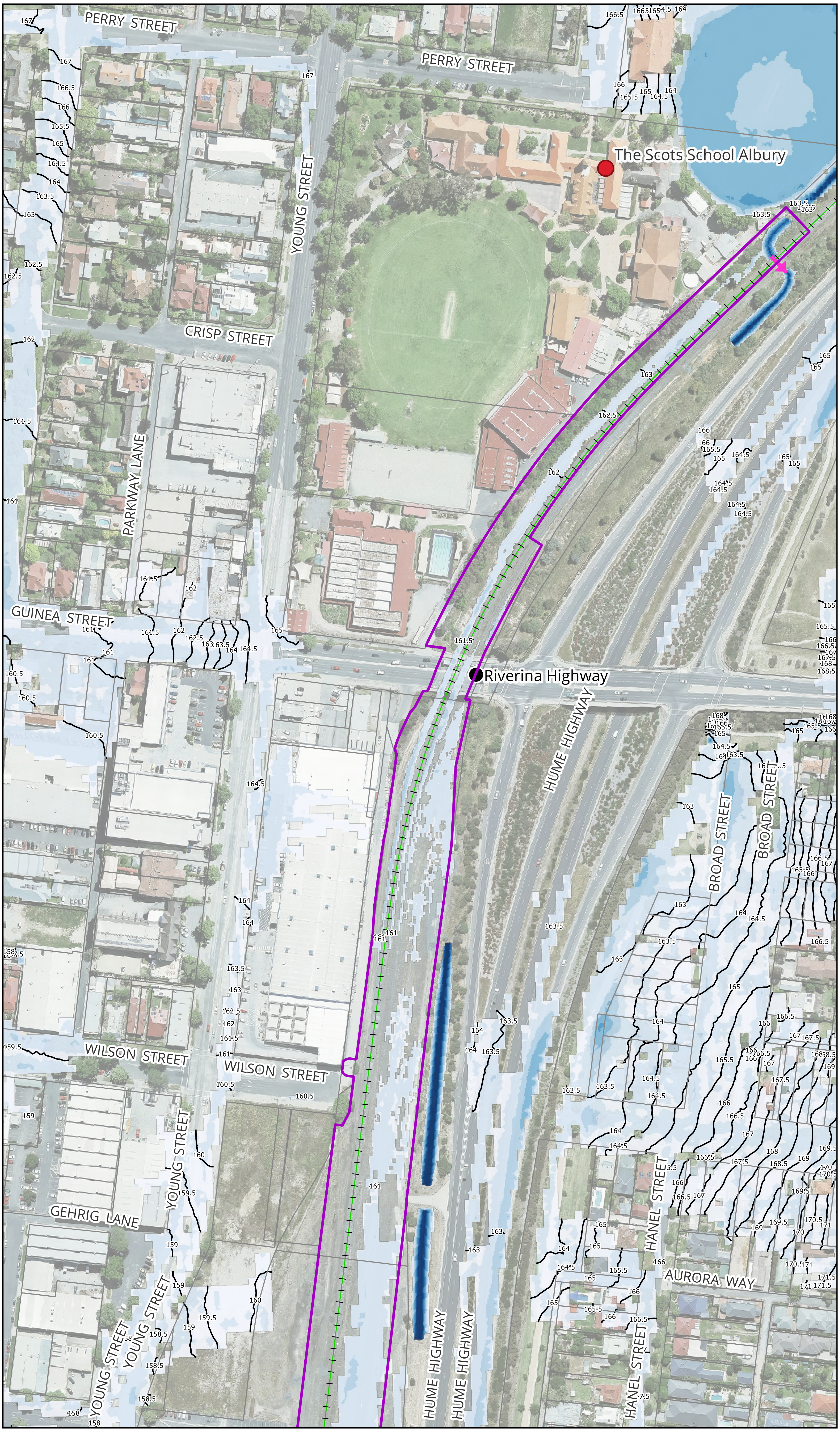
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A01: 10% AEP Peak Flood Depth and Levels - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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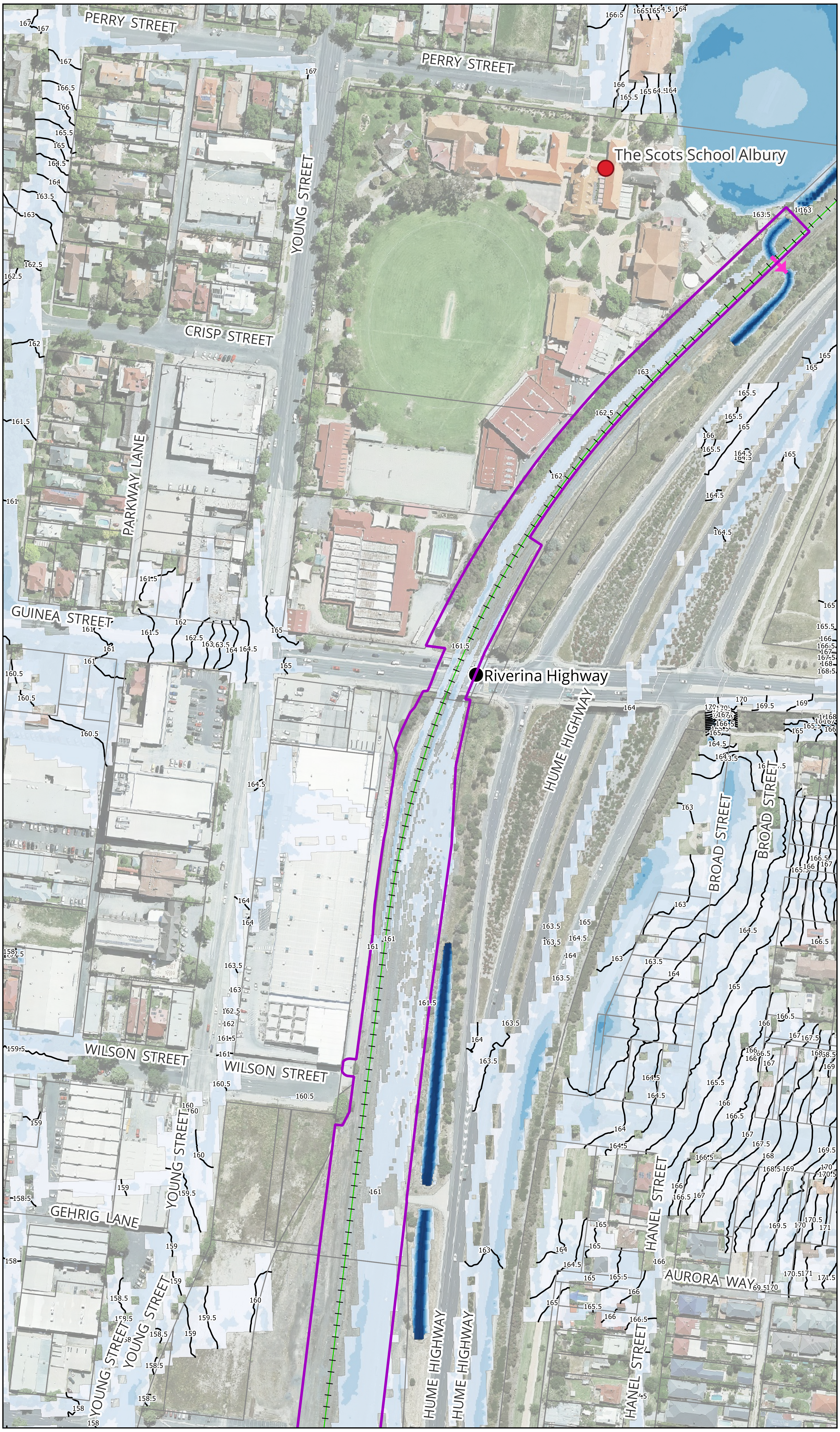
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A02: 5% AEP Peak Flood Depth and Levels - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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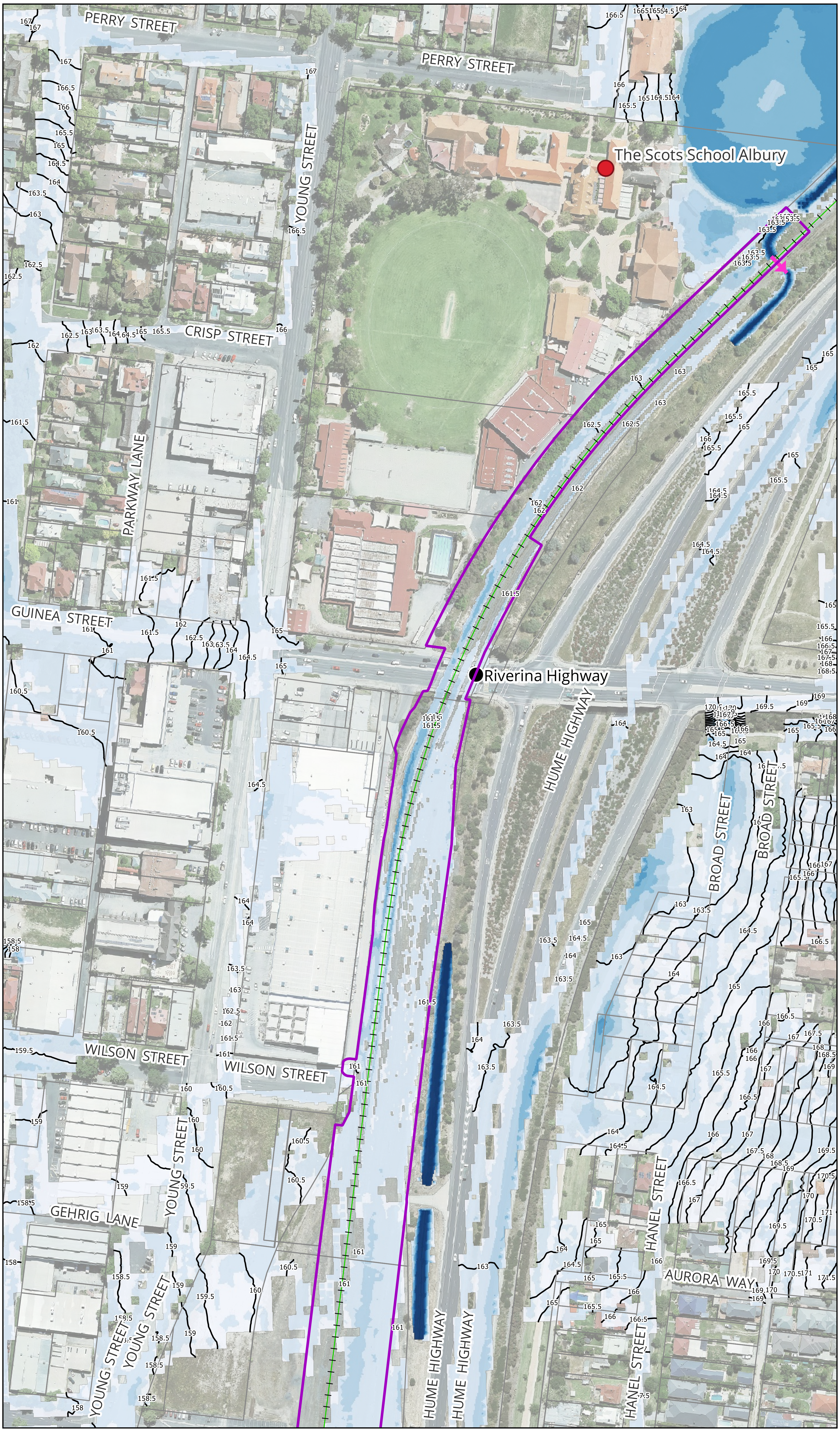
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A03: 2% AEP Peak Flood Depth and Levels - Existing Condition**




## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A04: 1% AEP Peak Flood Depth and Levels - Existing Condition**

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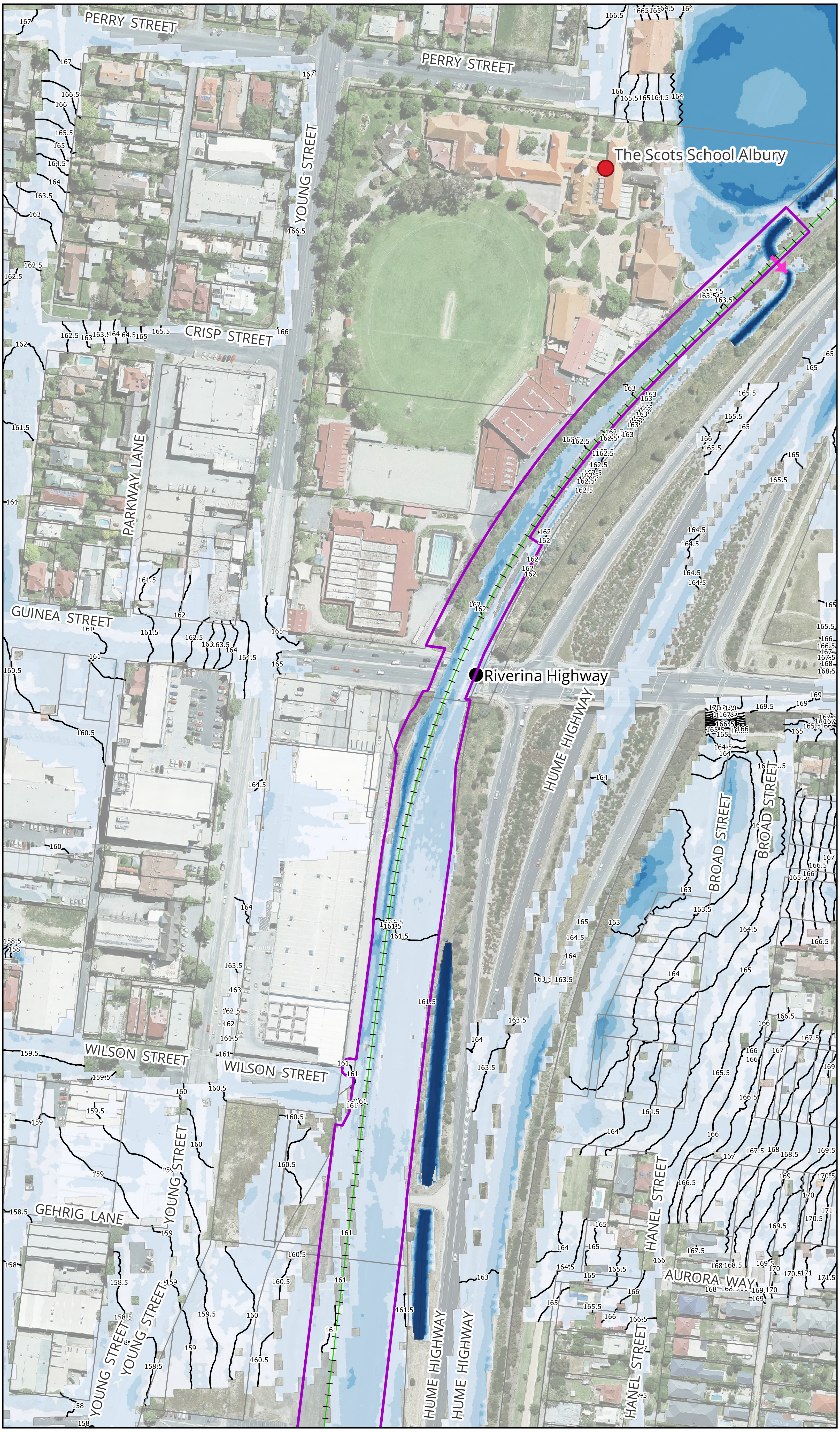


## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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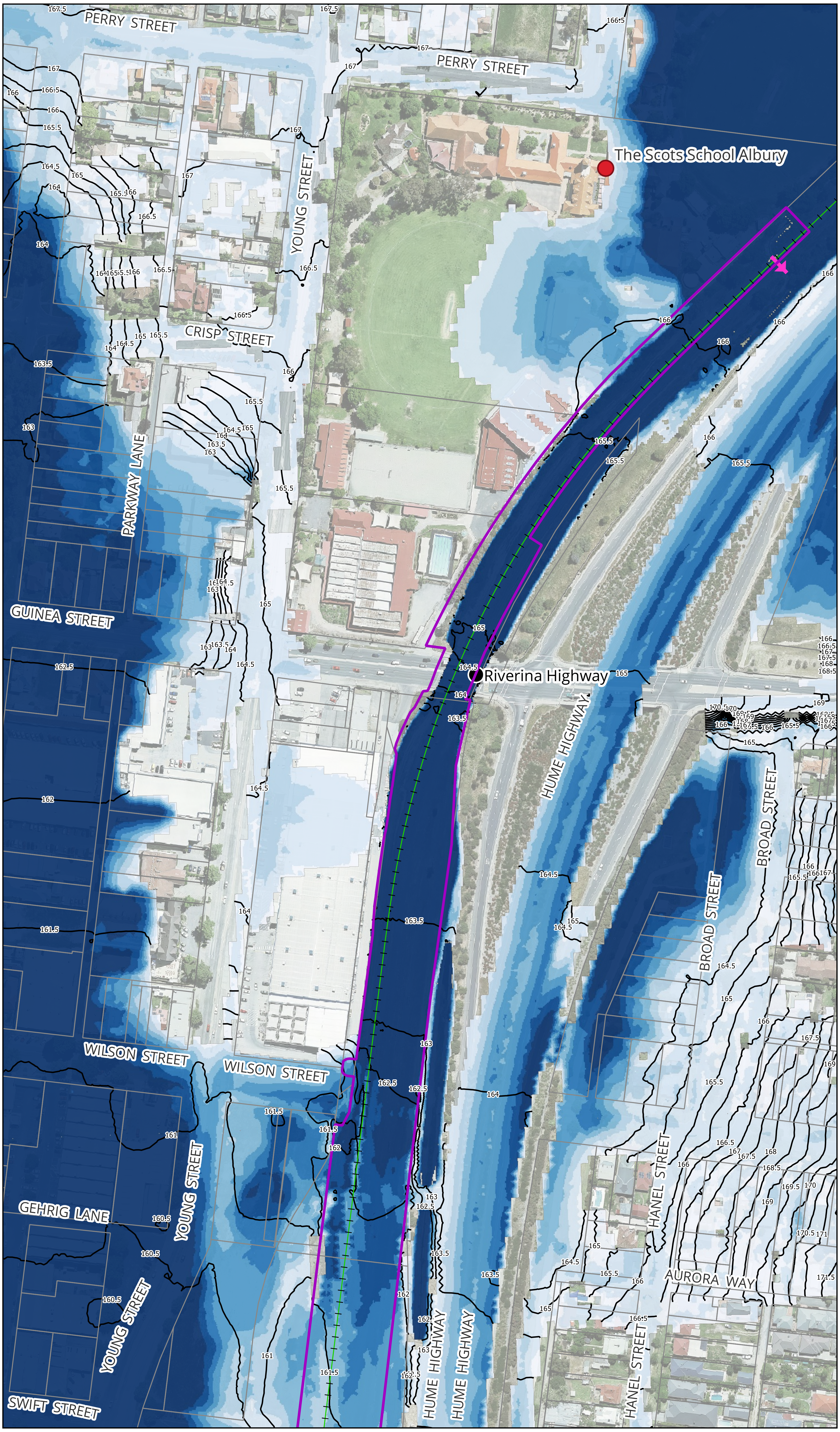
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A05: 1% AEP Climate Change Peak Flood Depth and Levels - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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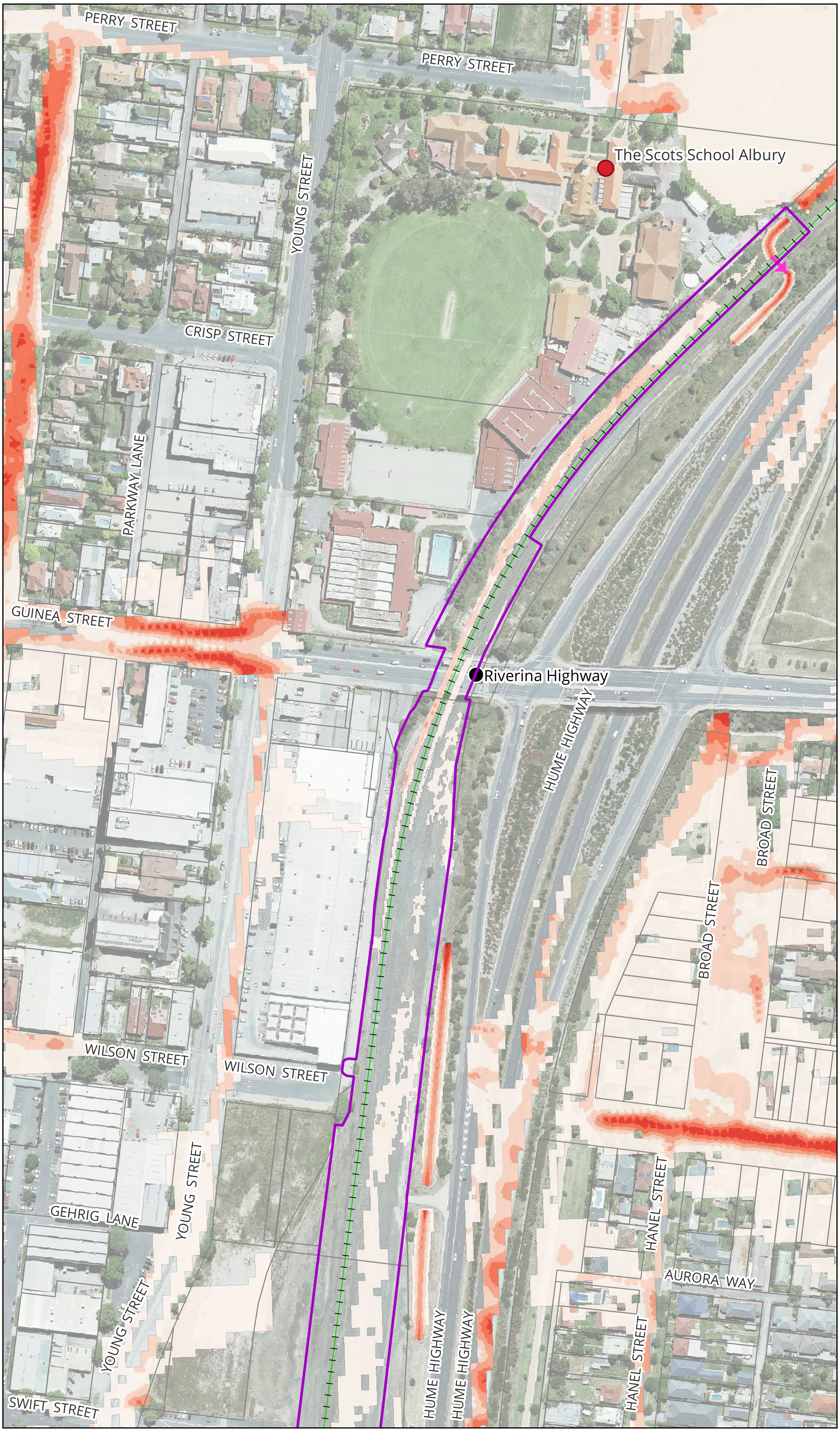
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A06: PMF Peak Flood Depth and Levels - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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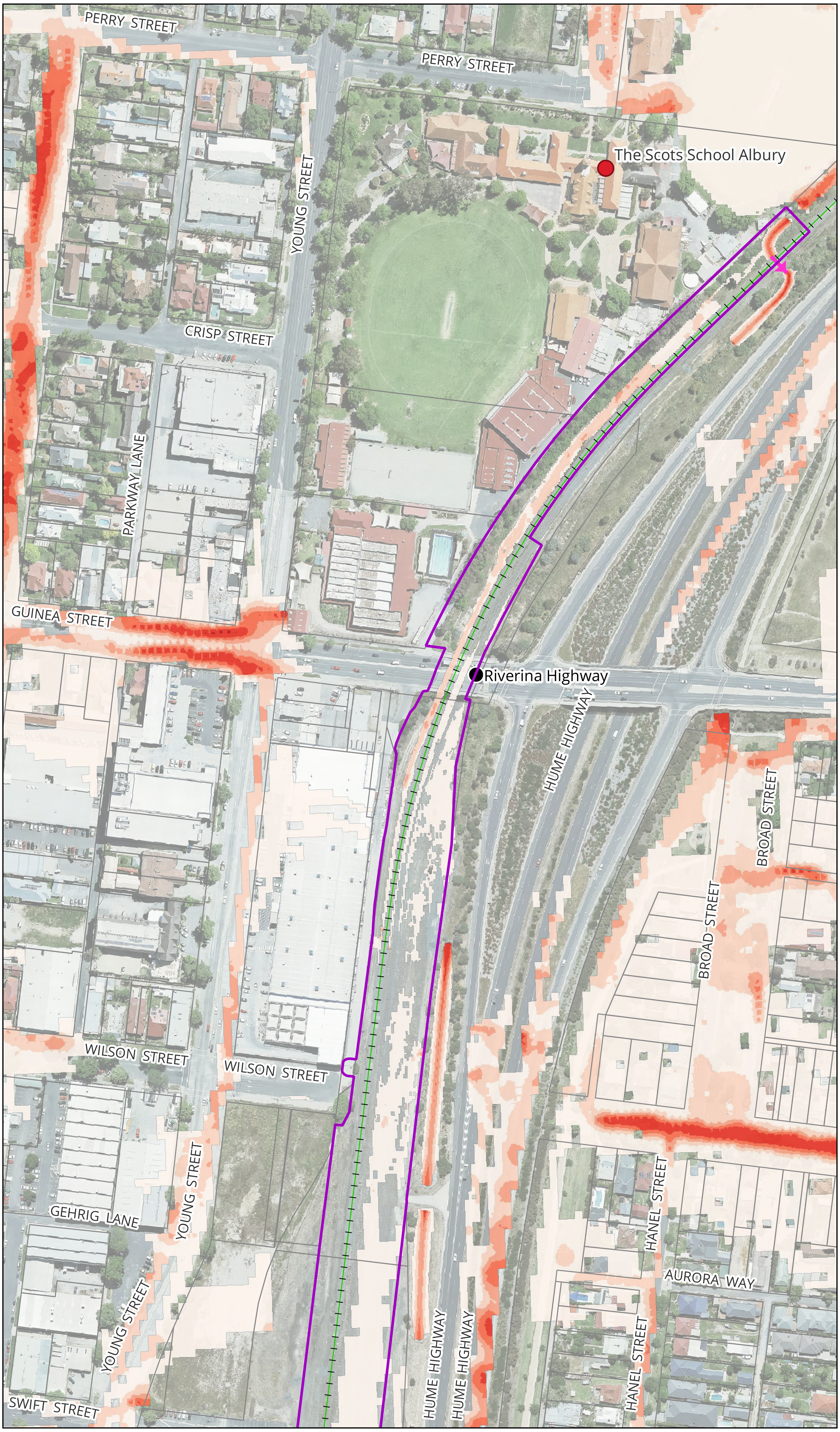
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A07: 10% AEP Peak Flood Velocity - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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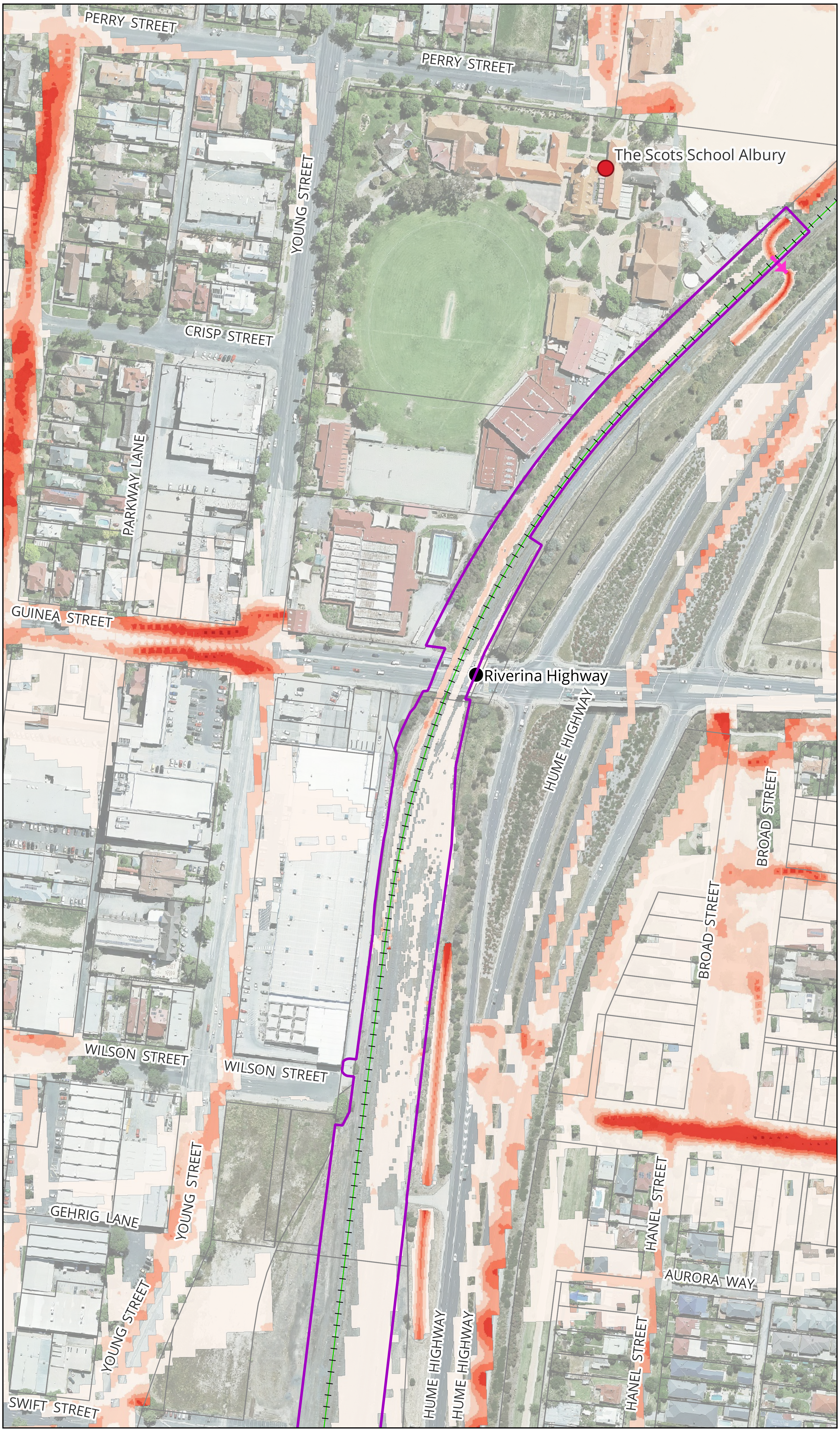
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A08: 5% AEP Peak Flood Velocity - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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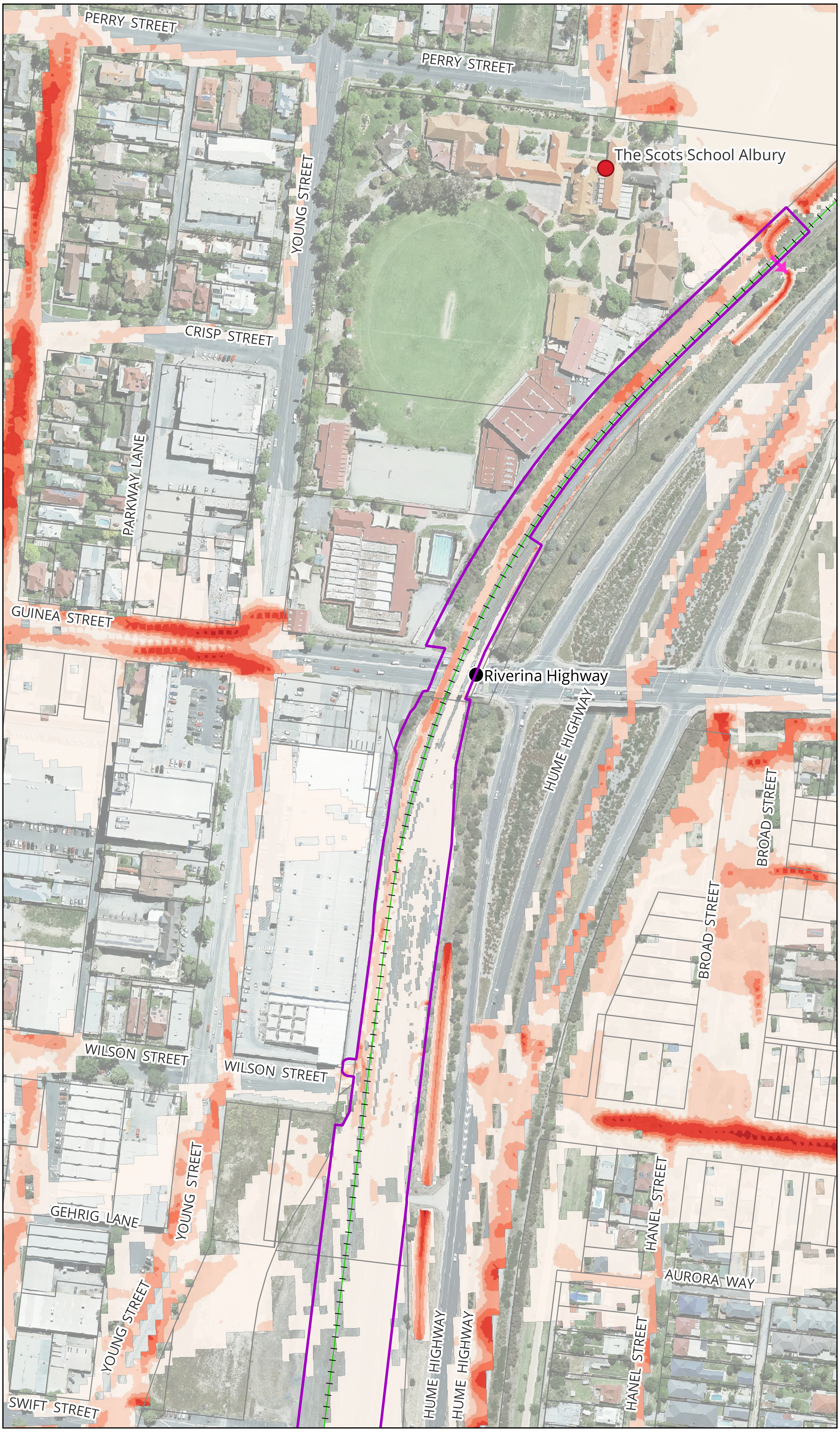
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A09: 2% AEP Peak Flood Velocity - Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

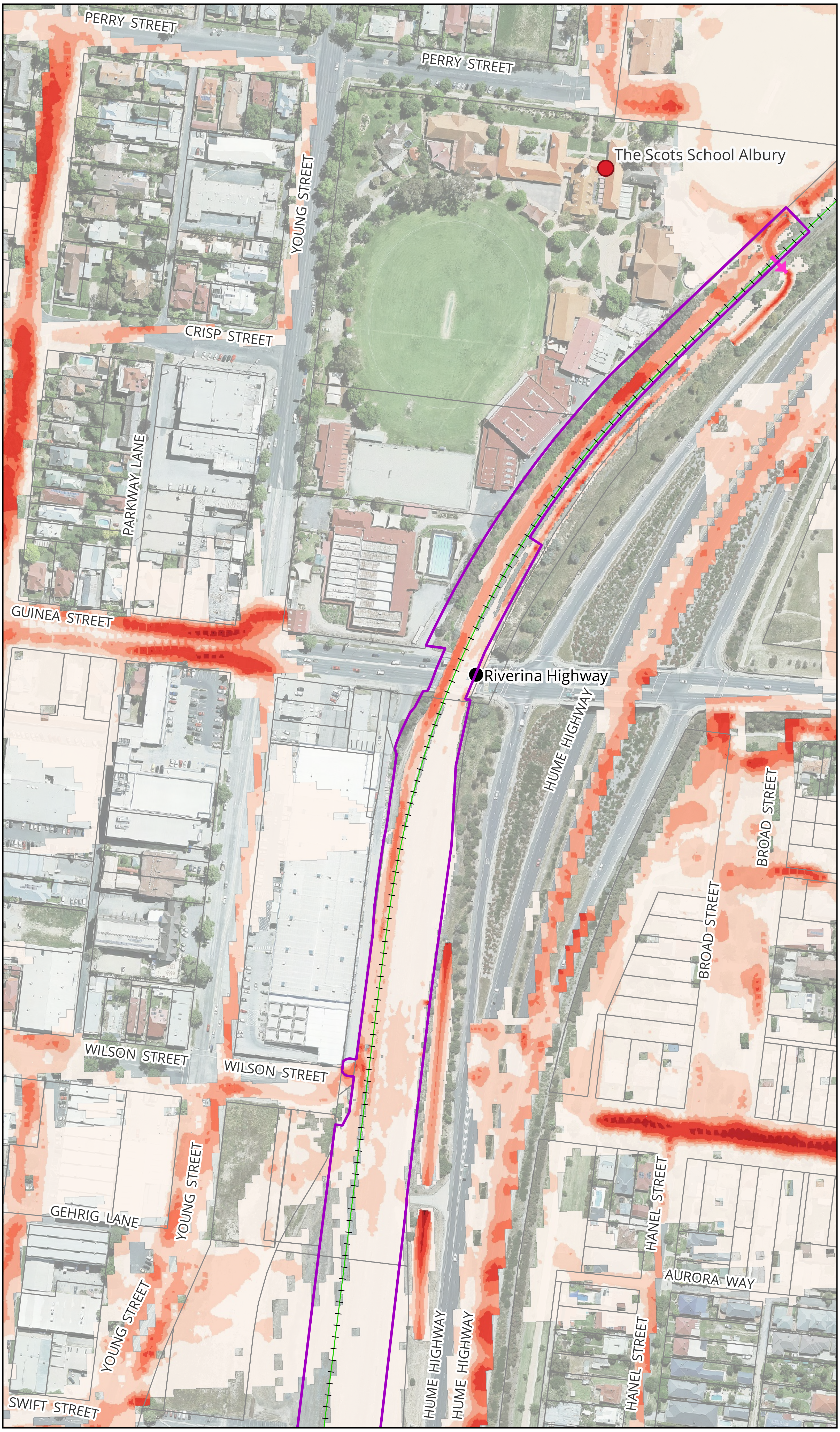
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A10: 1% AEP Peak Flood Velocity - Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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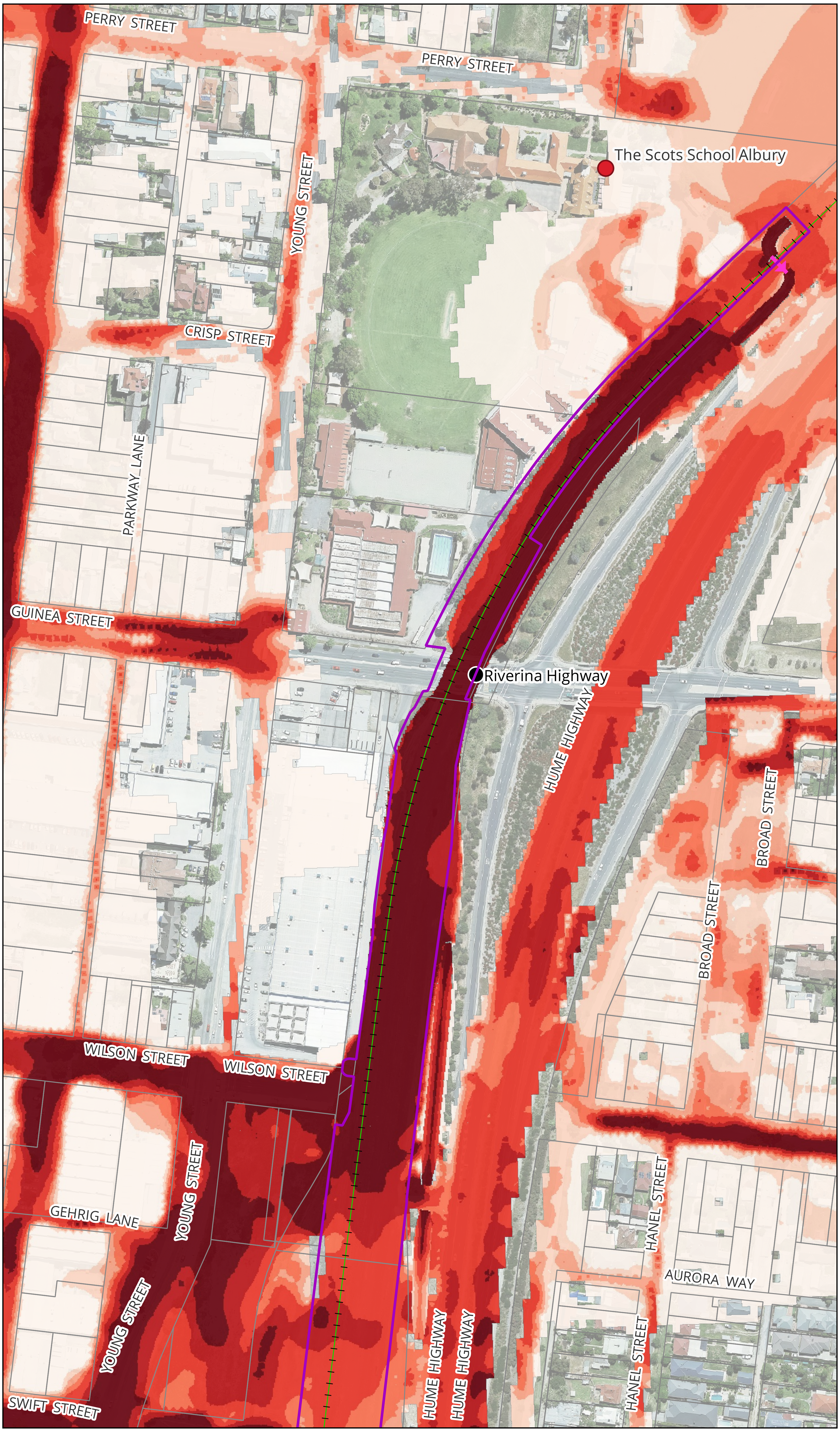
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A11: 1% AEP Climate Change Peak Flood Velocity - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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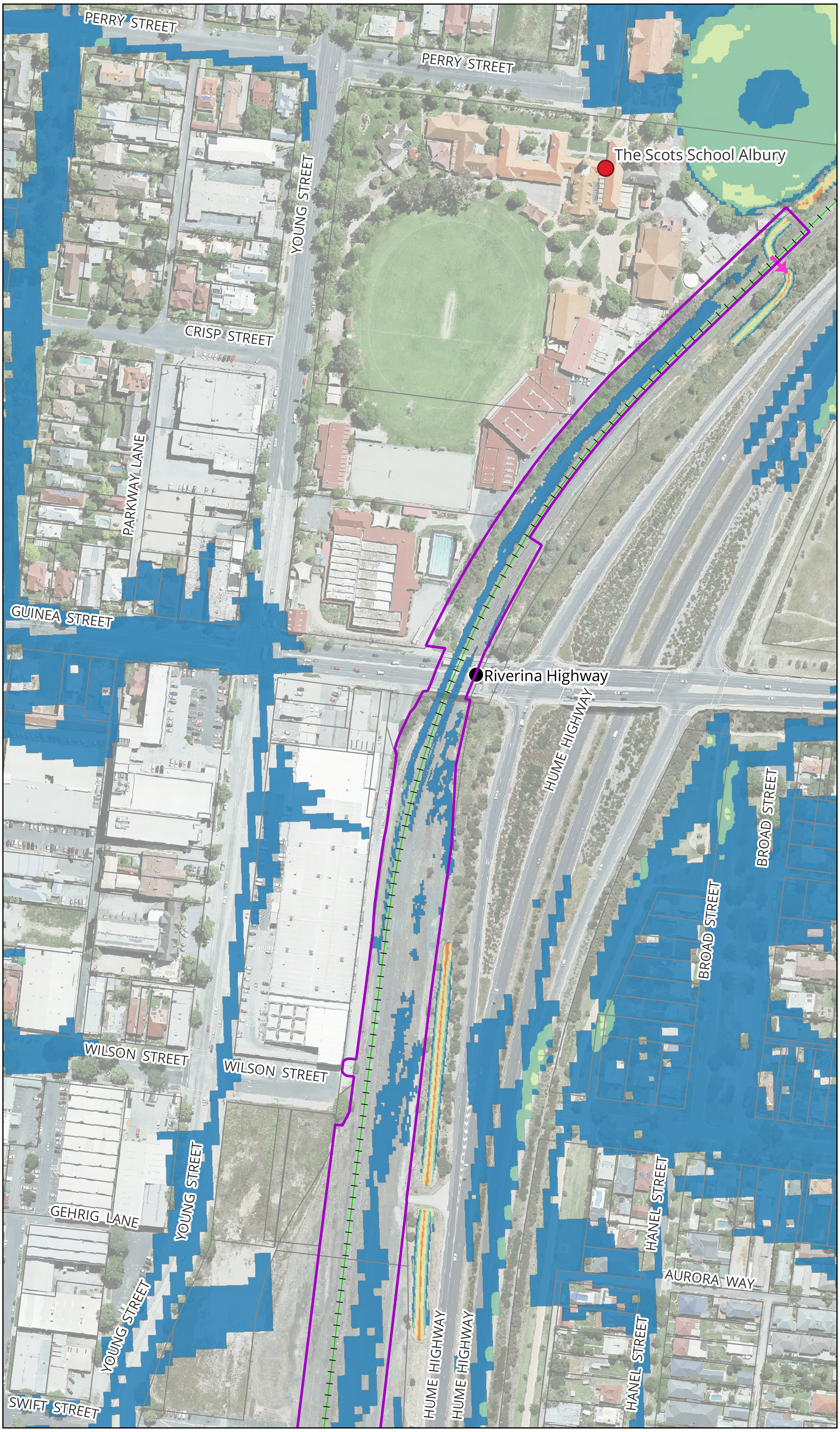
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A12: PMF Peak Flood Velocity - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

0 100 200 m

A3 Scale: 1:2,500

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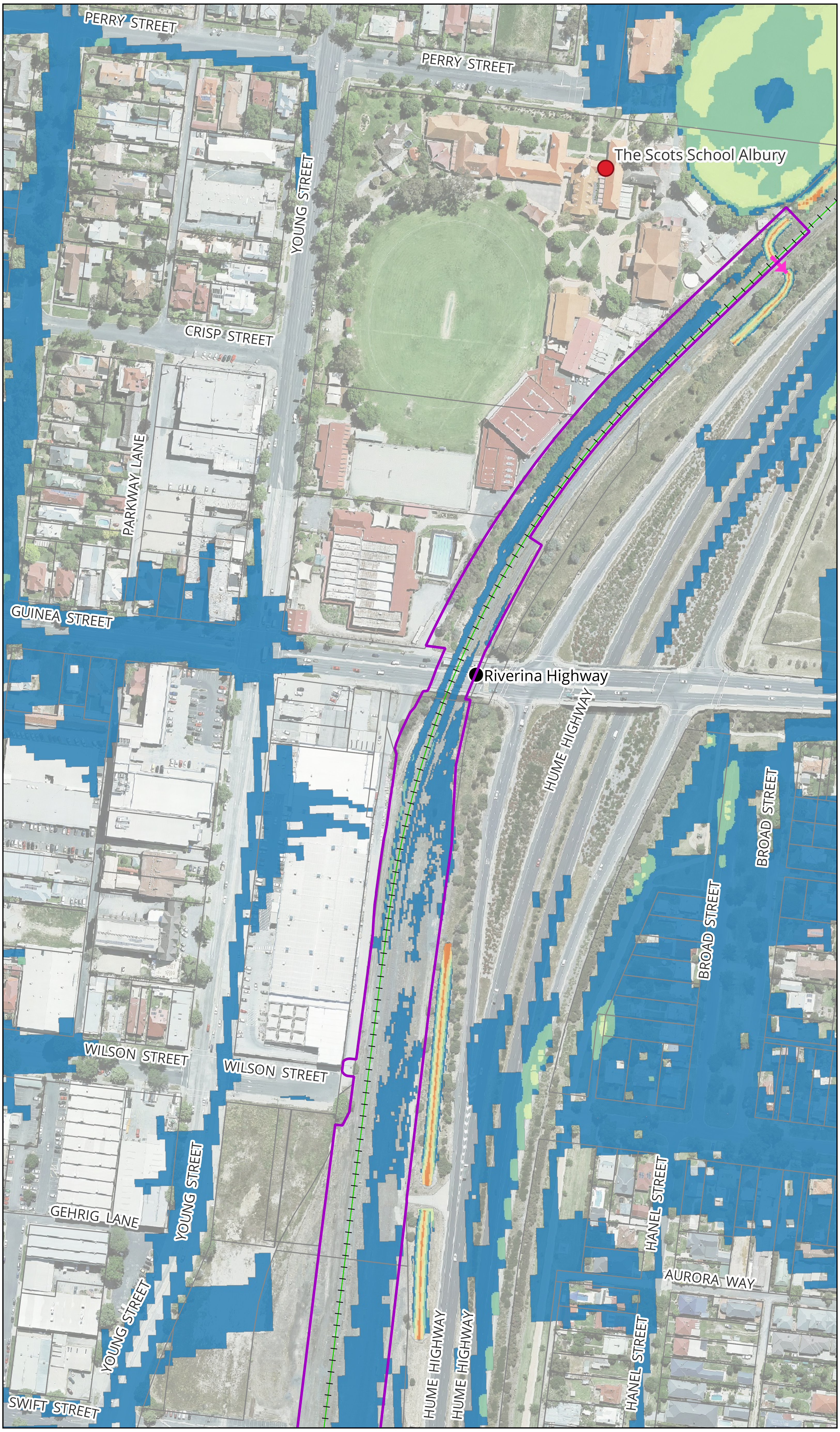
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A13: 10% AEP Peak Flood Hazard - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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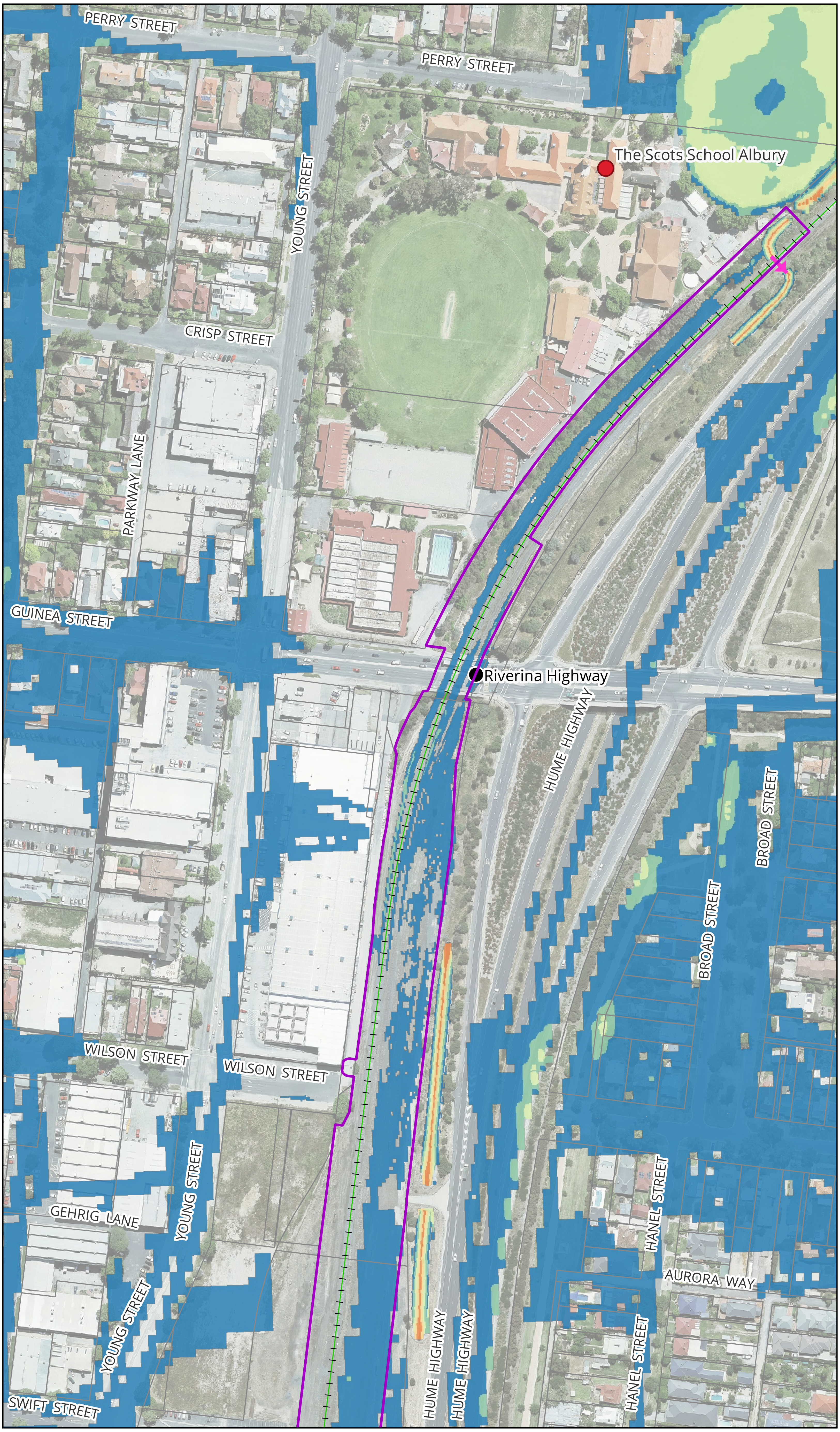
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A14: 5% AEP Peak Flood Hazard - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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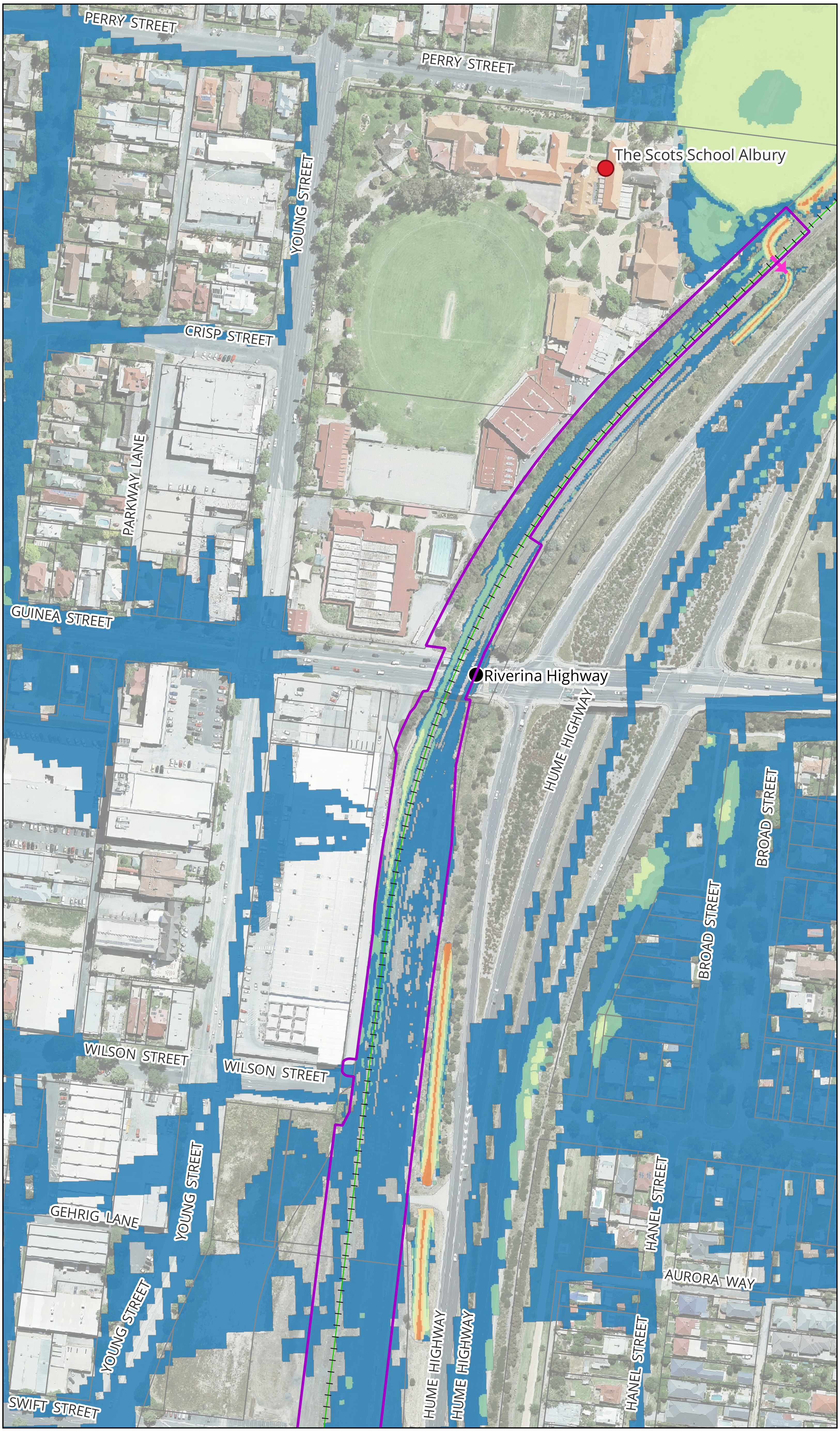
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A15: 2% AEP Peak Flood Hazard - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A16: 1% AEP Peak Flood Hazard - Existing Condition**

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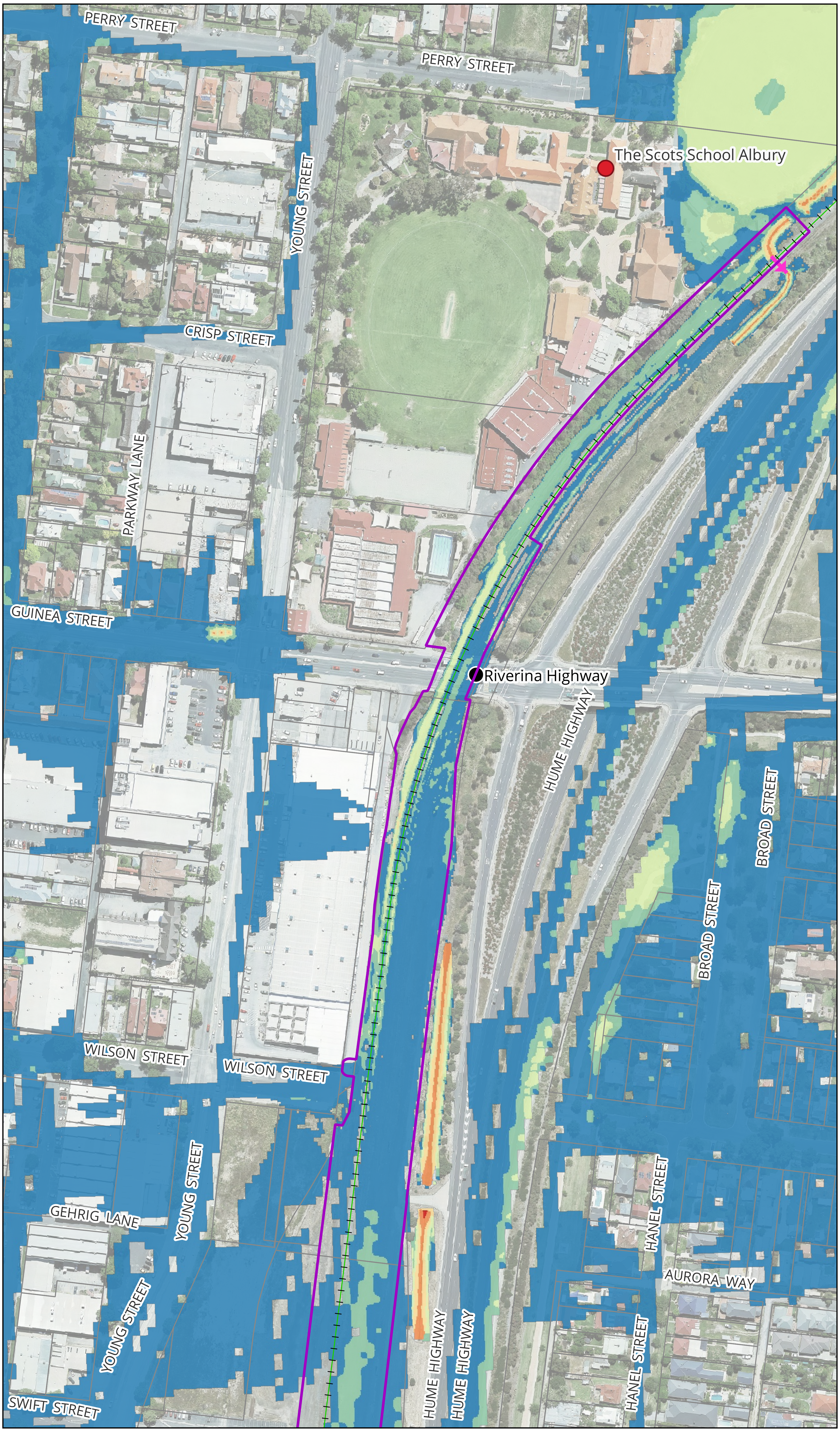


## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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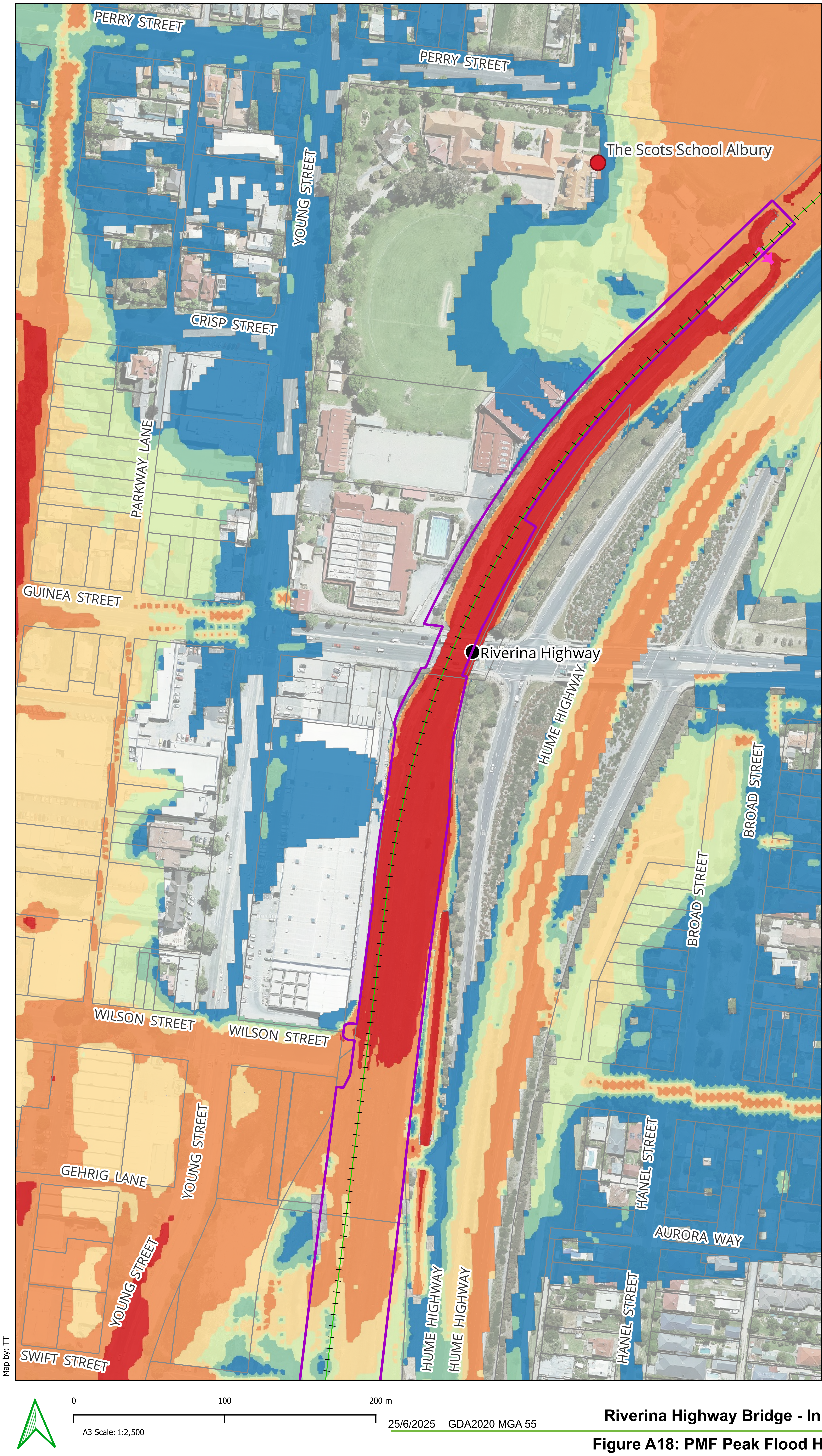
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A17: 1% AEP Climate Change Peak Flood Hazard - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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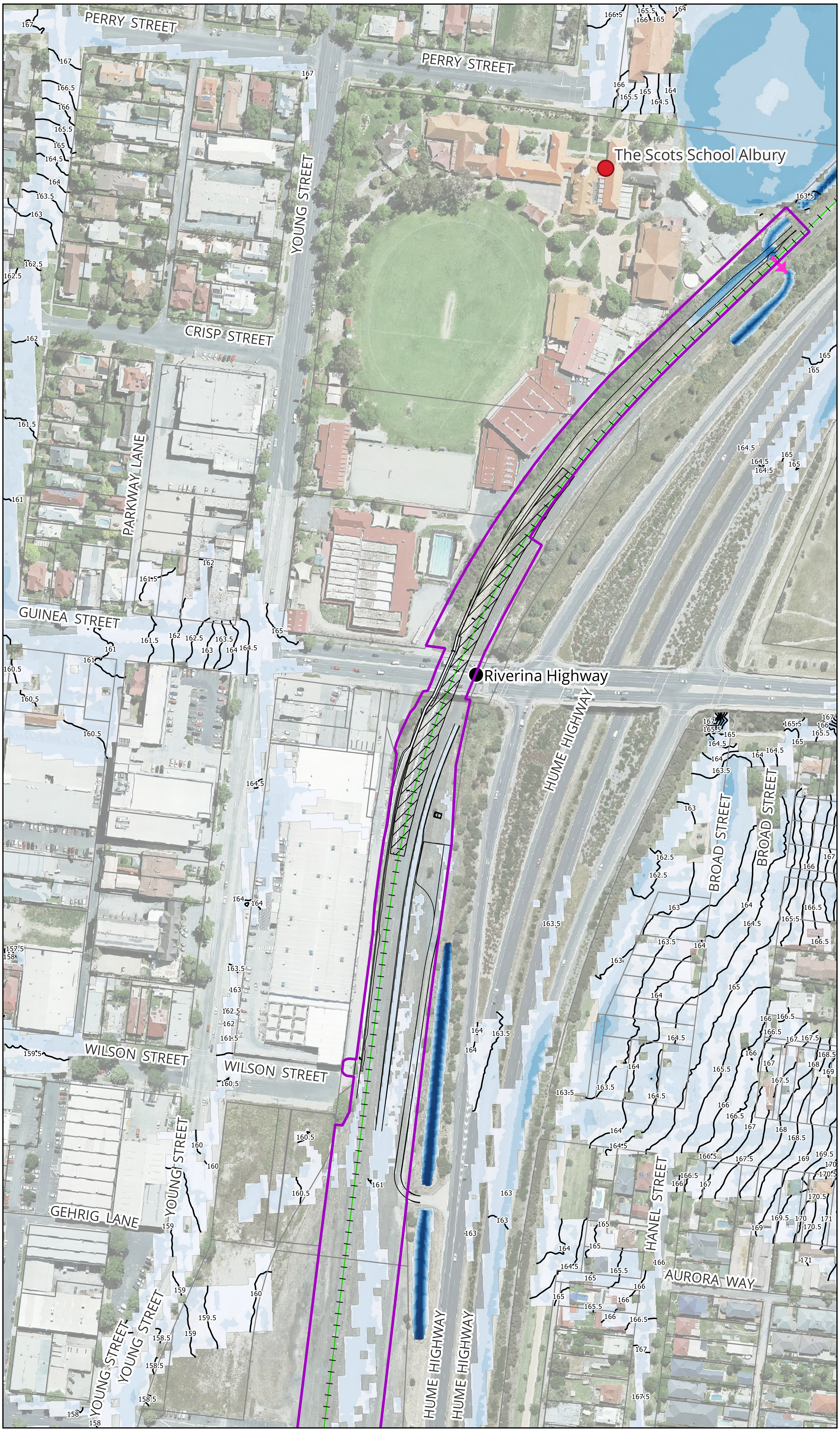
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A18: PMF Peak Flood Hazard - Existing Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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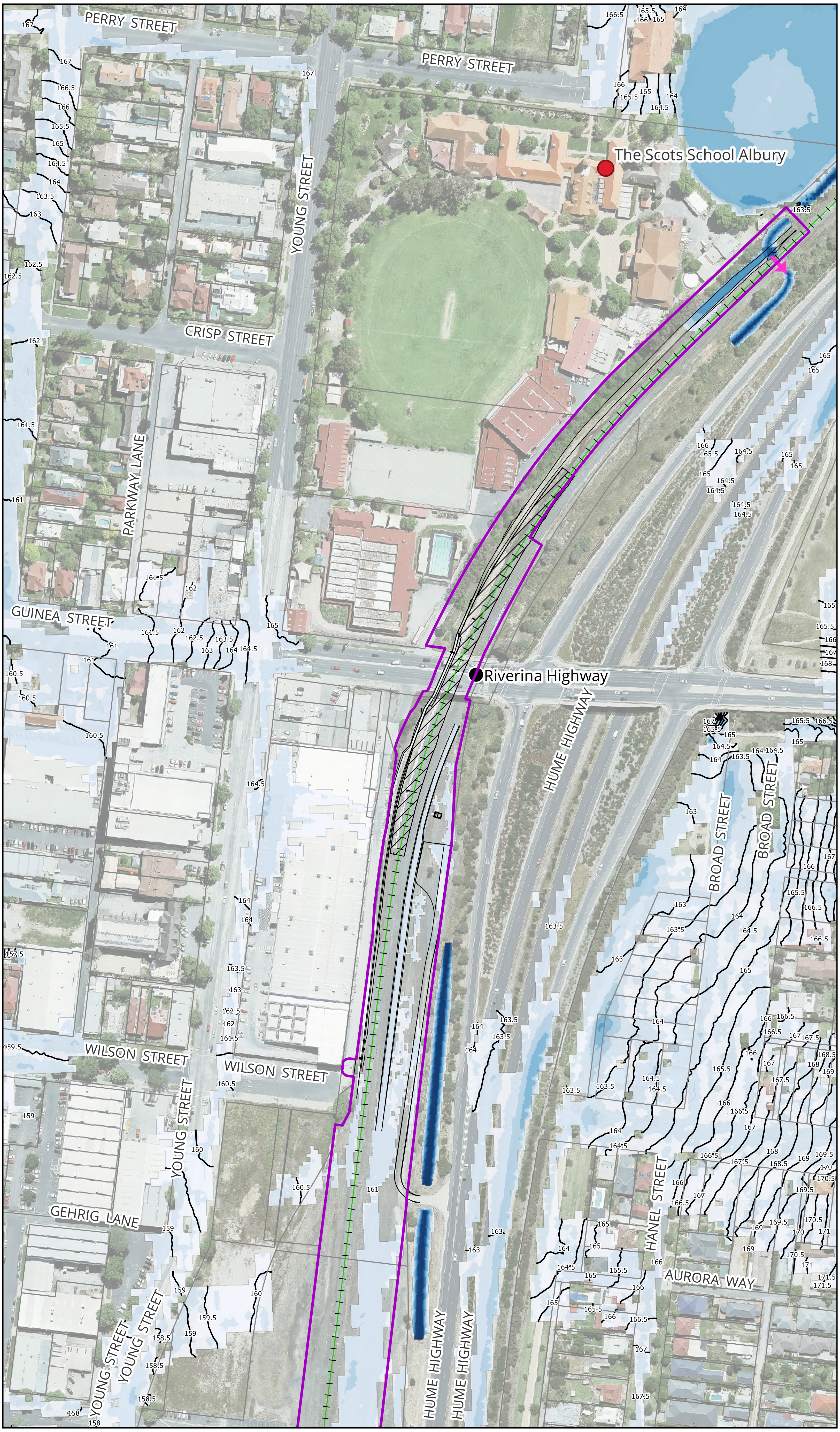
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A19: 10% AEP Peak Flood Depth and Levels - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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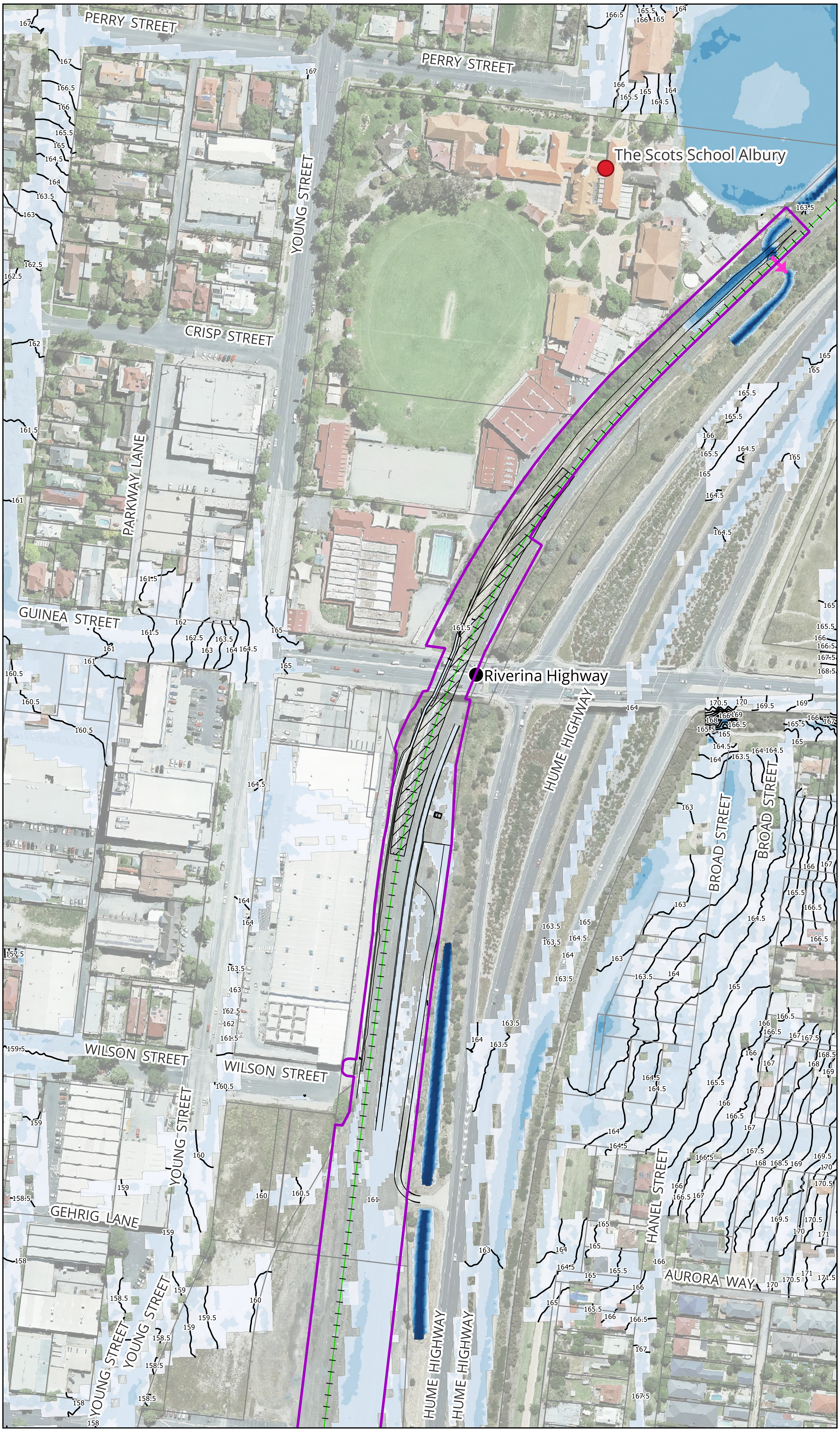
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A20: 5% AEP Peak Flood Depth and Levels - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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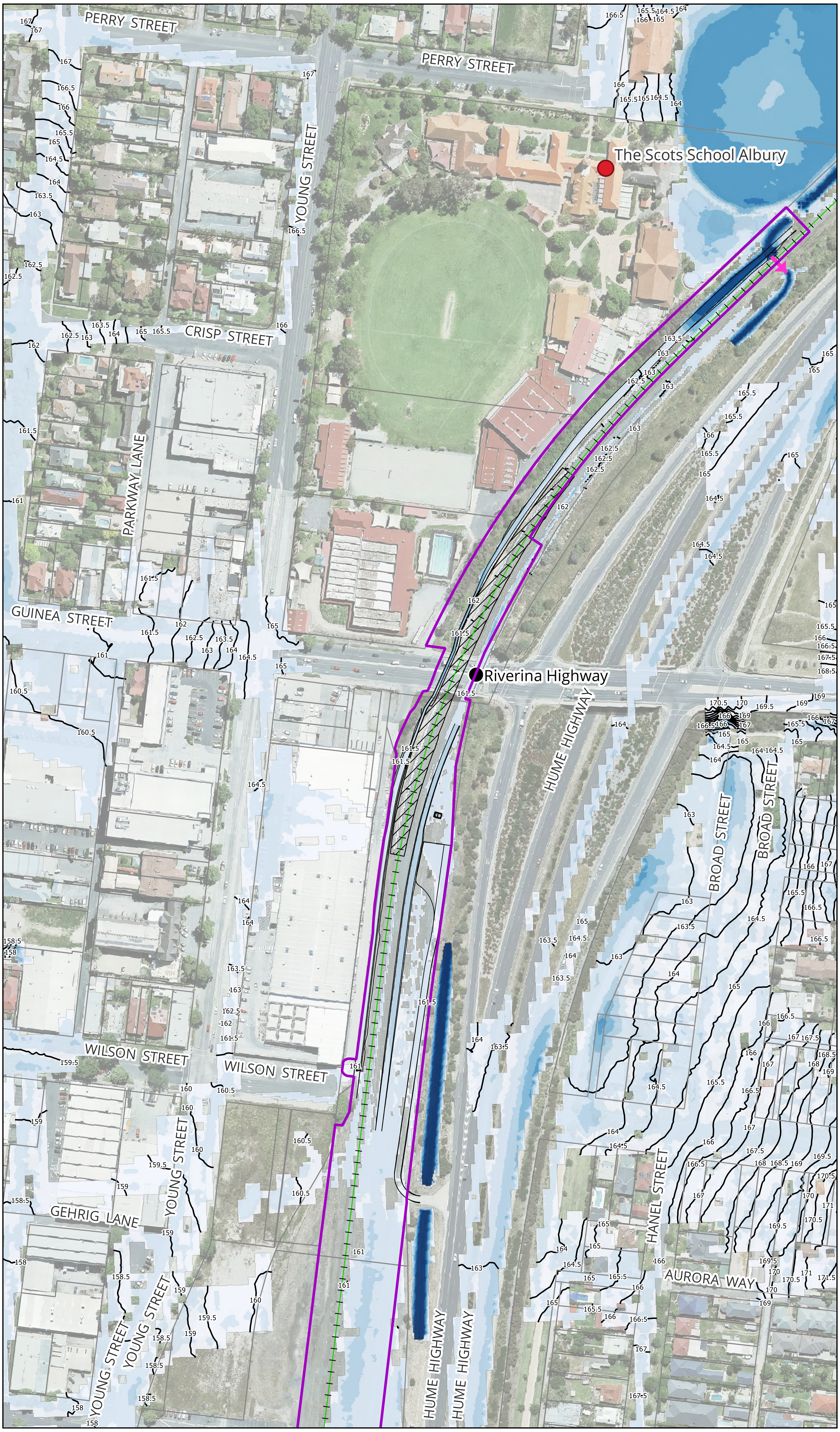
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A21: 2% AEP Peak Flood Depth and Levels - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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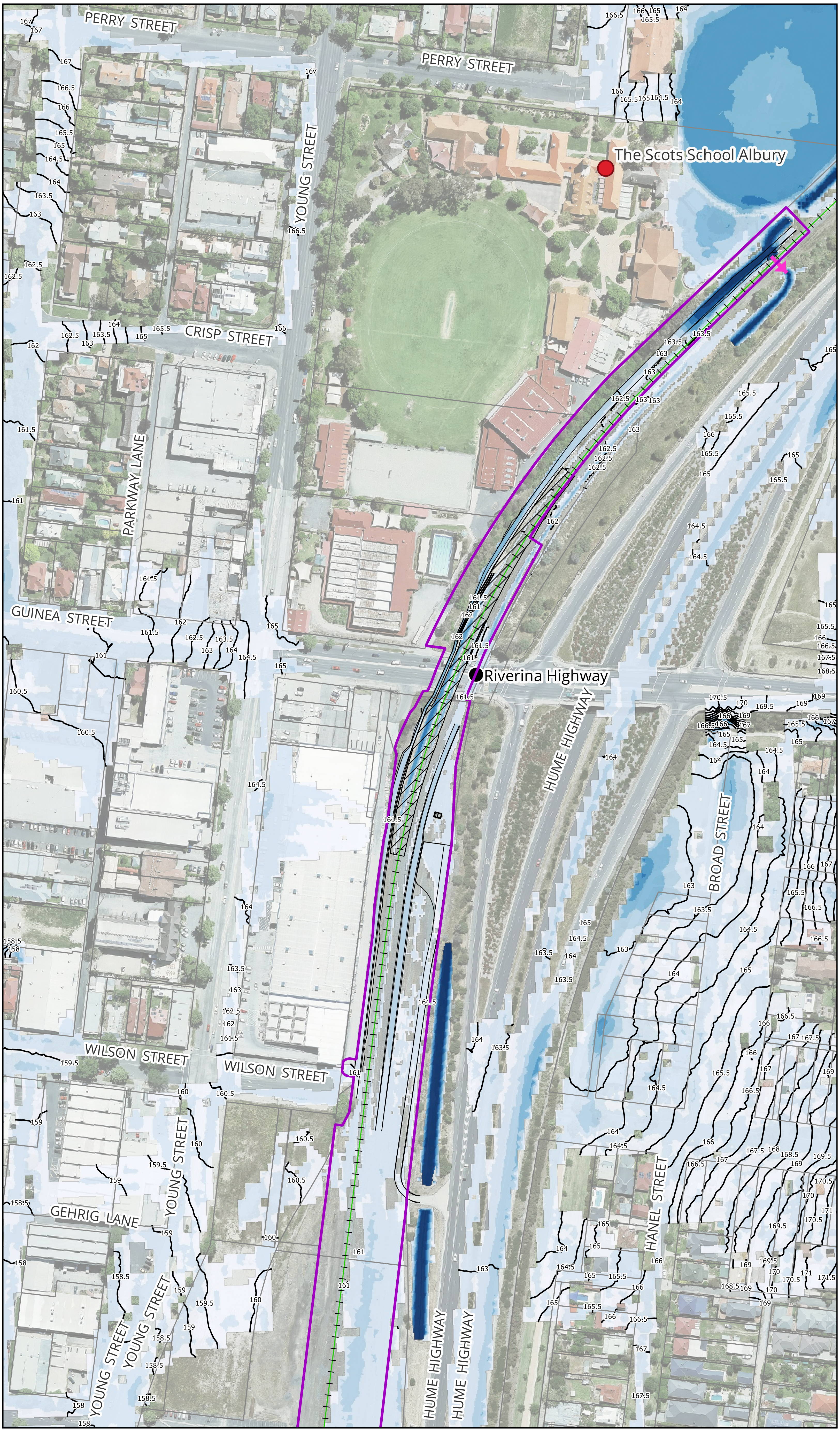
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A22: 1% AEP Peak Flood Depth and Levels - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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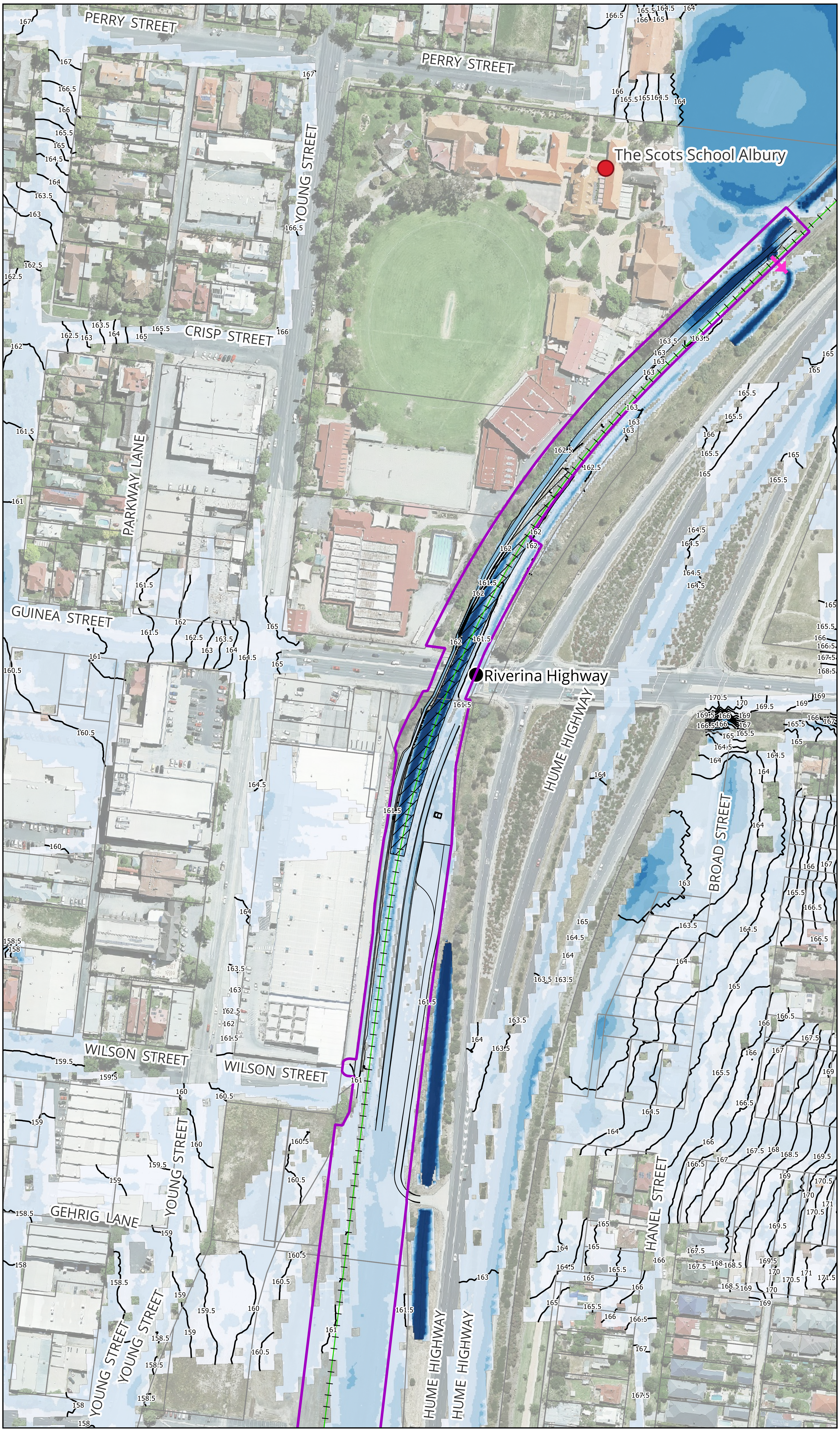
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A23: 1% AEP Peak Flood Depth and Levels - Design Blockage Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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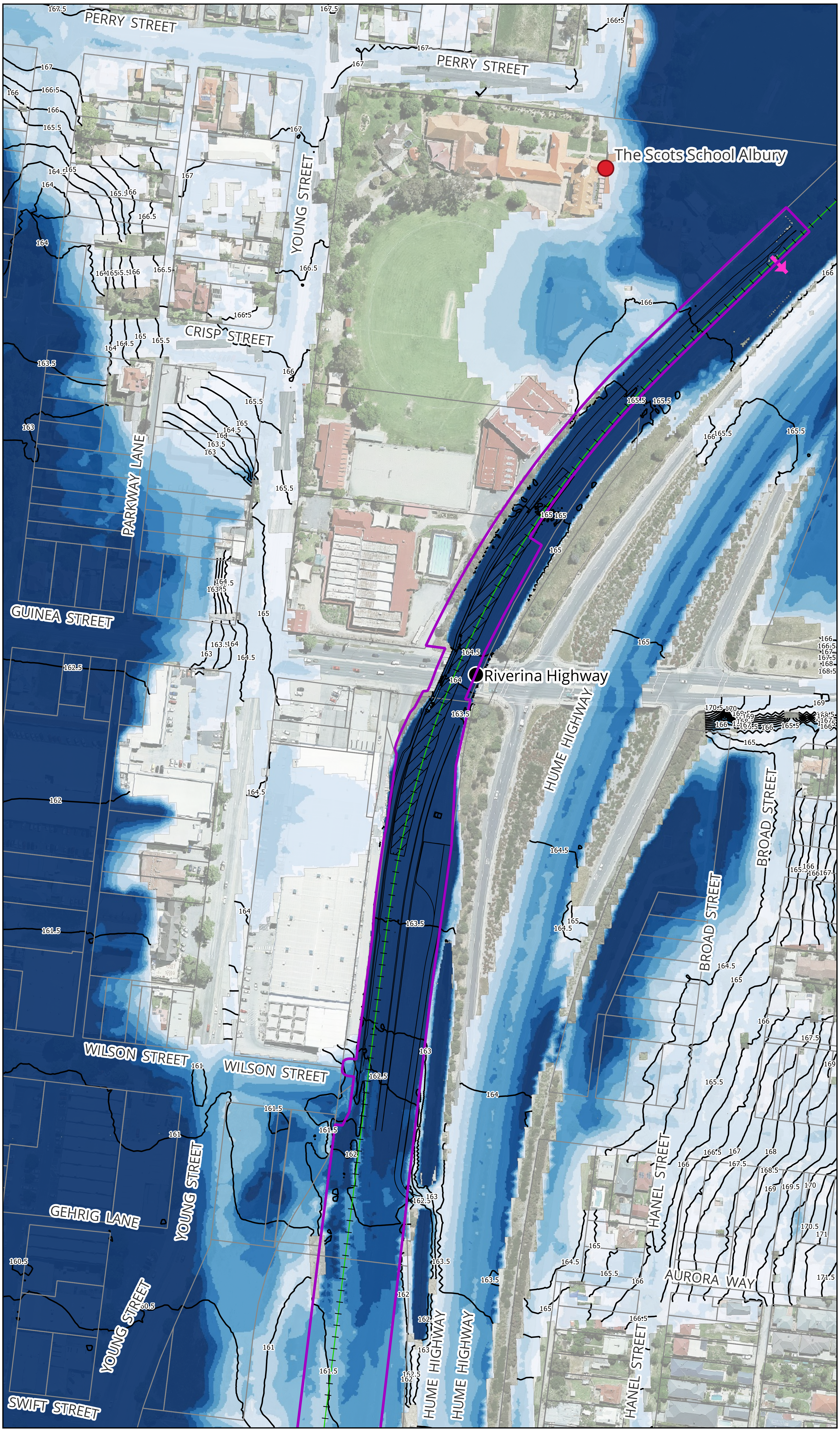
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A24: 1% AEP Climate Change Peak Flood Depth and Levels - Design Condition**

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**Legend**

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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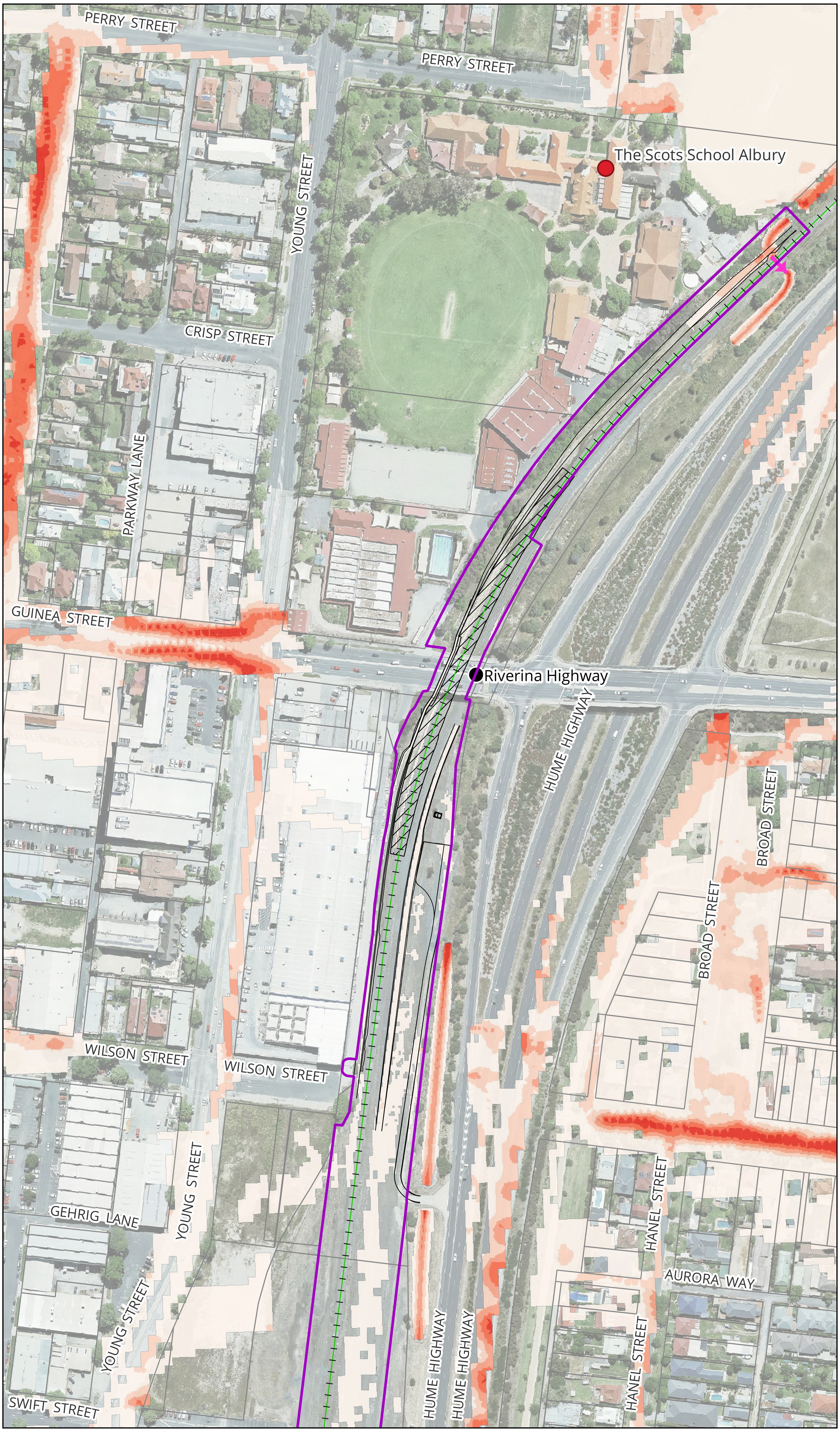
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A25: PMF Peak Flood Depth and Levels - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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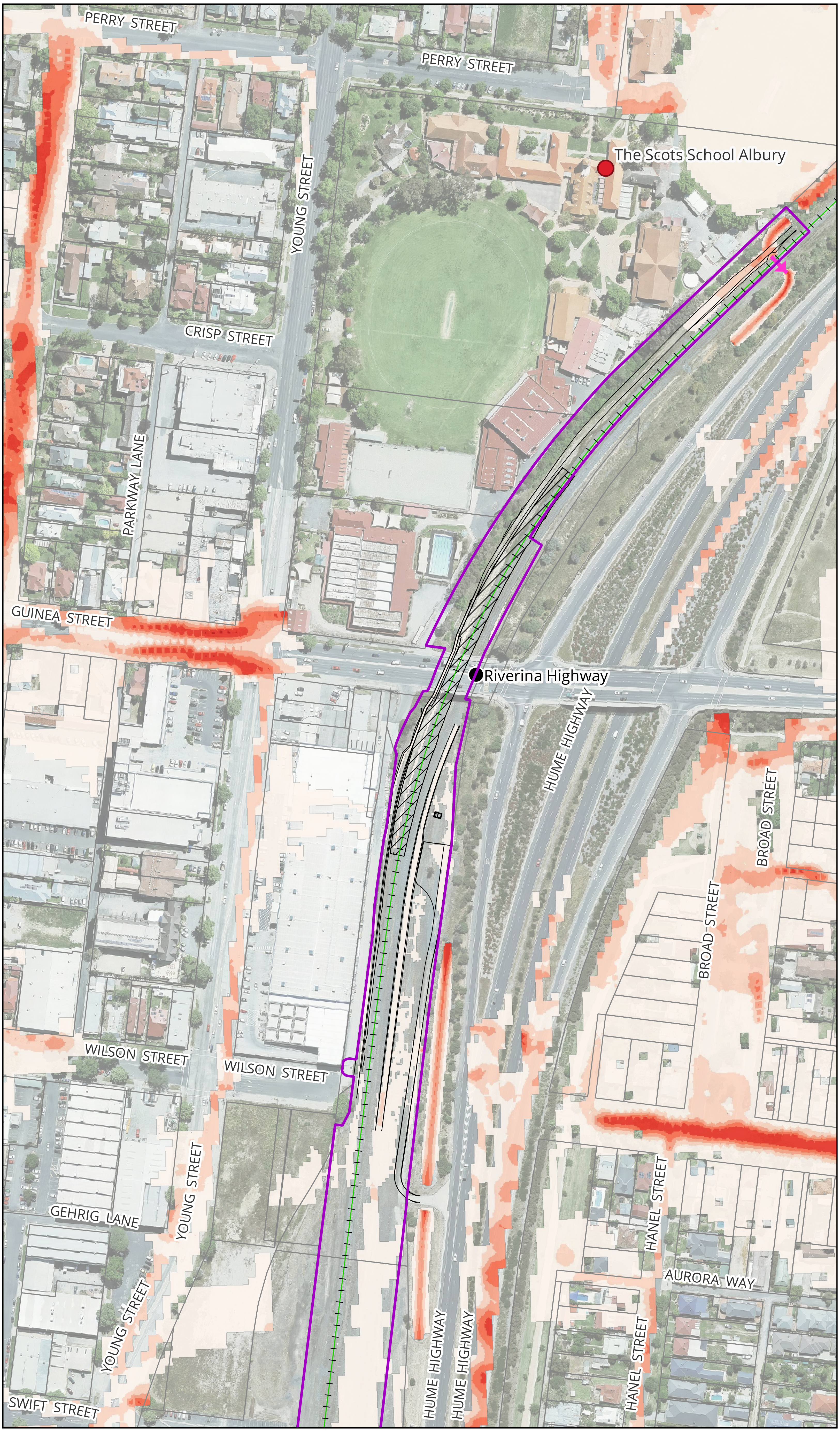
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A26: 10% AEP Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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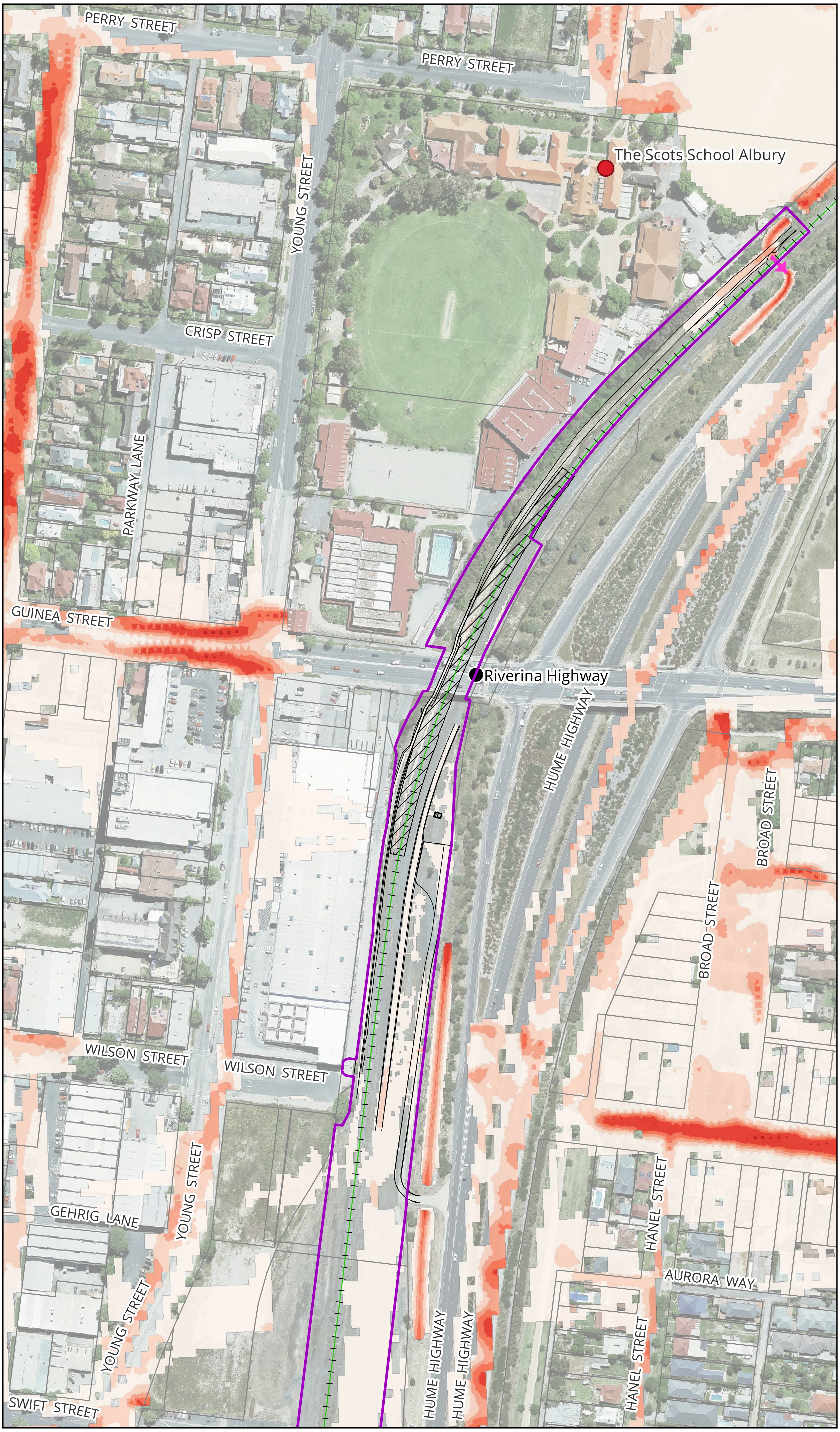
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A27: 5% AEP Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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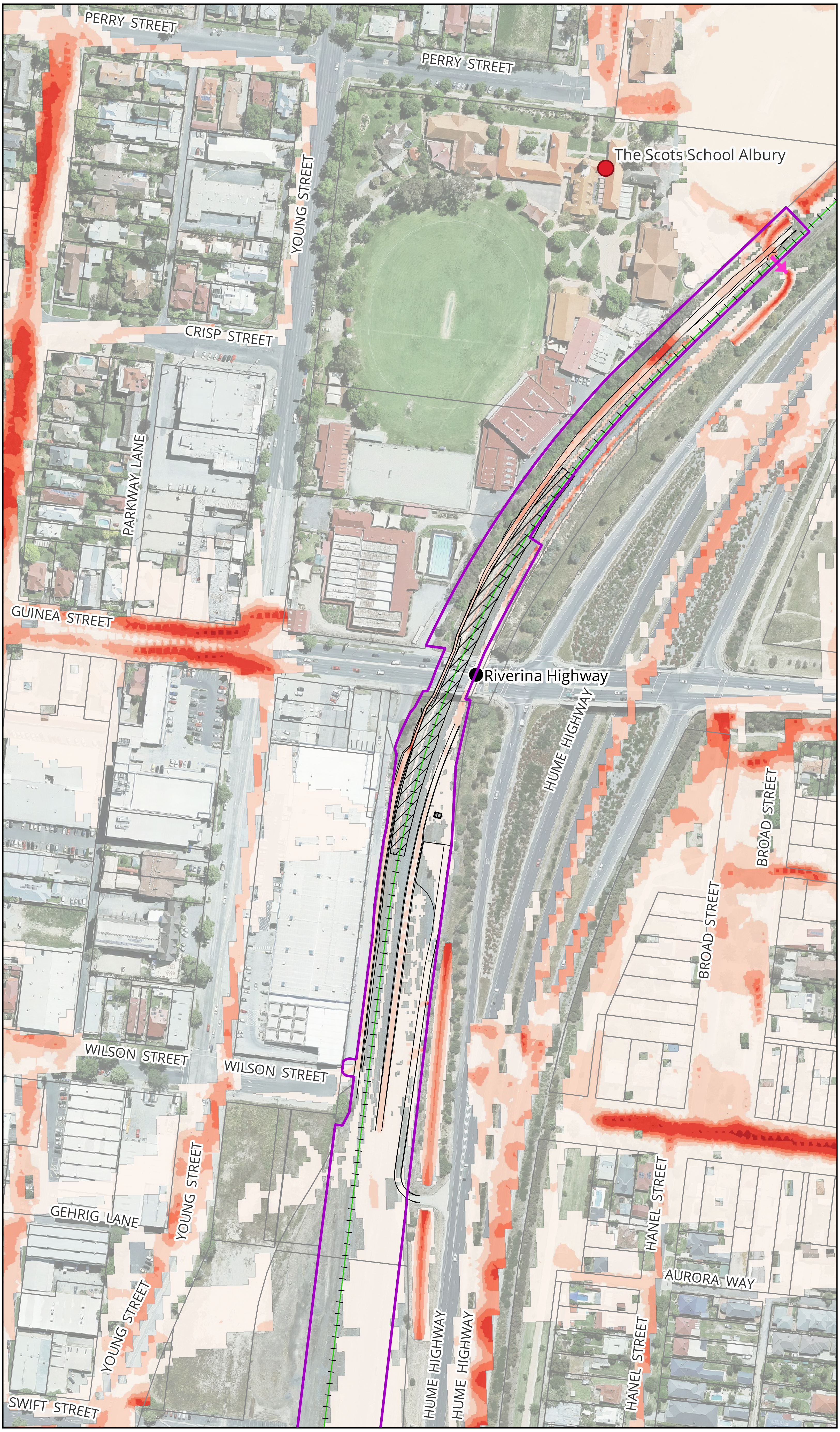
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A28: 2% AEP Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

0 100 200 m

A3 Scale: 1:2,500

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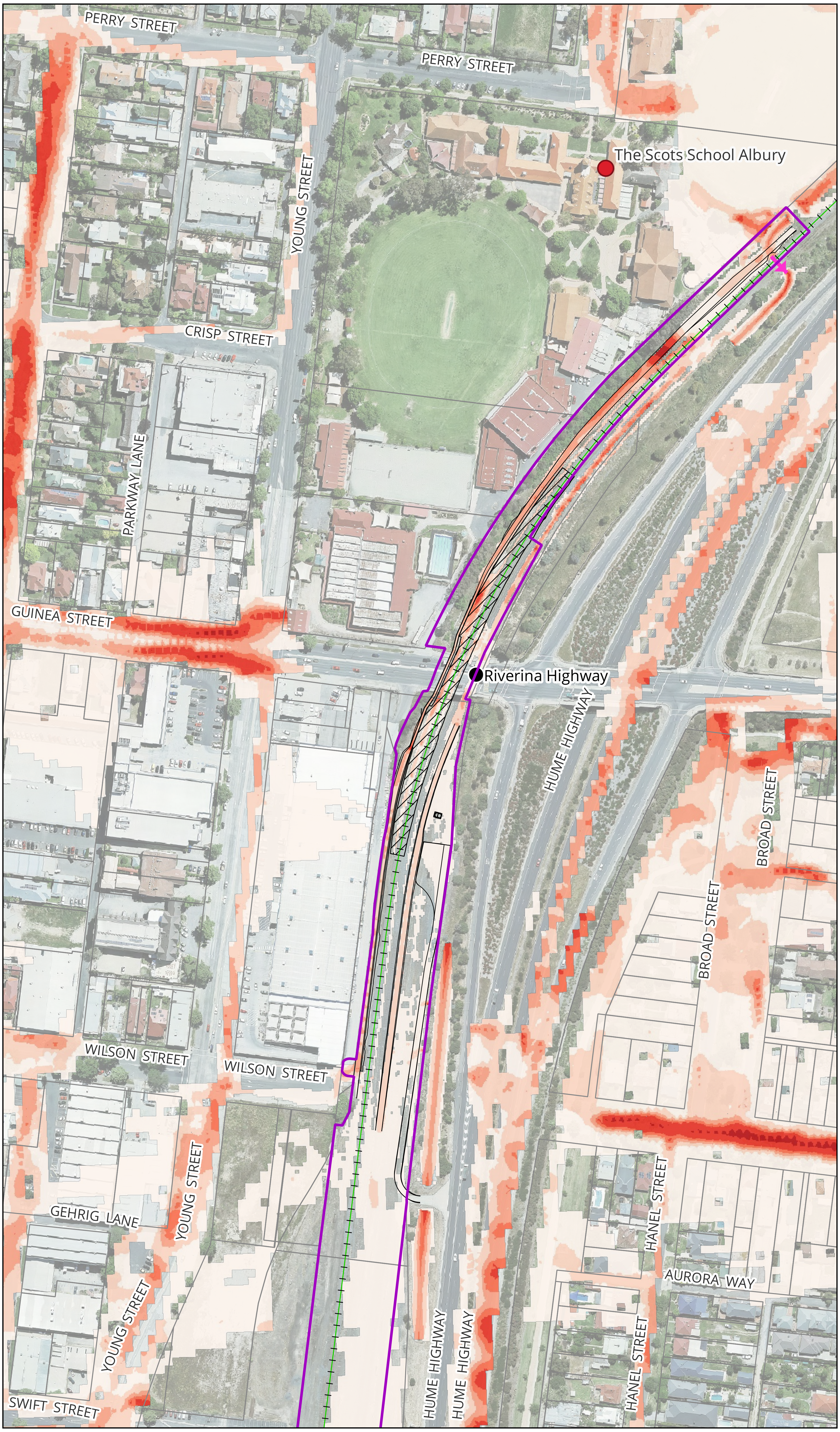
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A29: 1% AEP Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

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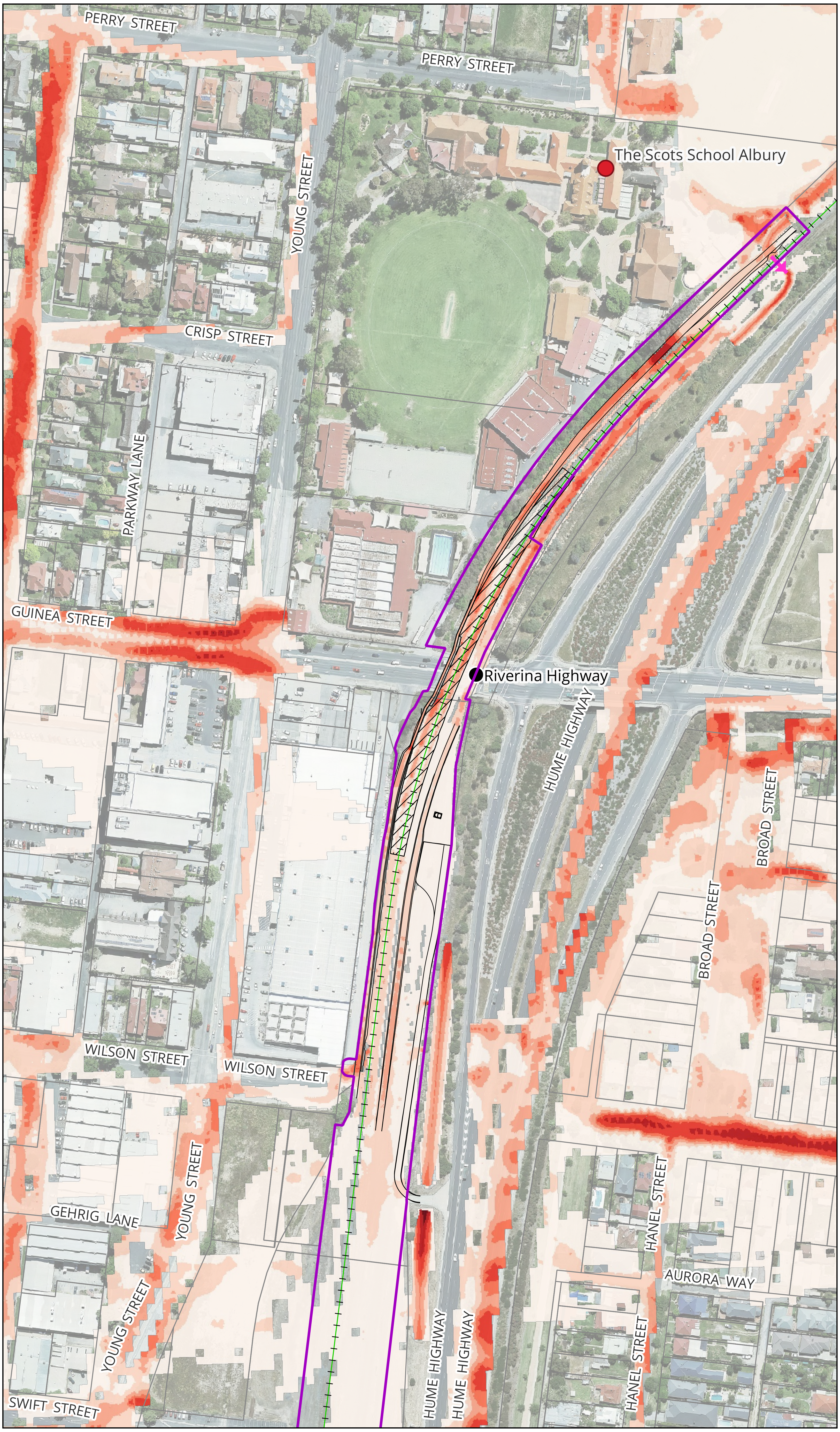
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A30: 1% AEP Peak Flood Velocity - Design Blockage Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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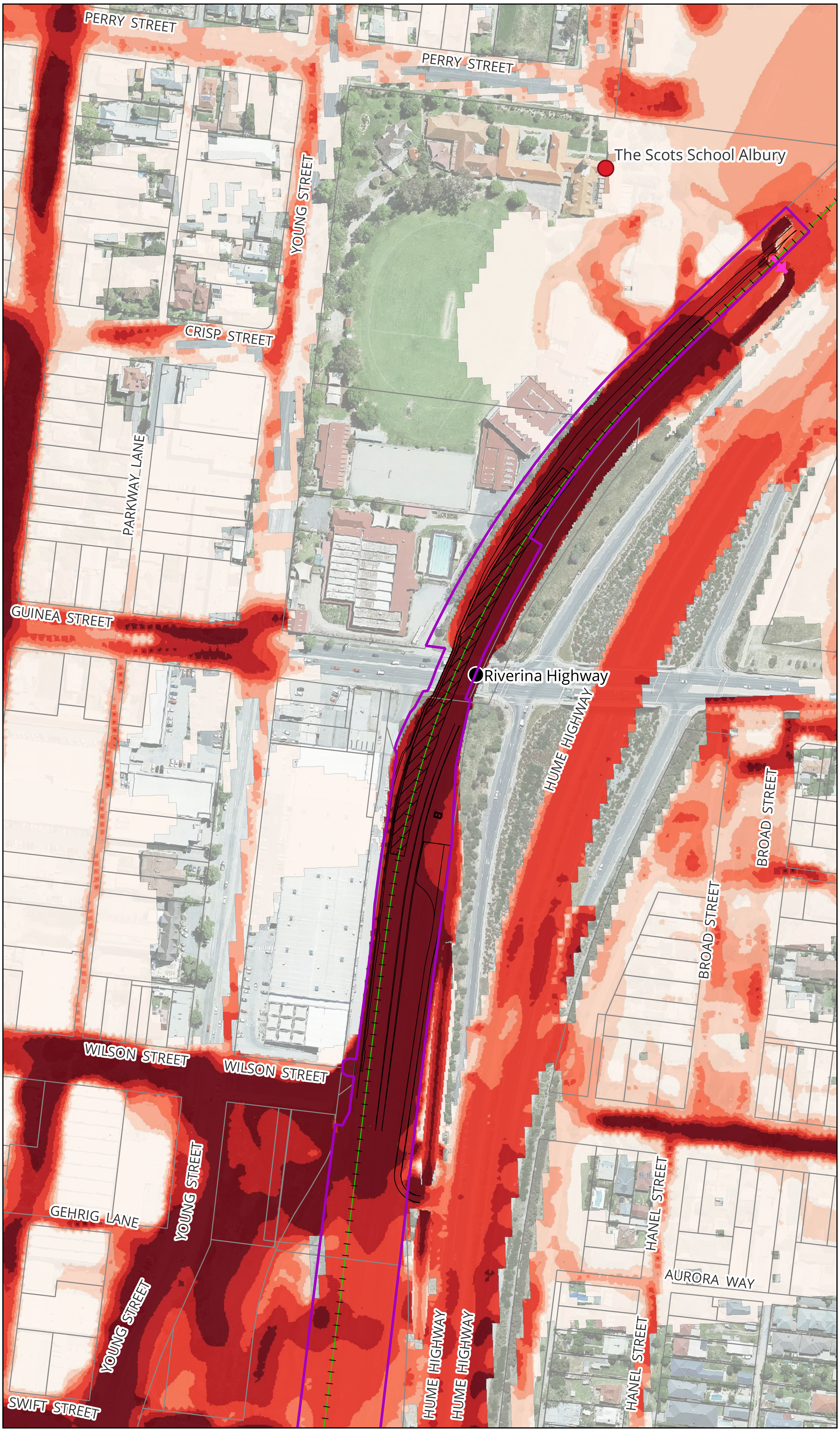
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A31: 1% AEP Climate Change Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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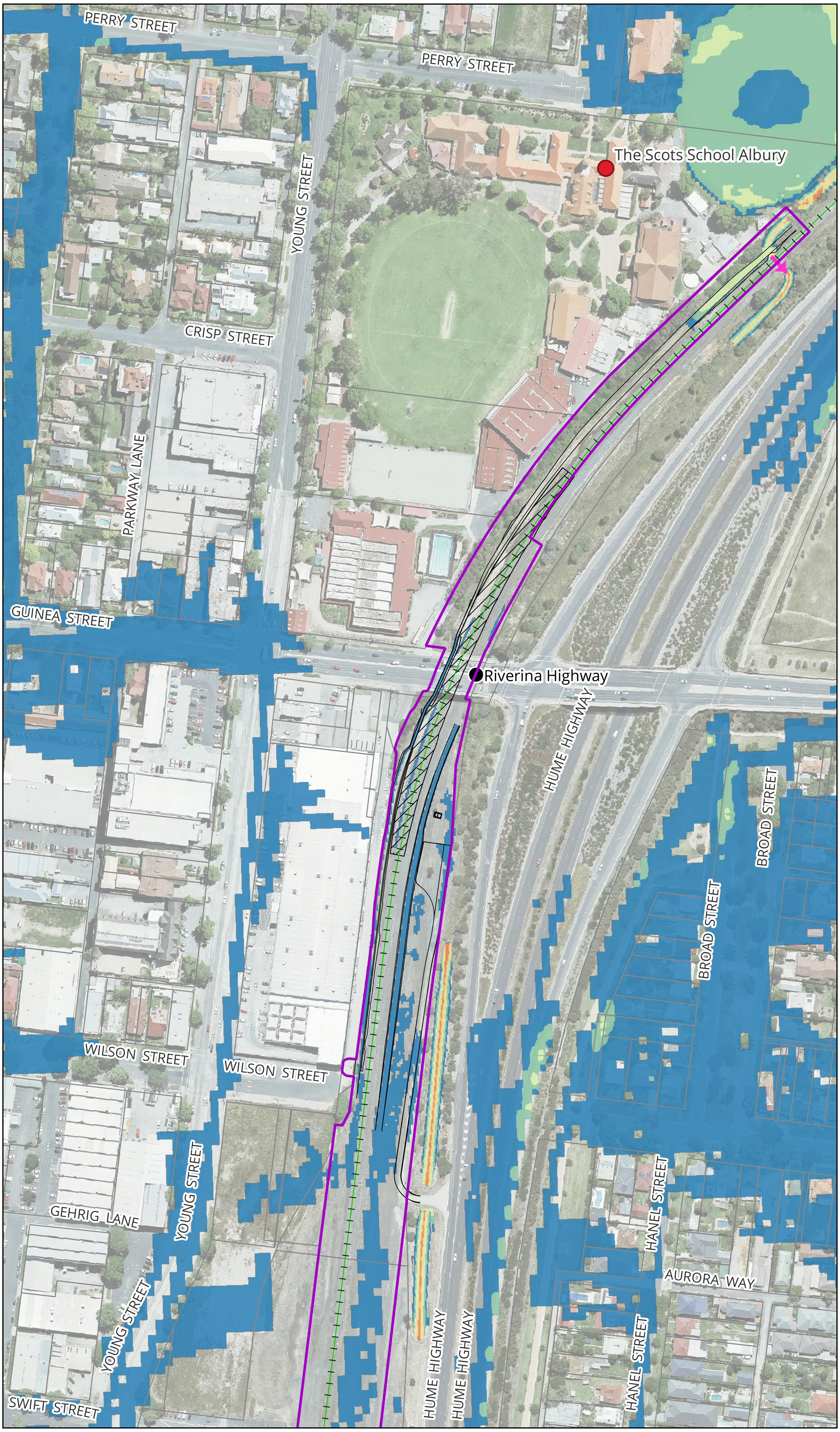
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A32: PMF Peak Flood Velocity - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

0 100 200 m

A3 Scale: 1:2,500

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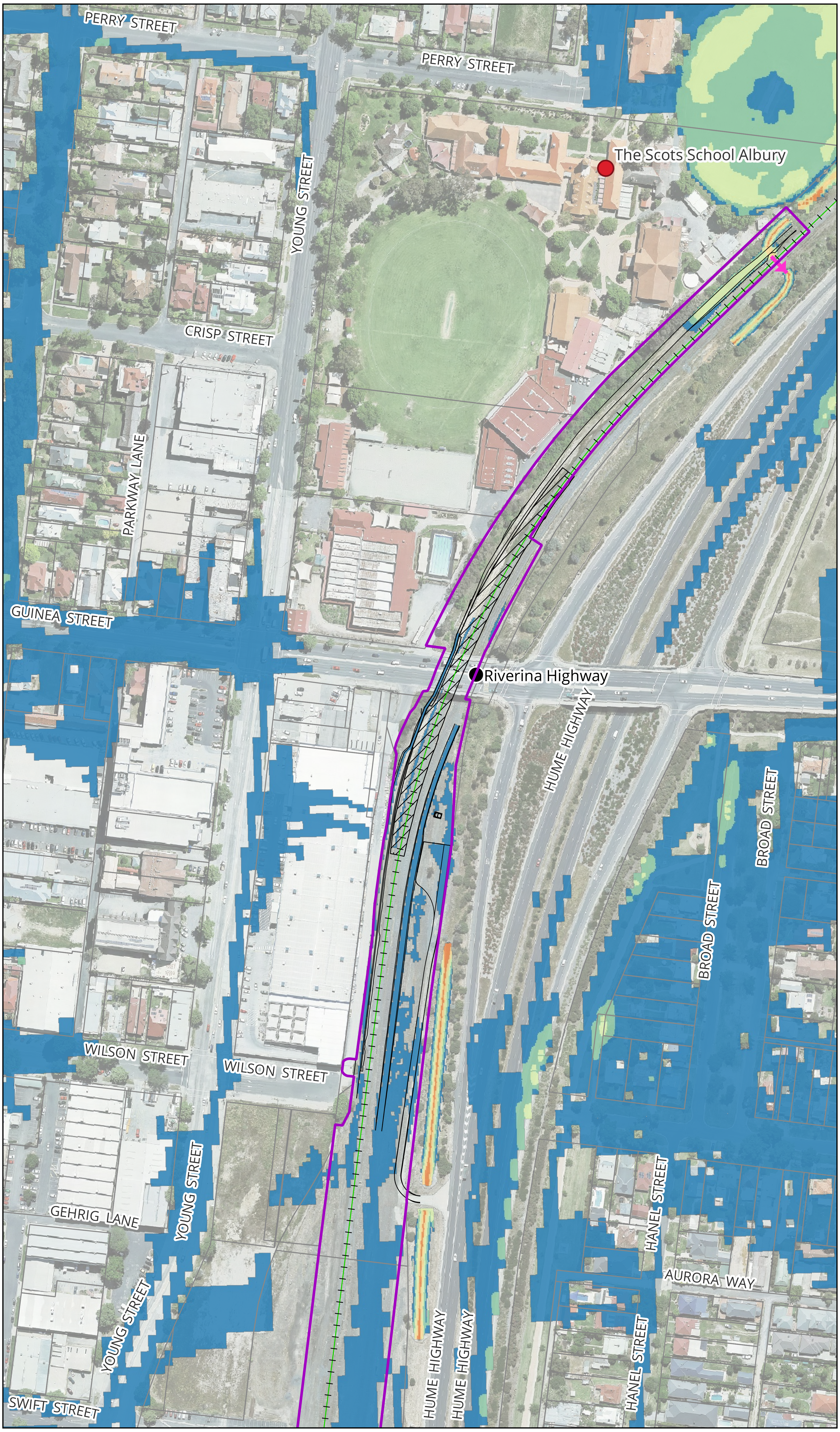
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A33: 10% AEP Peak Flood Hazard - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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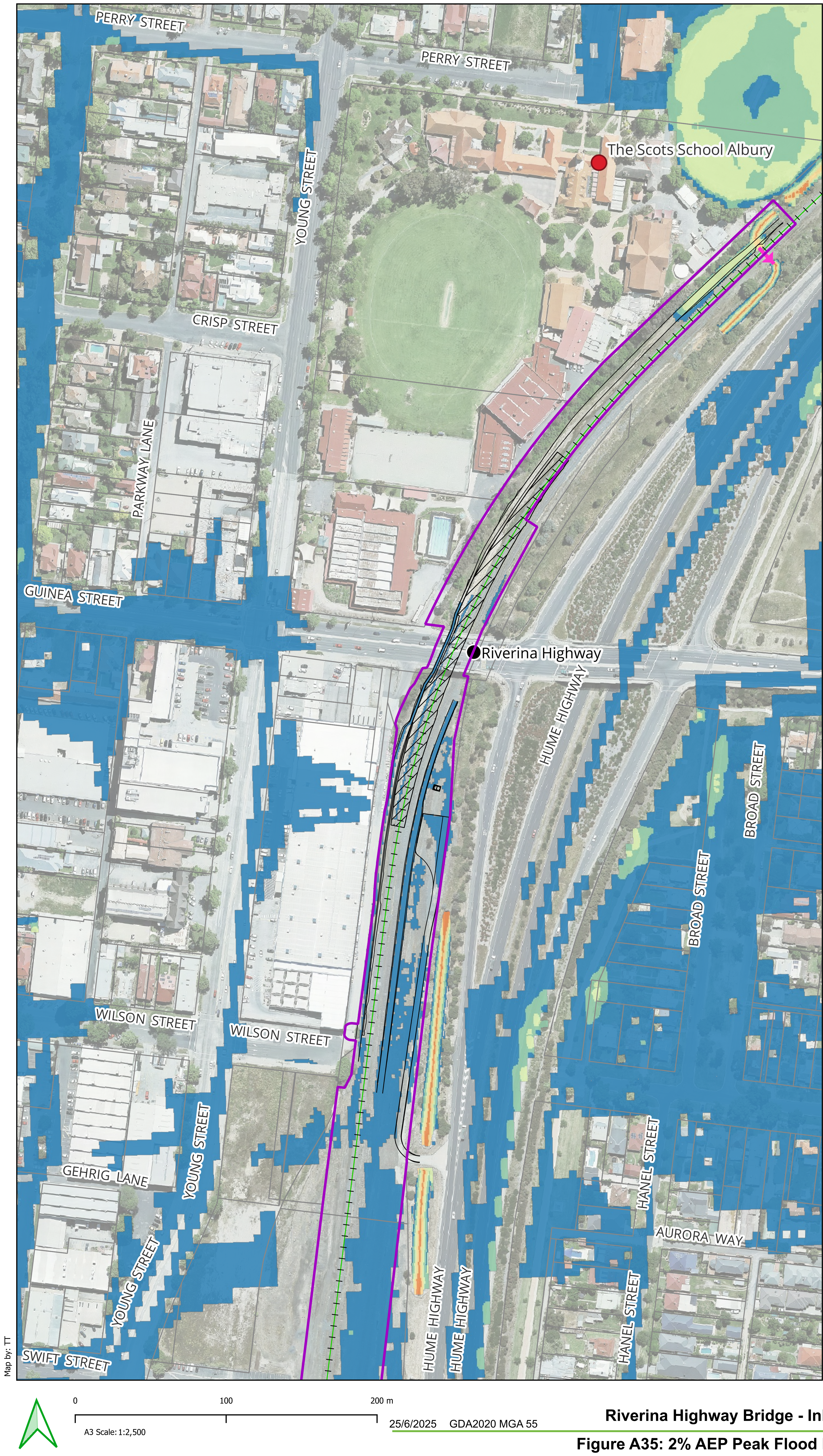
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A34: 5% AEP Peak Flood Hazard - Design Condition**

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## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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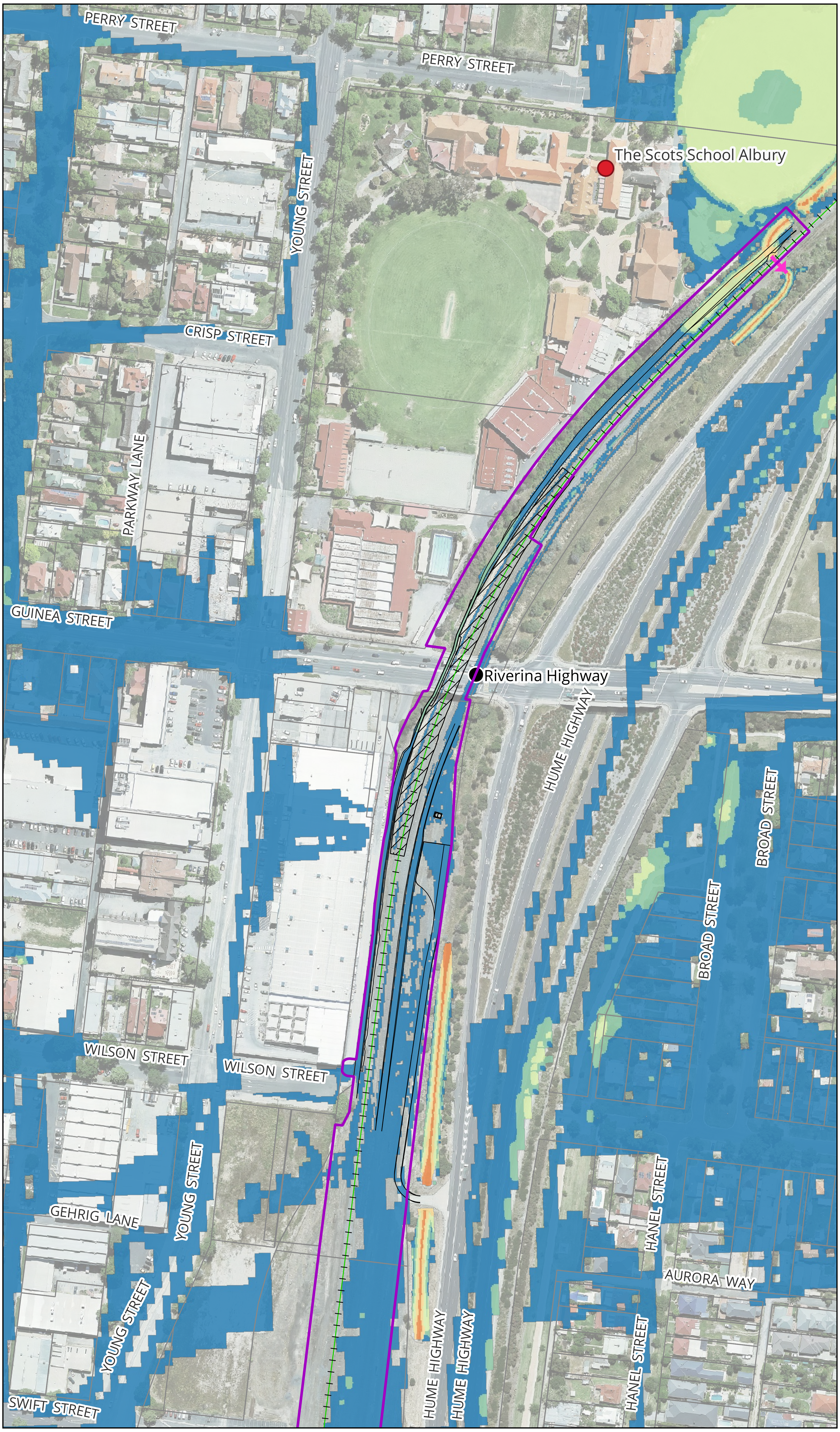
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A35: 2% AEP Peak Flood Hazard - Design Condition**




MARTINUS
aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

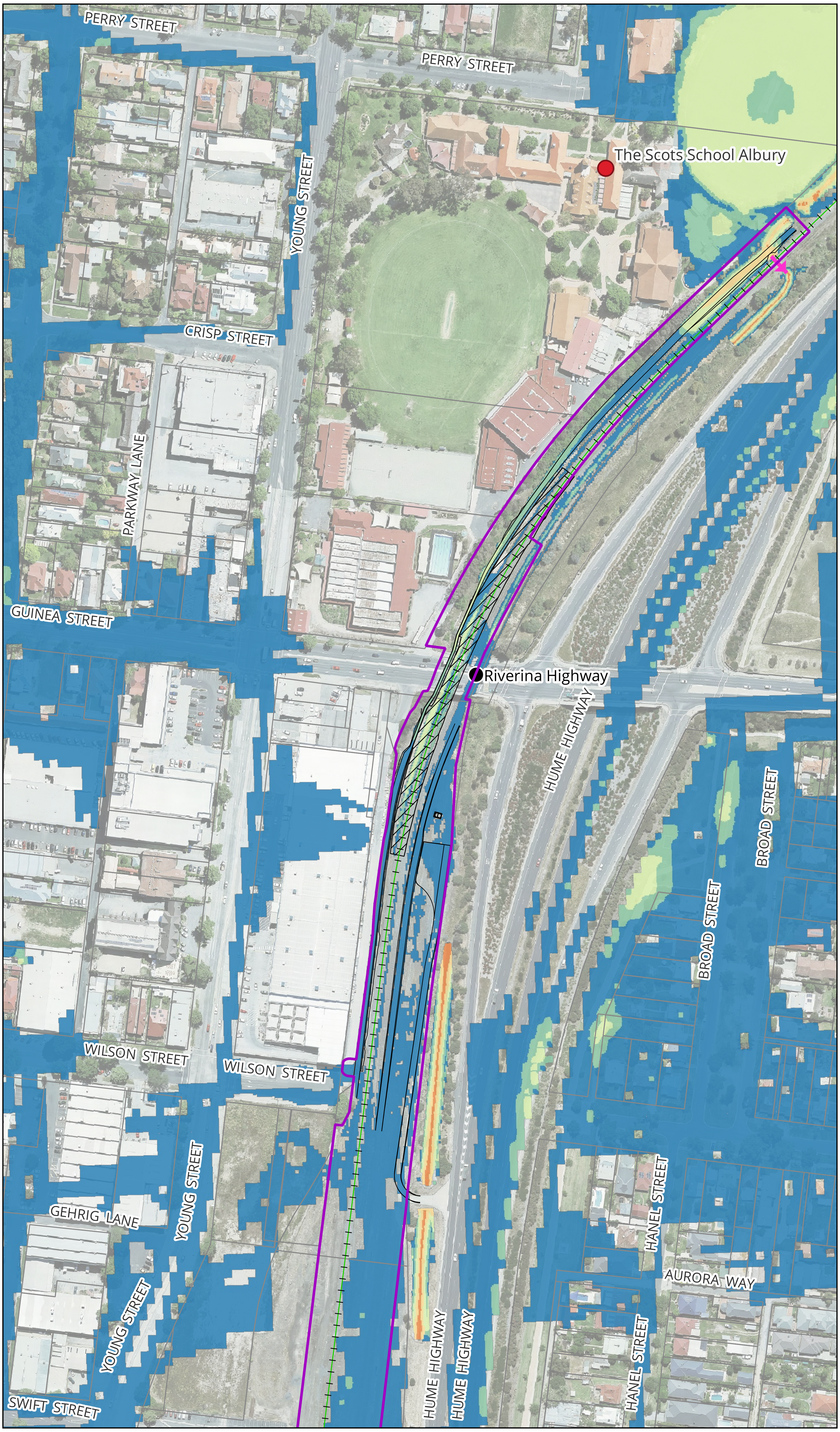
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A36: 1% AEP Peak Flood Hazard - Design Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

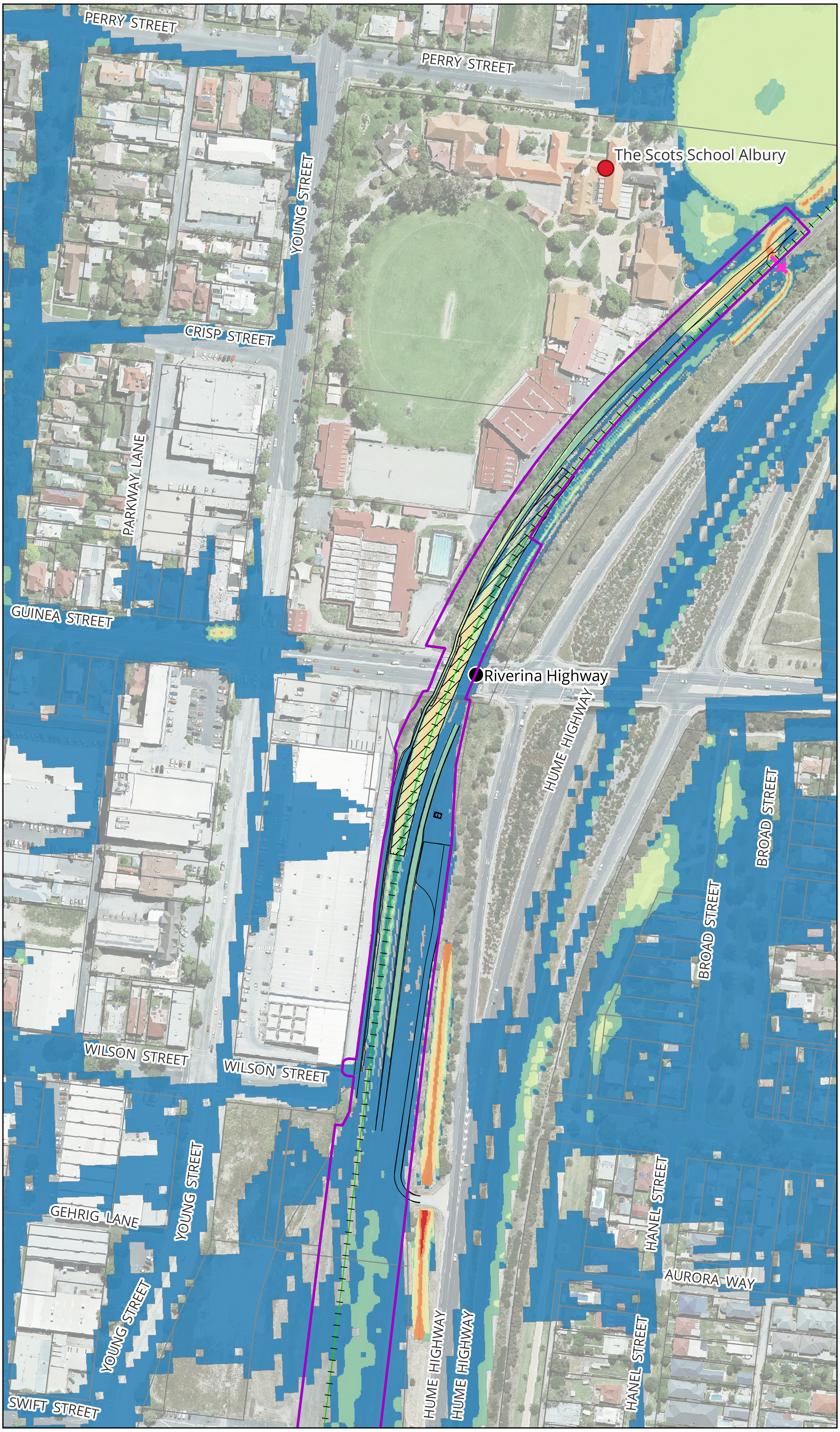
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A37: 1% AEP Peak Flood Hazard - Design Blockage Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

0 100 200 m

A3 Scale: 1:2,500

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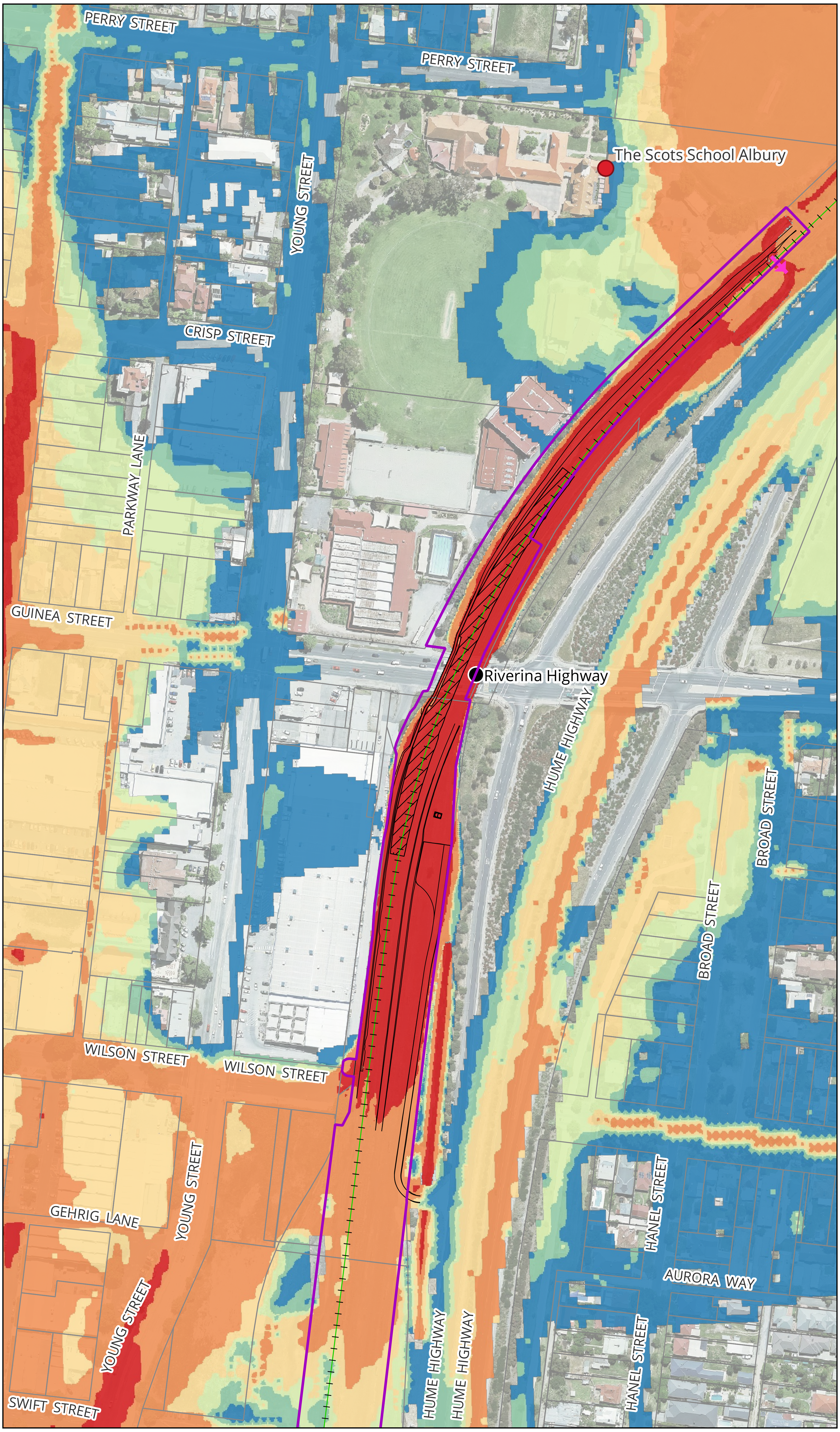
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A38: 1% AEP Climate Change Peak Flood Hazard - Design Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

0 100 200 m

A3 Scale: 1:2,500

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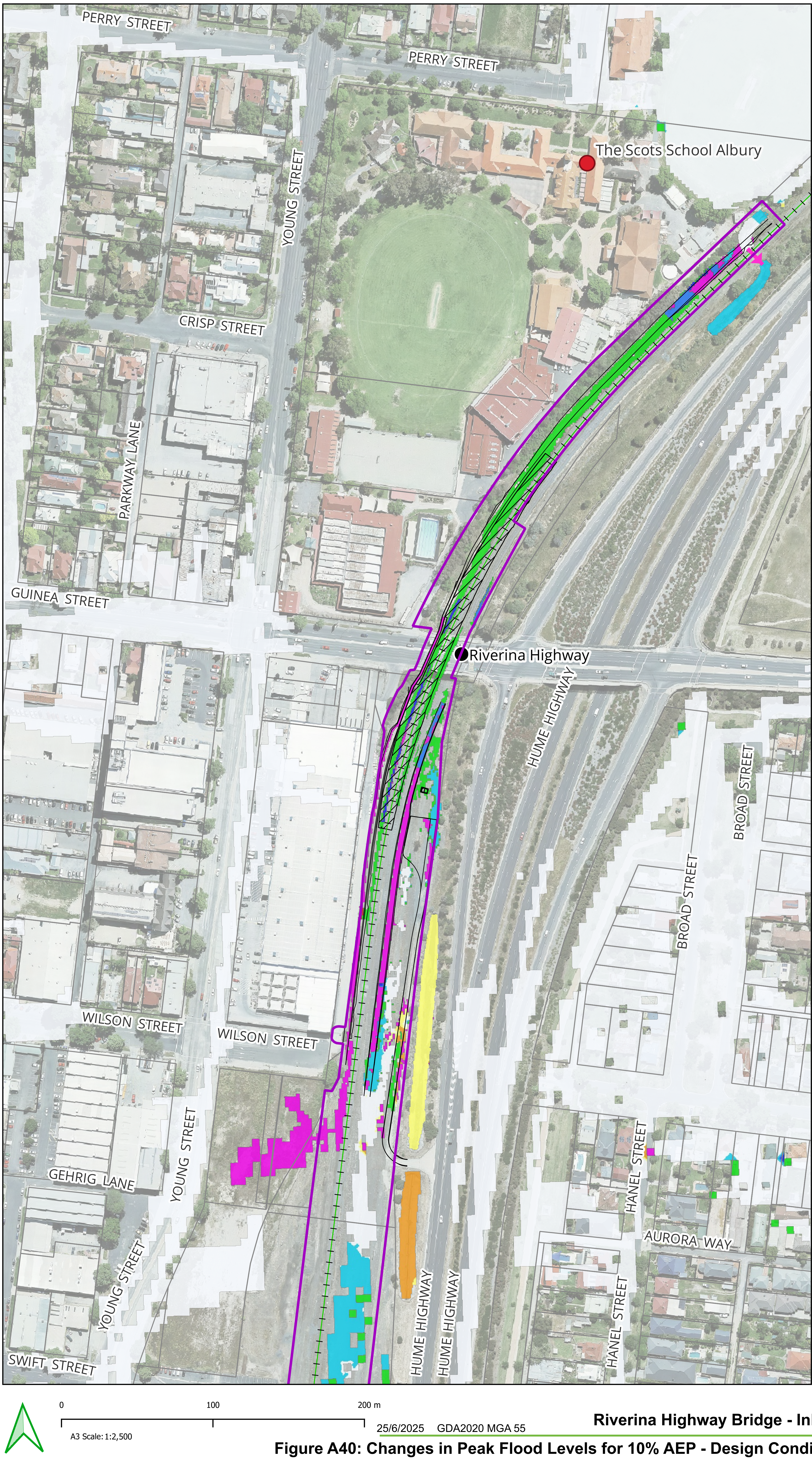
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A39: PMF Peak Flood Hazard - Design Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

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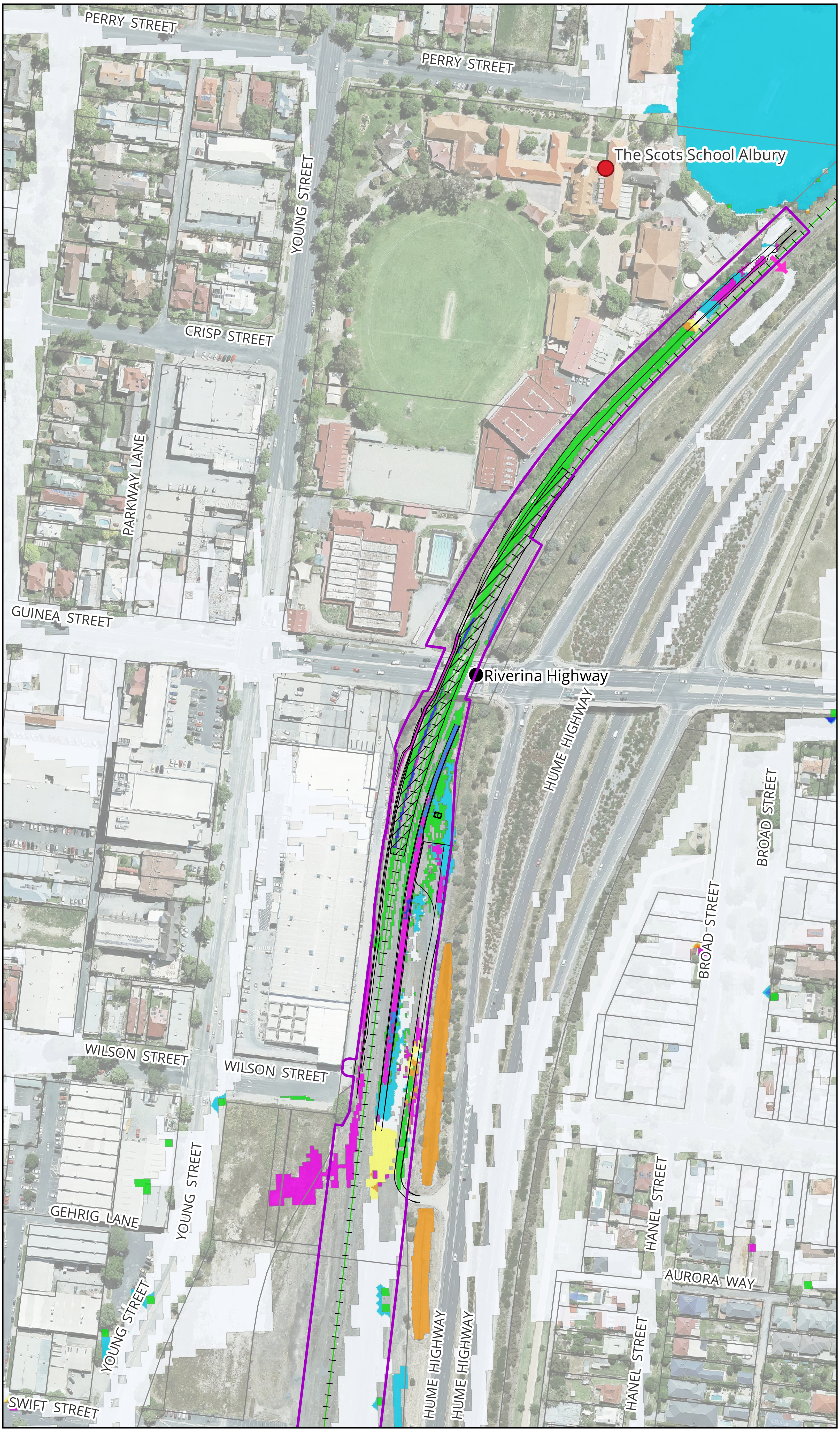
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A40: Changes in Peak Flood Levels for 10% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon

BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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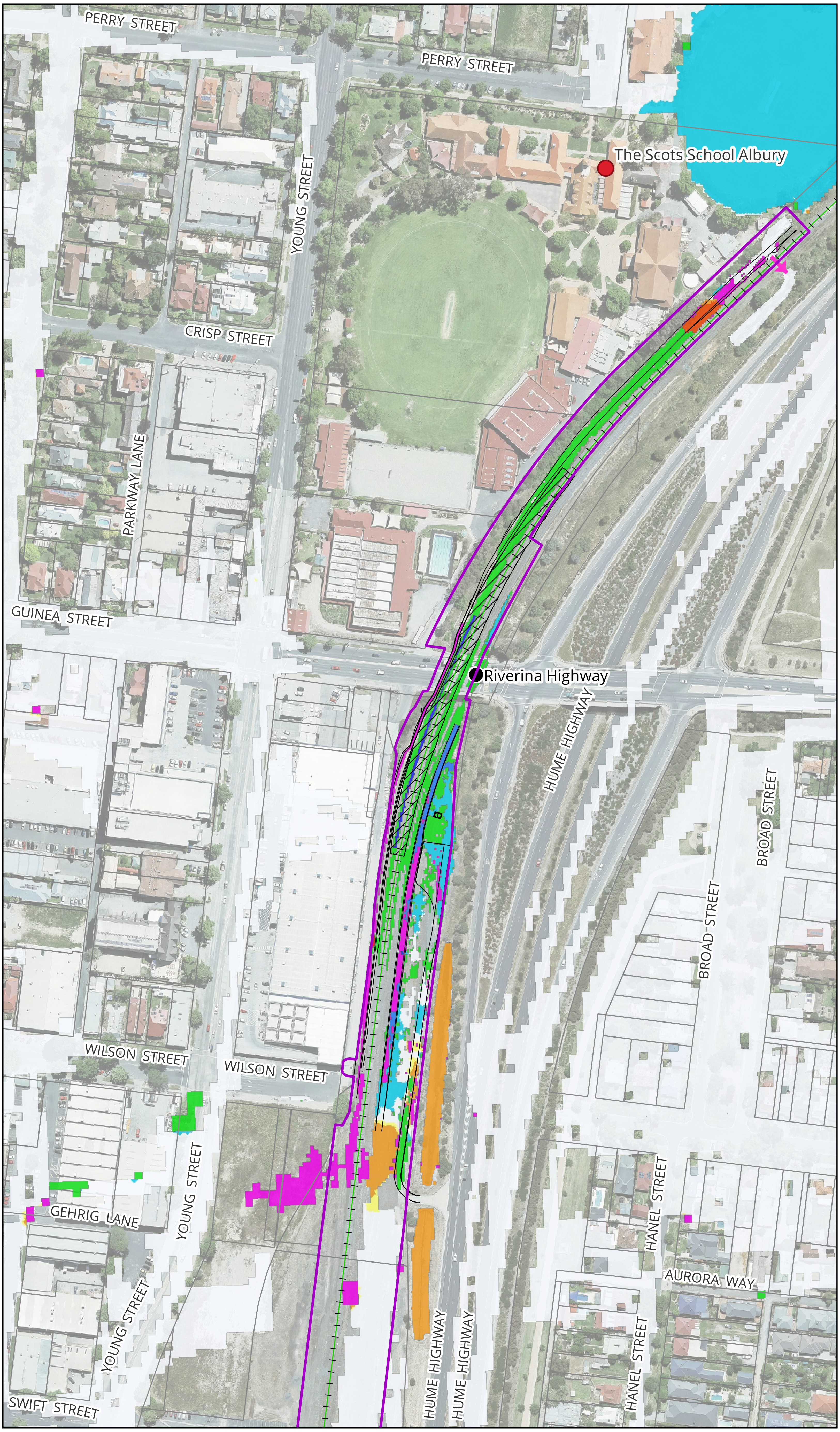
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A41: Changes in Peak Flood Levels for 5% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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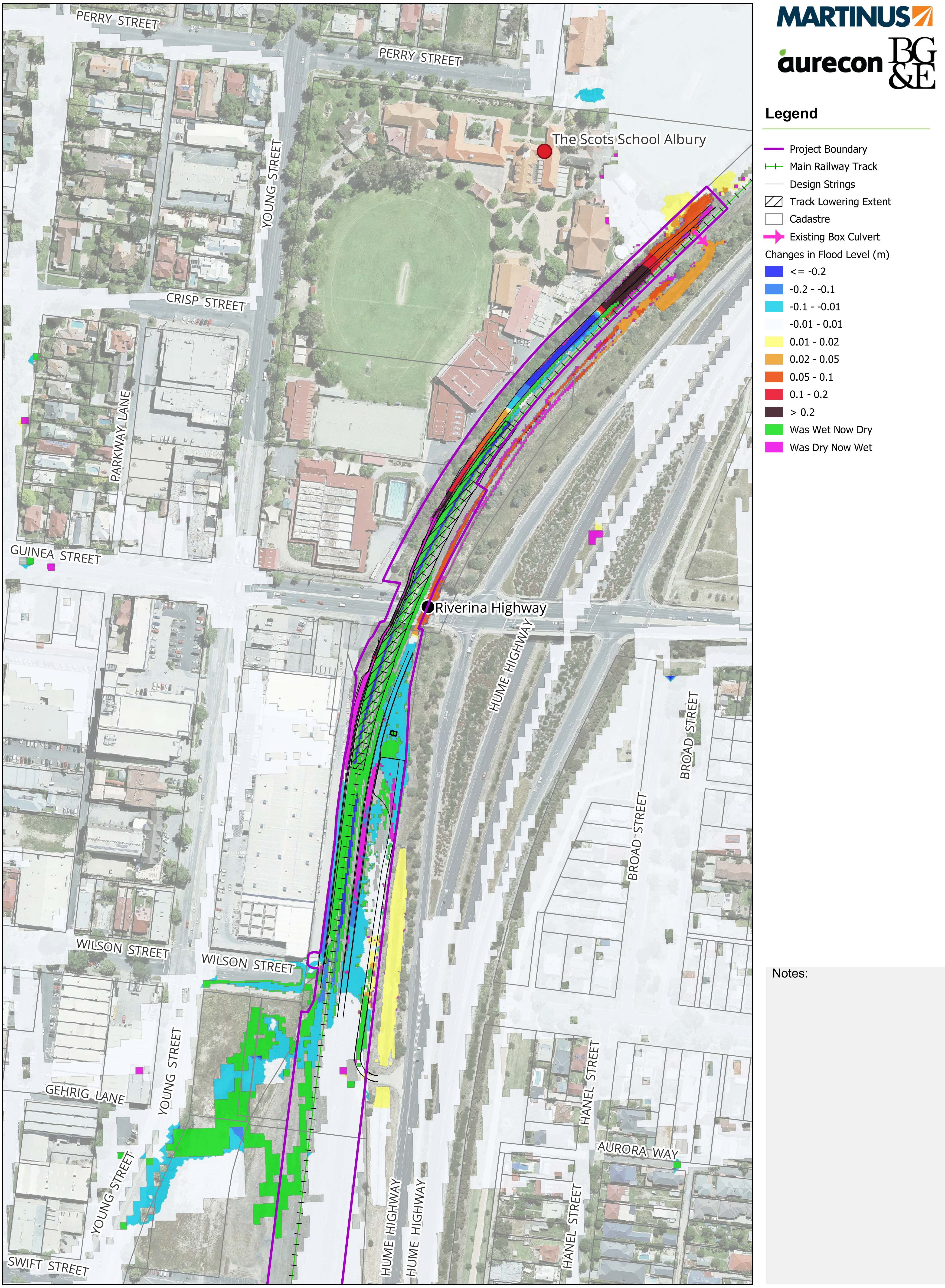
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A42: Changes in Peak Flood Levels for 2% AEP - Design Condition vs Existing Condition**



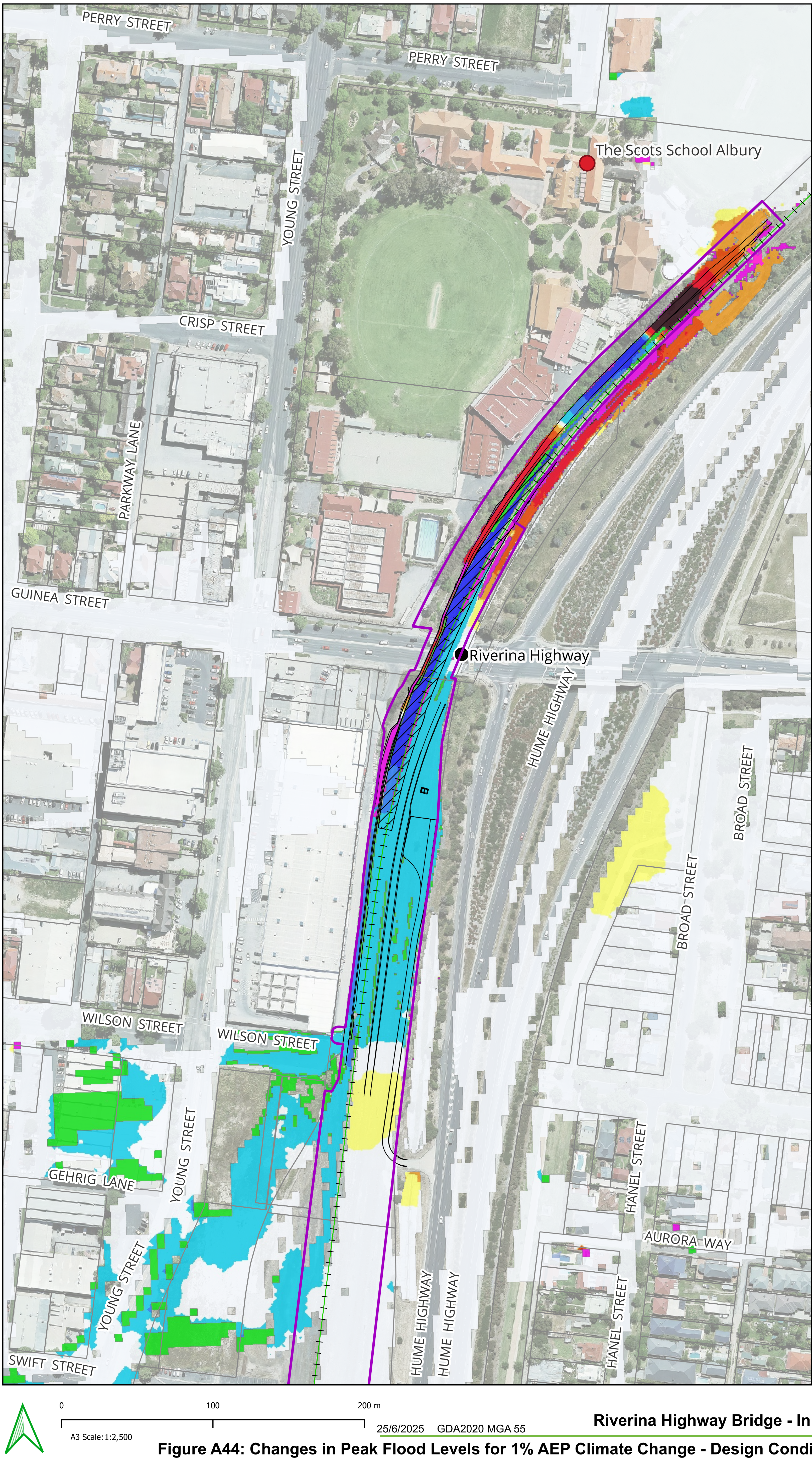

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A43: Changes in Peak Flood Levels for 1% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

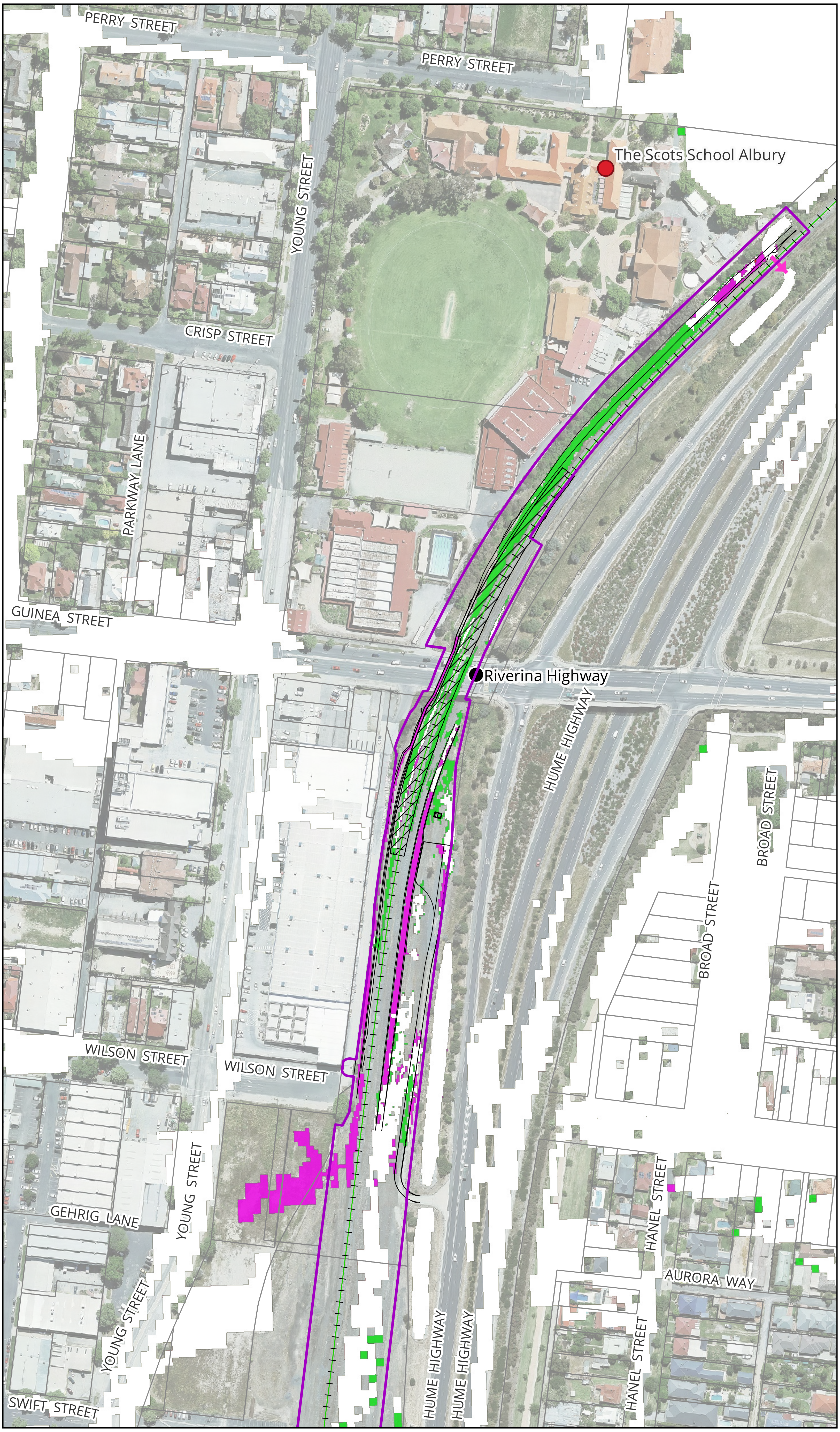
- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A44: Changes in Peak Flood Levels for 1% AEP Climate Change - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

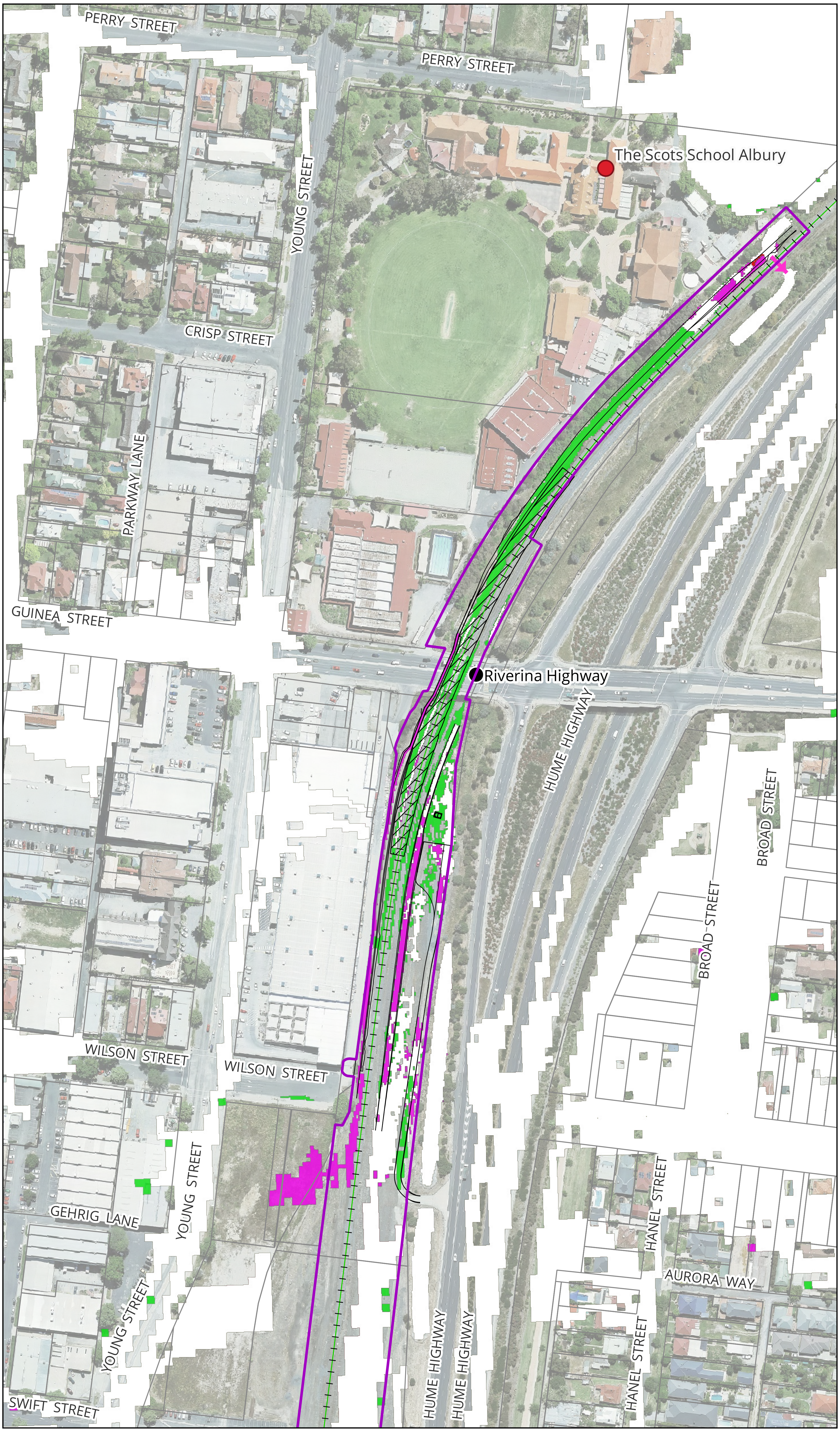
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A45: Changes in Peak Flood Velocity for 10% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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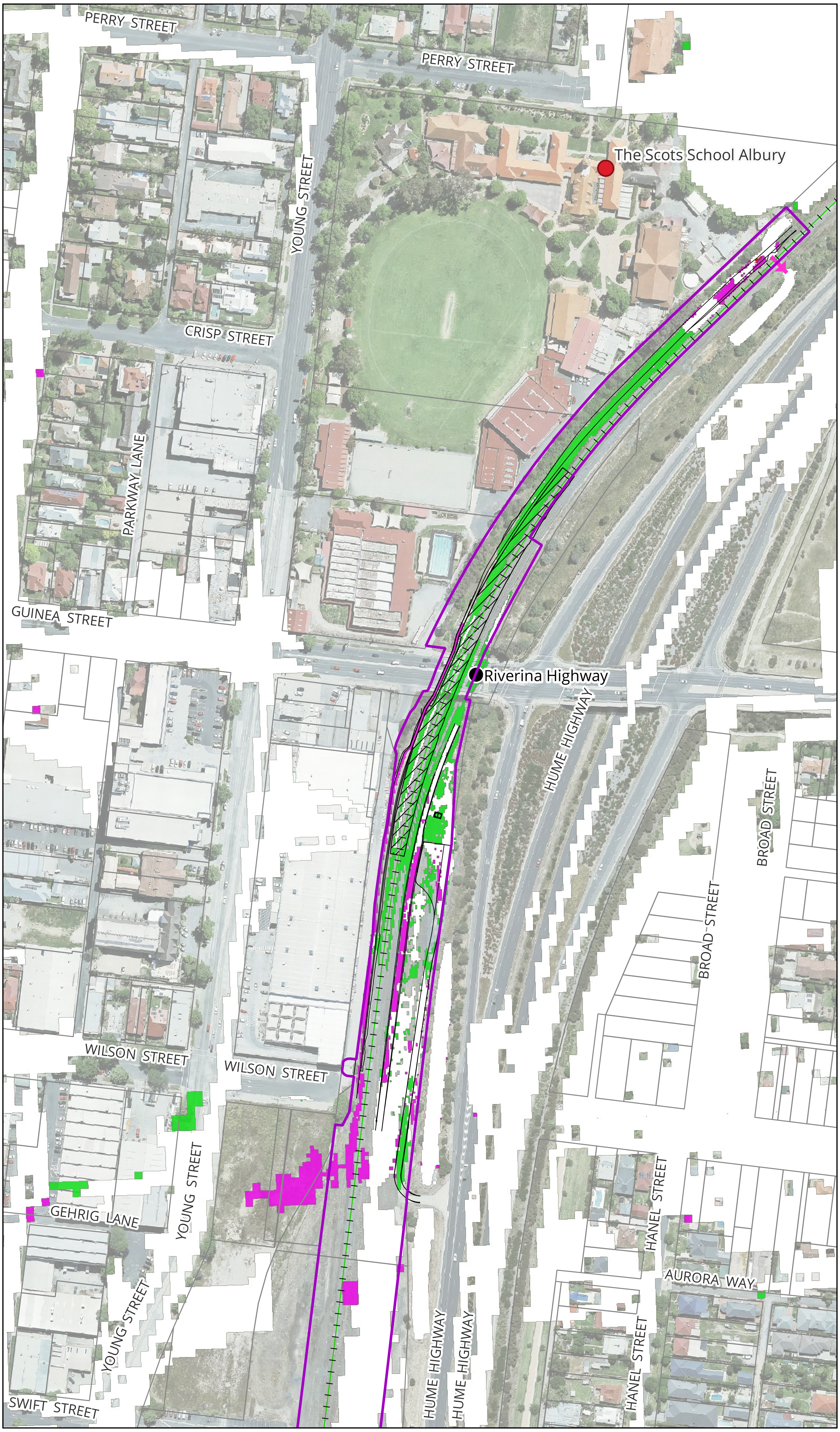
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A46: Changes in Peak Flood Velocity for 5% AEP - Design Condition vs Existing Condition**




MARTINUS
aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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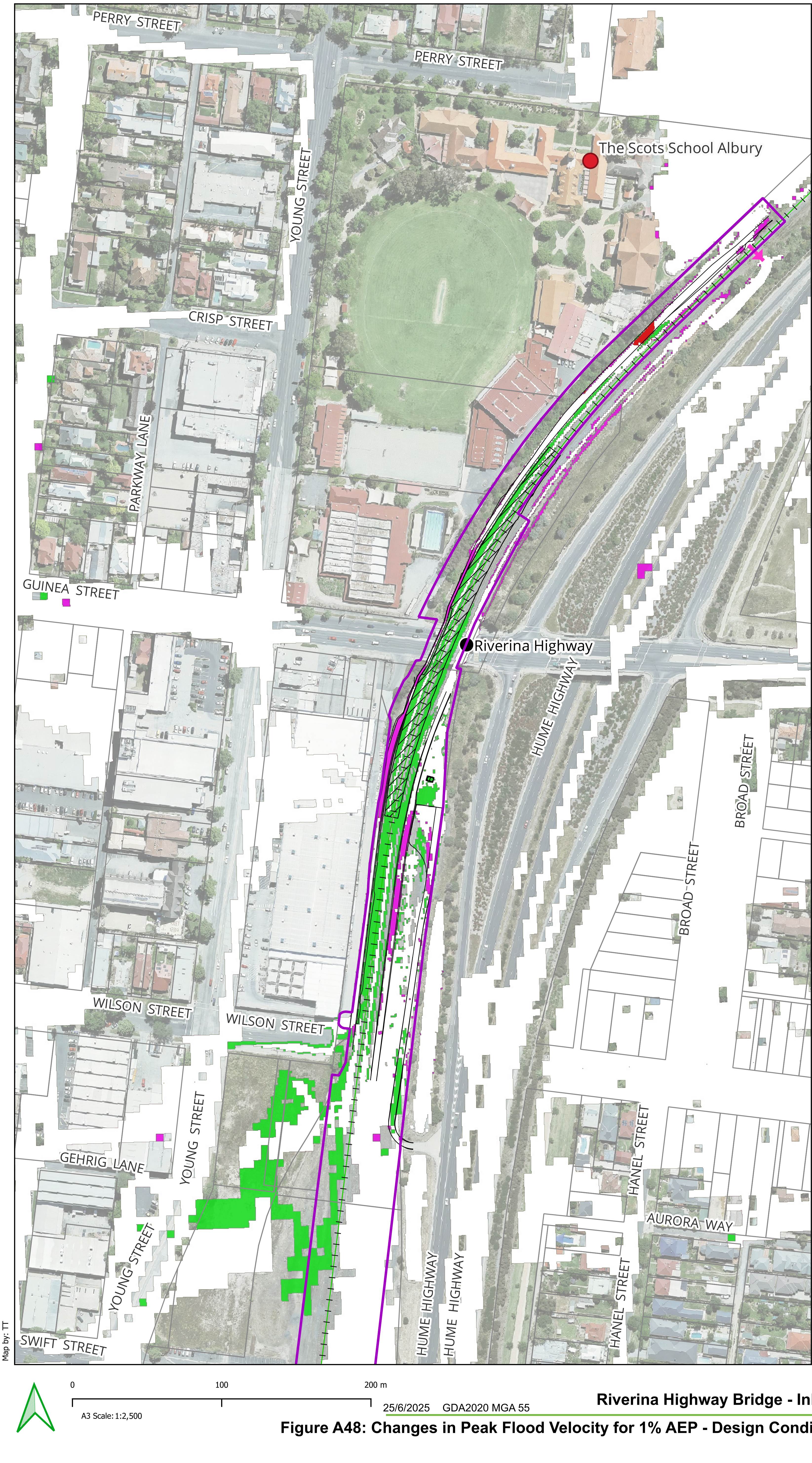
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A47: Changes in Peak Flood Velocity for 2% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

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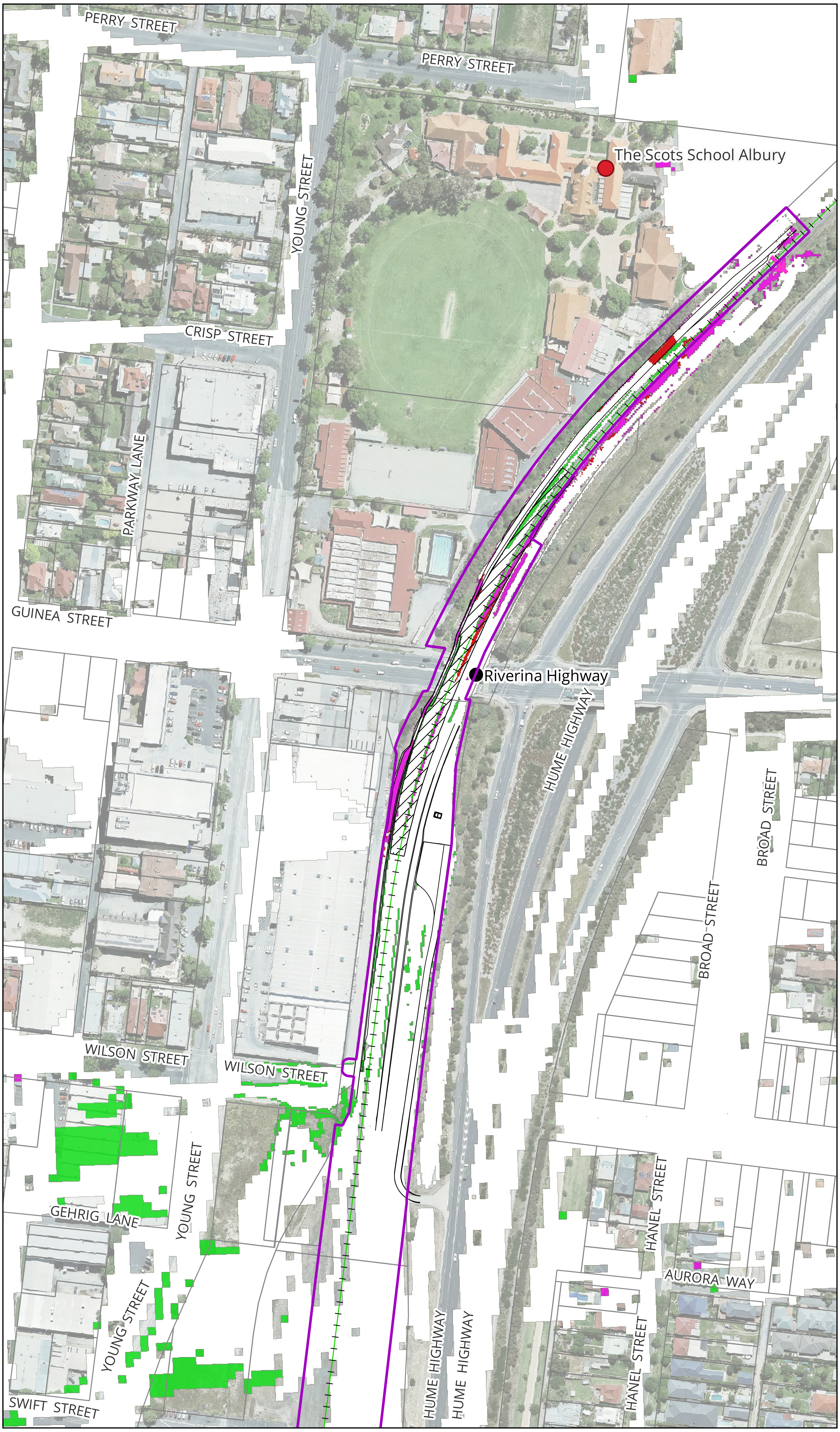
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A48: Changes in Peak Flood Velocity for 1% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

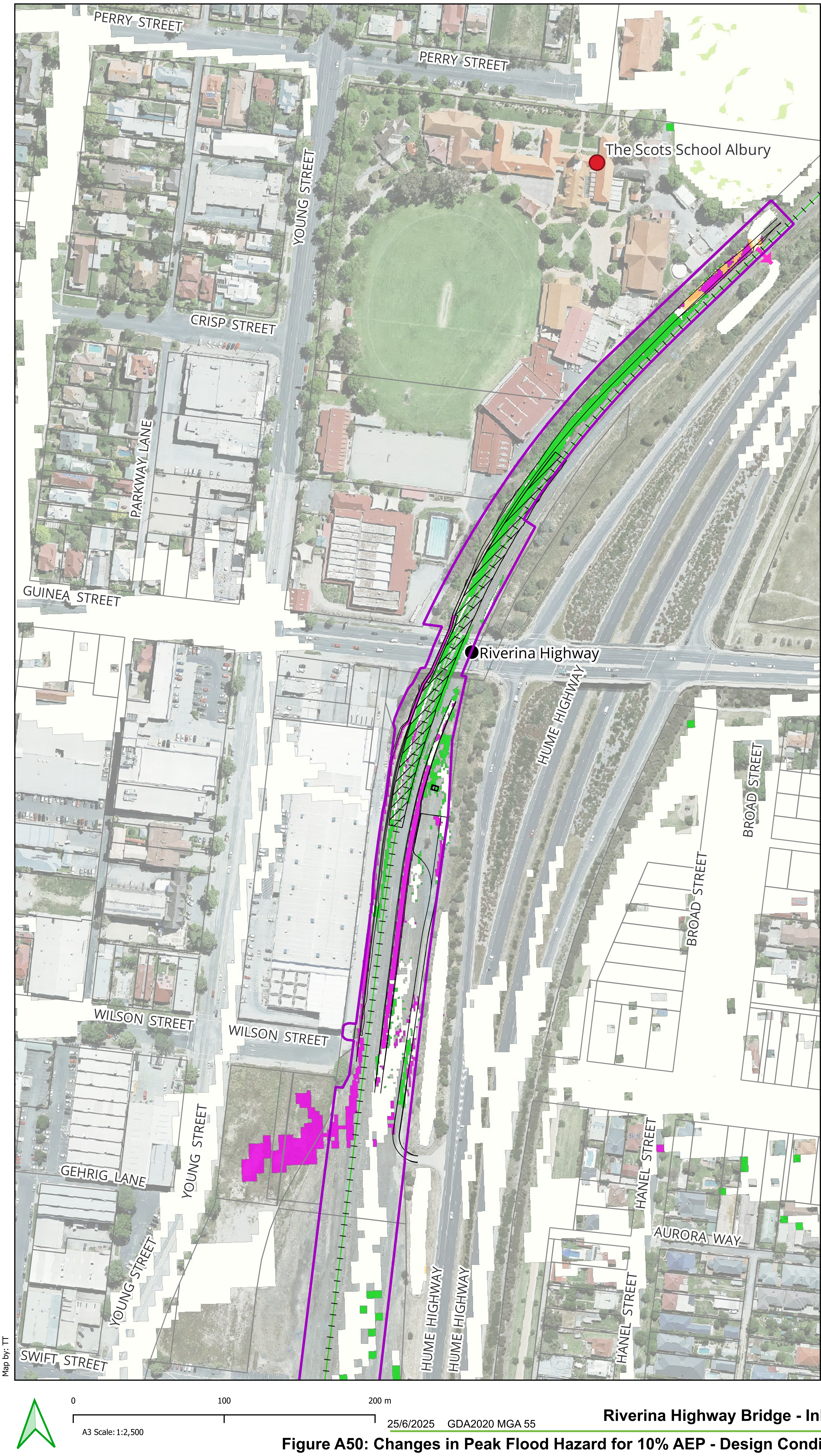
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A49: Changes in Peak Flood Velocity for 1% AEP Climate Change - Design Condition vs Existing Condition**




MARTINUS

aurecon

BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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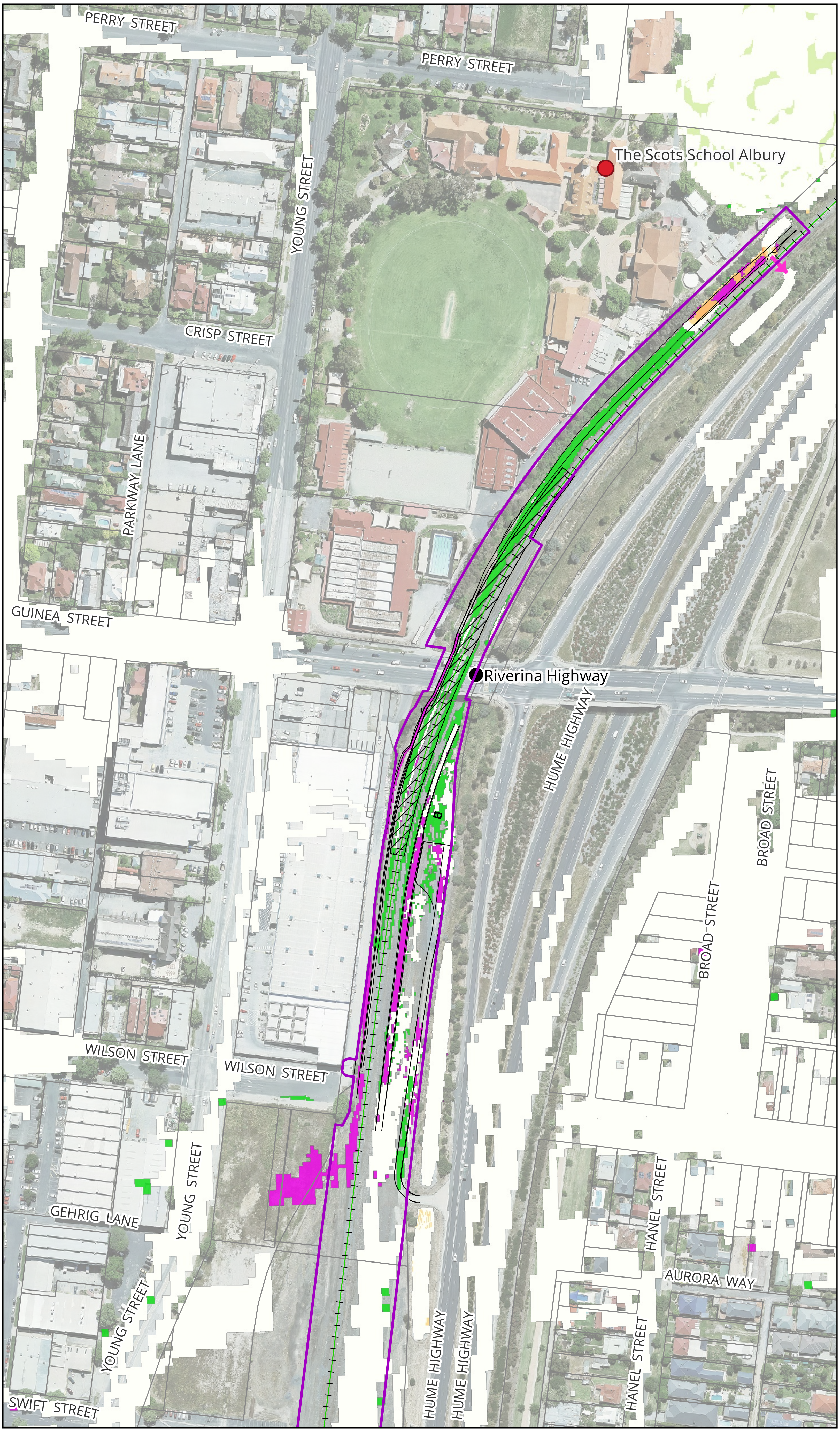
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A50: Changes in Peak Flood Hazard for 10% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

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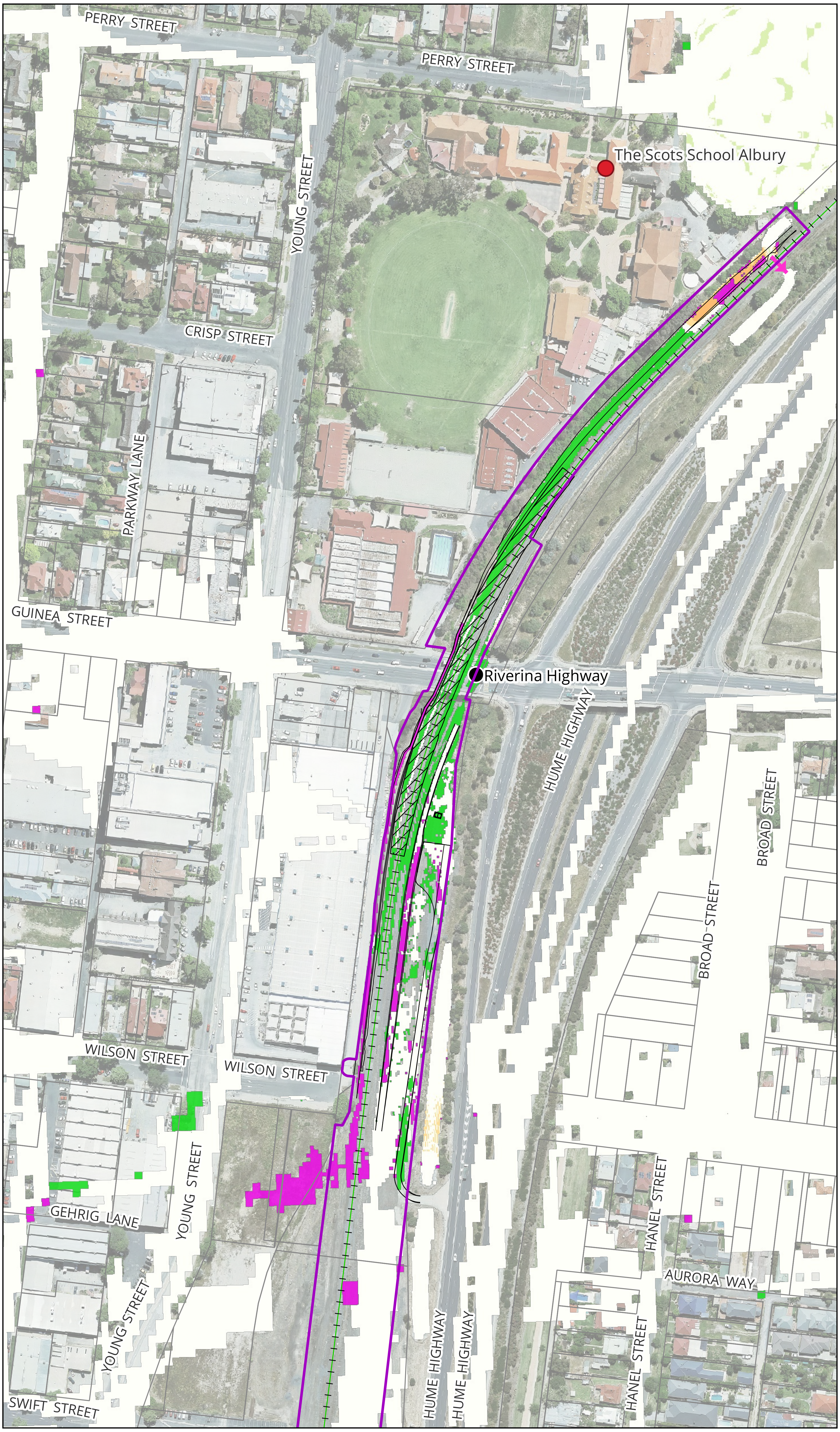
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A51: Changes in Peak Flood Hazard for 5% AEP - Design Condition vs Existing Condition**




Map by: TT

MARTINUS

aurecon

BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

0 100 200 m

A3 Scale: 1:2,500

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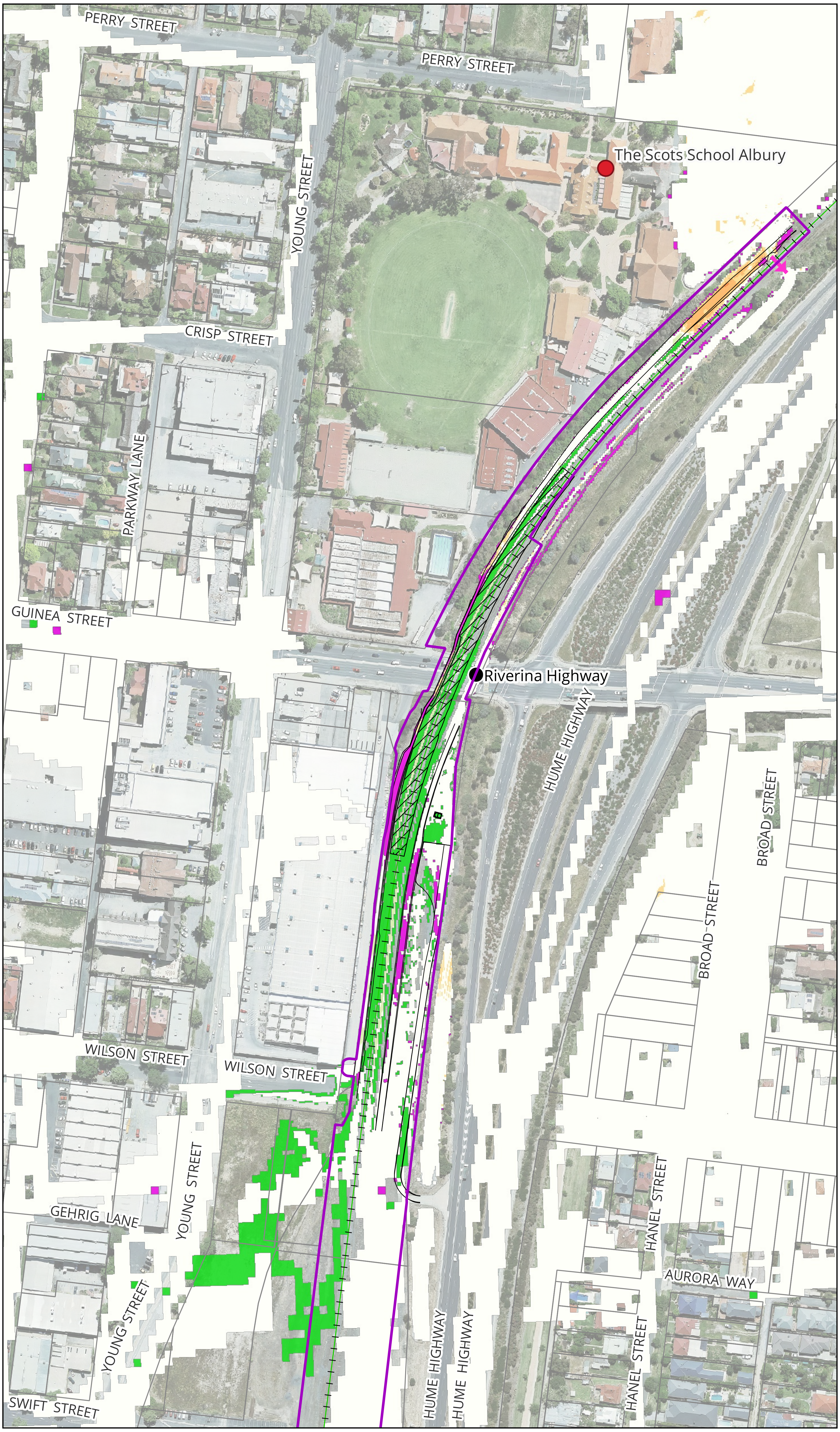
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A52: Changes in Peak Flood Hazard for 2% AEP - Design Condition vs Existing Condition**




MARTINUS
aurecon
BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m
A3 Scale: 1:2,500

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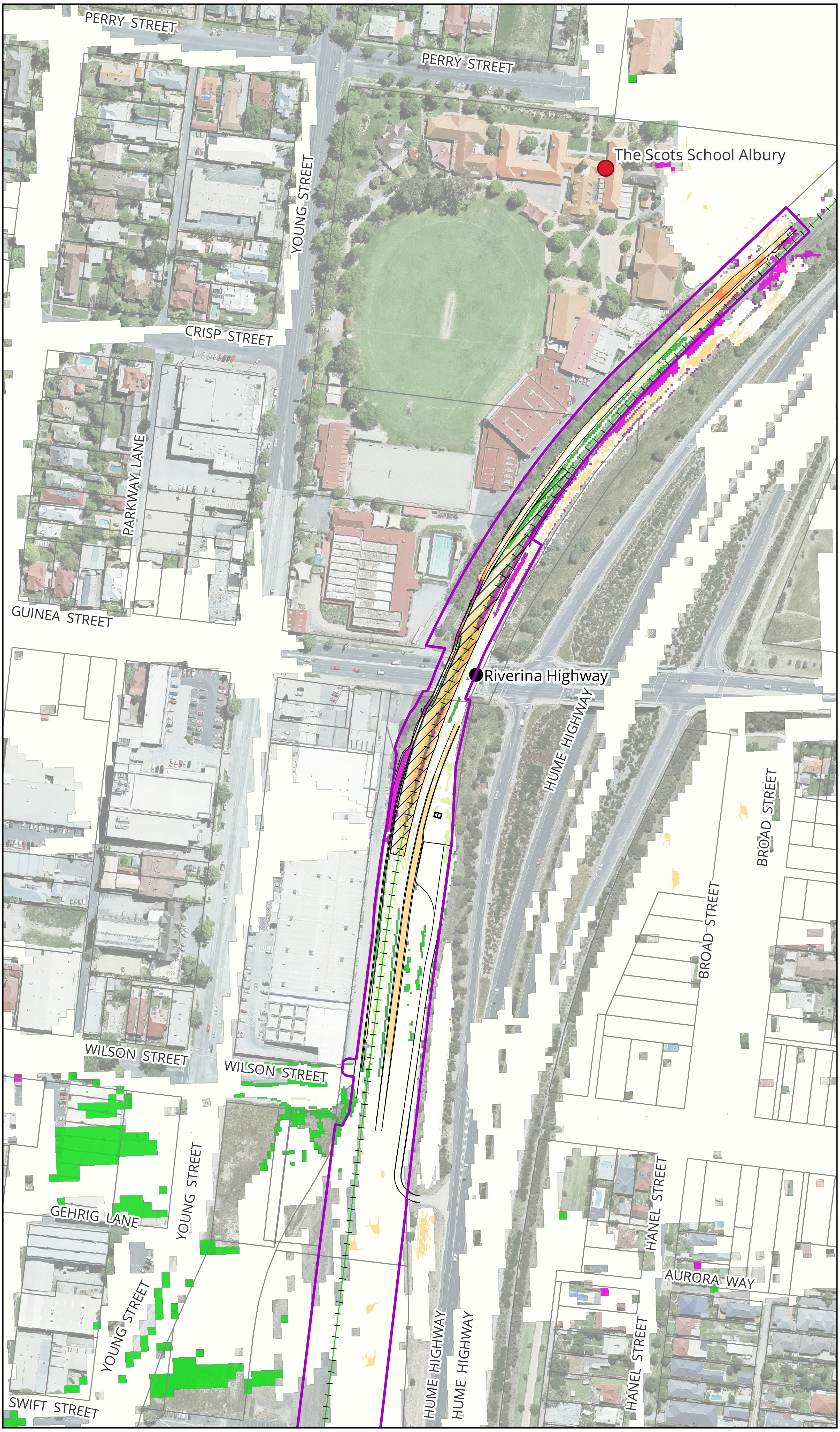
**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A53: Changes in Peak Flood Hazard for 1% AEP - Design Condition vs Existing Condition**




MARTINUS

aurecon BG&E

## Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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**Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage**

**Figure A54: Changes in Peak Flood Hazard for 1% AEP Climate Change - Design Condition vs Existing Condition**

# APPENDIX B

## ARR2019 Information

Results - ARR Data Hub
[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-36.046717
Longitude,146.927849
[END_INPUTDATA]

River Region
[RIVREG]
Division,Murray-Darling Basin
River Number,10
River Name,Murray Riverina
[RIVREG_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone,Southern Temperate
a,0.158
b,0.276
c,0.372
d,0.315
e,0.000141
f,0.41
g,0.15
h,0.01
i,-0.0027
[LONGARF_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,25723.0
Storm Initial Losses (mm),27.0
Storm Continuing Losses (mm/h),4.5
[LOSSES_META]

Time Accessed,30 May 2024 09:28PM

Version,2016_v1

[END_LOSSES]

Temporal Patterns

[TP]

code,MB

Label,Murray Basin

[TP_META]

Time Accessed,30 May 2024 09:28PM

Version,2016_v2

[END_TP]

Areal Temporal Patterns

[ATP]

code,MB

arealabel,Murray Basin

[ATP_META]

Time Accessed,30 May 2024 09:28PM

Version,2016_v2

[END_ATP]

Median Preburst Depths and Ratios

[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),2.5 (0.126),1.9 (0.074),1.6 (0.051),1.2 (0.035),1.2 (0.028),1.1 (0.024)

90 (1.5),2.5 (0.113),2.1 (0.073),1.9 (0.055),1.7 (0.043),1.0 (0.022),0.5 (0.009)

120 (2.0),4.0 (0.169),3.4 (0.108),3.0 (0.082),2.7 (0.063),1.3 (0.026),0.2 (0.004)

180 (3.0),2.8 (0.104),2.9 (0.081),2.9 (0.071),3.0 (0.064),1.4 (0.026),0.2 (0.004)

360 (6.0),2.6 (0.080),2.1 (0.050),1.8 (0.036),1.5 (0.026),3.4 (0.052),4.8 (0.067)

720 (12.0),0.3 (0.008),1.0 (0.019),1.4 (0.023),1.8 (0.027),3.1 (0.038),4.0 (0.045)

1080 (18.0),0.0 (0.000),0.5 (0.009),0.9 (0.012),1.2 (0.015),1.9 (0.021),2.5 (0.025)

1440 (24.0),0.0 (0.000),0.1 (0.002),0.2 (0.003),0.3 (0.004),0.9 (0.009),1.3 (0.012)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST_META]

Time Accessed,30 May 2024 09:28PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST]From preburst class

10% Preburst Depths

[PREBURST10]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST10_META]

Time Accessed,30 May 2024 09:28PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST10]From preburst class

25% Preburst Depths

[PREBURST25]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.1 (0.006),0.1 (0.003),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.1 (0.005),0.1 (0.002),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.1 (0.004),0.1 (0.002),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST25_META]

Time Accessed,30 May 2024 09:28PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST25]From preburst class

75% Preburst Depths

[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),17.2 (0.879),16.2 (0.615),15.5 (0.501),14.8 (0.418),14.8 (0.356),14.7 (0.319)
90 (1.5),16.8 (0.763),17.7 (0.601),18.3 (0.530),18.8 (0.477),14.8 (0.322),11.9 (0.232)
120 (2.0),16.5 (0.688),17.3 (0.545),17.8 (0.481),18.4 (0.433),15.6 (0.317),13.6 (0.248)
180 (3.0),14.6 (0.543),15.4 (0.435),15.9 (0.387),16.4 (0.351),14.1 (0.259),12.3 (0.205)
360 (6.0),12.5 (0.380),13.7 (0.322),14.6 (0.295),15.4 (0.275),18.0 (0.278),20.0 (0.279)
720 (12.0),5.4 (0.133),8.3 (0.158),10.2 (0.169),12.0 (0.176),15.7 (0.198),18.5 (0.210)
1080 (18.0),1.9 (0.042),6.1 (0.103),8.9 (0.130),11.5 (0.149),12.1 (0.133),12.5 (0.123)
1440 (24.0),1.5 (0.030),4.4 (0.067),6.3 (0.083),8.1 (0.095),9.6 (0.096),10.8 (0.096)
2160 (36.0),0.0 (0.000),0.9 (0.013),1.6 (0.018),2.2 (0.022),3.9 (0.034),5.3 (0.041)
2880 (48.0),0.0 (0.000),0.6 (0.007),1.0 (0.011),1.4 (0.013),2.0 (0.016),2.4 (0.017)
4320 (72.0),0.0 (0.000),0.1 (0.001),0.2 (0.002),0.3 (0.002),0.3 (0.002),0.4 (0.003)
[PREBURST75_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST75]From preburst class

90% Preburst Depths

[PREBURST90]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),39.4 (2.013),34.2 (1.303),30.9 (0.997),27.6 (0.777),27.7 (0.667),27.9 (0.602)
90 (1.5),32.5 (1.475),37.1 (1.259),40.1 (1.161),42.9 (1.087),33.0 (0.716),25.5 (0.499)
120 (2.0),36.1 (1.509),39.1 (1.232),41.1 (1.108),43.1 (1.015),45.5 (0.923),47.3 (0.866)
180 (3.0),27.2 (1.012),32.9 (0.933),36.8 (0.894),40.5 (0.864),34.4 (0.633),29.8 (0.497)
360 (6.0),23.4 (0.715),26.5 (0.622),28.6 (0.579),30.5 (0.546),36.2 (0.559),40.4 (0.565)
720 (12.0),19.0 (0.468),22.7 (0.433),25.1 (0.416),27.5 (0.403),29.7 (0.374),31.4 (0.356)
1080 (18.0),13.1 (0.284),18.7 (0.315),22.4 (0.327),26.0 (0.335),25.8 (0.284),25.7 (0.253)
1440 (24.0),12.5 (0.249),18.4 (0.283),22.3 (0.297),26.1 (0.306),24.8 (0.247),23.8 (0.213)
2160 (36.0),4.8 (0.085),9.7 (0.131),12.8 (0.150),15.9 (0.163),19.1 (0.165),21.4 (0.166)
2880 (48.0),4.6 (0.075),7.3 (0.091),9.2 (0.098),10.9 (0.102),18.7 (0.148),24.6 (0.173)
4320 (72.0),1.4 (0.021),6.2 (0.069),9.3 (0.089),12.3 (0.103),13.7 (0.096),14.7 (0.092)
[PREBURST90_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST90]From preburst class

Interim Climate Change Factors

[CCF]
,RCP 4.5,RCP6,RCP 8.5
2030,0.816 (4.1%),0.726 (3.6%),0.934 (4.7%)

2040,1.046 (5.2%),1.015 (5.1%),1.305 (6.6%)

2050,1.260 (6.3%),1.277 (6.4%),1.737 (8.8%)

2060,1.450 (7.3%),1.520 (7.7%),2.214 (11.4%)

2070,1.609 (8.2%),1.753 (8.9%),2.722 (14.2%)

2080,1.728 (8.8%),1.985 (10.2%),3.246 (17.2%)

2090,1.798 (9.2%),2.226 (11.5%),3.772 (20.2%)

[CCF_META]

Time Accessed,30 May 2024 09:28PM

Version,2019_v1

Note,ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

[END_CCF]

Probability Neutral Burst Initial Loss

[BURSTIL]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),18.3,9.5,8.9,9.7,9.7,8.7

90 (1.5),18.6,10.2,9.1,9.2,9.2,8.8

120 (2.0),17.8,10.1,9.2,9.2,9.0,7.8

180 (3.0),19.0,11.6,10.1,10.2,9.7,9.2

360 (6.0),19.7,13.3,11.6,12.1,10.3,6.7

720 (12.0),22.1,15.8,14.4,14.5,12.6,8.0

1080 (18.0),23.7,17.7,16.4,16.1,14.8,10.9

1440 (24.0),24.2,18.4,17.6,17.8,16.8,12.2

2160 (36.0),26.2,21.2,21.1,22.0,20.1,14.0

2880 (48.0),26.5,22.1,22.4,22.8,22.0,14.2

4320 (72.0),27.3,22.6,23.6,24.1,23.6,19.0

[BURSTIL_META]

Time Accessed,30 May 2024 09:28PM

Version,2018_v1

Note,As this point is in NSW the advice provided on losses and pre-burst on the <a href="./nsw_specific">NSW Specific Tab of the ARR Data Hub</a> is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

[END_BURSTIL]

Transformational Pre-burst Rainfall

[PREBURST_TRANS]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),8.6,17.4,18.0,17.2,17.2,18.2

90 (1.5),8.3,16.7,17.8,17.7,17.7,18.1

120 (2.0),9.1,16.8,17.7,17.7,17.9,19.1

180 (3.0),7.9,15.3,16.8,16.7,17.2,17.7

360 (6.0),7.2,13.6,15.3,14.8,16.6,20.2

720 (12.0),4.8,11.1,12.5,12.4,14.3,18.9

1080 (18.0),3.2,9.2,10.5,10.8,12.1,16.0

1440 (24.0),2.7,8.5,9.3,9.1,10.1,14.7

2160 (36.0),0.7,5.7,5.8,4.9,6.8,12.9

2880 (48.0),0.4,4.8,4.5,4.1,4.9,12.7

4320 (72.0),0.0,4.3,3.3,2.8,3.3,7.9

[PREBURST_TRANS_META]

The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.

[END_PREBURST_TRANS]

[ENDTXT]

# APPENDIX C

## Rainfall Depth

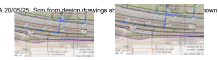
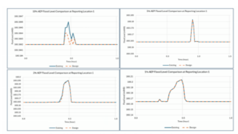
| Duration | 50% | 20% | 10% | 5% | 2% | 1% | 1 in 200 | 1 in 500 | 1 in 1000 | 1 in 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 min | 1.92 | 2.59 | 3.06 | 3.52 | 4.13 | 4.61 | 5.06 | 5.72 | 6.24 | 6.78 |
| 2 min | 3.25 | 4.38 | 5.16 | 5.9 | 6.81 | 7.5 | 8.35 | 9.54 | 10.5 | 11.5 |
| 3 min | 4.42 | 5.95 | 7 | 8.02 | 9.28 | 10.2 | 11.3 | 12.9 | 14.2 | 15.5 |
| 4 min | 5.43 | 7.32 | 8.61 | 9.87 | 11.5 | 12.7 | 14 | 15.9 | 17.4 | 19 |
| 5 min | 6.32 | 8.52 | 10 | 11.5 | 13.4 | 14.9 | 16.4 | 18.6 | 20.3 | 22.1 |
| 10 min | 9.55 | 12.9 | 15.3 | 17.6 | 20.7 | 23.1 | 25.3 | 28.5 | 31.1 | 33.7 |
| 15 min | 11.7 | 15.8 | 18.7 | 21.6 | 25.5 | 28.5 | 31.2 | 35.2 | 38.4 | 41.6 |
| 20 min | 13.3 | 18 | 21.2 | 24.5 | 28.9 | 32.4 | 35.5 | 40.1 | 43.7 | 47.4 |
| 25 min | 14.5 | 19.7 | 23.2 | 26.8 | 31.6 | 35.3 | 38.8 | 43.9 | 47.9 | 52 |
| 30 min | 15.5 | 21 | 24.8 | 28.6 | 33.7 | 37.7 | 41.4 | 46.9 | 51.2 | 55.7 |
| 45 min | 17.9 | 24.1 | 28.4 | 32.7 | 38.4 | 42.8 | 47.1 | 53.4 | 58.4 | 63.6 |
| 1 hour | 19.5 | 26.3 | 30.9 | 35.5 | 41.6 | 46.3 | 51 | 57.8 | 63.3 | 68.9 |
| 1.5 hour | 22 | 29.4 | 34.5 | 39.5 | 46.1 | 51.1 | 56.3 | 63.8 | 69.8 | 76 |
| 2 hour | 23.9 | 31.8 | 37.1 | 42.4 | 49.3 | 54.6 | 60.1 | 68 | 74.3 | 80.9 |
| 3 hour | 26.8 | 35.3 | 41.1 | 46.8 | 54.3 | 60 | 65.8 | 74.3 | 81 | 88 |
| 4.5 hour | 30.1 | 39.3 | 45.6 | 51.8 | 60 | 66.3 | 72.3 | 81.5 | 88.7 | 96 |
| 6 hour | 32.8 | 42.6 | 49.3 | 55.9 | 64.7 | 71.6 | 77.9 | 87.6 | 95.2 | 103 |
| 9 hour | 37.1 | 47.9 | 55.3 | 62.6 | 72.7 | 80.5 | 87.5 | 98.2 | 107 | 115 |
| 12 hour | 40.5 | 52.3 | 60.3 | 68.2 | 79.5 | 88.2 | 95.9 | 108 | 117 | 126 |
| 18 hour | 46 | 59.4 | 68.6 | 77.6 | 90.9 | 101 | 110 | 124 | 135 | 147 |
| 24 hour | 50.3 | 65.1 | 75.3 | 85.4 | 100 | 112 | 123 | 139 | 152 | 165 |
| 30 hour | 53.8 | 69.9 | 81 | 91.9 | 108 | 121 | 138 | 159 | 176 | 194 |
| 36 hour | 56.8 | 74 | 85.9 | 97.6 | 115 | 129 | 149 | 174 | 194 | 216 |
| 48 hour | 61.5 | 80.6 | 93.8 | 107 | 127 | 143 | 165 | 193 | 217 | 242 |
| 72 hour | 68.1 | 89.7 | 105 | 119 | 142 | 161 | 183 | 213 | 238 | 264 |
| 96 hour | 72.4 | 95.5 | 111 | 127 | 151 | 171 | 191 | 221 | 246 | 273 |
| 120 hour | 75.3 | 99 | 115 | 131 | 156 | 177 | 196 | 226 | 250 | 276 |
| 144 hour | 77.4 | 101 | 117 | 133 | 159 | 180 | 198 | 229 | 253 | 280 |
| 168 hour | 78.8 | 102 | 117 | 133 | 159 | 180 | 200 | 231 | 256 | 283 |

# APPENDIX D

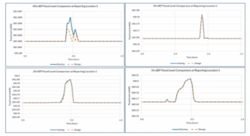
## ARTC Review

ARTC INLAND RAIL

| Document Control Information | | | |
|---|---|---|---|
| | Contractor DC to update for re-submission | Submitted Document No. or Transmittal No.: | Martinus-PTRAN-001532 |
| Project: | 2100 - A2I | Date Submission Received: | 3/07/2025 |
| Comment Sheet Number, Revision: | 5-0052-210-IHY-B4-CS-0001_E | Comment Sheet Title: | *External Comment Sheet - A2I \| Flood Design Report - Riverina Highway Bridge* |
| Revision Date: | 10/07/2025 | Documents related in Aconex (by IR DC) | Yes |

| Review Comments (Reviewer) | | | | | | | | | Responses (Document Owner) | | | | | Close-Out | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | PSR ID No. or Compliance Reference Document (State the fully qualified reference the deliverable is non-compliant with) | Document / drawing number - Revision Number | Section # / page # | Engineering Assurance Stage | Comment (for example must be specific on non compliance. Reference mark-ups, if required) | Comment Type | Full Name | Date | Full Name | Company | Date | Response (must be specific on how the comment has been addressed. Agreed approach for re-submission ) | Documentation Section # / Figure # | Full Name | Date | Comment Status | Close-Out Comment |
| Example | IR-SR-A2I-517 or 01-3500-PD-P00-DE-0008-A | 0-0000-900-PEN-00-TE-0020_A | | CRR | Is there sufficient space for a 10m maintenance vehicle to turn around at the end of the RMAR? | Non-Compliant | Joe Bloggs | 15/02/2023 | Fred Bloggs | Designer | 15/03/2023 | The area has been increased - now possible to turn 12.5m vehicle. The drawings are updated. | 01-3500-PD-P00-DE-0008-A 01-3500-PD-P00-DE-0015-C | Jane Doe | 27/09/2023 | CLOSED | |
| 1 | Opportunity | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 8, 5-0052-210-IHY-B4-RP-0001_A, Section 1.4 | PDR | I believe it would be "Design" instead of "Definition". | Opportunity | Ayub Ali | 25/07/2024 | Jasmine Lee | DJV Flooding Lead | 17/09/2024 | Noted. It will be updated in the next design phase report.<br>26/9 Comments workshop - need to see evidence to close (Next Phase)<br>05/03/25 - Updated for DDR to read Detailed Design Review - refer snip at right | **1.4 Objectives**<br>This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Detailed Design Review (DDR) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary.<br>This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001) | Ayub Ali | 14/03/2025 | CLOSED | **IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H |
| 2 | PSR Annexure B Technical Requirements (IR-SR-A2I-352) | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 15, 5-0052-210-IHY-B4-RP-0001_A, Table 2-1 | PDR | Any damage due to ponding of water adjacent to the formation also to be considered (not necessarily due to ponding on the formation only). | Non-Compliant | Ayub Ali | 25/07/2024 | Steve Ho / Jasmine Lee | DJV Drainage/Flooding Lead | 17/09/2024 | There is no water ponding next to the proposed formation. The statement will be revised and updated in the next design stage report.<br>This clause is addressed in Drainage Section (Section 4.3 of the 5-0052-210-PEN-B4-RP-0001)<br>26/9 Comments workshop - need to see evidence to close (Next Phase)<br>05/03/25 - Compliance Evidence Refrence updated to read: "No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site. Refer to Sections 5.2 & 5.3."<br>Refer snip at right | Requirement: A2I Technical Requirements; Identifier: IR-SR-A2I-352; A2P Technical Requirements Description: The Corridor System shall prevent damage of the formation due to ponding of water.; Compliance Evidence Reference: No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site. Refer to Sections 5.2 & 5.3. | Ayub Ali | 14/03/2025 | CLOSED | **IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H |
| 3 | Opportunity | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 24, 5-0052-210-IHY-B4-RP-0001_A, Section 4.3.1.4 | PDR | Figure numbers have been referenced twice in every cases. Hence correction is required. | Opportunity | Ayub Ali | 25/07/2024 | Jasmine Lee | DJV Flooding Lead | 17/09/2024 | Noted. It will be updated in the next design phase report.<br>26/9 Comments workshop - need to see evidence to close (Next Phase) | | Ayub Ali | 14/03/2025 | CLOSED | **IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H |
| 4 | PSR Annexure B (items IR-SR-A2I-459, IR-SR-A2I-464, IR-SR-A2I-465) | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 29, 5-0052-210-IHY-B4-RP-0001_A, Section 5 | PDR | Could you please compare flow rates at all locations where IR is discharging stormwater into Council's drainage systems and demonstrate that the post development peak flow rates at above points do not exceed the existing peak flow rates. Please include appropriate mitigation measures (e.g. on-site detention) if required to achieve this objective. | Non-Compliant | Ayub Ali | 12/08/2024 | Steve Ho/ Thinesh Thirumurugan | DJV Drainage Lead/ Flood modeller | 18/09/2024 | Water is discharged from the site at 2 locations, via overland flow path towards Wilson St, and pumped discharge to Mudges Canal. Overland flows to Wilson St maintains existing flow regime with no adverse impacts. Pumped discharge to Mudges Canal is minimal relative to the available capacity with less than 20mm afflux within the canal during the 1% AEP event. These have been assessed in the flood model.<br>The proposed design is compliant with PSR Annexure B items IR-SR-A2I-459 (no worse than existing), IR-SR-A2I-464 (no adverse impacts), IR-SR-A2I-465 (maintain existing/natural flow paths). Additionally, consultation with Council has been undertaken at each design stage and no objection were raised to date with the proposed design.<br>26/9 Comments Workshop - ACTION for IR: if Council comments have been received, may IR please provide these to MR. Comments Sheet are the formal, contractual mechanism for obtaining council review and comment.<br>05/03/25: to date, no Council comments have been received. May IRPL pelase confirm ACC has been provided with the Riverina Hwy FDR? | 5-0052-210-IHY-B4-RP-0001_A, Section 5.2 and Section 6.<br>**1.4 Objectives**<br>This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Detailed Design Review (DDR) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary.<br>This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001)<br>TT 20/05/2025 5-0052-210-IHY-B4-RP-0001_C, Section 5.4 & Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001 | Ayub Ali | 2/06/2025 | CLOSED | This is closed based on the respose and screenshot evidence |
| 5 | NA | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 31, Table 5-2 | PDR | this table needs the levels of the shoulder of the capping layer of the embankment so that the flood levels can be compared (i.e. how much flood immunity there is at each point) | Opportunity | Hartley Bulcock | 7/08/2024 | Jasmine Lee | DJV Flooding Lead | 17/09/2024 | The survey data for the corner of the capping layer (existing) is not available. The surveyed top of rail level could be provided as references. | | AyubAli | 14/03/2025 | CLOSED | This item is cosed based on the additional information in Section 5.3 of the report. |
| 6 | PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458) | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 34, 5-0052-210-IHY-B4-RP-0001_A, Section 5.1.2 | PDR | Please include long sections along the centre of all open channels / cess drains identifying ground levels and water surface levels. | Non-Compliant | Ayub Ali | 13/08/2024 | Steve Ho / Zoe | DJV Drainage Lead | 18/09/2024 | As per response to Comment 191.<br>26/9 Comments workshop - need to see evidence to close (Next Phase)<br>05/02/25: In place of long-sections, direction and grade-vale arrows are provided on CDR drainage drawings, as part of the track and civil design package. Longitudinal drainage flows patterns are not a part of the Flood Design Report. Refer to the (track and civil0 Detailed Design Report for full drainage assessment and findings.<br>TT 20/05/2025: Drainage design drawings refernced in The Flooding report<br>**5.2 Design Condition**<br>IA 20/05/25: Snip from design drawings sh... own below<br><br>ZC 30/6/25: Sentence added below to confirm that in construction there will be no localised depression between adjace... le will be the nominated average grade | 5-0052-210-CDR-B4-DR-0101 and 5-0052-210-CDR-B4-DR-0102<br>**5.4 Flood Impact Assessment**<br>INLAND RAIL MARTINUS | Ayub Ali | 14/03/2025 | CLOSED | This item is closed based on the snipshot of updated design report with inserted Table 4-4 along with its note. |
| 7 | PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458) | 5-0052-210-IHY-B4-RP-0001_A.pdf | Page 34, 5-0052-210-IHY-B4-RP-0001_A, Section 5.1.2 | PDR | I believe, the raised crest near Point 2 will cause ponding unless it is diverted through an alternative drainage system. What is the design solution to prevent any ponding? Please clarify it with further details. | Non-Compliant | Ayub Ali | 12/08/2024 | Steve Ho / Jasmine Lee | DJV Drainage/Flooding Lead | 17/09/2024 | The raised level at point 2 will divert the water back into the Mudge Canal with the lowering bank at the western side of the Mudge Canal bank. As such, the ponding will not happen. This clarification will be added to the next design phase report.<br>26/9 Comments workshop - need to see evidence to close (Next Phase)<br>05/03/25: refer to Appendix A flood maps for assessment of impacts arising from the incorporation of the raised crest. THis shows that the raised crest diverts water back towards Mudges Canal. Positive flow is providing and | To be added in next stage flood report 5-0052-210-IHY-B4-RP-0001 | Ayub Ali | 14/03/2025 | CLOSED | **IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H |
| 8 | PSR Annexure B (items IR-SR-A2I-459, IR-SR-A2I-464, IR-SR-A2I-465) | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 34, 5-0052-210-IHY-B4-RP-0001_B, Section 5 | DDR | Could you please compare flow rates at all locations where IR is discharging stormwater into Council's drainage systems and demonstrate that the post development peak flow rates at above points do not exceed the existing peak flow rates. Please include | Non-Compliant | Ayub Ali | 13/03/2025 | Thinesh Thirumurugan | DJV Flood Modeller | 20/05/2025 | 20.05/2025: close out Comment addded in the flooding report as per Comment #4 above | 20/05/2025 5-0052-210-IHY-B4-RP-0001_C, Section 5.4 and Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001 | Ayub Ali | 2/06/2025 | CLOSED | This is closed based on the respose and screenshot evidence |
| 9 | PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458) | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 39, 5-0052-210-IHY-B4-RP-0001_B, Section 5.2 | DDR | Please include long sections along the centre of all open channels / cess drains identifying ground levels and water surface levels. | Non-Compliant | Ayub Ali | 13/03/2025 | Zoe Cruice / Isaac Athfield | Martinus | 17/05/2025 | Long-section on open channels and swales will not be provided. As previously discussed and agreed, the flow direction and grade is shown on the drainage plans, to demonstrate compliant with the requirement to drain the formation and prevent ponding.<br>TT 20/05/2025: Drainage design drawings referenced in The Flooding report<br>**5.2 Design Condition**<br>IA 20/05/25: Snip from design drawings showing plan grade annotations shown below<br>ZC 30/6/25: A residual statement has been provided in the design report. Wording added regarding "Between two cross-sections, there will be n... ...rkshop of 30/6/25 HB okay to close | 5-0052-210-CDR-B4-DR-0101 and 5-0052-210-CDR-B4-DR-0102 | Ayub Ali | 14/03/2025 | CLOSED | This item is closed based on the snipshot of updated design report with inserted Table 4-4 along with its note. |
| 10 | CoA E42 | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 44, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4 | DDR | Flow rate vs time is not an appropriate parameter for estimating duration of inundation. Rather flood level vs time should be used at all locations for estimating the change in duration of inundation. | Non-Compliant | Ayub Ali | 13/03/2025 | Thinesh Thirumurugan | DJV Flood Modeller | 20/05/2025 | 20/05/2025: all flow rate vs time graphs are removed and replaced with flood level vs time graphs.<br><br>Figure 5-5: Comparison of Flood Level vs. Time at Baseline Location 1 | 5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4 | Ayub Ali | 2/06/2025 | CLOSED | This is closed based on the respose and screenshot evidence |

| Comment Sheet Number_Revision: | 5-0052-210-IHY-B4-CS-0001_E | Comment Sheet Title: | External Comment Sheet - A2I \| Flood Design Report - Riverina Highway Bridge |
|---|---|---|---|
| Revision Date: | 10/07/2025 | Documents related in Aconex (by IR DC) | Yes |

| Review Comments (Reviewer) | | | | | | | | | Responses (Document Owner) | | | | | Close-Out | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | PSR ID No. or Compliance Reference Document (State the fully qualified reference the deliverable is non-compliant with) | Document / drawing number - Revision Number | Section # / page # | Engineering Assurance Stage | Comment (for example must be specific on non compliance. Reference mark-ups, if required) | Comment Type | Full Name | Date | Full Name | Company | Date | Response (must be specific on how the comment has been addressed. Agreed approach for re-submission ) | Documentation Section # / Figure # | Full Name | Date | Comment Status | Close-Out Comment |
| 11 | CoA E42 | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 46, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4 | DDR | I believe, it would be "flow rate vs time" instead of "flow level vs time". However, all flow rate vs time graphs to be replaced with flood level vs time graphs as it is not an appropriate parameter for estimating duration of inundation. | Non-Compliant | Ayub Ali | 13/03/2025 | Thinesh Thirumurugan | DJV Flood Modeller | 20/05/2025 | 20/05/2025: all flow rate vs time graphs are removed and replaced with flood level vs time graphs.  Figure 5-5: Comparison of Flood Level vs. Time at Reporting Location 1 | 5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4 | Ayub Ali | 2/06/2025 | CLOSED | This is closed based on the respose and screenshot evidence |
| 12 | Clarification | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 46, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4 | DDR | I believe, it would be "flood level vs time" instead of "flow level vs time". | Non-Compliant | Ayub Ali | 13/03/2025 | Thinesh Thirumurugan | DJV Flood Modeller | 20/05/2025 | 20/05/2025: text updated as "Flood level vs time"<br>Figure 5-5 and Figure 5-6 shows the comparison of flood level vs time for Reporting Locations 1 and 2. Both the existing and design flood level vs time are mostly similar for Location 1 and 2. These demonstrate that the design will not create an extra duration of inundation upstream and downstream outside the project boundary. Consequently, the changes in the duration of inundation comply with the CoA E42(a). | 5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4 | Ayub Ali | 2/06/2025 | CLOSED | This is closed based on the respose and screenshot evidence |
| 13 | CoA E42 | 5-0052-210-IHY-B4-RP-0001_B.pdf | Page 47, 5-0052-210-IHY-B4-RP-0001_B, Section 5.5.1 | DDR | Outcome of the blockage assessment to be discussed here under a separate subsection identifying the impact, risks and proposed mitigation measures. | Non-Compliant | Ayub Ali | 13/03/2025 | Zoe Cruice | Martinus | | Blockage impact is shown in Figure 5-8. It is not a requirement to mitigate impacts from blockage, but rather check the sensitivty of the results to blockage.<br>30/6/25 ZC: in workshop, the current wording and scope was discussed. HB indicated okay to close. | | Ayub Ali | 10/07/2025 | CLOSED | The blockage assessment is a sensitivity check. Hence, some sorts of discussion was requested on the outcome in that context. However, due to non-criticality and non-effect on the design outcome, this items is closed now. |

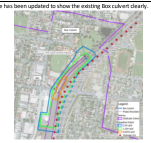
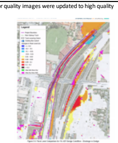
**Non-Compliant:** Non-compliance which requires correction before further design development occurs.
**Opportunity:** Comment which identifies an opportunity to save capex, achieve increased quality or operational outcome. Not a non-compliance.

**OPEN:** Comment has not been addressed.
**CLOSED:** Comment is closed. No further action.
**NEXT PHASE:** Comment response has been accepted. Resulting actions have been deferred to the next Phase of the Project (for Doc Control purposes the comment is considered OPEN)
**TRANSFERRED:** Response is not acceptable or review has been split and the comment has been transferred to another comment sheet. (for Doc Control purposes comment is considered CLOSED)

# APPENDIX E

## External Consultation Review

**A2I Flood Design Report CONSULTATION - COMMENTS REGISTER**

| Stakeholder Category | Stakeholder Name | Flood Design Report name | Document reference (e.g. section, figure, table) | Date raised | Topic that comment relates to | Comments | Full Name | Role | Date | Response (must be specific on how the comment has been addressed) | Where addressed (Section # / Figure #) | Full Name | Company | Date | Comment Outcome | Close-Out Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Generally | 10/04/2025 | Major change to the design from that proposed in the EIS | The EIS proposed the stormwater storage tank and pumps to be located on the western side of the rail line discharging to the western drainage line and Wilson St. This seems to have now changed to be located to the east of the rail line discharging to Mudges Canal. The need for this significant change in the design should be explained and justified. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The reason for the change has already been discussed in the Main Design report. The location was changed to "To facilitate the swept path requirements of maintenance vehicular access for the storage tank and pump. "<br>Item \| Difference \| Reason for Change<br>4 \| Drainage Storage Tank and Pump relocated to the east side of rail alignment to the inactive stabling yard, with pumped discharge to Mudges Canal as opposed to existing drainage at Wilson Street. \| To facilitate the swept path requirements of maintenance vehicular access for storage tank and pump. | 5-0052-210-PEN-B4-RP-0001_D Section 3.2, Table 3-2, item 4<br>5-0052-210-PEN-B4-RP-0001_D Section 4.5.6.4 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Figure 4-4 | 10/04/2025 | Unclear features | The existing box culvert under the rail is a critical element controlling flooding into the site. However, it is not clear exactly where this structure is on Figure 4-4. I think the label for Ch644750 may be overlaying it? Important that this is clearly represented since sections of the report refer to the culvert in this figure. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The image has been updated to show the existing Box culvert clearly.<br> | 5-0052-210-IHY-B4-RP-0001_C Figure 4-4 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Table 4-4 & Figure 4-6 | 10/04/2025 | Detail lacking | The explanation of the design condition features, and supporting Figure 4-6, is lacking in detail (i.e. "approximate depth of up to 1.1 metres from the existing track level" – over what extent? Cess drain dimensions? Again the Design Report would have probably answered these questions if supplied. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | Yes, the Main design report discusses the design features in more detail and the image in the Flood design report is only a general indication. Relevant sections of the main report have been referenced in the flood design report.<br>Table 4-4: Design Condition Key Features | 5-0052-210-IHY-B4-RP-0001_C Table 4-4 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Section 5.1 | 10/04/2025 | Detail lacking | Section 5.1 states "stormwater network in the site flows towards to the Mudges Canal", however Figure 5-1 shows a "flow line" discharging form the site into Wilson St. Flow to and from Point 9 on Figure 5-1 needs explanation. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | Figure 5-1 only shows the overland flow paths. A new figure showing the existing stormwater network has been added to the report with reference to additional details in Section 5.1 to provide more clarity.<br>5.1 Existing Condition<br> | 5-0052-210-IHY-B4-RP-0001_c Section 5.1 and Figure 5-2 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Section 5.2 & Figure 5-3 | 10/04/2025 | Clarification needed | Section 5.2 states "The raised crest at point 2 will divert the water back into the Mudges Canal." However, the flow lines on Figure 5-3 clearly show flows from point 2 onwards remaining to the west of the tracks and discharging into Wilson St as discussed above. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The raised crest fully diverts the water into Mudges canal only during small storm events. During large storm events like 1% AEP the water overtops the crest which flows south and then via Wilson Street. The section already addresses the details, however, to provide more clarity, the caption of Figure 5-3 was updated to clarify the flow path is for the 1% AEP.<br>The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert positioned to the north of the site. The raised crest near Point 2 prevents the water from flowing south during small storm events up to the 2% AEP. However, in large storm events from the 1% AEP, the crest is overtopped, and water is flowing south along the overland flow channel (refer to Figure 5-3). The raised crest at point 2 will divert the water back into the Mudges Canal.<br><br>Figure 5-3: Riverina Highway Site Design Scenario Overland Flow Paths for 1% AEP | 5-0052-210-IHY-B4-RP-0001_c Figure 5-3 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Design vs Existing Condition Mapping | 10/04/2025 | Detail lacking | The "raised crest" at point 2 seems to be causing elevated flood levels at point 1 (upstream) under design conditions, particularly in the 10% AEP. However, this does not translate to increases in flood levels elsewhere like the Mudges Canal and upstream areas. It would be worth discussing this more. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | During the 10% AEP, point 1 experiences an increase in flood depth but a reduction in flood levels due to the lowered design surface levels. So the flood level increase was not shown on the map.<br><br>In addition, compared to the existing surface, the design surface is lowered at the southern side of the Mudges Canal, which allows more water from the Mudges Canal to flow back to the area between the Mudges Canal south bank and point 2. Mudge's canal water level experiences less than a 10 mm reduction. Therefore, no afflux is shown in the Mudges Canal on the map.<br><br>Additional details were added in the report to provide clarity.<br>The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert positioned to the north of the site. The raised crest near Point 2 prevents the water from flowing south during small storm events up to the 2% AEP. However, in large storm events from the 1% AEP, the crest is overtopped, and water is flowing south along the overland flow channel (refer to Figure 5-3). The raised crest at point 2 will divert the water back into the Mudges Canal. Point 1 experiences a greater flood depth under design conditions compared to existing conditions. This is due to the reduction in topographic levels near the Mudges Canal, which forces more water to flow into Point 1. The changes in flood levels at point 1 between the existing and design scenarios will be greater due to alterations in topography, particularly when compared to the upstream areas of the Mudges Canal. | 5-0052-210-IHY-B4-RP-0001_C Section 5.2 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Section 5.5 | 10/04/2025 | Pumps | A sensitivity assessment should be included that evaluates the flood impacts if the pumps fail during a flood event/s. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The pump failure sensitivity assessment is not part of the DJV flooding scope.<br>In addition, there are 2 pumps proposed (one on duty and one backup) as well as a standby generator if loosing power to the site.<br>The risk of pump failure is minimal. | N/A | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Figures 5-7 & 5-8 | 10/04/2025 | Duplicated and poor quality figures | Impossible to discern details in these figures. Suggest replacing with a higher quality images. Also these figures seem to be duplicated. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | Duplicated images were deleted and poor quality images were updated to high quality<br>  | 5-0052-210-IHY-B4-RP-0001_c Figure 5-8 and 5-7 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Throughout report | 10/04/2025 | Incorrect referencing | Incorrectly referenced the Bugam Creek FS regularly throughout the report. Sometimes referred to as BMT 2011 or WMAwater 2011. Obviously should be L&A 2011. Other than being poor practice it does make it difficult to determine whether they are meant to be referring to the Bugam Creek FS (L&A, 2011) or the Albury FRMS&P (WMAwater, 2016) | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | Bugam Creek FS references have been corrected and updated.<br>4.2 Hydrologic Modelling<br>4.2.1 ARR2019 Approach<br>The hydrology models (DRAINS-RAFTS and DRAINS-ILSAX) related to Albury FRMSP (WMAwater, 2016) and Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Lyall & Associates, 2011) were originally built based on ARR1987, by Others. An excerpt from the study report is shown in the Figure below.<br>Figure 4-1 Sub-catchment Plan from Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Source: Figure 3.1-1 of Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study, Lyall & Associates, 2011).<br>4.3.3 Existing Flow Comparison between ARR2019 and ARR1987 at Key Location<br>The updated existing case TUFLOW model with ARR2019 was compared against the information provided in Table E3 of Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011). As a key inflow into the study area, the 1% AEP flow breaking out from the 3-cell culvert (Ch644.770km) into the railway corridor from the updated model (ARR2019) was compared with the flows reported in the flood study (indicated in Figure 4-6). The flood | 5-0052-210-IHY-B4-RP-0001_C Section 4.2.1 and 4.3.3, Figure 4-1 | | | | OPEN | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Generally | 10/04/2025 | Mudges Canal | There is a small but significant increase in the flows down Mudges Canal as a result of these works especially in more frequent events. This Canal flows down through urban areas of South Albury which are already significantly flood affected. Suggest inserting some commentary concerning this in consultation with Albury City Council. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | Based on the flood modelling, the flood impacts outside the project boundary are within the Conditions of Approval limits. The flood impact section discusses the impacts outside the project.<br>In addition, the design has been presented to Albury City Council during workshops (PDR and DDR stage), and the wording has been included in Table 2-2 E46. | 5-0052-210-IHY-B4-RP-0001_C Section 5.4<br>5-0052-210-IHY-B4-RP-0001_C Section 2.2 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-Flood Design Report (5-0052-210-IHY-B4-RP-0001) | Table 2-1 | 10/04/2025 | Compliance with Condition E46 | Condition of Approval E46 stated "*The design, operation and maintenance of pumping stations and storage tanks and discharges to council's stormwater network must be developed in consultation with the relevant council. The results of the consultation are to be included in the report required in Condition E43* ". A specific response to this condition was included in Table 2-2 that indicated that since no changes to the catchment areas and imperviousness are proposed then there is no additional flows towards Councils stormwater networks. This may be the case but the balance of these flows have changed i.e. more flow down Mudges Canal and less towards Wilson St. Suggest that the response to this Condition is modified to suit and additional details regarding consultation with Council on this matter added. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The words are updated and this has been presented to Council in the workshops during PDR and DDR stages.<br>E46 \| The design, operation and maintenance of pumping stations and storage tanks and discharges to council's stormwater network must be developed in consultation with the relevant council. The results of the consultation are to be included in the report required in **Condition E47.** \| Although the flow balance has been changed, (i.e. more flow down Mudges Canal and less towards Wilson Street), the overall catchment area and imperviousness remain the same as per existing condition, there is no additional flow towards the existing Council's stormwater network. The design has not worsened the existing condition. Discharges to the council's stormwater networks have been consulted with Albury City Council during the briefing workshops, various stages of design submissions. Refer to Section 4.5 (Drainage Design) on the Riverina Highway Bridge Design Report (5-0052-210-PEN-B4-RP-0001). | 5-0052-210-IHY-B4-RP-0001_C Section 2.2 | | | | OPEN | |
| | CPHR | A2I-Riverina Hwy Bridge-**Detailed Design Report** (5-0052-210-PEN-B4-RP-0001_C) | Section 7.1 - Outstanding Items and Actions | 22/04/2025 | Drainage Pump design | Note that the designs of the drainage pump and sump are still in development (Table 7-1). Once this design is complete the actual dimensions and performance of this drainage system should be included in the flood model and rerun to verify that the flood impacts remain within acceptable ranges. Also concerned that Table 6-1 indicates that there is a risk that this drainage pump station cannot be located in this location due to clashes with a proposed drainage bund resulting in the possibility of alternative solutions needing to be developed. If this eventuates it is important to revise the design reports and models to suit and seek further comments from CPHR and Council. | Thinesh Thirumurugan | DJV flood mdoeller | 22/05/2025 | The pump design in DDR stage has been assessed in DDR flood assessment and the flood impact shows compliance with CoA. If the pump's location will be changed in a later stage, further investigation will be implemented. | | | | | OPEN | |

# APPENDIX F

## Independent Flood Consultant

ARTC INLAND RAIL

v30

**Project:** 2100 **Deliverable:** Riverina Highway Bridge

**Comment Sheet Reference:** 5-0052-210-IHY-B4-RP-0001-PE_G

| Review Comments (Reviewer) | | | | | | | | | | | Responses (Document Owner) | | | | | Close-Out | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Document number / drawing number - Revision Number | Section # / page # | Company | Full Name | Functional Area | Date | Design Gate | Comment (for example must be specific on non compliance. Reference mark-ups, if required) | Compliance Reference Document (State the | Comment Type | Full Name | Role | Date | Response (must be specific on how the comment has been addressed) | Where addressed (Section # / Figure #) | Full Name | Company | Date | Comment Outcome | Close-Out Comment |
| 1 | 5-0052-210-IHY-B4-RP-0001_A | Section 4.2.2 | Hatch | Dan Williams | Flood Assessment | 3/10/2024 | PDR | The report text indicates that the interim climate change factors from the ARR data hub were used to represent the 1% AEP CC conditions. However, there are notes on some of the mapping figures that suggest the 0.2% AEP event was used to represent climate change. This should be updated for consistency to whichever is correct (I expect that the figure notes are incorrect?) | | Minor | Jasmine Lee | DJV Flooding Lead | 25/10/2024 | The interim climate change factors from the ARR data hub were used to represent the 1% AEP CC conditions.<br><br>The note on the mapping will be removed in next stage of mapping. | DDR flood design report | Dan Williams | Hatch | 6/11/2024 | CLOSED | Noted |
| 2 | 5-0052-210-IHY-B4-RP-0001_A | Section 4.3.2.1 | Hatch | Dan Williams | Flood Assessment | 3/10/2024 | PDR | Table 4-4 includes reference to the overland flow channel. This is the key feature in the proposed design that has the potential to impact on the broader catchment flood behaviour because otherwise we are effectviely dealing with stormwater management. To minimise the potential for the proposed design to alter the catchment flood flow distribution, the control crest level along the overland flow channel should be set to match the existing level of control, which appears to have been undertaken within the proposed design. However, the lowest level of control along the existing surface is much narrower than that being provided in the design and so the flood flow distribution is altered. For example, in the existing case a peak flow of around 6.7 $m^3$/s is discharged through the Mudges Canal box culverts at the 1% AEP 90m event (the critical durationat this location), with around 0.9 $m^3$/s being conveyed along the overland flow channel. Under the proposed design conditions the peak flow distribution for these events changes to around 6.4 $m^3$/s and 1.2 $m^3$/s, respectively. This does not appear to result in any significant change to the off-site peak flood levels due to other existing hydraulic controls. However, it is good practice to try and maintain the existing flood flow distribution to reduce the liklihood of any unforseen impacts. | | Minor | Jasmine Lee | DJV Flooding Lead | 25/10/2024 | It is acknowledged that maintaining the existing flow distribution in the design condition is the most desirable approach. However, the track lowering site design must meet the requirements of all disciplines involved. Therefore, the scope of the flood assessment is to control floodwaters to ensure that there is no adverse flood impact beyond the stipulated criteria outside the project boundary.<br><br>During the Detailed Design Review (DDR) stage, the flow distribution will be checked and maintained as closely as possible to the existing condition. Nevertheless, it should be noted that the flood assessment will adhere to the stipulated criteria. | DDR flood design report | Dan Williams | Hatch | 6/11/2024 | CLOSED | Noted |
| 3 | 5-0052-210-IHY-B4-RP-0001_A | TUFLOW files | Hatch | Dan Williams | Flood Assessment | 3/10/2024 | PDR | A longitudinal profile of the overland flow channel is provided in Figure 4-25 of the Detailed Design Report (5-0052-210-PEN-B4-RP-0001_B). There are inconsistencies between this longitudinal profile and the TUFLOW files that represent it, including the design terrain model (240705_DESIGN_MD21B4501), the Z Shape overwriting it (2d_zsh_010Dtest8_RMAR_modification_R) and the 1D channel cross-sections where the RMAR crosses Mudges Canal. The inconsistencies are in the bed level of the channel, the crest level controlling the overflow and the level of tie-in between the Mudges Canal channel and the overland flow channel. As discussed above, this is the one aspect of the design with the potential to alter broader catchment flood conditions and so we need to ensure that there is consistency between the final design and final TUFLOW model representation. | | Minor | Jasmine Lee | DJV Flooding Lead | 25/10/2024 | The differences between the overland flow profiles occurred because, during the Preliminary Design Review (PDR) flood assessment, the overland flow channel was modelled in TUFLOW as a mitigation option first and then the drainage design DEM was updated.<br><br>For the DDR submission, the DEM for the overland flow channel will be made consistent between the TUFLOW and drainage models. | DDR flood design report | Dan Williams | Hatch | 6/11/2024 | CLOSED | Noted |
| 4 | 5-0052-210-IHY-B4-RP-0001_A | TUFLOW files | Hatch | Dan Williams | Flood Assessment | 3/10/2024 | PDR | The way in which the proposed pump has been set up within the TUFLOW model is incorrect. The pump has not been modelled dynamically and that is OK as this is acknowledged as such in the Flood Assessment Report. However, whilst a contstant outflow of 0.075 $m^3$/s has been applied to Mudges Canal in the model, the intake is configured with a contant water level boundary, which effectively enables an infinite outflow from the drainage sag. For example, in the modelled design case scenario the peak flow within the 450 mm pipe discharging to the pump chamber is 0.56 $m^3$/s at the 1% AEP 120 m event, with a velocity of 3.5 m/s. The pump inlet boundary should be configured as a constant flow of -0.075 $m^3$/s. This has been undertaken in the Proof Engineering review modelling and it results in a peak flood level within the drainage sag some 0.45 m higher at the 1% AEP 120 m event. This means that rather than the top of rail level being (just) flood free at the 1% AEP event (as suggested in Table 5-9 of the Flood Assessment Report), it is instead submerged to a depth of around 0.4 m. This represents a worsening of the rail flood immunity, as in the existing case the depth of rail overtopping is less than 50 mm. The design of the pump sizing should be re-visited and increased accordingly. It is important that the critical flood conditions at the drainage sag location are determined to ensure that the pump performance is confirmed across the full range of storm durations. | | Major | Jasmine Lee | DJV Flooding Lead | 25/10/2024 | During the PDR stage, the manufacturer's pump capacity curve was not available, and the pump design was undertaken by the drainage and pump teams. As a result, in our flood modelling assessment, the pump was considered only in terms of its outflow impact downstream. This is why the pump intake was modelled at a constant level, under the assumption that it could handle all incoming water.<br><br>For the DDR design, the pump will be accurately modelled using the provided manufacturer's pump capacity curve with the 1d_nwke pump. | DDR flood design report | Dan Williams | Hatch | 6/11/2024 | CLOSED | Noted |
| 5 | 5-0052-210-IHY-B4-RP-0001_A | TUFLOW files | Hatch | Dan Williams | Flood Assessment | 3/10/2024 | PDR | The TUFLOW model for the proposed design has included the subdivision of the open channel immediately upstream of the Mudges Canal box culverts into lengths as short as ~3.5 m. This inevitably causes model instabilities, which appear to have been resolved by supressing the intertial terms of the hydraulic equations, through the application of the "SN" channel type in the 1d_nwk file. This appears to have been undertaken within the existing scenario representation, which is appropriate for ensuring consistency. However, it would be best to not use the "SN" channel type and retain the 1d_nwk representation of the existing scenario in the design scenario, i.e. with a single 30 m long open channel reach. The additional detail that has been incorporated within the open channel in the design scenario is superfluous, as the box culverts through the embankment provide a dominant hydraulic control and the impacts of the minor change in channel geometry at the overland flow channel causeway will be negligible. This has not been undertaken for the Proof Engineering modelling as it would involve re-simulation of the existing flood conditions as well as those of the design. It is not expected that this change will have any significant impact on the modelling results but it would be preferable for it to be addressed moving forward to DDR. | | Minor | Jasmine Lee | DJV Flooding Lead | 25/10/2024 | To accurately represent changes in the channel's cross-sections, the channel was divided into smaller segments, and the 'SN' type was utilised. In the existing condition, the channel has a uniform cross-section, so modelling it as a single open channel reach was sufficient. However, in the design condition, the southern side of the channel bank has been lowered. To model this revised cross-section accurately, multiple channel reaches were necessary.<br><br>The purpose of lowering the channel bank is to redirect overland water flow into Mudges Canal instead of allowing it to flow into the RMAR, which would cause downstream afflux. Without properly representing the changes in the channel cross-section, this objective could not be achieved. | DDR flood design report | Dan Williams | Hatch | 6/11/2024 | CLOSED | The channel bank control is represented in the 2D domain, with the 1D channel cross-sections only relevent for conveyance and stage-storage calculations. In this case the cross-section modifications only result in a negligible change to the storage volume upstream of the box culverts and aren't integral to the modelling of the proposed design. However, I am happy for this to be left as-is for DDR, as it won't affect the model outcome. It was just raised as an observation to uneccesary changes having been made to the existing TUFLOW model. |
| 6 | 5-0052-210-IHY-B4-RP-0001_B | TUFLOW files | Hatch | Dan Williams | Flood Assessment | 20/05/2025 | DDR | Confirmed that the pump is now set up and working correctly in the model. | | | Zoe Cruice | Engineering Manager | 17/06/2025 | Noted. No further action at DDR. Package to be provied at IFC to confirm no further change. | | Darren Lyons | Hatch | 20/05/2025 | CLOSED | No further comments. |
| 7 | 5-0052-210-IHY-B4-RP-0001_0 | 1.1 | Hatch | Dan Williams | Flood Assessment | 7/10/2025 | IFC | It is agreed that the minor changes from DDR to IFC will not significantly alter the outcome of the flood assessment undertaken at DDR. | | | Zoe Cruice | Engineering Manager | 17/06/2025 | Noted. No further action. | | | | | | |

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