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FLOOD DESIGN REPORT

A2I | Albury to Illabo

Package: A2I – Henty Yard Clearance

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GLOSSARY

Specific terms and acronyms used throughout this plan and sub-plans are listed and described in the table below.

Table 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
LPA	Licensed Project Area
LiDAR	Light Detection and Ranging
MGA	Map Grid of Australia
MIRDA	Master Inland Rail Development Agreement
NCR	Non-Conformance Report

Term	Definition
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
RCP	Representative Concentration Pathways
REF	Review of Environmental Factors
RFI	Request for Information
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
UMM	Updated Mitigation Measures
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-alone 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:

- Darroobalgie 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 Sites Description

This study conducts a flood assessment for the Henty Yard clearances (refer to the figure below for site location). The background and previous studies for the site is listed below.



Figure 1: Location

1.3.1 Background

Henty Yard works form part of the Albury to Illabo Section works at Chainage (CH) 580.060 to CH581.140m. The Henty Yard works are located south of Buckaringah Creek. As part of the project scope, the existing tracks are being slewed by up to 605mm to achieve compliant track centres for F2M Inland Rail rolling stock. The proposed track slews will also require modifications to the existing Sladen Street Level Crossing.

1.4 Objectives

This report has been prepared to support the delivery of the track slews at the Henty Yard clearances and provide 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.

1.5 Scopes

The scope of this study includes:

- Carrying out the flood assessment for the design in the IFC stage for design events of 5%, 2%, 1%, AEPs, 1% AEP with Climate Change, and PMF.
- 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 all the flood studies associated with the Henty Yard site

Table 2: Summary of the previous flood studies

Item No.	Flood Study	Description
1	Culcairn, Henty Holbrook Flood Studies (WMA Water, 2013)	The study determines the nature and extent of the floodplain at Henty and assesses management options for the floodplain. The hydraulic model was run for 20%, 10%, 5%, 2%, 1%, and 0.5% AEPs and PMF design events.
2	Henty Floodplain Risk Management Study and Plan (WMA Water, 2017)	The Henty Floodplain Risk Management Study and Plan is updated from the Culcairn, Henty Holbrook Flood Studies by replacing the Henty-Rand railway bridge south of Grubben Road with a new bridge. The Henty DDR flood assessment adopted the flood study (WMA Water, 2013) as the Henty Floodplain Risk Management Study and Plan did not include the detailed model parameter. In addition, the changes between the models adopted in Culcairn, Henty Holbrook Flood Studies, and Henty Floodplain Risk Management Study and Plan are minor, resulting in minor localised effects 2km away from the Henty Yard site. This effect will not affect the flood behaviour for the Henty Yard site.
3	Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Lockhart & Greater Hume (June 2022)	This study mentioned that Henty Yard was not affected by flooding from Buckaringah Creek
4	Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, Flooding, and Water Quality (July 2022)	This study mentioned that Henty Yard is not affected by flooding from Buckaringah Creek up to PMF. The proposed drainage works mimic the existing drainage conditions. Thus, changes resulting from the proposed works are expected to have negligible flood impacts.

1.6.2 Reference Design

The prior Reference Design, by Others, was documented within the below report:

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

Hydrology and hydraulic assessments as part of the Reference Design were undertaken in accordance with ARR2019. The flood impact modelling was not undertaken. A qualitative assessment only was undertaken. The Reference Design found that Henty Yard is not subject to regional flooding and the track is overtopped at the Sladen Street level crossing from the 20% AEP.

1.6.3 Environmental Impact Statement

The Environmental Impact Statement (EIS) was supported by the following report, compiled by Others:

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

This report found that Henty Yard is not subject to flooding from the Buckaringah Creek regional flood (refer to Figure 2). However, there is some localised flooding near the track within Henty Yard due to local overland stormwater accumulation (refer to Figure 3 for the 1% AEP).

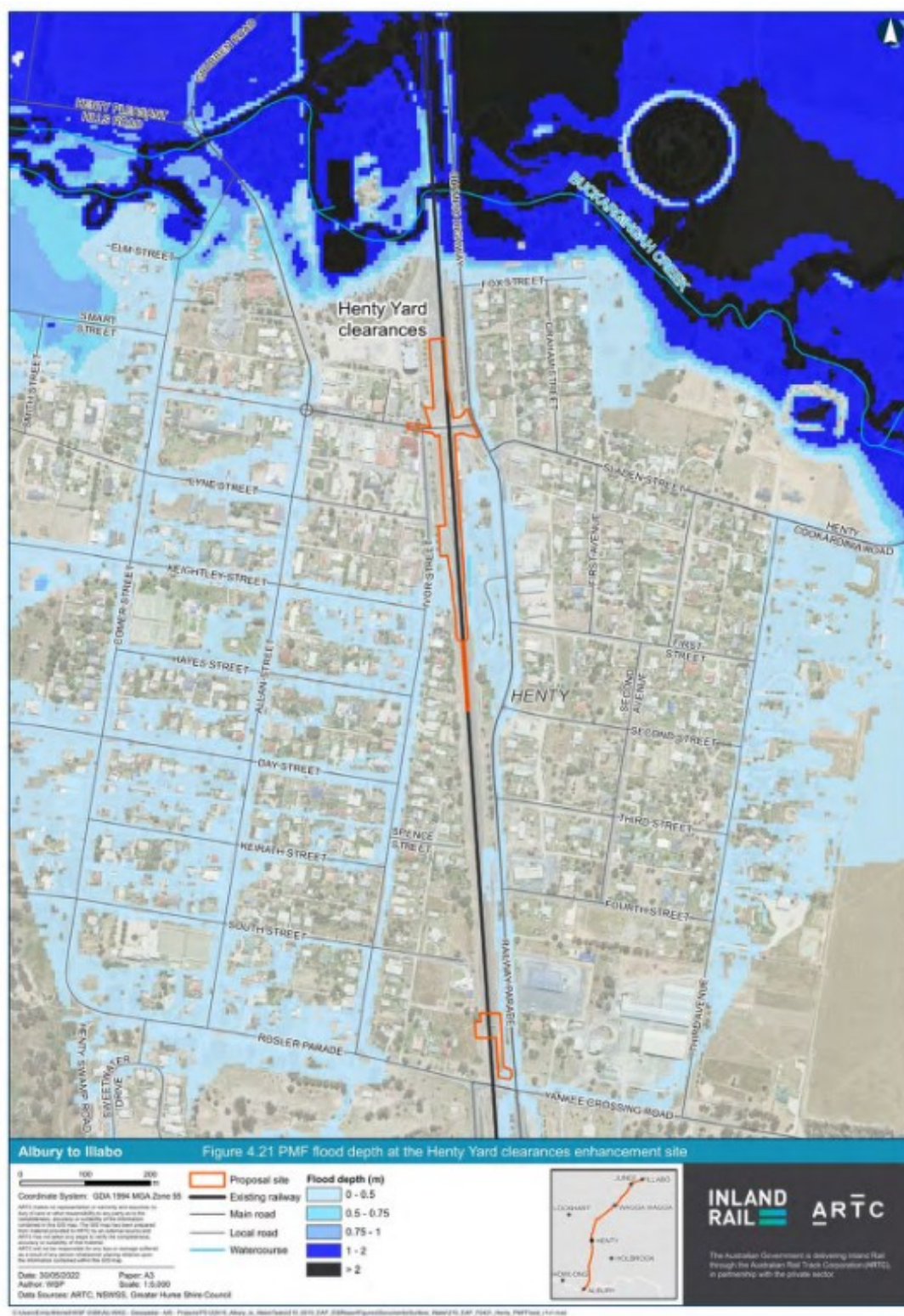


Figure 2: PMF Regional Flooding (Image source: Albury to Illabo EIS Technical Paper 11 Figure 4.37 (July 2022))



Figure 3: 1% AEP Regional Flooding (Image source: Albury to Illabo EIS Technical Paper 11 Figure 4.37 (July 2022))

1.7 Purpose and Requirements

The primary purpose of this IFC flood design report is to describe how the design development and the associated review process will be and is being managed. This report is produced to comply with CSSI Planning Condition of Approval E43.

A series of tasks and activities that the design development and design reporting process need to address and include is described in the set of requirements within the Conditions of Approval (CoA), PSR Annexure F, and Inland Rail's Design Management Specification. Refer to Appendix C for ARTC review, Appendix D for external consultation 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:

- Henty Floodplain Risk Management Study and Plan (WMA water, 2017)
- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Lockhart & Greater Hume (June 2022)
- 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, v4.1.
- 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 3: Available Information

Item	Information	Type	Description / Comments
1	1m 2015 LiDAR. The data derived points have an accuracy of 0.15m (68% confidence interval) ARTC LiDAR	TIF format in 1m resolution in GDA94 projection	The existing 1m LiDAR (flown by ARTC in 2015) was received from Martinus on 12/11/2024.
2	5-0052-210-CDR-G2-DR-COMBINED	pdf	Drawing plans of existing drainage based on surveyed data. Received from the DJV drainage team on 30/08/2024.
3	A2P_HTY_EXT_GDA20Z55_COMBINED_240723.dem	DEM	Verified Point cloud data – Site survey in GDA2020 projection – Received from the DJV drainage team on 29/08/2024.
4	EXISTING DRAINAGE DESIGN.12daz PROPOSED DRAINAGE DESIGN.12daz	12daz	Updated existing and proposed drainage information in GDA2020 projection Received from the DJV Civil team on 02/09/2024
5	5-0052-210-CAL-G2-MD-0001-HENTY_YARD_3D_RAIL_DESIGN_STRING_DWG	dwg	IFC design – top of the rail design strings in GDA2020 projection Received from the DJV Drainage team on 22/05/2025

Item	Information	Type	Description / Comments
6	CAPPING 21 G2 0.2m.dem BALLAST 21 G2 0.2m.dem	DEM	IFC design – Civil Design (Capping and ballast) DEM in GDA2020 projection Received from the DJV Civil team on 11/06/2025
7	20250618 1830 G2 HENTY YARD DESIGN TIN	DEM	IFC design – Level Crossing dem (1m) surface in GDA 2020 projection Received from the DJV Civil team on 19/06/2025
8	5-0052-210-CDR-G2-MD-0001- HENTY_YARD_3D_DRAINAGE_DESIGN _STRINGS_12D	12da	IFC Design – Drainage in 12da format Received from the DJV Drainage team on 11/6/25

1.10 Outputs

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

1.11 Limitations and Assumptions

The following limitations and assumptions are applied to the Henty Yard site.

- An assessment of temporary works and staging has not been undertaken.
- According to Clause 5.4.2 and Clause 5.4.3 in Annexure B of PSR (refer Figure 3), the highest flood event shall be the one stipulated by the ARTC Safety Management System (SMS). As per Section 10.1.3 of the 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 'Blockage Assessment Methodology' technical memo for detailed explanation of this approach.
- The TUFLOW Flood depths have been 'filtered' using a map cut-off depth of 0.05 m as per industry practice to eliminate immaterial sheet flow.
- Detailed survey of a culvert at CH 580+375km has not been received at the time of the preparation of this report and the dimension (1 x 600mm RCP as per the terrain and aerial imagery) and invert levels have been assumed. However, due to the limited flow through this culvert and location, this is unlikely to cause material impact to the overall results.

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 the table below summarising the Henty Yard Design's Compliance with the PSRs.

Table 4: 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: 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 (No watercourse associated with this site.)
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 the 1% AEP. However, the railway is overtopped in the 1% AEP in the existing scenario. The railway is overtopped in the 5% AEP event and so the existing immunity is found to be less than the 5% AEP. The existing immunity is improved under design conditions. Refer to Section 6.3.
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. However, the railway is overtopped in the 1% AEP in the existing scenario. The railway is overtopped in the 5% AEP event and so the existing immunity is found to be less than the 5% AEP.
Project Wide	5.4.5	Bridge and culvert hydraulics shall comply with Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures.	No bridge and culvert design within the site.
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 + Year 2090 Representative Concentration Pathways (RCP) 8.5. Refer to Section 6.5.2.
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 improved under design conditions. Refer to Section 6.3
A2I Technical Requirements	IR-SR-A2I-350	The Corridor System, where the existing track is lowered, shall maintain the existing flood immunity.	N/A (No track lowering for Henty Yard Clearance site.)
A2I Technical Requirements	IR-SR-A2I-352	The Corridor System shall prevent damage of the formation due to ponding of water.	There is no ponding of water. The existing flooding condition is maintained. Refer to Section 6.4.4.

Requirement	Identifier	A2P Technical Requirements Description	Compliance Evidence Reference
A2I Technical Requirements	IR-SR-A2I-458	The Corridor System shall prevent ponding in longitudinal open channels.	There is no ponding of water in the open channel. Refer to the Drainage Design Section in 5-0052-210-PEN-G2_RP-0001 (Section 4.5)
A2I Technical Requirements	IR-SR-A2I-459)	The Corridor System for Enhancement Corridors shall provide mitigation for flood impacts no worse than existing conditions.	There is no adverse flood impact outside of the project boundary. Refer to Section 6.4
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.	There is no adverse flood impact outside of the project boundary. Refer to Section 6.4
A2I Technical Requirements	IR-SR-A2I-465	The Corridor System shall minimise changes to the existing or natural flow patterns.	There is no adverse flood impact outside of the project boundary. Refer to Section 6.4
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 bridge proposed in this package)
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. Refer to Section 6.4
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 https://www.planningportal.nsw.gov.au/major-projects/projects/inland-rail-albury-illabo "	Refer to the details in Table 4

2.2 Conditions of Approval - Flooding

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

Table 5: 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, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Compliant, see rows below.
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 Refer to Section 6.4)
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 Refer to Sections 4 and 6)

E40	a) Hydrologic and hydraulic assessments consistent with Australian Rainfall and Runoff – A Guide to Flood Estimation (GeoScience Australia, 2019);	Compliant. Section 4 methodology shows that ARR2019 guidelines were used for this assessment.
E40	b) Use of modelling software appropriate to the relevant modelling task;	Compliant. Section 4 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. Section 1.9 shows that existing field survey and rail levels were used in the models.
E40	d) Confirmation of predicted afflux at industrial properties adjacent to Railway Street, Wagga Wagga based on field survey.	N/A – Railway Street in Wagga Wagga is not relevant to this site.
E40	Updated flood modelling must be made publicly available in accordance with Condition B18 .	Flood design report and an 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 has been undertaken by the Proof Engineer's specialist contractor, who satisfies and complies with the requirements of A16. Consultation with Council has been undertaken through a formal review of this Flood Design Report. Consultation with other stakeholders will occur prior to finalisation of the 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 E42 items below
E42	(a) a maximum increase in inundation time of one hour, or 10%, whichever is greater;	Compliant Refer to Section 6.4.4
E42	(b) a maximum increase of 10 mm in above-floor inundation to habitable rooms where floor levels are currently exceeded;	Compliant. No flood level increase on any properties. Refer Section 6.4.1
E42	(c) no above-floor inundation of habitable rooms which are currently not inundated;	Compliant. No flood level increase on any properties. Refer Section 6.4.1
E42	(d) a maximum increase of 50 mm in inundation of land zoned as residential, industrial or commercial;	Compliant. No flood level increase in residential, industrial and commercial areas. Refer Section 6.4.1
E42	(e) a maximum increase of 100 mm in inundation of land zoned as environment zone or public recreation;	Compliant. No increases of more than 100mm on land zoned as environment or public recreation. Refer Section 6.4.1
E42	(f) a maximum increase of 200 mm in inundation of land zoned as rural or primary production, environment zone or public recreation;	Compliant. No increases of more than 200mm on land zoned as rural or primary production.

		Refer Section 6.4.1
E42	(g) no increase in the flood hazard category or risk to life; and	Compliant No reasonable flood hazard increase or increase in Velocity x Depth to cause risk to life. Refer Section 0
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 No increase in velocity of more than 0.5m/s. Refer Section 6.4.2
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 Refer to 6
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
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 E43 .	Local drainage flow regime, 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 Council's stormwater network have been consulted with Greater Hume Shire Council through staged design submissions, and receipt of

	review comments, details are documented in 5-0052-210-PEN-G3-RP-0001.
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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 the table below.

Table 6: 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 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. This would be informed by topographic and building floor surveys and a review of localised drainage structures (as required). 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	This report relates to Henty Yard, and so is not relevant to Wagga Wagga Yard. Compliant. Quantitative assessment has been undertaken. Refer to Section 6.
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.	This report relates to Henty Yard and so is not relevant to the Riverina Highway track lowering site.

* 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

Flood modelling is not applicable to this stage.

Table 7: Design differences between Concept and SDR

Item	Difference	Reason for Change
N/A	N/A	N/A

3.2 SDR to PDR

Flood modelling is not applicable to this stage.

Table 8: Design differences between SDR and PDR

Item	Difference	Reason for Change
N/A	N/A	N/A

3.3 PDR to DDR

DJV created a new TUFLOW hydraulic model to model the area of interest as no hydraulic model was available for the PDR stage or earlier. This is required as per the draft Conditions of Approval (CoA).

Table 9: Design differences between PDR and DDR

Item	Difference	Reason for Change
1	Established a new flood model to assess the DDR design	It is required as per the Conditions of Approval (CoA)

3.4 DDR to IFC

Refer to the table below, for the flood assessment changes between DDR and this IFC report.

Table 10: Design differences between DDR and IFC

Item	Difference	Reason for Change
1	Updated TUFLOW model for existing drainage at CH580+375km	To address comments from the external review
2	Updated TUFLOW model with the IFC drainage, rail, track and civil design	To reflect the IFC design

4 MODELLING METHODOLOGY

The flood assessment comprises a TUFLOW hydraulic model and desktop analysis based on the Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013).

The findings in this flood study showed that the site is not affected by regional flooding from Buckaringah Creek in the PMF event as shown in Figure 2. Therefore, it was concluded that the site is only affected by local catchment flooding and therefore a TUFLOW Direct Rainfall (Rain-on-Grid) model was sufficient for this assessment in which rainfall was directly applied to the model area.

The overall approaches for flood modelling are listed below:

- Creation of a new Direct Rainfall (Rain-on-Grid) TUFLOW hydraulic model for the area of interest around Henty Yard to represent the existing pre-development conditions using existing conditions survey, LiDAR and drainage information from the Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013)
- The existing ground surface of the catchment used in the hydraulic model was based on the 1m resolution LiDAR data acquired from ARTC Feature survey data was used to represent the topography within the project site. The hydraulic model was run using a 1m cell size.
- Manning's roughness coefficients were selected based on land zoning, aerial imagery and the guidance in ARR2019 as well as the values used in Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013).
- The TUFLOW hydraulic model uses the Australian Rainfall and Runoff (ARR2019) input parameters and the Australian Bureau of Meteorology (BoM) rainfall data.
- Use of the Probability Neutral Burst Losses from the ARR DataHub as input to the Rain-on-Grid TUFLOW hydraulic model. Initial and continuing losses were considered and applied using a rainfall excess approach.
- Update the existing condition TUFLOW hydraulic model to the design condition by incorporating the rail design and drainage design into the existing condition hydraulic model.
- Undertaking the flood impact assessment for the 5%, 2%, and 1% AEPs events.
- Conducting a climate change risk sensitivity assessment for the 1% AEP to inform the potential impact on the top of the railway track flood immunity.
- Conducting a blockage assessment on hydraulic structures as per ARR2019 procedures for the 1% AEP event design scenario to inform the potential impact on the railway track flood immunity .

4.1 Hydrology Modelling

As mentioned in the above section, the Rain-on-Grid method was adopted for hydrology input. A summary of the hydrology input can be found in the table below.

Table 11: Model Hydrologic Parameters

Parameter	Value	Notes
Initial Loss (Probability Neutral Burst Loss)	Probability Neutral Burst Loss (refer Appendix B) (PMF 0mm)	ARR Data Hub
Continuing Loss	1.8 mm/hr (PMF 1mm /hr)	ARR Data Hub
Event	PMF, 1% + Climate Change, 1%, 2%, 5%	-
Duration	All events apart from PMF: 10min to 1440min PMF: 15min to 180min	-
Temporal Pattern	All events apart from PMF: 10 Temporal Patterns for each duration PMF: a total of 11 Temporal Patterns (10 TPs as per Jordan. et. al 2005 and 1 TP from BoM)	As per ARR2019 guidelines
Areal Reduction Factor	None	The catchment area is 2km ² , which is small

4.2 Hydraulic Modelling

4.2.1 Existing Model

A TUFLOW model was developed to investigate the flood behaviour in Henty Yard. The model extent encompasses the Henty Township (Refer to Figure 4).



Figure 4: TUFLOW Model Extent – Henty Yard

The updated TUFLOW model parameters are listed in Table 11.

Table 12: Parameters in the TUFLOW Model

Parameters	Updated TUFLOW Model
Build	TUFLOW 2023-03-AE HPC
Coordination Reference System (CRS)	GDA2020 MGA 55
Grid Size	1m
Hydrology	TUFLOW Rain-on-Grid as per ARR2019 guidelines (Refer Table 10)
Inflow type	Rainfall on Grid is applied with a 2d_rf layer comprising the entire model extent
Extent	Henty Town
Downstream Boundary	Water level (head) versus flow taken from the slope of the terrain.
Timestep	Dynamic
Building Representation	Null polygon
Topography	1 m resolution LiDAR collected in 2015 Site survey and verified cloud point data (Refer to Items 5 and 6 in Table 2)

Parameters	Updated TUFLOW Model
Roughness	Pasture: 0.05 Ponds and other water bodies: 0.015 Roads: 0.02 Buckaringah Creek: 0.04 Railway: 0.03
Design Events	PMF, 1% AEP + Climate Change, 1%AEP, 2% AEP, 5% AEP

4.2.1.1 Topography

The model topography comprised of the 1m, 2015 LiDAR, for the entire model extent and site-specific topographic survey for the site areas. These were supplemented with breaklines to reinforce the topography of the rail lines and roads throughout the model area.

4.2.1.2 Drainage Network

The drainage network was modelled using the site-specific drainage survey, and information was also available in the Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013).

4.2.2 Design Model Update

The design model was updated from the existing condition by incorporating the Inland Rail Project Works as part of the IFC stage, including (Figure 5):

- Track: the track slews between CH580+060km and CH580+690km.
- Updated terrain to reflect the level crossing at CH580+216km.
- Changes in the culvert design underneath the level crossing. See Table 12 below.
- A cess drain was included on the western side of the railway between CH580+103km and CH580+400km. See Table 13 below.
- Changes to the Gantry at CH 580 + 225km
- New Signal hut at CH 580 + 180km

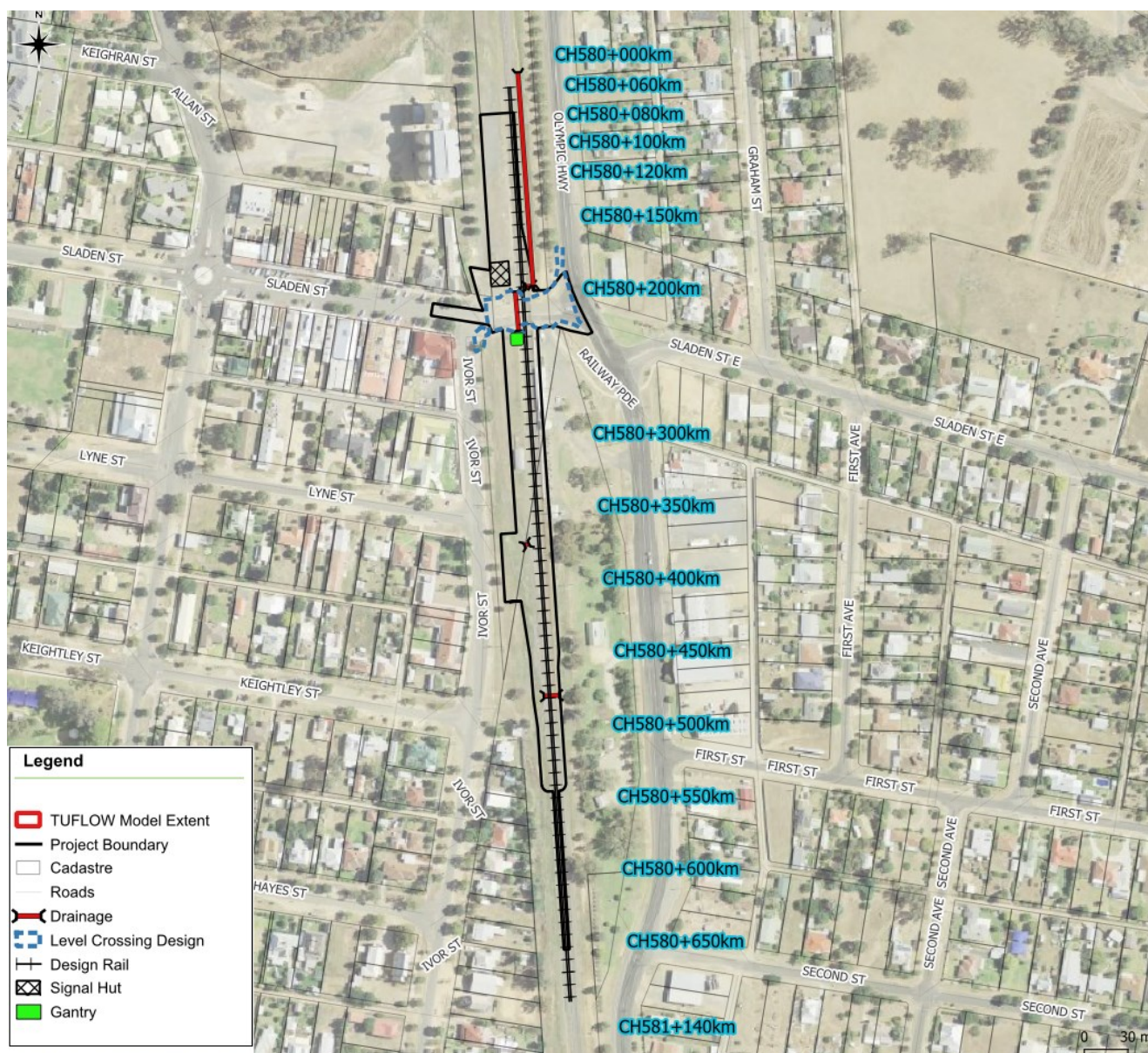


Figure 5: Proposed Works

Table 13: Design Culvert Details

ID	Chainage (m)	Length (m)	Size (mm)	Size (mm)	US IL (m AHD)	DS IL (m AHD)	Grade* (%)
G2-LX-01	580227.315	28.06	300	300	237.041	236.863	0.5

Table 14: Channel Details

ID	Chainage (m)	Length (m)	Channel Type	Base Width (mm)	Min Channel Depth (mm)	Average Grade* (%)
Cess Drain	580400 - 580335	79.300	Cess – Grass Lined	600	300	0.3
Cess Drain	580335 - 580290	32.900	Inverted RCBC	400	300	0.4
Cess Drain	580290 - 580229	62.108	Cess – Grass Lined	600	300	0.3

Cess Drain	580200 -580100	97.976	Cess – Grass Lined	600	300	0.3
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* Between two adjacent drainage cross-sections, the works will be constructed to ensure there will be no localised depressions between those cross-sections.

4.2.3 Design Events

The critical duration analysis was conducted by using rainfall hyetographs that served as the input boundary condition for the TUFLOW Rain-on-Grid Model. The storm durations of 10min, 15min, 20min, 25min, 30min, 45min, 60min, 90min, 120min, 180min, 270min, 360min, 540min, 720min, 1080min, and 1440min were modelled for the events of 5%, 2%, 1%AEPs and 1% AEP with climate change. An ensemble of 10 temporal patterns was run for each duration as recommended in ARR2019. The medium for the 10 temporal patterns will represent each duration. For PMF, 15min, 30min, 45min, 60min, 90min, 120min, 150min, and 180min were modelled. 11 temporal patterns were run for each duration, which is in line with the ARR2019 approach. The maximum for the 11 temporal patterns will represent each duration. The critical durations were determined based on the maximum envelope method across the selected durations.

The critical duration and temporal patterns determined and elaborated below in the table below.

Table 15: Summary of Events and Critical Durations Run in TUFLOW

Design Events	Master Design Critical Duration
5% AEP	180 and 540 minutes
2% AEP	360 and 540 minutes
1% AEP	45 and 180 minutes
1% AEP + Climate Change	180 and 360 minutes
PMF	30, 45, and 60 minutes

4.2.3.1 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), the Year 2090 RCP8.5 interim climate change factor sourced from the ARR Data Hub (<https://data.arr-software.org/>) was adopted. This approach has been confirmed through RFI (IR2140-RTRFI-000773).

5 HYDRAULIC MODEL COMPARISONS

The comparison in this section involved the flood map showing the results from the flood study (WMA Water, 2013) for the 5% AEP against the results from the TUFLOW IFC model's existing condition for the same storm event. Comparisons for the other events were checked but it could only be done for 5% AEP since the flood map from the 2013 Flood study has no flood level contours within the vicinity of the present study area. The comparison is shown in Figure 6.

Generally, the comparison shows that the updated TUFLOW model produced flood level of 238 mAHD at similar locations and flood accumulation against the flood study at the adjacent localised low point east of the railway. Conversely, the latter has fewer areas of flooding within the study area. This difference can be primarily attributed to the following reasons:

- The updated TUFLOW model incorporated the point cloud survey data and the top of the railway track. The updated terrain generally has better resolution than the terrain data used for the flood study, resulting in a higher flood level.
- The updated TUFLOW model also has a finer grid size (1m) and focus of analysis, so the corresponding results better represent flooding behaviour compared to the flood study.



Figure 6: Comparison of 5% AEP Flood Map (Left - Figure 46 from the Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013) vs Right - 2024 IFC TUFLOW Model, Unit Within the Map is mAHD)

6 FLOOD ASSESSMENT

Existing flood maps, including peak flood depth and levels, peak flood velocity, and peak flood hazard for the modelled events, are provided in Appendix A.

Along the rail track, the water flows from the south going to the north of the project site as dictated by the terrain. There is a localised low point in the vicinity of CH580+480km. A single barrel box culvert with dimensions 1.5m(W) x 0.9m(H) is at this location which conveys water from the east side of the railway to the downstream side at the west so that no overtopping occurs. Subsequently, a 300mm pipe culvert is currently installed underneath the level crossing at CH580+216km to provide uninterrupted flow conveyance and prevent overtopping of the level crossing. Another 225mm pipe culvert at CH580+200km is currently in place next to the railway that captures water downstream of the level crossing and runs north up to the discharge point outside the northern boundary of the project site.

Contrary to the flow path along the rail track, water flows in a southerly direction along the two adjacent roads, Ivor St. and Railway PDE. There are also some other localised low points next to the project boundary between CH580+350km and CH580+550km where stormwater coming from the road is accumulated and captured by the box culvert at CH580+480km. The general flow behaviour is illustrated in the figure below.

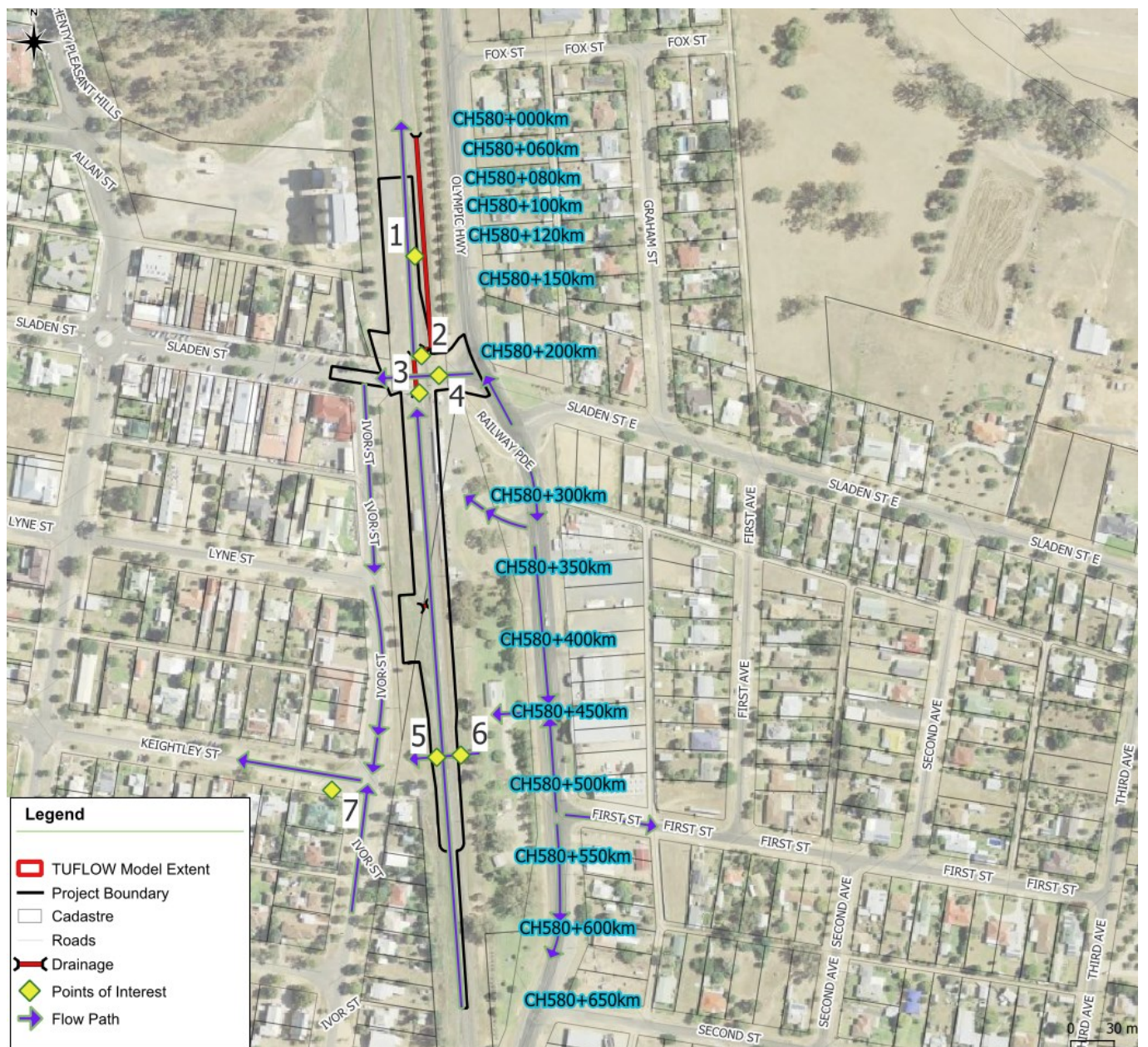


Figure 7: Henty Yard Site Flow Paths - Existing Conditions

6.1 Existing Condition

Figure 7 above shows points of interest that have been used for the flood impact assessment presented in the following sections and the table below describes the location at each point of interest.

Table 16: Points of Interest

Point of Interest	Chainage (m)	Description
1	CH580+134km	Along the track to the north of the level crossing
2	CH580+201km	Directly adjacent to the north of the level crossing
3	CH580+227km	Directly adjacent to the south of the level crossing
4	CH580+216km	Level crossing
5	CH580+480km	Downstream of the box culvert opposite Keightley St
6	CH580+480km	Upstream of the box culvert opposite Keightley St
7	CH580+501km	Along Keightley St.

Table 16 to Table 21 summarise the existing flood levels (peak and location), and the flood maps are shown in Appendix A (Figure A1 to Figure A15)

Table 16 and Table 17 summarise the peak flood level results for the existing conditions at the Henty Yard site.

Table 17: Peak Flood Levels – Existing Conditions

Design Events	Flood Levels
Probable Maximum Flood	Overtopping of the level crossing (CH580+216km)
1% AEP and 1% AEP wCC	- Accumulation of stormwater and minimal overtopping of the railway at the south side of the level crossing (CH580+227km). - Water depth outside the eastern boundary of the project (CH580+350km to CH580+600km) is less than 1 m - Water depth along the roadside of Keightley Street is less than 0.4 m
All other % AEP events	- Accumulation of stormwater and minimal overtopping of the railway at the south side of the level crossing (CH580+227km). - Water outside the eastern boundary of the project (CH580+350km to CH580+600km) with depths less than 0.6 m. - Water along the roadside of Keightley Street with depths less than 0.3m

Table 18: Peak Flood Levels (mAHD) at Points of Interest – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	237.47	237.47	237.47	237.47	237.56
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	237.93
Point 3	237.59	237.60	237.60	237.62	238.22
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	238.21
Point 5	237.12	237.13	237.16	237.17	237.23
Point 6	237.55	237.68	237.86	237.96	238.68
Point 7	236.04	236.06	236.08	236.08	236.38

Table 18 and Table 19 summarises the peak flood velocity results for existing conditions at the Henty Yard site.

Table 19: Peak Flood Velocity – Existing Conditions

Design Events	Flood Velocity
Probable Maximum Flood (PMF)	- Peak velocity within the site is generally between 0.2m/s to 2.1m/s - Peak velocity at the level crossing is around 1.8 m/s
1% AEP and 1% AEP with Climate Change (w/CC)	- Peak velocity at the downstream of the box culvert (Point 5) is between 1.5 and 1.6 m/s for 1% AEP and 1% w/ CC, respectively. - Outside the project site (e.g. Point 7), the peak velocity is 0.7 m/s for 1% AEP and 1% w/ CC, respectively
5% AEP and 2% AEP	- Peak velocity at the downstream of the box culvert (Point 5) is between 1.2 and 1.4 m/s for 5% and 2% AEP, respectively. - Outside the project site (e.g. Point 7), the peak velocity is 0.5 m/s and 0.6 m/s for 5% and 2% AEP, respectively.
All % AEP events	- Downstream of the project site such as at Point 1, peak velocity is generally less than 0.1 m/s - Peak velocity at the upstream of the box culvert (Point 6) is 0.8 m/s for all return periods. - Refer to Table 33 for flood velocity comparison based on points of interest.

Table 20: Flood Velocity (m/s) at Points of Interest – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	Less than 0.1	Less than 0.1	Less than 0.1	Less than 0.1	0.5
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	0.8
Point 3	0.1	0.1	0.1	0.1	0.3
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	1.7
Point 5	1.2	1.4	1.5	1.7	2.1
Point 6	0.8	0.8	0.8	0.8	0.8
Point 7	0.5	0.6	0.7	0.7	1

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

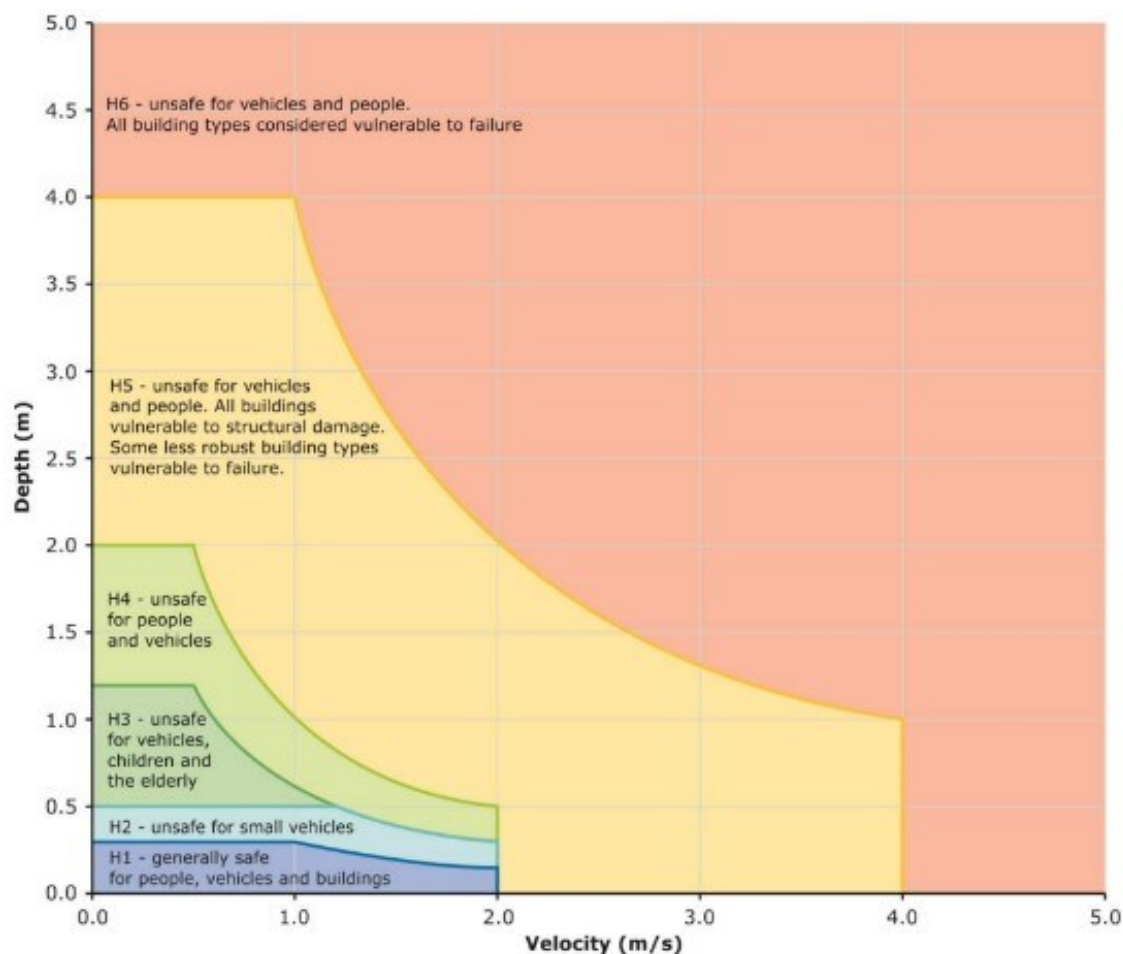


Figure 8: Hazard Category Classification

Table 20 and Table 21 summarises the peak flood hazard for the existing conditions at the Henty Yard site.

Table 21: Flood Hazard – Existing Conditions

Design Events	Flood Hazard
All % AEP events	- Other than the two locations within the vicinity of the box culvert exposed to medium hazard (H3-H4), the majority of the project site generally experiences low flood hazard (H1-H2) - Refer to Table 21 for flood hazard comparison based on points of interest. - Areas outside the project site also experience low flood hazard (H1-H2)

Table 22: Peak Flood Hazard Category at Points of Interest – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	H1	H1	H1	H1	H1
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	H1
Point 3	H1	H1	H1	H1	H3
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	H1
Point 5	H1	H1	H2	H2	H4
Point 6	H3	H3	H3	H3	H4
Point 7	H1	H1	H1	H1	H2

6.2 Design Condition

Design condition flood maps, including peak flood depth and levels, peak flood velocity, and peak flood hazard for the events modelled, are provided in Appendix A.

During design conditions, the proposed rail track, cess drain, level crossing, and culvert (refer to Figure 5) prevent the water from overtopping the railway. Flood water flowing toward the north is collected in the cess drain and then conveyed through the culvert underneath the level crossing at CH580+216km. In summary, the proposed civil works affect flow behaviour and result in less flooding (Refer to Figure A19 to A24 in Appendix A).

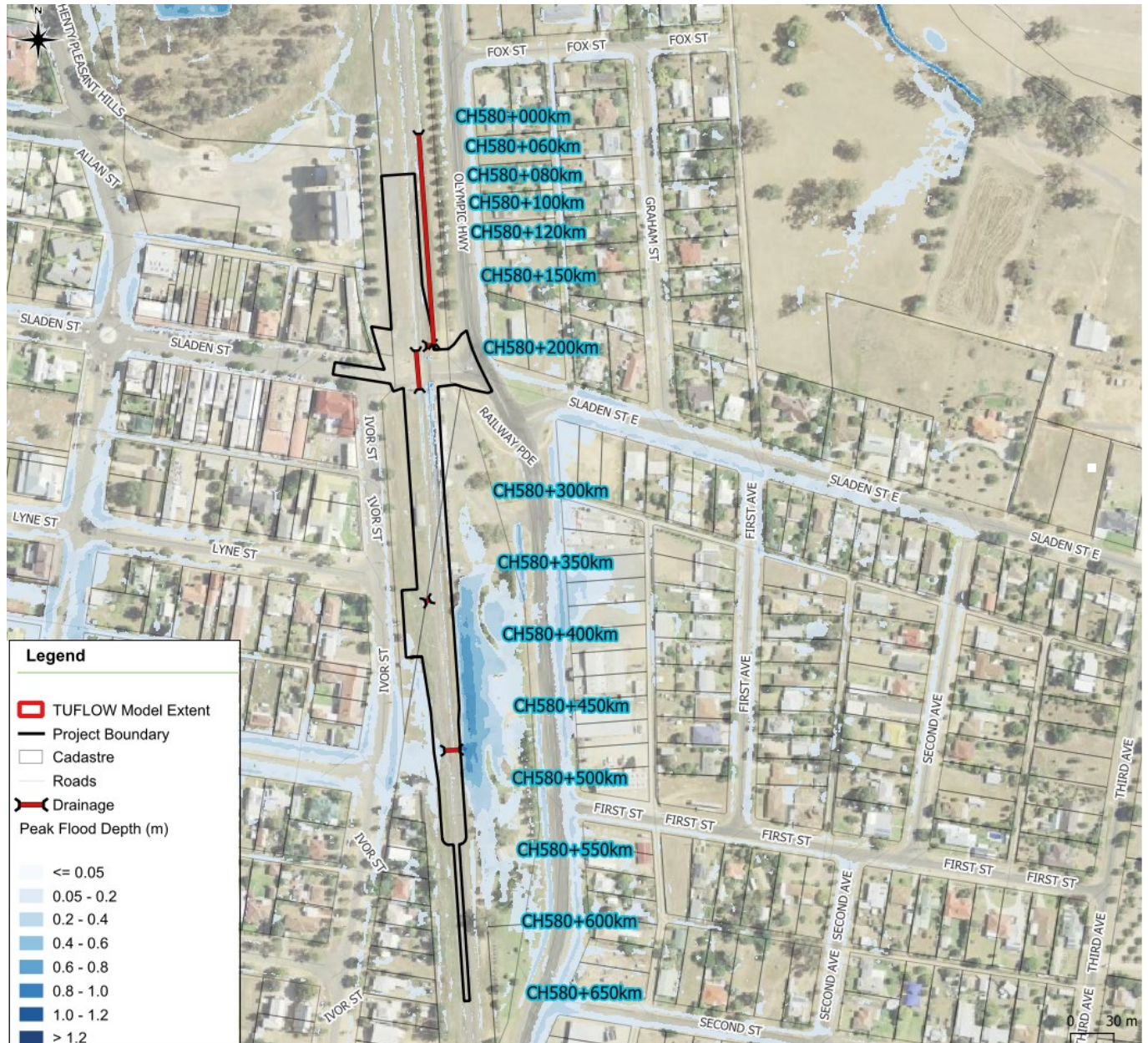


Figure 9: 1% AEP Flood Depth - Design

The design conditions for flooding behaviour are discussed below from Table 22 to Table 27.

Table 22 and Table 23 discuss the peak flood levels for the design conditions at the Henty Yard site.

Table 23: Peak Flood Levels – Design Conditions

Design Events	Flood Levels
Probable Maximum Flood	Overtopping of the level crossing (CH580+216km)
2%, 1% AEP and 1% AEP with Climate Change	Accumulation of stormwater and minimal overtopping of the railway at the south side of the level crossing (CH580+227km).
5% AEP Event	No overtopping

Table 24: Peak Flood Levels (mAHD) at Points of Interest – Design Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	237.46	237.46	237.46	237.46	237.56
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	237.90
Point 3	No Flooding	No Flooding	No Flooding	No Flooding	238.24
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	238.22
Point 5	237.12	237.13	237.16	237.17	237.24
Point 6	237.55	237.67	237.85	237.96	238.70
Point 7	236.04	236.06	236.08	236.09	236.37

Table 24 and Table 25 summarises the peak flood velocity for the design conditions at the Henty Yard site.

Table 25: Peak Flood Velocity – Design Conditions

Design Events	Flood Velocity
Probable Maximum Flood (PMF)	- Peak velocity within the site is generally between 0.2m/s and to 2.1m/s - Peak velocity at the level crossing is 1.8 m/s
1% AEP and 1% AEP wCC	- Peak velocity downstream of the box culvert (Point 5) is between 1.5 and 1.6 m/s for 1% AEP and 1% w/ CC, respectively. - Outside the project site (e.g. Point 7), the peak velocity is 0.5 m/s for 1% AEP and 1% w/ CC, respectively
5% AEP and 2% AEP	- Peak velocity at the downstream of the box culvert (Point 5) is between 1.2 and 1.3 m/s for 5% and 2% AEP, respectively. - Outside the project site (e.g. Point 7), the peak velocity is 0.5 m/s for 5% and 2% AEP, respectively.
All % AEP events	- Downstream of the project site, such as at Point 1, peak velocity is generally less than 0.1 m/s - Peak velocity at the upstream of the box culvert (Point 6) is 0.7 m/s for all return periods. - Refer to Table 25 for flood velocity comparison based on points of interest.

Table 26: Peak Flood Velocity (m/s) at Points of Interest – Design Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	Less than 0.1	Less than 0.1	Less than 0.1	Less than 0.1	0.6
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	1.2
Point 3	No Flooding	No Flooding	No Flooding	No Flooding	0.6
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	0.8
Point 5	1.2	1.4	1.5	1.7	2.1

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 6	0.8	0.8	0.8	0.8	0.8
Point 7	0.5	0.6	0.7	0.7	1.0

Table 26 and Table 27 summarises the peak flood hazard for the design conditions at the Henty Yard site.

Table 27: Flood Hazard – Design Conditions

Design Events	Flood Hazard
All % AEP events	- Other than the two locations within the vicinity of the box culvert exposed to medium hazard (H3-H4), the majority of the project site generally experiences low flood hazard (H1-H2) - Refer to Table 27 for flood hazard comparison based on points of interest.

Table 28: Peak Flood Hazard Category at Points of Interest – Design Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	H1	H1	H1	H1	H1
Point 2	No Flooding	No Flooding	No Flooding	No Flooding	H1
Point 3	No Flooding	No Flooding	No Flooding	No Flooding	H3
Point 4	No Flooding	No Flooding	No Flooding	No Flooding	H1
Point 5	H1	H1	H2	H2	H5
Point 6	H3	H3	H3	H3	H4
Point 7	H1	H1	H1	H1	H2

6.3 Flood Immunity and Scour Protection

The railway corridor achieves less than the 5% AEP flood immunity in the existing case, while it achieves the 5% AEP in the design conditions, which complies with the criteria in PSRs. Furthermore, in the design condition, the changes in flood velocity are generally less than 0.1m/s within the project boundary for all events, which complies with CoA. Hence, it is not necessary for scour protection measures apart from the proposed culvert and proposed cess drain shown in Figure 5 (refer to Section 4.5.9 in 5-0052-210-PEN-G2-RP-0001). It should be noted that the flood velocity for the 1% AEP downstream of the culvert (CH 580+480km) is around 1.6m/s, which is generally greater than other locations within the project boundary. It is recommended that scour protection may be provided if any erosion is observed.

Table 28 below shows the overtopping details at CH 580+225km.

Table 29: Overtopping Details

Chainage	Top of the Rail Level (mAHD)		Top of the Formation Level* (mAHD)		5% AEP Flood Level (mAHD)		2% AEP Flood Level (mAHD)		1% AEP Flood Level (mAHD)	
	Existing	Design	Existing	Design	Existing	Design	Existing	Design	Existing	Design
CH 580 + 225km	237.96	237.97	237.29	237.30	237.96	Not Overtopped	237.96	237.97	237.97	237.97

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

6.4 Flood Impact Assessment

The railway has equal flood immunity for both existing and design conditions, at the 2% AEP. As a direct consequence, there was no visible change in the peak flood depth, peak flood velocity, and flood hazard in most areas of the study area. The discussion about the peak level, velocity and hazard effect due to the design is illustrated in the following sections.

6.4.1 Changes in Peak Flood Levels

The changes in flood levels outside of the project boundary are within $\pm 0.01\text{m}$, which complies with the CoA. The impacts presented below are due to the implementation of the design surface for the rail line, cess drain, and level crossing. The flood maps are shown in Appendix A (Figure A31 to Figure A34).

Table 29 and Table 30 summarises the change in Peak Flood levels at the Henty Yard site.

Table 30: Flood Levels Impact Assessment

Design Events	Changes in Peak Flood Levels
All % AEP events	Apart from Point 3, which becomes dry, the overall changes in flood levels are within $\pm 0.01\text{m}$.

Table 31: Changes in Flood Levels (m) at Points of Interest

Locations	5% AEP	2% AEP	1% AEP
Point 1	-0.010	-0.010	-0.010
Point 2	No Flooding	No Flooding	No Flooding
Point 3	Was wet now dry	Was wet now dry	Was wet now dry
Point 4	No Flooding	No Flooding	No Flooding
Point 5	Less than 0.010m	Less than 0.010m	Less than 0.010m
Point 6	Less than 0.010m	Less than 0.010m	Less than 0.010m
Point 7	Less than 0.010m	Less than 0.010m	Less than 0.010m

6.4.2 Changes in Peak Flood Velocity

Generally, the changes in flood velocity outside of the project boundary are within 10% or less than 0.5m/s, which complies with the CoA. The flood maps are shown in Appendix A (Figure A35 to Figure A38).

Table 31 and Table 32 summarise the change in Peak Flood velocity at the Henty Yard site.

Table 32: Flood Velocity Impact Assessment

Design Events	Changes in Peak Flood Velocity
All % AEP events	Apart from Point 3, the overall changes in flood velocity are less than 0.1 m/s

Table 33: Changes in Flood Velocity (m/s) at Points of Interest

Locations	5% AEP	2% AEP	1% AEP
Point 1	Less than 0.01m/s	Less than 0.01m/s	Less than -0.01m/s
Point 2	No Flooding	No Flooding	No Flooding
Point 3	Was wet now dry	Was wet now dry	Was wet now dry
Point 4	No Flooding	No Flooding	No Flooding
Point 5	Less than 0.02m/s	Less than 0.01m/s	Less than 0.01m/s
Point 6	Less than 0.01m/s	Less than 0.01m/s	Less than 0.01m/s
Point 7	Less than 0.01m/s	Less than 0.01m/s	Less than 0.01m/s

6.4.3 Changes in Peak Flood Hazard

Generally, there is no change in flood hazard outside the project boundary, which complies with the CoA. The flood maps are shown in Appendix A (Figure A39 to Figure A42).

Table 33 and Table 34 summarises the change in Peak Flood hazard at the Henty Yard site.

Table 34: Flood Hazard Impact Assessment

Design Events	Changes in Peak Flood Hazard
All %AEP events	Apart from Point 3, there is no changes in hazard for the rest of the points.

Table 35: Changes in Flood Hazard at Points of Interest

Locations	5% AEP	2% AEP	1% AEP
Point 1	No Change	No Change	No Change
Point 2	No Flooding	No Flooding	No Flooding
Point 3	Was wet now dry	Was wet now dry	Was wet now dry
Point 4	No Flooding	No Flooding	No Flooding
Point 5	No Change	No Change	No Change
Point 6	No Change	No Change	No Change
Point 7	No Change	No Change	No Change

6.4.4 Changes in Inundation of Duration

The analysis around the change in inundation of duration was undertaken by comparing the flood level vs. time at two points (refer to Figure 10 for the locations) between the design and existing conditions. As shown in the figure below, both locations show in the flood level vs time curve for the 1%, 2% and 5% AEP events comparison between design and existing. Therefore, there is no impact on the changes in inundation of duration for the area upstream and downstream outside of the project boundary. Consequently, the change in inundation of duration complies with the CoA E42(a).

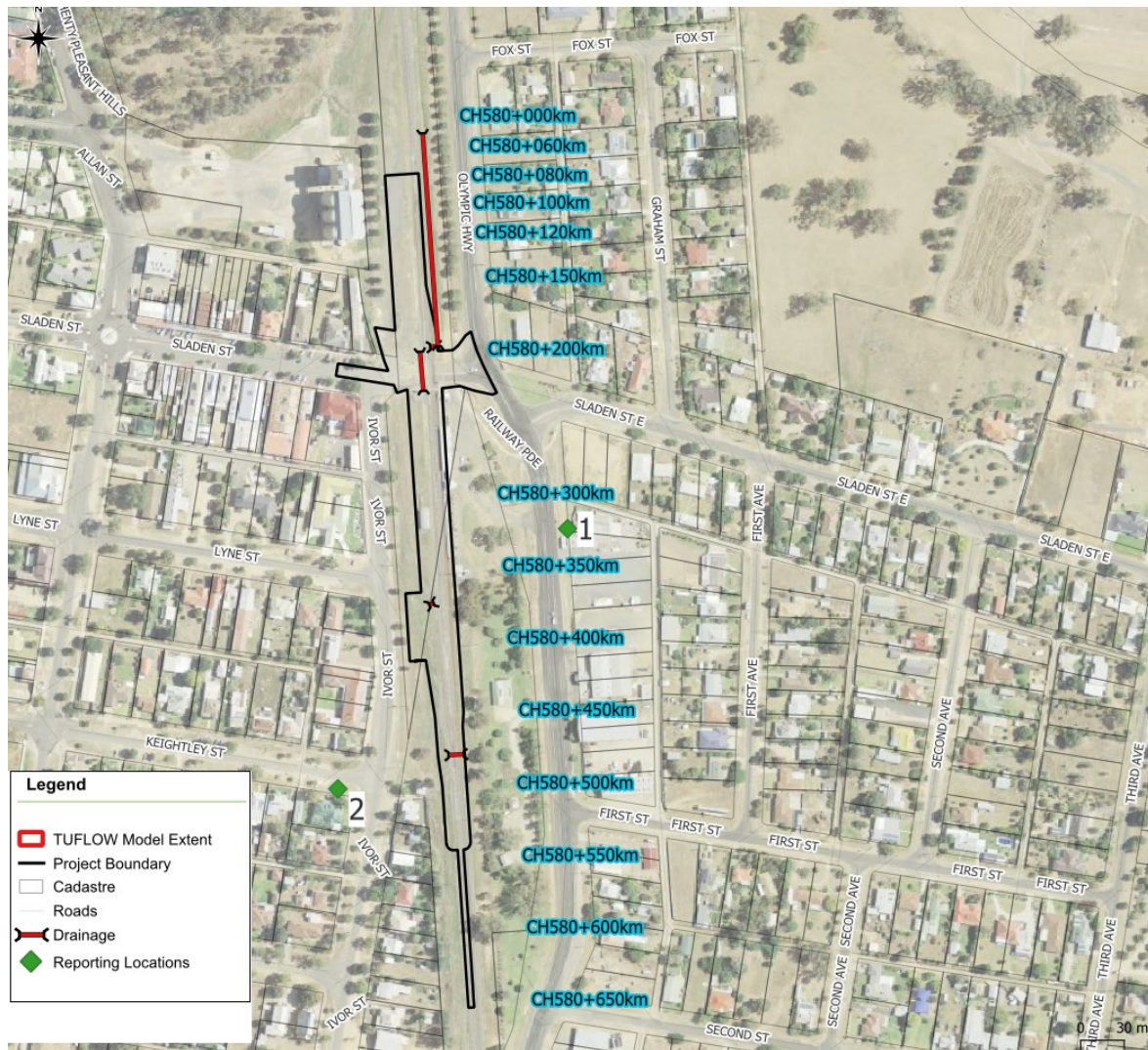


Figure 10: Locations for the Changes in Inundation of Duration

1% AEP - Water Level vs Time

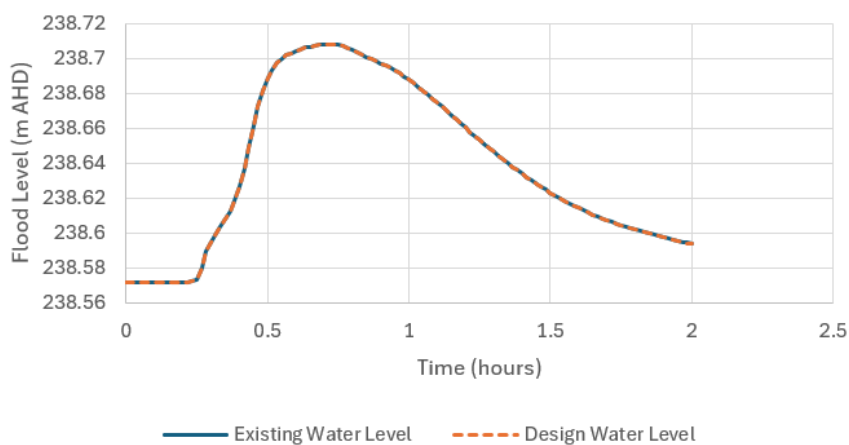


Figure 11: Comparison of the Flood Level vs Time at Locations P1 – 1% AEP

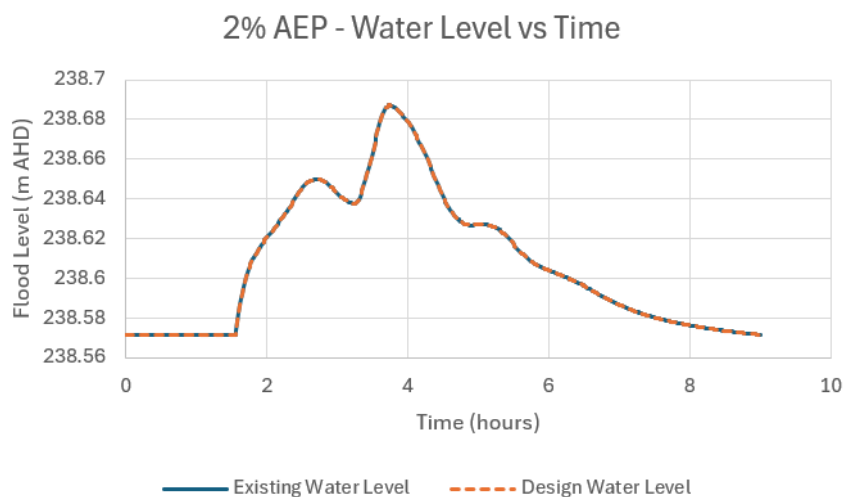


Figure 12: Comparison of the Flood Level vs Time at Locations P1 – 2% AEP

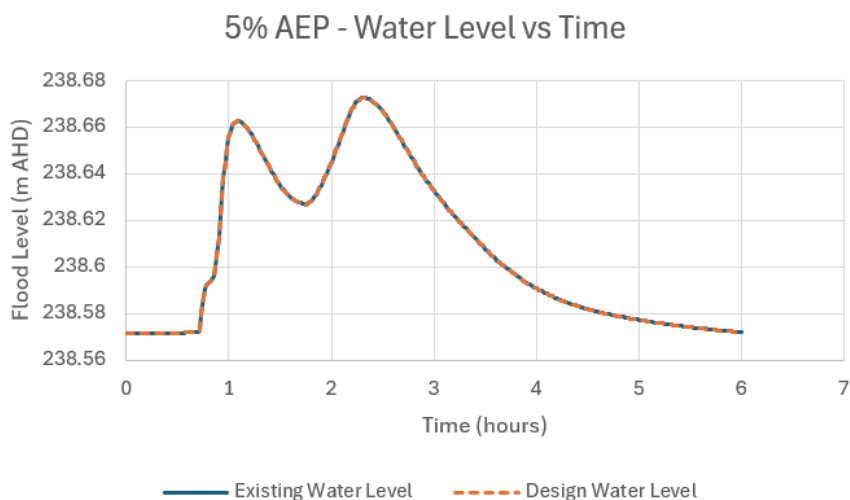


Figure 13: Comparison of the Flood Level vs Time at Locations P1 – 5% AEP

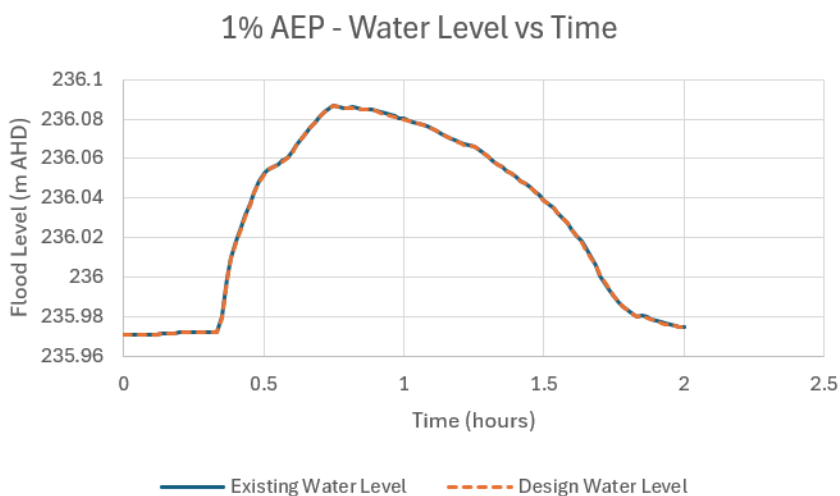


Figure 14: Comparison of the Flood Level vs Time at Locations P2 – 1% AEP

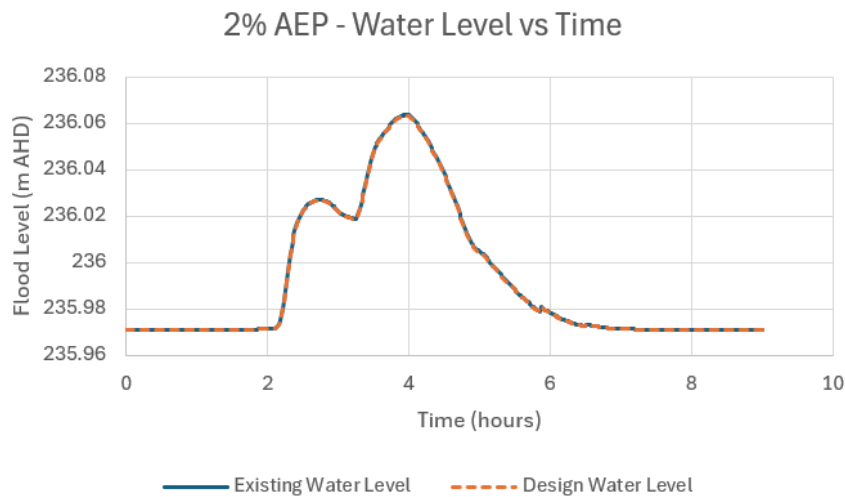


Figure 15: Comparison of the Flood Level vs Time at Locations P2 – 2% AEP

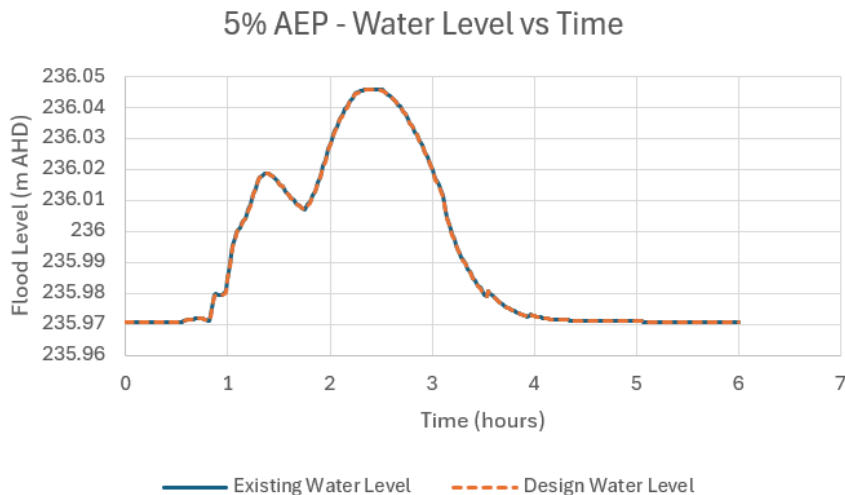


Figure 16: Comparison of the Flood Level vs Time at Locations P2 – 5% AEP

6.5 Sensitivity Test

6.5.1 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 (Table 35 and Table 36) below. Apart from the four culverts (CH 580+060km, CH 580+225km, CH 580+375km, and CH 580+480km) within the project boundary, 20% blockage was adopted for all the other culverts, pits and pipes outside the project boundary (refer to Section 1.11).

A flood level comparison between the blockage scenario and the design is shown in Figure 17. Considering the same 25% blockage computed for all four culverts within the project boundary, the overall flood behaviour is subject to the blockage for existing culverts near the rail track. The water level increases of up to 0.02m and 0.04m are mainly found at the upstream side of CH 580+225km and CH 580+480km, respectively. The excess water at CH 580+225km stays within the cess drain, while at CH 580+480km, excess water collects on the eastern side of the project boundary.

Table 36: Culvert Blockage Percentage

Culvert	Blockage Percentage (1% AEP)	Comments
CH 580+060km (1 cell 0.225m in diameter)	25%	Inside the project boundary
CH 580+225km (1 cell 0.300m in diameter)	25%	Inside the project boundary

Culvert	Blockage Percentage (1% AEP)	Comments
CH 580+480km (1 cell 1.5m (W) and 0.9m (H))	25%	Inside the project boundary
CH 580+375km (1 cell 0.600m in diameter)	25%	Inside the project boundary
All others (culvert, pit and pipe)	20%	Outside of the project boundary

Table 37: Culvert Blockage Parameters

Culvert	Debris Availability	Debris Mobility	Debris Transportability	AEP Adjusted Debris Potential
CH 580+060km	Low	Medium	Low	Low
CH 580+225km	Low	Medium	Low	Low
CH 580+375km	Low	Medium	Low	Low
CH580+480km	Low	Medium	Low	Low

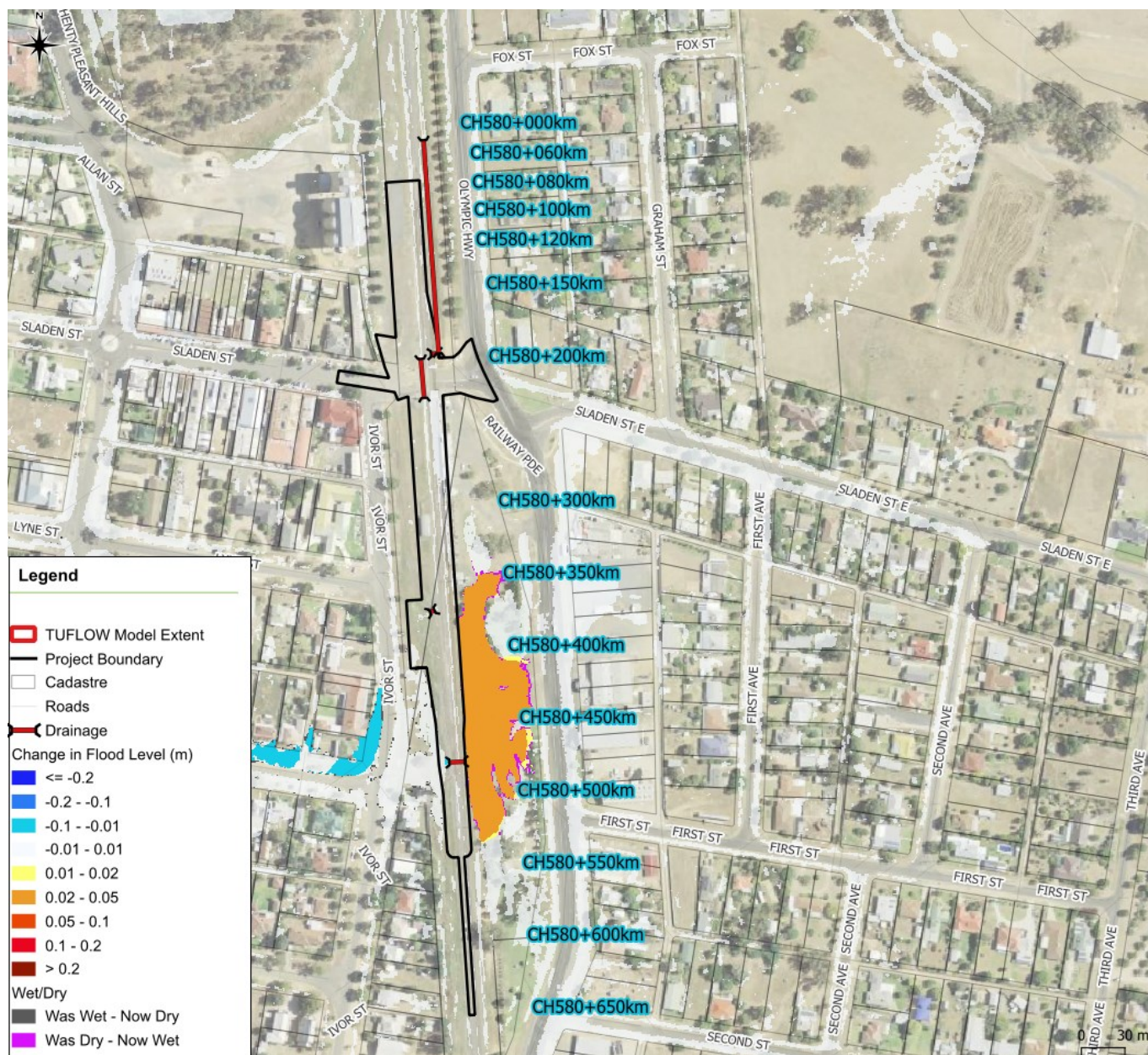


Figure 17: Flood Level Comparison for the 1% AEP Design Condition – Blockage vs Design

6.5.2 Climate Change Risk Assessment

A Climate Change risk assessment was carried out by running the 1% AEP with the Year 2090 RCP8.5 interim climate change factor (refer to Section 4.2.3.1 for details of the approach) and the results of flood depth, flood velocity and flood hazard can be found in Section 6.1 and Section 6.2. The corresponding flood maps can be found in Appendix A. The assessment is summarised below:

- The floodwater overtops the railway with a flood depth of around 0.1 to 0.2m around CH580+225km in the existing conditions while in the design conditions, the floodwaters overtop the railways with a flood depth of around 0.05m at the same location.

7 MITIGATION MEASURES

Based on the results discussed in the previous sections, the proposed design for Henty Yard Clearances has no impact on the flooding condition of the project site. Thus, no mitigation measures were proposed or analysed.

8 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 C, D, and E)

Consequently, there are no further recommendations.

This report will be provided to the Planning Secretary for approval.



APPENDICES



APPENDIX A

Flood Maps

Table A- 1: List of Maps in Appendix A

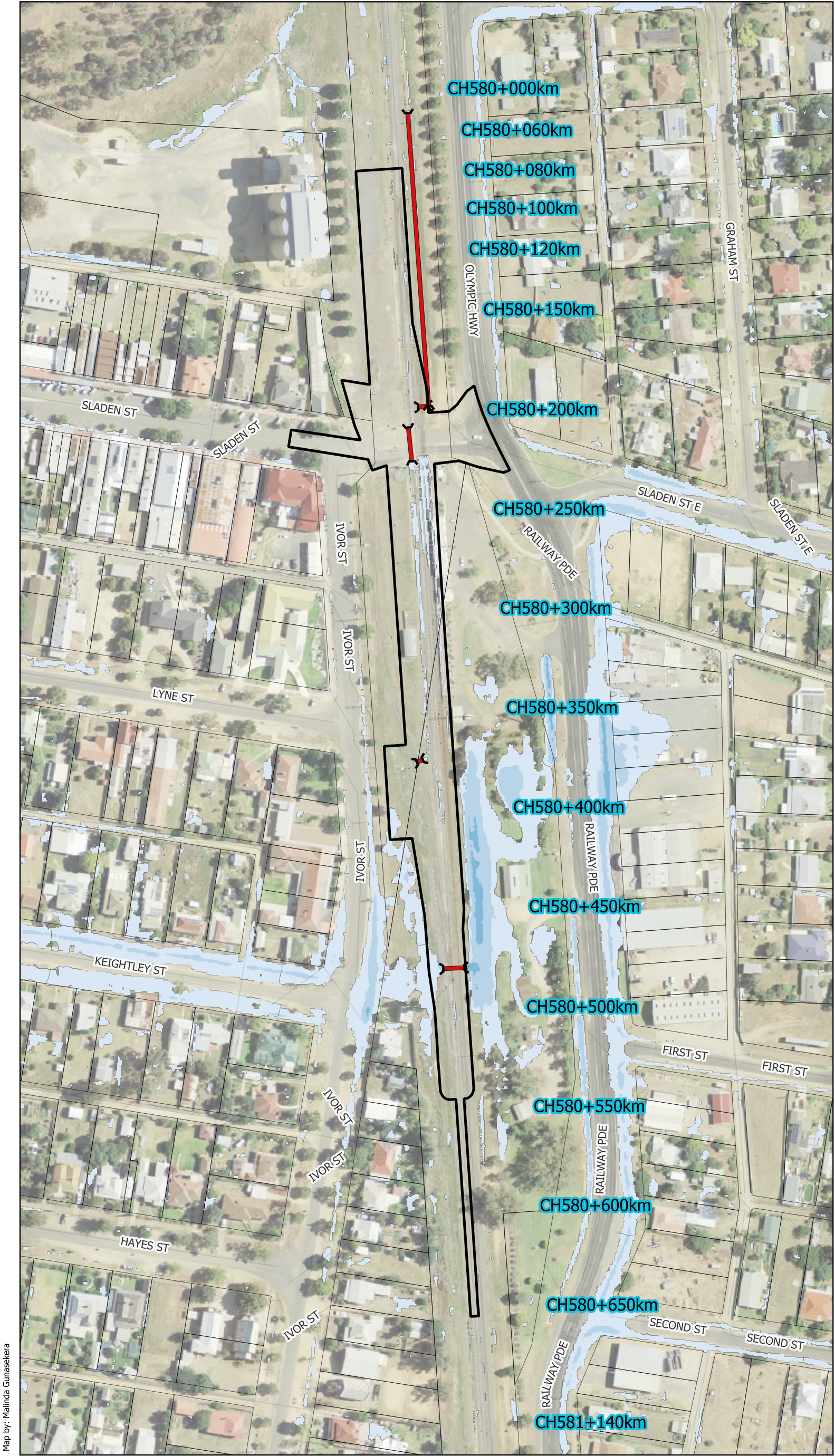
Map ID	Map description
Figure A1	5% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A2	2% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A3	1% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A4	1% AEP with Climate Change Peak Flood Depth and Levels (Existing Condition)
Figure A5	PMF Peak Flood Depth and Levels (Existing Condition)
Figure A6	5% AEP Peak Flood Velocity (Existing Condition)
Figure A7	2% AEP Peak Flood Velocity (Existing Condition)
Figure A8	1% AEP Peak Flood Velocity (Existing Condition)
Figure A9	1% AEP with Climate Change Peak Flood Velocity (Existing Condition)
Figure A10	PMF Peak Flood Velocity (Existing Condition)
Figure A11	5% AEP Peak Flood Hazard (Existing Condition)
Figure A12	2% AEP Peak Flood Hazard (Existing Condition)
Figure A13	1% AEP Peak Flood Hazard (Existing Condition)
Figure A14	1% AEP with Climate Change Peak Flood Hazard (Existing Condition)
Figure A15	PMF Peak Flood Hazard (Existing Condition)
Figure A16	5% AEP Peak Flood Depth and Levels (Design Condition)
Figure A17	2% AEP Peak Flood Depth and Levels (Design Condition)
Figure A18	1% AEP Peak Flood Depth and Levels (Design Condition)
Figure A19	1% AEP with Climate Change Peak Flood Depth and Levels (Design Condition)
Figure A20	PMF Peak Flood Depth and Levels (Design Condition)
Figure A21	5% AEP Peak Flood Velocity (Design Condition)
Figure A22	2% AEP Peak Flood Velocity (Design Condition)
Figure A23	1% AEP Peak Flood Velocity (Design Condition)
Figure A24	1% AEP with Climate Change Peak Flood Velocity (Design Condition)
Figure A25	PMF Peak Flood Velocity (Design Condition)
Figure A26	5% AEP Peak Flood Hazard (Design Condition)
Figure A27	2% AEP Peak Flood Hazard (Design Condition)
Figure A28	1% AEP Peak Flood Hazard (Design Condition)
Figure A29	1% AEP with Climate Change Peak Flood Hazard (Design Condition)
Figure A30	PMF Peak Flood Hazard (Design Condition)
Figure A31	5% AEP Changes in Peak Flood Levels (Design Condition vs. Existing Condition)
Figure A32	2% AEP Changes in Peak Flood Levels (Design Condition vs. Existing Condition)
Figure A33	1% AEP Changes in Peak Flood Levels (Design Condition vs. Existing Condition)
Figure A34	5% AEP Changes in Peak Flood Velocity (Design Condition vs. Existing Condition)
Figure A35	2% AEP Changes in Peak Flood Velocity (Design Condition vs. Existing Condition)
Figure A36	1% AEP Changes in Peak Flood Velocity (Design Condition vs. Existing Condition)
Figure A37	5% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)
Figure A38	2% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)
Figure A39	1% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)
Figure A40	1% AEP Peak Flood Depth and Levels (Blockage Assessment)
Figure A41	1% AEP Peak Flood Velocity (Blockage Assessment)
Figure A42	1% AEP Peak Flood Hazard (Blockage Assessment)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera

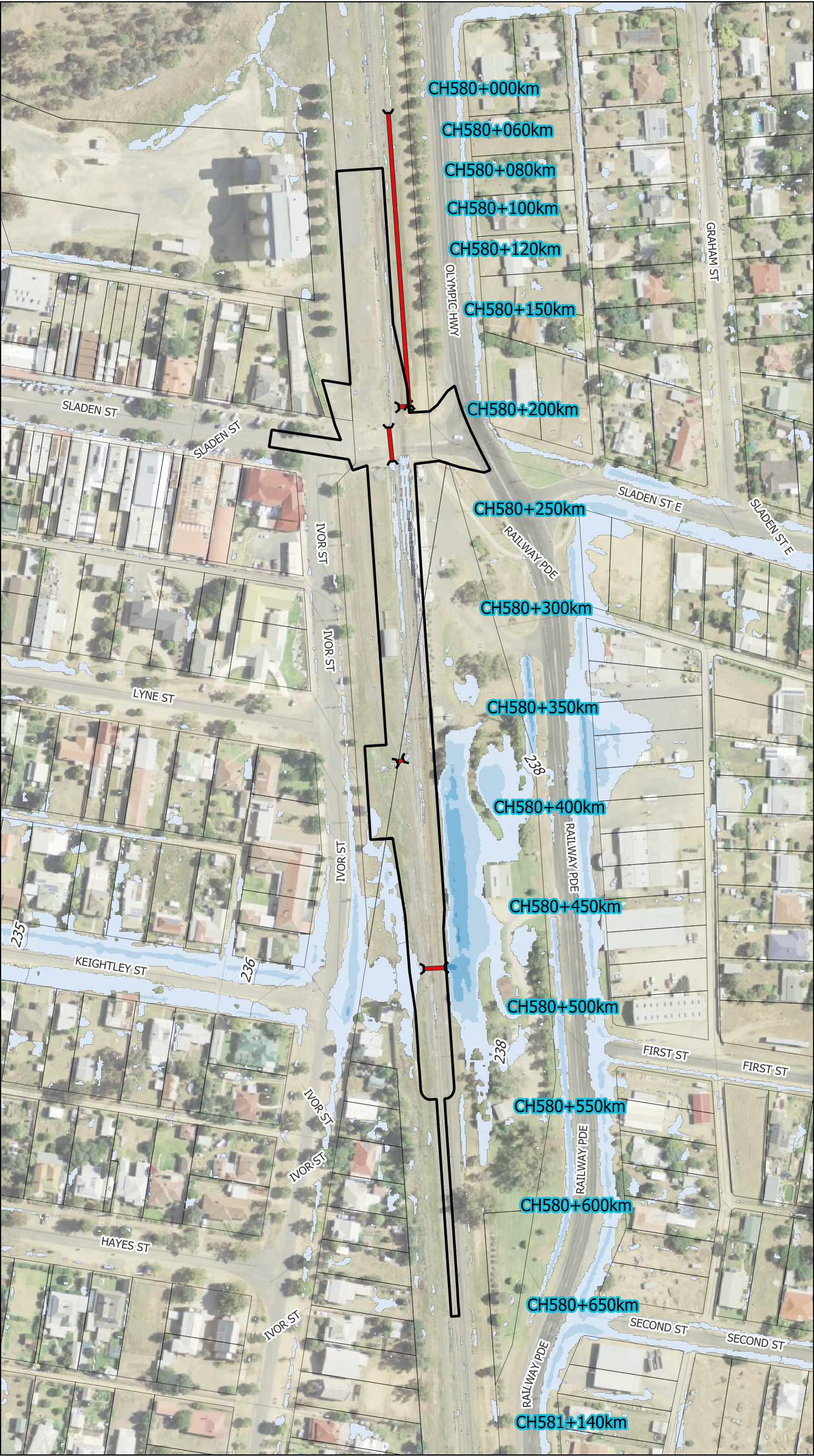


0 80 160 m
A3 Scale: 1:2,000.000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera

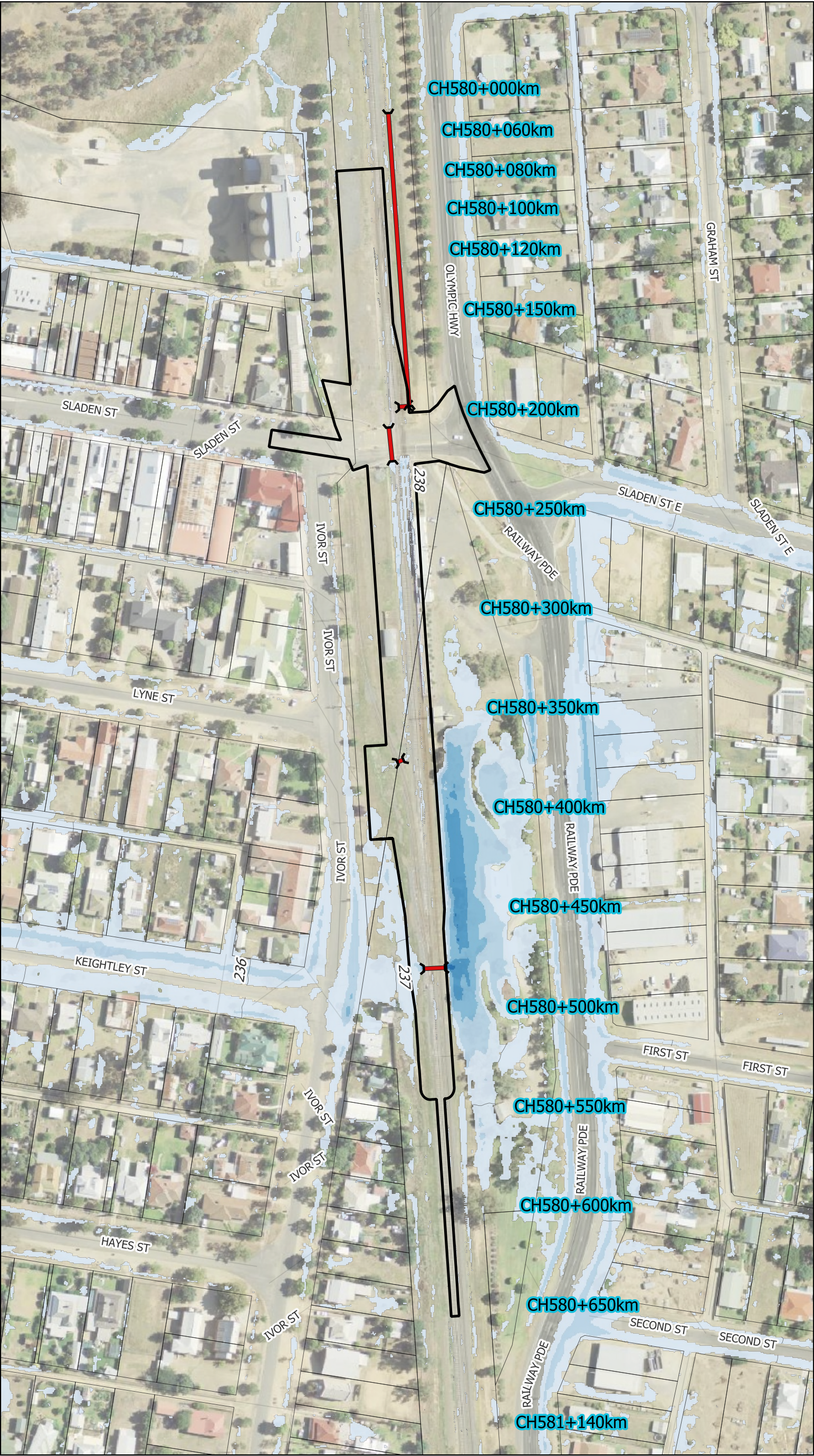


0 80 160 m
A3 Scale: 1:2,000.000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000.000002

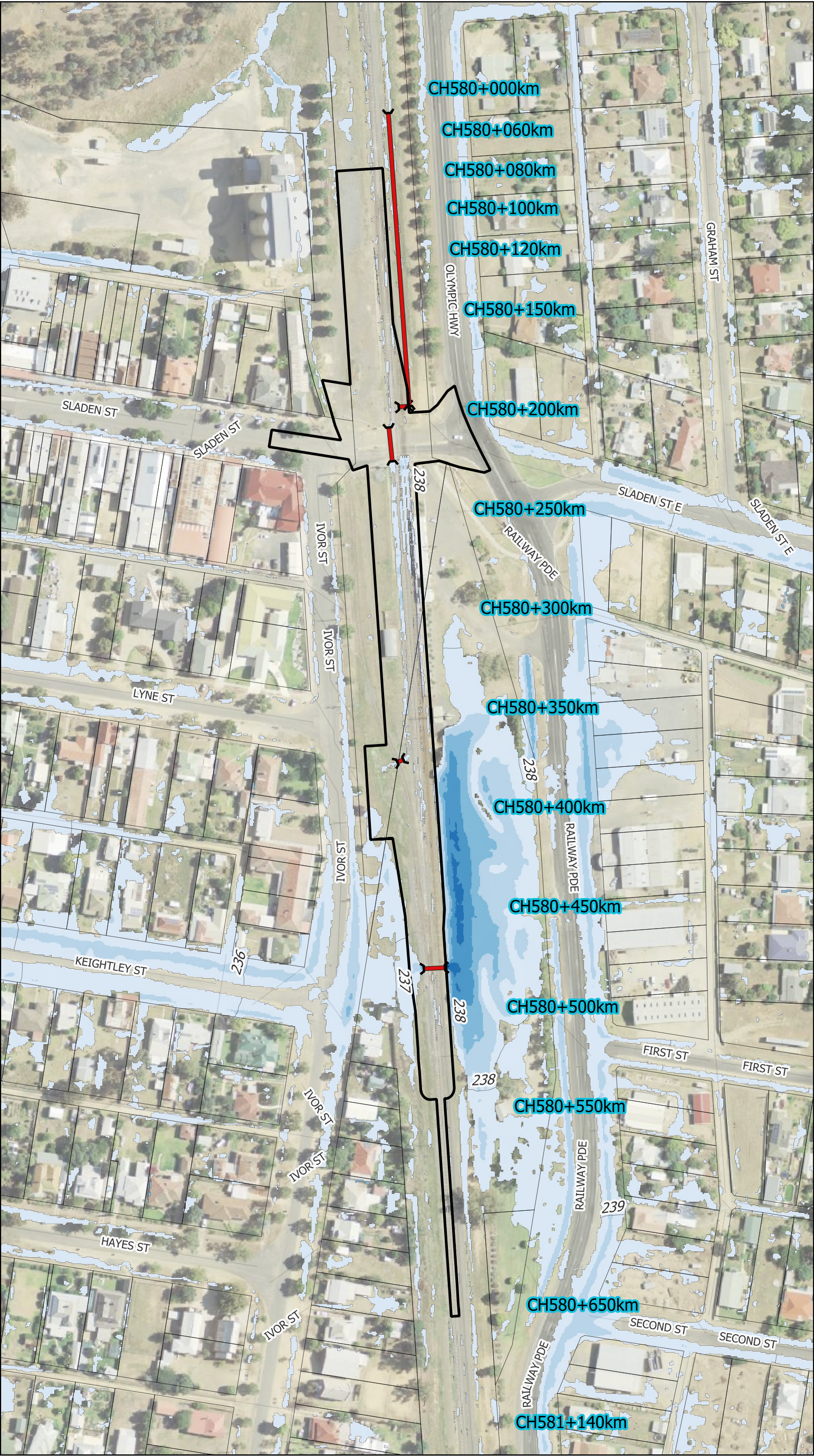
23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera



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A3 Scale: 1:2,000,000002

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Henty Yard Clearances - A2P - IFC Stage

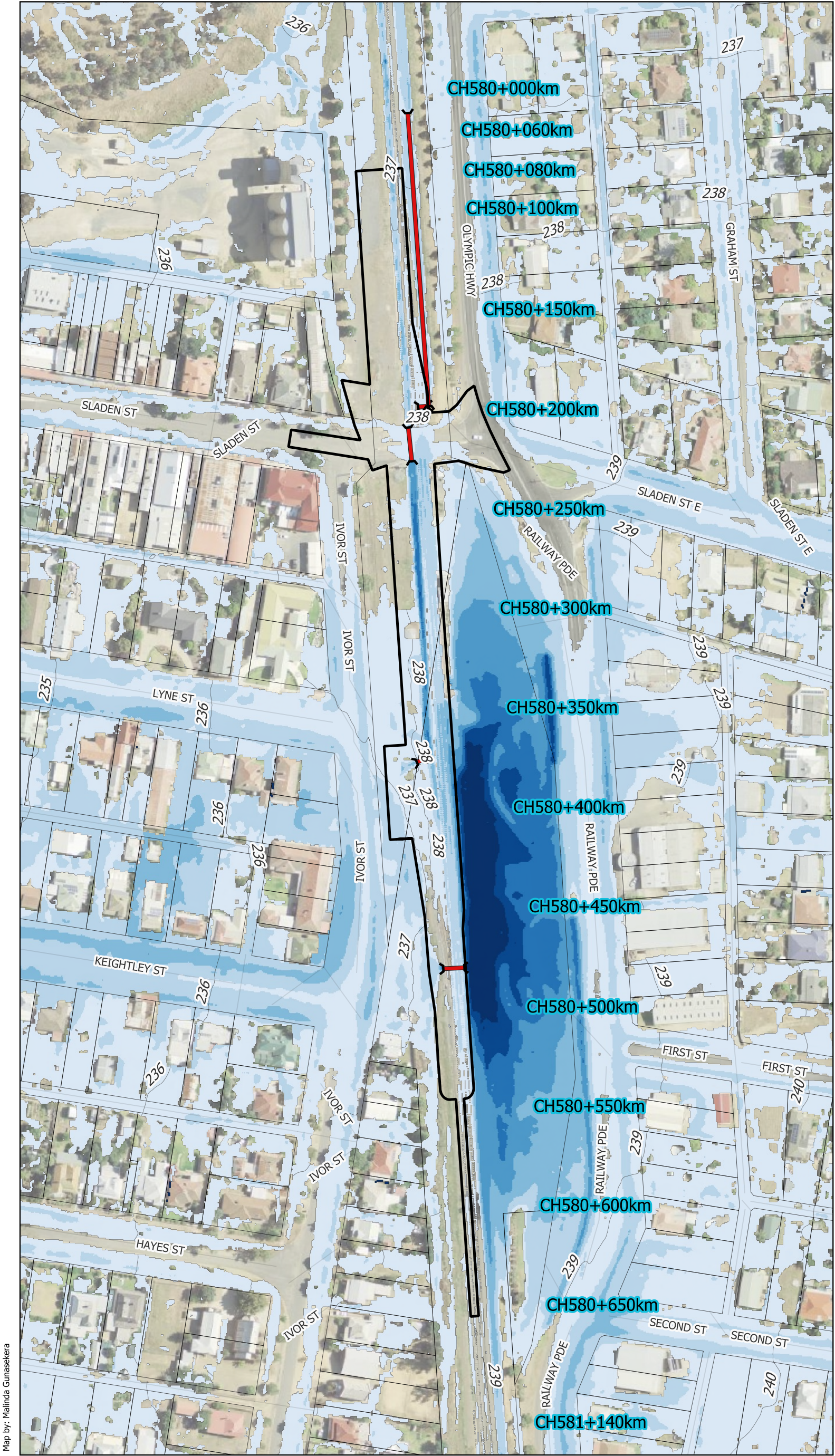
Figure A4 - 1% AEP with Climate Change Peak Flood Depth and Levels (Existing Condition)

Legend

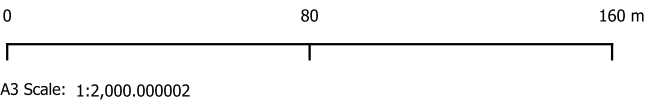
- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2



Notes:



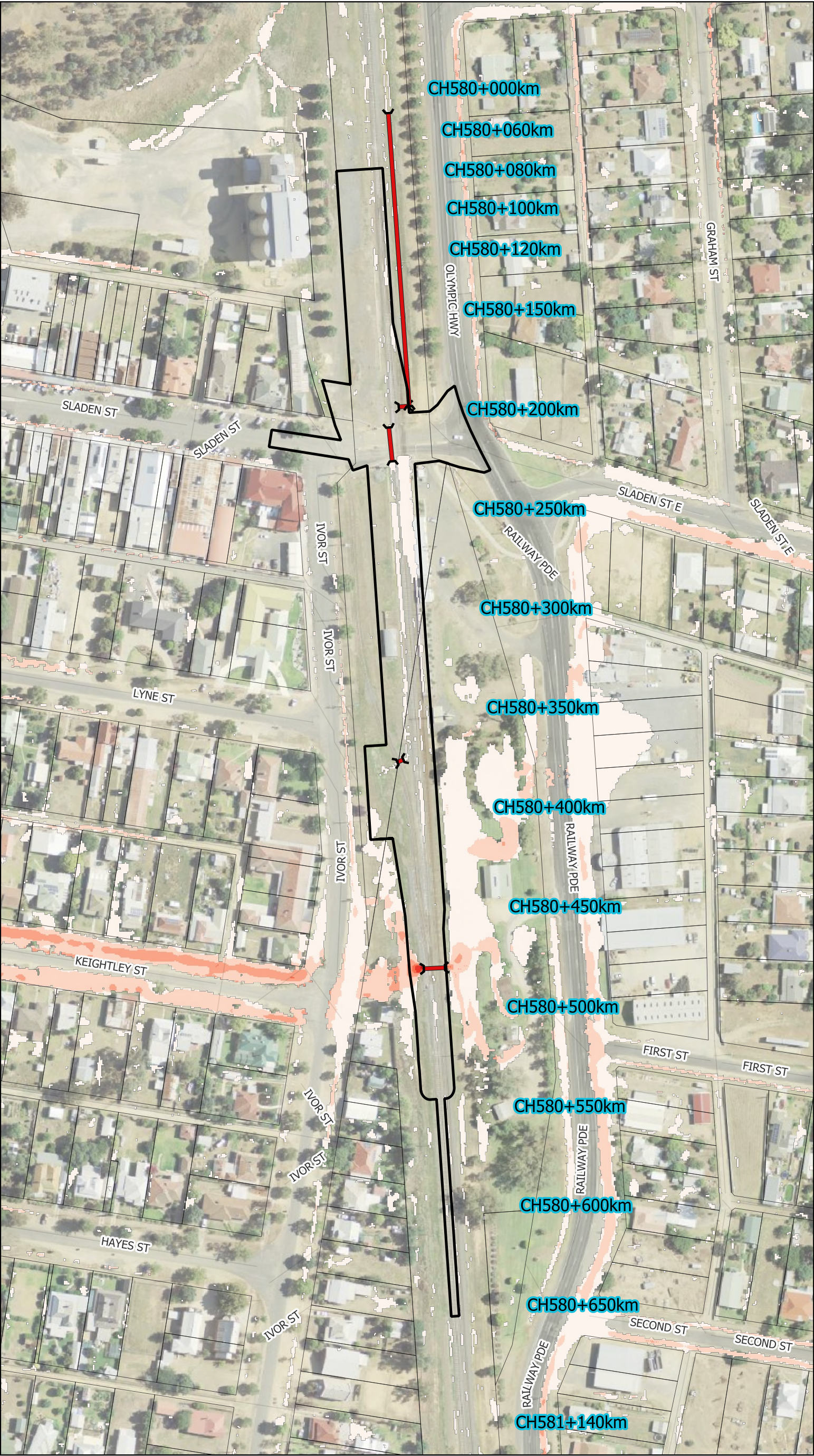
Map by: Malinda Gunasekera



23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

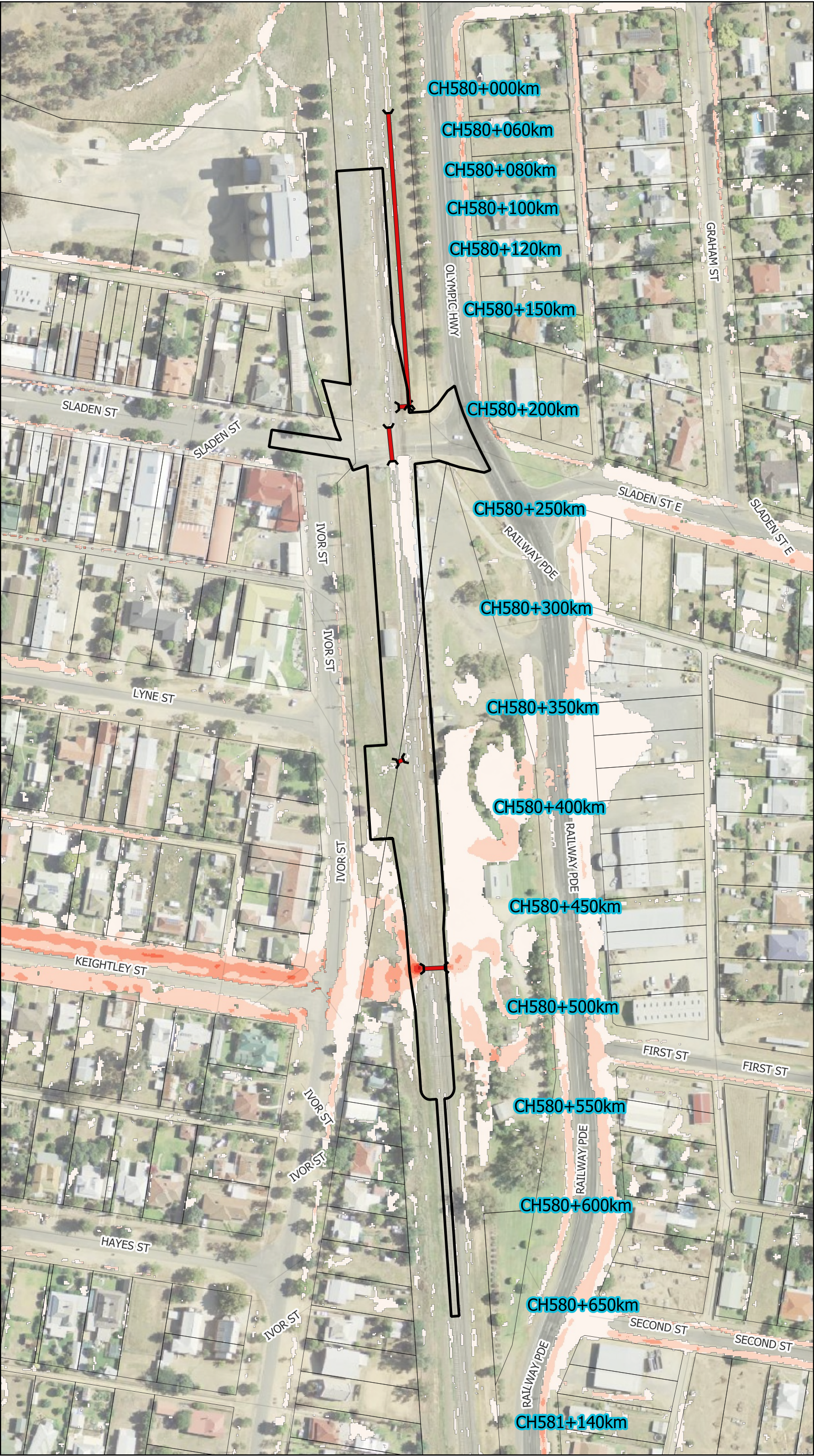


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

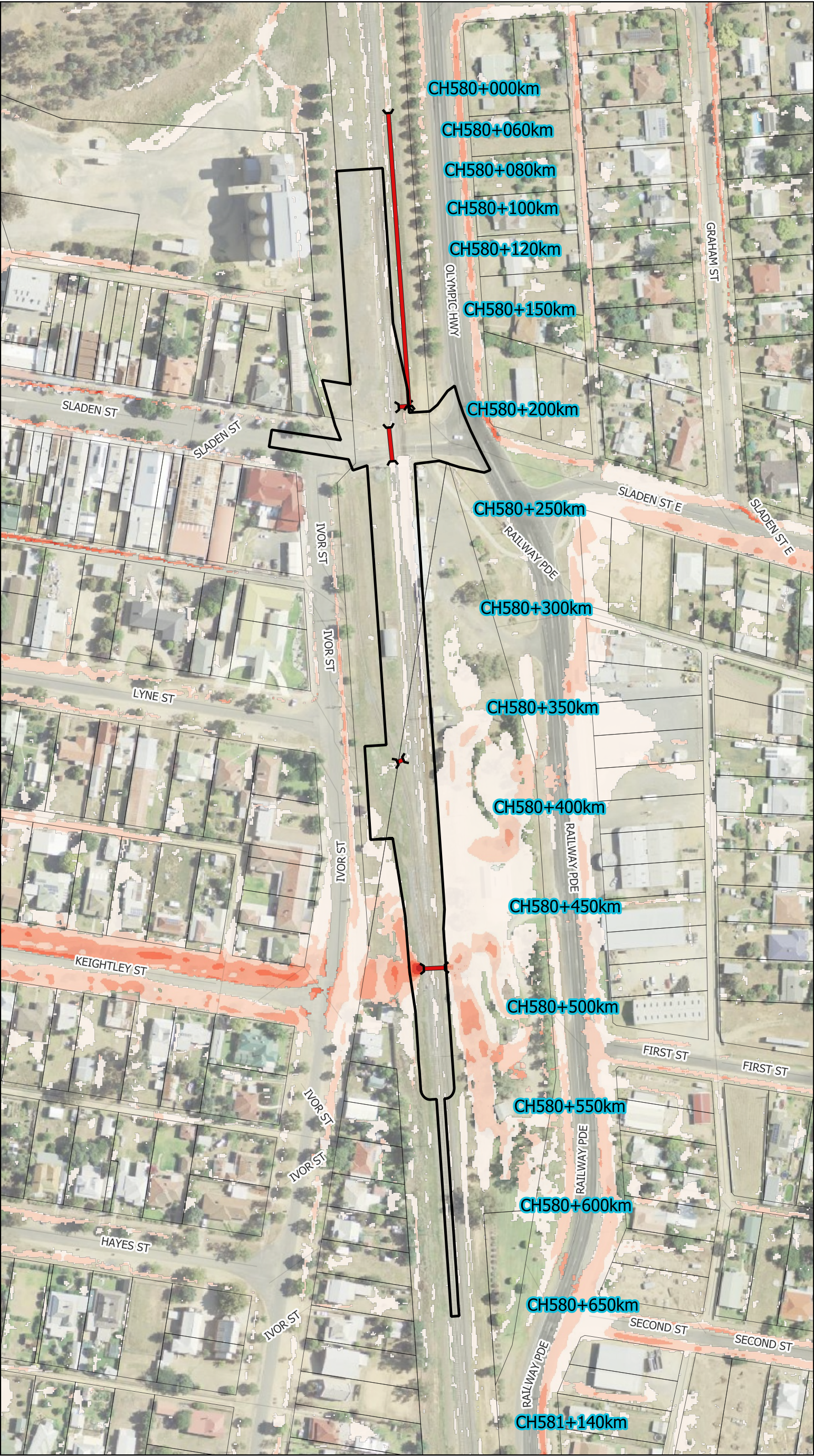


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

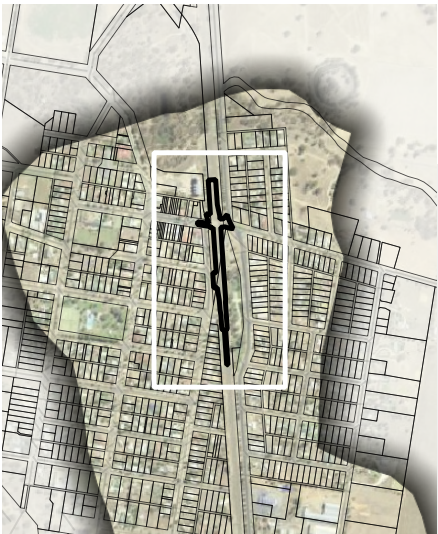
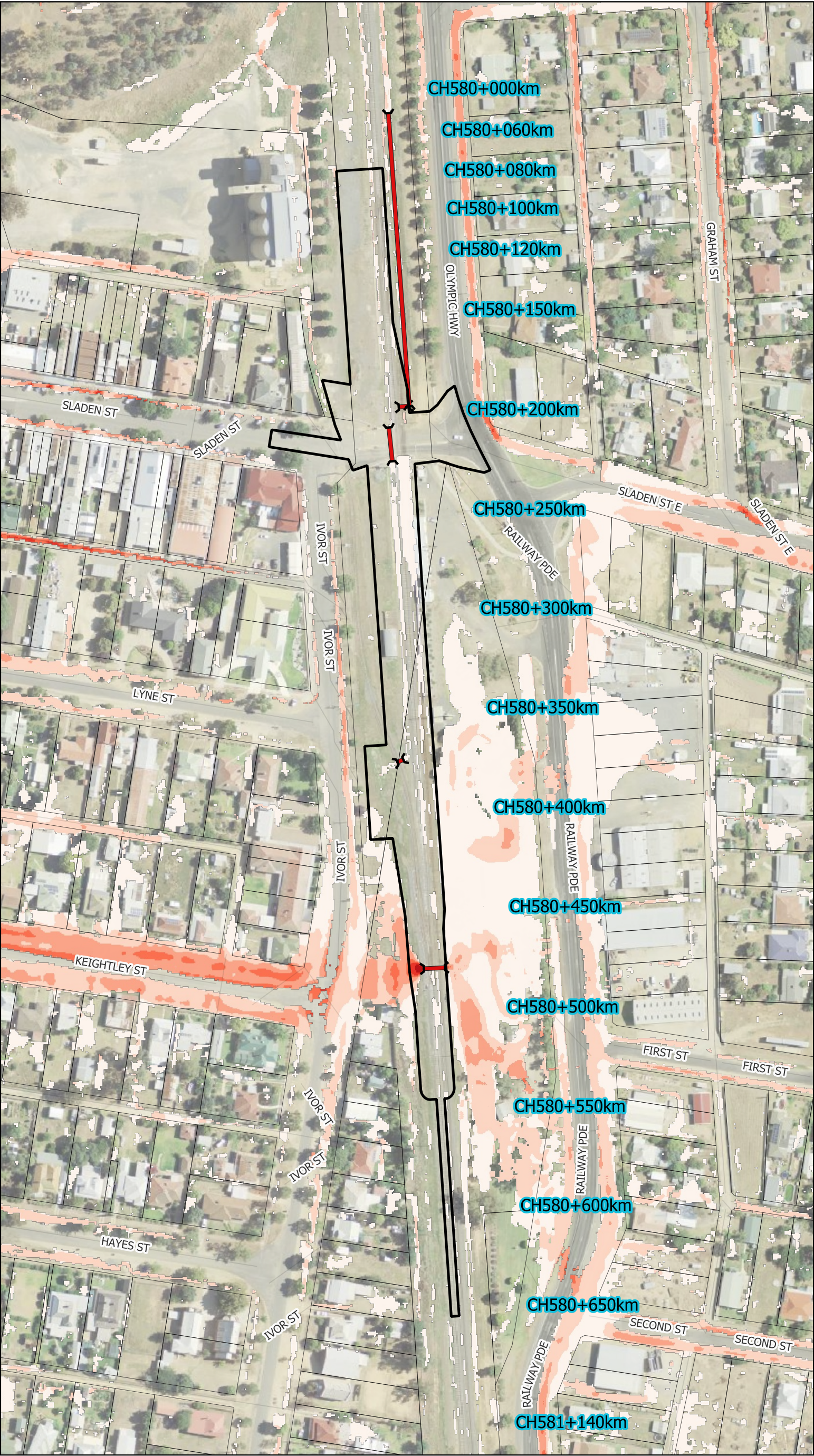


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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: Malinda Gunasekera



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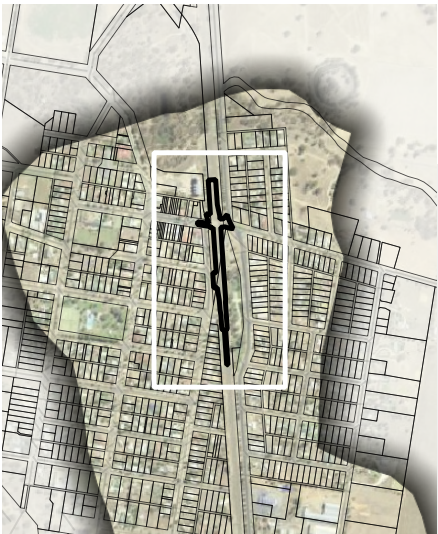
23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A9 - 1% AEP with Climate Change Peak Flood Velocity (Existing Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

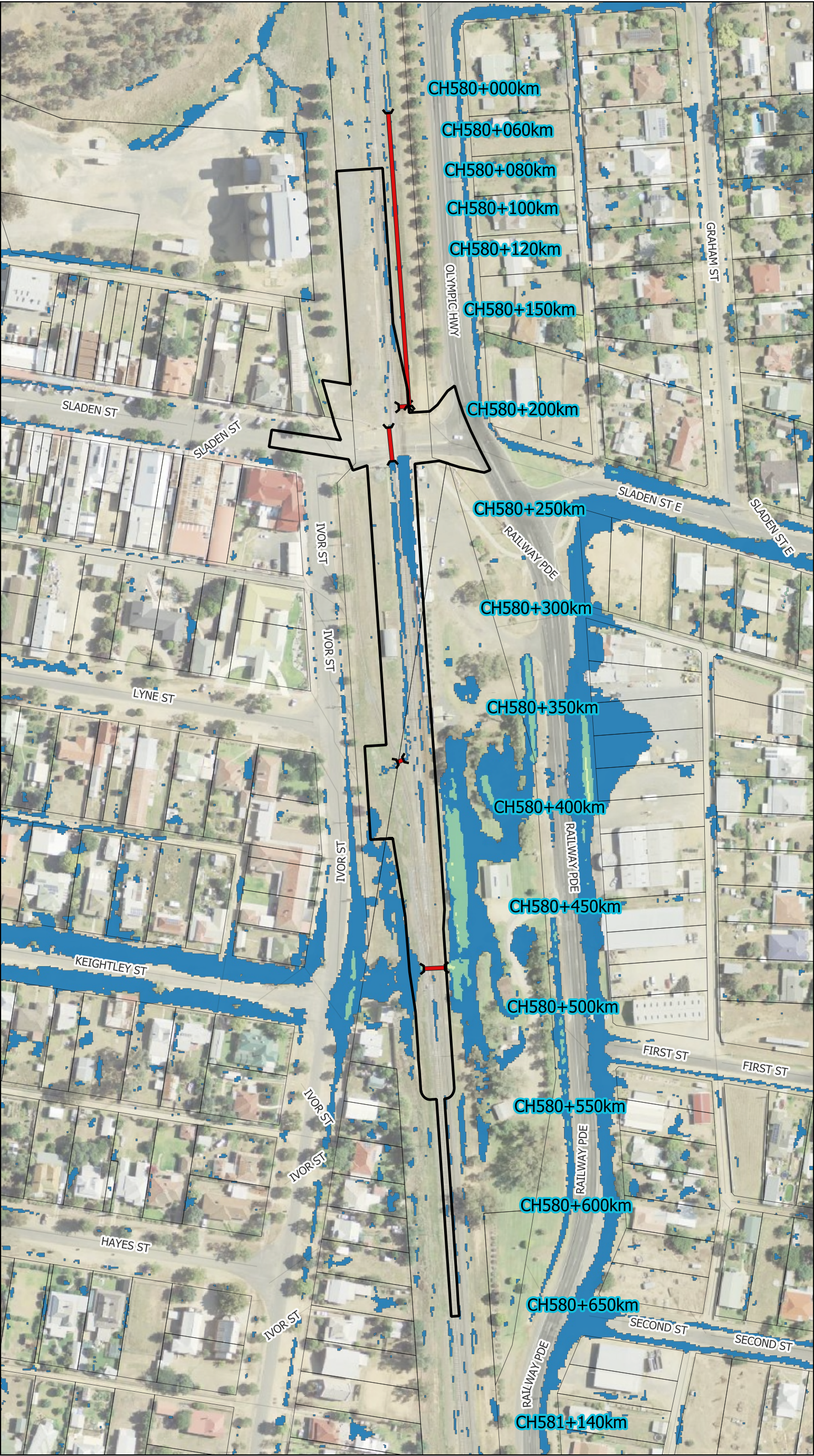


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

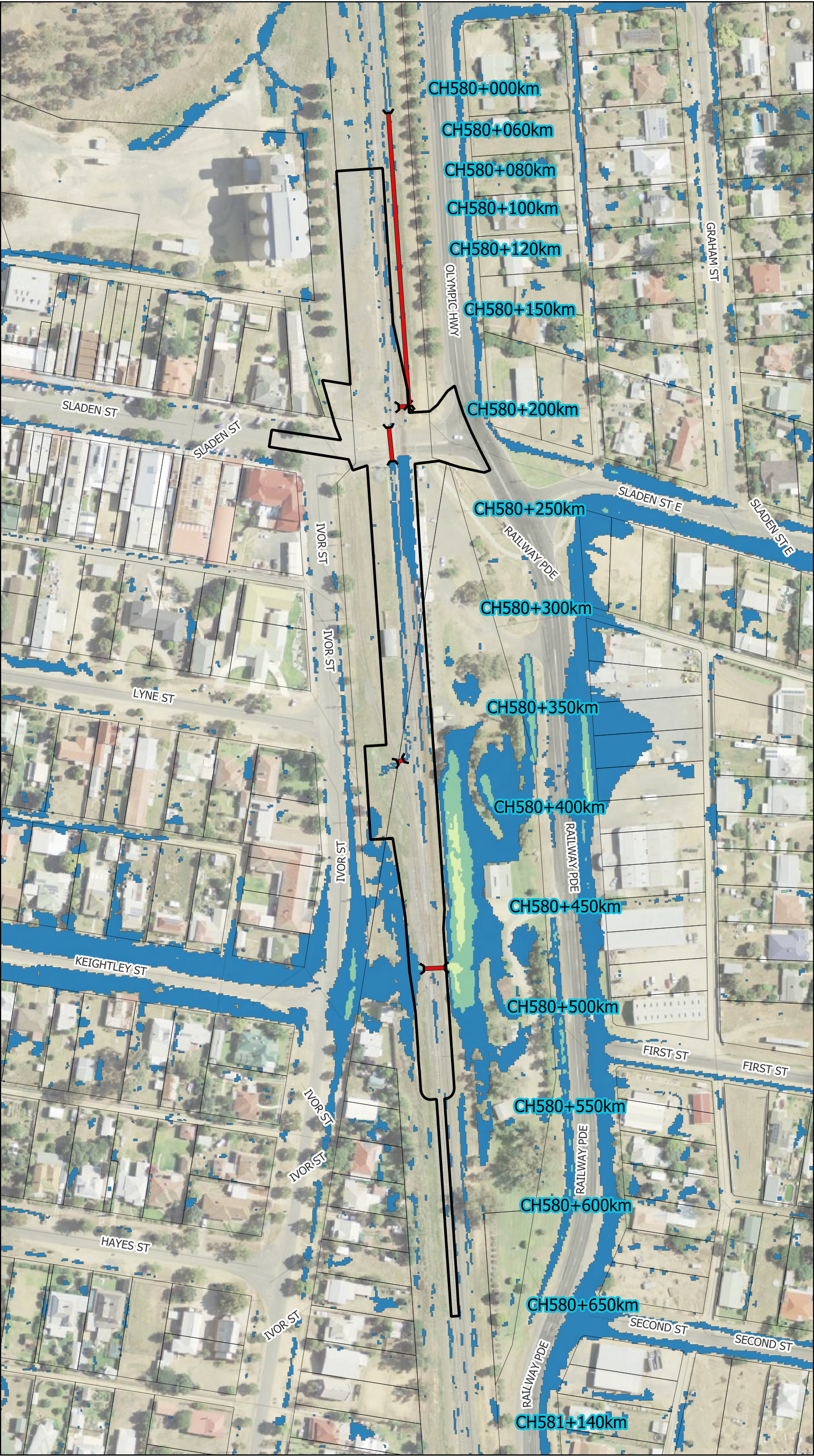


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

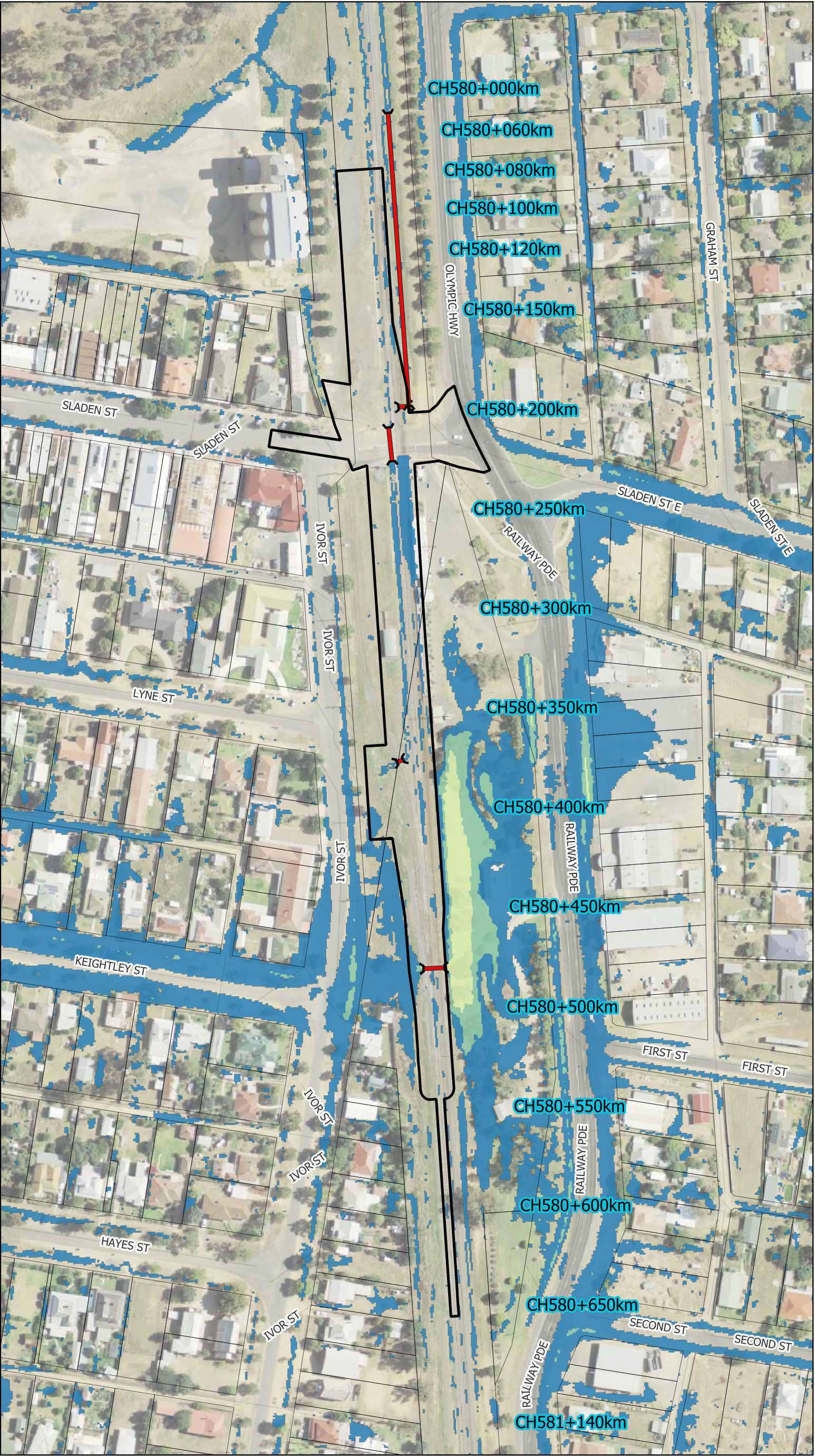


Notes:



Legend

- Project Boundary
- Cadastral
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

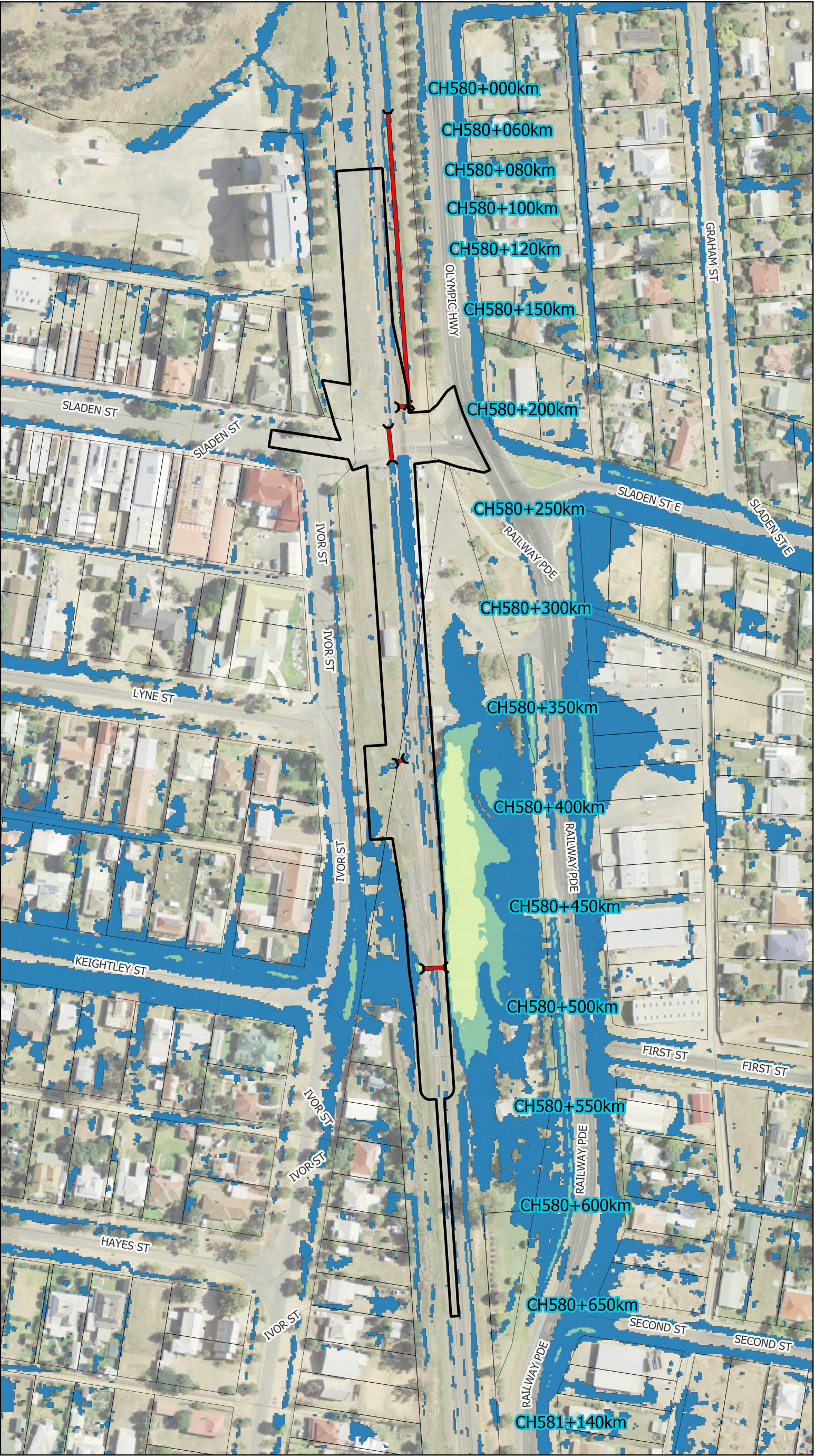


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera

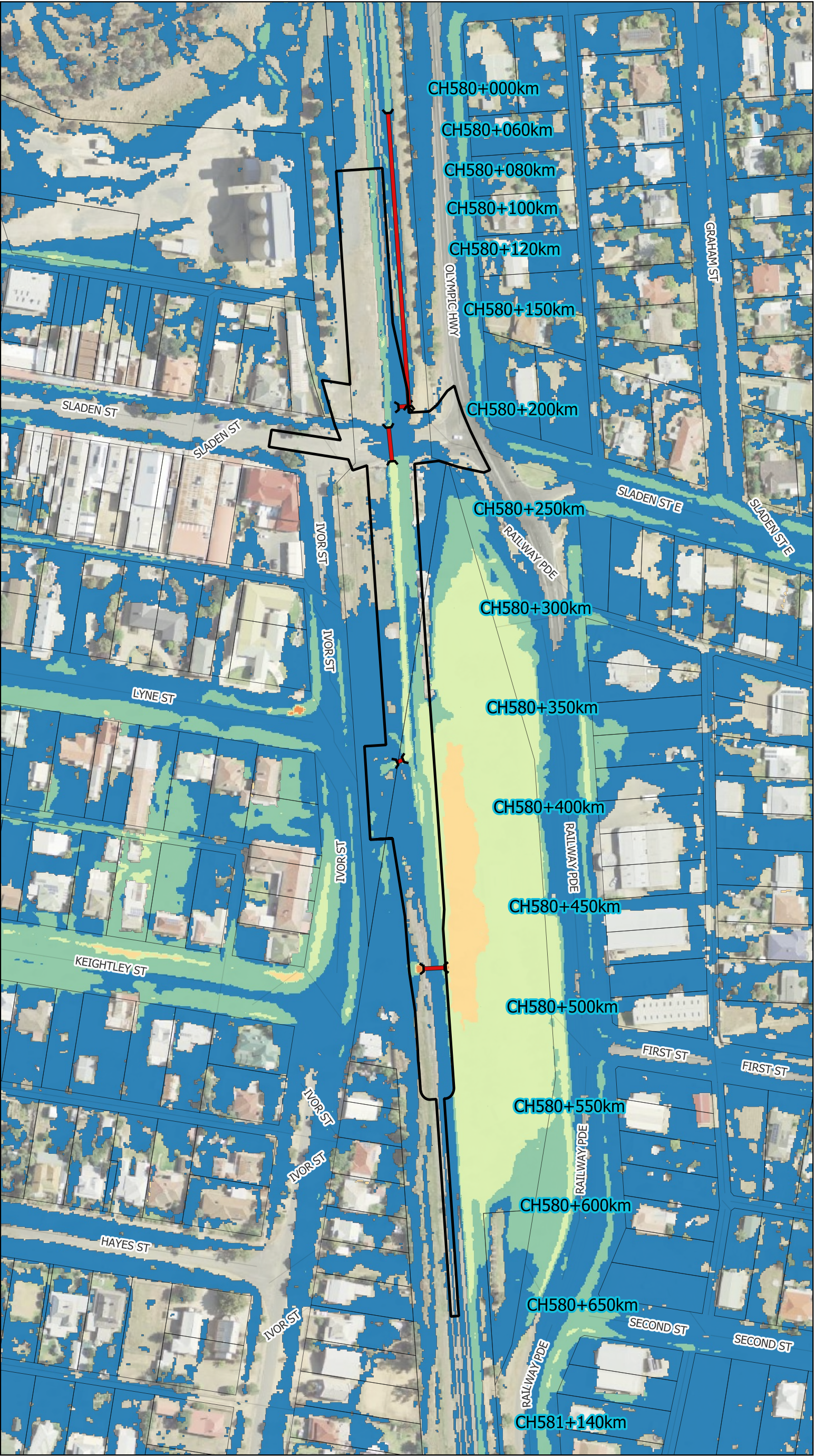


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A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera



0 80 160 m

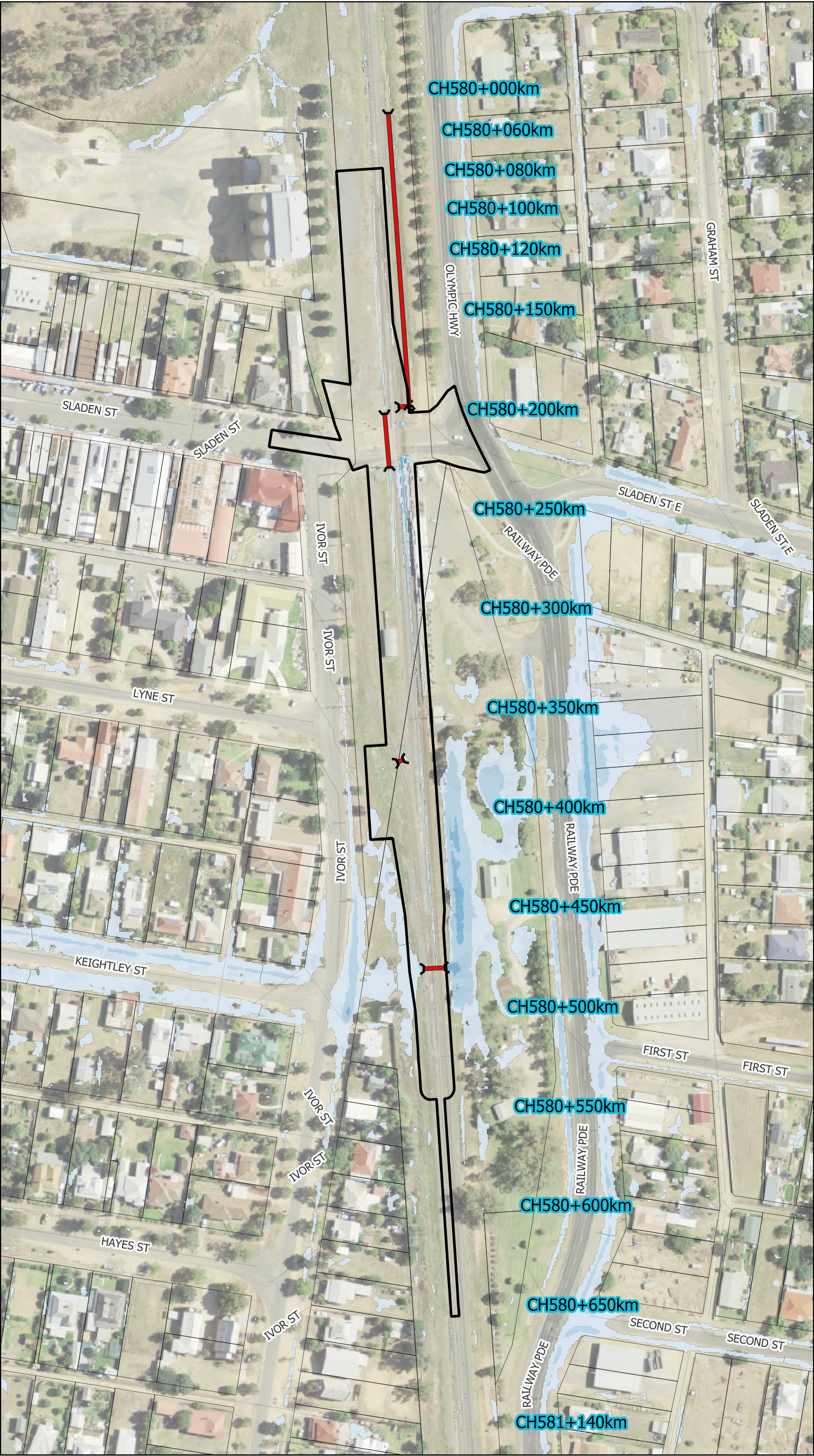
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23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage
Figure A15 - PMF Peak Flood Hazard (Existing Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera

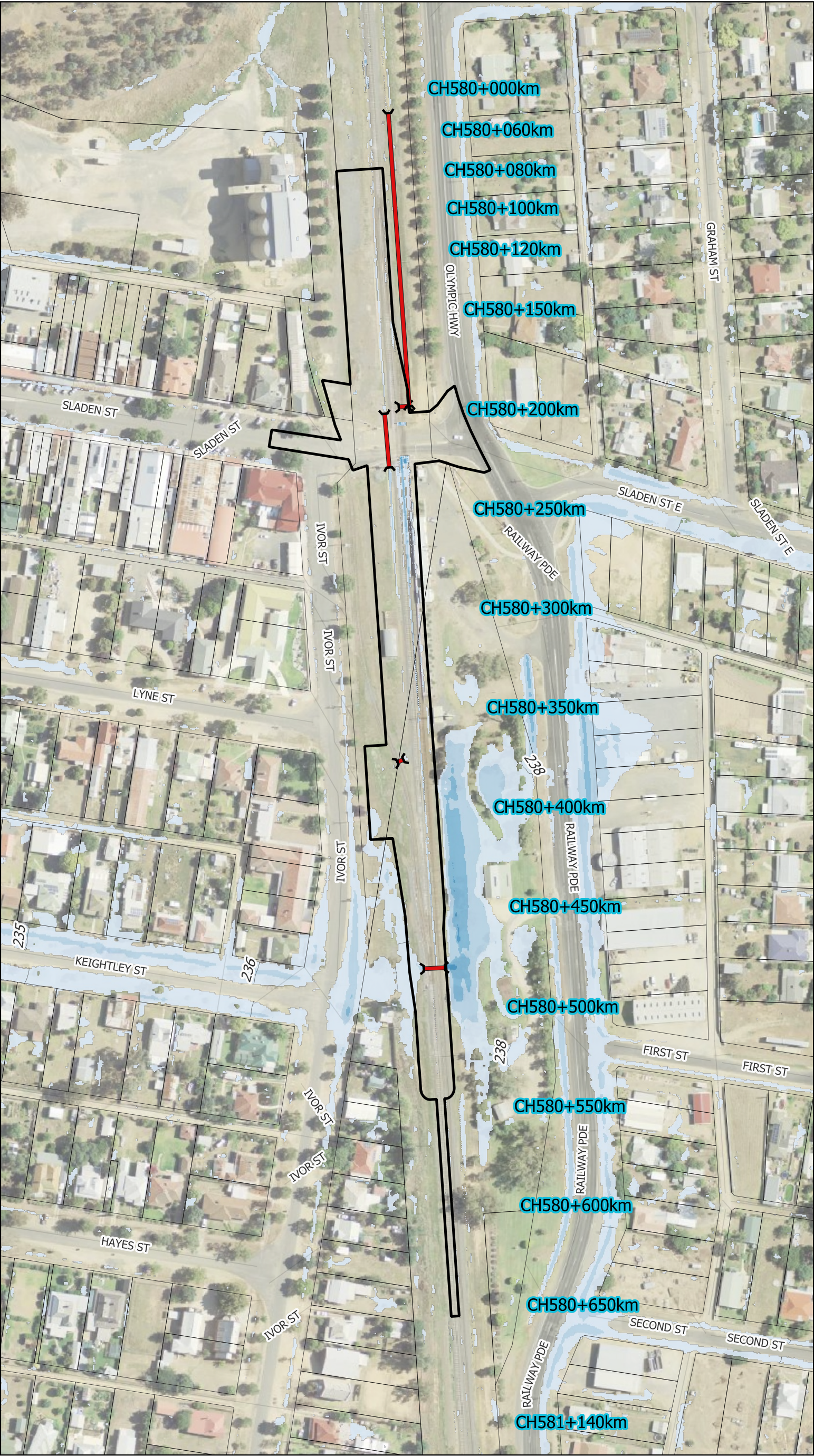


0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

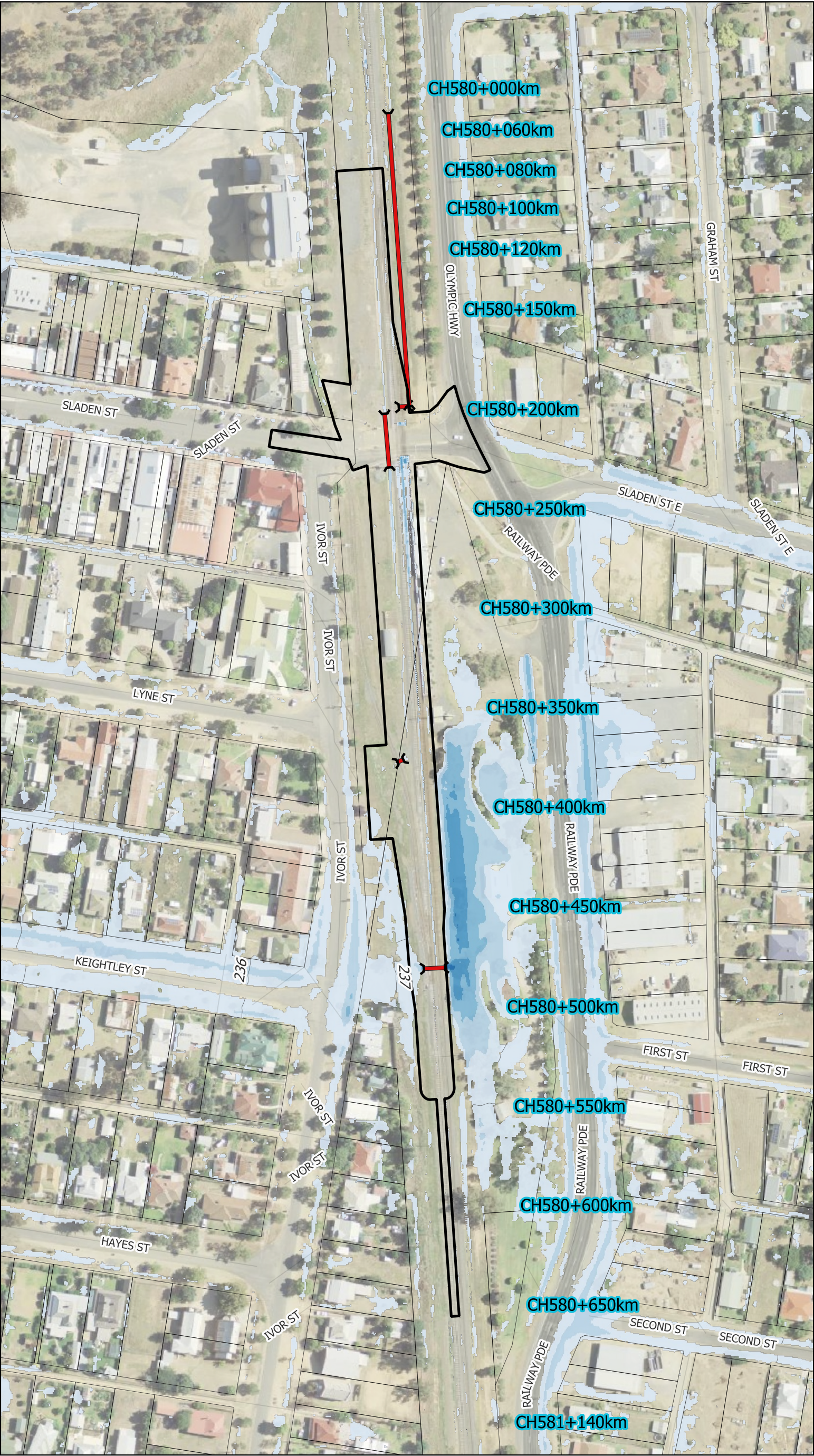


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000,000002

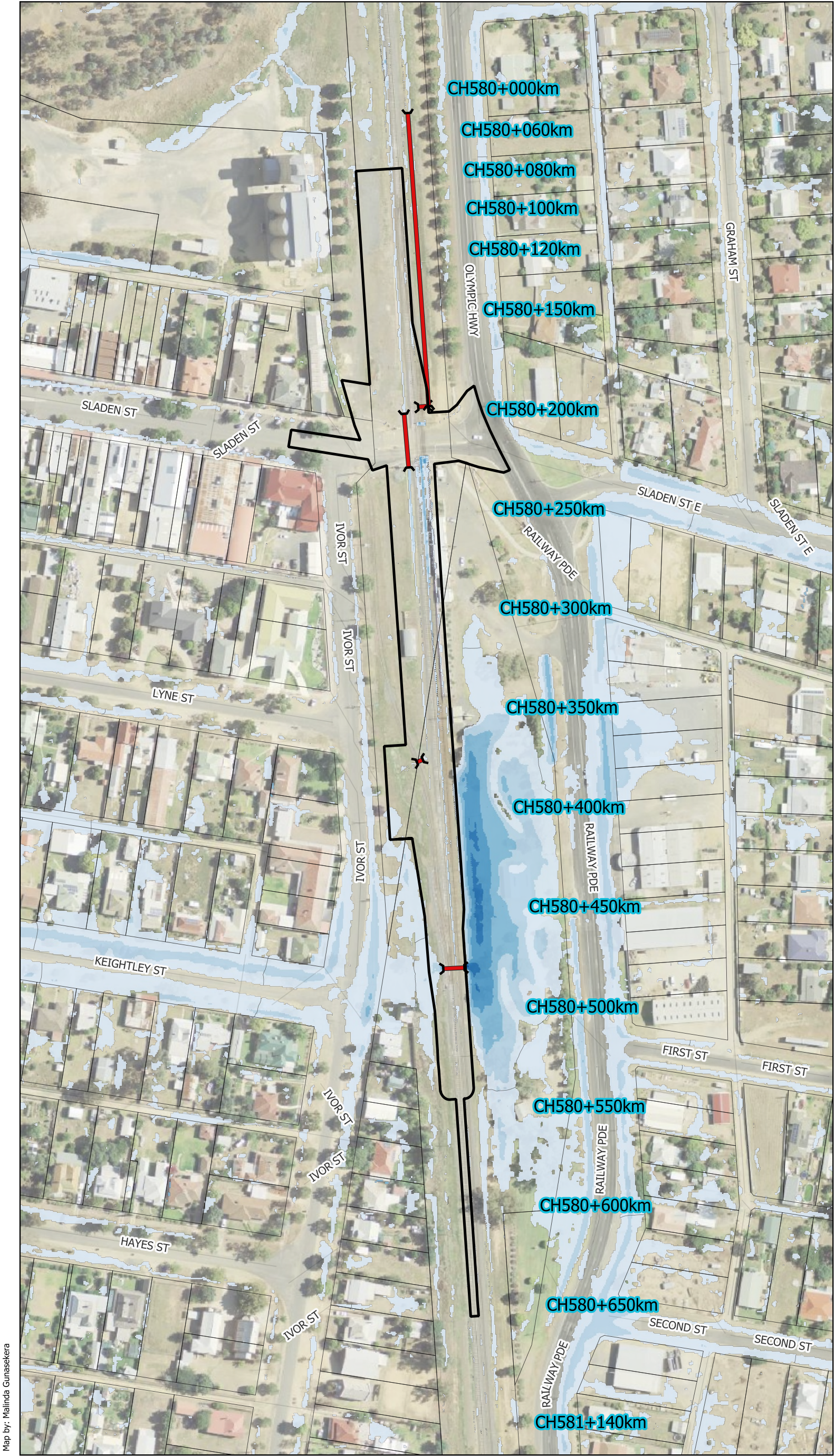
23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

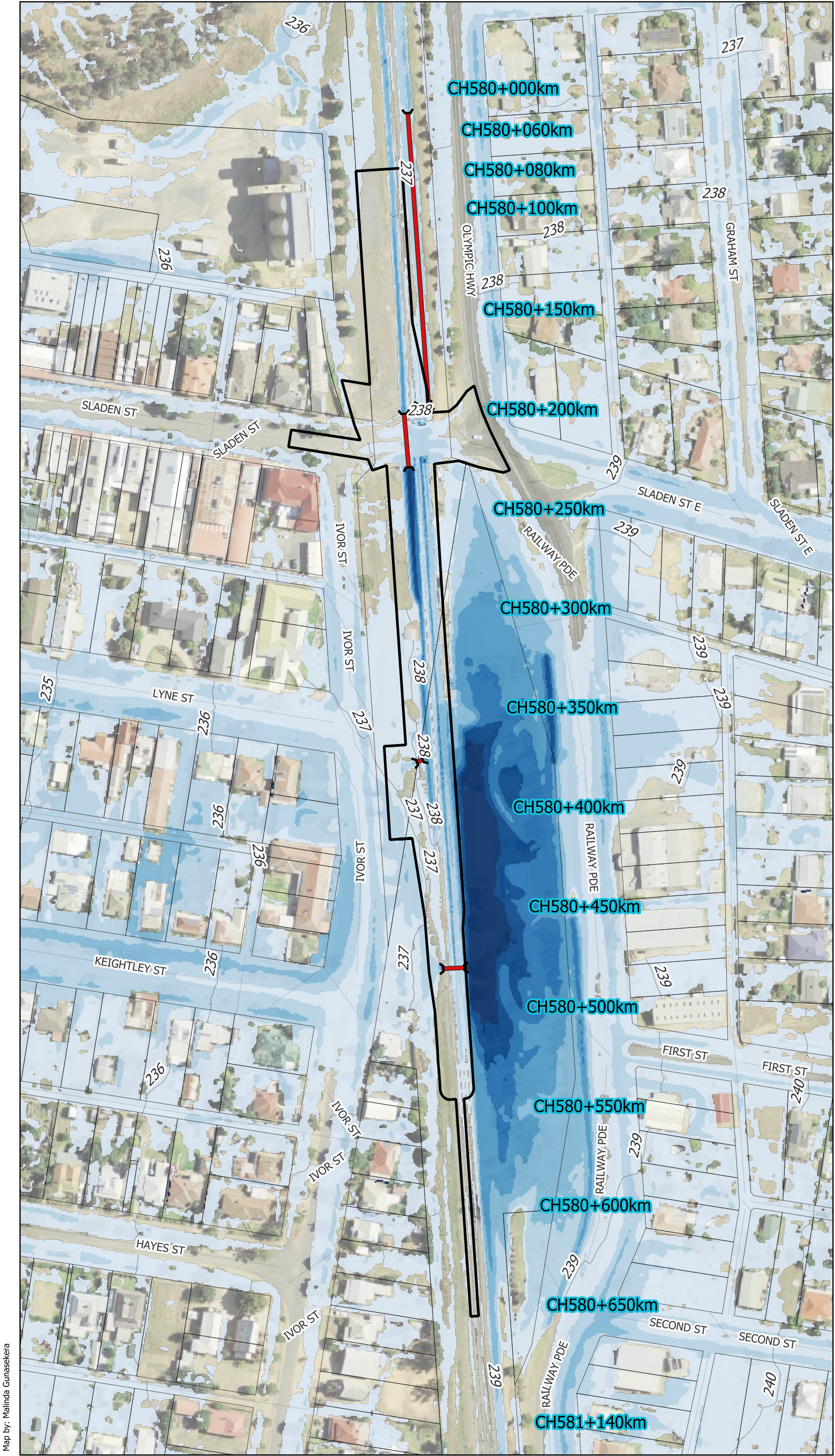
Figure A19 - 1% AEP with Climate Change Peak Flood Depth and Levels (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 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: Malinda Gunasekera

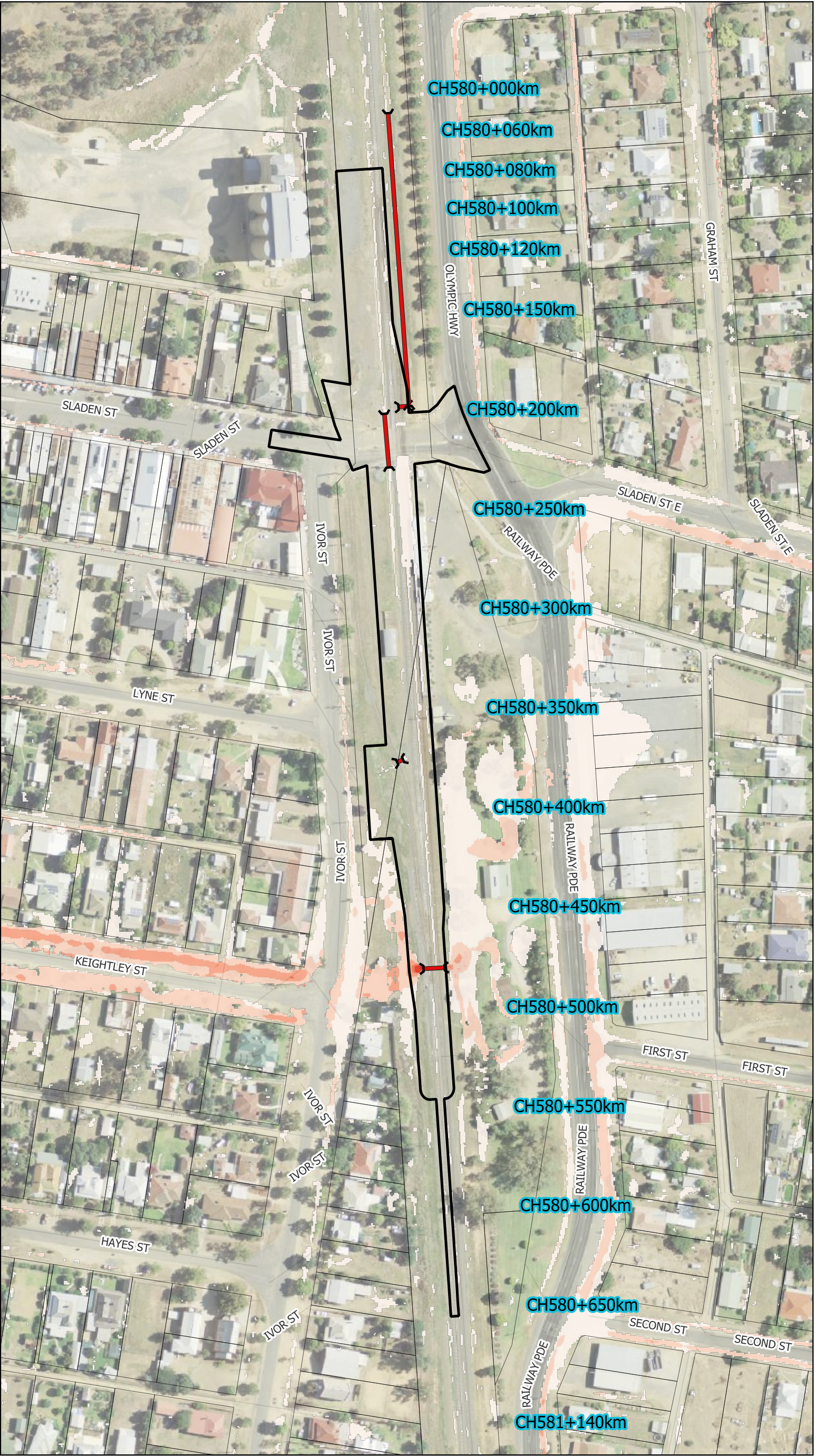


0 80 160 m
A3 Scale: 1:2,000.000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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: Malinda Gunasekera



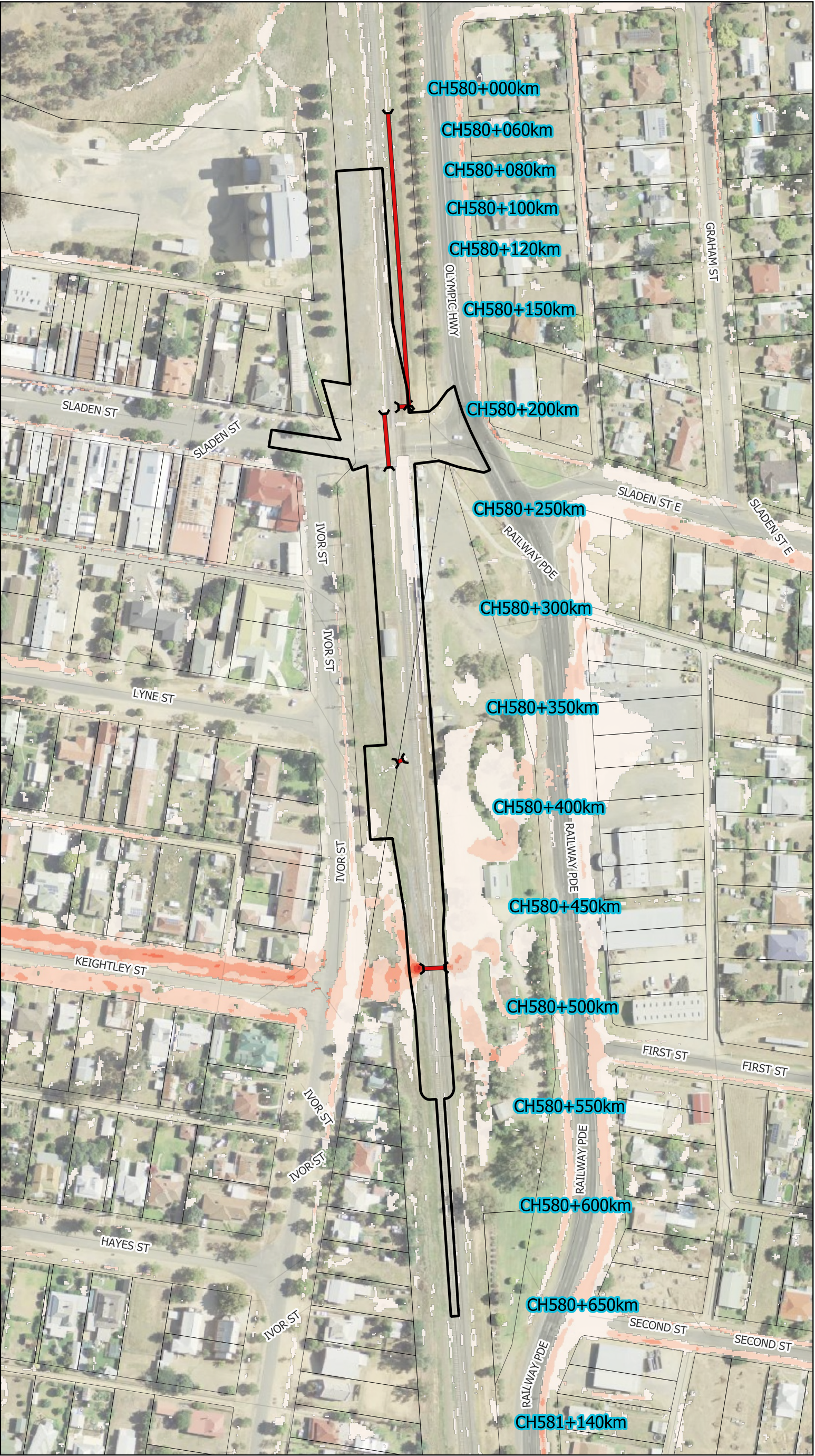
0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage
Figure A21 - 5% AEP Peak Flood Velocity (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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: Malinda Gunasekera



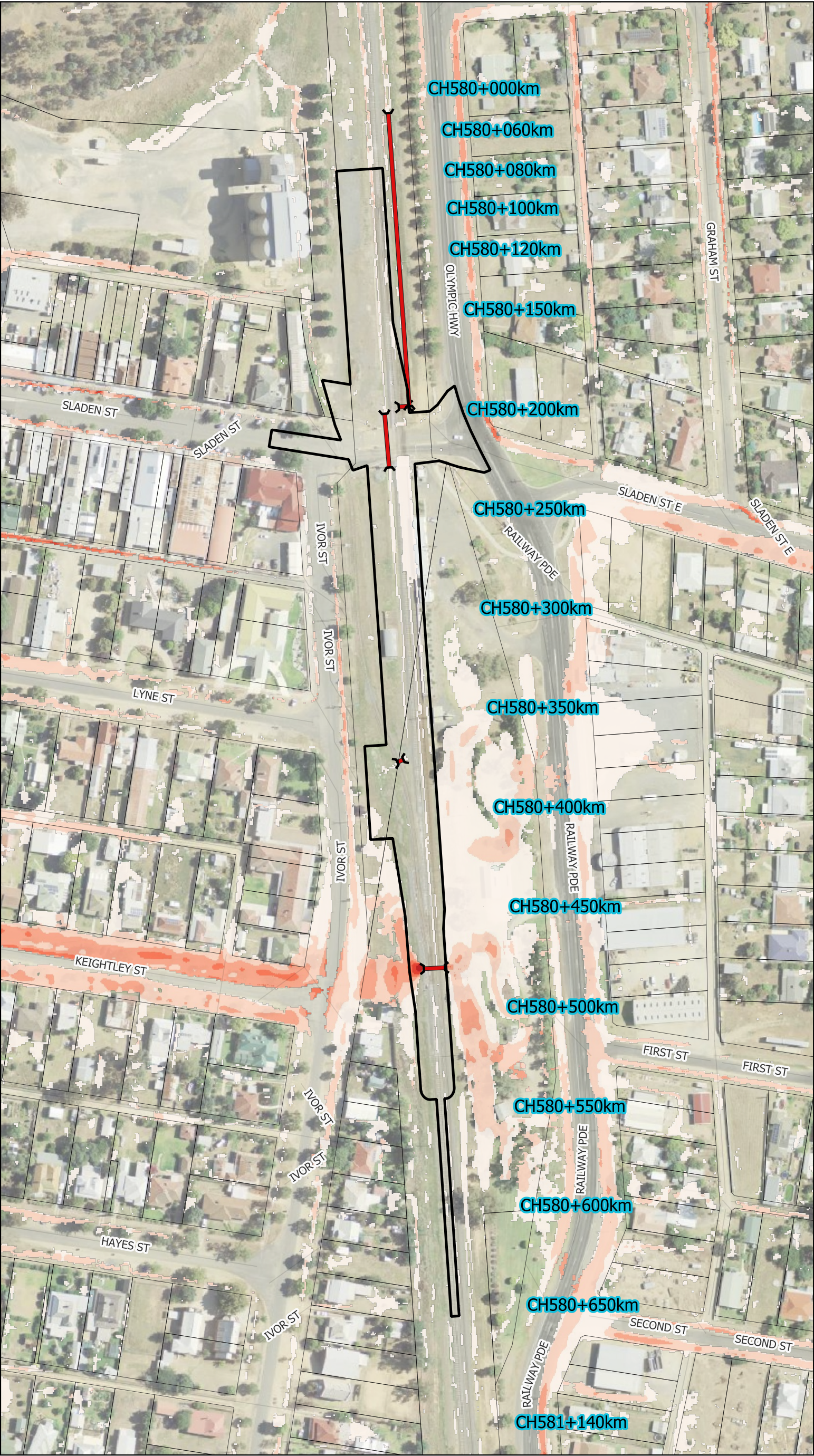
0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage
Figure A22 - 2% AEP Peak Flood Velocity (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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: Malinda Gunasekera



0 80 160 m

A3 Scale: 1:2,000.000002

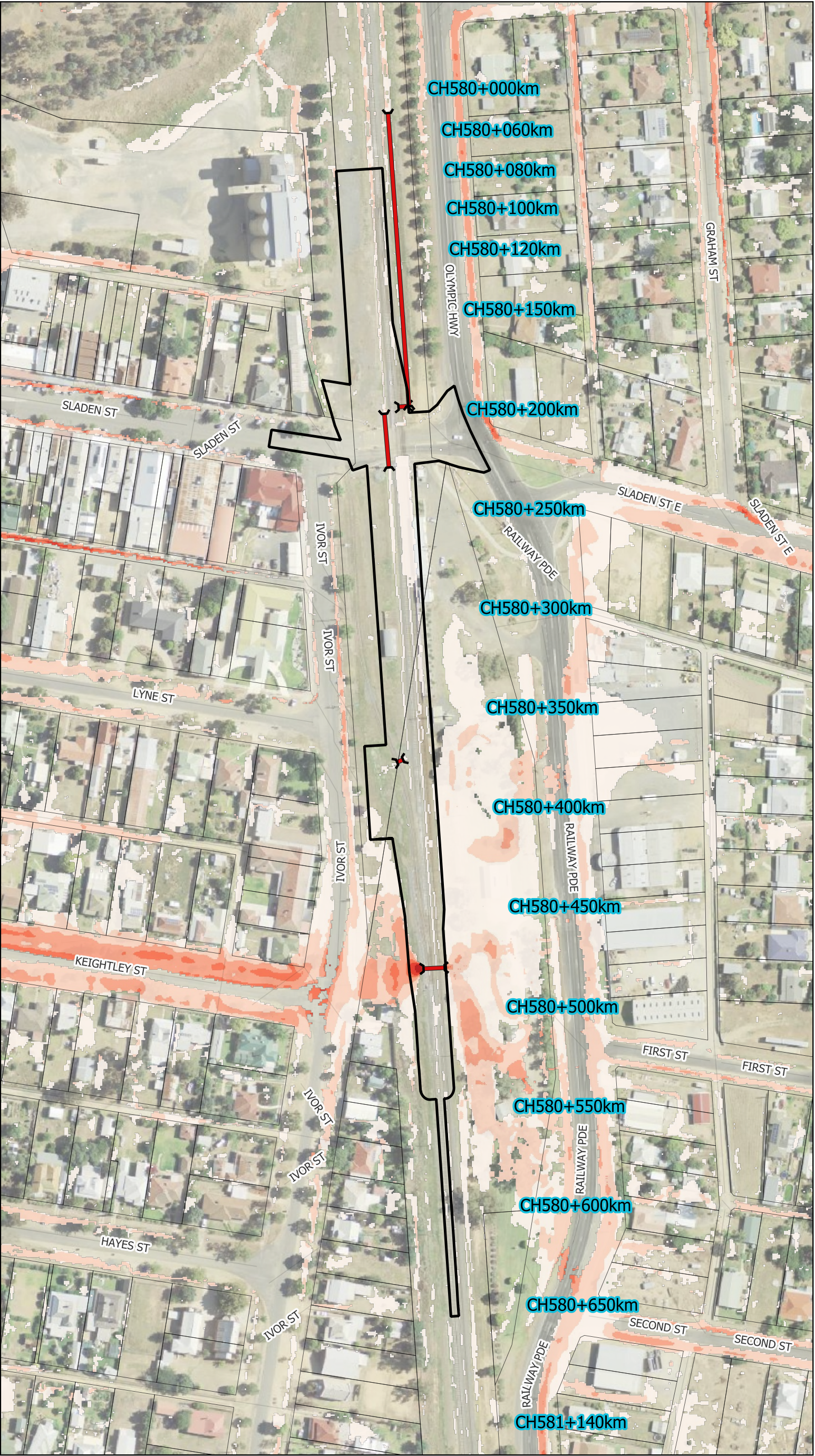
23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A23 - 1% AEP Peak Flood Velocity (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A24 - 1% AEP with Climate Change Peak Flood Velocity (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

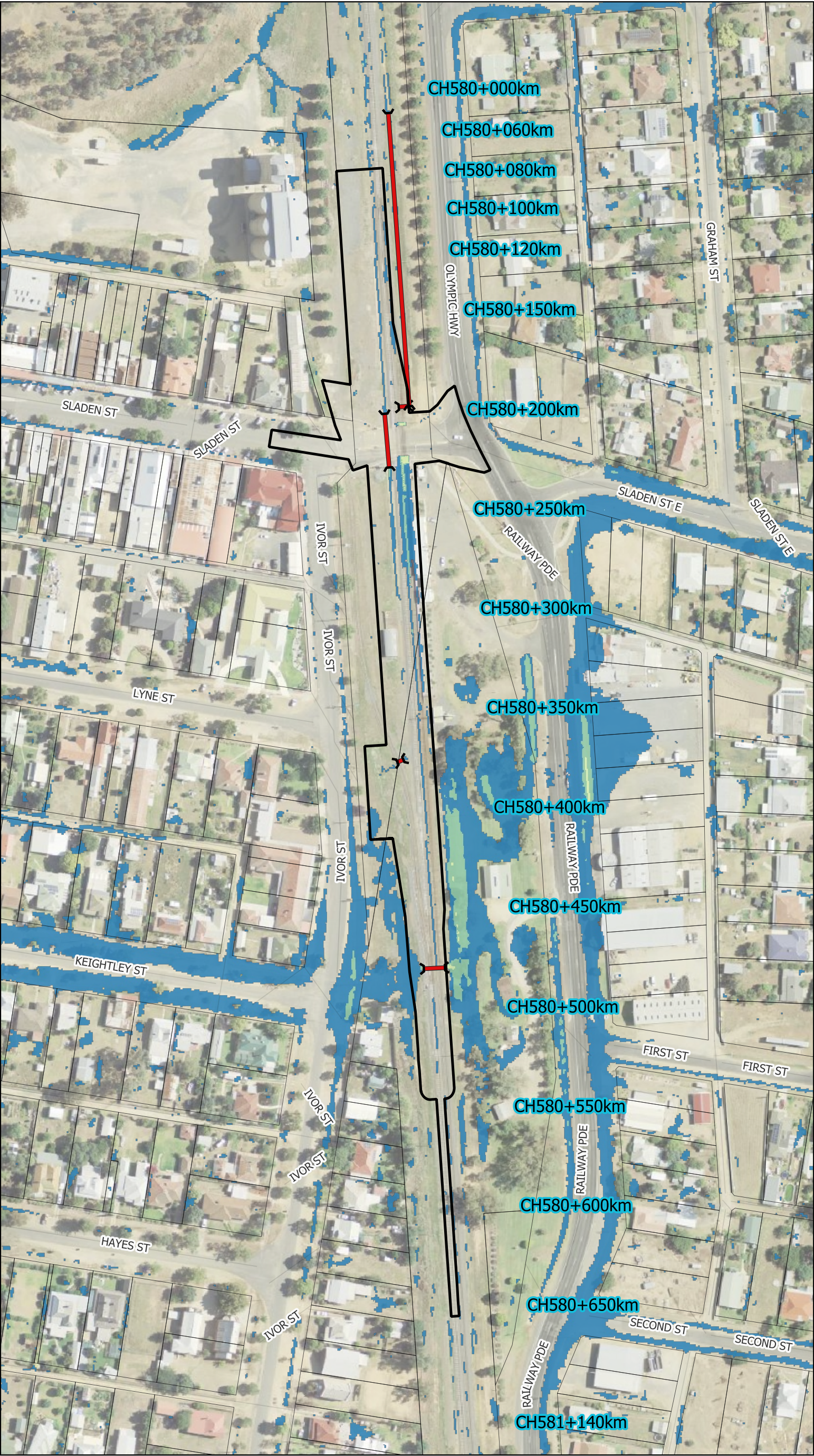


Notes:



Legend

- Project Boundary
- Cadastral
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera

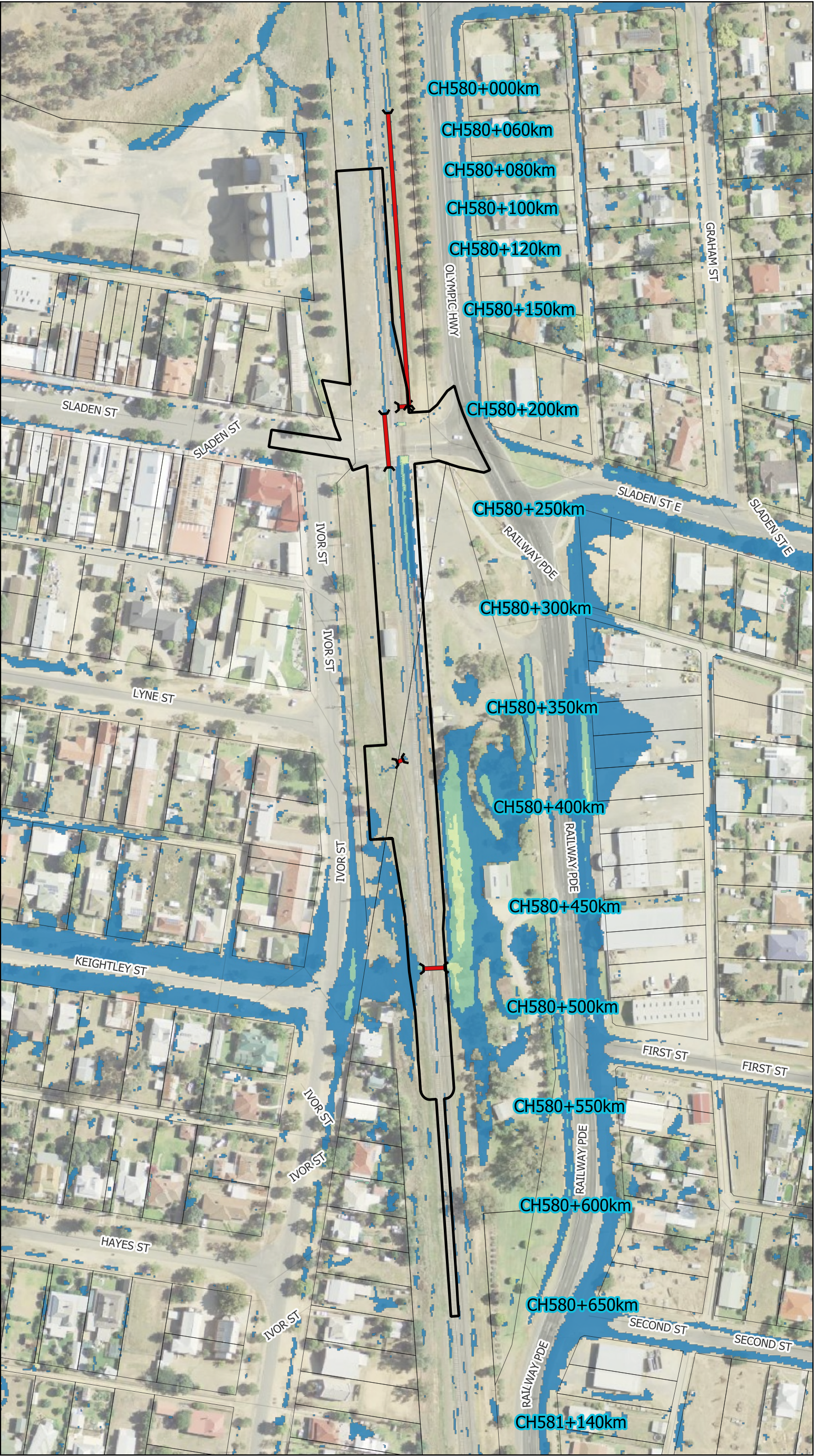


0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera



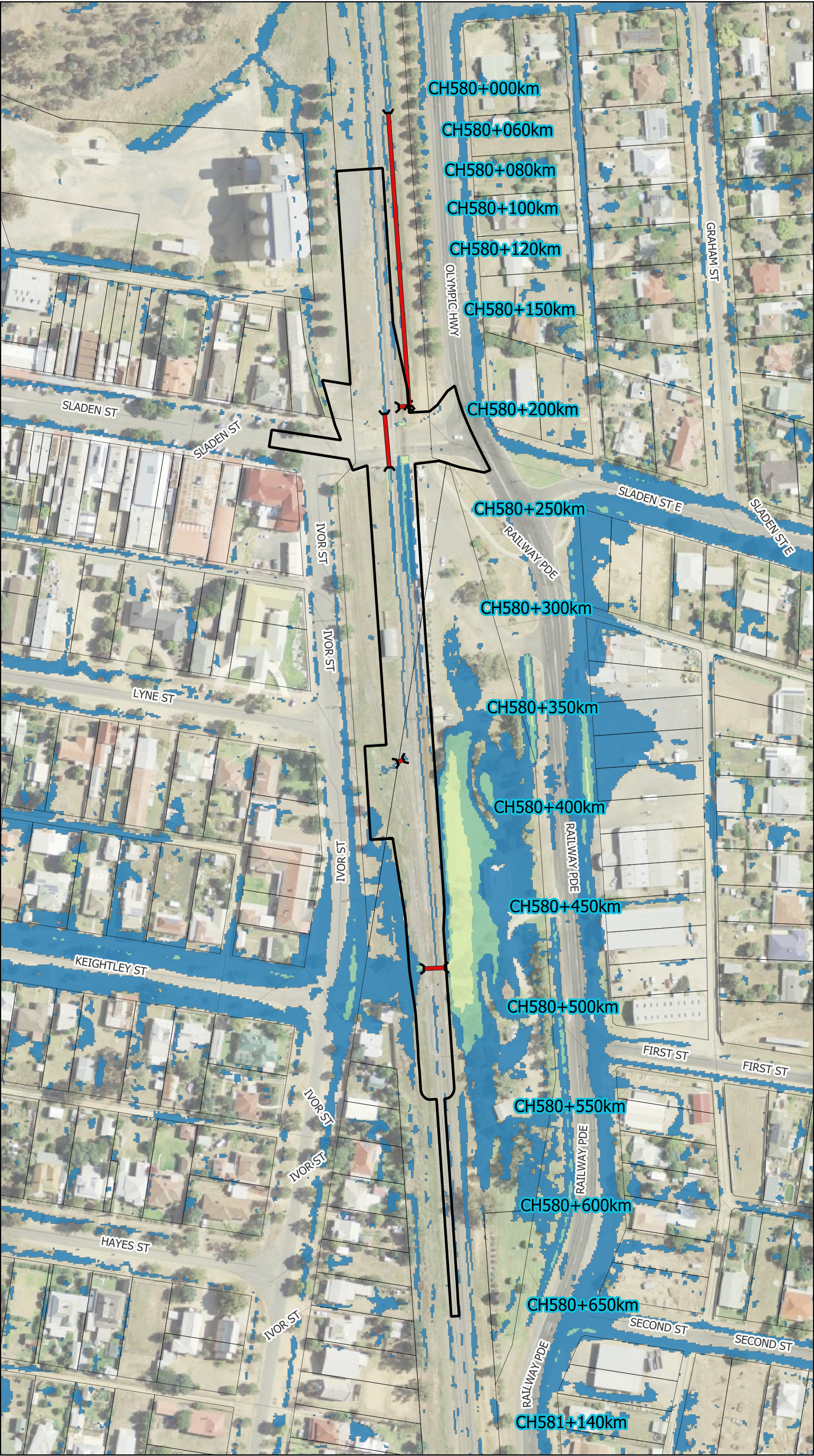
0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage
Figure A27 - 2% AEP Peak Flood Hazard (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

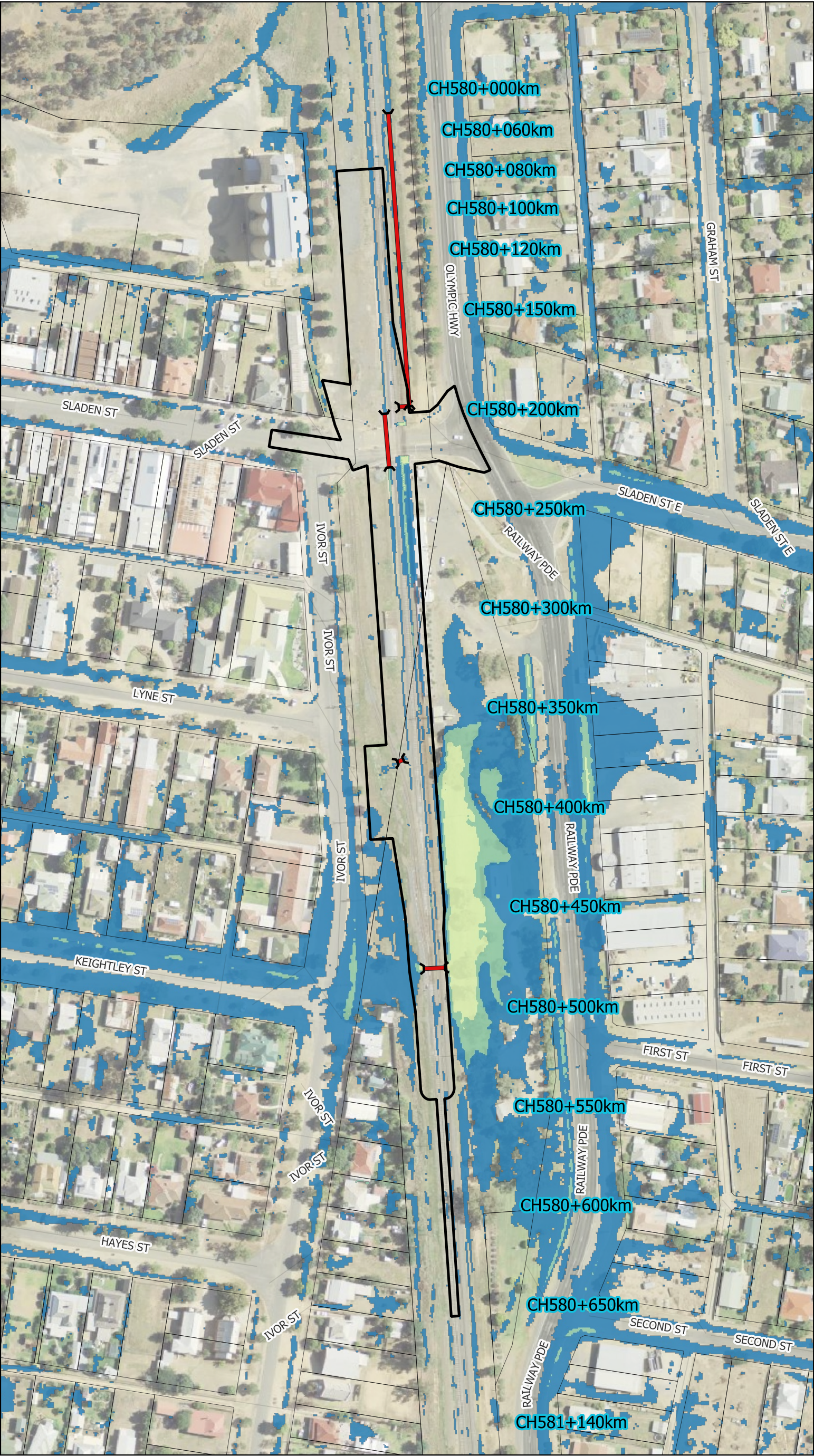


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera

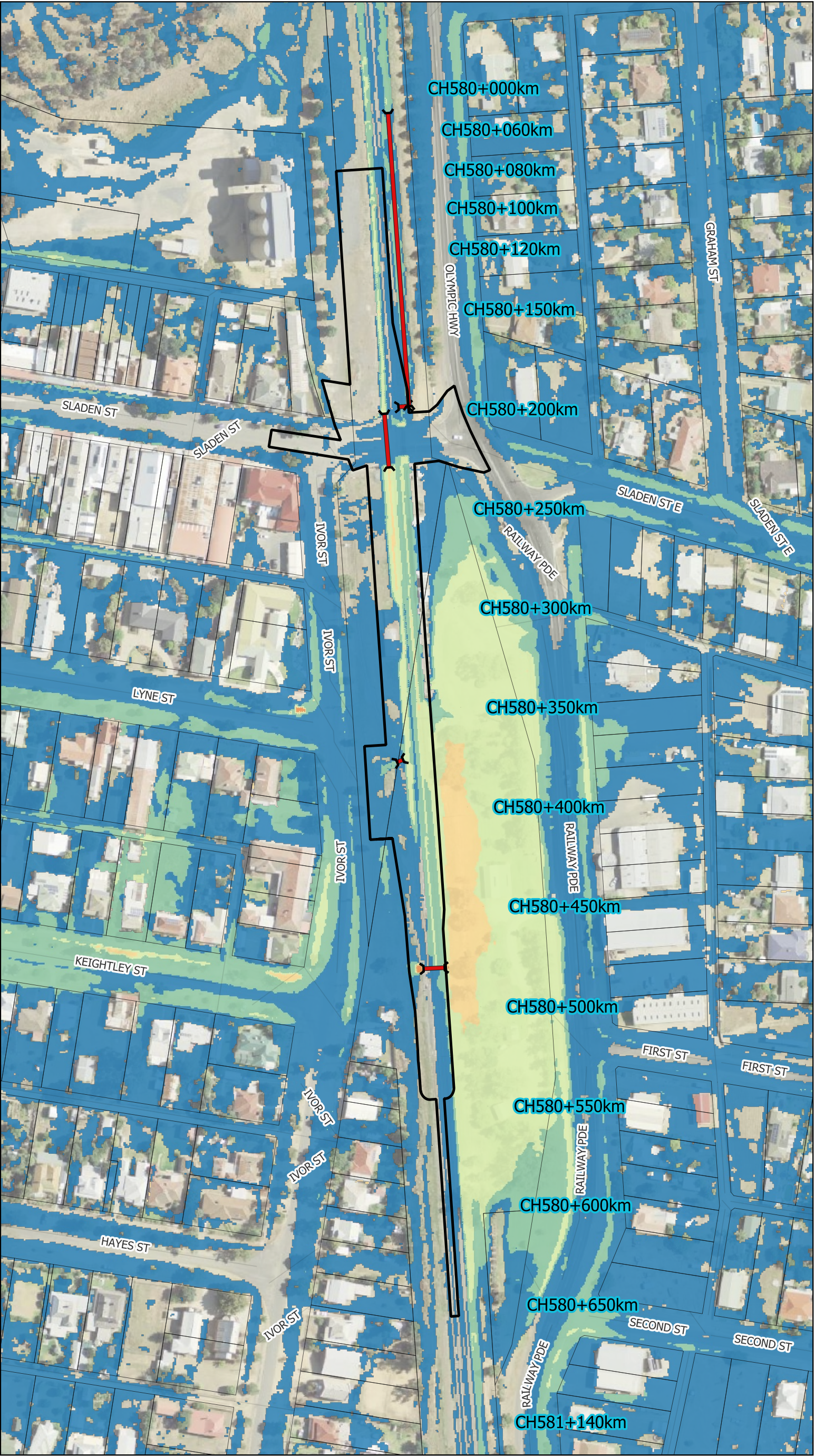


0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera



0 80 160 m

A3 Scale: 1:2,000.000002

23/6/2025 GDA2020 / MGA zone 55

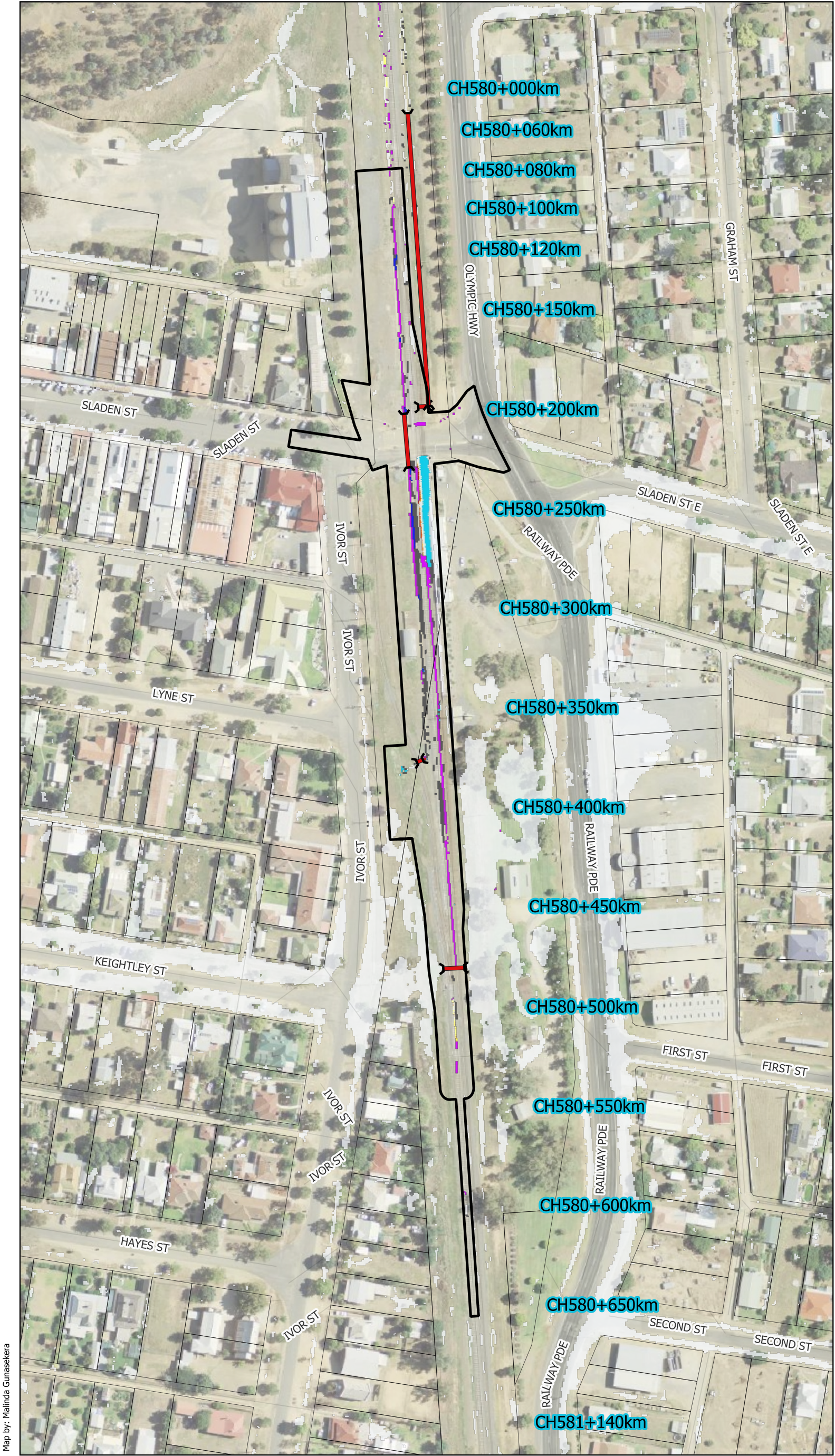
Henty Yard Clearances - A2P - IFC Stage
Figure A30 - PMF Peak Flood Hazard (Design Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Change 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
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:



Map by: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

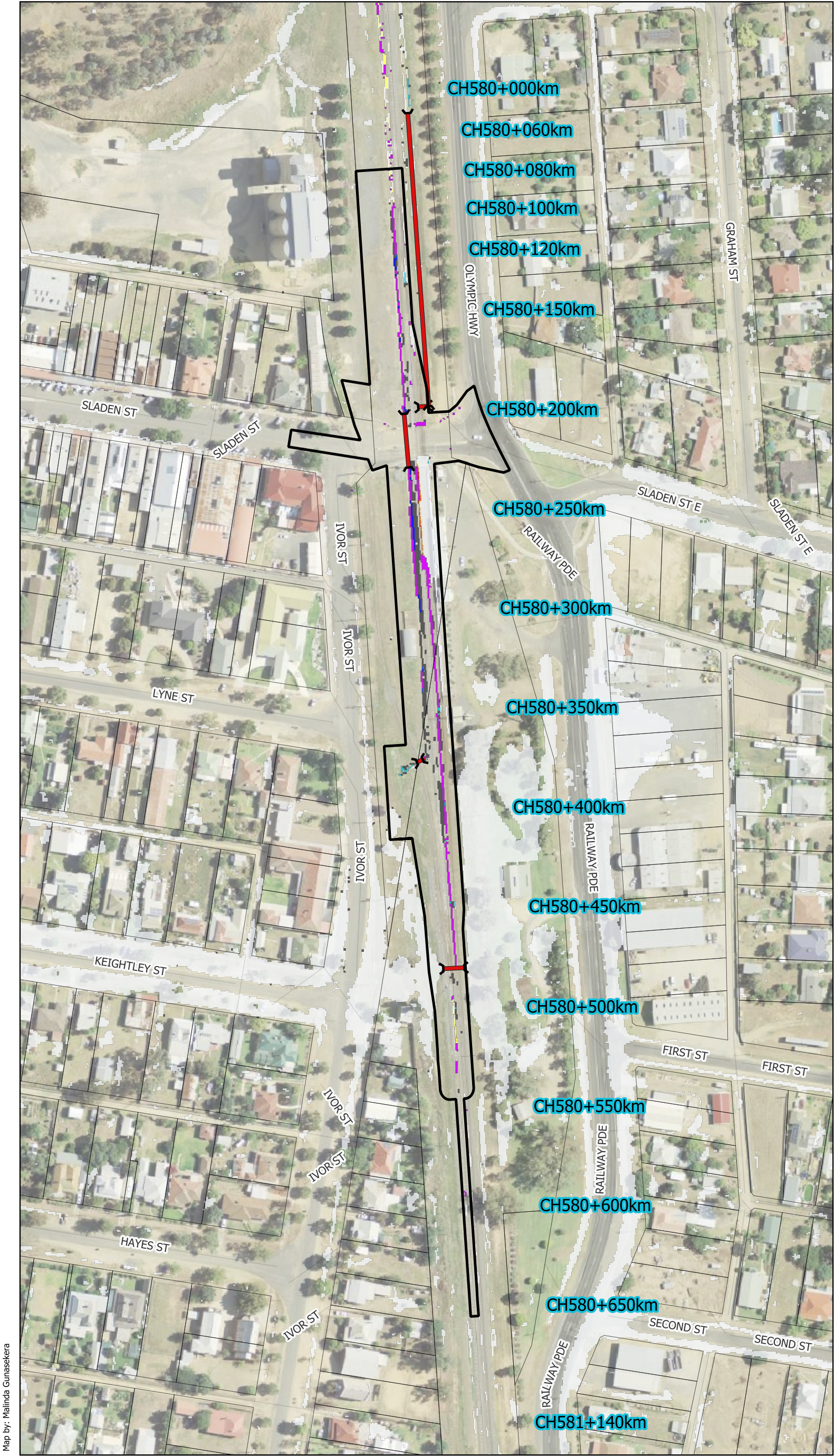
Henty Yard Clearances - A2P - IFC Stage
Figure A31 - 5% AEP Changes in Peak Flood Levels (Design Condition vs. Existing Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Change 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
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:



Map by: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage
Figure A32 - 2% AEP Changes in Peak Flood Levels (Design Condition vs. Existing Condition)

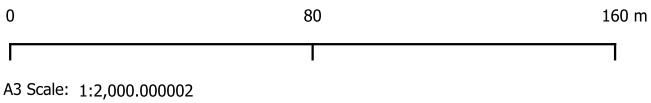
Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Change 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
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

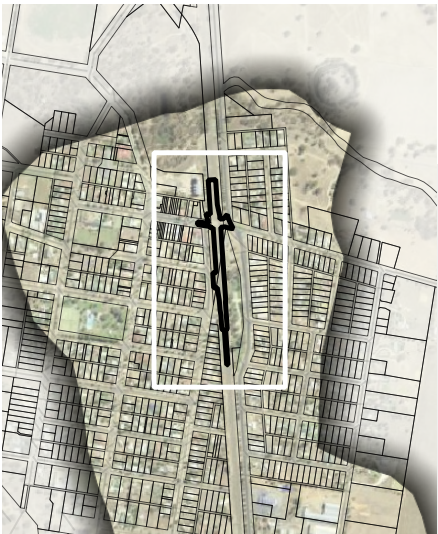
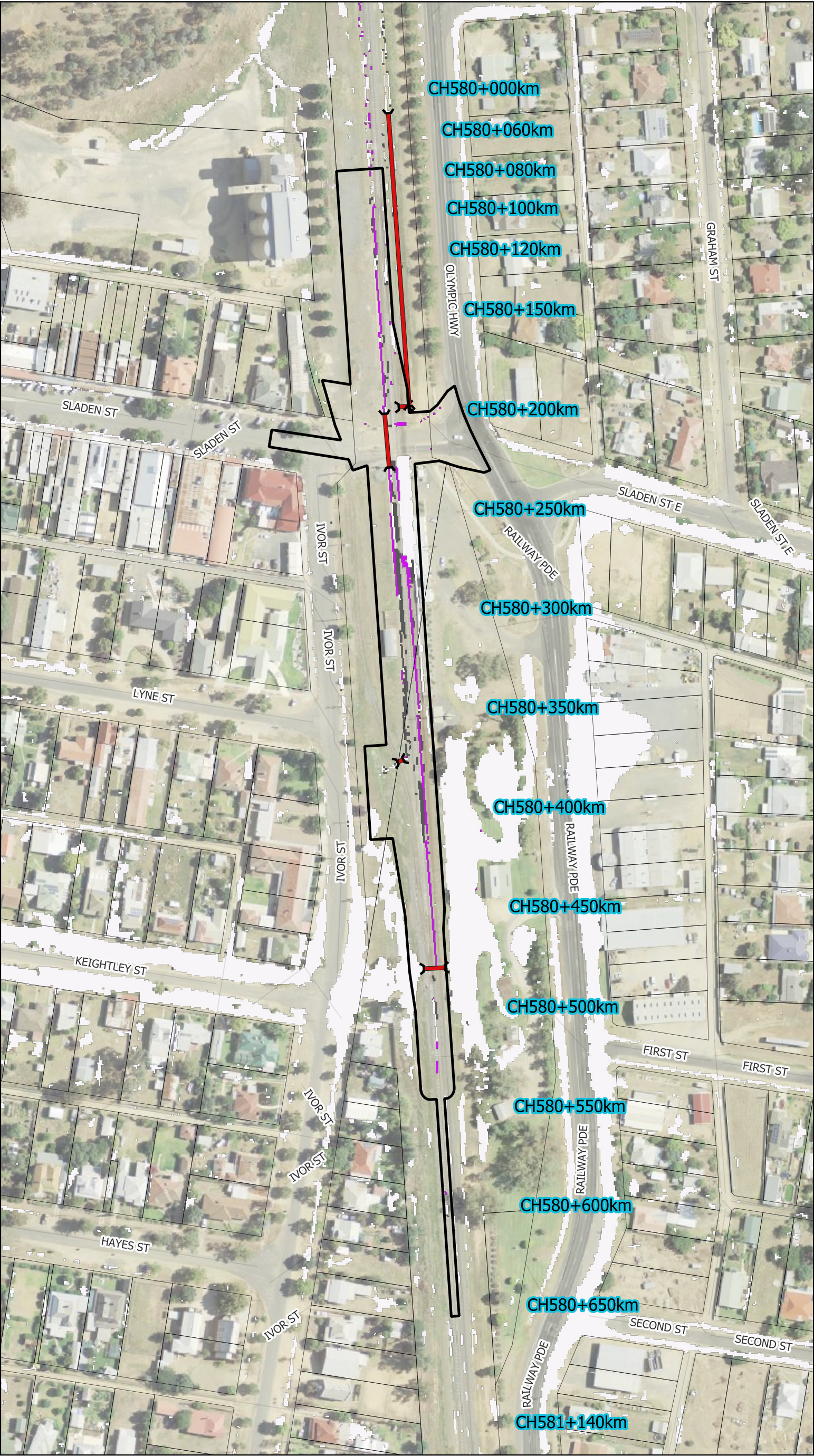
Map by: Malinda Gunasekera



23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- road
- Lot
- Drainage
- Change in Velocity (m/s)
- <= 0.5
- > 0.5
- Wet/Dy
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera

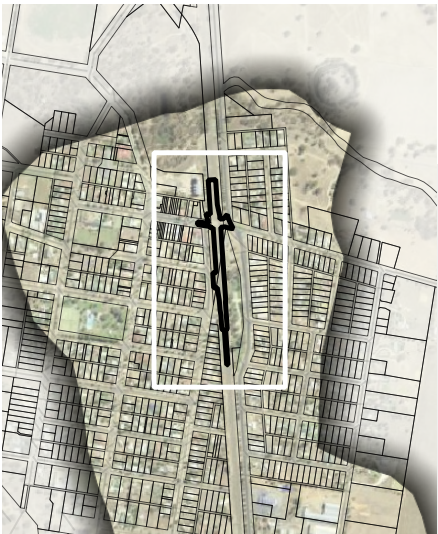
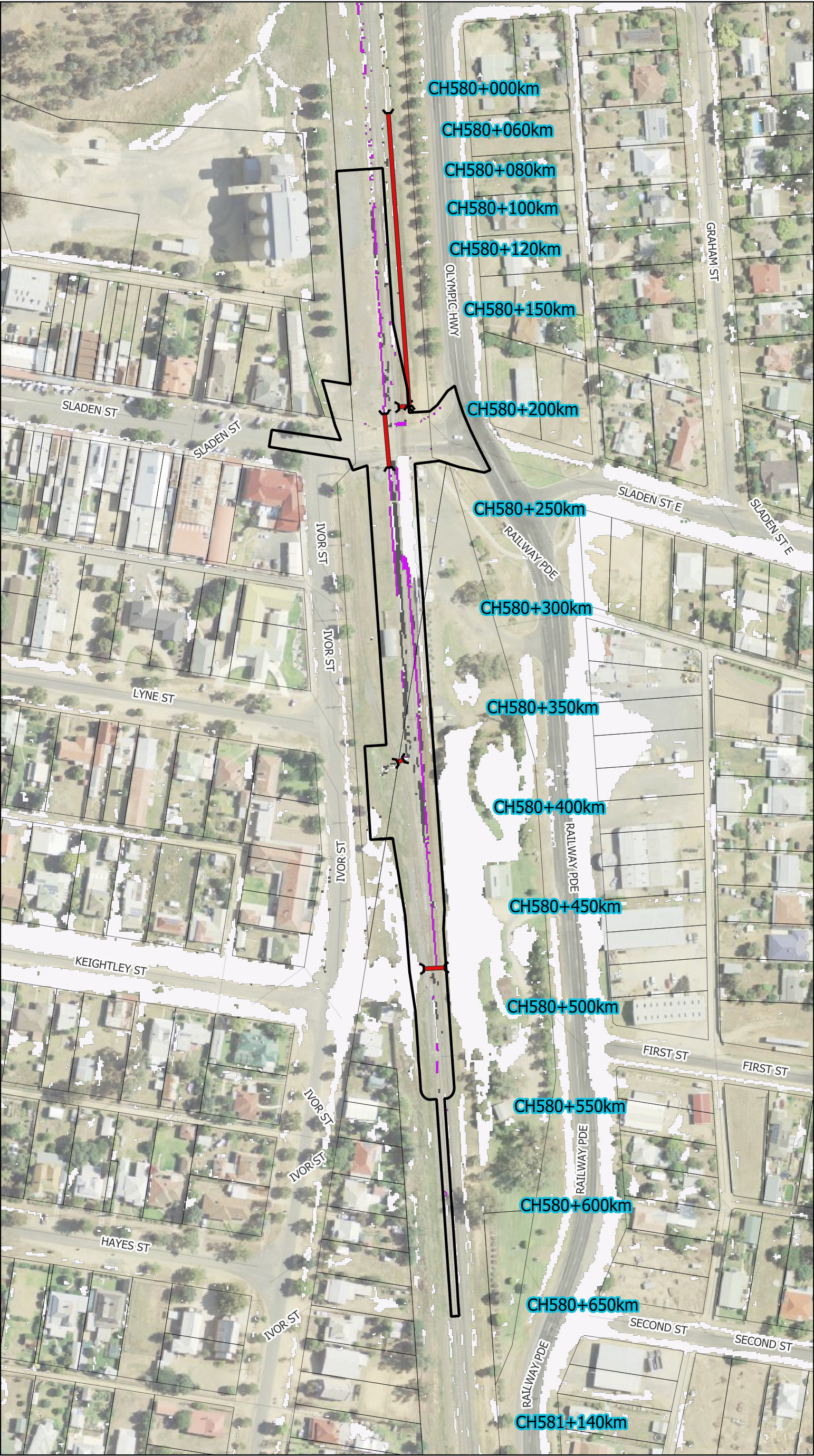


0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

Legend

- Project Boundary
- road
- Lot
- Drainage
- Change in Velocity (m/s)
- <= 0.5
- > 0.5
- Wet/Dy
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera

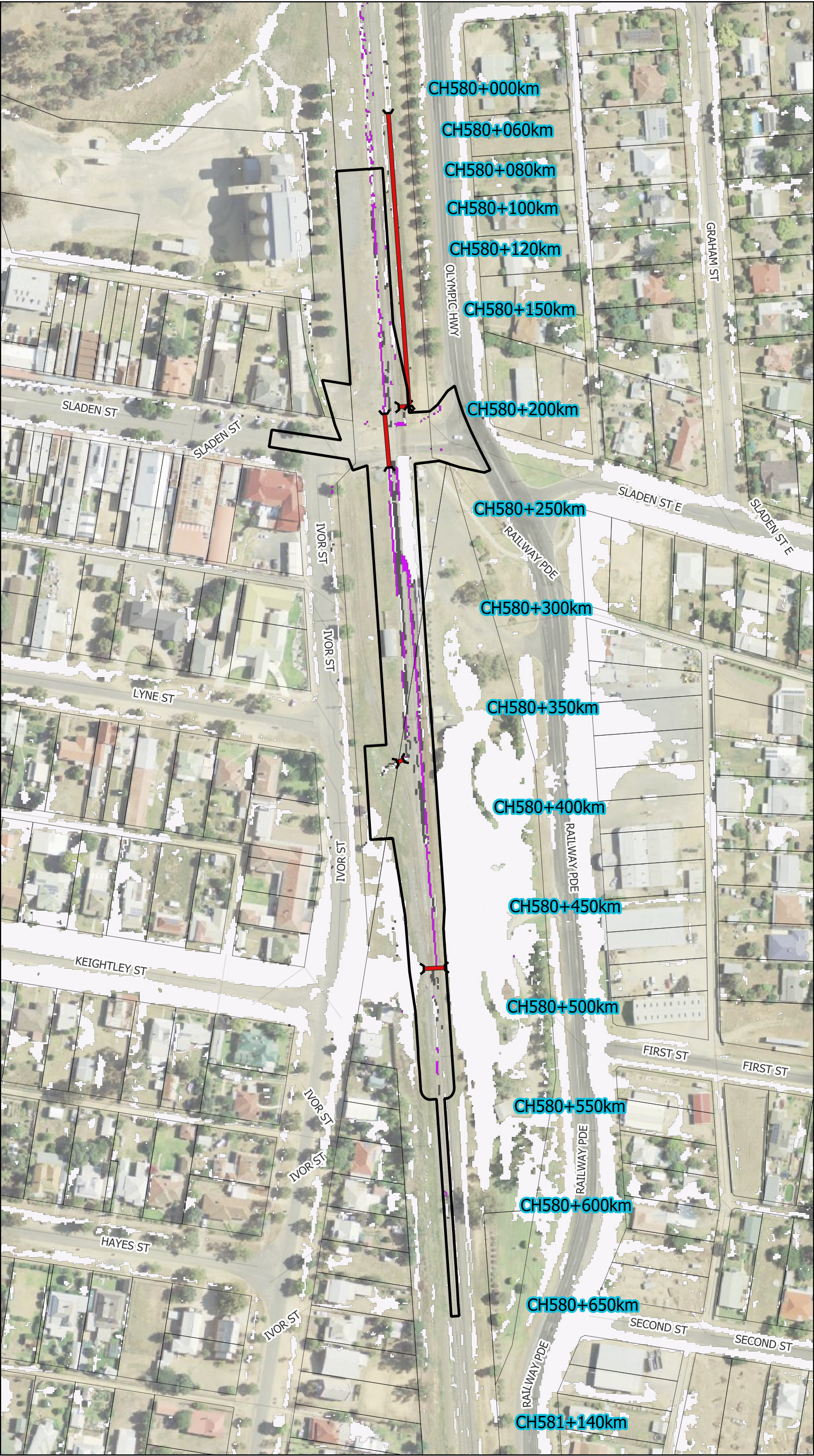


0 80 160 m
A3 Scale: 1:2,000,000002

23/6/2025 GDA2020 / MGA zone 55

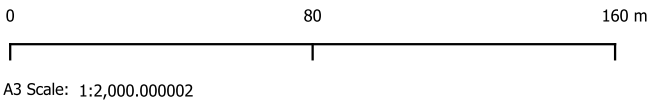
Legend

- Project Boundary
- road
- Lot
- Drainage
- Change in Velocity (m/s)
- <= 0.5
- > 0.5
- Wet/Dy
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera



23/6/2025 GDA2020 / MGA zone 55

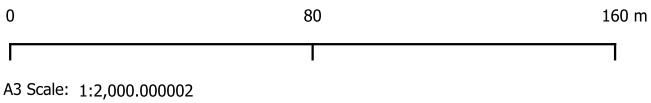
Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Change in Flood Hazard Band 1 (Gray)
- Decreased 6 Classes
- Decreased 5 Classes
- Decreased 4 Classes
- Decreased 3 Classes
- Decreased 2 Classes
- Decreased 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Increased 6 Classes
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera



23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A37 - 5% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)

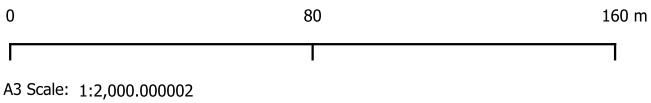
Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Change in Flood Hazard Band 1 (Gray)
- Decreased 6 Classes
- Decreased 5 Classes
- Decreased 4 Classes
- Decreased 3 Classes
- Decreased 2 Classes
- Decreased 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Increased 6 Classes
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera



23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A38 - 2% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)

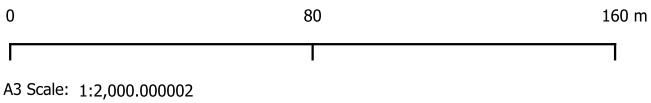
Legend

- Project Boundary
- Cadastral
- Roads
- Drainage
- Change in Flood Hazard Band 1 (Gray)
- Decreased 6 Classes
- Decreased 5 Classes
- Decreased 4 Classes
- Decreased 3 Classes
- Decreased 2 Classes
- Decreased 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Increased 6 Classes
- Wet/Dry
- Was Wet - Now Dry
- Was Dry - Now Wet



Notes:

Map by: Malinda Gunasekera



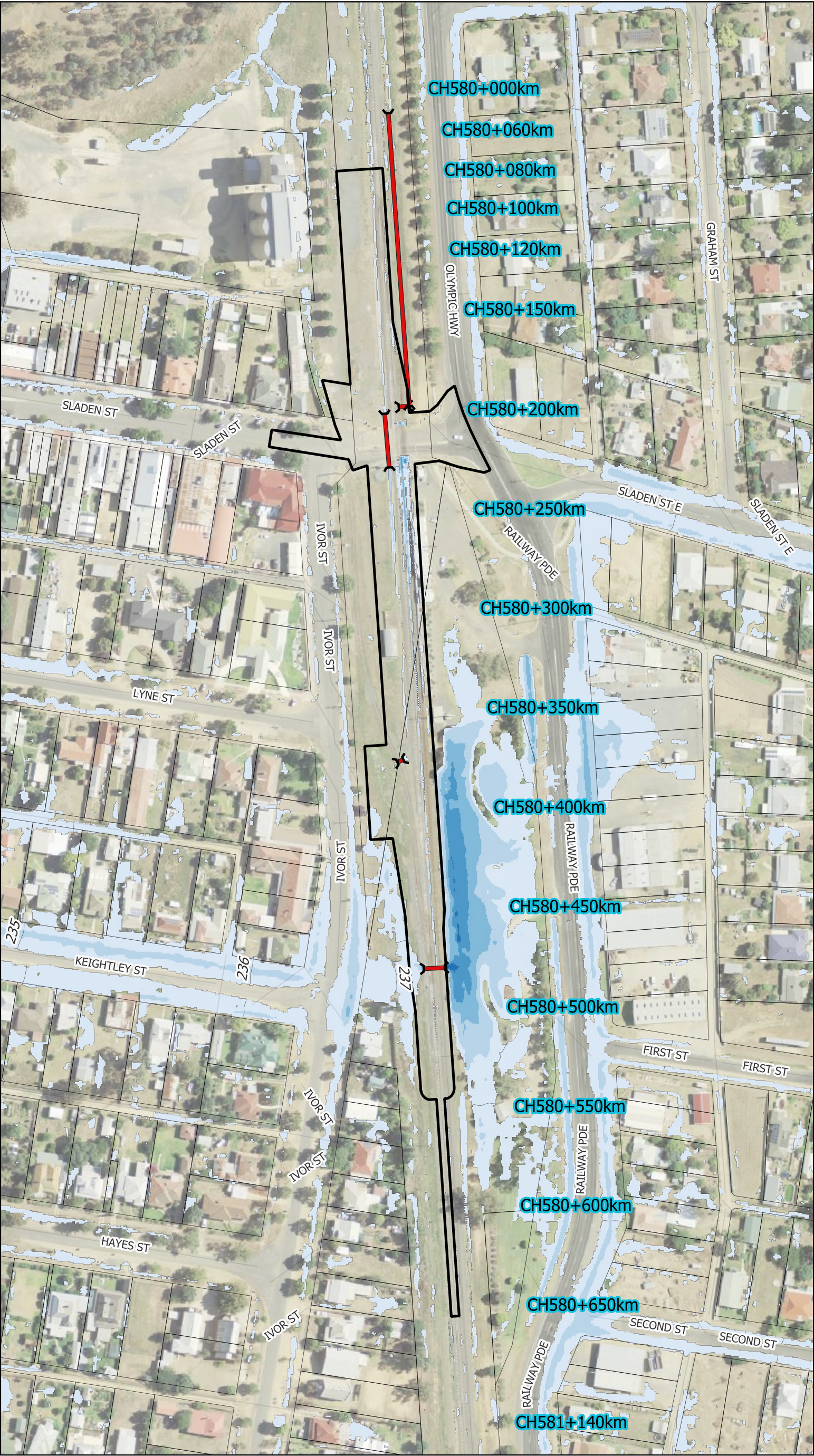
23/6/2025 GDA2020 / MGA zone 55

Henty Yard Clearances - A2P - IFC Stage

Figure A39 - 1% AEP Changes in Peak Flood Hazard (Design Condition vs. Existing Condition)

Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Flood Level Contours (1m Interval)
- Peak Flood Depth (m)
- <= 0.05
- 0.05 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

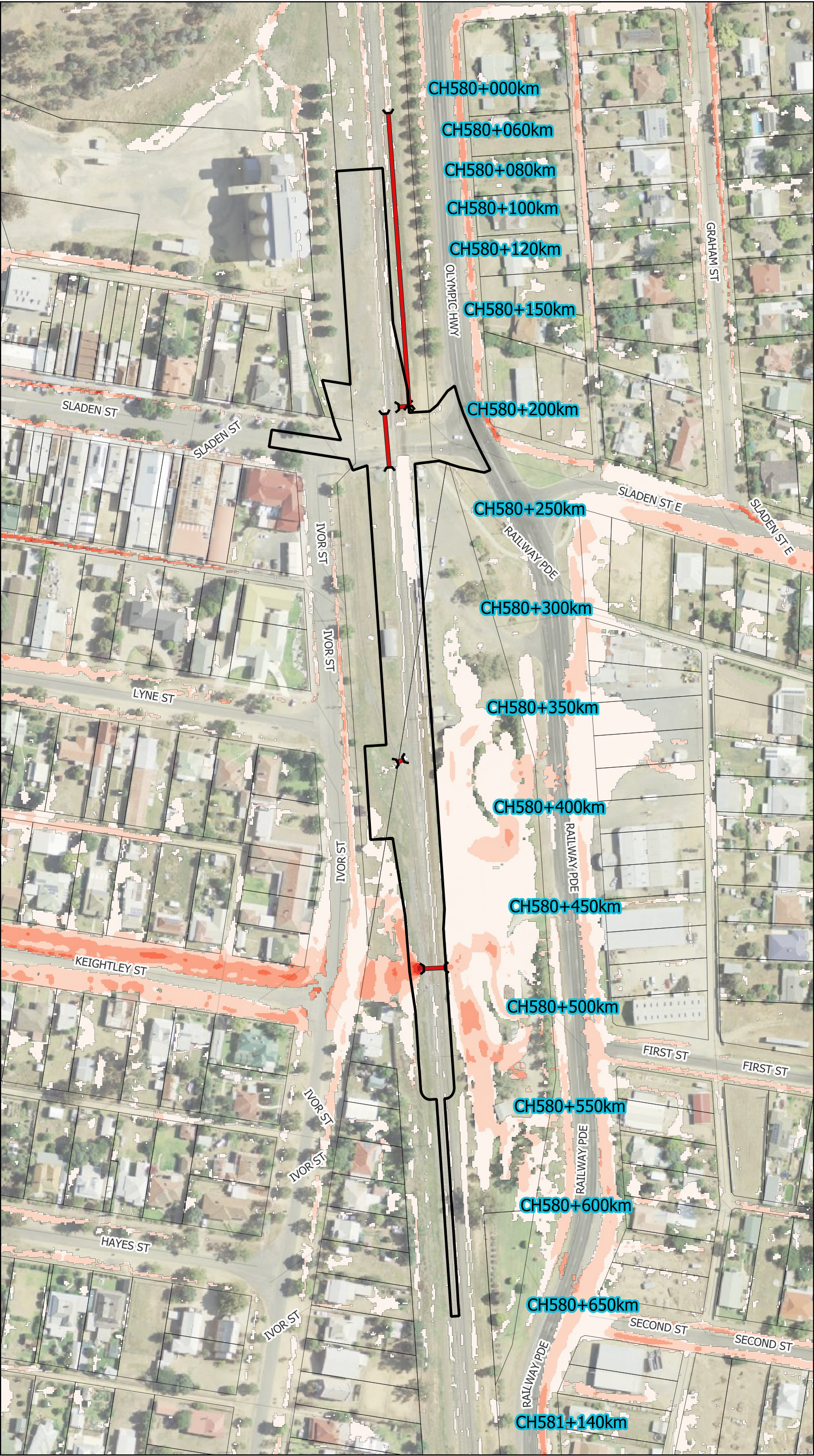


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- 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

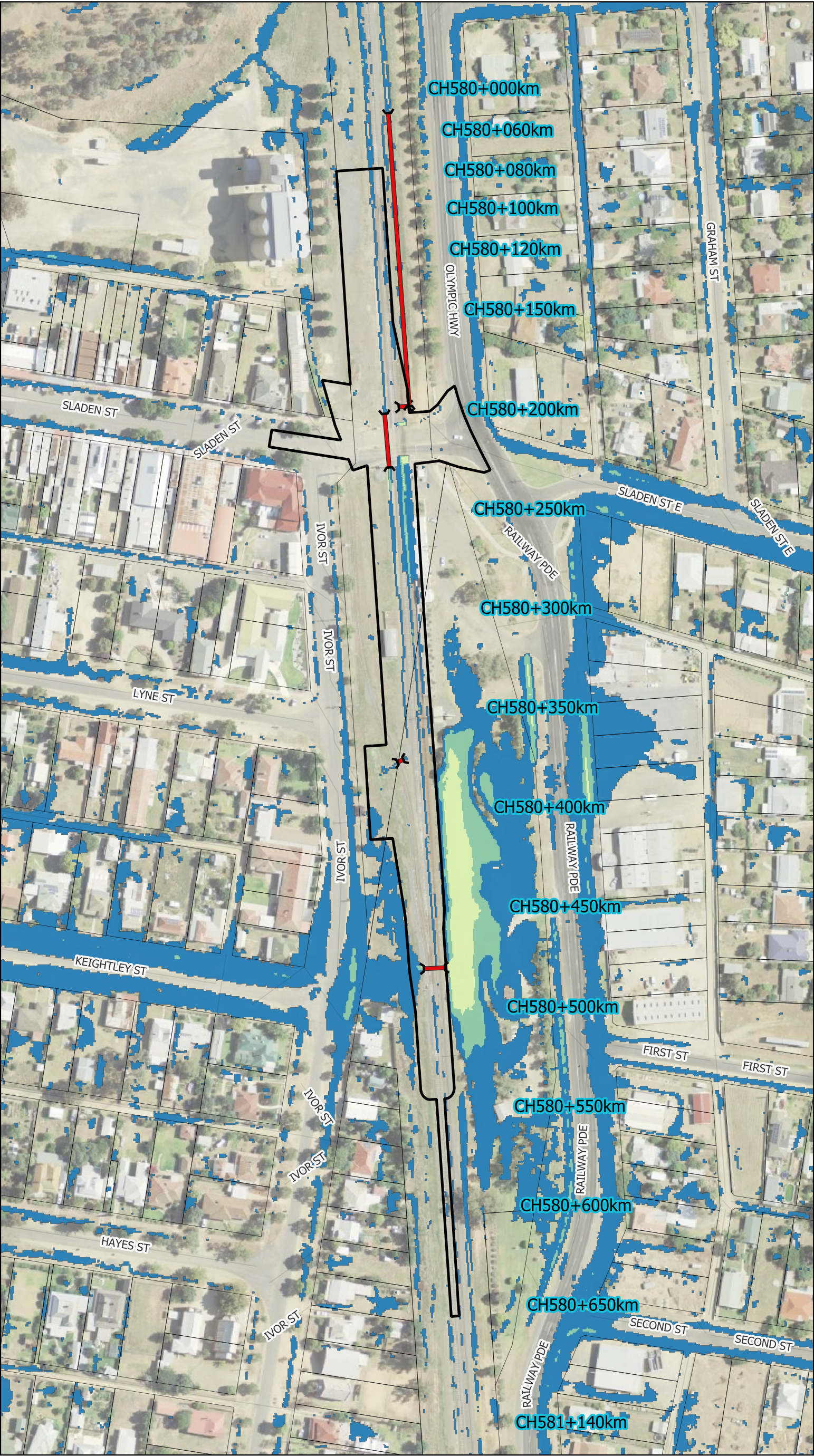


Notes:



Legend

- Project Boundary
- Cadastre
- Roads
- Drainage
- Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6



Notes:

Map by: Malinda Gunasekera



0 80 160 m
A3 Scale: 1:2,000.000002

23/6/2025 GDA2020 / MGA zone 55



APPENDIX B

ARR2019 Information

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	147.035
Latitude	-35.518
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show
Baseflow Factors	show





Data

River Region

Division	Murray-Darling Basin
River Number	11
River Name	Billabong-Yanco Creeks

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v1

ARF Parameters

$$ARF = Min \left\{ 1, \left[1 - a \left(Area^b - c \log_{10} Duration \right) Duration^{-d} \right. \right. \\ \left. \left. + e Area^f Duration^g \left(0.3 + \log_{10} AEP \right) \right. \right. \\ \left. \left. + h 10^{i Area \frac{Duration}{1440}} \left(0.3 + \log_{10} AEP \right) \right] \right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Temperate	0.158	0.276	0.372	0.315	0.000141	0.41	0.15	0.01	-0.0027

Short Duration ARF

$$ARF = Min \left[1, 1 - 0.287 \left(Area^{0.265} - 0.439 \log_{10} (Duration) \right) . Duration^{-0.36} \right. \\ \left. + 2.26 \times 10^{-3} \times Area^{0.226} . Duration^{0.125} \left(0.3 + \log_{10} (AEP) \right) \right. \\ \left. + 0.0141 \times Area^{0.213} \times 10^{-0.021 \frac{(Duration-180)^2}{1440}} \left(0.3 + \log_{10} (AEP) \right) \right]$$

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (/nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	28627.0
Storm Initial Losses (mm)	26.0
Storm Continuing Losses (mm/h)	4.5

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/MB.zip)

code	MB
Label	Murray Basin

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_MB.zip)

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-35.518&longitude=147.035&sadmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	27 September 2024 02:43PM
---------------	---------------------------

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	2.0 (0.102)	1.7 (0.065)	1.6 (0.049)	1.4 (0.038)	1.0 (0.022)	0.6 (0.013)
90 (1.5)	1.7 (0.076)	1.4 (0.045)	1.1 (0.032)	0.9 (0.022)	0.6 (0.012)	0.3 (0.006)
120 (2.0)	4.2 (0.176)	4.0 (0.121)	3.8 (0.097)	3.7 (0.081)	1.7 (0.031)	0.1 (0.002)
180 (3.0)	2.4 (0.091)	3.1 (0.084)	3.6 (0.081)	4.0 (0.079)	2.1 (0.036)	0.8 (0.011)
360 (6.0)	1.7 (0.052)	1.2 (0.027)	0.9 (0.016)	0.5 (0.009)	1.1 (0.015)	1.5 (0.019)
720 (12.0)	0.0 (0.001)	0.8 (0.014)	1.3 (0.020)	1.8 (0.023)	3.3 (0.037)	4.4 (0.044)
1080 (18.0)	0.0 (0.000)	0.5 (0.008)	0.8 (0.011)	1.1 (0.013)	2.5 (0.025)	3.5 (0.031)
1440 (24.0)	0.0 (0.000)	0.2 (0.002)	0.3 (0.003)	0.4 (0.004)	0.9 (0.009)	1.3 (0.011)
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)

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

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)

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.002)	0.0 (0.002)	0.0 (0.001)	0.0 (0.001)	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 (0.002)	0.0 (0.001)	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)

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	15.0 (0.776)	13.9 (0.514)	13.1 (0.406)	12.4 (0.329)	14.3 (0.320)	15.7 (0.313)
90 (1.5)	14.8 (0.678)	14.7 (0.485)	14.7 (0.405)	14.6 (0.347)	11.9 (0.237)	9.8 (0.175)
120 (2.0)	15.3 (0.643)	15.9 (0.482)	16.2 (0.414)	16.6 (0.364)	13.1 (0.243)	10.6 (0.174)
180 (3.0)	12.6 (0.472)	15.0 (0.407)	16.6 (0.378)	18.1 (0.356)	18.3 (0.304)	18.4 (0.274)
360 (6.0)	12.9 (0.392)	13.0 (0.290)	13.1 (0.247)	13.2 (0.215)	18.5 (0.254)	22.4 (0.275)
720 (12.0)	4.4 (0.108)	6.9 (0.127)	8.6 (0.133)	10.3 (0.137)	16.0 (0.181)	20.3 (0.204)
1080 (18.0)	2.5 (0.055)	5.9 (0.096)	8.2 (0.112)	10.4 (0.123)	12.5 (0.125)	14.1 (0.126)
1440 (24.0)	0.7 (0.014)	4.3 (0.065)	6.7 (0.084)	9.0 (0.098)	10.4 (0.095)	11.4 (0.094)
2160 (36.0)	0.0 (0.000)	0.8 (0.011)	1.3 (0.015)	1.8 (0.018)	3.5 (0.029)	4.8 (0.035)
2880 (48.0)	0.0 (0.000)	0.4 (0.005)	0.7 (0.007)	0.9 (0.009)	1.1 (0.009)	1.3 (0.009)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.000)

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	29.4 (1.520)	25.7 (0.955)	23.3 (0.722)	20.9 (0.558)	26.9 (0.602)	31.3 (0.624)
90 (1.5)	27.4 (1.253)	28.1 (0.927)	28.6 (0.789)	29.0 (0.690)	28.4 (0.569)	28.0 (0.499)
120 (2.0)	34.2 (1.437)	33.9 (1.029)	33.7 (0.858)	33.5 (0.735)	35.9 (0.664)	37.7 (0.623)
180 (3.0)	23.3 (0.868)	27.5 (0.745)	30.3 (0.690)	33.0 (0.649)	38.4 (0.638)	42.4 (0.630)
360 (6.0)	23.8 (0.724)	28.1 (0.626)	30.9 (0.581)	33.7 (0.548)	46.3 (0.638)	55.8 (0.686)
720 (12.0)	14.7 (0.365)	21.6 (0.394)	26.2 (0.403)	30.5 (0.406)	34.3 (0.386)	37.1 (0.372)
1080 (18.0)	15.5 (0.344)	18.9 (0.308)	21.2 (0.290)	23.3 (0.276)	29.1 (0.292)	33.5 (0.298)
1440 (24.0)	9.6 (0.195)	14.9 (0.223)	18.4 (0.232)	21.7 (0.237)	23.7 (0.219)	25.2 (0.207)
2160 (36.0)	0.7 (0.013)	9.7 (0.131)	15.7 (0.178)	21.4 (0.209)	19.1 (0.158)	17.4 (0.128)
2880 (48.0)	0.4 (0.007)	7.9 (0.099)	12.8 (0.136)	17.5 (0.160)	17.8 (0.137)	18.0 (0.123)
4320 (72.0)	0.0 (0.000)	2.6 (0.030)	4.3 (0.042)	6.0 (0.050)	14.0 (0.099)	20.0 (0.127)

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Climate Change Factors

Rainfall Factors

SSP1-2.6

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11	1.1	1.1
2040	1.21	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.11	1.11
2050	1.22	1.2	1.18	1.17	1.15	1.15	1.14	1.13	1.12	1.11
2060	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2070	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2080	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2090	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2100	1.22	1.2	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.12

SSP2-4.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11	1.1	1.1
2040	1.22	1.2	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.12
2050	1.27	1.24	1.23	1.21	1.19	1.18	1.17	1.16	1.15	1.14
2060	1.3	1.27	1.25	1.23	1.21	1.2	1.19	1.18	1.16	1.16
2070	1.33	1.3	1.28	1.26	1.24	1.22	1.21	1.19	1.18	1.17
2080	1.37	1.33	1.31	1.28	1.26	1.24	1.22	1.21	1.2	1.19
2090	1.4	1.36	1.34	1.31	1.28	1.26	1.24	1.23	1.21	1.2
2100	1.41	1.37	1.35	1.32	1.29	1.27	1.25	1.24	1.22	1.21

SSP3-7.0

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11	1.1	1.1
2040	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2050	1.29	1.26	1.24	1.22	1.2	1.19	1.18	1.17	1.16	1.15
2060	1.35	1.32	1.3	1.27	1.25	1.23	1.22	1.2	1.19	1.18
2070	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2080	1.5	1.45	1.42	1.38	1.35	1.33	1.3	1.28	1.26	1.25
2090	1.59	1.53	1.49	1.44	1.4	1.38	1.35	1.33	1.3	1.29
2100	1.66	1.59	1.55	1.5	1.45	1.42	1.39	1.37	1.34	1.32

SSP5-8.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	1.2	1.18	1.17	1.16	1.14	1.13	1.13	1.12	1.11	1.11
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	1.34	1.31	1.29	1.26	1.24	1.23	1.21	1.2	1.18	1.18
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	1.77	1.69	1.64	1.58	1.52	1.49	1.45	1.42	1.39	1.37
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

Loss Factors

Initial Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	1.04	1.04	1.04	1.04
2040	1.04	1.04	1.05	1.05
2050	1.04	1.05	1.06	1.07
2060	1.05	1.06	1.07	1.08
2070	1.05	1.07	1.08	1.1
2080	1.05	1.07	1.09	1.11
2090	1.05	1.07	1.11	1.13
2100	1.04	1.08	1.12	1.15

Continuing Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	1.08	1.08	1.08	1.09
2040	1.09	1.1	1.1	1.11

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2050	1.1	1.11	1.13	1.14
2060	1.1	1.13	1.15	1.18
2070	1.1	1.14	1.18	1.21
2080	1.1	1.16	1.21	1.25
2090	1.1	1.17	1.24	1.3
2100	1.1	1.17	1.27	1.33

Temperature Changes (Degrees, Relative to 1961-1990 Baseline)

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2030	1.2	1.2	1.2	1.3
2040	1.3	1.4	1.5	1.6
2050	1.4	1.7	1.8	2.1
2060	1.5	1.9	2.2	2.5
2070	1.5	2.1	2.5	3
2080	1.5	2.2	2.9	3.5
2090	1.5	2.4	3.3	4.1
2100	1.4	2.5	3.6	4.5

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2024_v1
Note	Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recommends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50.0	20.0	10.0	5.0	2.0	1.0
60 (1.0)	18.0	10.6	10.3	10.9	10.7	8.3
90 (1.5)	18.2	11.5	10.6	11.0	10.9	9.2
120 (2.0)	16.6	10.7	9.9	10.5	9.9	9.0
180 (3.0)	18.0	12.4	10.8	11.2	9.9	7.1
360 (6.0)	18.3	13.6	12.6	13.3	11.1	7.0
720 (12.0)	21.5	16.5	15.6	15.6	12.6	8.6
1080 (18.0)	22.0	17.5	16.7	17.3	14.5	8.9
1440 (24.0)	23.3	18.9	18.7	19.0	17.1	11.8
2160 (36.0)	25.5	21.0	20.8	21.6	19.4	14.9
2880 (48.0)	25.9	21.4	21.5	22.9	20.9	15.9
4320 (72.0)	26.3	22.5	23.9	25.3	22.2	16.7

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2018_v1
Note	As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) 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.

Baseflow Factors

Downstream	10814
Area (km2)	4477.94911775
Catchment Number	10844
Volume Factor	0.288732
Peak Factor	0.046337

Layer Info

Time Accessed	27 September 2024 02:43PM
Version	2016_v1

Download TXT (downloads/eea5063b-e679-4573-b1fb-dee6928b3be8.txt)

Download JSON (downloads/c538bf05-a9a0-4e15-8bd1-29637eea6ed2.json)

Generating PDF... (downloads/83187dcc-2fdf-49d3-ae36-6fb34c29928b.pdf)



APPENDIX C

ARTC Review

Document Control Information																		
		Contractor DC to update for re-submission		Submitted Document No. or Transmittal No.:		Martinus-PTRAN-000760												
Project:		2100 - A2I		Date Submission Received:		13/12/2024												
Comment Sheet Number_Revision:		5-0052-210-IHY-G2-CS-0001_C		Comment Sheet Title:		External Comment Sheet - A2I Flood Design Report - Henty Yard												
Revision Date:		1/07/2025		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	OPEN		
1	PSR Annexure B: Technical Requirements (Section 5.4)	5-0052-210-IHY-G2-RP-0001_A.pdf	Page 23, 5-0052-210-IHY-G2-RP-0001_A, Section 4.2.2	DDR	Further details of culvert design changes and proposed cess drain (e.g., shape, size, slope, capacity, depth, levels etc.) to be included in the report.	Non-Compliant	Ayub Ali	31/10/2024	Yucen Lu	DJV Flood Modeller	22/11/2024	The details of the design culvert and cess drain will be included in the next design phase report.	5-0052-210-IHY-G2-RP-0001 Section 4.2.2	Stephen Brierley	13/02/2025	CLOSED	As this is at DDR, I assume evidence will be provided ASAP to sight this change and close the comment. 27/6 SB - meeting with Ayub and Zoe Cruice, we agreed on the updated wording and changes required to satisfy this comment. Minimum grade required to be shown with an explanation providing assurance that no depressions will occur between drainage grade intervals.	
				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 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 D

External Consultation Review

Attachment 1: A2I Flood Design Report CONSULTATION - COMMENTS REGISTER

Stakeholder Category	Stakeholder Name	Flood Design Report name	Document reference (e.g.)	Date raised	Topic that comment	Comments	Full Name	Company & Role	Date	Response	Documentation Section # / Figure #
State Government Agency	TfNSW	5-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation 5-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation 5-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation 5-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation 5-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Whole document	14/11/2024	Administrative	Multiple cross-referencing links are broken in the reports. TfNSW assumes administrative errors such as these will be corrected.	Zoe Cruice	Martinus - Engineering Manager	29/11/2024	Noted. Apologies. These will be fixed to hyperlink and reference correctly.	Rev 0 Report
State Government Agency	TfNSW	5-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation 5-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation 5-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation 5-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation 5-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Blockage Assessment section of each report	14/11/2024	Blockage assumptions	All assessments adopted a site-specific blockage, but a consistent 20% blockage for all culverts outside of the project area. What informed this assumption? If the purpose was to assess ARR2019 blockage guidelines, TfNSW suggests that the blockage rates for all culverts should be informed by this guidance as even off-site culverts have the potential to influence flows within the sites.	Yucen Lu	DJV Flood Modeller	3/12/2024	A technical memo has been provided to provide explanation and justification of the proposed approach. Please review this memo (5-0052-210-IHY-99-ME-0001) and advise if the blockage assessment and assumptions are acceptable.	Technical Memo
State Government Agency	TfNSW	5-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation 5-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation 5-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation 5-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation 5-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Blockage Assessment section of each report	14/11/2024	Blockage assumptions	Why was the ARR2019 blockage guidance not included in the design runs? One of the compliance requirements is that all modelling be undertaken in line with this guidance. The design runs have not been undertaken with this blockage guidance incorporated. A typical blockage sensitivity test would have been to include the ARR2019 blockage guidance in the design runs, and then to assess higher and/or lower rates of blockage as necessary.	Yucen Lu	DJV Flood Modeller	3/12/2024	A technical memo has been provided to provide explanation and justification of the proposed approach. Please review this memo (5-0052-210-IHY-99-ME-0001) and advise if the blockage assessment and assumptions are acceptable.	Technical Memo
State Government Agency	TfNSW	5-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation	Appendix A - Flood Maps A3, A4, A13, A14, A18, A19, A33 and A34	14/11/2024	1% AEP and 1% AEP + Climate change mapping	The 1% AEP flood results shown a larger flood extent/depths than the 1% AEP + Climate change event. Please review and confirm the correct layers have been used to generate these maps.	Yucen Lu	DJV Flood Modeller	3/12/2024	Noted. The correct 1% AEP + Climate Change flood maps will be updated in the next design stage report.	Rev 0 Report



APPENDIX E

Independent Flood Consultant Review

Project: 2100 Deliverable: Henty Yard

Comment Sheet Reference: 5-0052-210-IHY-G2-CS-0001-PE_D

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)	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-G2-RP-0001	TUFLOW files	Hatch	Dan Williams	Flood Assessment	10/12/2024	DDR	Include local road drainage assets if modelled in the Henty Flood Study. If these were not included in the Flood Study then this is not necessary. Whilst their inclusion would improve the accuracy of the modelling and may result in a reduction in the critical duration, it is unlikely to have any material impact on the outcomes of the overall assessment.	Minor	Yucen Lu	DJV Flood Modeller	13/01/2025	The available road drainage from Culcairn, Henty, Holbrook Flood Studies (WMA Water, 2013) was included in the model and the detailed information will be included in Section 4.2.1.2		Darren Lyons	Hatch	21/01/2025	CLOSED	None
2	5-0052-210-IHY-G2-RP-0001	TUFLOW files	Hatch	Dan Williams	Flood Assessment	10/12/2024	DDR	Verify that the minor cross-drainage structure beneath the shunt neck or disused branch line at around chainage 580+375 does not impact the proposed design.	Minor	Yucen Lu	DJV Flood Modeller	13/01/2025	Noted. It will be checked with the latest survey data and also verified in the next design stage.		Darren Lyons	Hatch	21/01/2025	CLOSED	None
3	5-0052-210-IHY-G2-RP-0001		Hatch	Dan Williams	Flood Assessment	30/06/2025	IFC	No further comments											



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