PDP FOR EASING SYDNEY CONGESTION

PITT TOWN BYPASS

HYDROLOGY AND HYDRAULICS ASSESSMENT WORKING PAPER

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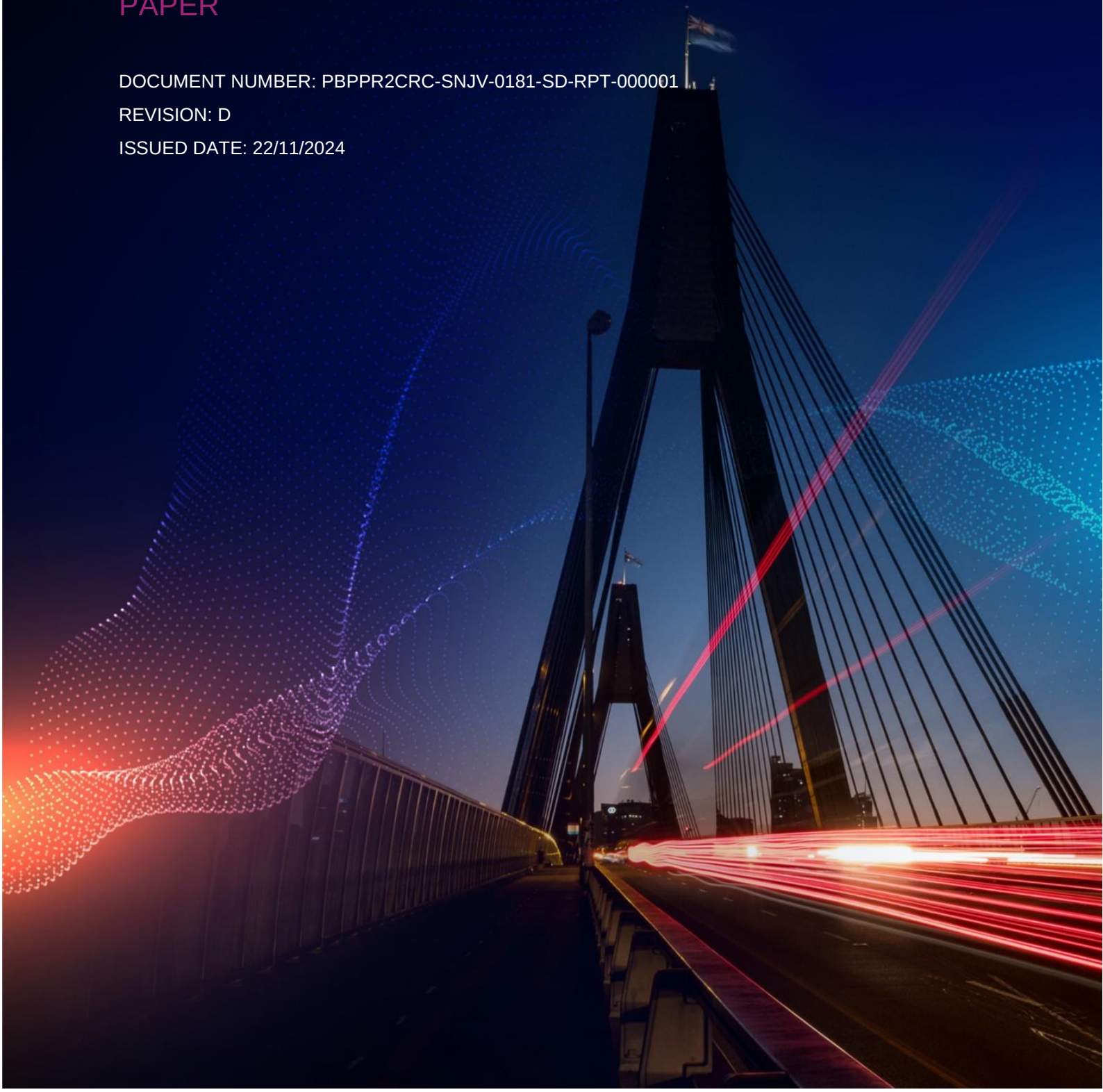

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TRANSPORT FOR NSW
PDP FOR EASING SYDNEY CONGESTION

HYDROLOGY AND HYDRUALICS ASSESSMENT WORKING PAPER

The Pitt Town Bypass Project - Detail Design Development Scope

TfNSW Project Number: P.0089596

SustainJV Project Number: W0-047

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REVISIONS

Revision	Date	Description	Prepared by	Approved by
A1.01	12/08/2024	Hydrology and Hydraulics Assessment	Sam Douglas	Cam Graziani
B1.01	19/09/2024	Second draft	Sam Douglas	Rainer Berg
C1.01	15/10/2024	Final draft	Sam Douglas	Rainer Berg
D1.01	22/11/2024	Final updated	Sam Douglas	Rainer Berg

CONTENTS

1 INTRODUCTION

1.1 Project description and proposed modifications

Transport for New South Wales (Transport) is planning to construct a one-kilometre Pitt Town Bypass. known as the project. This bypass, situated between Pitt Town Road and Cattai Road to the east of Pitt Town, will feature a single lane in each direction (the project). A project review of environmental factors (REF) was prepared for the project and approved in 2018 (referred to as project REF). Since then, a consistency assessment has been prepared to describe further amendments to the design in 2019. Collectively, the project REF and consistency assessment are referred to as the project approvals.

Further refinement of the to the approved design has resulted in the additional work (the proposed modification) which is currently being considered under an addendum REF.

Key features of the proposed modification would include:

- Adjustments to the road design including the horizontal alignment of Glebe Road and the southern tie in of the bypass with Pitt Town Road
- Changes to the centre median at the Pitt Town Bypass intersection to allow right turns from Buckingham Street onto Pitt Town Bypass while still restricting the right turn movement from Pitt Town Bypass onto Buckingham Street
- Changes to property and maintenance accesses by adjusting the alignment and turnaround areas to accommodate maintenance and emergency vehicles
- Refinement of the design including the installation of additional road safety barriers and fences along the Pitt Town Bypass and side streets and the removal of two previously proposed retaining walls at the northern roundabout and Buckingham Street
- Minor utility adjustment to accommodate the revised road design with the approved project boundary
- Installation of a new Closed Circuit Television (CCTV) camera in the vicinity of the southern roundabout, located at the intersection of Pitt Town Road/Bathurst Street and Glebe Road
- Minor adjustment of the approved project boundary to include the property adjustment of an existing Transport acquired property and two driveways adjustments.

The location of the project site is shows below in Figure 1.

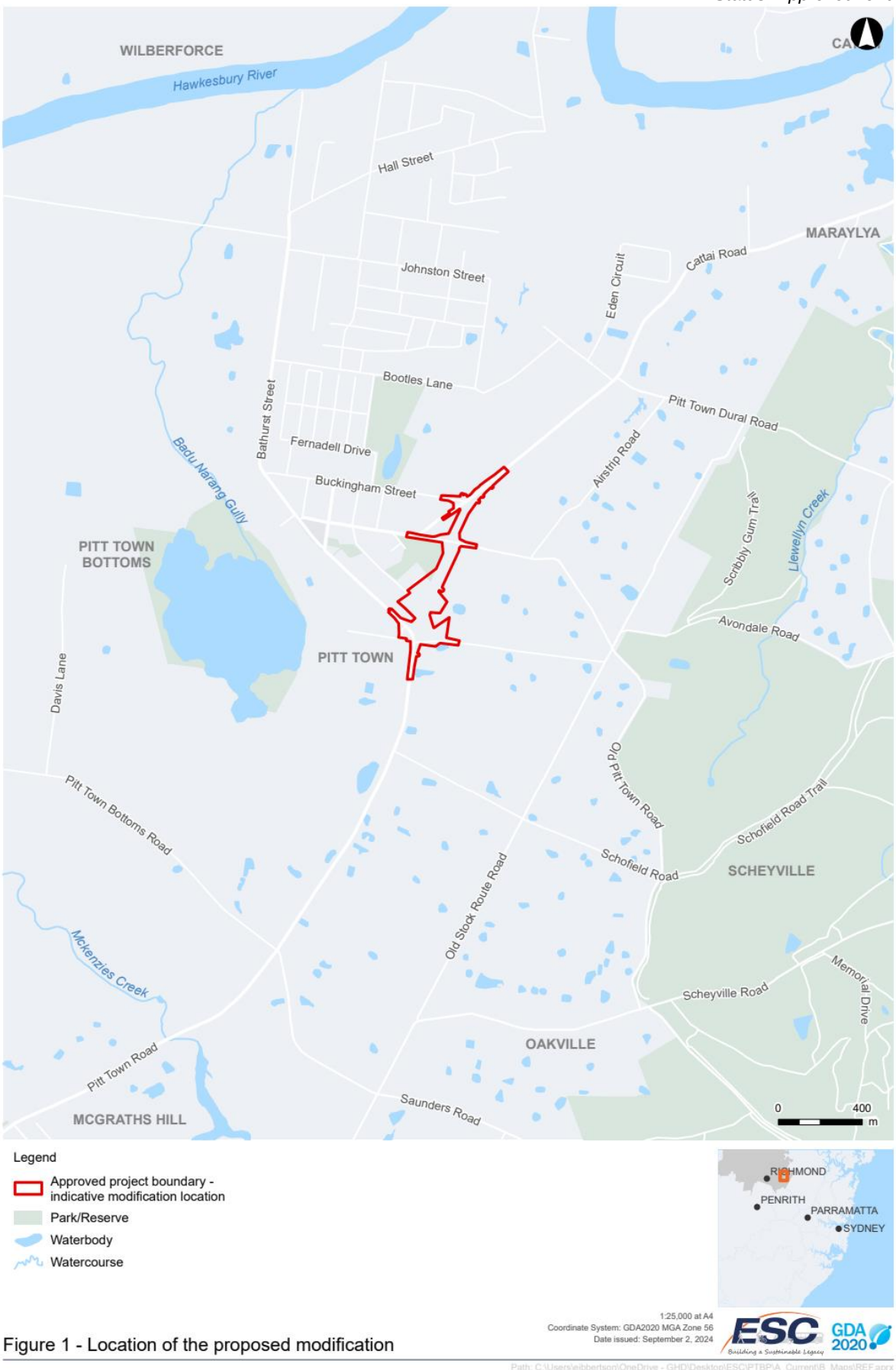

Figure 1 - Location of the proposed modification

Figure 1: Location of the proposed modification

The current road alignment area is generally rural residential, with urban development adjoining the town centre. The proposed road alignment passes over Hortons Creek at multiple locations where the watercourse meanders through the landscape.

1.2 Background

Transport has engaged Sustain Joint Venture (SJV) to review and update the design for the project. The updated design builds upon the earlier detailed design prepared by Arcadis in 2019 for Roads and Maritime Services, now part of Transport for NSW.

The project REF was prepared in November 2018 and was placed on public display for community and stakeholder comment. The *Pitt Town Bypass REF submissions report* (submissions report) dated 25 February 2019 was prepared to respond to issues raised. After consideration of the project REF and submissions report, Transport determined the project on 27 February 2019.

A consistency assessment was prepared in November 2019 following further design progress. The consistency assessment assessed environmental impacts where the design extended beyond the project REF boundary and was endorsed on 6 November 2019. The boundary adopted from the consistency assessment is referred to as the 'approved project boundary'.

As part of this review and update, an addendum to the project REF is required, in order to document key changes since the 2019 design and to identify any additional effects on the local environment as a result of any design updates. This includes preparing an Addendum REF (AREF) along with associated specialist reports. This hydrology and flooding technical working paper includes a due diligence assessment of the existing environment (as the project was determined over five years' ago) as well as assessing the potential impacts of the proposed modifications.

1.3 Purpose and Scope of Report

This technical working paper aims to support the AREF. This technical working paper should be read alongside other documents referenced within this paper.

This technical working paper summarises the hydrological assessment prepared for the project. The primary objectives of the project's hydrological assessment were to evaluate the existing and post-upgrade flooding conditions of the waterways crossing the project area. The flood analysis aimed to identify potential impacts, devise necessary mitigation measures, and determine cross drainage requirements. The assessment focused only on local catchment flows, with an emphasis on enhancing existing flood immunity where feasible.

This technical working paper also documents significant design changes that have occurred since the preparation of the project approvals. It includes updates reflecting changes in current industry practices since the completion of the project approvals.

1.4 Glossary and Terms

Table 1: Glossary and Terms

Acronym	Name
AEP	Annual Exceedance Probability
Afflux	Changes in level of water flow upstream of an obstruction or barrier
AGRD05-23	Austroads Guide to Road Design Part 5 General and Hydrology Considerations
AHD and mAHD	Australian Height Datum (metres)
ARI	Average Recurrent Interval
ARR	Australian Rainfall and Runoff (national guideline document, data and software suite)
ARR1987	1987 edition of ARR
ARR2019	2019 edition of ARR version 4.1
AS5100	Australian Standard for Bridge Design
BOM	Bureau of Meteorology
CCTV	Closed Circuit Television
CL	Continuing Loss
HEC-18	Hydraulic Engineering Circular No. 18 Evaluating Scour at Bridges
HEC-23	Hydraulic Engineering Circular No. 23 Bridge Scour and Stream Instability Countermeasures
IFD	Intensity-Frequency-Duration
IFT	Issue for Tender
m/s	Metres per second
NCHRP 24-20	National Cooperative Highway Research Program Project 24-20 Prediction of Scour at Bridge Abutments
PM	Project Manager
RCBC	Reinforced concrete box culvert
RCP	Reinforced concrete pipe
REF	Review of Environmental Factors
SES	State Emergency Service
SLS	Serviceability Limit State

Acronym	Name
TfNSW	Transport for NSW
TUFLOW	Two-dimensional Unsteady FLOW (A flood Modelling software package)
ULS	Ultimate Limit State

2 CATCHMENT DESCRIPTION

Flooding of the Project Site occurs due to the following processes:

- Local flooding: due to flooding along Hortons Creek due to runoff from the local watercourse, causing flooding of the Project Site; and
- Regional flooding: due to riverine flooding along the Hawkesbury-Nepean River, causing widespread inundation due to backwater inundation along Hortons Creek and overtopping of river banks.

The processes are described in the following sections.

2.1 Local flooding

The Project Site is located between the National Park and the urban residential areas of Pitt Town, along the banks of Hortons Creek and its tributaries. The land surrounding the project is generally rural residential in nature or farmland.

Hortons Creek flows in a southerly direction through and adjacent to the Pitt Town Bypass project alignment, discharging towards the Pitt Town Lagoon. The majority of the Pitt Town urban area discharges to Hortons Creek. The Hortons Creek catchment (green) and Pitt Town Bypass (red) is show below in Figure 2.

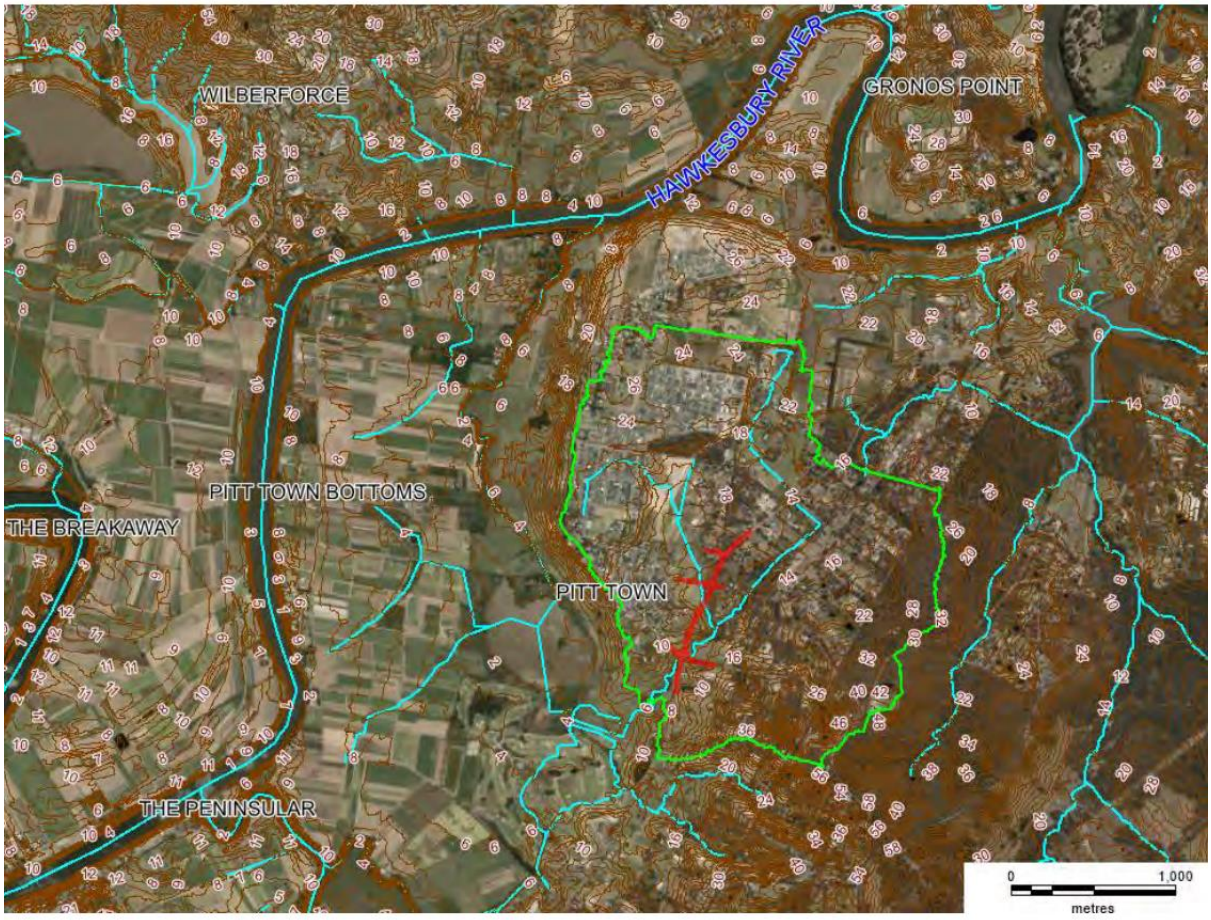

Figure 2 Local catchment boundary for Hortons Creek

Upstream of the Pitt Town Bypass, a new development project spanning between Buckingham Street and Jonston Street has been constructed, which includes multiple stormwater diversion channels diverting flows into a new stormwater detention basin to the north-west of the Pitt Town Bypass Project.

2.2 Regional flooding

The Hawkesbury-Nepean Valley catchment covers an area of approximately 22,000km^2 (2.2 million Ha). The catchment has been studied extensively in the past and recent mapping has been made available by SES and the for the local government area.

The Hawkesbury-Nepean River Flood Study Final Report (HNRFS 2024) describes regional flooding and flood levels in the Pitt Town area (Figure 3 below). Flood Levels have been reviewed from this study key flood levels in proximity of the Pitt Town area are summarised below in **Error! Not a valid bookmark self-reference.**.

Table 2: Regional flood levels (HNRFS 2024)

Design flood event	Design flood levels (mAHD)			
Location	South Creek confluence	Buttsworth Creek confluence	Bardenarang Gully confluence	Cattai Creek/ Gronos Point
1 in 2 Annual Exceedance Probability (AEP) (50% AEP)	5.5	5.2	4.9	4.4
1 in 5 AEP (20% AEP)	9.7	9.1	8.7	7.8
1 in 10 AEP (10% AEP)	11.7	11.6	11.4	10.8
1 in 20 AEP (5% AEP)	13.8	13.8	13.6	13.3
1 in 50 AEP (2% AEP)	15.9	15.9	15.8	15.6
1 in 100 AEP (1% AEP)	17.3	17.3	17.2	17.1
1 in 200 AEP (0.5% AEP)	18.5	18.5	18.4	18.3
1 in 2000 AEP (0.05% AEP)	22.8	22.8	22.8	22.7
PMF Event	30.6	30.5	30.5	30.5

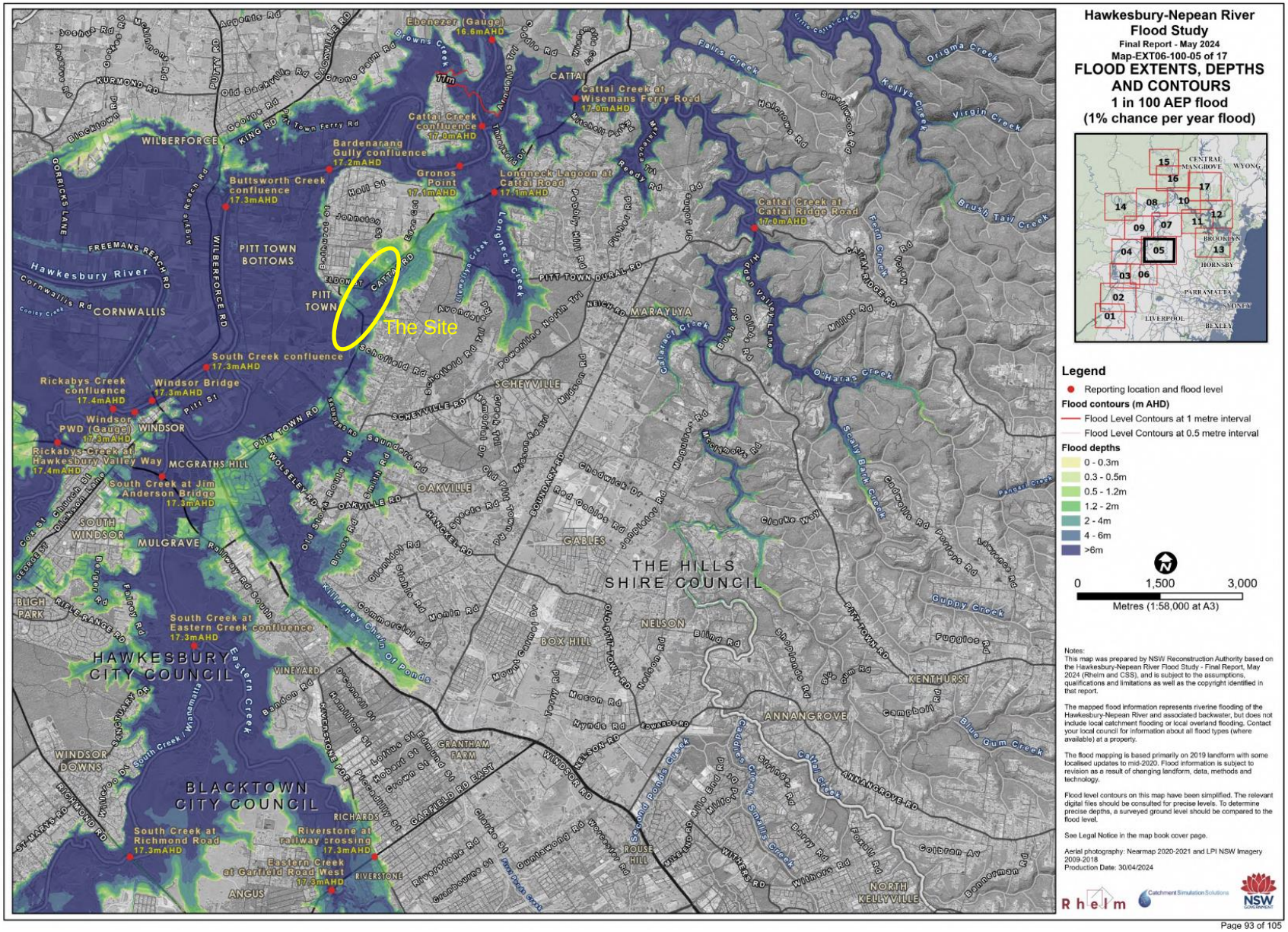

Figure 3:1% AEP Flood Extents (HNRFS 2024)

3 METHODOLOGY

The following approach was adopted for the hydrological and hydraulic assessment:

- The flood modelling from the project REF was reviewed and the model updated to include the latest drainage and geometric designs for the Pitt Town Bypass
- The hydrology was updated to reflect current industry practice in accordance with the Australian Rainfall and Runoff Guidelines 2019
- The flood model (TUFLOW) was rationalised and upgraded to the latest version to optimise model simulation times.
- Additional survey was incorporated into the flood model, along with drainage information from the recent Hawkesbury-Nepean Valley Flood Evacuation Road Resilience Program (TfNSW, 2024)
- For the purposes of this assessment, the flood model was re-simulated and the results compared to those presented in the Arcadis design report and project REF. The results were found to be consistent with those presented in the earlier documentation and the model was adopted on this basis.
- The design geometry and drainage for the updated detailed design was configured into the flood model and the model restimulated
- Flood impact mapping was prepared and this hydrology and hydraulics technical working paper, outlining the methodology, analysis, and findings of the flood modelling was prepared to support the Addendum REF.

For information regarding the original flood model configurations, please refer to the TfNSW Pitt Town Road Bypass Hydrology and Hydraulic investigations Report – concept design (10014101-EFC0001-RPT), prepared for the original Pitt Town Bypass REF (2018). The flood model prepared for the project REF reflects the Arcadis 100% Concept Design.

The design has since been revised by SJV on behalf of Transport. The following sections detail changes to the flood model which have occurred as part of the assessment of the revised design.

3.1 Flood immunity requirements

As per the project REF, the site is subjected to mainstream river floodings from the Hawkesbury River during relatively frequent flooding events. During a 20% AEP regional flood event, flood depths of up to 4 metres are expected near Pitt Town Road. Due to the significant regional flooding in the area, Transport concluded that achieving immunity to this level of flooding would not be feasible, as it would require constructing very large embankments and significantly increase the project's footprint and costs. Therefore, the flood immunity standard adopted by Transport for the project REF is based on the 1% Annual Exceedance Probability (AEP) local flood event. It is proposed to maintain this level of flood immunity for the hydrology impact assessment for the Addendum REF.

3.2 Culverts sizing

Drainage culverts were provided at locations so that disruptions to existing flow paths were minimised. Cross drainage structures have been sized for the 1% AEP local catchment event and to minimise flood afflux (changes in level) for events up to and including the 1% AEP event.

Culvert types are primarily Reinforced Concrete Pipe (RCP) or Reinforced Concrete Box Culvert (RCBC).

The details of the proposed culverts are shown below in **Error! Not a valid bookmark self-reference.**. The locations of proposed cross-drainage culverts are shown below in Figure 4.

Table 3: Pitt Town Bypass (SJV Design) proposed drainage - culvert sizes.

Culvert ID	Upstream Invert (mAHD)	Downstream Invert (mAHD)	Number of Culverts	Culvert Size
Bathurst1	6.44	5.83	1	900mm RCP
PTB2	5.95	5.83	2	1.8m x 0.75m RCBC
PTB3	6.13	5.83	5	3.6m x 1.8m RCBC
PTB6	10.35	9.56	3	675mm RCP
Buck1	12.04	11.99	1	0.9m x 0.6m RCBC
PA1	6.24	6.19	1	0.6m x 0.45m RCBC
Lagoon1	7.75	7.70	2	0.6m x 0.45m RCBC
PA4	13.66	13.61	1	0.6m x 0.45m RCBC
PA3	13.21	13.13	1	0.6m x 0.45m RCBC
PA2	12.77	12.69	1	0.6m x 0.45m RCBC
Mawson1	11.227	11.05	1	525mm RCP
Eldon1	10.81	10.16	1	375mm RCP
OPT2	10.17	9.31	1	750mm RCP
OPT3	10.76	10.70	1	450mm RCP
OPT1	11.88	10.18	1	750mm RCP
OPT5	9.37	9.30	3	1.8m x 0.75m RCBC
Glebe4	8.22	8.01	1	0.6m x 0.45m RCBC
Cattai2	11.32	11.28	1	0.6m x 0.45m RCBC
Glebe2	8.22	8.13	1	450mm RCP
Glebe3	10.80	10.77	1	375mm RCP
Cattai3	11.57	11.53	1	0.6m x 0.45m RCBC

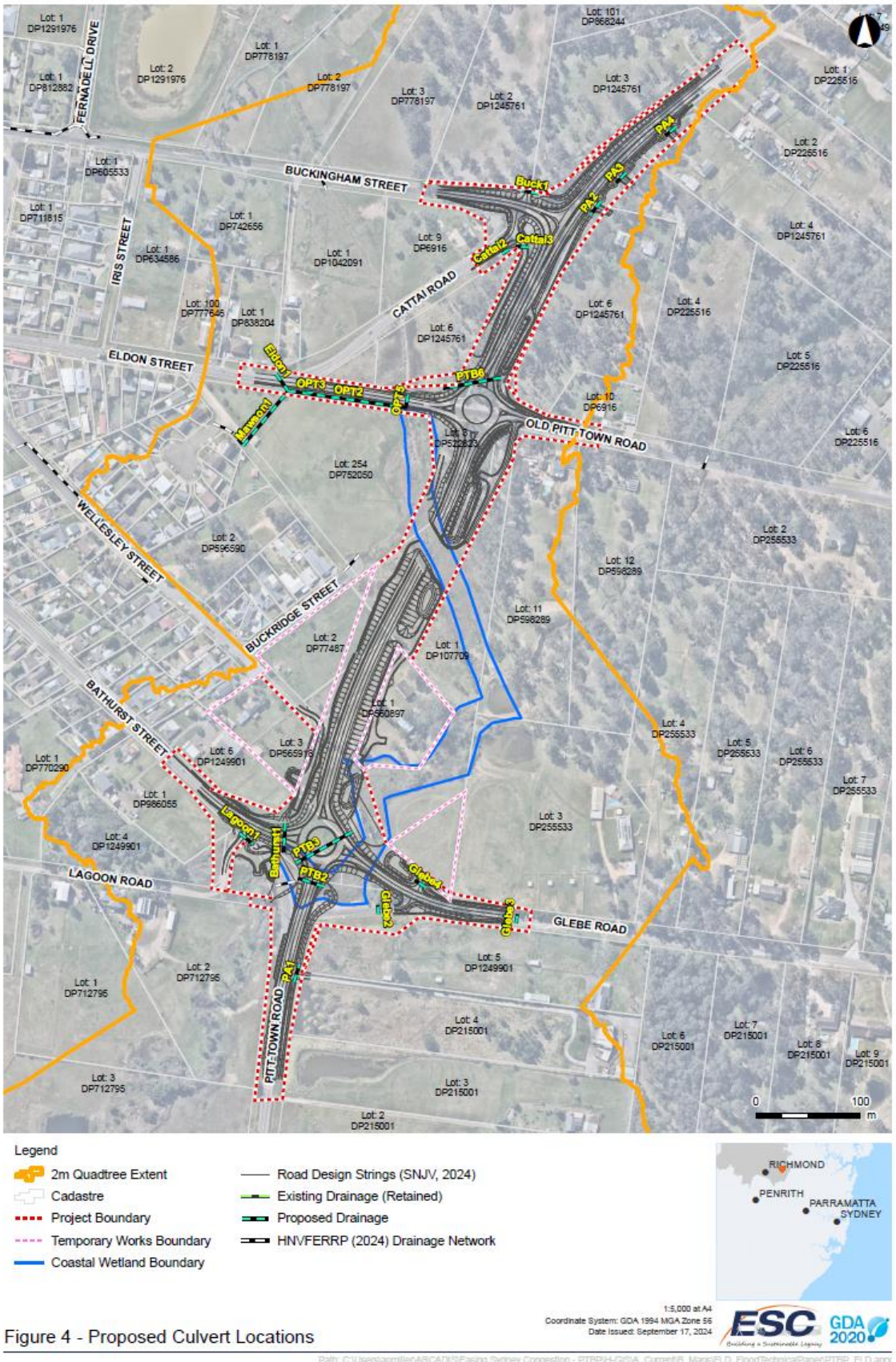

Figure 4 - Proposed Culvert Locations

Figure 4: Proposed culvert locations

3.3 Adoption of ARR2019

3.3.1 Design rainfall

Design rainfall information (including, design rainfall depths and temporal patterns and design storm losses) were extracted for the Project Site from the Bureau of Meteorology (BOM) Data Hub (https://data.arr-software.org/) at co-ordinates -33.582 S, 150.867 E (Date extracted 22 April 2024). The BOM Data Hub extract is provided in **Appendix A.**

For the purposes of this assessment, design rainfalls were applied directly to the flood model (rain-on-grid hydrology), consistent with the previous assessment for the project approvals. Design rainfall was applied to the flood model in accordance with the ARR2019 methods and procedures.

Since the technical assessments within this working paper were undertaken before the issue of ARR2019 Version 4.2, the global climate adjustments issued on the 27th August 2024 have not been adopted as part of this report

3.3.2 Initial and continuing loss

In accordance with jurisdiction specific requirements for NSW, pervious area losses for the rain-on-grid model were applied as follows:

- Initial losses were configured using Probability Neutral Initial Loss values (varying with storm duration and AEP) in accordance with the ARR DataHub.
- Continuing Loss (CL) for the model was set to the ARR DataHub Continuing Loss rate, with a factor of 0.4 applied.

Loss rates were configured directly into the flood model based to pervious areas, identified through review of aerial imagery for the Project Site.

3.4 Flood model updates

3.4.1 Additional topographic information

3.4.1.1 Detailed survey

Detailed survey received for the Pitt Town Bypass Project corridor was inserted into the model to better reflect existing conditions.

3.4.1.2 Design geometry

As part of the model update, for the proposed conditions, the Arcadis 80% IFT design (assessed for the project REF) was removed from the model and replaced with the updated SJV design geometry.

The revised design geometry of the Pitt Town Bypass includes the following elements:

- Earthworks formation.
- Culvert tail-in/tail out earthworks.
- Drainage channels.
- Sediment basins.
- Bridge abutments.
- Access tracks.

3.4.2 Additional drainage information

3.4.2.1 Hawkesbury Nepean Valley Flood Evacuation Road Resilience Program (2024)

Drainage information received from the Hawkesbury Nepean Valley Flood Evacuation Road Resilience Program (2024) was reviewed for the Pitt Town area. The flood models prepared as part of the Road Resilience Program for the Pitt Town area were found to include a substantially complete drainage network for the Pitt Town Area which was not present in the adopted flood model. These additional culvert details have been configured into the flood model to further improve the model representation of drainage pathways in the urbanised area upstream of the Pitt Town Bypass.

3.4.2.2 Design drainage

Similar to Section 0 above, the Arcadis 80% IFT design drainage was removed from the flood model and replaced with the revised drainage design. Generally, trunk drainage sizes have not been altered from the Arcadis 80% IFT design, however some drainage elements have been re-aligned to suit the revised geometry. Culvert sizes adopted are as per Section 1.1.

3.4.3 Tuflow model rationalisation

The flood model prepared for the project approvals utilised a 2-stage modelling approach, with rainfall applied to the flood model to simulate the whole-of-catchment using a coarser (4m resolution). Flows were then extracted and applied to a higher resolution (2m) flood model to assess flooding conditions at the Project Site.

The ARR2019 guidelines require a more robust assessment of how storms can influence flooding behaviour within the catchment, often requiring hundreds of simulations of the flood model to quantify flood behaviour. The 2-stage modelling approach was therefore considered to be too inefficient for the purpose of analysing flooding conditions using the ARR2019 guidelines.

The flood model was therefore rationalised to leverage recent advancements in modelling software (TUFLOW), improving model accuracy and simulation times. As part of this model rationalisation, the following changes were made to the model configuration:

- The flood model was updated to TUFLOW version 2023-03-AC.
- The TUFLOW model was consolidated to merge the 2m and 4m domains into a single model using the TUFLOW Quadtree Functionality, negating the need for a 2-stage modelling approach.
- The flood model was updated to utilise the GPU Solver, offering significant improvements in model simulation time.
- ARR2019 design rainfalls were applied as “rain-on-grid” time varying rainfall depths, in accordance with the ARR2019 methods and procedures.

3.5 Design blockage factors

3.5.1 Adopted approach

3.5.1.1 Adopted blockage factors

For the purpose of assessing the detailed design of the Pitt Town Bypass, the following blockage approach was adopted:

- For circular pipes or Box Culverts with a vertical opening height of 600mm or less, a blockage factor of 50% was applied.
- For all other pipes and culverts, a blockage factor of 0% was applied.

This approach is consistent with the approach in the adopted model used for the hydraulic assessment and project REF for the Pitt Town Bypass and was adopted on this basis.

3.5.2 Blockage sensitivity assessment

3.5.2.1 ARR 2019 blockage assessment methodology

The Australian Rainfall and Runoff Guidelines (ARR2019) provide guidance on the assessment of blockage in drainage systems to assist in drainage analysis and design for both urban and rural catchments. In accordance with the Guidelines, a site-specific blockage assessment for each culvert has been prepared to determine design blockage factors for the Pitt Town Bypass project.

3.5.2.2 Adopted sensitivity blockage factors

In consideration of the applicable design blockage factors, both blockage risk due to debris and blockage risk due to sediment have been assessed. The outcomes of the blockage assessment are summarised in Table 23 in **Appendix B**.

With reference to the table, the governing design blockage criteria tends to vary, with the Transport criteria generally governing the applied blockage factors for the smaller structures and debris blockage factors governing the majority of other structures.

A design blockage factor of up to 25% would be applied to the majority of culverts in the 1% AEP flood event. It is expected that the flood impacts associated with the design blockage assessment would be more severe than those described in the REF, particularly in areas upstream of major waterway crossings. The results of the blockage sensitivity analysis are summarised in Section 0 and discussed in Section 5.2.5 of this paper.

3.6 Post-processing of model results

Due to the use of a rain on grid hydraulic model and ARR 2019 methods and procedures, flood model results were processed in the following manner:

- The flood model was simulated for ensemble temporal patterns, for storm durations up to 720 minutes for the 20%, 10%, 5%, 2%, 1%, 0.05% AEP events and the 1% AEP event with climate change for existing and proposed conditions
- Flood model raster grid outputs were processed to compute median outputs from the ensemble temporal patterns for each storm duration and AEP for existing and proposed conditions
- A maximum envelope was computed using the processed median outputs from all storm durations for each AEP for existing and proposed conditions
- A 50mm cut-off depth was then applied to filter out very shallow “sheet flow” depths over the model area in order to identify the flood extents for the study area

This process produces a “maximum of medians” flood surface, representative of probability neutral flooding conditions associated with a particular design flood event (AEP).

4 RESULTS

4.1 Key locations

For the purposes of this assessment, flood data in the following sections of this technical working paper is summarised at key locations as shows below in Figure 5. Table 4 below provides a description of the identified key locations.

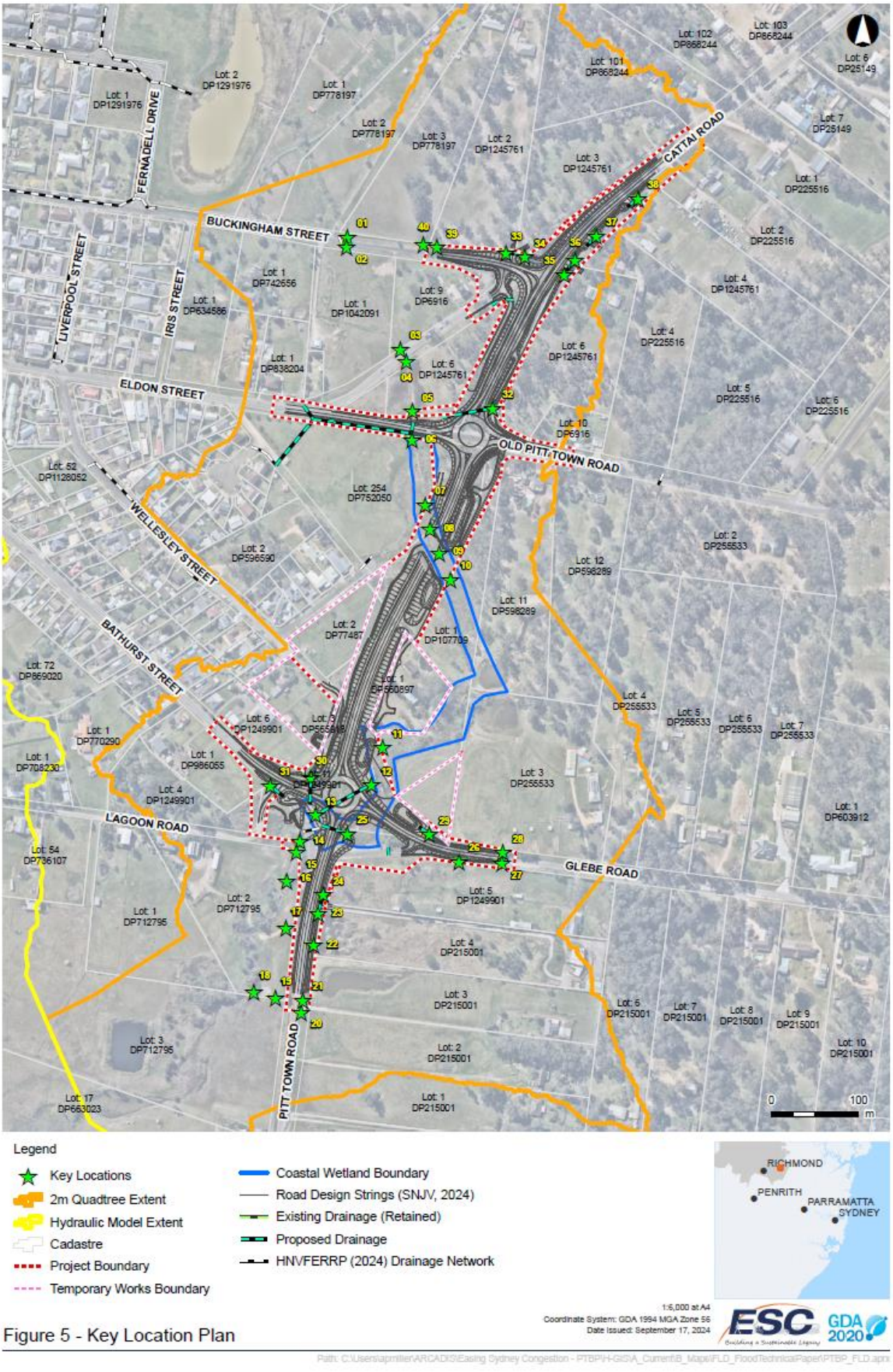

Figure 5 - Key Location Plan

Figure 5 Key Location Plan

Table 4: Key location summary

Key location	Location description	Key location	Location description
1	Hortons Creek upstream of Buckingham Street	**21**	Pitt Town Road, upstream of existing property access
2	Hortons Creek downstream of Buckingham Street	**22**	Pitt Town Road – West of Road Sag Location
3	Hortons Creek upstream of Cattai Road	**23**	Downstream of Culvert PA1
4	Hortons Creek downstream of Cattai Road	**24**	Upstream of Culvert PA1
5	Hortons Creek upstream of Eldon Street	**25**	SE Corner of southern intersection – Upstream of Culvert PTB2
6	Hortons Creek downstream of Eldon Street	**26**	Glebe Road – south of PTB Works
7	Hortons Creek at Project boundary upstream of BR01	**27**	Glebe Road – south of PTB Works @ limit of works
8	Upstream of BR01	**28**	Glebe Road – north of PTB Works @ limit of works
9	Upstream of BR01	**29**	Glebe Road - Upstream of Culvert Glebe4
10	Hortons Creek at Project boundary downstream of BR01	**30**	Bathurst Street - Upstream of Culvert Bathurst1
11	Hortons Creek at Project Boundary – Upstream of Cross Drainage under southern intersection (PTB3)	**31**	Lagoon Road - Upstream of Culvert Lagoon1
12	Hortons Creek upstream of Cross Drainage under southern intersection (PTB3)	**32**	Old Pitt Town Road – Upstream of Culvert PTB6
13	Hortons Creek downstream of Cross Drainage under southern intersection (PTB3)	**33**	Buckingham Street – Downstream of Culvert Buck1
14	Hortons Creek at Project Boundary – Downstream of Cross Drainage under southern intersection (PTB3)	**34**	Buckingham Street – Upstream of Culvert Buck1
15	Hortons Creek at Project Boundary – Downstream of Cross Drainage under southern intersection (PTB3)	**35**	Buckingham Street – Downstream of Culvert PA2
16	Hortons Creek – Downstream of Bypass #1	**36**	Buckingham Street – Upstream of Culvert PA2
17	Hortons Creek – Downstream of Bypass #2	**37**	Buckingham Street – Upstream of Culvert PA3
18	Hortons Creek – Downstream of Bypass #3	**38**	Buckingham Street – Upstream of Culvert PA4
19	Hortons Creek – Downstream of Bypass #4	**39**	Buckingham Street – Limit of works
20	Pitt Town Road, Downstream of existing property access	**40**	Buckingham Street – Limit of works

4.2 Existing flooding conditions

4.2.1 Peak flood levels

Peak flood levels under existing conditions are summarised at the key locations in Table 5 below. Flood mapping, showing peak flood levels and depths is presented in Appendix C**.**

Table 5: Existing flooding conditions - Peak flood levels at key locations

Location ID	Design flood levels (mAHD)						Location ID	Design flood levels (mAHD)					
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP		20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP
1	11.548	11.569	11.582	11.601	11.612	11.630	**21**	7.117	7.129	7.140	7.148	7.153	7.162
2	11.341	11.371	11.391	11.411	11.426	11.451	**22**	6.981	6.989	6.996	7.009	7.017	7.032
3	10.762	10.893	11.023	11.180	11.233	11.285	**23**	6.984	6.995	7.004	7.019	7.029	7.044
4	10.603	10.643	10.673	10.701	10.714	10.731	**24**	7.201	7.209	7.216	7.225	7.233	7.255
5	10.437	10.466	10.489	10.516	10.535	10.570	**25**	7.233	7.347	7.441	7.594	7.665	7.759
6	10.151	10.172	10.190	10.219	10.247	10.283	**26**	10.386	10.406	10.420	10.440	10.453	10.473
7	9.606	9.646	9.680	9.729	9.779	9.835	**27**	11.329	11.342	11.354	11.367	11.376	11.386
8	9.391	9.430	9.466	9.516	9.572	9.637	**28**	11.175	11.208	11.234	11.264	11.290	11.333
9	9.357	9.392	9.425	9.474	9.523	9.588	**29**						
10	9.297	9.331	9.364	9.418	9.467	9.536	**30**						
11	7.421	7.508	7.607	7.776	7.862	7.985	**31**						8.512
12	7.230	7.340	7.432	7.585	7.654	7.742	**32**						
13	7.228	7.343	7.436	7.590	7.660	7.752	**33**						
14	6.586	6.659	6.733	6.861	6.930	7.028	**34**			12.632	12.640	12.645	12.653
15	6.578	6.658	6.731	6.853	6.918	7.008	**35**						
16	6.556	6.623	6.686	6.799	6.861	6.943	**36**	13.775	13.784	13.791	13.801	13.808	13.817
17	6.405	6.457	6.502	6.578	6.620	6.680	**37**						
18	5.949	6.014	6.065	6.155	6.207	6.285	**38**						
19	6.131	6.151	6.173	6.231	6.270	6.332	**39**	11.663	11.680	11.694	11.709	11.719	11.734
20	7.436	7.453	7.465	7.476	7.484	7.494	**40**	11.555	11.572	11.587	11.604	11.615	11.631

Note: Blank cells in this table are indicative of locations with no flooding

4.2.2 Peak velocities

With reference to the flood mapping presented in Appendix C. Peak velocities vary throughout the study area, with peak velocities of up to 0.75 – 1.00 m/s predicted along local tributaries of Hortons Creek, and velocities of up to 2.0 m/s along Hortons Creek.

4.3 Proposed flooding conditions

4.3.1 Peak flood levels

Peak flood levels under proposed conditions are summarised at the key locations in Table 6 below. Flood mapping, showing peak flood levels and depths is presented in Appendix D**.**

With reference to the table below, and mapping in Appendix D**,** the modelling shows that peak flood levels are generally consistent with existing conditions, and that edge of lane flood immunity is achieved along the main alignment between the Bathurst Street/Glebe Road Intersections through to the northern limit of works for the Pitt Town Bypass Project.

At other locations, such as the southern limit of works, Eldon Street, Glebe Road and Buckingham Street, existing flooding and road immunity issues result in inundation of the local roads, affecting vehicular access to the Pitt Town Bypass.

Table 6: Proposed flooding conditions - Peak flood levels at key locations

Location ID	Design flood levels (mAHD)						Location ID	Design flood levels (mAHD)					
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP		20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP
1	11.548	11.568	11.582	11.601	11.613	11.650	**21**	7.105	7.125	7.139	7.154	7.163	7.189
2	11.341	11.368	11.388	11.411	11.425	11.483	**22**	6.932	6.943	6.951	6.963	6.970	6.991
3	10.759	10.889	11.018	11.178	11.234	11.344	**23**	6.932	6.943	6.950	6.961	6.968	6.989
4	10.599	10.640	10.671	10.702	10.719	10.815	**24**	7.016	7.064	7.090	7.124	7.142	7.254
5	10.312	10.378	10.440	10.535	10.598	10.757	**25**	6.765	6.877	6.966	7.124	7.199	7.423
6	10.138	10.168	10.199	10.226	10.245	10.296	**26**	10.372	10.398	10.414	10.438	10.453	10.498
7	9.614	9.658	9.702	9.771	9.837	10.036	**27**	11.329	11.347	11.357	11.371	11.381	11.401
8	9.422	9.466	9.507	9.564	9.621	9.816	**28**	11.174	11.214	11.247	11.286	11.323	11.407
9	9.362	9.396	9.427	9.480	9.523	9.717	**29**	8.653	8.763	8.848	8.874	8.889	8.982
10	9.297	9.330	9.359	9.417	9.463	9.669	**30**	7.028	7.118	7.192	7.265	7.343	7.726
11	7.406	7.463	7.520	7.649	7.758	8.352	**31**	8.393	8.523	8.559	8.587	8.609	8.661
12	6.844	6.995	7.134	7.396	7.552	8.221	**32**	10.662	10.707	10.768	10.828	10.867	11.044
13	6.772	6.894	6.998	7.183	7.279	7.620	**33**	12.430	12.436	12.444	12.453	12.458	12.476
14	6.602	6.676	6.741	6.866	6.947	7.306	**34**	12.218	12.249	12.296	12.352	12.378	12.457
15	6.592	6.666	6.727	6.839	6.909	7.204	**35**	13.238	13.252	13.260	13.269	13.277	13.291
16	6.574	6.643	6.701	6.808	6.868	7.098	**36**	13.279	13.362	13.419	13.479	13.570	13.705
17	6.394	6.451	6.496	6.572	6.614	6.781	**37**	13.682	13.722	13.740	13.764	13.795	13.970
18	5.947	6.014	6.065	6.154	6.206	6.416	**38**	14.348	14.361	14.364	14.369	14.374	14.395
19	6.133	6.152	6.175	6.233	6.272	6.452	**39**	11.653	11.674	11.690	11.713	11.726	11.764
20	7.456	7.473	7.484	7.495	7.503	7.527	**40**	11.555	11.572	11.586	11.604	11.615	11.650

4.3.2 Peak velocities

With reference to the flood mapping presented in Appendix D. Peak velocities under post-upgrade conditions are similar pre-upgrade conditions, with some notable increases in velocity at the entrance and exit of proposed cross drainage infrastructure.

4.3.3 Change in flood level

Flood impact mapping, comparing flood levels under post upgrade conditions to pre-upgrade conditions is presented in Appendix D. A comparison of the flood levels and afflux at key locations is summarised below in Table 7.

With reference to the table below:

- In the 20% AEP event, a maximum afflux of up to 30 mm is predicted to occur.
- In the 10% AEP event, a maximum afflux of up to 36 mm is predicted to occur.
- In the 5% AEP event, a maximum afflux of up to 41 mm is predicted to occur.
- In the 2% AEP event, a maximum afflux of up to 48 mm is predicted to occur.
- In the 1% AEP event, a maximum afflux of up to 63 mm is predicted to occur.

Flood afflux acceptability is discussed further in Section 5 of this technical working paper.

Table 7: Flood afflux (change in flood level) at key locations

Location ID	Pre-upgrade conditions - Flood levels (mAHD)						Post-upgrade conditions - Flood levels (mAHD)						Flood Afflux (mm)					
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.05% AEP
1	11.548	11.569	11.582	11.601	11.612	11.630	11.548	11.568	11.582	11.601	11.613	11.650	Nil	-1	Nil	Nil	Nil	+1
2	11.341	11.371	11.391	11.411	11.426	11.451	11.341	11.368	11.388	11.411	11.425	11.483	Nil	-2	-2	-1	-1	+1
3	10.762	10.893	11.023	11.180	11.233	11.285	10.759	10.889	11.018	11.178	11.234	11.344	-4	-4	-5	-2	+1	+2
4	10.603	10.643	10.673	10.701	10.714	10.731	10.599	10.640	10.671	10.702	10.719	10.815	-4	-3	-2	+1	+5	+41
5	10.437	10.466	10.489	10.516	10.535	10.570	10.312	10.378	10.440	10.535	10.598	10.757	-125	-88	-48	+19	+63	+132
6	10.151	10.172	10.190	10.219	10.247	10.283	10.138	10.168	10.199	10.226	10.245	10.296	-13	-4	+8	+8	-2	-47
7	9.606	9.646	9.680	9.729	9.779	9.835	9.614	9.658	9.702	9.771	9.837	10.036	+8	+12	+22	+43	+58	+112
8	9.391	9.430	9.466	9.516	9.572	9.637	9.422	9.466	9.507	9.564	9.621	9.816	+30	+36	+41	+48	+49	+53
9	9.357	9.392	9.425	9.474	9.523	9.588	9.362	9.396	9.427	9.480	9.523	9.717	+5	+4	+2	+6	Nil	-1
10	9.297	9.331	9.364	9.418	9.467	9.536	9.297	9.330	9.359	9.417	9.463	9.669	Nil	-1	-5	-1	-4	-3
11	7.421	7.508	7.607	7.776	7.862	7.985	7.406	7.463	7.520	7.649	7.758	8.352	-15	-46	-87	-127	-103	+158
12	7.230	7.340	7.432	7.585	7.654	7.742	6.844	6.995	7.134	7.396	7.552	8.221	-385	-345	-298	-189	-102	+340
13	7.228	7.343	7.436	7.590	7.660	7.752	6.772	6.894	6.998	7.183	7.279	7.620	-455	-449	-438	-407	-381	-285
14	6.586	6.659	6.733	6.861	6.930	7.028	6.602	6.676	6.741	6.866	6.947	7.306	+17	+17	+8	+5	+18	+80
15	6.578	6.658	6.731	6.853	6.918	7.008	6.592	6.666	6.727	6.839	6.909	7.204	+14	+8	-4	-14	-9	+20
16	6.556	6.623	6.686	6.799	6.861	6.943	6.574	6.643	6.701	6.808	6.868	7.098	+18	+20	+15	+9	+7	-3
17	6.405	6.457	6.502	6.578	6.620	6.680	6.394	6.451	6.496	6.572	6.614	6.781	-11	-5	-6	-6	-6	-10
18	5.949	6.014	6.065	6.155	6.207	6.285	5.947	6.014	6.065	6.154	6.206	6.416	-1	Nil	Nil	-2	-1	-9
19	6.131	6.151	6.173	6.231	6.270	6.332	6.133	6.152	6.175	6.233	6.272	6.452	+2	+1	+2	+2	+3	-4
20	7.436	7.453	7.465	7.476	7.484	7.494	7.456	7.473	7.484	7.495	7.503	7.527	+20	+19	+19	+19	+19	+20
21	7.117	7.129	7.140	7.148	7.153	7.162	7.105	7.125	7.139	7.154	7.163	7.189	-12	-4	Nil	+6	+10	+15
22	6.981	6.989	6.996	7.009	7.017	7.032	6.932	6.943	6.951	6.963	6.970	6.991	-49	-46	-45	-46	-47	-64
23	6.984	6.995	7.004	7.019	7.029	7.044	6.932	6.943	6.950	6.961	6.968	6.989	-52	-52	-54	-58	-60	-84
24	7.201	7.209	7.216	7.225	7.233	7.255	7.016	7.064	7.090	7.124	7.142	7.254	-185	-145	-126	-101	-91	-60
25	7.233	7.347	7.441	7.594	7.665	7.759	6.765	6.877	6.966	7.124	7.199	7.423	-468	-470	-476	-470	-467	-495
26	10.386	10.406	10.420	10.440	10.453	10.473	10.372	10.398	10.414	10.438	10.453	10.498	-14	-8	-5	-1	+1	+4
27	11.329	11.342	11.354	11.367	11.376	11.386	11.329	11.347	11.357	11.371	11.381	11.401	+1	+5	+3	+4	+4	+6
28	11.175	11.208	11.234	11.264	11.290	11.333	11.174	11.214	11.247	11.286	11.323	11.407	-2	+6	+13	+23	+33	+33
29	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	8.653	8.763	8.848	8.874	8.889	8.982	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
30	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	7.028	7.118	7.192	7.265	7.343	7.726	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
31	Note 3	Note 3	Note 3	Note 3	Note 3	8.512	8.393	8.523	8.559	8.587	8.609	8.661	*Note1	*Note1	*Note1	*Note1	*Note1	+119
32	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	10.662	10.707	10.768	10.828	10.867	11.044	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
33	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	12.430	12.436	12.444	12.453	12.458	12.476	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
34	Note 3	Note 3	12.632	12.640	12.645	12.653	12.218	12.249	12.296	12.352	12.378	12.457	*Note1	*Note1	-335	-287	-267	-206
35	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	13.238	13.252	13.260	13.269	13.277	13.291	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
36	13.775	13.784	13.791	13.801	13.808	13.817	13.279	13.362	13.419	13.479	13.570	13.705	-495	-422	-372	-322	-238	-121
37	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	13.682	13.722	13.740	13.764	13.795	13.970	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
38	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	14.348	14.361	14.364	14.369	14.374	14.395	*Note1	*Note1	*Note1	*Note1	*Note1	*Note1
39	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	11.653	11.674	11.690	11.713	11.726	11.764	-10	-7	-4	+4	+7	+15
40	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	11.555	11.572	11.586	11.604	11.615	11.650	Nil	-1	Nil	Nil	+1	+2

*Note 1: Was Dry, Now Wet | **Note 2: Was Wet, Now Dry | ***Note3: Not Flooded

4.3.4 Change in velocity

Flood impact mapping, comparing flood levels under post-upgrade conditions to pre-upgrade conditions is presented in Appendix D**.**

With reference to the mapping, Peak velocities under proposed conditions are similar existing conditions, with some notable increases in velocity at the entrance and exist of post-upgrade cross drainage infrastructure. In all other areas, velocities are typically within +/- 0.1 m/s of pre-upgrade velocities.

4.4 Blockage sensitivity assessment

The following sections present the findings of the assessment of flooding conditions pre and post upgrade when the blockage sensitivity parameters are adopted as described in Section 0 of this technical working paper.

4.4.1 Peak flood levels

Peak flood levels under adopted blockage sensitivity conditions are summarised at the key locations in **Error! Not a valid bookmark self-reference.**. Flood mapping, showing peak flood levels and depths is presented in **Appendix E.**

Table 8: Post-upgrade flooding conditions (blockage sensitivity) - peak flood levels at key locations

Location ID	Design flood levels (mAHD)					Location ID	Design flood levels (mAHD)				
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP		20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
1	11.548	11.568	11.582	11.601	11.613	**21**	7.105	7.125	7.139	7.154	7.163
2	11.340	11.368	11.388	11.410	11.425	**22**	6.932	6.943	6.951	6.963	6.970
3	10.759	10.889	11.018	11.178	11.234	**23**	6.932	6.943	6.950	6.962	6.969
4	10.599	10.641	10.671	10.702	10.719	**24**	7.016	7.064	7.095	7.127	7.144
5	10.312	10.378	10.440	10.535	10.597	**25**	6.770	6.886	6.989	7.114	7.173
6	10.138	10.168	10.198	10.226	10.245	**26**	10.373	10.398	10.414	10.438	10.453
7	9.614	9.658	9.702	9.771	9.837	**27**	11.329	11.347	11.357	11.371	11.381
8	9.422	9.465	9.507	9.564	9.621	**28**	11.174	11.214	11.247	11.286	11.323
9	9.362	9.396	9.427	9.480	9.523	**29**	8.653	8.763	8.848	8.874	8.889
10	9.297	9.330	9.359	9.417	9.463	**30**	7.051	7.154	7.240	7.337	7.427
11	7.406	7.463	7.520	7.672	7.808	**31**	8.393	8.523	8.559	8.587	8.609
12	6.857	7.011	7.190	7.480	7.659	**32**	10.675	10.723	10.788	10.856	10.909
13	6.772	6.894	6.996	7.183	7.281	**33**	12.430	12.436	12.444	12.453	12.458
14	6.602	6.676	6.739	6.865	6.947	**34**	12.233	12.276	12.321	12.383	12.415
15	6.592	6.666	6.726	6.838	6.908	**35**	13.238	13.252	13.260	13.267	13.277
16	6.574	6.643	6.700	6.808	6.868	**36**	13.279	13.362	13.419	13.479	13.570
17	6.394	6.451	6.496	6.572	6.613	**37**	13.682	13.722	13.740	13.764	13.795
18	5.947	6.014	6.066	6.153	6.205	**38**	14.348	14.361	14.364	14.369	14.374
19	6.133	6.152	6.175	6.233	6.271	**39**	11.653	11.674	11.690	11.713	11.726
20	7.456	7.473	7.484	7.495	7.503	**40**	11.555	11.572	11.586	11.604	11.615

4.4.2 Peak velocities

With reference to the flood mapping presented in Appendix E**,** Peak velocities under post-upgrade flooding conditions were found to be similar when comparing results with using the design blockage factors and blockage sensitivity factors.

4.4.3 Flood impacts

The following sections present a comparison of flooding conditions pre-upgrade and post-upgrade, using the adopted blockage sensitivity factors described in Section 0 of this technical working paper.

4.4.3.1 Change in flood level

Flood impact mapping, comparing flood levels under post upgrade conditions with adopted sensitivity blockage factors to pre upgrade conditions is presented in Appendix E. A comparison of the flood levels and afflux at key locations is summarised below in Table 9.

With reference to the table below:

- In the 20% AEP event, a maximum afflux of up to 30 mm is predicted to occur.
- In the 10% AEP event, a maximum afflux of up to 36 mm is predicted to occur.
- In the 5% AEP event, a maximum afflux of up to 41 mm is predicted to occur.
- In the 2% AEP event, a maximum afflux of up to 48 mm is predicted to occur.
- In the 1% AEP event, a maximum afflux of up to 62 mm is predicted to occur.

Table 9: Blockage sensitivity - Flood afflux (change in flood level) at key locations

Location ID	Pre-upgrade Conditions - Flood levels (mAHD)					Post-upgrade conditions - Flood levels (mAHD)					Flood Afflux (mm)				
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
1	11.548	11.569	11.582	11.601	11.612	11.548	11.568	11.582	11.601	11.613	Nil	-1	Nil	Nil	Nil
2	11.341	11.371	11.391	11.411	11.426	11.340	11.368	11.388	11.410	11.425	-1	-2	-3	-1	-1
3	10.762	10.893	11.023	11.180	11.233	10.759	10.889	11.018	11.178	11.234	-4	-4	-5	-2	+1
4	10.603	10.643	10.673	10.701	10.714	10.599	10.641	10.671	10.702	10.719	-4	-3	-2	+1	+5
5	10.437	10.466	10.489	10.516	10.535	10.312	10.378	10.440	10.535	10.597	-125	-88	-48	+19	+62
6	10.151	10.172	10.190	10.219	10.247	10.138	10.168	10.198	10.226	10.245	-13	-4	+8	+7	-2
7	9.606	9.646	9.680	9.729	9.779	9.614	9.658	9.702	9.771	9.837	+8	+11	+22	+43	+58
8	9.391	9.430	9.466	9.516	9.572	9.422	9.465	9.507	9.564	9.621	+30	+36	+41	+48	+49
9	9.357	9.392	9.425	9.474	9.523	9.362	9.396	9.427	9.480	9.523	+5	+4	+2	+6	Nil
10	9.297	9.331	9.364	9.418	9.467	9.297	9.330	9.359	9.417	9.463	Nil	-1	-5	-1	-4
11	7.421	7.508	7.607	7.776	7.862	7.406	7.463	7.520	7.672	7.808	-15	-46	-87	-104	-53
12	7.230	7.340	7.432	7.585	7.654	6.857	7.011	7.190	7.480	7.659	-373	-329	-242	-104	+5
13	7.228	7.343	7.436	7.590	7.660	6.772	6.894	6.996	7.183	7.281	-456	-448	-441	-407	-379
14	6.586	6.659	6.733	6.861	6.930	6.602	6.676	6.739	6.865	6.947	+17	+17	+7	+5	+17
15	6.578	6.658	6.731	6.853	6.918	6.592	6.666	6.726	6.838	6.908	+14	+8	-5	-15	-10
16	6.556	6.623	6.686	6.799	6.861	6.574	6.643	6.700	6.808	6.868	+18	+19	+14	+9	+7
17	6.405	6.457	6.502	6.578	6.620	6.394	6.451	6.496	6.572	6.613	-11	-5	-6	-7	-6
18	5.949	6.014	6.065	6.155	6.207	5.947	6.014	6.066	6.153	6.205	-1	Nil	Nil	-2	-2
19	6.131	6.151	6.173	6.231	6.270	6.133	6.152	6.175	6.233	6.271	+2	+1	+2	+1	+2
20	7.436	7.453	7.465	7.476	7.484	7.456	7.473	7.484	7.495	7.503	+20	+19	+19	+19	+19
21	7.117	7.129	7.140	7.148	7.153	7.105	7.125	7.139	7.154	7.163	-12	-4	Nil	+6	+10
22	6.981	6.989	6.996	7.009	7.017	6.932	6.943	6.951	6.963	6.970	-49	-46	-45	-46	-47
23	6.984	6.995	7.004	7.019	7.029	6.932	6.943	6.950	6.962	6.969	-52	-52	-54	-57	-60
24	7.201	7.209	7.216	7.225	7.233	7.016	7.064	7.095	7.127	7.144	-185	-146	-121	-98	-89
25	7.233	7.347	7.441	7.594	7.665	6.770	6.886	6.989	7.114	7.173	-463	-461	-452	-480	-492
26	10.386	10.406	10.420	10.440	10.453	10.373	10.398	10.414	10.438	10.453	-13	-8	-5	-1	+0
27	11.329	11.342	11.354	11.367	11.376	11.329	11.347	11.357	11.371	11.381	+1	+5	+3	+4	+4
28	11.175	11.208	11.234	11.264	11.290	11.174	11.214	11.247	11.286	11.323	-2	+6	+13	+23	+33
29	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	8.653	8.763	8.848	8.874	8.889	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
30	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	7.051	7.154	7.240	7.337	7.427	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
31	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	8.393	8.523	8.559	8.587	8.609	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
32	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	10.675	10.723	10.788	10.856	10.909	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
33	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	12.430	12.436	12.444	12.453	12.458	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
34	*Note 3*	*Note 3*	12.632	12.640	12.645	12.233	12.276	12.321	12.383	12.415	*Note 1*	*Note 1*	-311	-257	-230
35	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	13.238	13.252	13.260	13.267	13.277	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
36	13.775	13.784	13.791	13.801	13.808	13.279	13.362	13.419	13.479	13.570	-496	-422	-372	-322	-238
37	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	13.682	13.722	13.740	13.764	13.795	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
38	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	14.348	14.361	14.364	14.369	14.374	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
39	11.663	11.680	11.694	11.709	11.719	11.653	11.674	11.690	11.713	11.726	-10	-7	-4	+4	+7
40	11.555	11.572	11.587	11.604	11.615	11.555	11.572	11.586	11.604	11.615	Nil	-1	Nil	Nil	+1

**Note 1: Was Dry, Now Wet | **Note 2: Was Wet, Now Dry | ***Note3: Not Flooded*

4.4.3.2 Change in velocity

Flood impact mapping, comparing flood levels under proposed conditions with adopted sensitivity blockage factors to pre upgrade conditions is presented in Appendix E**.**

With reference to the mapping, Peak velocities under proposed conditions are similar pre upgrade conditions, with some notable increases in velocity at the entrance and exit of post upgrade cross drainage infrastructure. In all other areas, velocities are typically within +/- 0.1 m/s of existing velocities.

4.4.4 Blockage sensitivity - relative impacts on design

The following sections present an assessment of the relative impacts on post-upgrade flood behaviour when comparing flooding conditions with design blockage factors to flooding conditions using adopted sensitivity blockage factors described in Section 0 of this technical working paper.

4.4.4.1 Change in flood level

Flood impact mapping, comparing flood levels under post upgrade conditions with adopted sensitivity blockage factors to pre upgrade conditions with design blockage factors is presented in Appendix E

A comparison of the flood levels and afflux at key locations is summarised below in Table 10.

With reference to the table below:

- The adopted ARR2019 blockage factors were found to have relatively minimal effects on mainstream flood levels along Hortons Creek.
- A localised impact was noted upstream of the main culvert (PTB3) under the southern intersection at key location 11 and Key Location 12. At this location, the ARR2019 blockages result in an increase of up to 50mm in flood afflux at the project boundary. This additional afflux covers a small area upstream of the project boundary and would not have any detrimental impact to flood levels on adjacent properties.

Table 10: Blockage sensitivity assessment – Relative change in flood afflux at key locations due to adoption of blockage sensitivity factors

Location ID	Post-upgrade conditions - Design blockage (mAHD)					Pre-upgrade conditions – Sensitivity blockage (mAHD)					Sensitivity Blockage – Relative impact on Design Flood Levels (mm)				
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
1	11.548	11.568	11.582	11.601	11.613	11.548	11.568	11.582	11.601	11.613	Nil	Nil	Nil	Nil	Nil
2	11.341	11.368	11.388	11.411	11.425	11.340	11.368	11.388	11.410	11.425	-2	Nil	Nil	Nil	Nil
3	10.759	10.889	11.018	11.178	11.234	10.759	10.889	11.018	11.178	11.234	Nil	Nil	Nil	Nil	Nil
4	10.599	10.640	10.671	10.702	10.719	10.599	10.641	10.671	10.702	10.719	Nil	Nil	Nil	Nil	Nil
5	10.312	10.378	10.440	10.535	10.598	10.312	10.378	10.440	10.535	10.597	Nil	Nil	Nil	Nil	-1
6	10.138	10.168	10.199	10.226	10.245	10.138	10.168	10.198	10.226	10.245	Nil	Nil	Nil	Nil	Nil
7	9.614	9.658	9.702	9.771	9.837	9.614	9.658	9.702	9.771	9.837	Nil	Nil	Nil	Nil	Nil
8	9.422	9.466	9.507	9.564	9.621	9.422	9.465	9.507	9.564	9.621	Nil	Nil	Nil	Nil	Nil
9	9.362	9.396	9.427	9.480	9.523	9.362	9.396	9.427	9.480	9.523	Nil	Nil	Nil	Nil	Nil
10	9.297	9.330	9.359	9.417	9.463	9.297	9.330	9.359	9.417	9.463	Nil	Nil	Nil	Nil	Nil
11	7.406	7.463	7.520	7.649	7.758	7.406	7.463	7.520	7.672	7.808	Nil	Nil	Nil	+23	+50
12	6.844	6.995	7.134	7.396	7.552	6.857	7.011	7.190	7.480	7.659	+12	+16	+56	+85	+107
13	6.772	6.894	6.998	7.183	7.279	6.772	6.894	6.996	7.183	7.281	Nil	+1	-2	Nil	+2
14	6.602	6.676	6.741	6.866	6.947	6.602	6.676	6.739	6.865	6.947	Nil	Nil	-1	-1	-1
15	6.592	6.666	6.727	6.839	6.909	6.592	6.666	6.726	6.838	6.908	Nil	Nil	-1	-1	-1
16	6.574	6.643	6.701	6.808	6.868	6.574	6.643	6.700	6.808	6.868	Nil	Nil	-1	Nil	-1
17	6.394	6.451	6.496	6.572	6.614	6.394	6.451	6.496	6.572	6.613	Nil	Nil	Nil	Nil	-1
18	5.947	6.014	6.065	6.154	6.206	5.947	6.014	6.066	6.153	6.205	Nil	Nil	Nil	Nil	-1
19	6.133	6.152	6.175	6.233	6.272	6.133	6.152	6.175	6.233	6.271	Nil	Nil	Nil	Nil	-1
20	7.456	7.473	7.484	7.495	7.503	7.456	7.473	7.484	7.495	7.503	Nil	Nil	Nil	Nil	Nil
21	7.105	7.125	7.139	7.154	7.163	7.105	7.125	7.139	7.154	7.163	Nil	Nil	Nil	Nil	Nil
22	6.932	6.943	6.951	6.963	6.970	6.932	6.943	6.951	6.963	6.970	Nil	Nil	Nil	Nil	Nil
23	6.932	6.943	6.950	6.961	6.968	6.932	6.943	6.950	6.962	6.969	Nil	Nil	Nil	Nil	Nil
24	7.016	7.064	7.090	7.124	7.142	7.016	7.064	7.095	7.127	7.144	Nil	Nil	+5	+3	+2
25	6.765	6.877	6.966	7.124	7.199	6.770	6.886	6.989	7.114	7.173	+5	+9	+24	-10	-26
26	10.372	10.398	10.414	10.438	10.453	10.373	10.398	10.414	10.438	10.453	Nil	Nil	Nil	Nil	Nil
27	11.329	11.347	11.357	11.371	11.381	11.329	11.347	11.357	11.371	11.381	Nil	Nil	Nil	Nil	Nil
28	11.174	11.214	11.247	11.286	11.323	11.174	11.214	11.247	11.286	11.323	Nil	Nil	Nil	Nil	Nil
29	8.653	8.763	8.848	8.874	8.889	8.653	8.763	8.848	8.874	8.889	Nil	Nil	Nil	Nil	Nil
30	7.028	7.118	7.192	7.265	7.343	7.051	7.154	7.240	7.337	7.427	+23	+37	+48	+72	+84
31	8.393	8.523	8.559	8.587	8.609	8.393	8.523	8.559	8.587	8.609	Nil	Nil	Nil	Nil	Nil
32	10.662	10.707	10.768	10.828	10.867	10.675	10.723	10.788	10.856	10.909	+13	+16	+19	+28	+42
33	12.430	12.436	12.444	12.453	12.458	12.430	12.436	12.444	12.453	12.458	Nil	Nil	Nil	Nil	Nil
34	12.218	12.249	12.296	12.352	12.378	12.233	12.276	12.321	12.383	12.415	+14	+26	+25	+30	+37
35	13.238	13.252	13.260	13.269	13.277	13.238	13.252	13.260	13.267	13.277	Nil	Nil	Nil	-2	Nil
36	13.279	13.362	13.419	13.479	13.570	13.279	13.362	13.419	13.479	13.570	Nil	Nil	Nil	Nil	Nil
37	13.682	13.722	13.740	13.764	13.795	13.682	13.722	13.740	13.764	13.795	Nil	Nil	Nil	Nil	Nil
38	14.348	14.361	14.364	14.369	14.374	14.348	14.361	14.364	14.369	14.374	Nil	Nil	Nil	Nil	Nil
39	11.653	11.674	11.690	11.713	11.726	11.653	11.674	11.690	11.713	11.726	Nil	Nil	Nil	Nil	Nil
40	11.555	11.572	11.586	11.604	11.615	11.555	11.572	11.586	11.604	11.615	Nil	Nil	Nil	Nil	Nil

4.4.4.2 Change in velocity

Flood impact mapping, comparing flood levels under proposed conditions with adopted sensitivity blockage factors to proposed conditions with design blockage factors is presented in Appendix E**.**

With reference to the mapping, changes in velocity are negligible when comparing results using the two blockage approaches.

4.5 Climate change assessment

4.5.1 Adopted climate change factors

For the purposes of this assessment, a climate change impact assessment has been prepared using ARR2019 methods and procedures. Since the technical assessments within this working paper were undertaken before the issue of ARR2019 Version 4.2, the global climate adjustments issued on the 27th August 2024 have not been adopted as part of this report. The adopted parameters for the climate change impact assessment are summarised below in **Error! Not a valid bookmark self-reference.**.

Table 11: Adopted parameters for climate change assessment

Design Parameter	Value
Events Considered	1% AEP event
Design Planning Horizon	Year 2090
Shared Socioeconomic Pathway	SSP5 - 8.5
Changes in Tailwater due to Sea Level Rise	Not Considered
ARR2019 Rainfall Intensity Increase - Year 2090 (ARR Data Hub –Refer Appendix A)	19.7%

ARR Data Hub outputs only provide climate change factors for design planning horizons up to and including the year 2090. Year 2090 has therefore been adopted as the most appropriate design planning horizon for consideration of a project with expected design life of 100 years.

The 19.7% increase in rainfall intensity was applied to the 1% AEP design rainfall and the flood model re-simulated.

4.5.2 Peak flood levels and impacts on design flood levels

Peak flood levels under climate change conditions are summarised at the key locations in Table 12. Flood Mapping, showing peak flood levels and depths is presented in **Appendix F.**

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Table 12: Flood Impacts - 1% AEP event - Change in design flood level due to climate change

Key Location	Post upgrade Conditions without Climate Change (mAHD)	Post Upgrade Conditions with Climate change (mAHD)	Change in flood level due to climate change (mm)	Key Location	Post Upgrade Conditions without Climate Change (mAHD)	Post Upgrade Conditions with Climate change (mAHD)	Change in flood level due to climate change (mm)
1	11.631	11.650	+18	**21**	7.175	7.189	+12
2	11.451	11.483	+26	**22**	6.980	6.991	+10
3	11.285	11.344	+51	**23**	6.978	6.989	+10
4	10.746	10.815	+27	**24**	7.191	7.254	+49
5	10.657	10.757	+59	**25**	7.296	7.423	+97
6	10.264	10.296	+19	**26**	10.476	10.498	+23
7	9.909	10.036	+72	**27**	11.392	11.401	+11
8	9.691	9.816	+70	**28**	11.373	11.407	+51
9	9.590	9.717	+67	**29**	8.940	8.982	+51
10	9.533	9.669	+70	**30**	7.484	7.726	+141
11	7.940	8.352	+182	**31**	8.634	8.661	+26
12	7.765	8.221	+213	**32**	10.936	11.044	+69
13	7.408	7.620	+129	**33**	12.467	12.476	+9
14	7.067	7.306	+119	**34**	12.420	12.457	+42
15	7.005	7.204	+96	**35**	13.285	13.291	+9
16	6.949	7.098	+80	**36**	13.650	13.705	+81
17	6.674	6.781	+61	**37**	13.869	13.970	+75
18	6.284	6.416	+78	**38**	14.380	14.395	+5
19	6.335	6.452	+62	**39**	11.745	11.764	+19
20	7.513	7.527	+11	**40**	11.632	11.650	+17

4.5.3 Peak velocities

With reference to the flood mapping presented in **Appendix F**, changes in velocity associate with climate change for the 1% AEP event are in the order of 0.10 – 0.30 m/s along Hortons Creek.

4.6 Bridge design input

To inform design of bridge structure, scour depths have been computed for each of the proposed bridge structures for the Pitt Town Bypass project. The following structures have been assessed:

- BR01 – Bridge over Hortons Creek

4.6.1 Design criteria

Serviceability Limit State

The Serviceability Limit State (SLS) event has been identified as the 1% AEP event for the Pitt Town Bypass project in accordance with the Australian Standard for Bridge Design (AS5100).

Ultimate limit State

The Ultimate Limit State (ULS) event has been identified as the 0.05% AEP event for the Pitt Town Bypass in accordance with AS5100.

4.6.2 Methodology

Scour depths have been calculated in accordance with the Austroads – Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures (2018), applying the assumption that soils are non-cohesive.

Contraction scour was estimated using the equations developed by Laursen (1960, 1963), for which live bed and clear water formulations have been developed.

Abutment scour was calculated using the National Cooperative Highway Research Program (NCHRP) Project 24-20 *Prediction of Scour at Bridge Abutments* (NCHRP 24-20) formulation which is described in Hydraulic Engineering Circular No. 18 *Evaluating Scour at Bridges* (HEC-18). This procedure calculates combined abutment and contraction scour depths based on a contraction amplification factor determined at each abutment from the hydraulic conditions.

Pier scour has not been assessed on the basis that no piers are located within the watercourse and the proposed structure is a single span over Hortons Creek.

Total scour depths have been computed by assessing the individual scour components for contraction, pressure and abutment separately and the results summarised to provide estimated depths of total abutment scour.

4.6.3 Geotechnical information

Subsurface conditions for BR01 were defined in the Project REF. Borehole information, describing subsurface conditions was available at the locations shown in Figure 6.

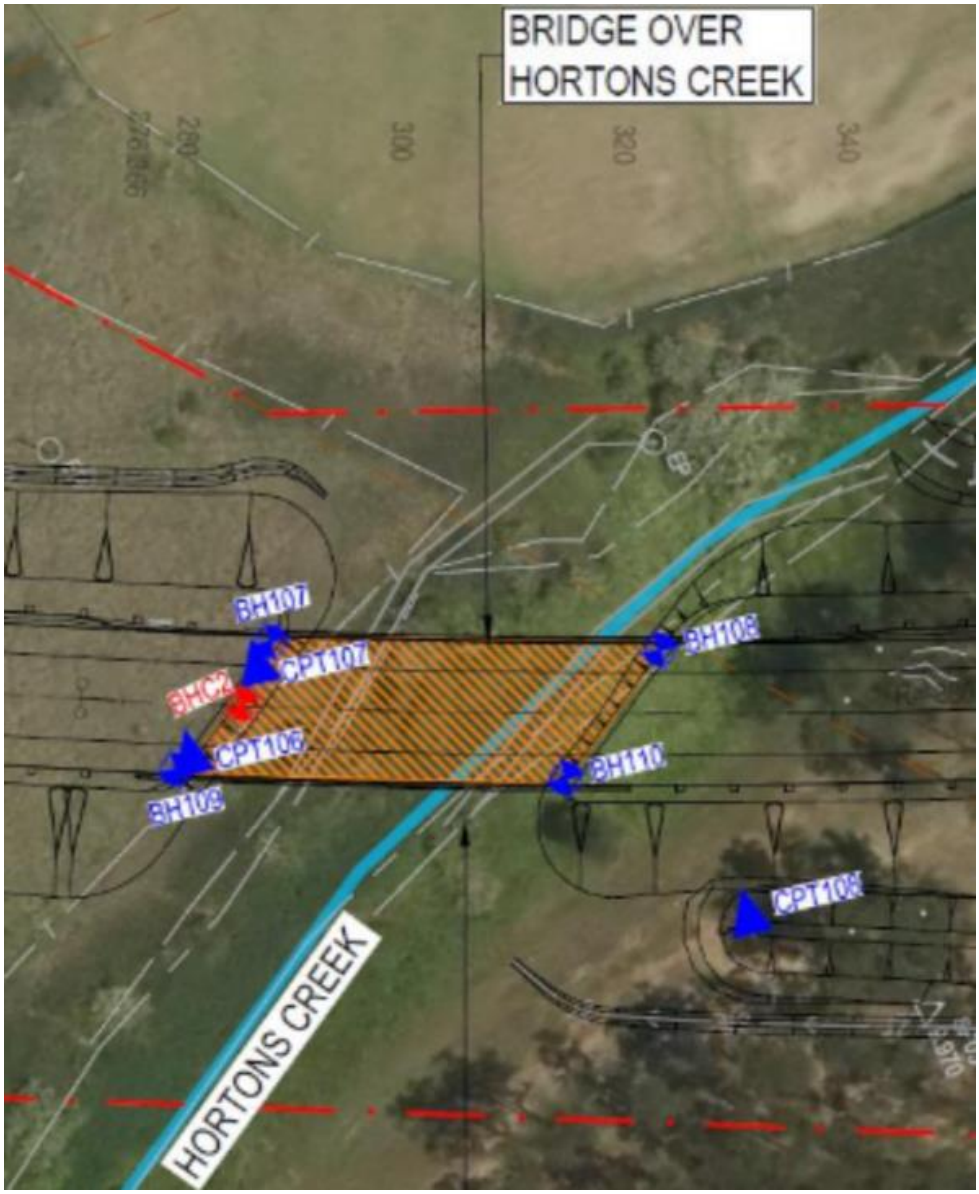


Figure 6 Locations of borehole samples at BR01

Borehole logs (BH107, BH108, BH109, BH110) and ground profiles were reviewed from the Arcadis Geotechnical Interpretive report for Detailed Design (10024434-EGD0001-RPT-A-01-GIR, Revision 02, 2019) for BR01. The review indicated that the upper layers of ground in the vicinity of the structure largely consisted of clayey material. The indicative depth to rock at the northern and southern abutment locations was found to be approximately 7.3 – 7.95 m below ground level.

HEC-18 notes that a reasonable lower limit of D_{50} particle size of 0.2mm can be assumed for scour calculations, noting the relationship between critical shear stress and D_{50} particle size show the critical shear stress reaches a minimum at the 0.2mm particle size.

On this basis, a D_{50} particle size of 0.2 mm was adopted for the bridge structure as the recommended particle size.

4.6.4 Flood data

Flooding conditions associated with local flooding with no tailwater along the Hawkesbury-Nepean River are expected to govern scour protection design on the basis that peak velocities associated with the local flood event will generally be higher than those associated with backwater flooding of the Hawkesbury Nepean River during a regional flood event.

Notwithstanding the above, flood depths and levels associated with regional flooding of the Hawkesbury Nepean River are expected to be significantly higher than those predicted for the local catchment. Regional Flood levels, associated with flooding Hawkesbury Nepean River are summarised below in Table 13.

Table 13: Flood data - Regional flood event - BR01 - Bridge over Hortons Creek

Location	Deck level (mAHD)	Deck soffit (mAHD)	1% AEP Peak flood level (mAHD)	0.05% AEP Peak flood level (mAHD)
Abutment A (South)	13.276	11.576	17.30	22.80
Abutment B (North)	12.328	10.628		

Table 14 below provides a summary of flood data at the bridge location for the local flood event. Flood Mapping in Appendix D shows the local flooding conditions at the locations of the bridge.

Table 14: Flood data - Local flood event - BR01 - Bridge over Hortons Creek

Location Deck soffit	(mAHD)	1% AEP				0.05% AEP			
		Critical storm duration (hrs)	**Peak flow (m^3/s)**	**Peak flood level (mAHD)**	**Peak velocity (m/s)**	**Critical storm duration (hrs)**	**Peak flow (m^3/s)**	**Peak flood level (mAHD)**	**Peak velocity (m/s)**
Abutment A (South)	11.576	2	10.71	9.621	0.25 – 0.50	0.75	20.22	9.816	0.50 - 0.75
Abutment B (North)	10.628			9.621	1.50 – 1.75			9.816	1.75 – 2.00

With reference to the tables above and flood mapping provided in Appendix D, the following is noted:

- The highest velocities occur on the upstream face of Abutment B, along the northern edge of the Hortons Creek watercourse.
- Relatively shallow flooding conditions and slower velocities occur along Abutment A towards the along the southern edge of the Hortons Creek watercourse.
- Velocities are limited to less than 2.0 m/s for all events up to and including the 0.05% AEP event.

4.6.5 Calculated scour depths

Predicted scour depths for the SLS and ULS events are summarised below in Table 15.

Table 15: Predicted scour depths

Location	1% AEP event (SLS)	0.05% AEP event (ULS)
Abutment A (South)	0.10	0.53
Abutment B (North)	0.26	0.57

4.6.6 Scour protection

Scour protection is required to be provided on bridge abutments and piers. Scour protection has been designed in accordance with the HEC-23 guidelines, Transport standard T HR CI 12020 ST and the Austroads Guide to Bridge Technology Part 8 Hydraulic Design of Waterway Structures (Austroads, 2018).

Dimensions have been annotated as shown below in Figure 7.

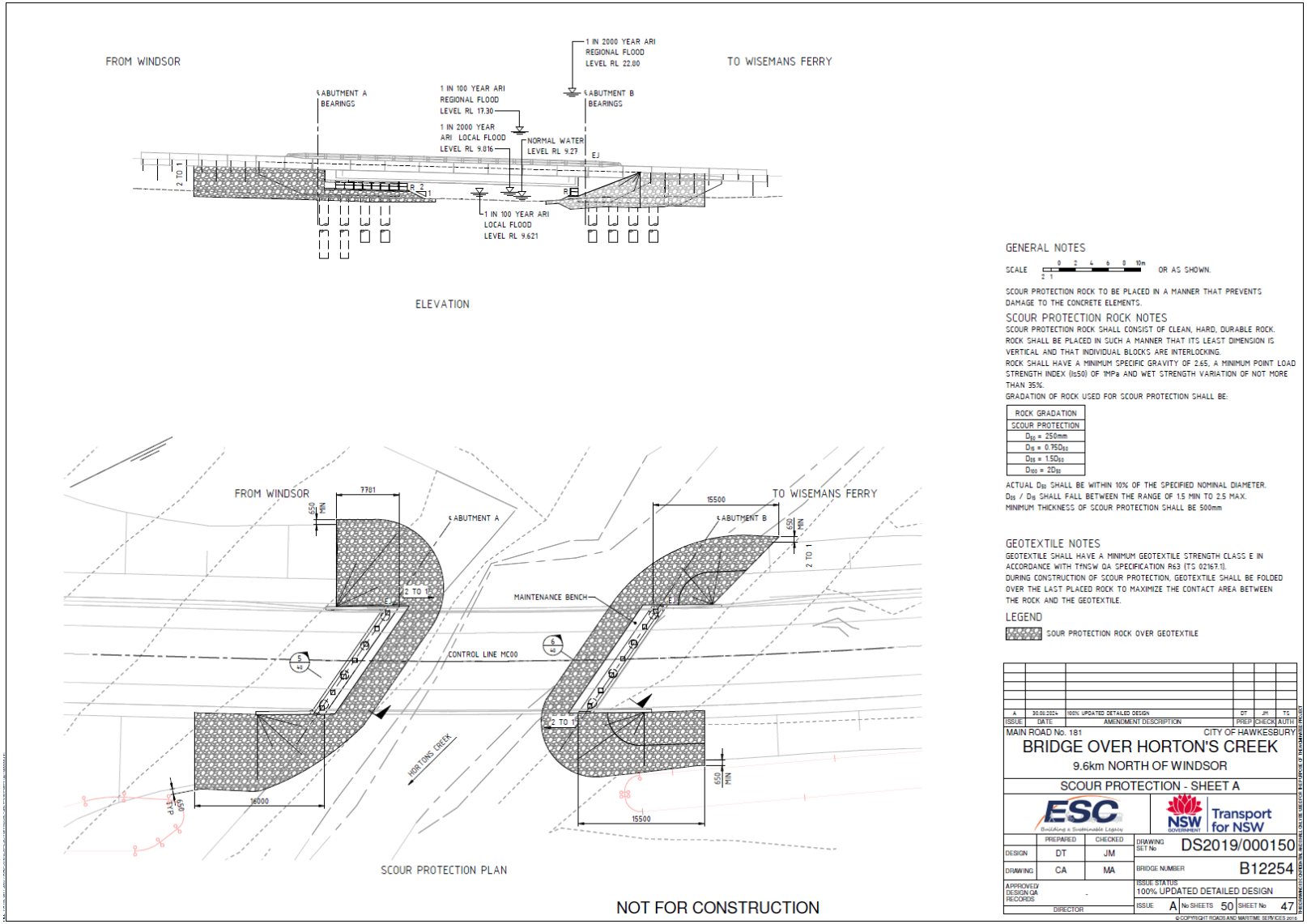


Figure 7 Typical scour protection design arrangement and dimensions

4.6.6.1 Abutment scour protection

The bridge abutments will require rock protection to achieve the 1% AEP serviceability requirements. Rip rap D50 sizes have been determined based on the velocities determined from the flood modelling using HEC-23 guidelines

Rip rap dimensions have been determined from HEC-23. Required rock sizes and apron dimensions are shown below in **Error! Not a valid bookmark self-reference.**

Table 16: Scour protection details

Location	Abutment A (South)	Abutment B (North)
D_{15} rock size (mm)	110	190
D_{50} rock size (mm)	150	250
D_{85} rock size (mm)	230	380
D_{100} rock size (mm)	300	500
Section Thickness, T (m)	0.5	0.5
Apron Width, L1 (m)	0.65	0.65
Downstream Extension, L2 (m)	7.5	7.5
Upstream extension, L3 (m)	Nil	Nil

With reference to the table above, flooding conditions and proposed scour protection are consistent with those proposed in the Project REF.

5 DISCUSSION

5.1 Construction

An assessment of construction impacts is included in the project REF, submissions report, and consistency assessment (the project approvals). For further detail on these assessments, please refer to these documents. This technical working paper aims to support the analysis of impacts on hydrology and hydraulics from the modifications in the design, which are further assessed in the AREF.

5.2 Operation

5.2.1 Achieved flood immunity

A summary of design road levels and regional and local flood levels is provided below in Table 17. With reference to the table above, the following is noted:

- **Local Flooding**
  - The updated Pitt Town Bypass design achieves the desired 1 per cent AEP event flood immunity to the local catchment flooding event.
- **Regional Flooding:**
  - The proposed Pitt Town Bypass would potentially become inundated by a regional flood event more frequent than the 20 per cent AEP event.
  - To provide flood immunity to a 1 per cent AEP regional flood event along the Hawkesbury-Nepean River, up to an additional 8.6 metres of additional fill would be required along the full length of the Pitt Town Bypass project alignment, which would result in a significant increase in the extent of the approved project as well as proposed modification, and could result in wide ranging flood impacts.

Table 17: Regional and local flooding - Achieved flood immunity

	Northern Intersection					Southern Intersection				
		Regional Flooding		Local Flooding			Regional Flooding		Local Flooding	
Design Flood Event	Design Road Levels (mAHD)*	Regional Flood Levels (mAHD) (Refer Section 2.2	Additional Fill Required to Achieve Target Immunity (m)	Local Flood Levels (mAHD)**	Additional Fill Required to Achieve Target Immunity (m)	Design Road Levels (mAHD)*	Regional Flood Levels (mAHD) (Refer Section 2.2	Additional Fill Required to Achieve Target Immunity (m)	Local Flood Levels (mAHD)**	Additional Fill Required to Achieve Target Immunity (m)
1 in 2 AEP (50%)	11.78	5.5	Nil	Not Available	Not Available	8.70	5.5	Nil	Not Available	Not Available
1 in 5 AEP (20%)		9.7	Nil	10.312	Nil		9.7	1	6.844	Nil
1 in 10 AEP (10%)		11.7	Nil	10.378	Nil		11.7	3	6.995	Nil
1 in 20 AEP (5%)		13.8	2.02	10.440	Nil		13.8	5.1	7.134	Nil
1 in 50 AEP (2%)		15.9	4.12	10.535	Nil		15.9	7.2	7.396	Nil
1 in 100 AEP (1%)		17.3	5.52	10.598	Nil		17.3	8.6	7.552	Nil
1 in 200 AEP (0.5%)		18.5	6.72	Not Available	Not Available		18.3	18.5	Not Available	Not Available
1 in 2000 AEP (0.05%)		22.8	11.02	10.757	Nil		22.8	14.1	8.221	Nil

**Design road levels are indicative of the lowest elevations at the proposed roundabout/intersections only, noting pavement levels transition down to existing pavement levels at the Pitt Town Bypass project limit of works.*

*** Local Flood levels noted in this table are based on the maximum local flood level at the northern intersection (Old Pitt Town Road - Key Location 5) and southern intersection (Glebe Road - Key Location 12) respectively*

5.2.2 ARR 2019 – Impacts on flood hydrology and comparison to project REF

This technical working paper has adopted the industry standard approach to hydrology (ARR2019 version 4.1 guidelines) for the purposes of assessing the Pitt Town Bypass Project. A comparative analysis has also been undertaken using ARR 1987 methods and procedures to quantify the impacts on design flood levels associated with the change in adopted hydrology.

Table 18 below shows a comparison of design flood levels at key locations under existing conditions for a range of flood events, using both the ARR 1987 and ARR2019 v4.1 hydrology.

With reference to the table below:

- Peak Flood levels under both existing conditions are relatively consistent irrespective of the hydrology adopted.
- Upstream of Cattai Road, for all events up to and including the 1% AEP event, peak flood levels increase by 20-30 mm using the ARR2019 v4.1 hydrology when compared to the ARR1987 hydrology. This localised increase is attributed to changes to the hydraulic model and rationalisation of the model to suit ensemble hydrology associated with ARR 2019 v4.1 hydrology.
- Downstream of Cattai Road, for all events up to and including the 1% AEP event, peak flood levels decrease by up to 40 – 180 mm. this is attributed to small changes in design rainfall depths associated with the adoption of the new design rainfall depths for the ARR2019 v4.1 assessment.
- Peak Flood Levels increase in the 0.05% AEP when using the ARR2019 v4.1 hydrology when compared to the ARR1987 hydrology. This increase is attributed to changes in design rainfall depths and better capture of the critical storm durations using the rationalise flood model.

On this basis that the peak flood levels are not significantly different, the ARR 2019 v4.1 hydrology has been adopted for the Pitt Town Bypass Project detailed design.

Table 18: ARR1987 vs ARR 2019 - Results Comparisons - Existing Conditions

Location ID	Existing Conditions - Flood Levels (mAHD)					Proposed Conditions - Flood Levels (mAHD)					Flood Afflux (mm)				
	20% AEP	10% AEP	5% AEP	1% AEP	0.05% AEP	20% AEP	10% AEP	5% AEP	1% AEP	0.05% AEP	20% AEP	10% AEP	5% AEP	1% AEP	0.05% AEP
1	11.515	11.536	11.561	11.600	11.624	11.548	11.569	11.582	11.548	11.649	+34	+33	+21	+12	+24
2	11.270	11.279	11.286	11.329	11.361	11.341	11.371	11.391	11.341	11.482	+72	+92	+105	+98	+121
3	10.886	11.016	11.169	11.274	11.322	10.762	10.893	11.023	10.762	11.342	-123	-124	-146	-41	+20
4	10.644	10.676	10.707	10.742	10.778	10.603	10.643	10.673	10.603	10.774	-41	-33	-34	-29	-4
5	10.485	10.509	10.507	10.558	10.600	10.437	10.466	10.489	10.437	10.625	-48	-43	-19	-23	+25
6	10.280	10.292	10.308	10.352	10.386	10.151	10.172	10.190	10.151	10.343	-129	-121	-118	-106	-43
7	9.651	9.679	9.720	9.823	9.891	9.606	9.646	9.680	9.606	9.925	-45	-33	-40	-44	+33
8	9.436	9.464	9.508	9.631	9.727	9.391	9.430	9.466	9.391	9.763	-45	-35	-42	-59	+36
9	9.398	9.424	9.463	9.577	9.675	9.357	9.392	9.425	9.357	9.719	-42	-31	-38	-55	+44
10	9.339	9.364	9.404	9.525	9.624	9.297	9.331	9.364	9.297	9.672	-42	-33	-40	-58	+48
11	7.552	7.626	7.763	7.955	8.109	7.421	7.508	7.607	7.421	8.194	-131	-118	-156	-93	+86
12	7.366	7.443	7.568	7.716	7.818	7.230	7.340	7.432	7.230	7.881	-136	-103	-136	-62	+64
13	7.370	7.449	7.576	7.729	7.840	7.228	7.343	7.436	7.228	7.905	-143	-106	-139	-68	+65
14	6.760	6.813	6.907	7.052	7.169	6.586	6.659	6.733	6.586	7.226	-174	-154	-174	-122	+57
15	6.760	6.810	6.899	7.040	7.156	6.578	6.658	6.731	6.578	7.184	-182	-152	-169	-122	+28
16	6.690	6.730	6.801	6.913	7.016	6.556	6.623	6.686	6.556	7.102	-134	-107	-115	-52	+86
17	6.475	6.508	6.569	6.665	6.750	6.405	6.457	6.502	6.405	6.792	-70	-52	-67	-46	+42
18	6.033	6.073	6.144	6.267	6.373	5.949	6.014	6.065	5.949	6.424	-84	-60	-79	-60	+51
19	6.145	6.171	6.225	6.319	6.411	6.131	6.151	6.173	6.131	6.456	-14	-20	-52	-50	+45
20	7.459	7.468	7.480	7.491	7.474	7.436	7.453	7.465	7.436	7.508	-23	-15	-16	-7	+34
21	7.086	7.103	7.111	7.129	7.109	7.117	7.129	7.140	7.117	7.174	+31	+26	+28	+25	+65
22	6.992	6.999	7.009	7.029	7.048	6.981	6.989	6.996	6.981	7.055	-11	-10	-13	-12	+7
23	6.996	7.006	7.019	7.047	7.071	6.984	6.995	7.004	6.984	7.073	-12	-11	-15	-18	+2
24	7.207	7.212	7.219	7.252	7.291	7.201	7.209	7.216	7.201	7.313	-6	-3	-4	-19	+22
25	7.378	7.456	7.585	7.743	7.861	7.233	7.347	7.441	7.233	7.918	-145	-109	-144	-78	+57
26	10.374	10.387	10.405	10.419	10.393	10.386	10.406	10.420	10.386	10.494	+12	+19	+14	+33	+101
27	11.321	11.334	11.353	11.365	11.335	11.329	11.342	11.354	11.329	11.395	+8	+8	+2	+12	+60
28	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	11.175	11.208	11.234	11.175	11.375	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*
29	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
30	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
31	8.448	8.448	8.465	8.490	8.448	*Note3*	*Note3*	*Note3*	*Note3*	8.543	*Note 2*	*Note 2*	*Note 2*	*Note 2*	+94
32	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
33	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
34	*Note3*	*Note3*	*Note3*	12.671	*Note3*	*Note3*	*Note3*	12.632	*Note3*	12.663	*Note3*	*Note3*	*Note 1*	-26	Note 1
35	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
36	13.790	13.798	13.806	13.819	13.807	13.775	13.784	13.791	13.775	13.826	-16	-15	-15	-11	+20
37	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
38	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*	*Note3*
39	11.673	11.684	11.696	11.713	11.697	11.663	11.680	11.694	11.663	11.748	-10	-4	-2	+6	+51
40	11.565	11.572	11.584	11.604	11.622	11.555	11.572	11.587	11.555	11.648	-10	Nil	+3	+11	+26

*Note 1: Was Dry, Now Wet | **Note 2: Was Wet, Now Dry | ***Note3: Not Flooded

5.2.3 Flood impacts to properties

The updated hydrology assessment, described above in Section 0 and presented in the flood mapping in Appendix D of this working paper shows flood impacts external to the project boundary.

A review and comparison of the updated hydrology assessment results (including the location of these flood impacts, the affected areas and magnitude of the flood impacts) noted that flood impacts associated with the revised design are consistent with the potential impacts previously identified in the project REF.

Given this project has been assessed and determined under Division 5.1 of the *Environmental Planning and Assessment Act 1979* no flood impact criteria have been defined for the Pitt Town Bypass Project.

For the purposes of this assessment, and in lieu of available project specific criteria, flood impact criteria have therefore been adopted from Austroads Guide to Road Design Part 5 General and Hydrology Considerations (AGRD05-23). The adopted criteria are summarised below in Table 19.

Table 19: Acceptable Impacts for major transport projects (Austroads, 2023)

Flood Impact Criteria	Residential Buildings (mm)	Residential Yards (mm)	Industrial and Commercial Buildings (mm)	Industrial and Commercial Lots LotsYards (mm)	Non-Habitable structures (sheds) (mm)	Agricultural (mm)	Open Space/ Forest (mm)
Flood Levels	25 (general) 10-20 (sensitive receivers, including hospitals, schools, critical infrastructure)	50	50	100	100	200-400	400

Change in Duration of inundation	No more than the larger or 10% of the existing duration of inundation or 1 hour, whichever is largest for durations over 2 hours.
Flow distribution	No more than 10% change
Velocities	Velocity increase to keep velocities less than 1m/s Nor more than 10% change if existing velocity > 1m/s
Events to be considered	5% AEP and 1% AEP as a minimum 20% AEP or smaller for agricultural lands 0.05% AEP or PMF to check extreme event changes in flood behaviour but not for acceptable impacts Tunnel Portal events to be considered depends on design criteria

A preliminary assessment was prepared using the afflux criteria defined above in Table 19. As part of this assessment, NSW Cadastre and land use zoning datasets were utilised to assign afflux thresholds to land parcels and land use types. Following consultation with TfNSW, the flood afflux thresholds adopted for the project as shown below in Table 20.

Error! Reference source not found. below shows the land use zonings in the Pitt Town area a djacent to the Pitt Town Bypass. Based on the land use zonings in the region the study area is comprised primarily of RU4 (Primary Production Small Lots) and RE1 (Public Recreation) zoned areas only.

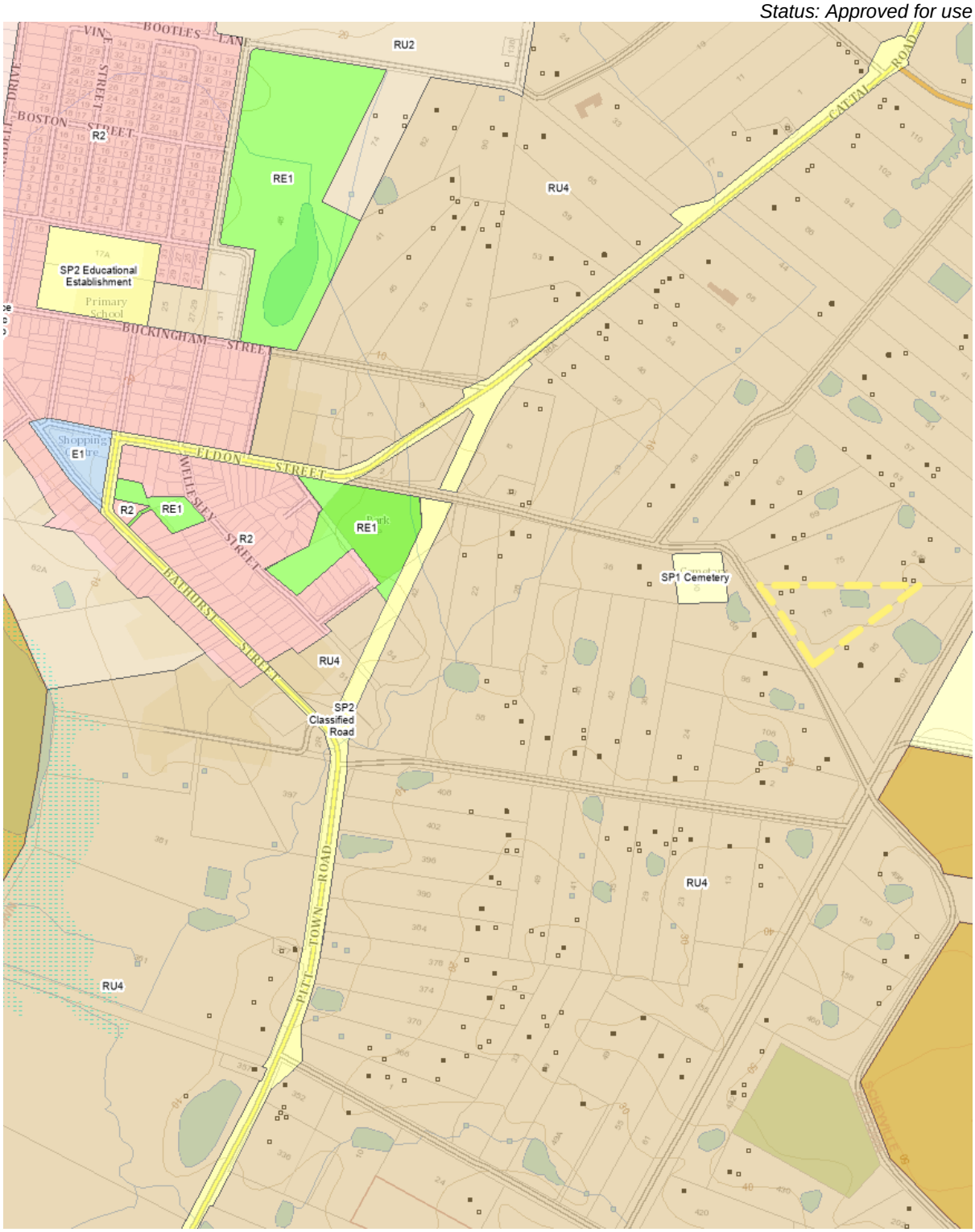


Figure 8 land use zonings in the Pitt Town Area

Table 20 below shows the adopted NSW Land Use Zonings and the applicable afflux thresholds adopted for this assessment.

Table 20: Adopted land use zoning and afflux thresholds

Category ID	Land Use Category	"Acceptable" impacts for major transport projects (mm)	Applicable NSW Land Zoning	Applicable Areas for the Pitt Town Bypass Project
1	Residential - Buildings	10	As per category ID #2, RU1, RU2, RU4, RU5, RU6, RUR, SET, SP5 SPU, UD, UR	All other Areas
2	Residential – Yards	100	A, 2a, R, R1, R2, R3, R4, R5,	All other Areas
3	Industrial and Commercial Buildings	10	As per category ID #4	N/A
4	Industrial and Commercial Lots	100	B, B1, B2, B3, B4, B5, B6, B7, B8, D, E, E1, E2, E3, E4, E5 EM, EP, ENT, IN1, IN2, IN3, IN4, MU, MU1, REZ, SP4,	N/A
5	Non-Habitable structures (sheds)	50	As per category ID #2 and #4	All other Areas
6	Agricultural	200-400	RAC, RAZ, RU1, RU2, RU3,	N/A
7	Open Space/Forest	400	C1, C2, C3, C4, DR, ENP, ENZ, F, G, H, I, MAP, P, PAE, PEP, PRC, RE1, RE2, REC, RO, RP, RW, SP1, SP2, SP3, T, W1, W2, W3, W4, WFU, U, UL, DM	Existing Roads, Brinsley Park

Table 21 below provides a summary of all properties where flood afflux (>10mm) has been identified across all events up to and including the 0.05% AEP event and provides an overview of the Land Use Category, adopted Flood Afflux limits and acceptability of flood afflux in accordance with the adopted guidelines.

Table 21: Flood afflux acceptability assessment

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?
DP1245761	2	RU4	100	10	50	20% AEP	88	Nil	Nil	No	No	localised ponding west of property access	Design amended to allow for free-draining design between property accesses
						10% AEP	79	Nil	Nil	No	No		
						5% AEP	121	Nil	Nil	No	Yes		
						2% AEP	126	Nil	Nil	No	Yes		
						1% AEP	115	Nil	Nil	No	Yes		
						0.05% AEP	115	Nil	Nil	No	Yes		
DP1245761	3	RU4	100	10	50	20% AEP	135	Nil	Nil	No	Yes	localised ponding north of property access	Design amended to allow for free-draining design between property accesses.
						10% AEP	135	Nil	Nil	No	Yes		
						5% AEP	125	Nil	Nil	No	Yes		
						2% AEP	135	Nil	Nil	No	Yes		
						1% AEP	135	Nil	Nil	No	Yes		
						0.05% AEP	118	Nil	Nil	No	Yes		
DP1245761	6 - West	RU4	100	10	50	20% AEP	Nil	Nil	Nil	No	No	Ponding north of Old Pitt Town Road	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	Nil	Nil	Nil	No	No		
						5% AEP	Nil	Nil	Nil	No	No		
						2% AEP	20	Nil	Nil	No	No		
						1% AEP	53	Nil	Nil	No	No		
						0.05% AEP	121	Nil	Nil	No	Yes		
DP1245761	6 - East	RU4	100	10	50	20% AEP	Nil	Nil	Nil	No	No	Localised Afflux	Consultation excluded on the basis that flood impacts to lot do not

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?
						10% AEP	Nil	Nil	Nil	No	No	adjacent to property access	exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						5% AEP	Nil	Nil	Nil	No	No		
						2% AEP	23	Nil	Nil	No	No		
						1% AEP	57	Nil	Nil	No	No		
						0.05% AEP	50	Nil	Nil	No	No		
DP1249901	5	RU4	100	10	50	20% AEP	34	Nil	Nil	No	No	localised afflux south of Glebe Road	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	32	Nil	Nil	No	No		
						5% AEP	33	Nil	Nil	No	No		
						2% AEP	38	Nil	Nil	No	No		
						1% AEP	37	Nil	Nil	No	No		
						0.05% AEP	38	Nil	Nil	No	No		
DP255533	3	RU4	100	10	50	20% AEP	Nil	Nil	Nil	No	No	Local afflux due to ponding upstream of Culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	Nil	Nil	Nil	No	No		
						5% AEP	Nil	Nil	Nil	No	No		
						2% AEP	Nil	Nil	Nil	No	No		
						1% AEP	Nil	Nil	Nil	No	No		
						0.05% AEP	54	Nil	Nil	No	No		
DP712795	2	RU4	100	10	50	20% AEP	15	Nil	Nil	No	No	localised afflux downstream of culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	17	Nil	Nil	No	No		
						5% AEP	17	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?
						2% AEP	14	Nil	Nil	No	No		
						1% AEP	16	Nil	Nil	No	No		
						0.05% AEP	16	Nil	Nil	No	No		
DP712795	3	RU4	100	10	50	20% AEP	80	Nil	Nil	No	No	localised afflux downstream of culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	47	Nil	Nil	No	No		
						5% AEP	66	Nil	Nil	No	No		
						2% AEP	45	Nil	Nil	No	No		
						1% AEP	39	Nil	Nil	No	No		
						0.05% AEP	Nil	Nil	Nil	No	No		
DP752050	254	RE1	400	10	50	20% AEP	55	Nil	Nil	No	No	local afflux downstream of Old Pitt Town Road Culvert Bank	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	57	Nil	Nil	No	No		
						5% AEP	56	Nil	Nil	No	No		
						2% AEP	63	Nil	Nil	No	No		
						1% AEP	115	Nil	Nil	No	No		
						0.05% AEP	117	Nil	Nil	No	No		
DP1127986	52	RE1	400	10	50	20% AEP	Nil	Nil	Nil	No	No	Local Afflux due to surcharging of drainage line at Somerset Street	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						10% AEP	51	Nil	Nil	No	No		
						5% AEP	61	Nil	Nil	No	No		
						2% AEP	65	Nil	Nil	No	No		
						1% AEP	66	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?
DP1187464	52	RU4	100	10	50	0.05% AEP	59	Nil	Nil	No	No	Ponding north of Old Pitt Town Road	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
						20% AEP	Nil	Nil	Nil	No	No		
						10% AEP	Nil	Nil	Nil	No	No		
						5% AEP	Nil	Nil	Nil	No	No		
						2% AEP	20	Nil	Nil	No	No		
						1% AEP	55	Nil	Nil	No	No		
						0.05% AEP	116	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?
DP1245761	2	RU4	100	10	50	20% AEP	88	Nil	Nil	No	No	localised ponding west of property access	Design amended to allow for free-draining design between property accesses
						10% AEP	79	Nil	Nil	No	No		
						5% AEP	121	Nil	Nil	No	Yes		
						2% AEP	126	Nil	Nil	No	Yes		
						1% AEP	115	Nil	Nil	No	Yes		
						0.05% AEP	115	Nil	Nil	No	Yes		
DP1245761	3	RU4	100	10	50	20% AEP	135	Nil	Nil	No	Yes	localised ponding north of property access	Design amended to allow for free-draining design between property accesses.
						10% AEP	135	Nil	Nil	No	Yes		
						5% AEP	125	Nil	Nil	No	Yes		
						2% AEP	135	Nil	Nil	No	Yes		
						1% AEP	135	Nil	Nil	No	Yes		
						0.05% AEP	118	Nil	Nil	No	Yes		
DP1245761	6 - West	RU4	100	10	50	20% AEP	Nil	Nil	Nil	No	No	Ponding north of Old Pitt Town Road	Consultation excluded on the basis that flood impacts to lot do not exceed
						10% AEP	Nil	Nil	Nil	No	No		
						5% AEP	Nil	Nil	Nil	No	No		
						2% AEP	20	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?				
										1% AEP	53	Nil	Nil	No	No		adopted threshold(s) for flood events up to and including the 1% AEP.
										0.05% AEP	121	Nil	Nil	No	Yes		
DP1245761	6 - East	RU4		100		10			50	20% AEP	Nil	Nil	Nil	No	No	Localised Afflux adjacent to property access	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	Nil	Nil	Nil	No	No		
										5% AEP	Nil	Nil	Nil	No	No		
										2% AEP	23	Nil	Nil	No	No		
										1% AEP	57	Nil	Nil	No	No		
										0.05% AEP	50	Nil	Nil	No	No		
DP1249901	5	RU4		100		10			50	20% AEP	34	Nil	Nil	No	No	localised afflux south of Glebe Road	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	32	Nil	Nil	No	No		
										5% AEP	33	Nil	Nil	No	No		
										2% AEP	38	Nil	Nil	No	No		
										1% AEP	37	Nil	Nil	No	No		
										0.05% AEP	38	Nil	Nil	No	No		
DP255533	3	RU4		100		10			50	20% AEP	Nil	Nil	Nil	No	No	Local afflux due to ponding upstream of Culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	Nil	Nil	Nil	No	No		
										5% AEP	Nil	Nil	Nil	No	No		
										2% AEP	Nil	Nil	Nil	No	No		
										1% AEP	Nil	Nil	Nil	No	No		
										0.05% AEP	54	Nil	Nil	No	No		
DP712795	2	RU4		100		10			50	20% AEP	15	Nil	Nil	No	No	localised afflux downstream of culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted
										10% AEP	17	Nil	Nil	No	No		
										5% AEP	17	Nil	Nil	No	No		
										2% AEP	14	Nil	Nil	No	No		
										1% AEP	16	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?				
										0.05% AEP	16	Nil	Nil	No	No		threshold(s) for flood events up to and including the 1% AEP.
DP712795	3	RU4	100		10				50	20% AEP	80	Nil	Nil	No	No	localised afflux downstream of culvert PTB3	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	47	Nil	Nil	No	No		
										5% AEP	66	Nil	Nil	No	No		
										2% AEP	45	Nil	Nil	No	No		
										1% AEP	39	Nil	Nil	No	No		
										0.05% AEP	Nil	Nil	Nil	No	No		
DP752050	254	RE1	400		10				50	20% AEP	55	Nil	Nil	No	No	local afflux downstream of Old Pitt Town Road Culvert Bank	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	57	Nil	Nil	No	No		
										5% AEP	56	Nil	Nil	No	No		
										2% AEP	63	Nil	Nil	No	No		
										1% AEP	115	Nil	Nil	No	No		
										0.05% AEP	117	Nil	Nil	No	No		
DP1127986	52	RE1	400		10				50	20% AEP	Nil	Nil	Nil	No	No	Local Afflux due to surcharging of drainage line at Somerset Street	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for flood events up to and including the 1% AEP.
										10% AEP	51	Nil	Nil	No	No		
										5% AEP	61	Nil	Nil	No	No		
										2% AEP	65	Nil	Nil	No	No		
										1% AEP	66	Nil	Nil	No	No		
										0.05% AEP	59	Nil	Nil	No	No		
DP1187464	52	RU4	100		10				50	20% AEP	Nil	Nil	Nil	No	No	Ponding north of Old Pitt Town Road	Consultation excluded on the basis that flood impacts to lot do not exceed adopted threshold(s) for
										10% AEP	Nil	Nil	Nil	No	No		
										5% AEP	Nil	Nil	Nil	No	No		
										2% AEP	20	Nil	Nil	No	No		
										1% AEP	55	Nil	Nil	No	No		

DP	Lot	Land Use/Property Zoning	Flood Afflux threshold – Lot Area (mm)	Flood Afflux threshold – Buildings (mm)	Flood Afflux threshold – Sheds/non-habitable buildings (mm)	Flood Event	Max Afflux – Lot (mm)	Max Afflux – Building (mm)	Max Afflux – Sheds/non-habitable buildings (mm)	Sheds and/or buildings affected?	Afflux Thresholds Exceeded?	Comment	Consultation Basis?				
										0.05% AEP	116		Nil		Nil	No	No	flood events up to and including the 1% AEP.

With reference to the flood impact mapping in Appendix D and the table above:

- No habitable dwellings or non-habitable dwellings were identified within extents of impacts as a result of the road upgrade.
- Flood afflux on some properties (Lot 2 DP 1245761, Lot 3 DP 1245761) is attributed to local drainage at or adjacent to proposed property accesses. Design amendments have been made to address local drainage issues at the identified properties.
- For all other properties, whilst flood impacts have been identified on properties adjacent the Pitt Town Bypass, the flood impacts for all events up to and including the 1% AEP event were found to be below the threshold values agreed with TfNSW.
- With the exception of Lot 6 DP 1245761 and Lot 254 DP 752050, the flood impacts noted on the affected lots are relatively minimal, covering a very small portion of the total lot area and land parcel.

Whilst a full compliance assessment has not been undertaken for the project, a review of the flood mapping and associated impacts indicates that there are some areas where flood impacts exceed the applicable criteria based on the Austroads guidelines. Overall however, flood impacts are generally consistent with the project REF.

The design changes that have occurred since the project approval have resulted in a change in flooding impacts. These changes include the optimisation of proposed retention basins, which has aided in the reduction in localised flooding impacts.

Environmental Safeguard H4 requires that “landowners potentially affected by afflux would be consulted during detailed design”. It is understood that consultation with affected landowners is yet to take place.

5.2.4 Climate change assessment

A climate change assessment has been undertaken adopting a 19.7% increase in rainfall intensity to assess the 1% AEP design flood event.

The predicted effects on the design due to climate change are not considered significant(i.e. in the order of 50-80 mm along Hortons Creek, and locally up to 100-200mm adjacent to the main cross drainage infrastructure at culvert PTB3 under the intersection), and whilst there is a localised increase in flood afflux upstream of the main culvert bank under the southern intersection, this flood afflux only impacts the riparian corridor and does not affect any adjacent landholders.

Increases in predicted peak velocities in the order of 0.2-0.3 m/s are also considered negligible and can be managed through considering the higher outlet velocities in the detailed design of the outlet scour protection works.

The design is expected to still achieve the flood immunity in the local catchment 1% AEP event with climate change.

5.2.4.1 Climate Change considerations in the Australian Rainfall and Runoff (ARR) 2019 v4.2 Guidelines

Engineers Australia on the 27 August 2024 have released (Version 4.2) an updated to the climate change considerations chapter in Australian Rainfall and Runoff - A Guide to Flood Estimation (2019). Since the technical assessments within this working paper were undertaken before the issue of ARR2019 Version 4.2, the global climate adjustments issued on the 27th August 2024 have not been adopted. The updated guidelines provide key recommendations for all practitioners to consider when assessing the impacts of climate change.

Under the new guidelines, the predicted increase design rainfall intensities is proportional to the predicted increase in global surface temperature(s). The guidelines are based on Shared Socioeconomic Pathways (SSPs) that cover a broad range of potential future development options often referred to as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5).

A climate change impact assessment using the new guidelines has not been undertaken for the Pitt Town Bypass Project, however a review of the recommended climate change factors, for the Pitt Town area has been undertaken using the re-issued ARR Data hub extracts for the Pitt Town area.

Table 22 below shows the revised climate change factors using the updated guidelines for climate change scenario SSP5-8.5 and provides the closest comparison to the scenario described in Section 4.5 above.

Table 22 ARR2019 revised climate change factors (post ARR 2019 v4.2 release) SSP5 –8.5

Year	Storm Duration									
	<1hr	**1.5hrs**	**2hrs**	**3hrs**	**4.5 hrs**	**6 hrs**	**9 hrs**	**12 hrs**	**18 hrs**	**>24 hrs**
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

With reference to the table above, the predicted increase in design rainfall intensity for the design planning horizon (Year 2090) ranges from between 37% for longer duration storms and up to 77% for shorter duration storms, compared to a predicted increase in design rainfall intensity of 19.7% using the recommendations contained in the earlier release of the ARR guidelines for the SSP5-8.5 scenario.

The above assessment highlights that projected rainfall intensity increases have changed due to the revised guidelines and that the conditions presented in the climate change sensitivity flood mapping in Appendix F (considered representative of climate change risk in the Year 2090) would be more applicable to year 2030, given the relatively short critical storm durations for the Hortons Creek Catchment at the location of the Pitt Town Bypass Project.

Flood Impacts under climatic conditions for the Year 2090 for the SSP5-8.5 pathway may potentially be greater than those presented in Appendix F and described in Section 4.5 of this report.

5.2.5 Blockage sensitivity assessment

For consistency with the project REF assessment, design blockage factors were adopted without change. A sensitivity assessment on adopted blockage factors and potential impacts on the design and to the surrounding environment are summarised above in Section 0.

With reference to Section 0., flood levels are predicted to increase under climate change conditions by up to 213 mm immediately upstream of the main culvert bank under the southern intersection (PTB3).

In other locations, further away from cross drainage infrastructure, the increases in flood level due to climate change are generally smaller, with flood afflux in the order of 50 – 80mm when comparing the proposed flooding conditions with climate change to proposed flooding conditions without climate change.

6 OTHER WORKS WITHIN THE AREA

Following a review of the area, several regional initiatives are understood to be in the planning phase for the Pitt Town area, aimed at improving flood emergency response, evacuation and community resilience, including, but not limited to:

- The Hawkesbury-Nepean Valley Flood Evacuation Road Resilience Program (TfNSW, 2024).
- Hawkesbury-Nepean Valley Flood Risk Management Strategy – Taskforce Options Assessment Report (Infrastructure NSW, 2019).

The Pitt Town Bypass project would commence construction prior to other proposed works within the region. This assessment therefore does not consider the cumulative effects of these projects on this basis. It is assumed that each project would require consideration of its own potential impacts on flooding.

Environmental Safeguard TT6 of the Pitt Town Bypass Submission Report (March 2019) required that "*consultation with NSW State Emergency Service will continue during detailed design about the proposed interaction with the Hawkesbury Nepean Resilience Valleys program and current and desired evacuation routes*".

SJV have undertaken a review of the desired evacuations routes and have confirmed the proposed routes remain unaffected by the Pitt Town Bypass.

It is recommended that works within the region continue to be co-ordinated in order to produce a "best for community" outcome for the Pitt Town area, and potential opportunities to improve drainage along local roads considered improve access through the region.

7 RECOMMENDED MANAGEMENT AND MITIGATION

The project approvals identified a range of environmental outcomes and management measures for the project that would be required to avoid or reduce environmental impacts.

No significant changes to the design have been proposed as part of model review and update, and the revised design does not result in any substantial changes to the design and or predicted flood impacts.

The hydrology assessment has identified two potential opportunities where flood mitigation could be considered as part of the detailed design, namely:

- Sizing of the cross-drainage infrastructure in order to provide additional capacity to manage potential increases in design flows associated with the predicted effects on rainfall due to climate change;

On this basis, no further management and/or mitigation measures are proposed for the Pitt Town Bypass.

8 CONCLUSION

The results indicate that flood immunity at the proposed Pitt Town Bypass would be greatly improved compared to current conditions over its current level to the 1% AEP local catchment flows, except at transitions to the existing road and the causeway at Old Pitt Town Road. The hydrological assessment outlined in this working paper shows that the proposed culvert configurations provide sufficient hydraulic capacity beneath the proposed bypass to convey the 1% AEP local catchment flows for all locations except at the road tie ins.

Generally, flood impacts associated with the Pitt Town Bypass are limited to less than 50mm, however at select locations some minor impacts >50mm occur to small areas of adjacent lots. No impacts to buildings are predicted on any of the affected lots. Overall, flood impacts associated with the Pitt Town Bypass revised design are consistent with those predicted in the project REF.

Similarly to the project REF, the flood model developed for this project only analyses local catchment flows, assuming no backwater from the Hawkesbury River. Regional Flooding was not assessed in the current project on the basis that the magnitude, duration and extent of flooding associated with regional flood events would generally remain unaffected by the proposed works

The flood models developed for this assessment have been specifically set-up to predict the potential hydrologic and hydraulic impacts for the road upgrade and to determine sizings for major cross-drainage structures. The model (s) should not be used for any other purpose without thorough knowledge of the models configurations.

It must be acknowledged that since the technical assessments within this working paper were undertaken before the issue of ARR2019 Version 4.2, the global climate adjustments issued on the 27th August 2024 have not been adopted as part of this report.

9 REFERENCES

Austroads Guide to Road Design Part 5 General and Hydrology Considerations (AGRD05-23), Austroads, 2023

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019.

Hawkesbury-Nepean River Flood Study Final Report, NSW Reconstruction Authority, 2024

Hawkesbury Nepean Valley Flood Evacuation Road Resilience Program (TfNSW, 2024)

Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability, Countermeasures: Experience, Selection, and Design Guidance-Third Edition, U.S Department of Transportation – Federal Highway Administration[Publication Number FHWA-NHI-09-111}

NSW Floodplain Risk Management Manual – The Policy and Manual for the management of flood liable land (NSW Department of Climate Change, Energy, the Environment and Water , 2023)

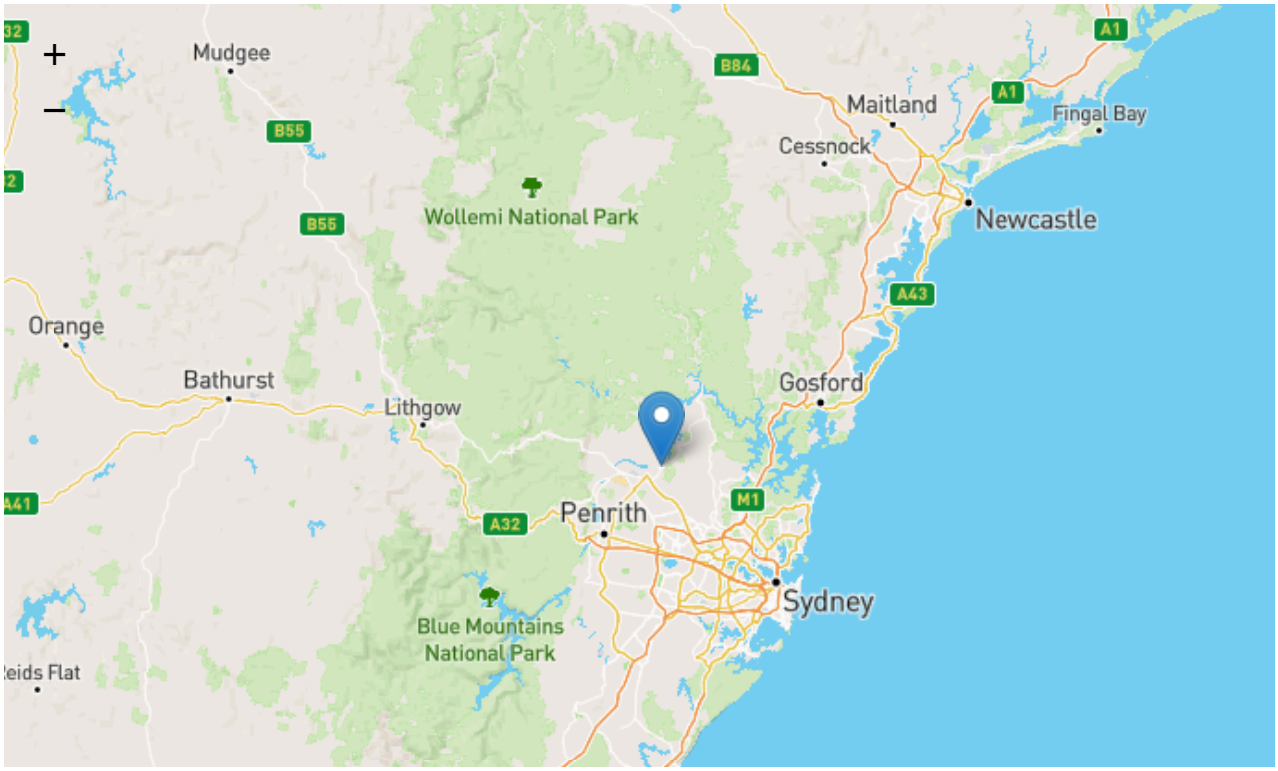
Pitt Town Bypass REF (TfNSW, 2018)1Pitt Town Bypass Hydrology and Hydraulic investigation – Concept Design Report (Rev03) (10014101-EFC0001-RPT), Arcadis, 2018

APPENDIX A– DESIGN RAINFALL IFD'S

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	150.867
Latitude	-33.582
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
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show



Data

River Region

Division	South East Coast (NSW)
River Number	12
River Name	Hawkesbury River

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

Short Duration ARF

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

Layer Info

Time Accessed	11 April 2024 09:37AM
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	11860.0
Storm Initial Losses (mm)	41.0
Storm Continuing Losses (mm/h)	3.5

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2016_v1

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

code	ECsouth
Label	East Coast South

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2016_v2

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

code	ECsouth
arealabel	East Coast South

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-33.582&longitude=150.867&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	11 April 2024 09:37AM

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)	1.0 (0.038)	1.1 (0.031)	1.2 (0.027)	1.2 (0.025)	2.2 (0.037)	2.9 (0.044)
90 (1.5)	0.2 (0.005)	0.5 (0.013)	0.7 (0.015)	1.0 (0.017)	1.0 (0.015)	1.1 (0.014)
120 (2.0)	0.5 (0.016)	0.7 (0.016)	0.8 (0.016)	1.0 (0.016)	1.7 (0.024)	2.2 (0.028)
180 (3.0)	1.5 (0.040)	2.7 (0.054)	3.5 (0.060)	4.3 (0.063)	2.4 (0.030)	1.0 (0.011)
360 (6.0)	3.4 (0.072)	10.3 (0.162)	14.8 (0.196)	19.2 (0.217)	17.1 (0.161)	15.6 (0.129)
720 (12.0)	1.0 (0.017)	5.7 (0.067)	8.7 (0.085)	11.7 (0.096)	16.0 (0.109)	19.3 (0.115)
1080 (18.0)	1.2 (0.016)	5.4 (0.053)	8.2 (0.066)	10.9 (0.073)	15.7 (0.087)	19.2 (0.093)
1440 (24.0)	0.0 (0.000)	3.7 (0.032)	6.2 (0.043)	8.5 (0.050)	10.3 (0.049)	11.6 (0.049)
2160 (36.0)	0.0 (0.000)	1.9 (0.013)	3.1 (0.018)	4.3 (0.021)	5.4 (0.022)	6.3 (0.022)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	1.0 (0.003)	1.7 (0.005)
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	11 April 2024 09:37AM
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	11 April 2024 09:37AM
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 (0.000)	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	11 April 2024 09:37AM
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)	13.6 (0.517)	14.9 (0.415)	15.8 (0.370)	16.7 (0.336)	20.9 (0.354)	24.0 (0.362)
90 (1.5)	10.9 (0.367)	14.9 (0.369)	17.5 (0.367)	20.1 (0.362)	19.4 (0.294)	18.9 (0.254)
120 (2.0)	11.3 (0.350)	20.9 (0.478)	27.3 (0.526)	33.4 (0.555)	34.4 (0.480)	35.2 (0.434)
180 (3.0)	23.0 (0.625)	36.8 (0.743)	45.9 (0.782)	54.7 (0.802)	46.5 (0.570)	40.3 (0.436)
360 (6.0)	19.3 (0.412)	39.0 (0.615)	52.0 (0.687)	64.4 (0.729)	75.9 (0.713)	84.5 (0.696)
720 (12.0)	29.4 (0.477)	36.9 (0.433)	41.8 (0.407)	46.6 (0.383)	58.5 (0.397)	67.4 (0.401)
1080 (18.0)	27.7 (0.379)	34.9 (0.341)	39.6 (0.318)	44.2 (0.297)	56.8 (0.315)	66.2 (0.321)
1440 (24.0)	14.8 (0.180)	22.8 (0.195)	28.2 (0.196)	33.3 (0.194)	39.4 (0.190)	44.1 (0.186)
2160 (36.0)	8.4 (0.087)	14.5 (0.104)	18.5 (0.107)	22.4 (0.108)	35.7 (0.142)	45.7 (0.160)
2880 (48.0)	6.4 (0.059)	6.8 (0.043)	7.1 (0.036)	7.3 (0.031)	16.6 (0.059)	23.6 (0.074)
4320 (72.0)	0.0 (0.000)	0.6 (0.003)	0.9 (0.004)	1.3 (0.005)	8.2 (0.025)	13.3 (0.037)

Layer Info

Time Accessed	11 April 2024 09:37AM
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)	42.4 (1.616)	49.7 (1.383)	54.6 (1.276)	59.2 (1.193)	82.0 (1.389)	99.1 (1.490)
90 (1.5)	36.6 (1.235)	59.8 (1.485)	75.2 (1.572)	89.9 (1.623)	80.2 (1.216)	73.0 (0.980)
120 (2.0)	46.2 (1.426)	86.3 (1.974)	113.0 (2.179)	138.5 (2.305)	124.0 (1.731)	113.2 (1.397)
180 (3.0)	54.0 (1.468)	80.4 (1.624)	97.9 (1.668)	114.7 (1.683)	120.6 (1.479)	125.0 (1.352)
360 (6.0)	44.0 (0.939)	77.8 (1.228)	100.2 (1.325)	121.7 (1.376)	134.3 (1.260)	143.7 (1.184)
720 (12.0)	50.8 (0.824)	74.5 (0.876)	90.3 (0.879)	105.4 (0.867)	109.8 (0.745)	113.1 (0.672)
1080 (18.0)	49.6 (0.679)	62.4 (0.609)	70.9 (0.568)	79.0 (0.531)	103.3 (0.573)	121.5 (0.590)
1440 (24.0)	52.3 (0.636)	55.6 (0.476)	57.8 (0.403)	59.9 (0.349)	76.1 (0.366)	88.3 (0.372)
2160 (36.0)	32.6 (0.338)	40.7 (0.291)	46.1 (0.267)	51.2 (0.246)	72.4 (0.288)	88.2 (0.309)
2880 (48.0)	21.4 (0.200)	21.3 (0.136)	21.3 (0.109)	21.2 (0.090)	55.4 (0.196)	81.0 (0.253)
4320 (72.0)	15.3 (0.126)	24.7 (0.138)	30.9 (0.139)	36.9 (0.137)	42.0 (0.130)	45.9 (0.126)

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.869 (4.3%)**	0.783 (3.9%)	**0.983 (4.9%)**
2040	**1.057 (5.3%)**	1.014 (5.1%)	**1.349 (6.8%)**
2050	**1.272 (6.4%)**	1.236 (6.2%)	**1.773 (9.0%)**
2060	**1.488 (7.5%)**	1.458 (7.4%)	**2.237 (11.5%)**
2070	**1.676 (8.5%)**	1.691 (8.6%)	**2.722 (14.2%)**
2080	**1.810 (9.2%)**	1.944 (9.9%)	**3.209 (16.9%)**
2090	**1.862 (9.5%)**	2.227 (11.5%)	**3.679 (19.7%)**

Layer Info

Time Accessed	11 April 2024 09:37AM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	**50.0**	**20.0**	**10.0**	**5.0**	**2.0**	**1.0**
60 (1.0)	26.5	14.4	13.3	13.5	11.7	9.0
90 (1.5)	27.5	15.4	13.7	13.1	12.0	11.2
120 (2.0)	26.2	14.5	12.1	11.8	10.5	8.5
180 (3.0)	23.4	13.5	11.8	11.1	11.0	8.4
360 (6.0)	23.4	13.8	12.3	10.7	10.1	6.1
720 (12.0)	23.4	16.6	15.9	15.7	14.4	7.2
1080 (18.0)	24.4	18.6	18.5	17.9	17.5	7.2
1440 (24.0)	27.0	21.4	21.8	21.1	20.6	14.4
2160 (36.0)	31.1	25.4	25.7	25.4	22.7	9.5
2880 (48.0)	33.6	29.9	31.1	35.6	25.3	15.1
4320 (72.0)	36.0	31.5	32.0	37.8	29.2	16.8

Layer Info

Time Accessed	11 April 2024 09:37AM
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.

Download TXT (downloads/01dbc5b4-6bb6-49eb-8004-acd0021f1583.txt)

Download JSON (downloads/e38f2ffc-bed9-47b0-97a1-dac89bf6a22a.json)

Generating PDF... (downloads/3658a86b-415e-45df-9451-944723384f83.pdf)

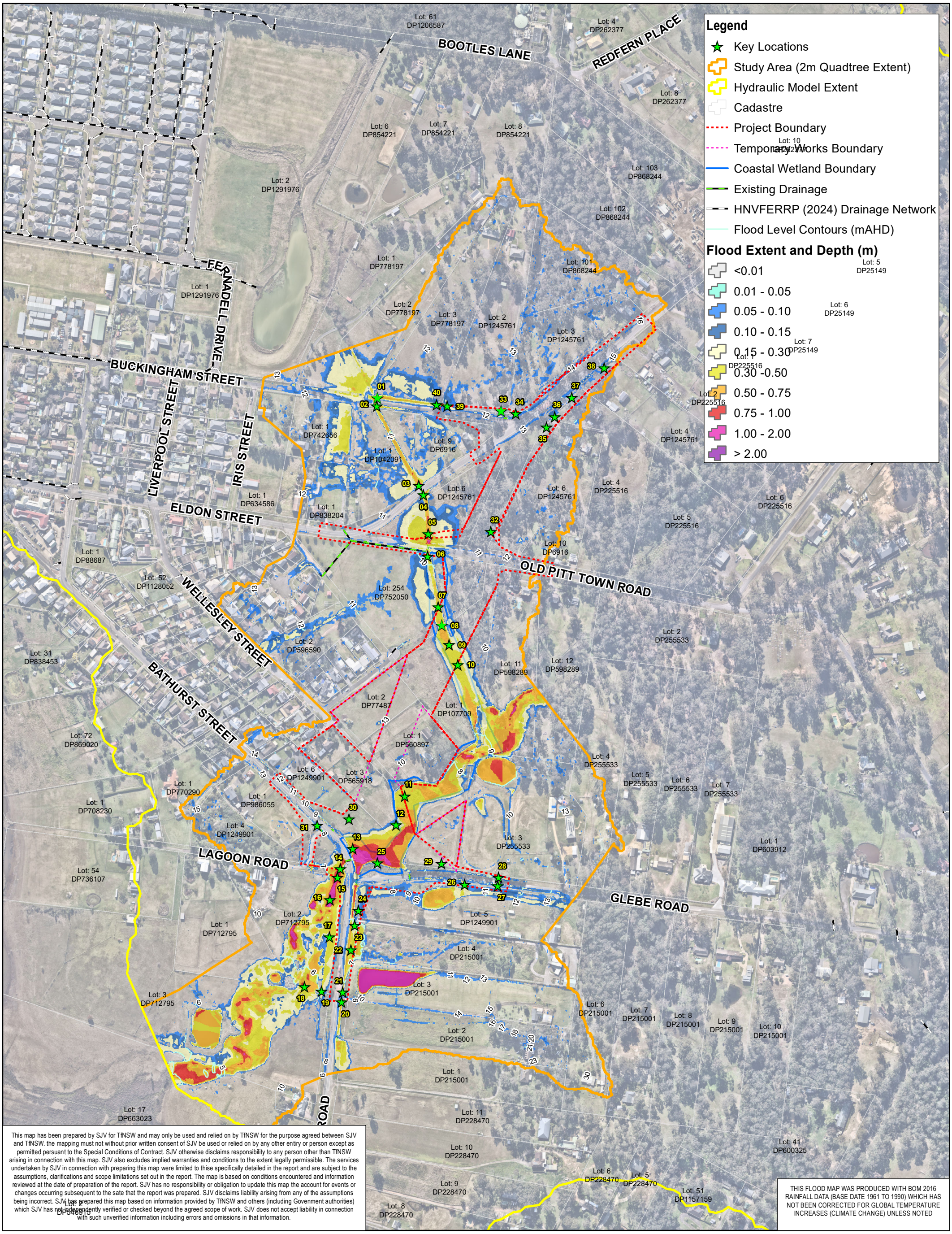
APPENDIX B – ARR 2019 BLOCKAGE ASSESSMENT

Status: Approved for use

Table 23: ARR 2019 Blockage Assessment

LINE ID	Culvert ID	Culvert Size	Width (m)	Height (m)	L10 (m)	Velocity (m/s)	Bed Material	D_{50} (mm)	Control Inlet Dimension	Debris Availability	Debris Mobility	Deris Transportability	Blockage due to Debris			Blockage Due to Sediment			Adopted Blockage			Governing Blockage		
Culvert Data						Input Data							**AEP>5%**	**AEP 5%-AEP 0.5%**	**AEP<0.5 %**	**AEP>5%**	**AEP 5%-AEP 0.5%**	**AEP<0.5 %**	**AEP>5%**	**AEP 5%-AEP 0.5%**	**AEP <0.5 %**	**AEP>5%**	**AEP 5%-AEP 0.5%**	**AEP<0.5 %**
001	Bathurst 1	1 x 900 RCP	0.9	0.9	1	1	Clay/Silt	<= 0.04mm	W < L10	M	M	L	25%	25%	50%	0%	0%	15%	**25%**	**25%**	**50%**	ARR Debris	ARR Debris	ARR Debris
002	PTB2	2 x 1.8 x 0.75 RCBC	1.8	0.75	3	1	Clay/Silt	<= 0.04mm	W < L10	M	M	L	25%	50%	100%	0%	15%	25%	**25%**	**50%**	**100%**	ARR Debris	ARR Debris	ARR Debris
003	PTB3	5 x 3.6 x 1.8 RCBC	3.6	1.8	3	1	Clay/Silt	<= 0.04mm	L10 <= W <= 3*L10	M	M	L	10%	20%	20%	15%	25%	25%	**15%**	**25%**	**25%**	ARR Sediment	ARR Sediment	ARR Sediment
004	PTB6	3 x 0.675 RCP	0.675	0.675	3	1	Clay/Silt	<= 0.04mm	W < L10	M	M	L	25%	25%	50%	0%	0%	15%	**25%**	**25%**	**50%**	ARR Debris	ARR Debris	ARR Debris
005	Buck1	1 x0.9 RCP	0.9	0.9	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**25%**	**25%**	**50%**	ARR Debris	ARR Debris	ARR Debris
006	PA1	2 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
007	Lagoon1	2 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	M	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
008	PA4	1 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
009	PA3	1 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
010	PA2	1 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
011	Mawson 1	1 x 0.525 RCP	0.525	0.525	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
012	Eldon1	1 x 0.375 RCP	0.375	0.375	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
013	OPT2	1 x 0.75 RCP	0.75	0.75	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**25%**	**25%**	**50%**	ARR Debris	ARR Debris	ARR Debris
014	OPT3	1 x 0.45 RCP	0.45	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
015	OPT1	1 x 0.75 RCP	0.75	0.75	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**25%**	**25%**	**50%**	ARR Debris	ARR Debris	ARR Debris
016	OPT5	3 x 1.8 x 0.75 RCP	1.8	0.75	1	1	Clay/Silt	<= 0.04mm	L10 <= W <= 3*L10	L	M	L	0%	0%	10%	0%	0%	15%	**0%**	**0%**	**15%**	Neither	Neither	ARR Sediment
017	Glebe4	1 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
018	Cattai2	1 x 0.6 x 0.45 RCBC	0.6	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
019	Glebe2	1 x 0.45 RCP	0.45	0.45	3	1	Clay/Silt	<= 0.04mm	W < L10	M	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris
020	Glebe3	1 x 0.375 RCP	0.375	0.45	1	1	Clay/Silt	<= 0.04mm	W < L10	L	M	L	25%	25%	50%	0%	0%	15%	**50%**	**50%**	**50%**	Transport	Transport	ARR Debris

APPENDIX C – EXISTING CONDITIONS FLOOD MAPPING



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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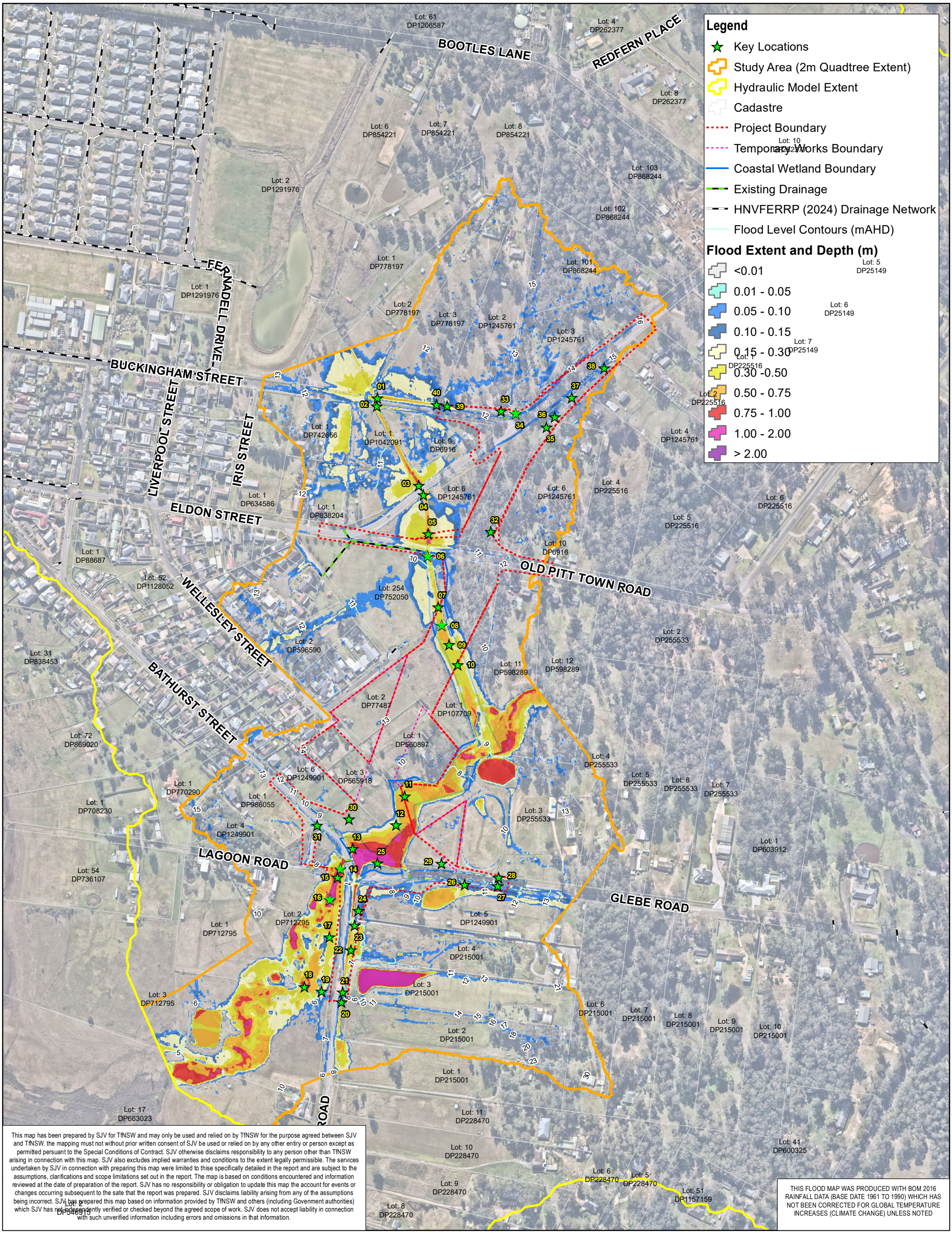
Existing Conditions
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B001

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B001_Flood Extent and Depth_20pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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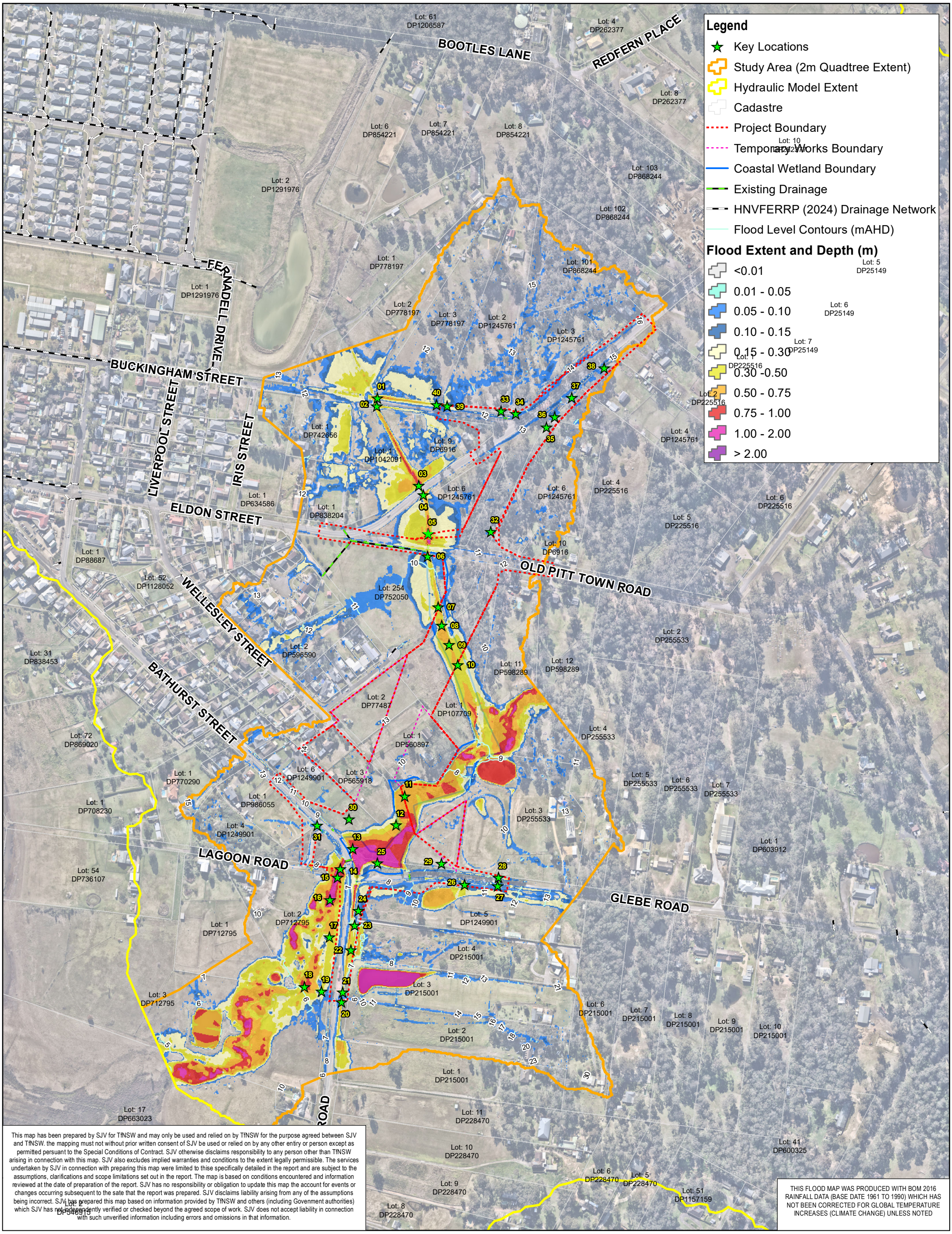
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B002

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B002_Flood Extent and Depth_10pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

Data source: . Created by: sldouglas



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Existing Drainage
- HNVFERRP (2024) Drainage Network
- Flood Level Contours (mAHD)

Flood Extent and Depth (m)

- <0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 -0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- > 2.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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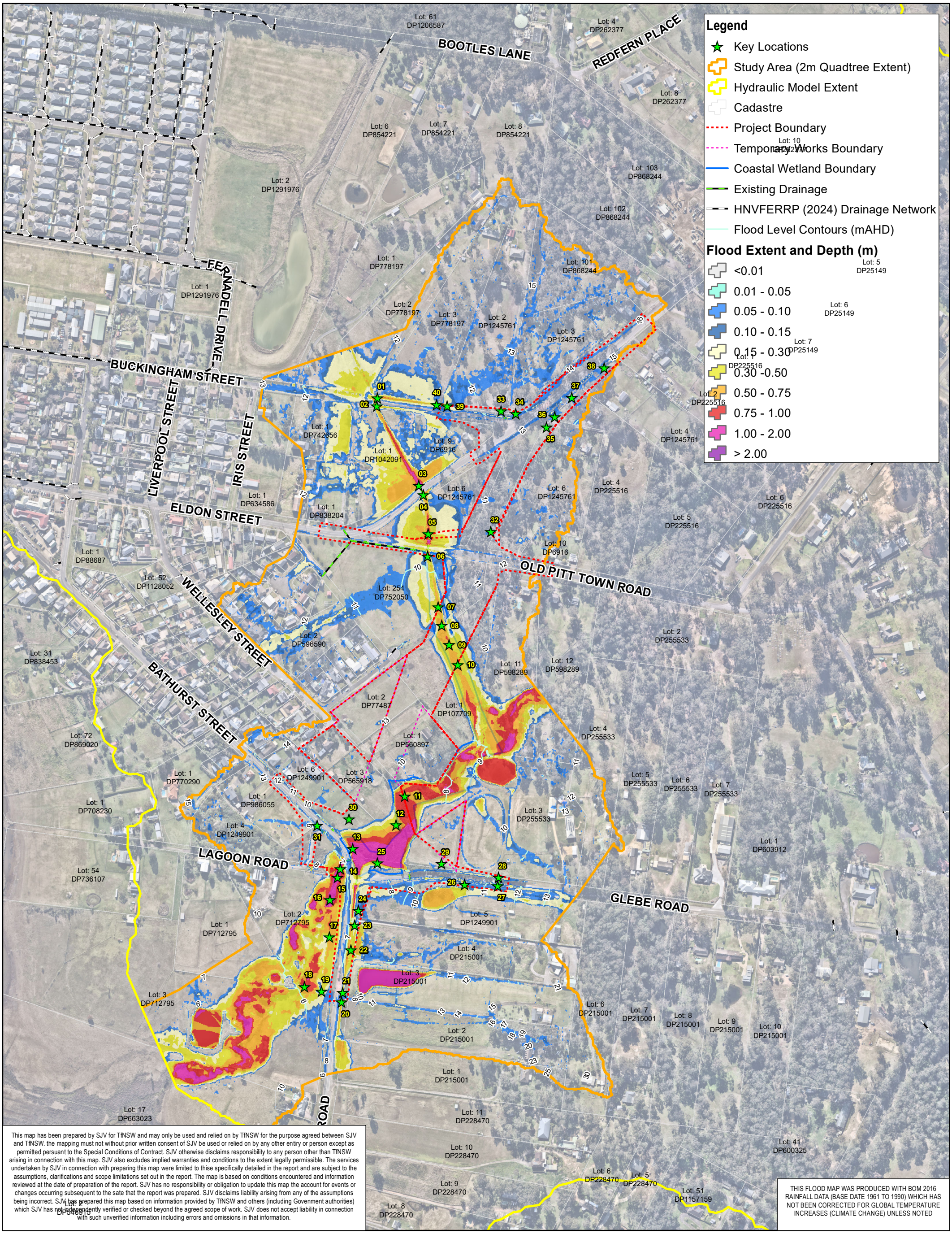
Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B003

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B003_Flood Extent and Depth_5pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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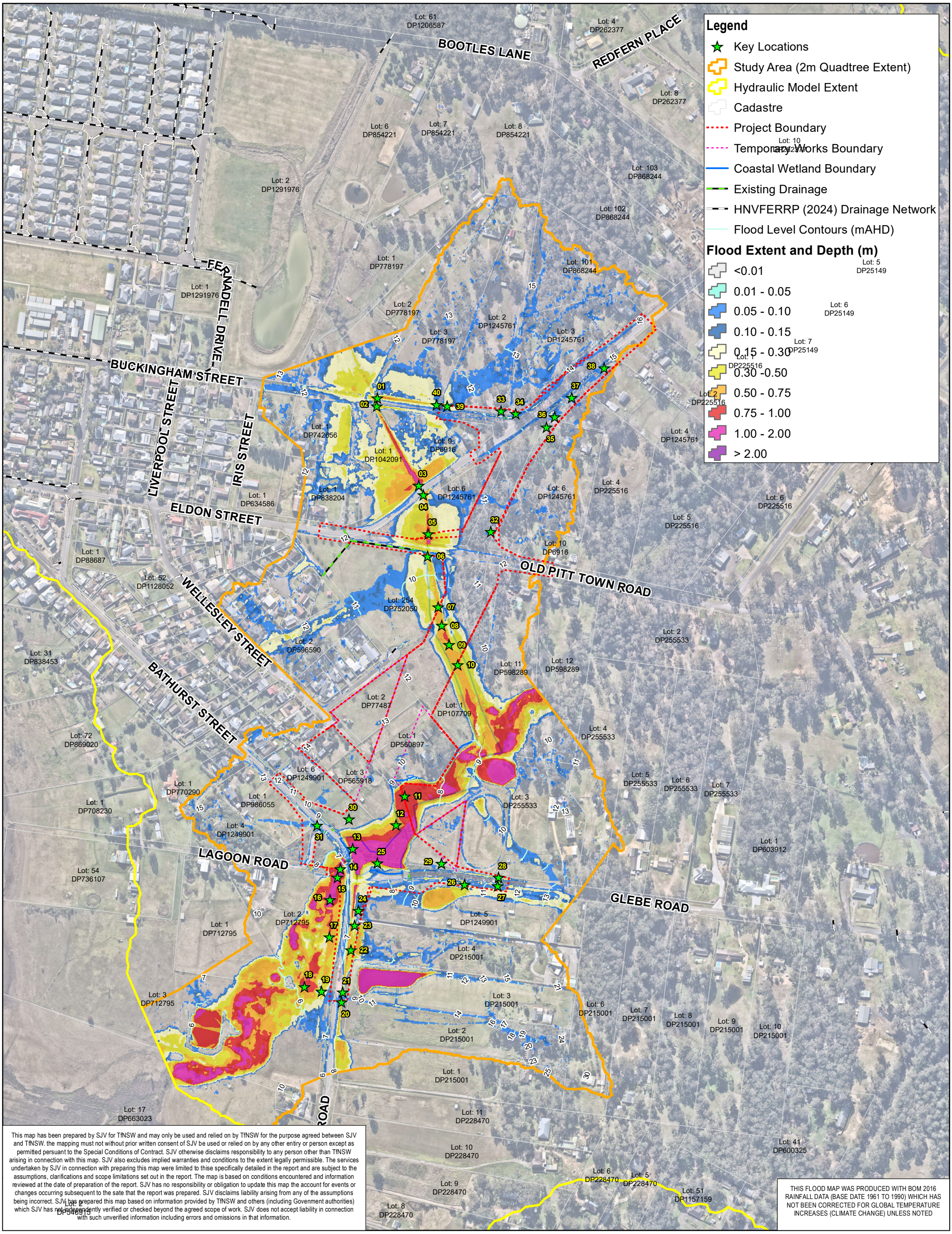
Existing Conditions
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B004

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B004_Flood Extent and Depth_2pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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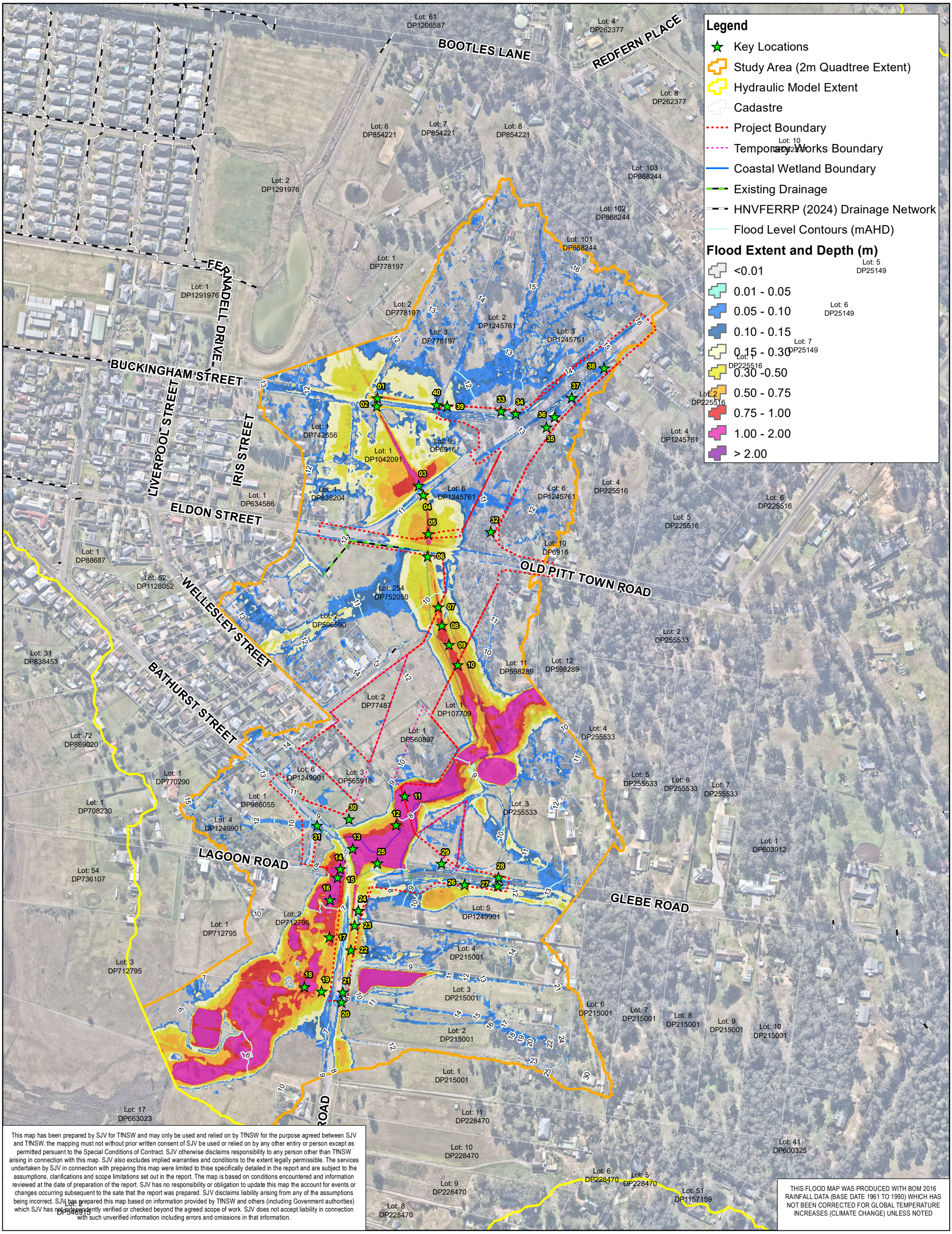
Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
Existing Conditions
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B005

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B005_Flood Extent and Depth_1pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
Existing Conditions
0.05% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B006

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B006_Flood Extent and Depth_0.05pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_EX.mxd

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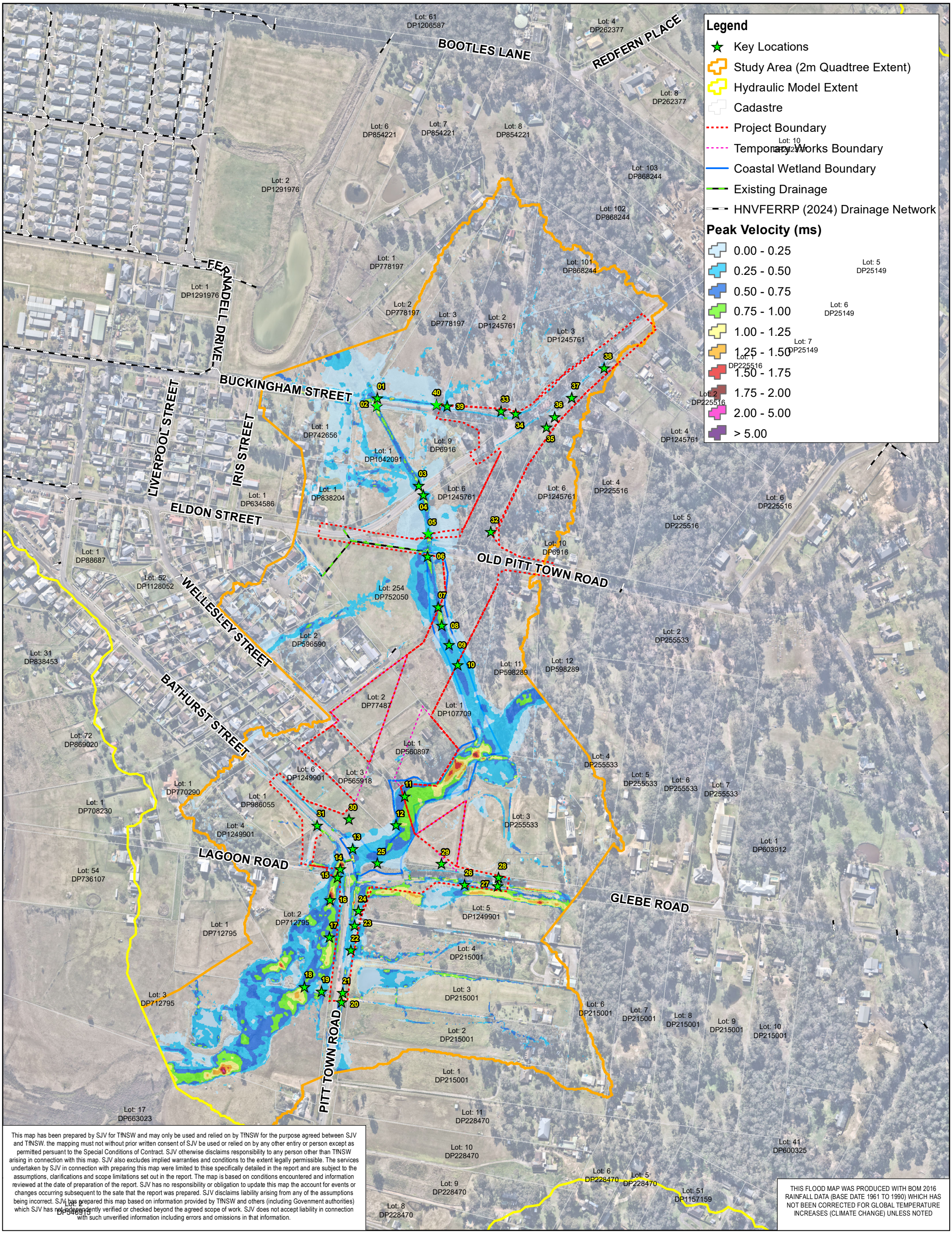

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Existing Drainage
- HNVFERRP (2024) Drainage Network

Peak Velocity (ms)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 1.75
- 1.75 - 2.00
- 2.00 - 5.00
- > 5.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD

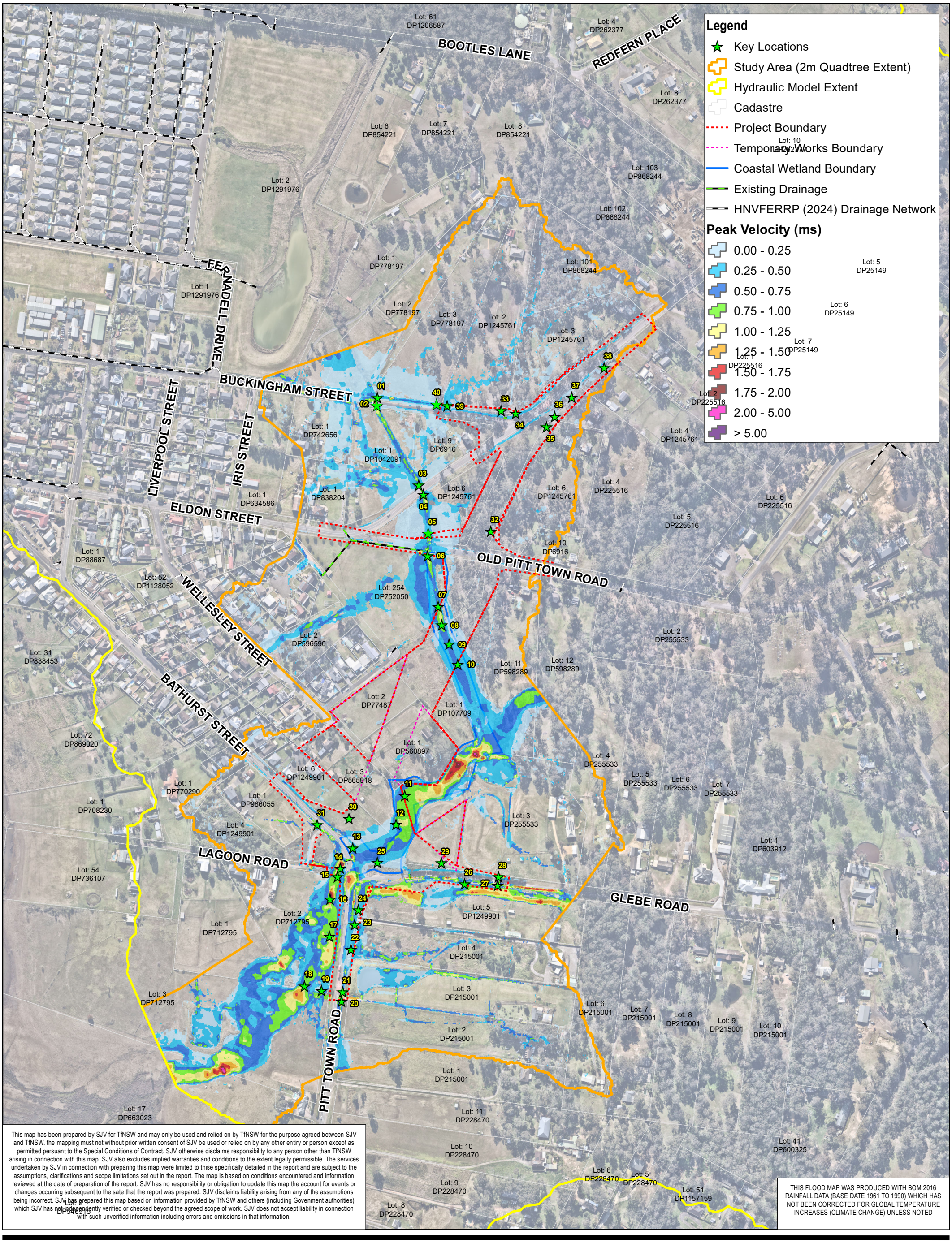
Addendum REF
Existing Conditions
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B007

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B007_Peak Velocity_20pct_Peak Velocity (ms)_EX.mxd
Print date: 07 Aug 2024 - 09:56

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Addendum REF
Existing Conditions
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B008

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B008_Peak Velocity_10pct_Peak Velocity (ms)_EX.mxd
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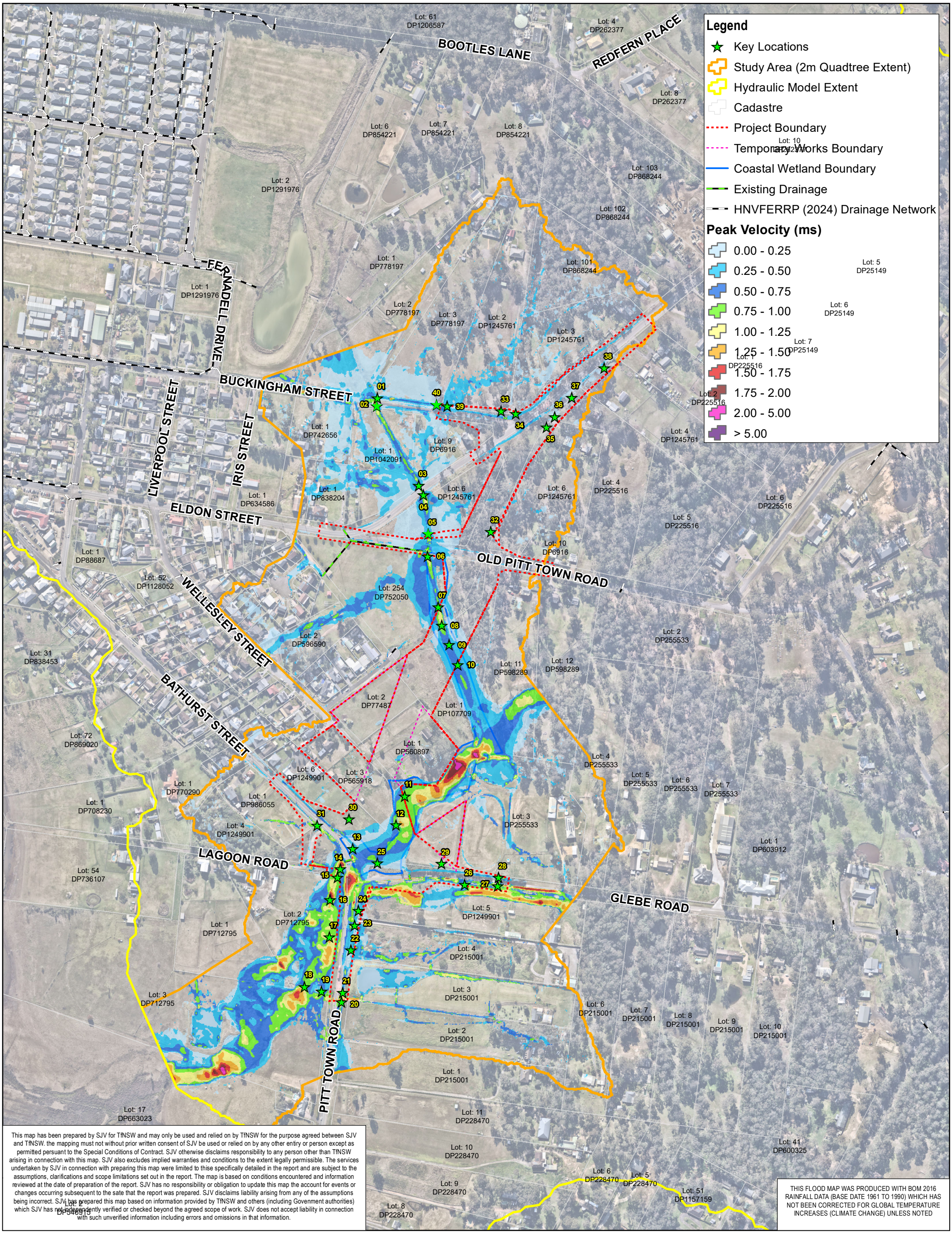

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Addendum REF
Existing Conditions
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B009

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B009_Peak Velocity_5pct_Peak Velocity (ms)_EX.mxd
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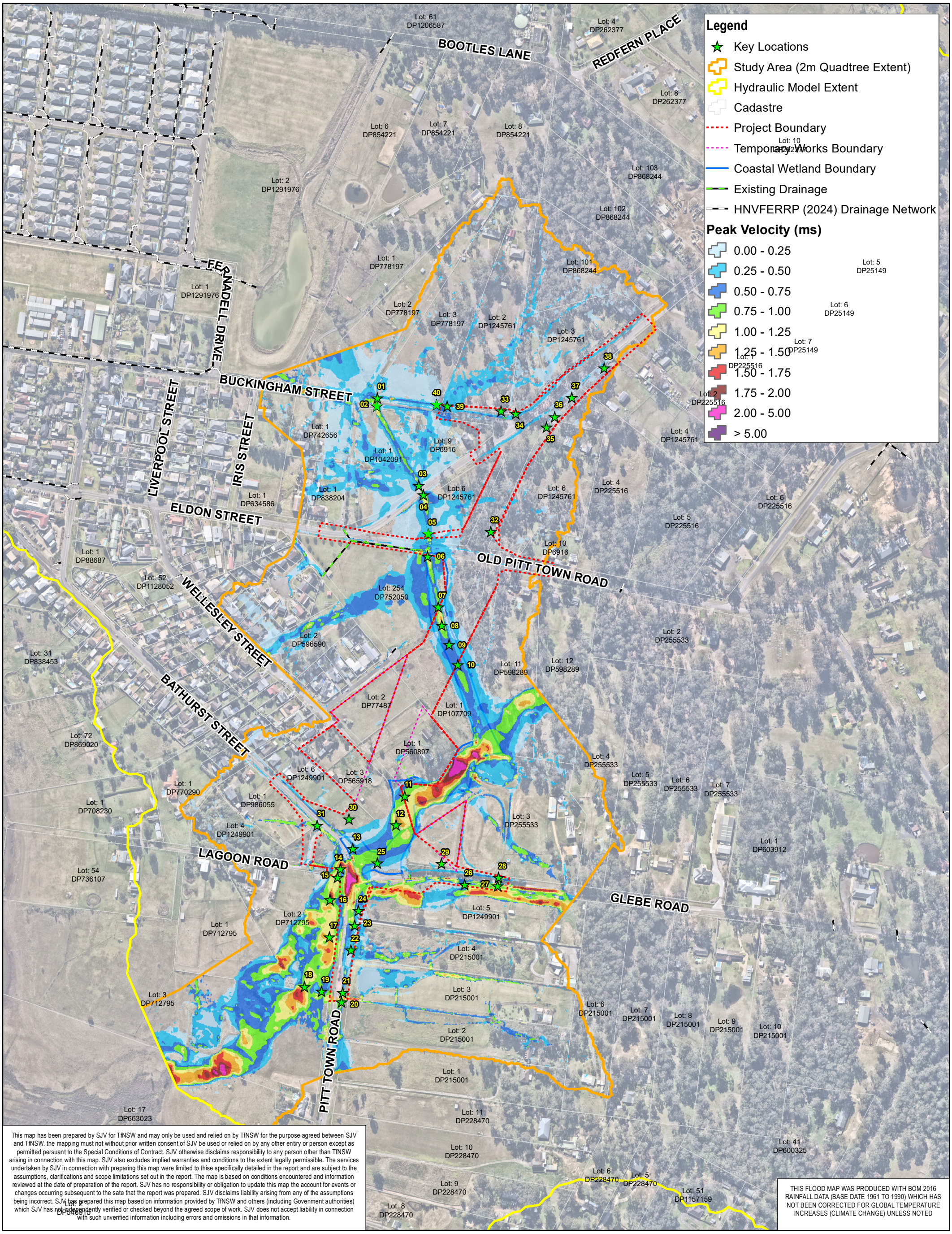

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Existing Drainage
- HNVFERRP (2024) Drainage Network

Peak Velocity (ms)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 1.75
- 1.75 - 2.00
- 2.00 - 5.00
- > 5.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Addendum REF
Existing Conditions
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B010

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B010_Peak Velocity_2pct_Peak Velocity (ms)_EX.mxd
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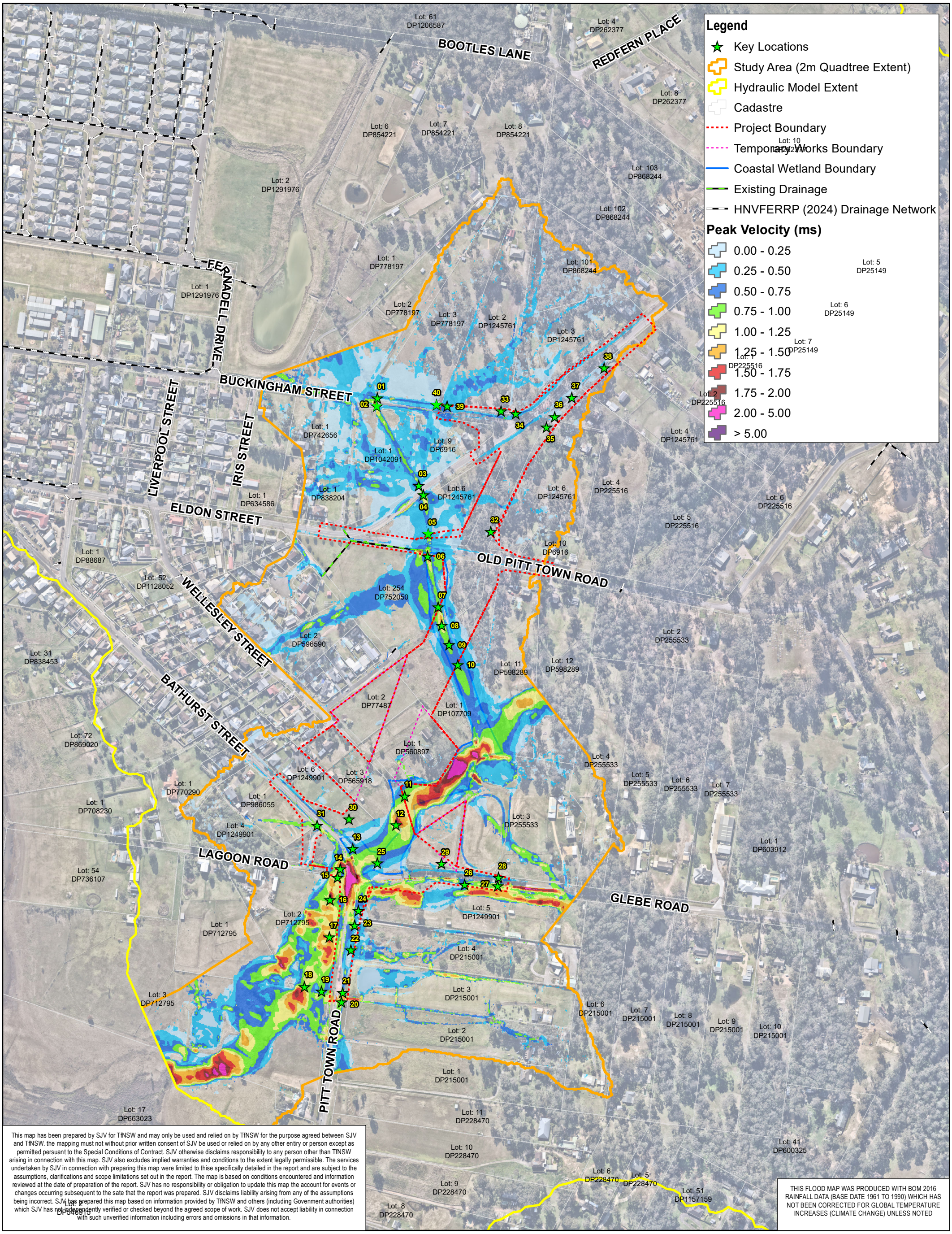

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Addendum REF
Existing Conditions
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B011

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B011_Peak Velocity_1pct_Peak Velocity (ms)_EX.mxd
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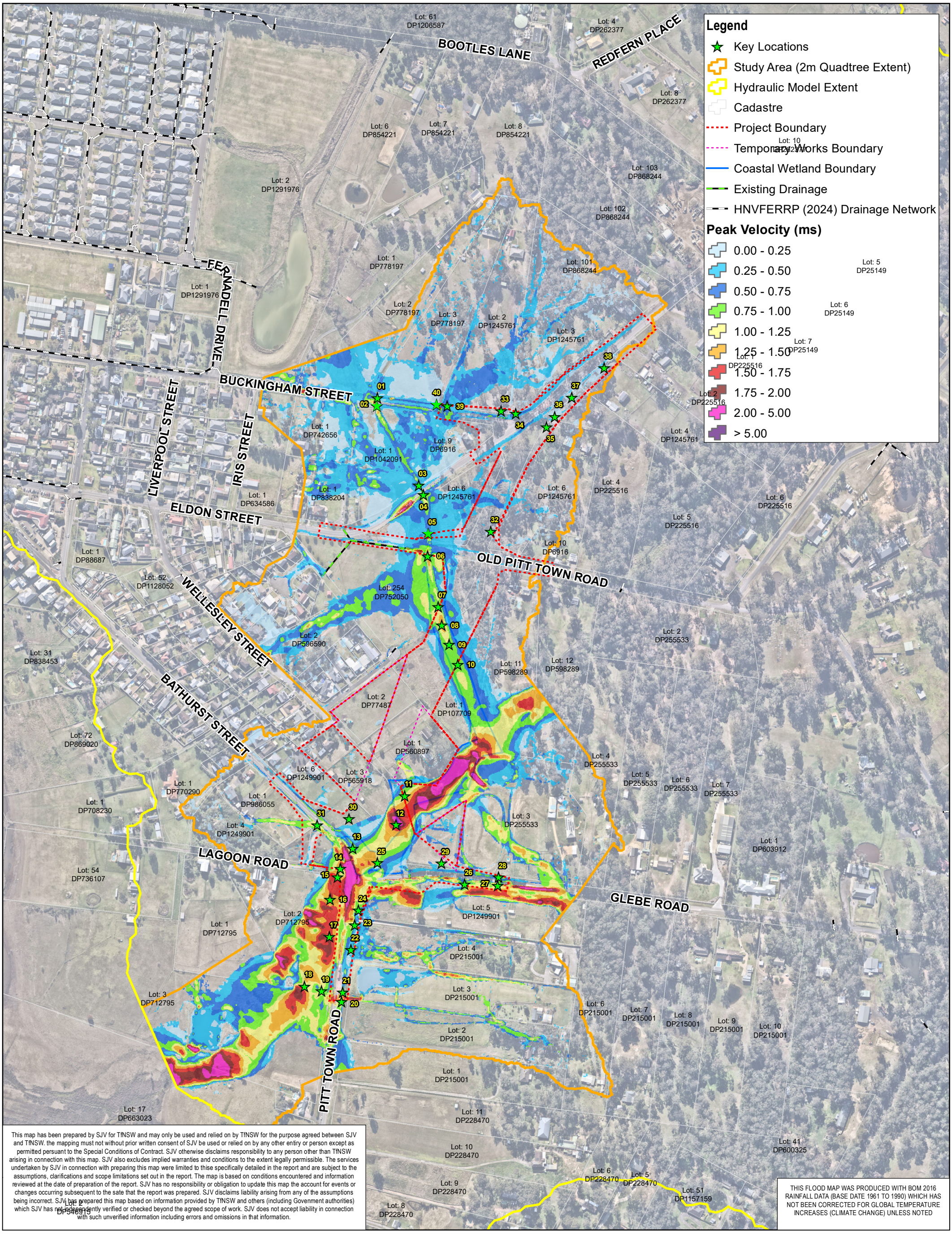

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF
Existing Conditions
0.05% AEP

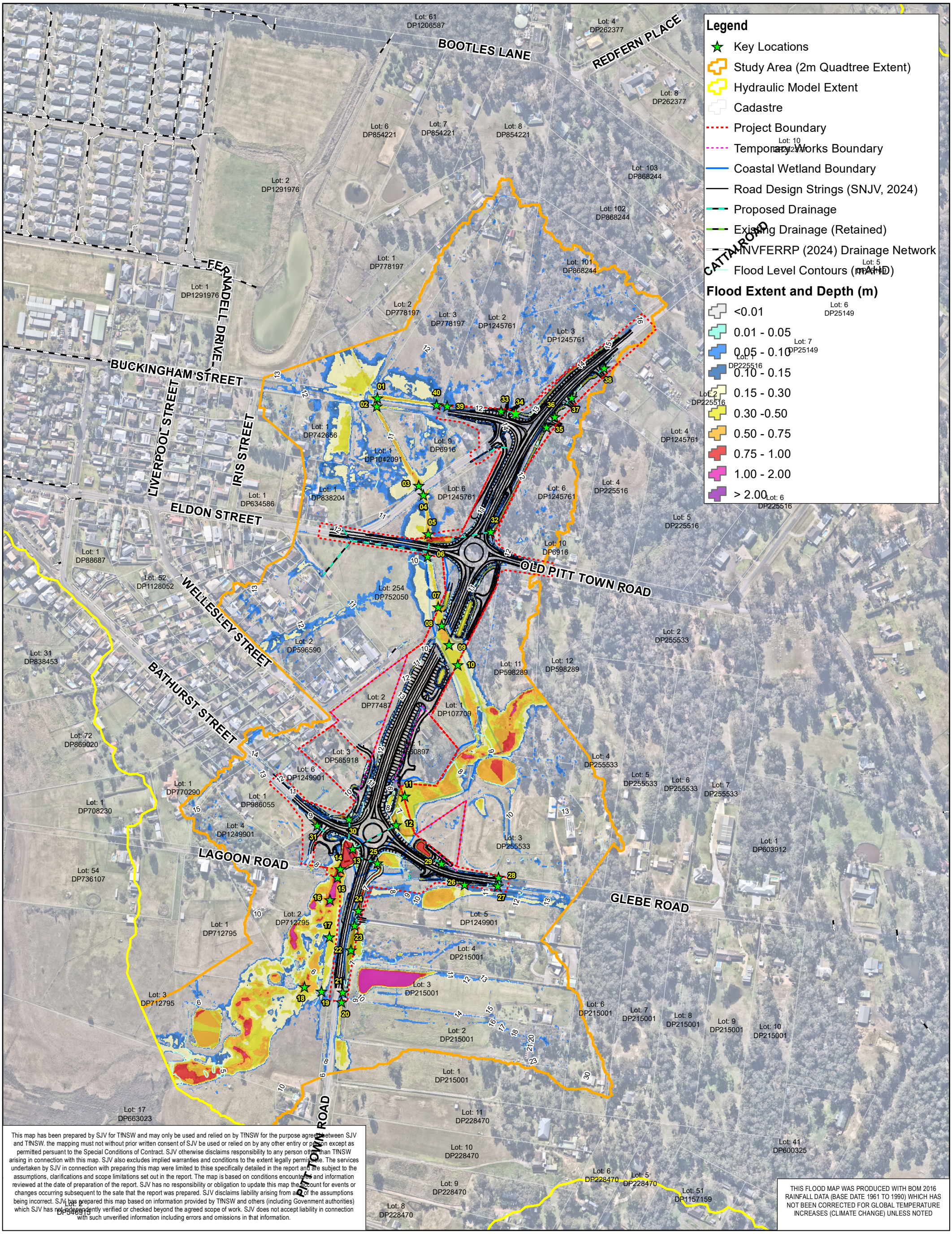
Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure B012

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_B012_Peak Velocity_0.05pct_Peak Velocity (ms)_EX.mxd
Print date: 07 Aug 2024 - 09:58

Data source: . Created by: sldouglas

APPENDIX D – PROPOSED CONDITIONS FLOOD MAPPING



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C001

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C001_Flood Extent and Depth_20pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

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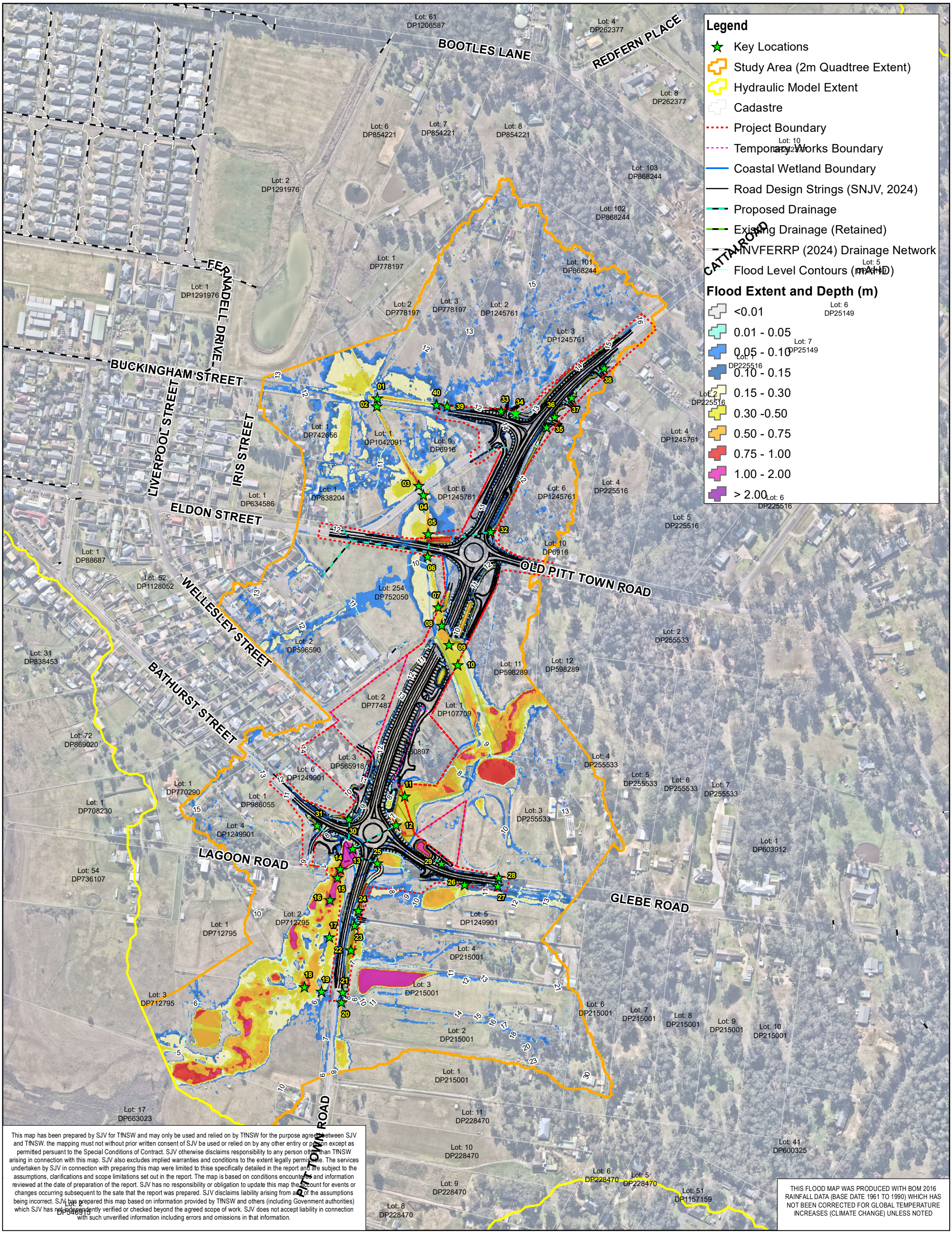

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C002

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C002_Flood Extent and Depth_10pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

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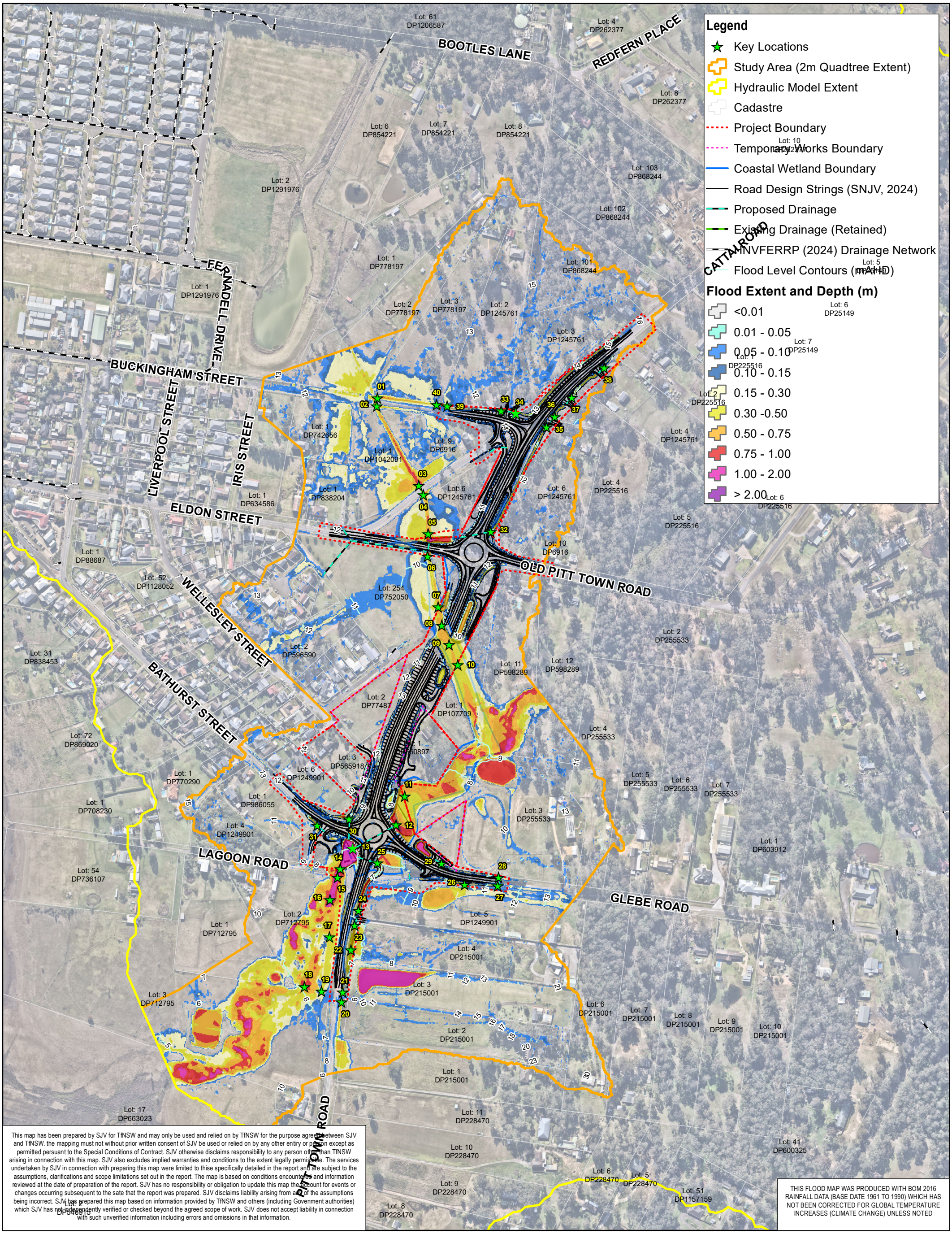

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C003

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C003_Flood Extent and Depth_5pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

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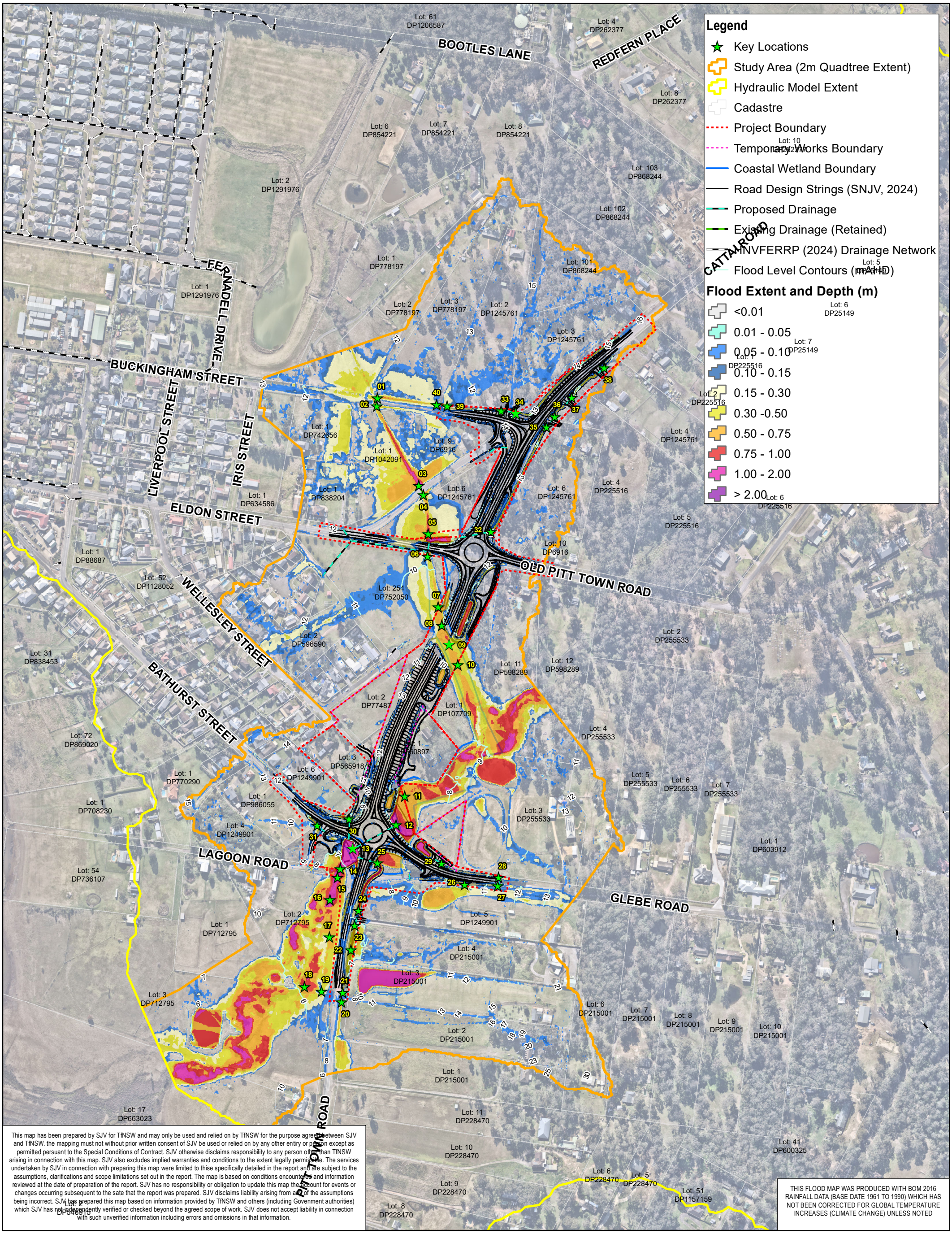

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Flood Level Contours (mAHD)

Flood Extent and Depth (m)

- <0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 -0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- > 2.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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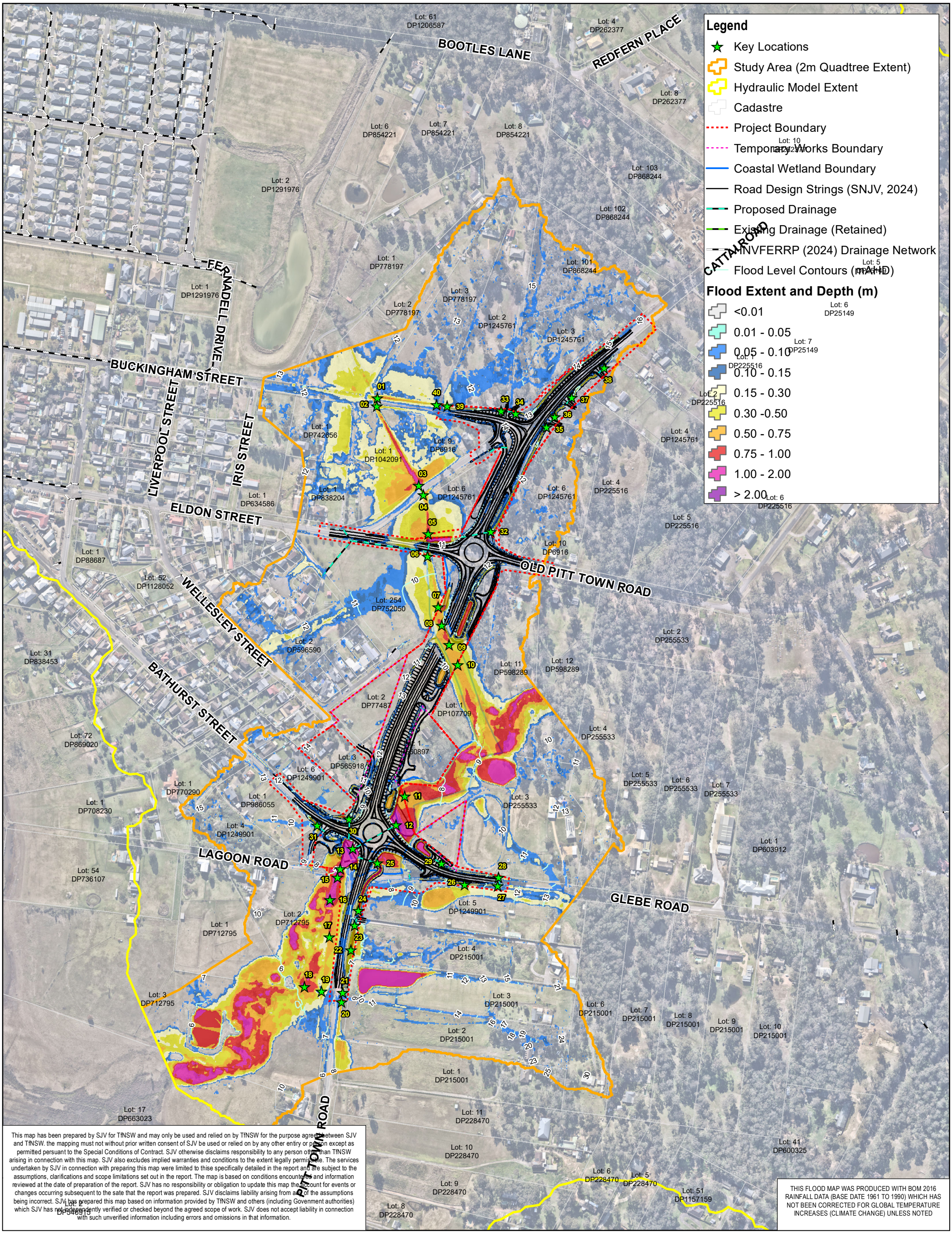
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C004

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C004_Flood Extent and Depth_2pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

Data source: . Created by: sldouglas



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Flood Level Contours (mAHD)

Flood Extent and Depth (m)

- <0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 -0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- > 2.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C005

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C005_Flood Extent and Depth_1pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

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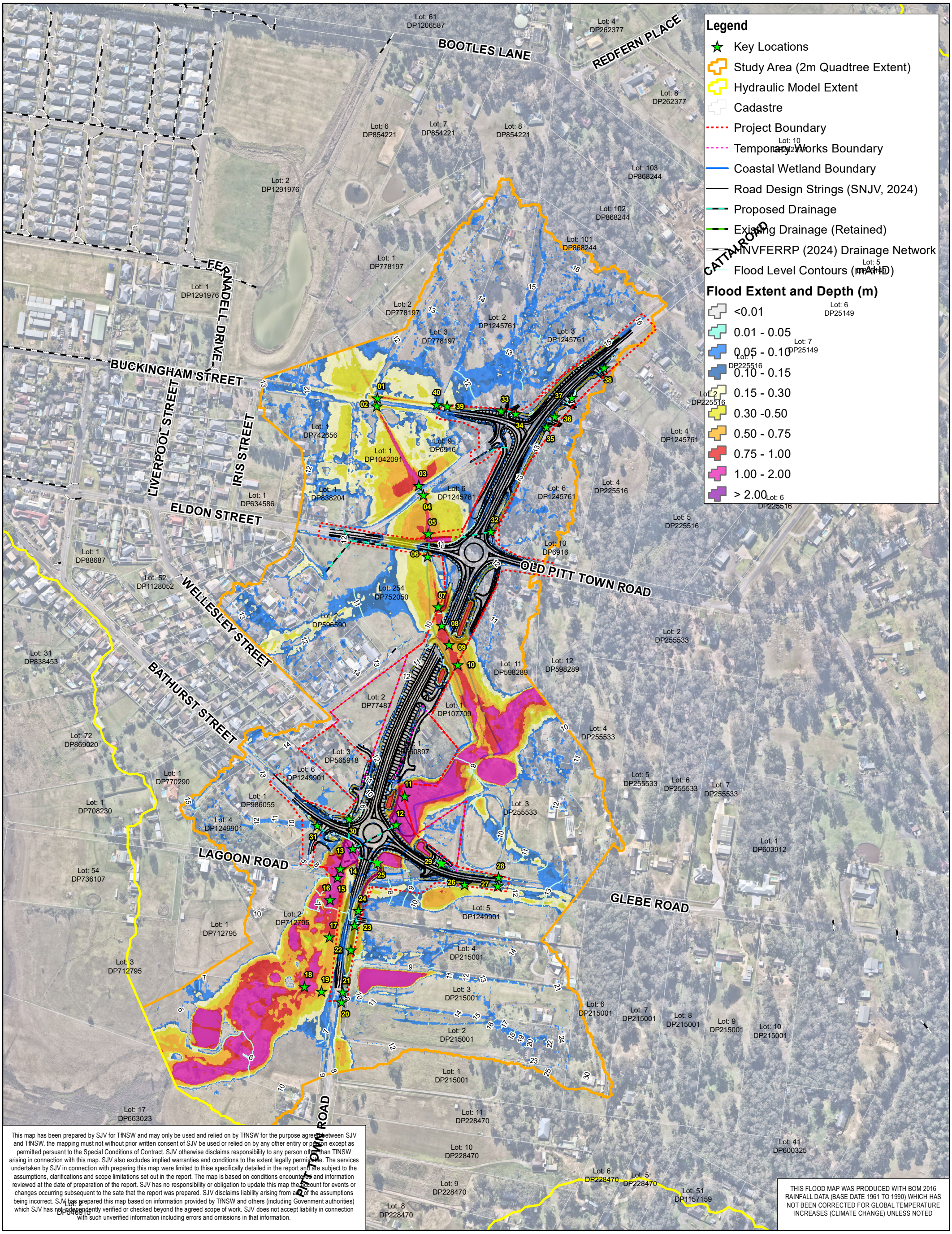

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

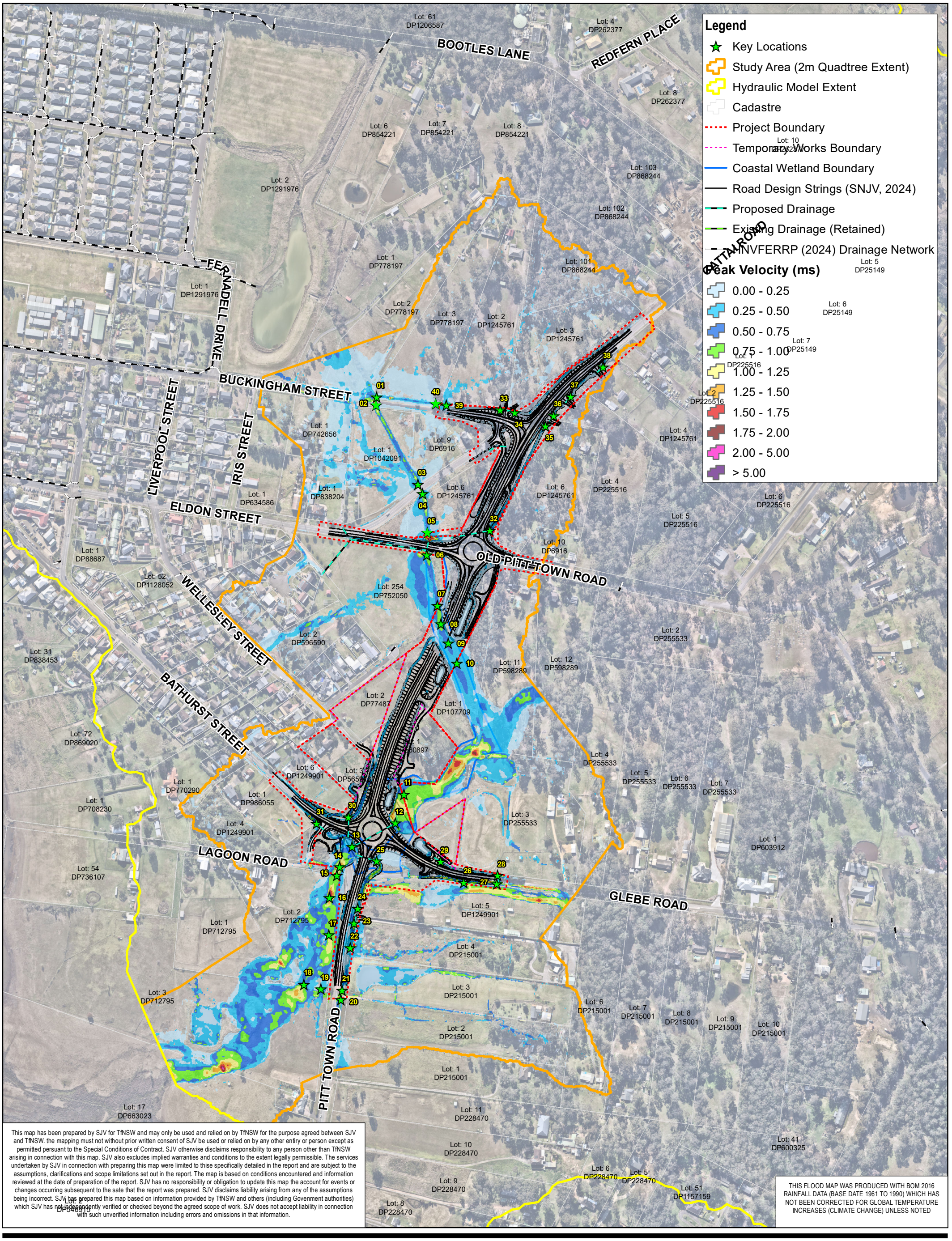
Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
0.05% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C006

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C006_Flood Extent and Depth_0.05pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C007

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C007_Peak Velocity_20pct_Peak Velocity (ms)_SJV_Des.mxd
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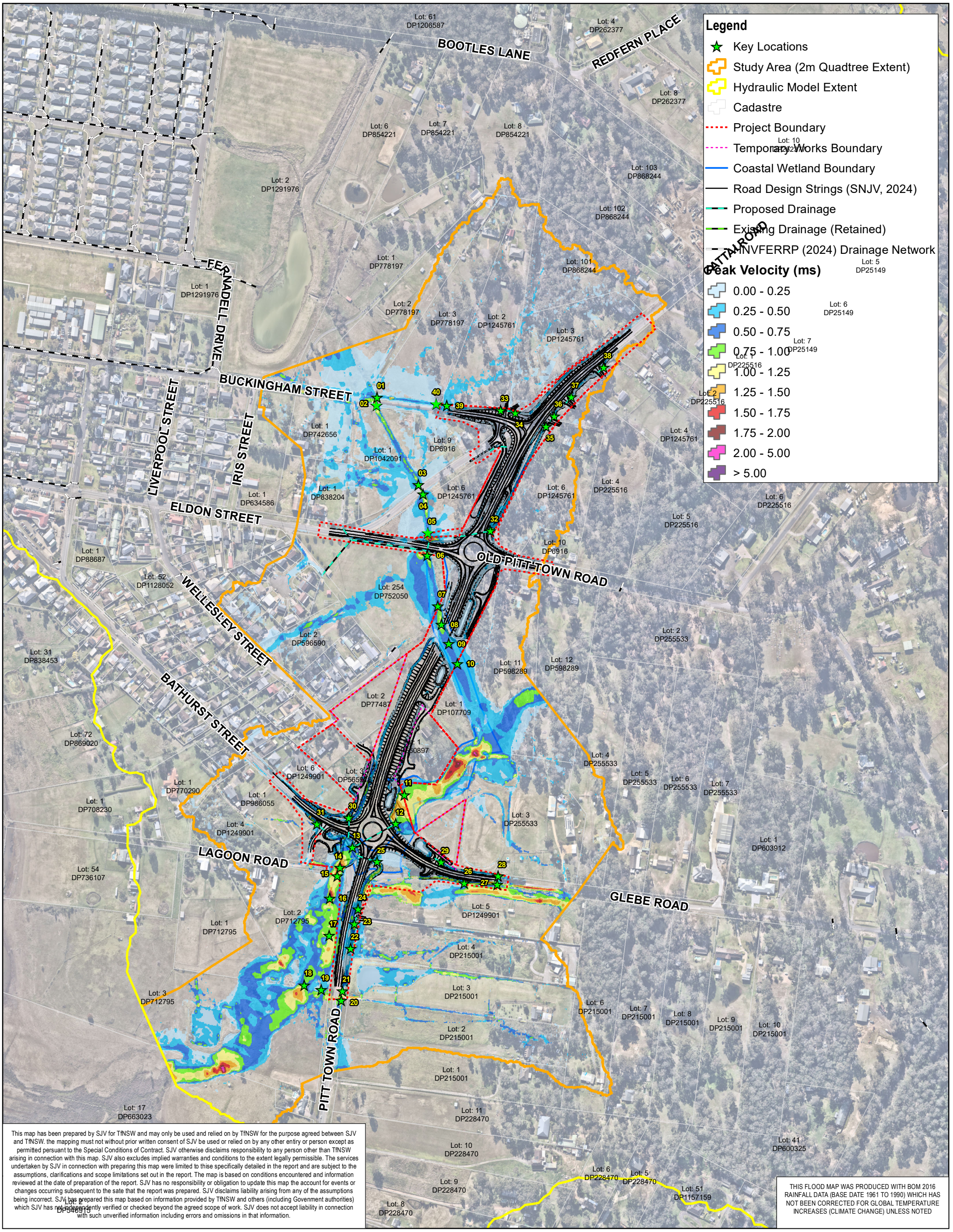

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C008

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C008_Peak Velocity_10pct_Peak Velocity (ms)_SJV_Des.mxd
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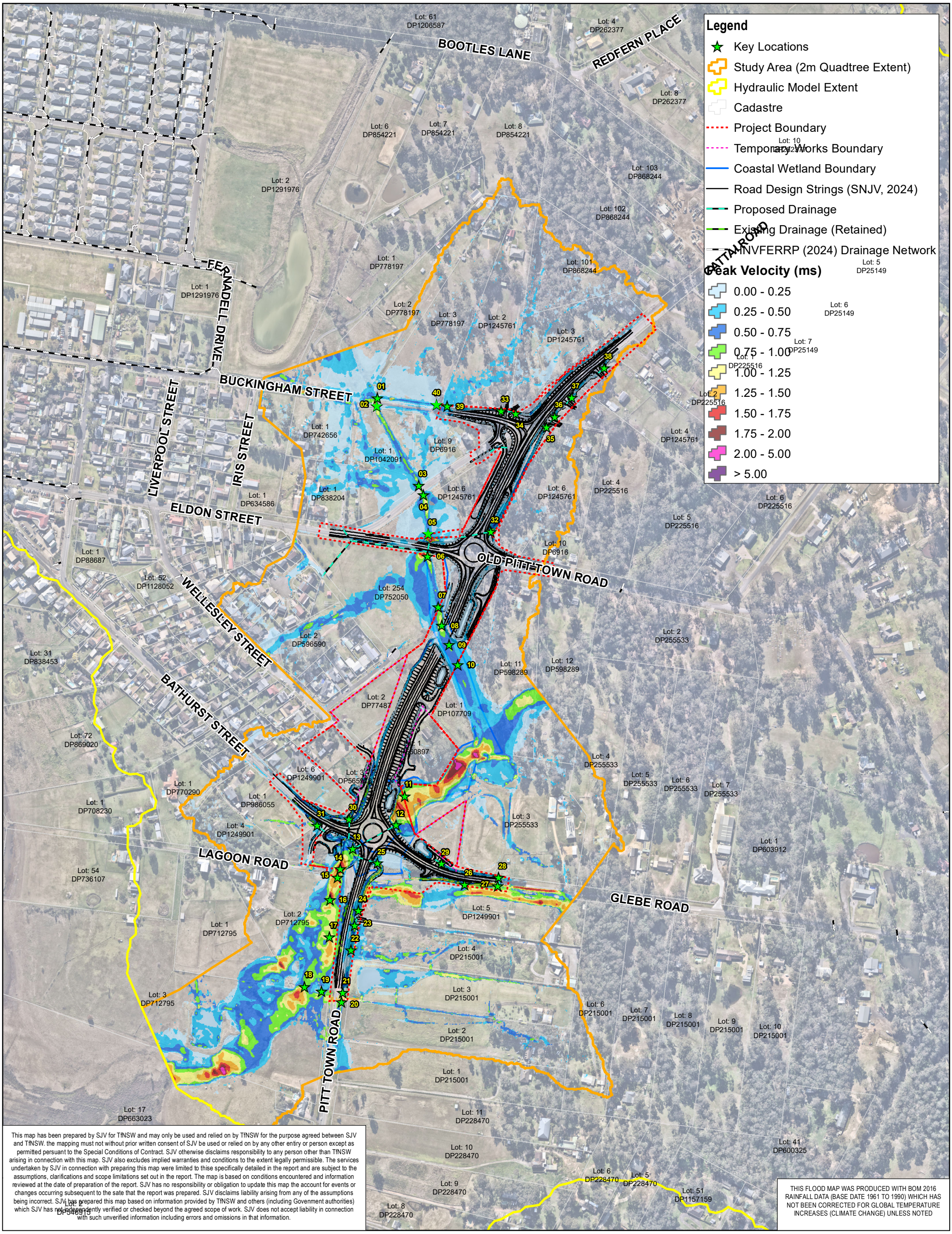

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C009

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C009_Peak Velocity_5pct_Peak Velocity (ms)_SJV_Des.mxd
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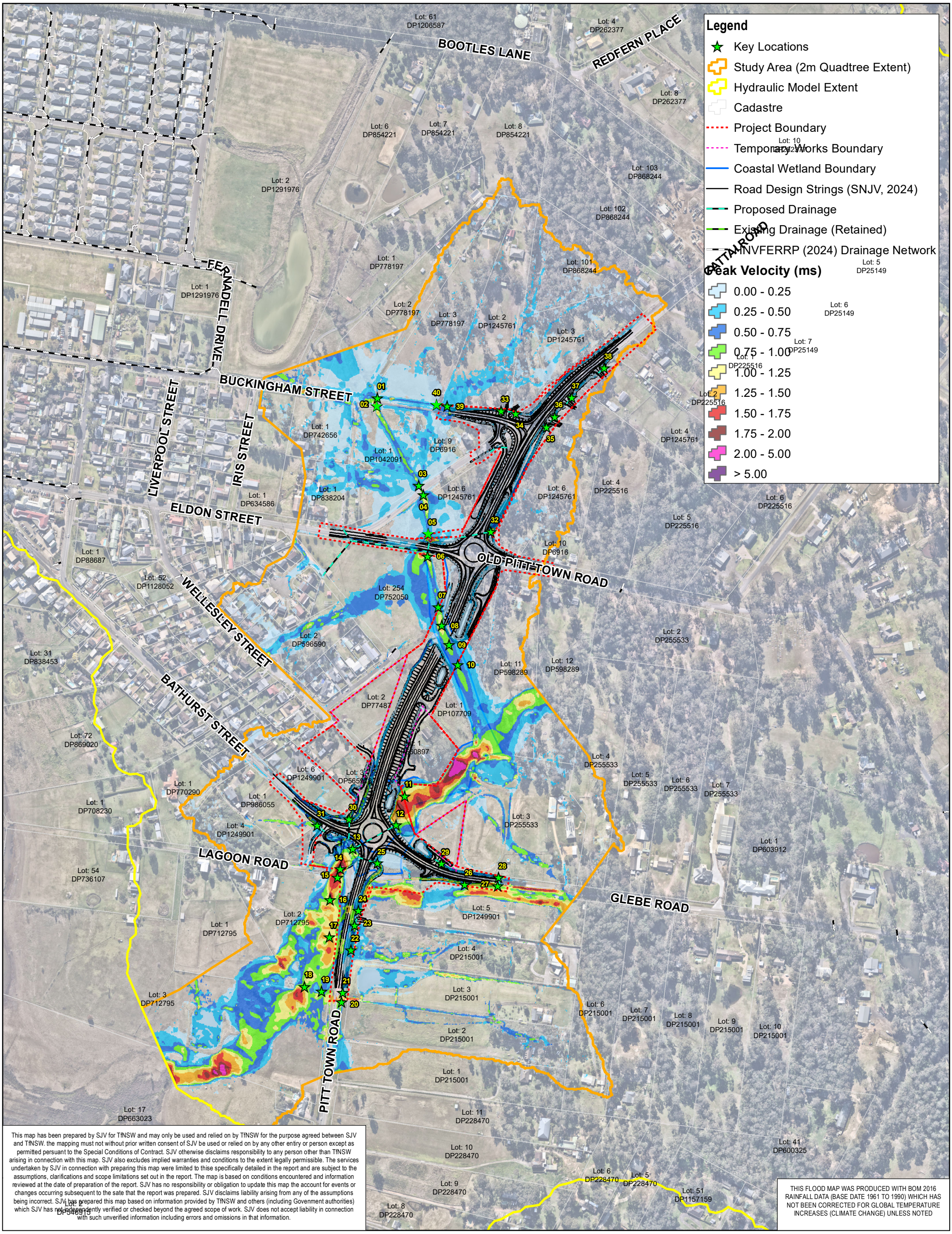

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C010

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C010_Peak Velocity_2pct_Peak Velocity (ms)_SJV_Des.mxd
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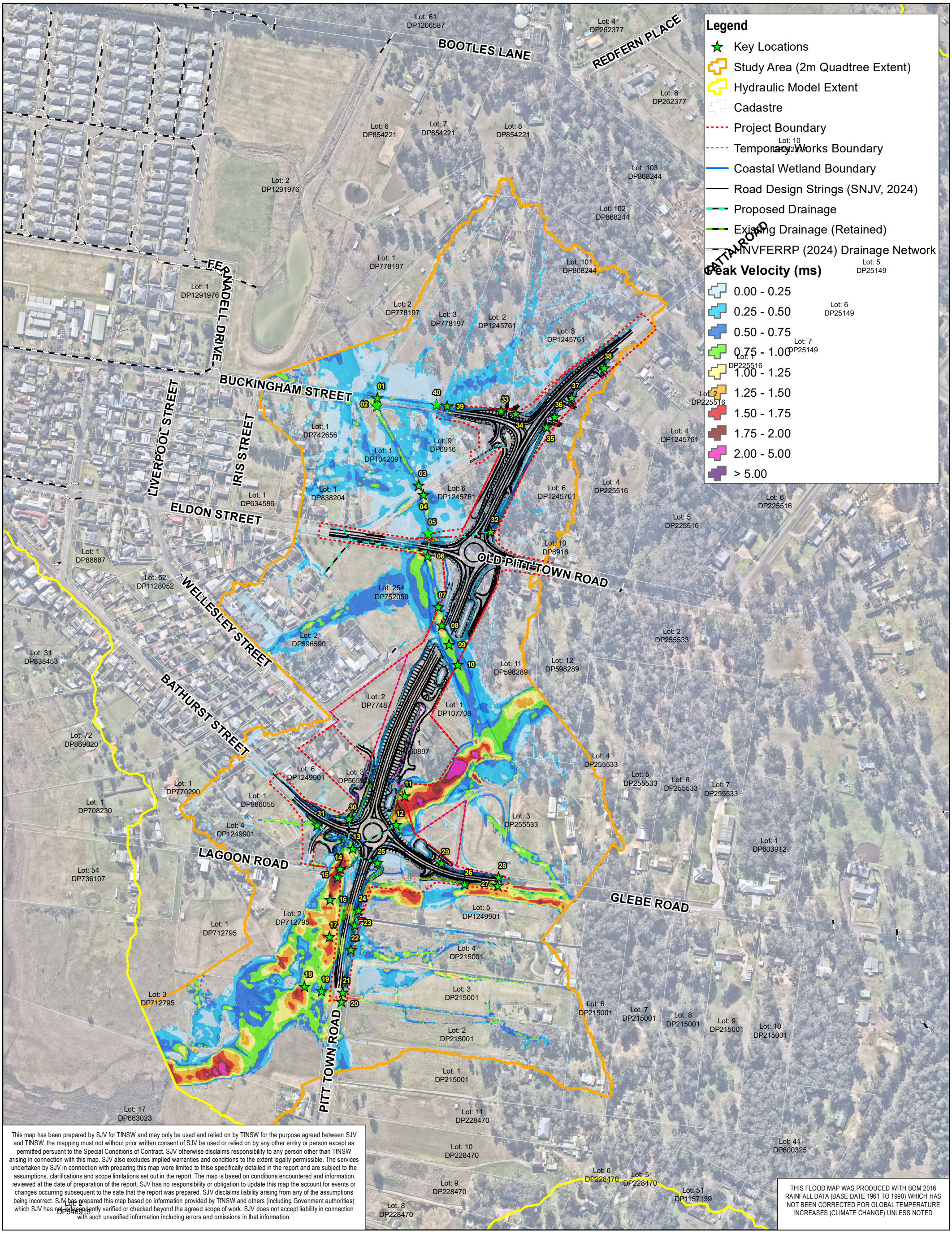

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C011

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C011_Peak Velocity_1pct_Peak Velocity (ms)_SJV_Des.mxd
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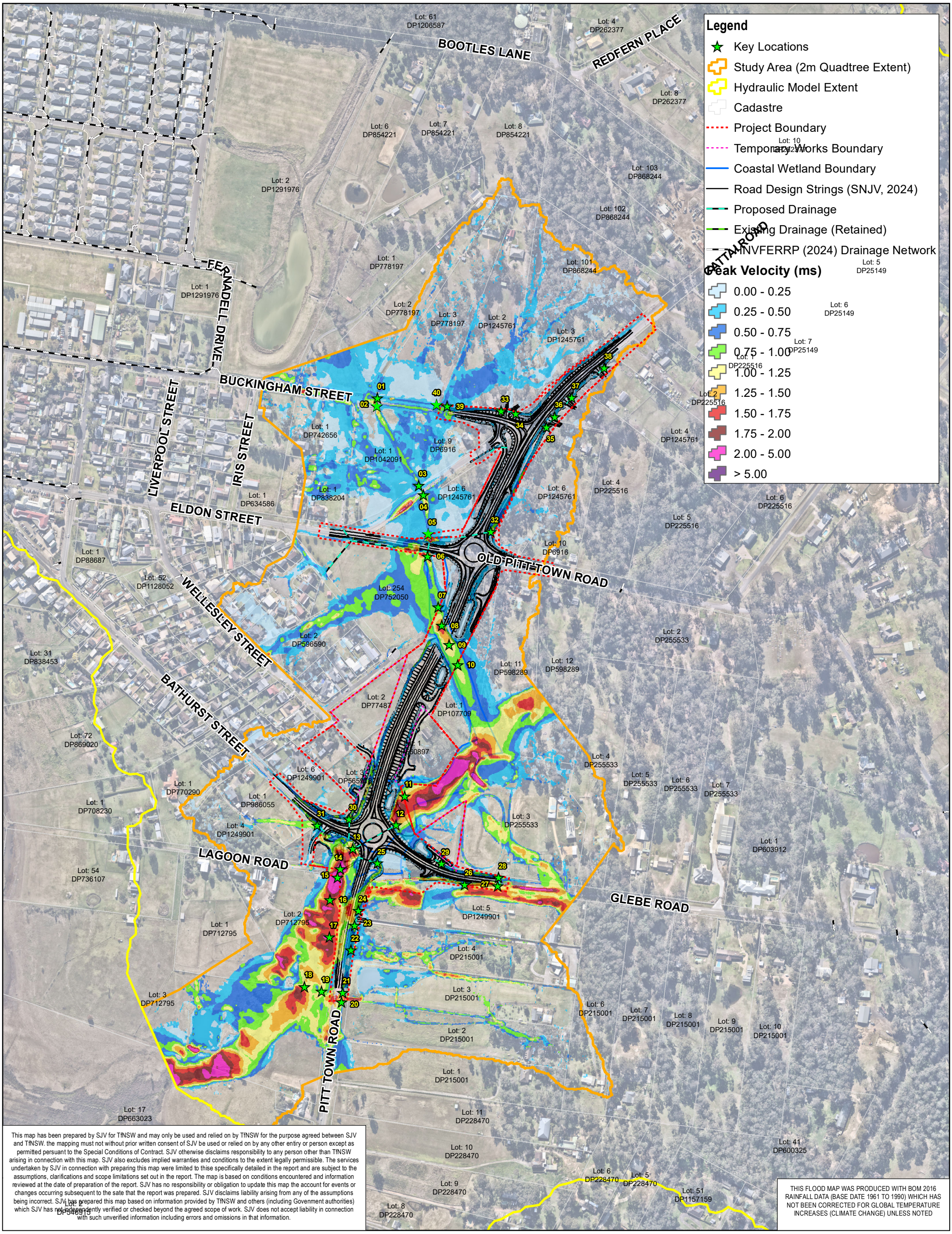

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
SJV Design
0.05% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C012

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C012_Peak Velocity_0.05pct_Peak Velocity (ms)_SJV_Des.mxd
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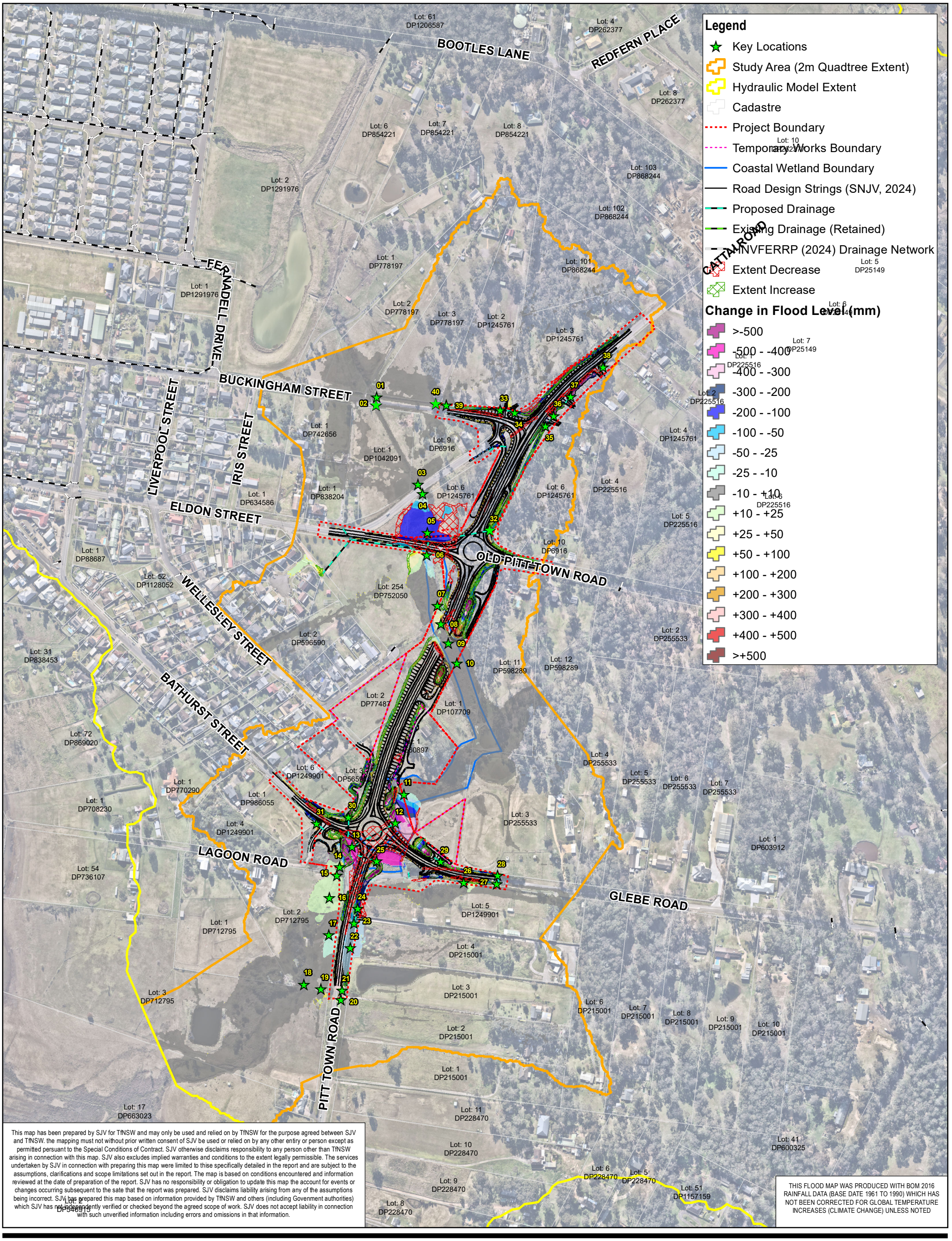

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C013

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C013_Change in Flood Level_20pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

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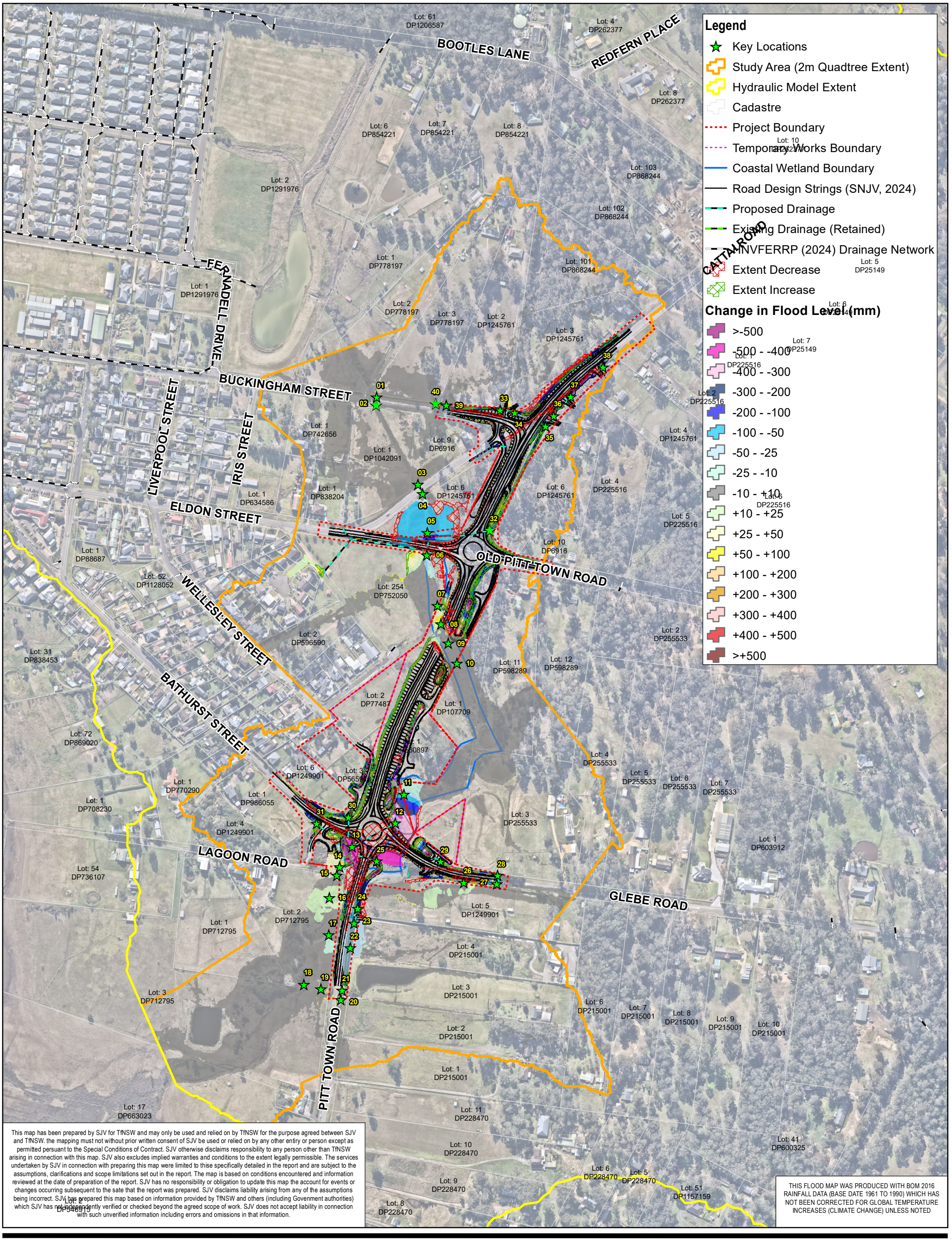

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

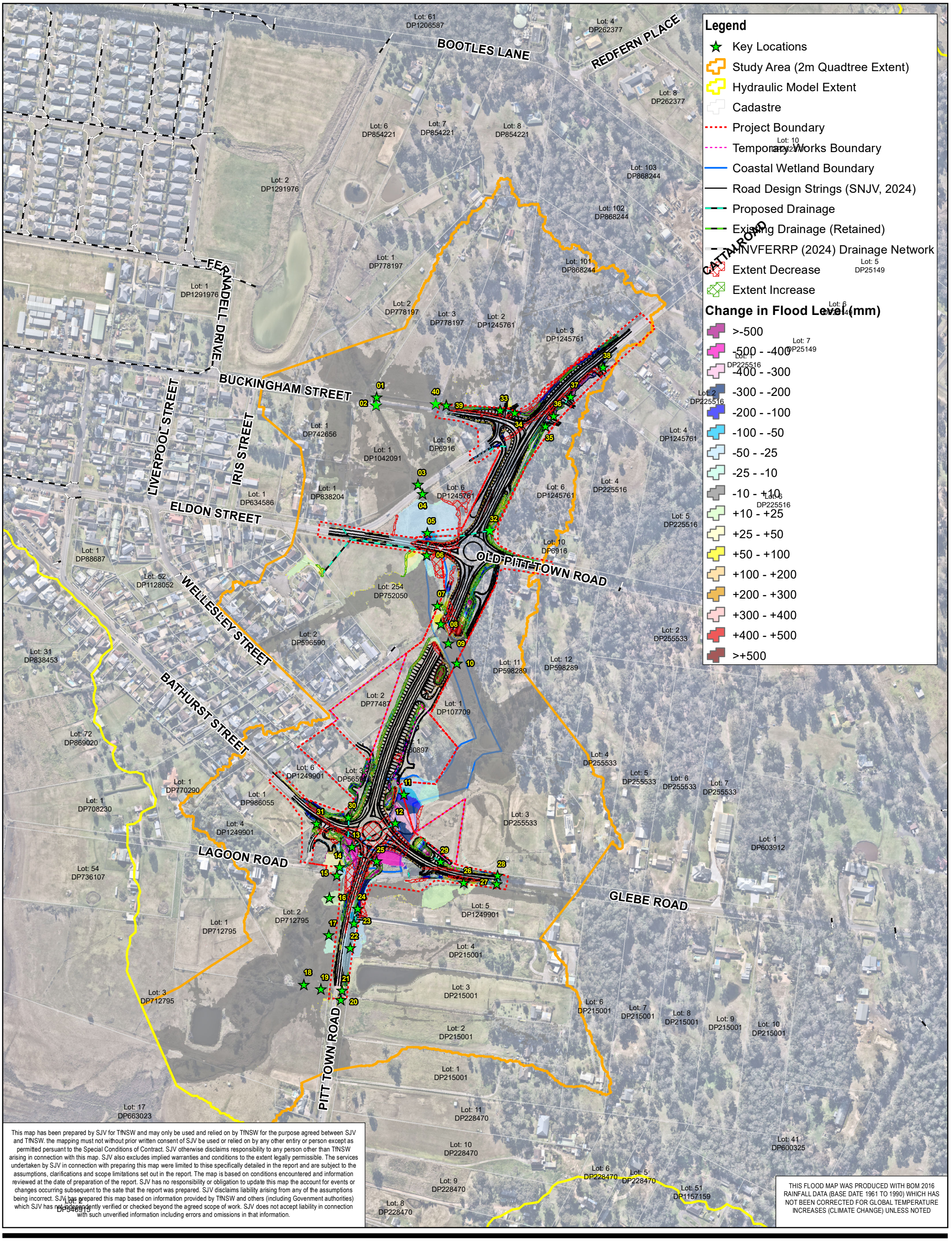
Flood Impacts (Design vs Existing)
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C014

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C014_Change in Flood Level_10pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C015

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C015_Change in Flood Level_5pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

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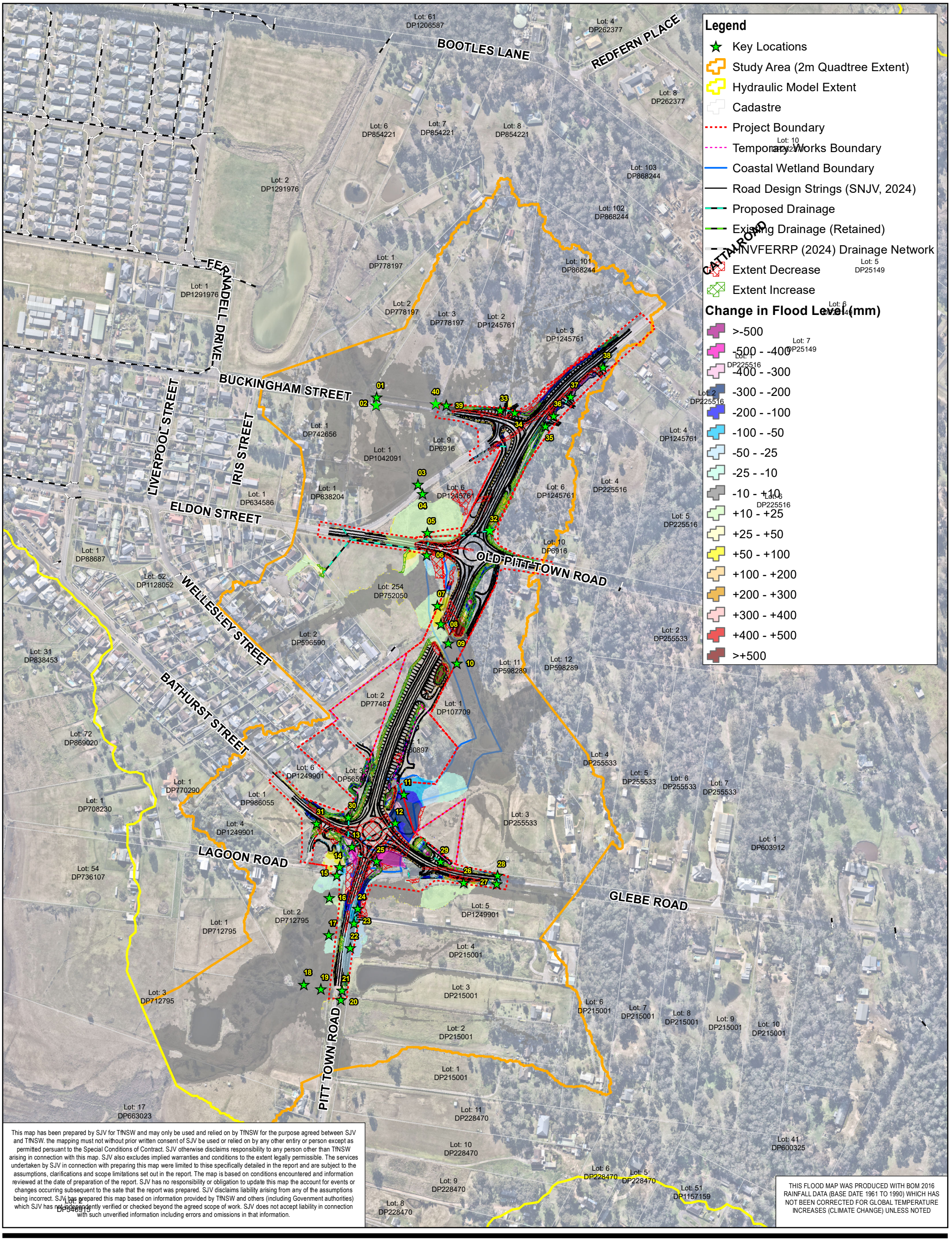

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C016

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C016_Change in Flood Level_2pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

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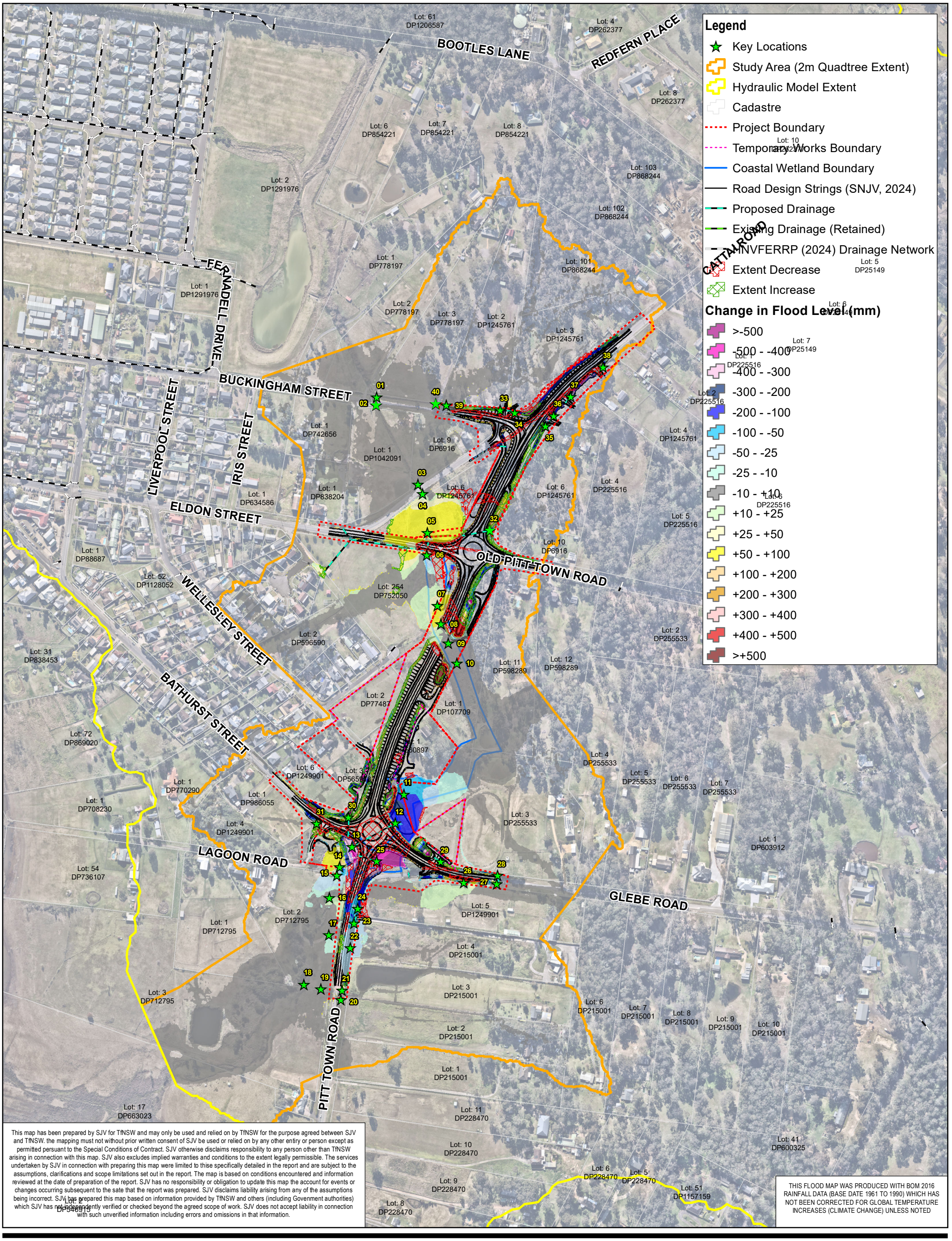

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

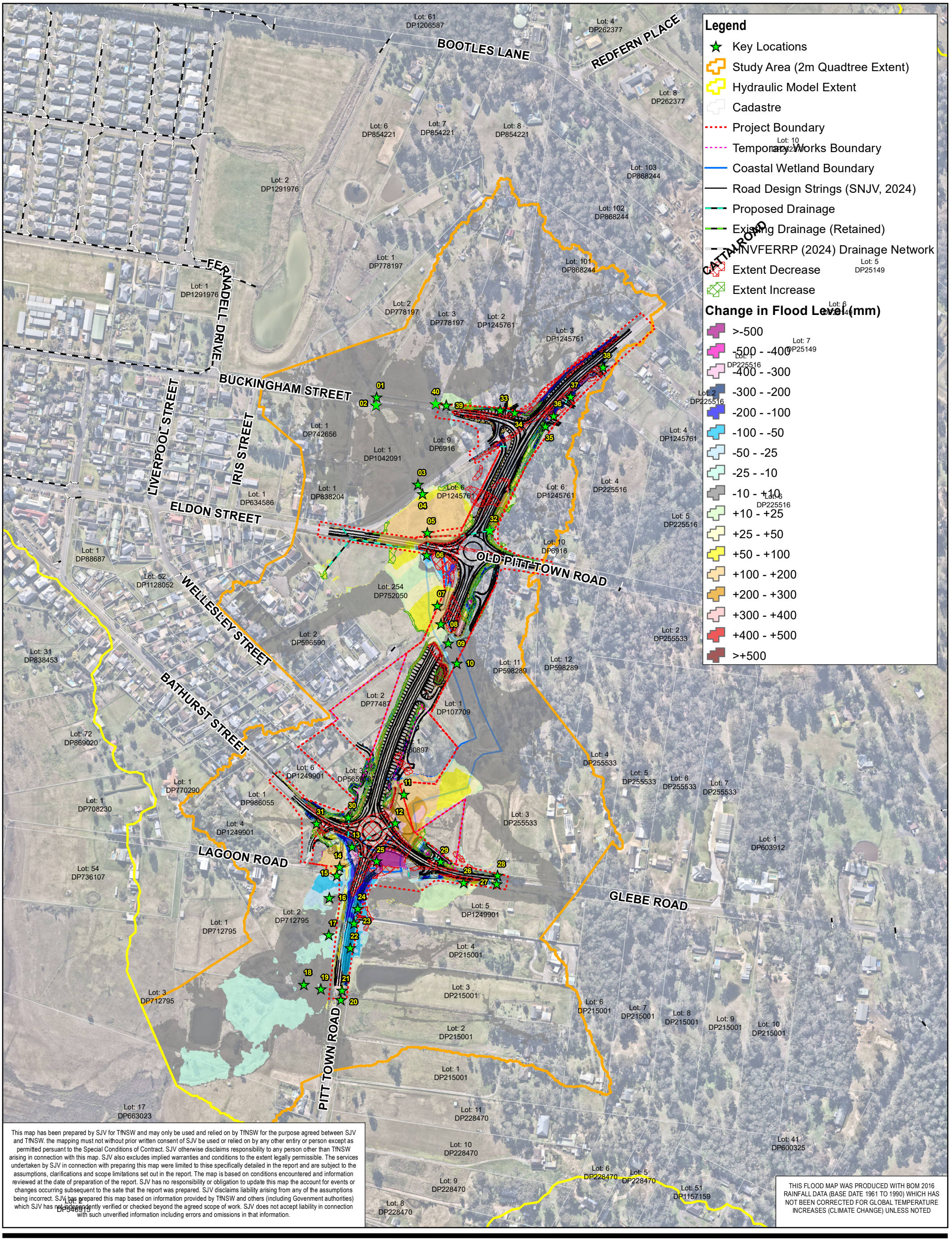
Flood Impacts (Design vs Existing)
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C017

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C017_Change in Flood Level_1pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

Data source: . Created by: sldouglas



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
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- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

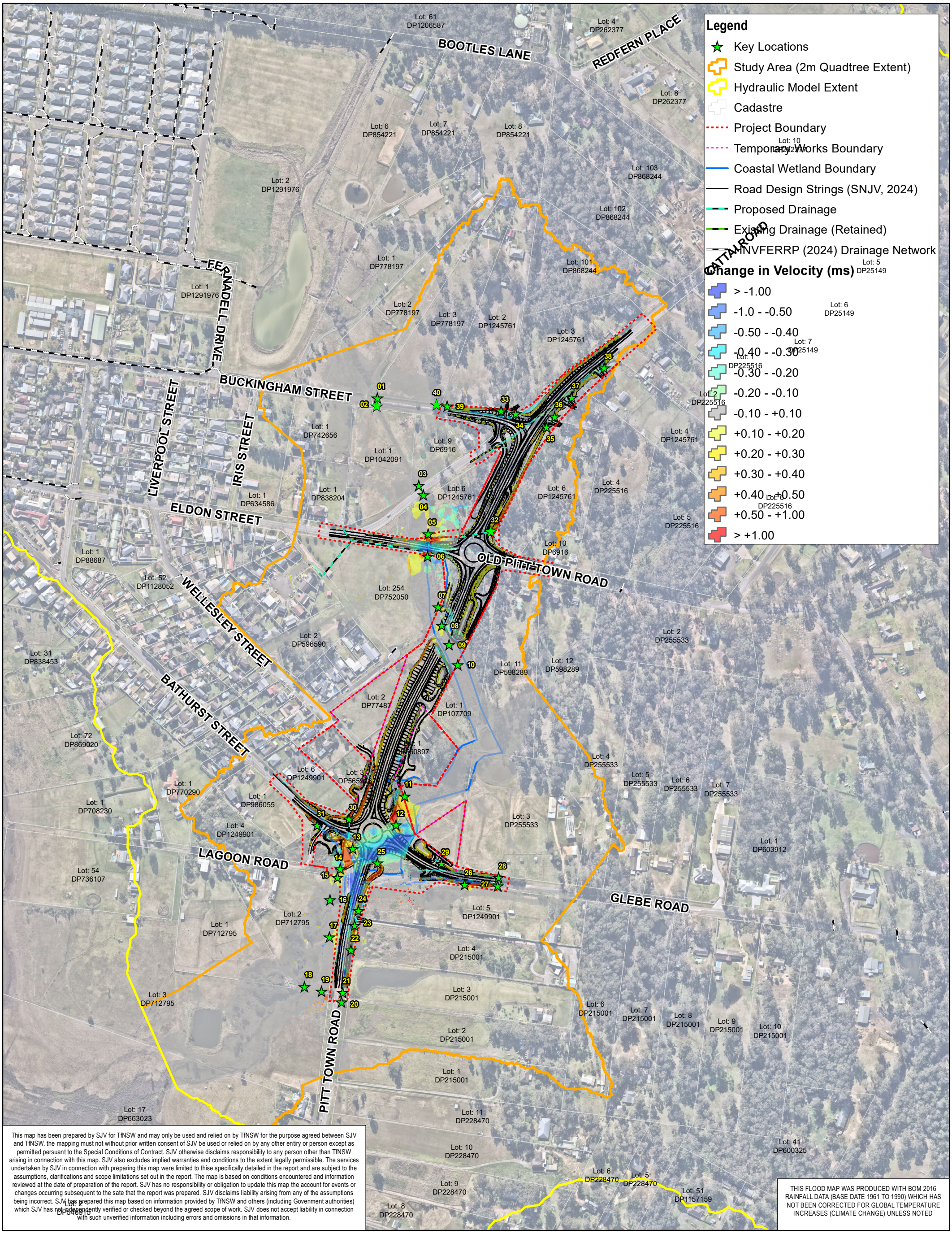
Flood Impacts (Design vs Existing)
0.05% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C018

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C018_Change in Flood Level_0.05pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des.mxd

Data source: . Created by: sldouglas



THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

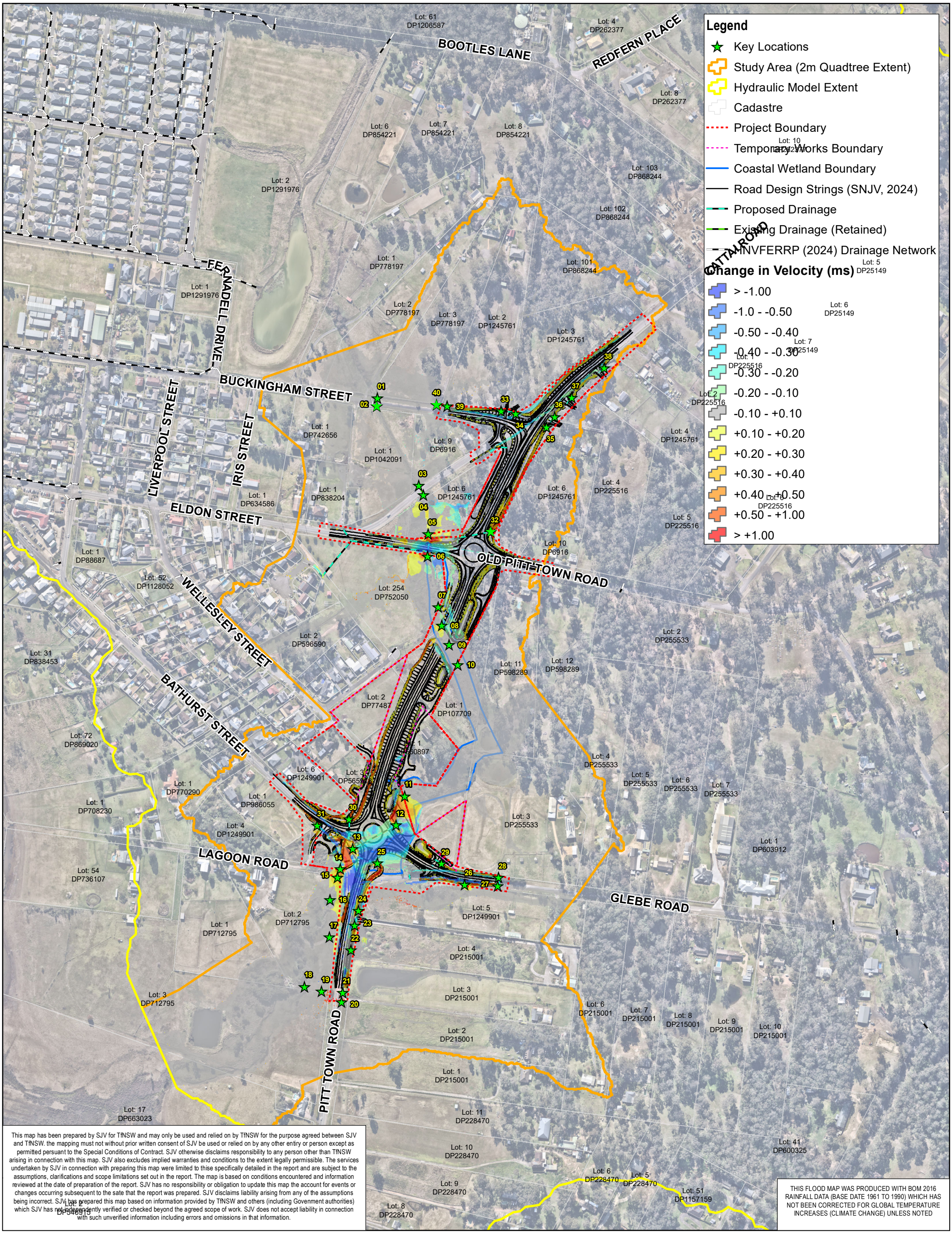
Flood Impacts (Design vs Existing)
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C019

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C019_Change in Velocity_20pct_Change in Velocity (ms)_SJV_Des.mxd
Print date: 07 Aug 2024 - 10:30

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C020

Data source: . Created by: sldouglas

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C020_Change in Velocity_10pct_Change in Velocity (ms)_SJV_Des.mxd
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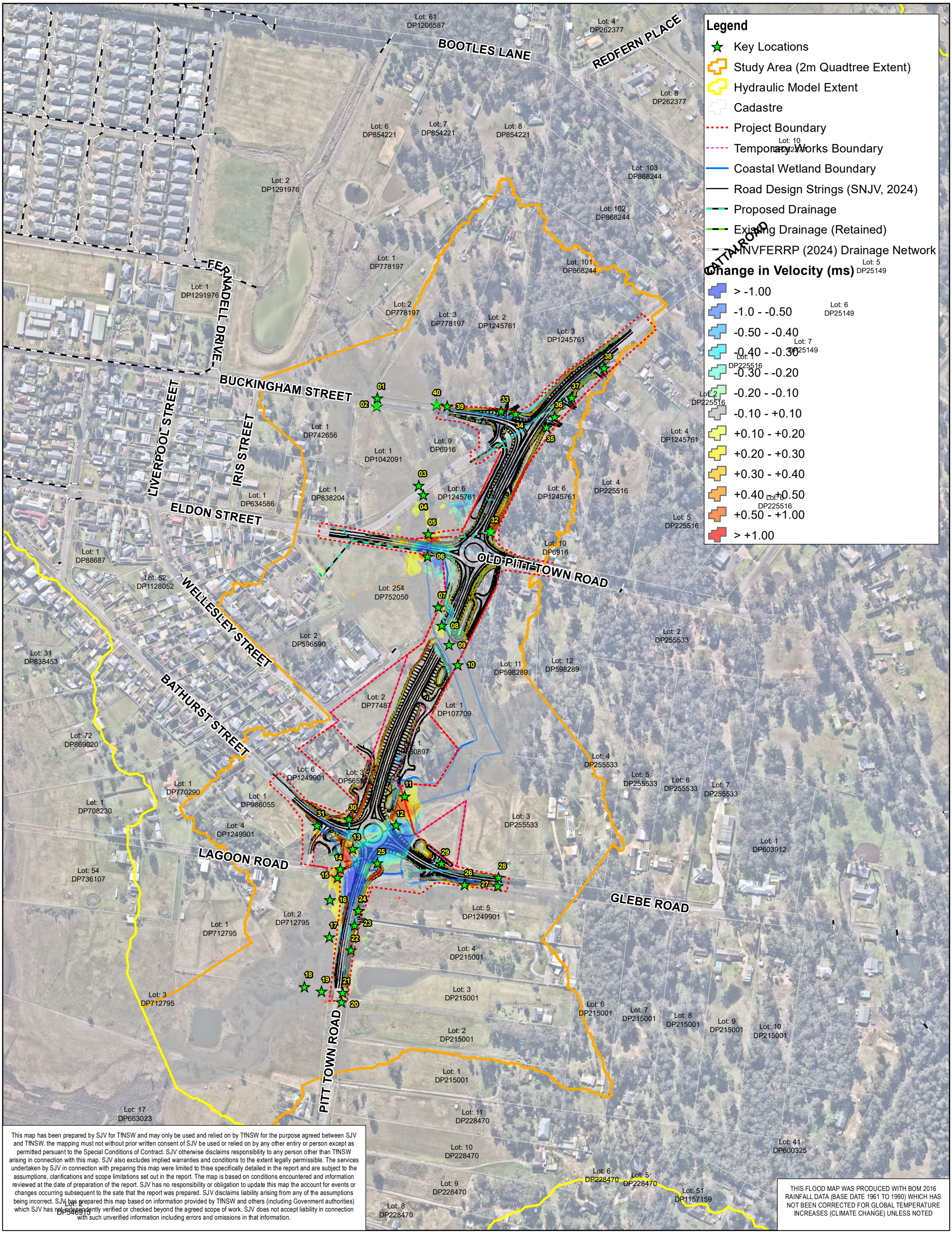

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C021

Data source: . Created by: sldouglas

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C021_Change in Velocity_5pct_Change in Velocity (ms)_SJV_Des.mxd
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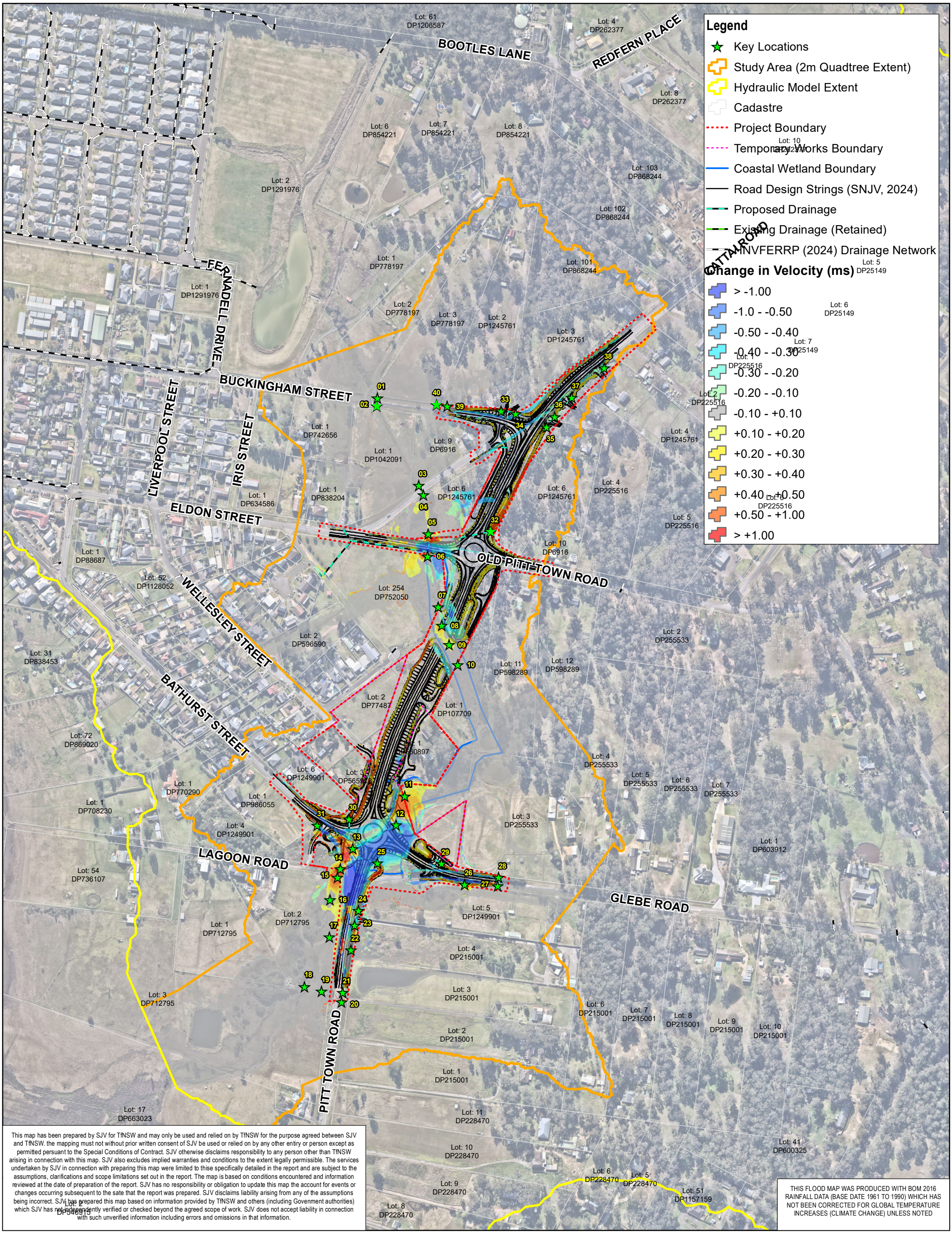

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C022

Data source: . Created by: sldouglas

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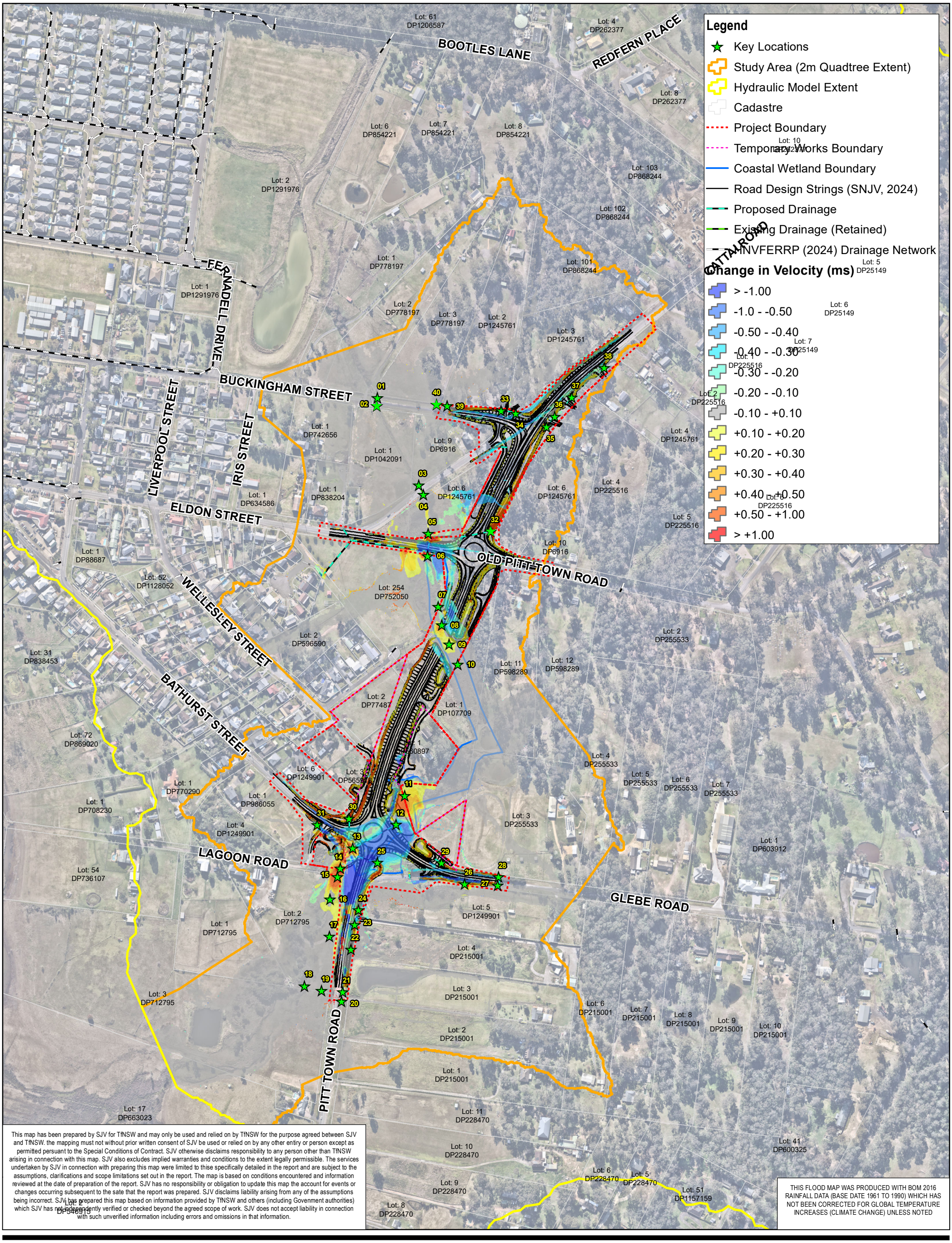
Print date: 07 Aug 2024 - 10:34



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

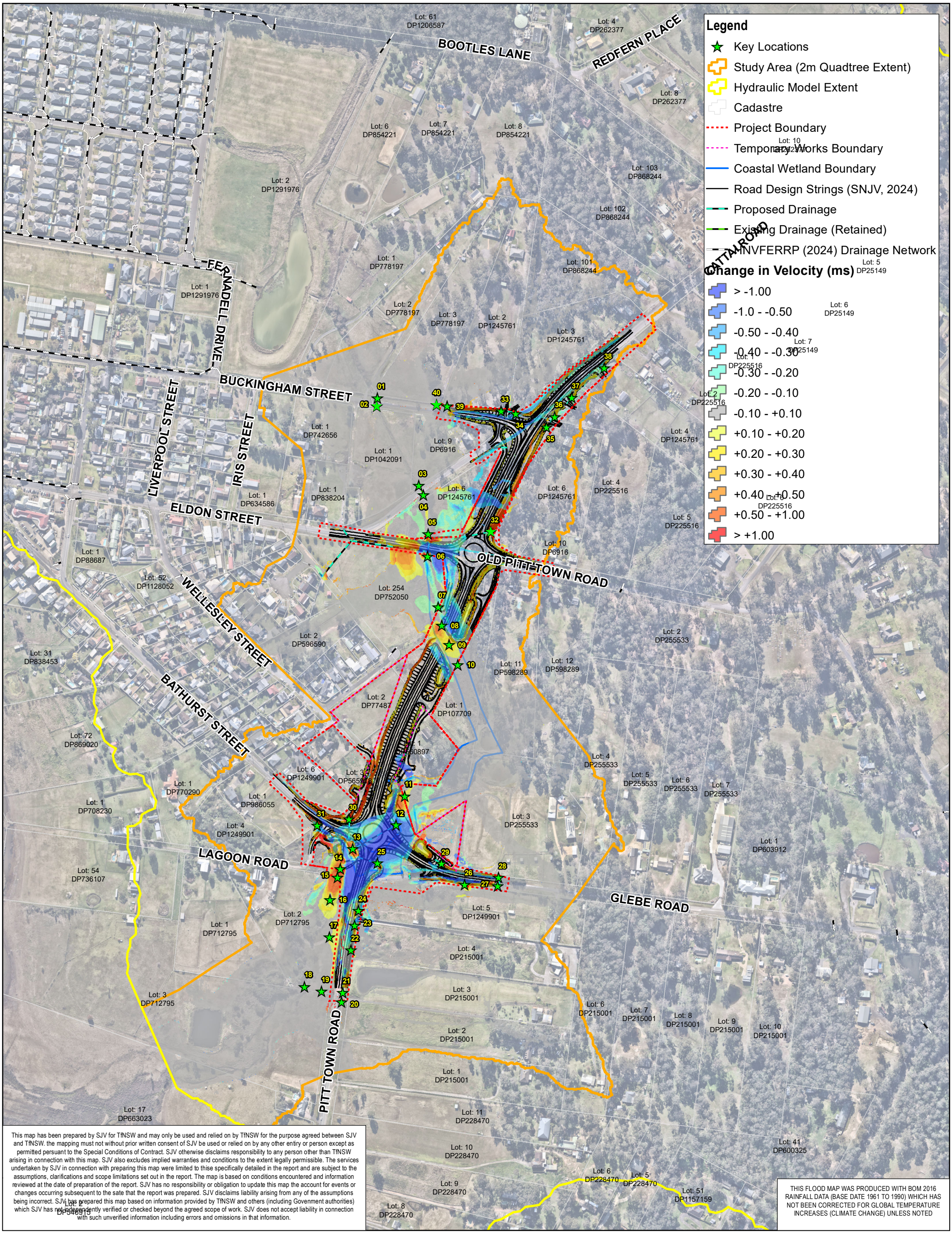
Flood Impacts (Design vs Existing)
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C023

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C023_Change in Velocity_1pct_Change in Velocity (ms)_SJV_Des.mxd
Print date: 07 Aug 2024 - 10:36

Data source: . Created by: sldouglas



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF

Flood Impacts (Design vs Existing)
0.05% AEP

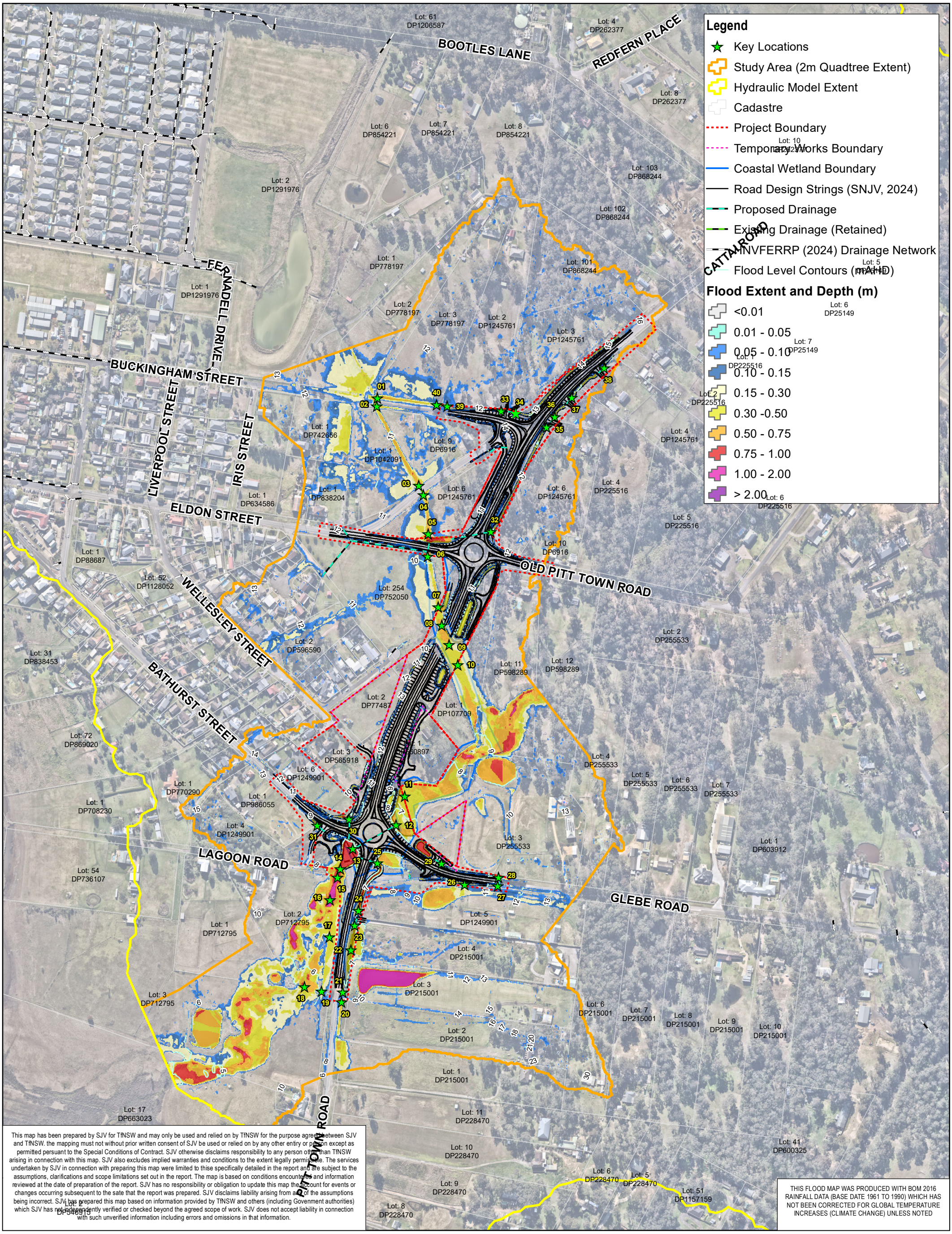
Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure C024

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_C024_Change in Velocity_0.05pct_Change in Velocity (ms)_SJV_Des.mxd
Print date: 07 Aug 2024 - 10:37

Data source: . Created by: sldouglas

APPENDIX E – BLOCKAGE SENSITIVITY FLOOD MAPPING



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
SJV Design
20% AEP

Project No. ESC - WO907
Revision No. A
Date 07/08/2024

Figure D001

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D001_Flood Extent and Depth_20pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des_BLK_Sens.mxd

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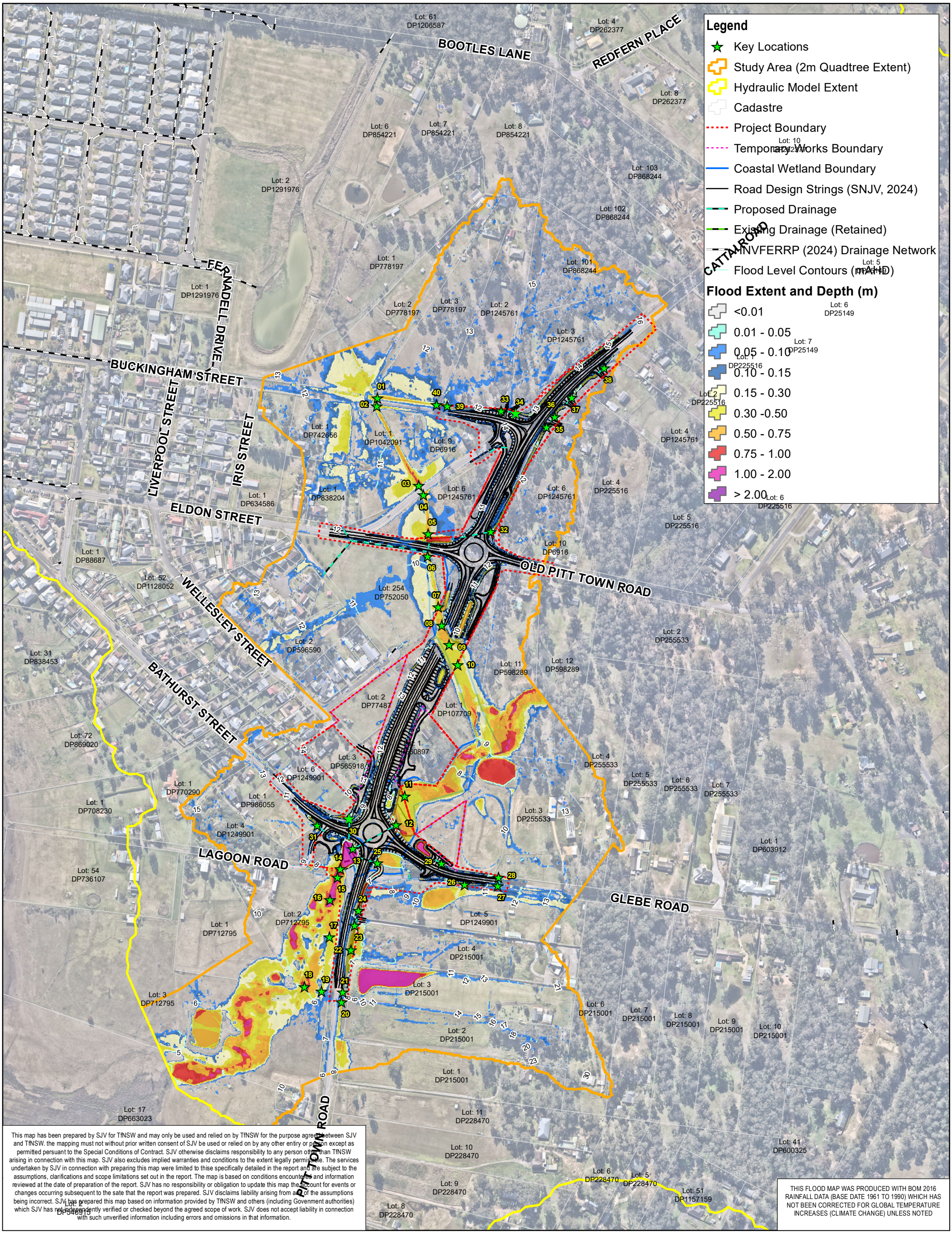

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
SJV Design
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D002

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D002_Flood Extent and Depth_10pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des_BLK_Sens.mxd

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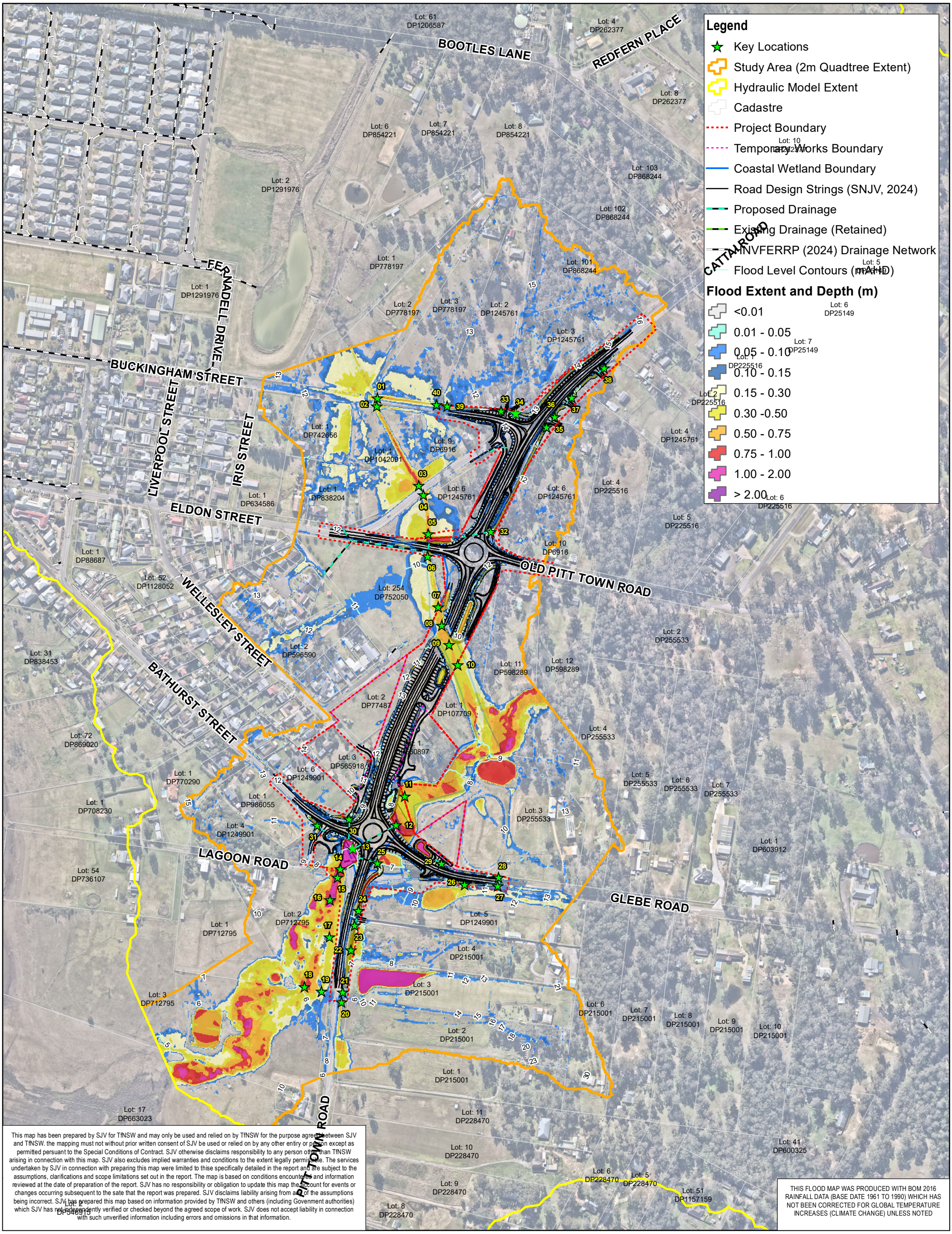

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
SJV Design
5% AEP

Project No. ESC - WO907
Revision No. A
Date 07/08/2024

Figure D003

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D003_Flood Extent and Depth_5pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des_BLK_Sens.mxd

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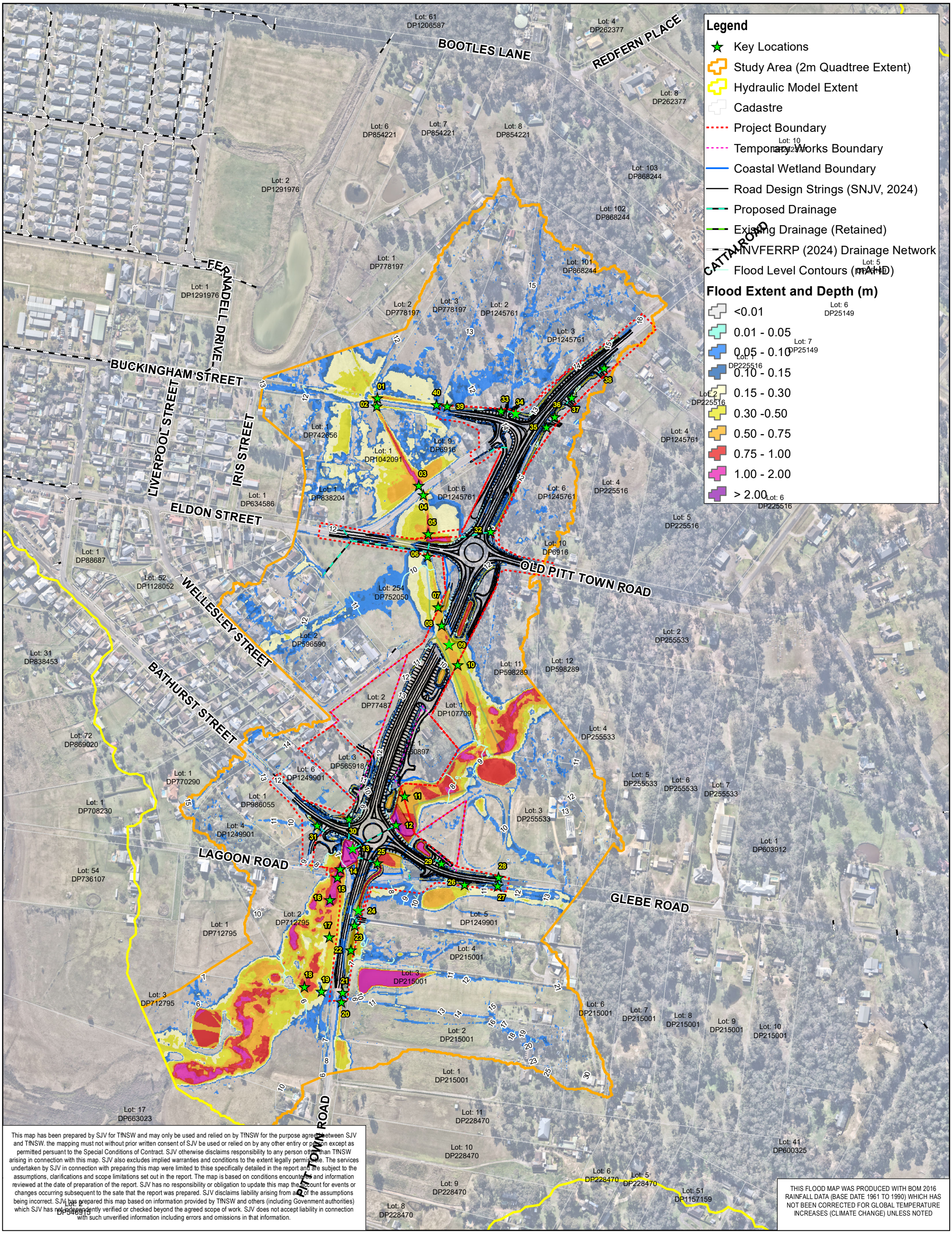

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
SJV Design
2% AEP

Project No. ESC - WO907
Revision No. A
Date 07/08/2024

Figure D004

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D004_Flood Extent and Depth_2pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des_BLK_Sens.mxd

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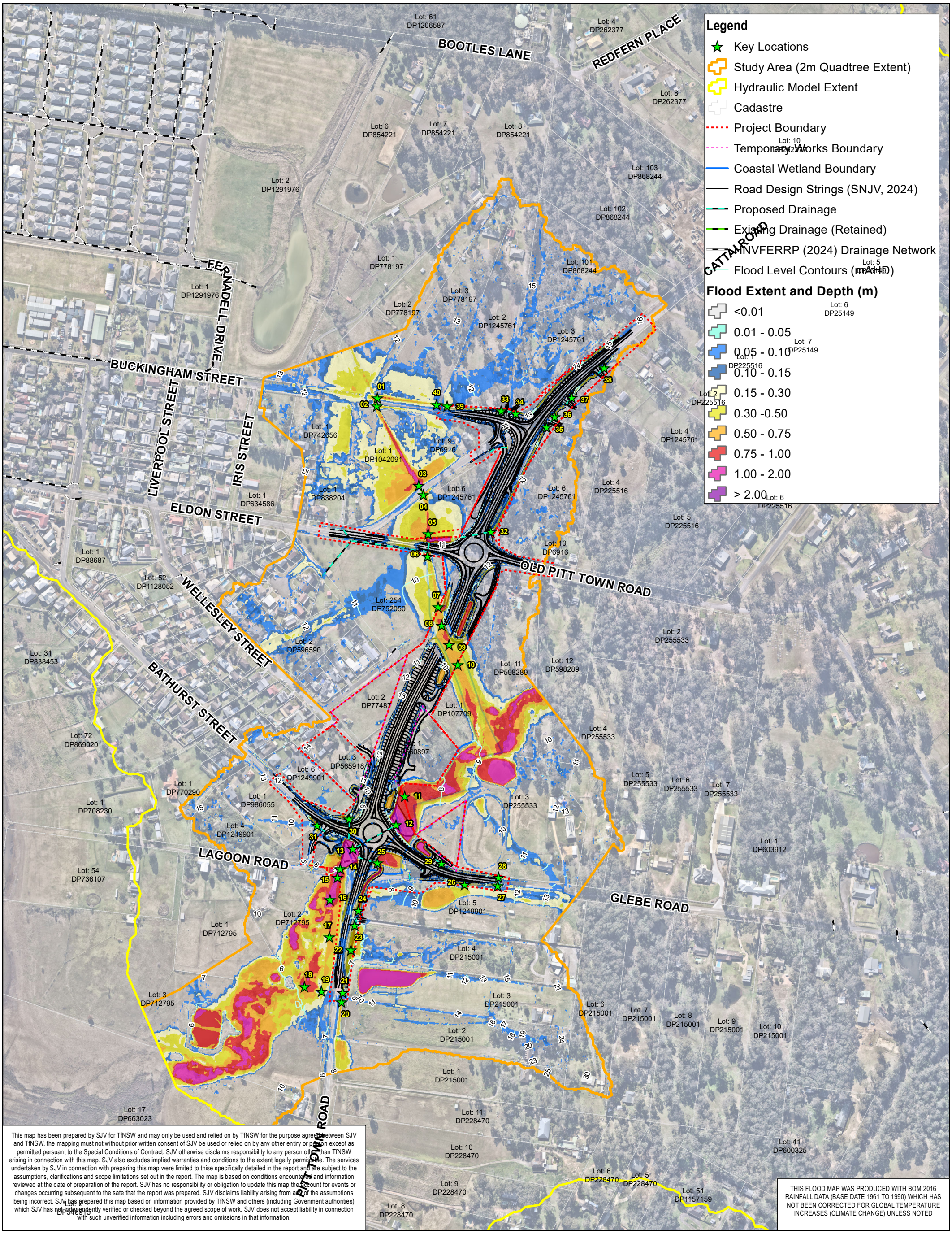

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Flood Level Contours (mAHD)

Flood Extent and Depth (m)

- <0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 -0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- > 2.00

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
SJV Design
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D005

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D005_Flood Extent and Depth_1pct_Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_Des_BLK_Sens.mxd

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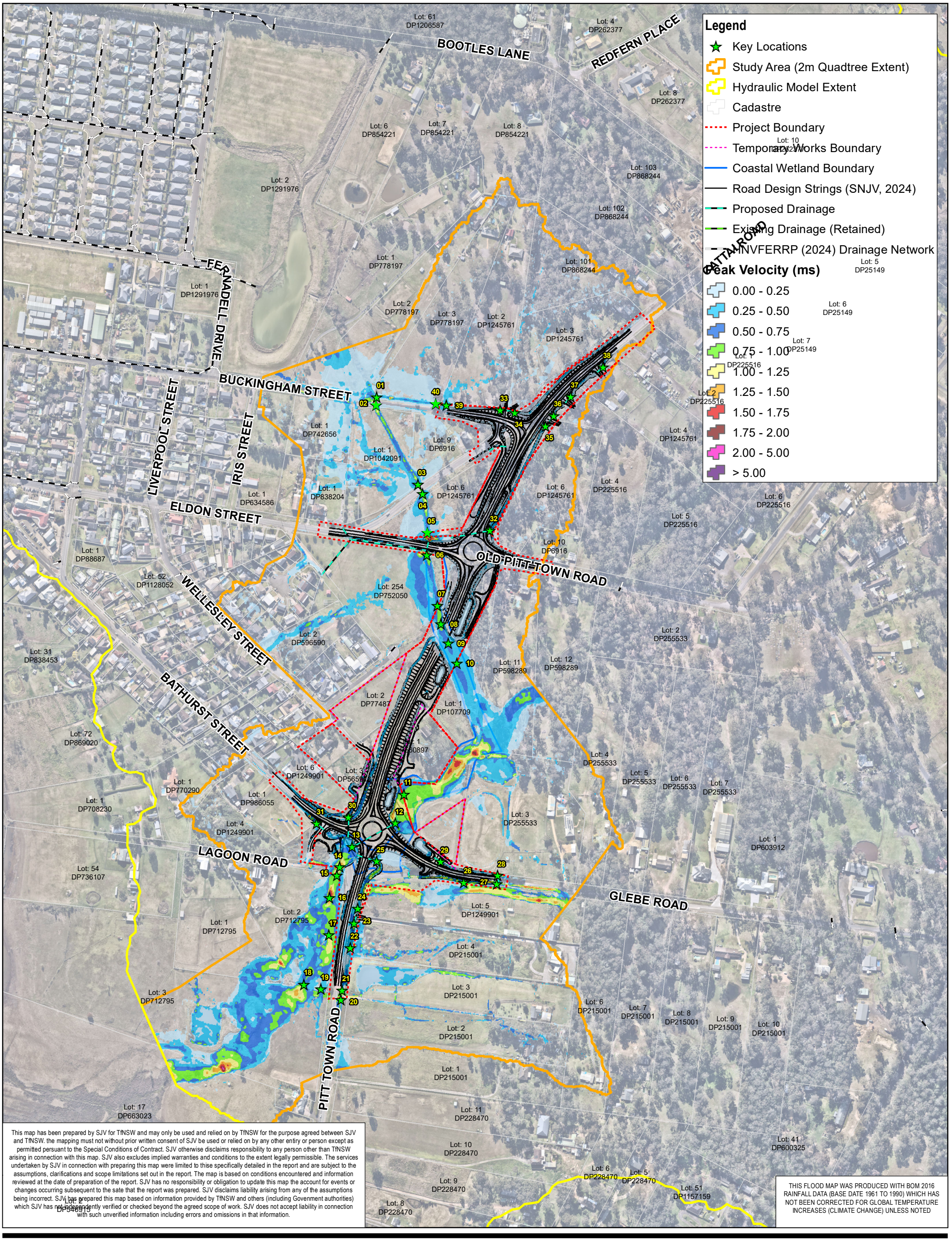

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment

SJV Design
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D006

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D006_Peak Velocity_20pct_Peak Velocity (ms)_SJV_Des_BLK_Sens.mxd
Print date: 07 Aug 2024 - 10:42

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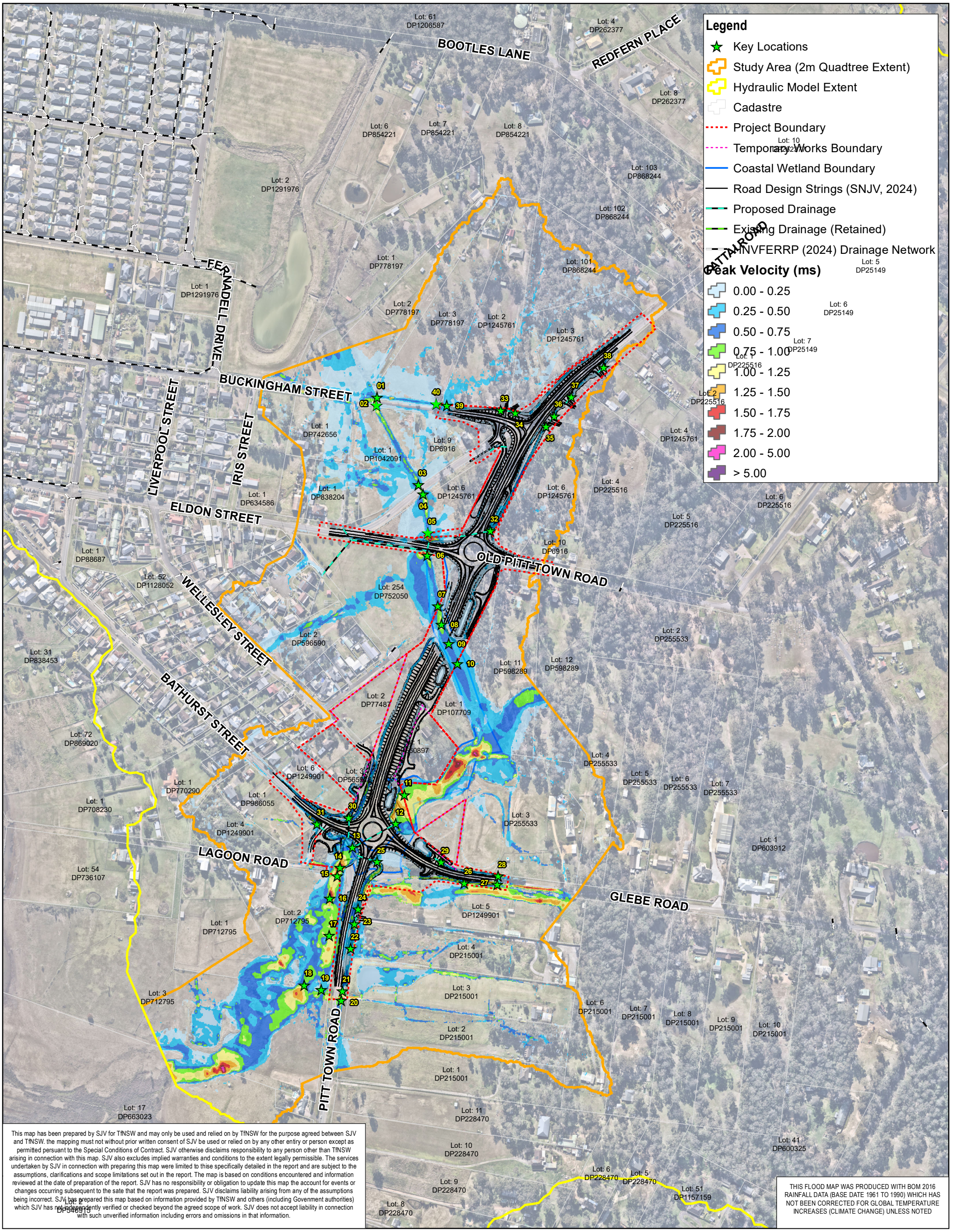

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment

SJV Design
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D007

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D007_Peak Velocity_10pct_Peak Velocity (ms)_SJV_Des_BLK_Sens.mxd
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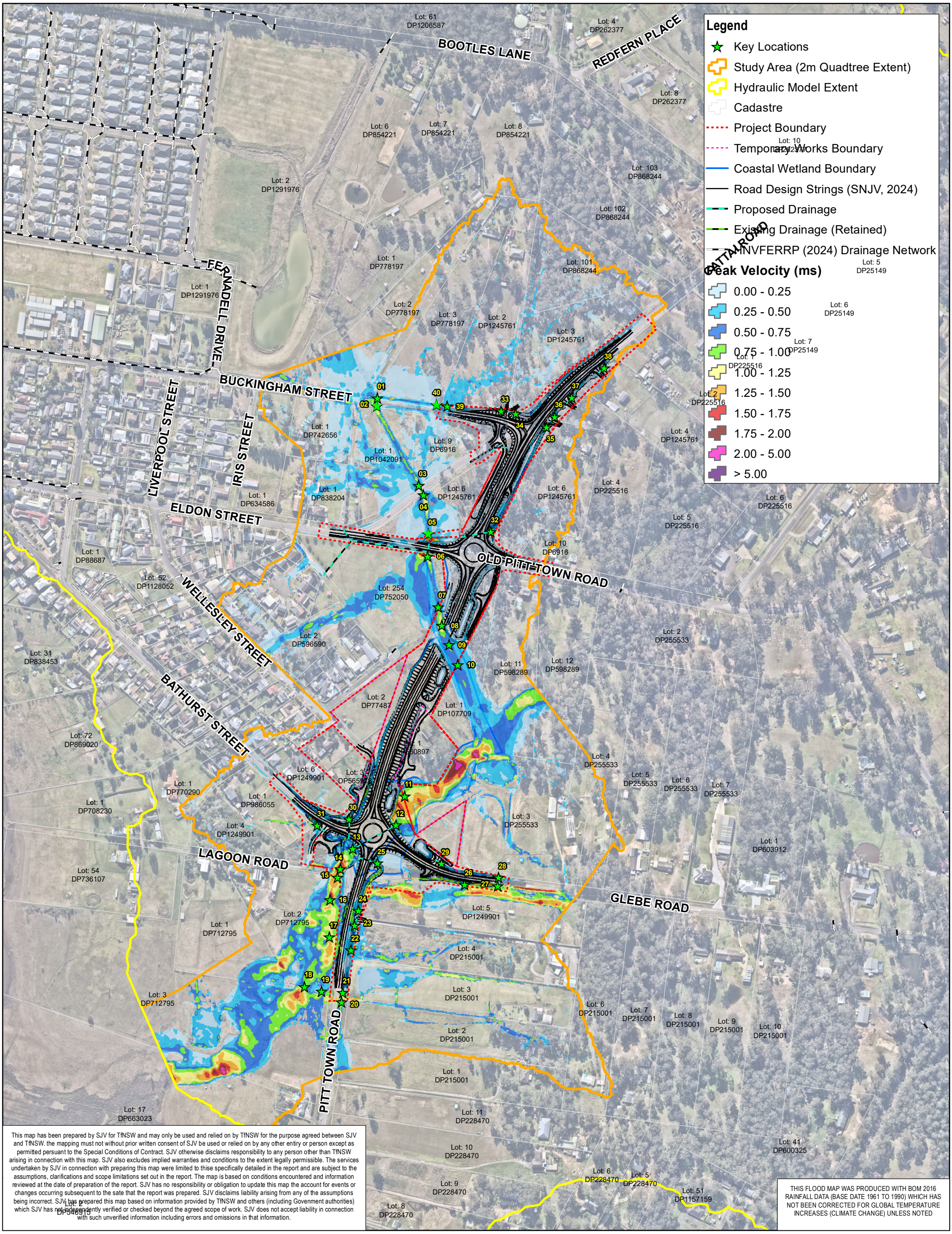

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment

SJV Design
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D008

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D008_Peak Velocity_5pct_Peak Velocity (ms)_SJV_Des_BLK_Sens.mxd
Print date: 07 Aug 2024 - 10:44

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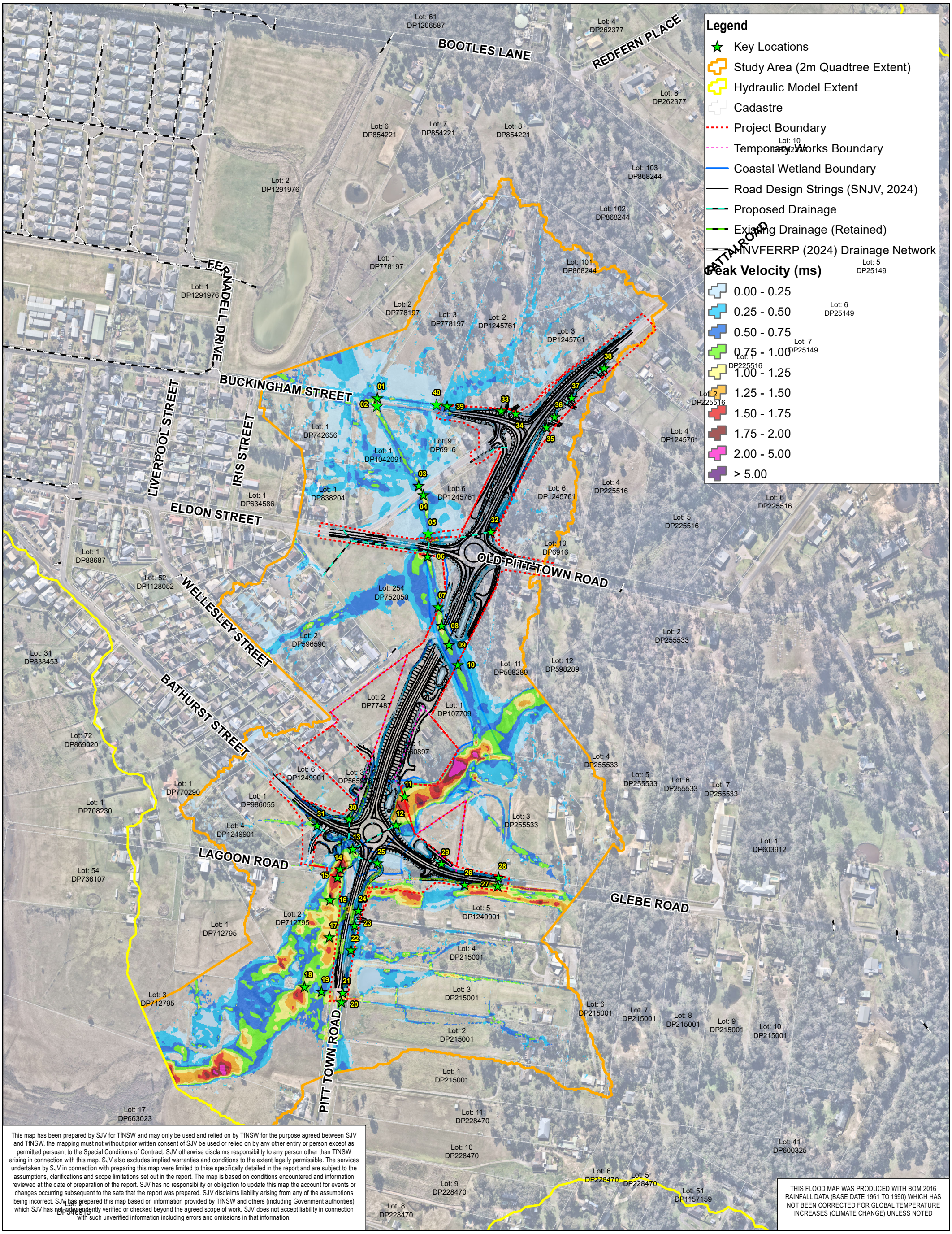

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment

SJV Design
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D009

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D009_Peak Velocity_2pct_Peak Velocity (ms)_SJV_Des_BLK_Sens.mxd
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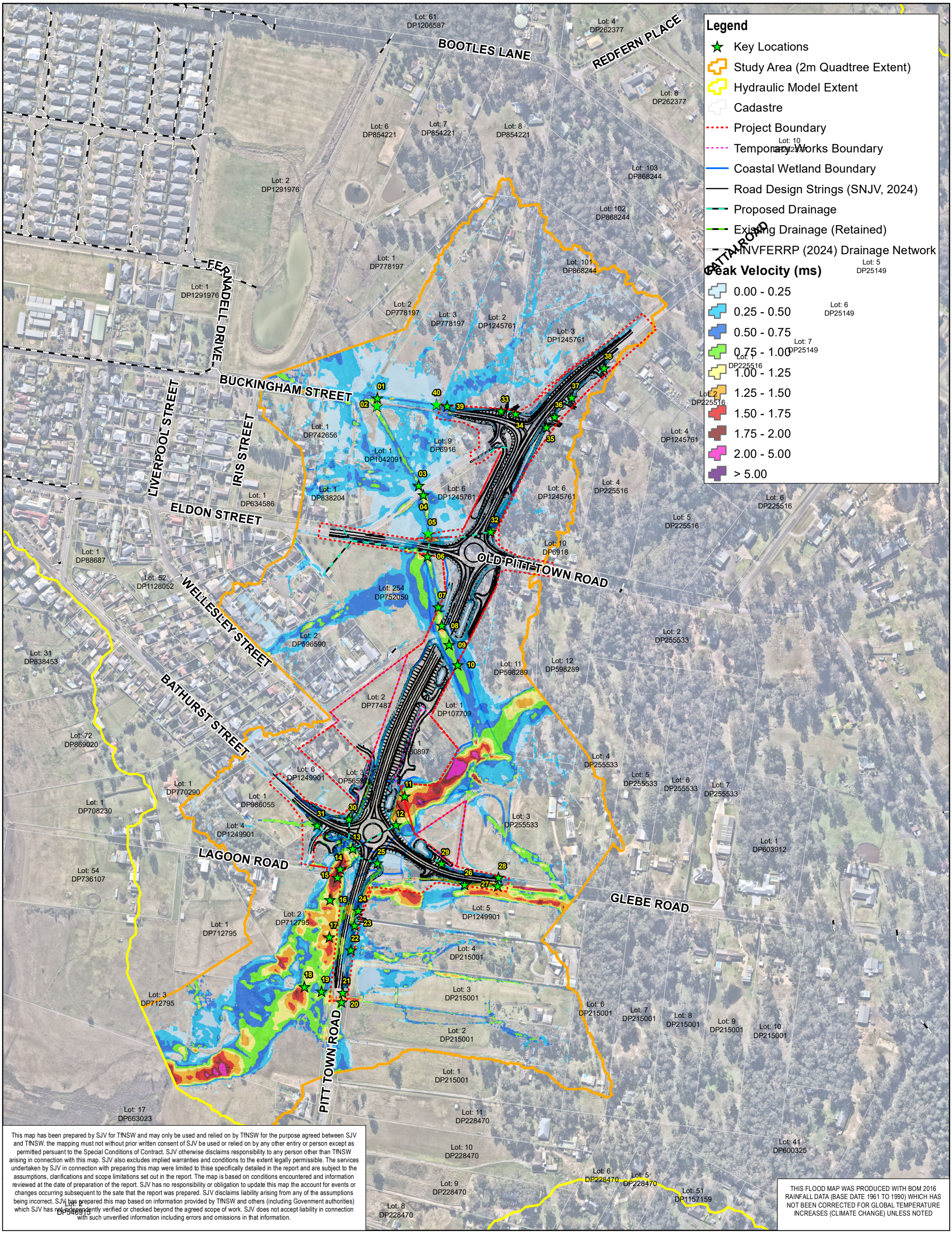

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment

SJV Design
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D010

Data source: . Created by: sldouglas

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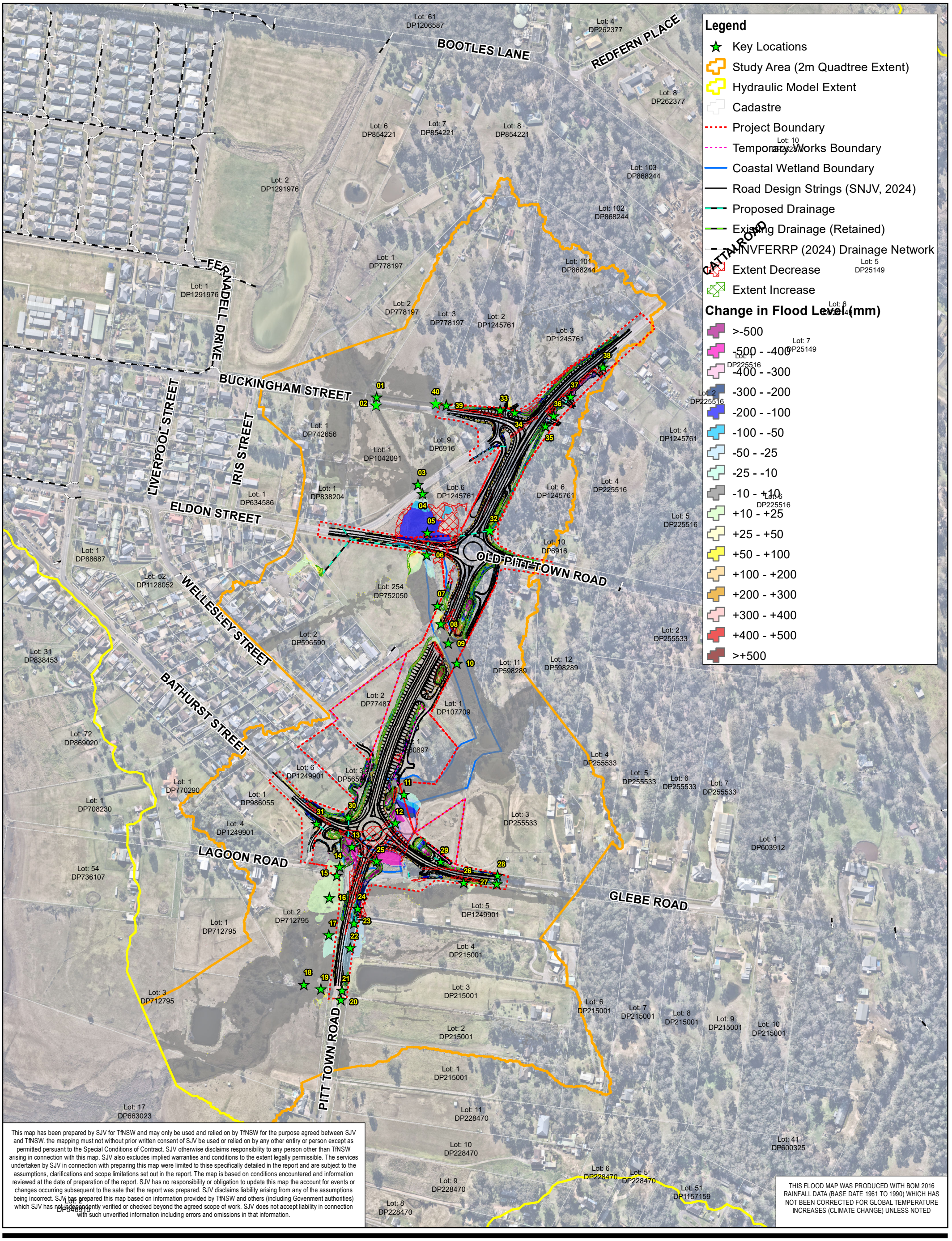

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D011

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D011_Change in Flood Level_20pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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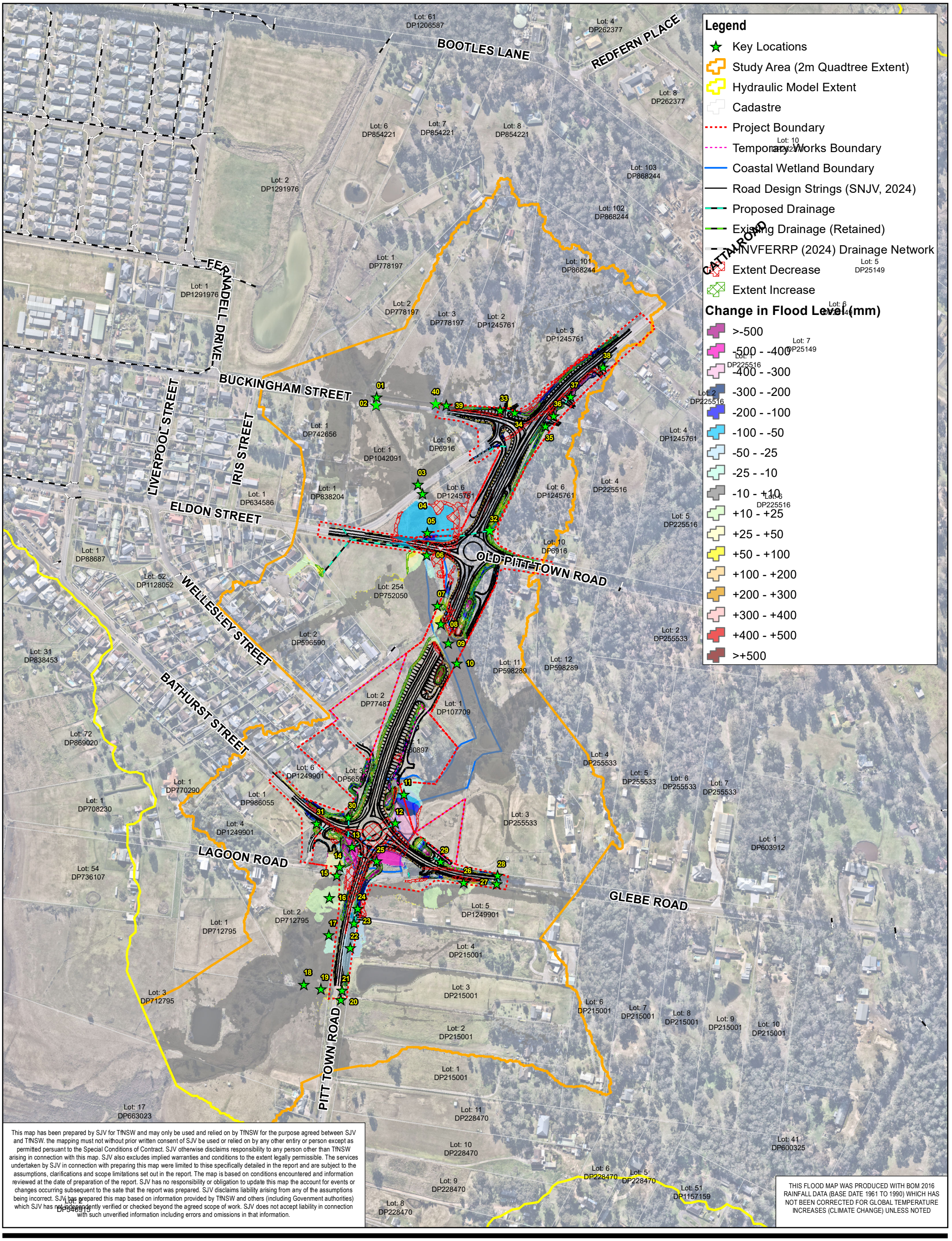

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D012

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D012_Change in Flood Level_10pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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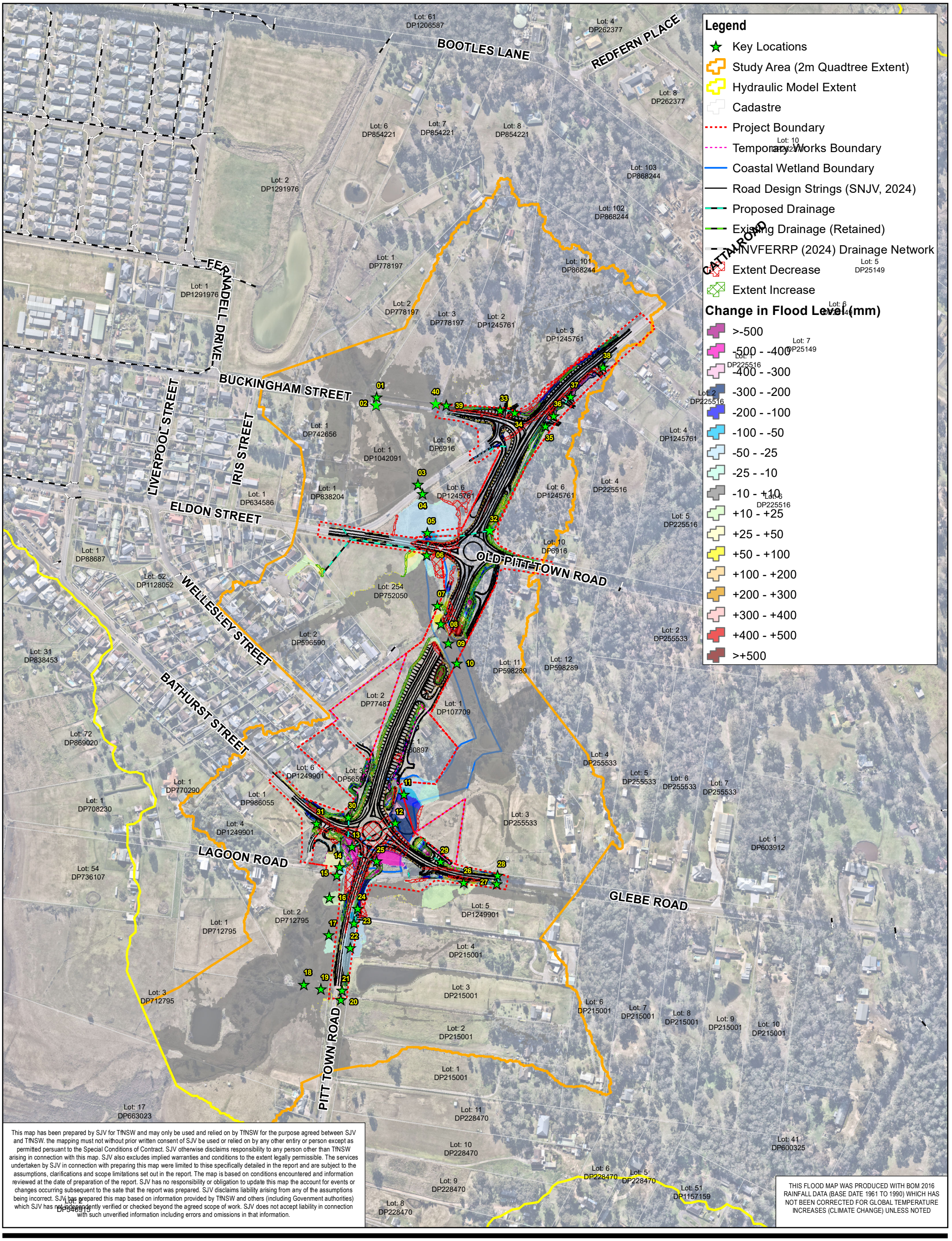

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D013

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D013_Change in Flood Level_5pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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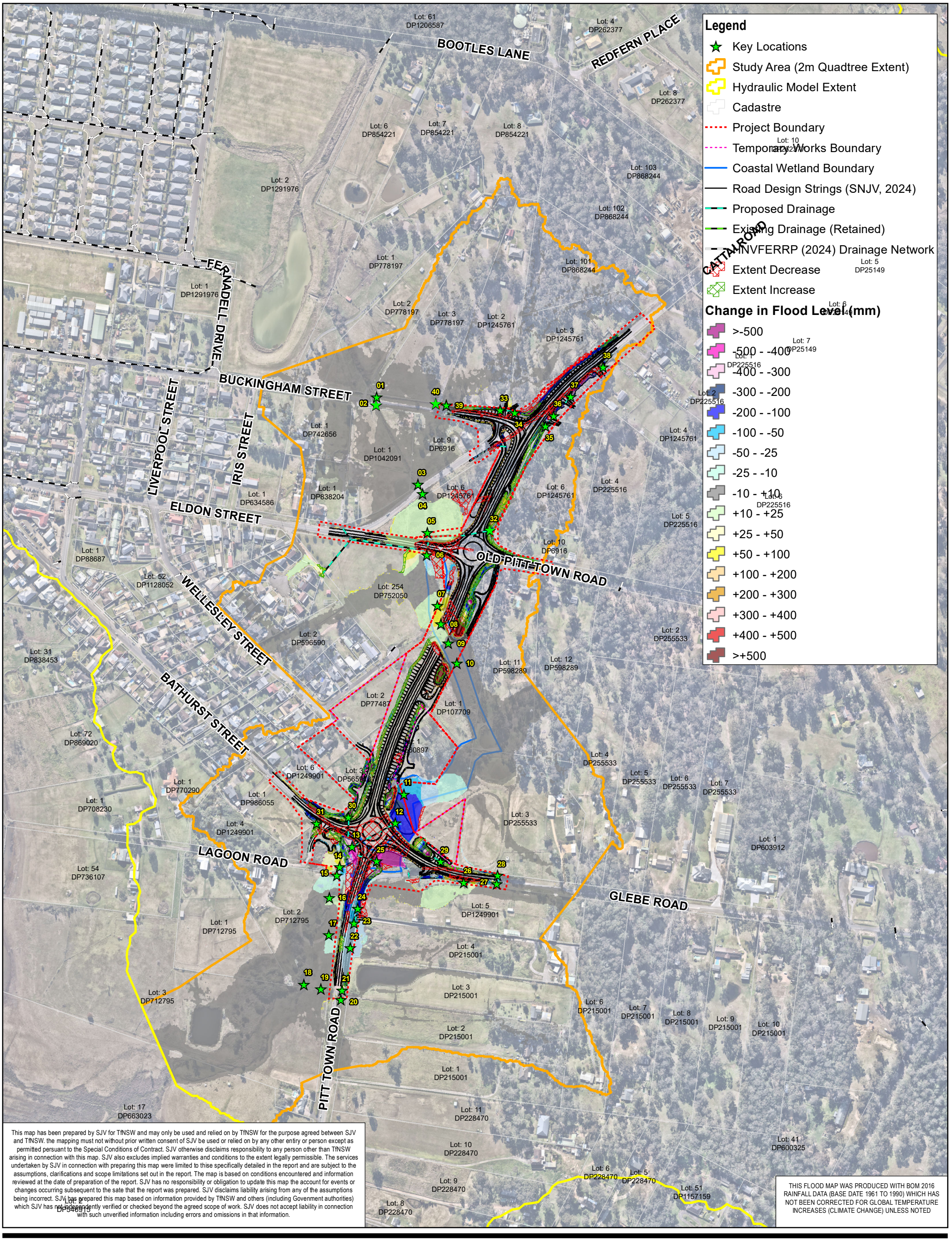

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D014

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D014_Change in Flood Level_2pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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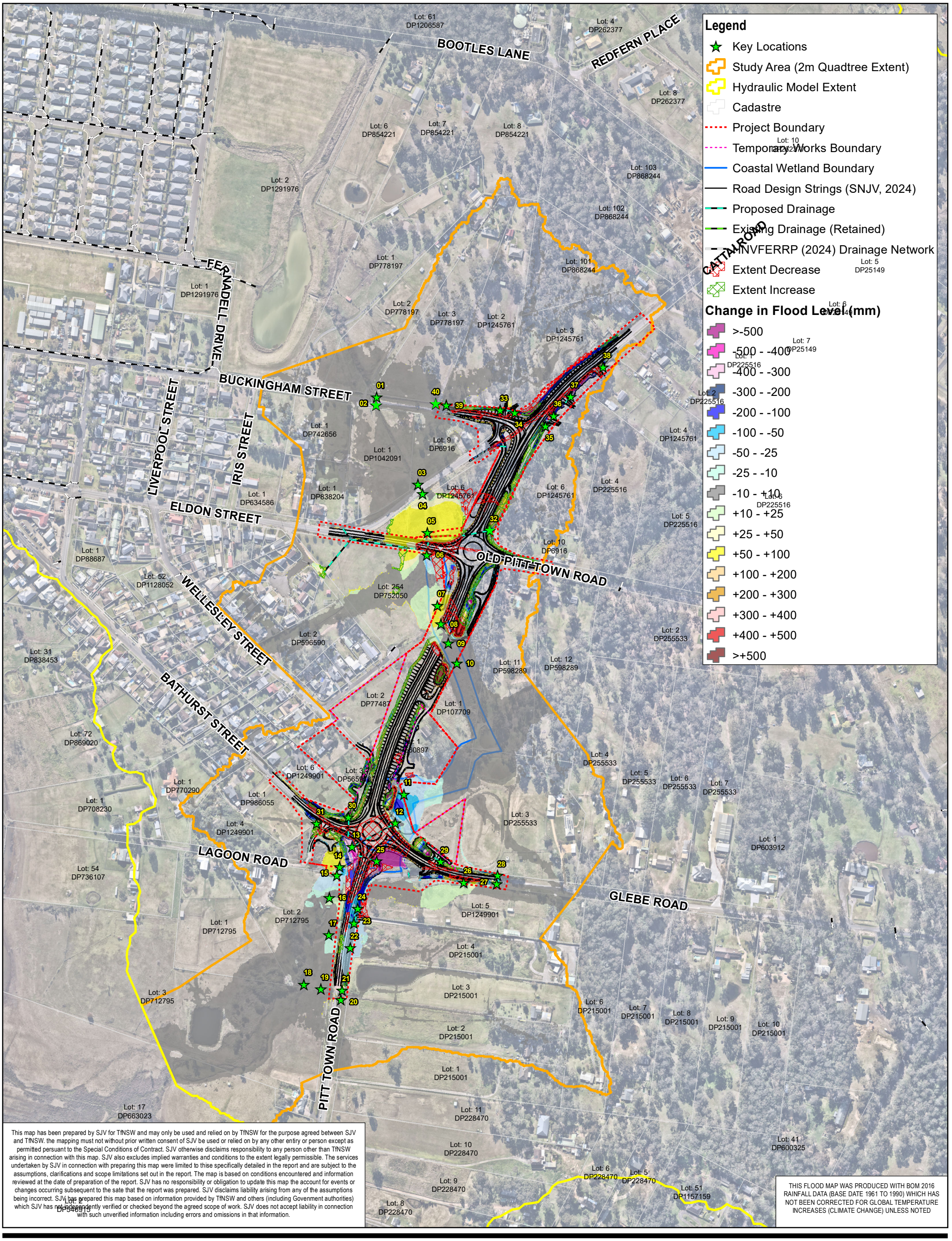

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D015

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D015_Change in Flood Level_1pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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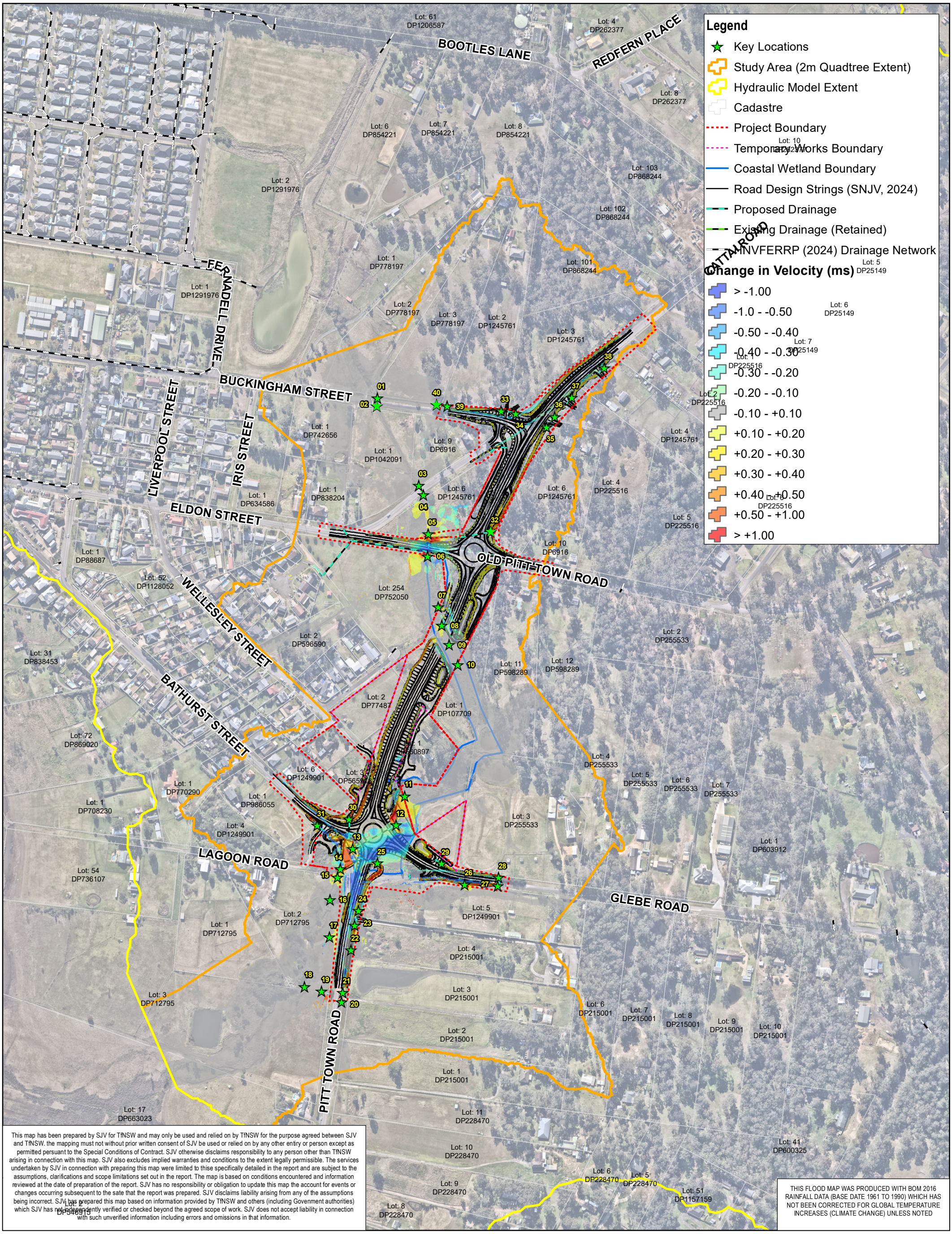

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
20% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D016

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D016_Change in Velocity_20pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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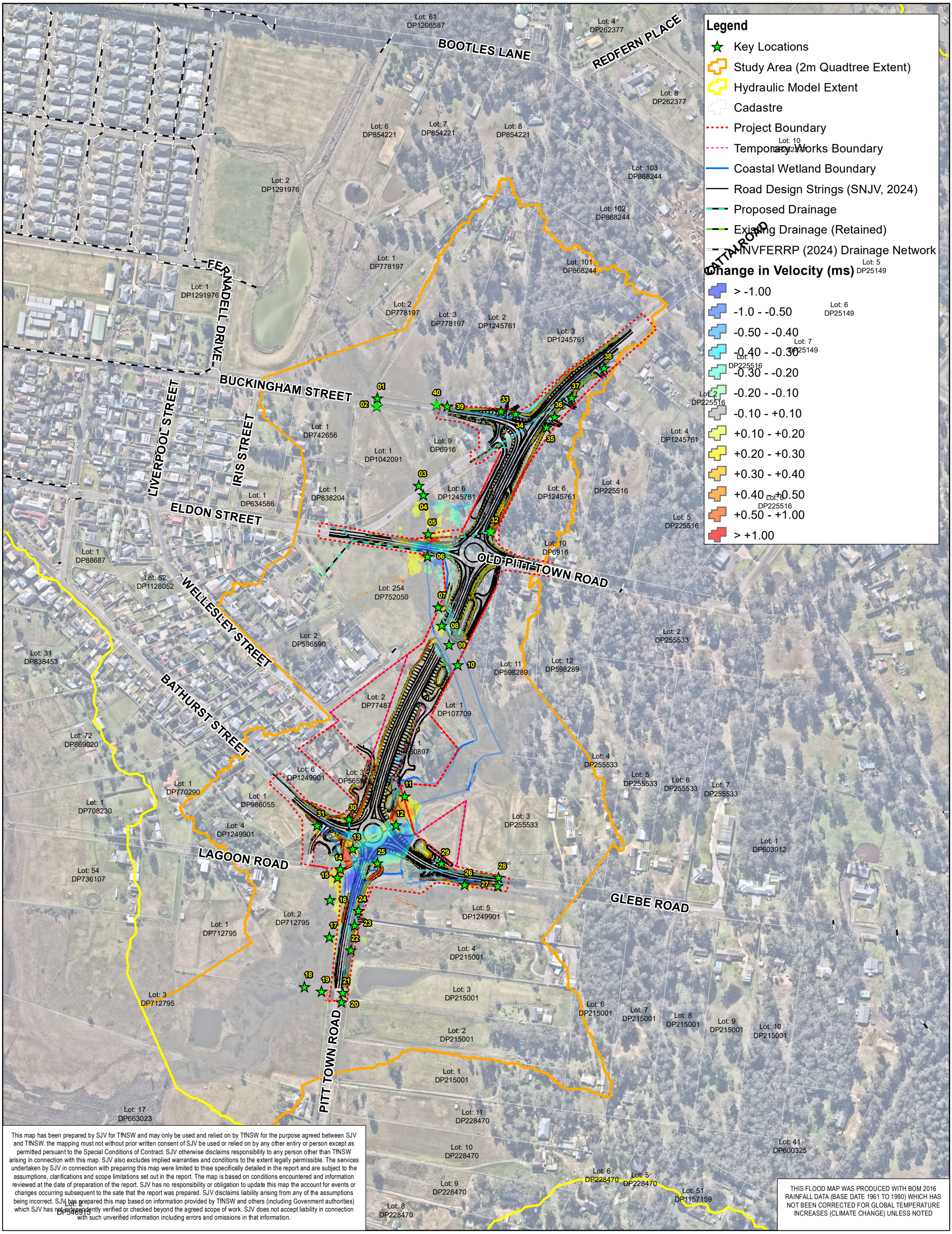

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
10% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D017

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D017_Change in Velocity_10pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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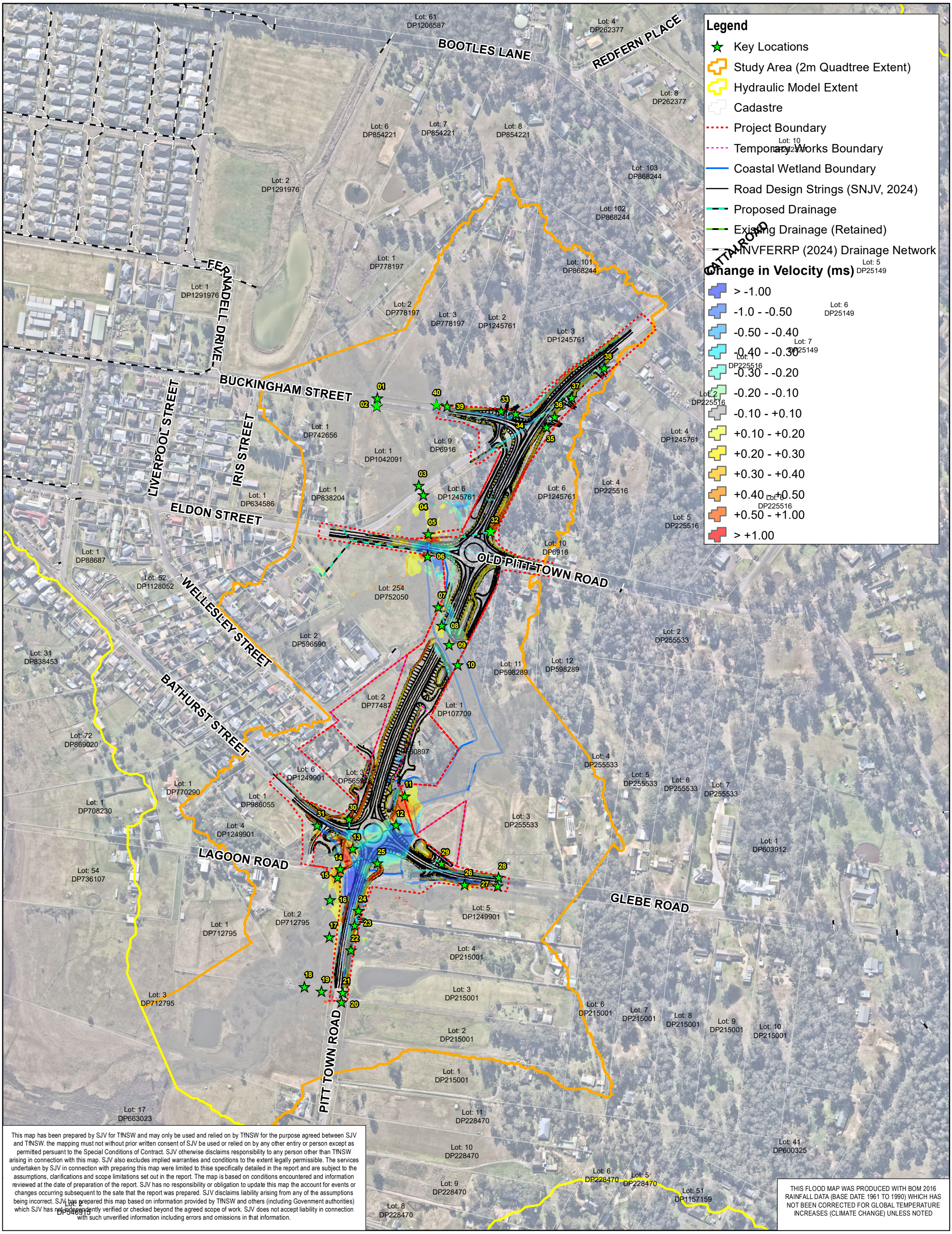

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
5% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D018

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D018_Change in Velocity_5pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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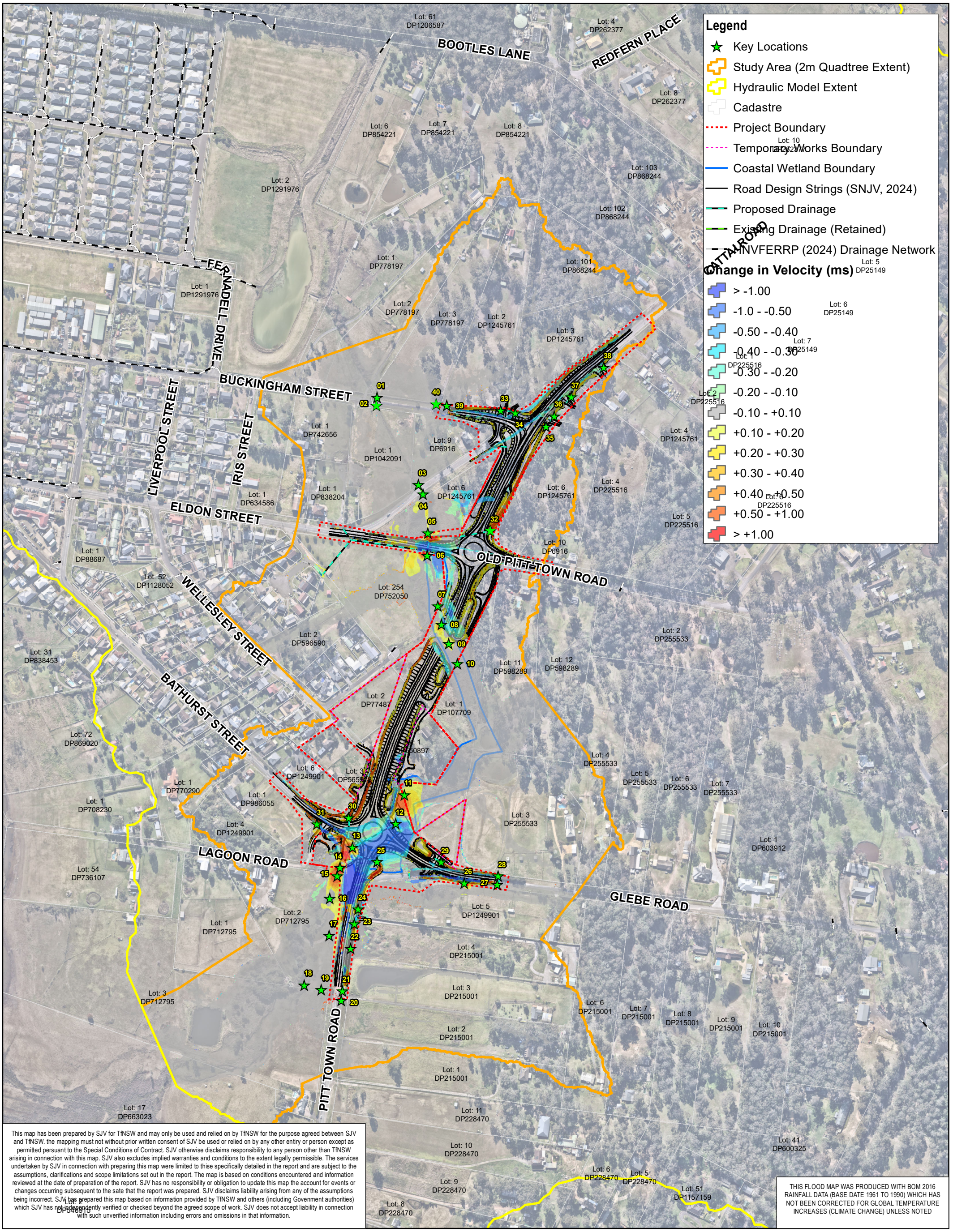

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
2% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D019

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D019_Change in Velocity_2pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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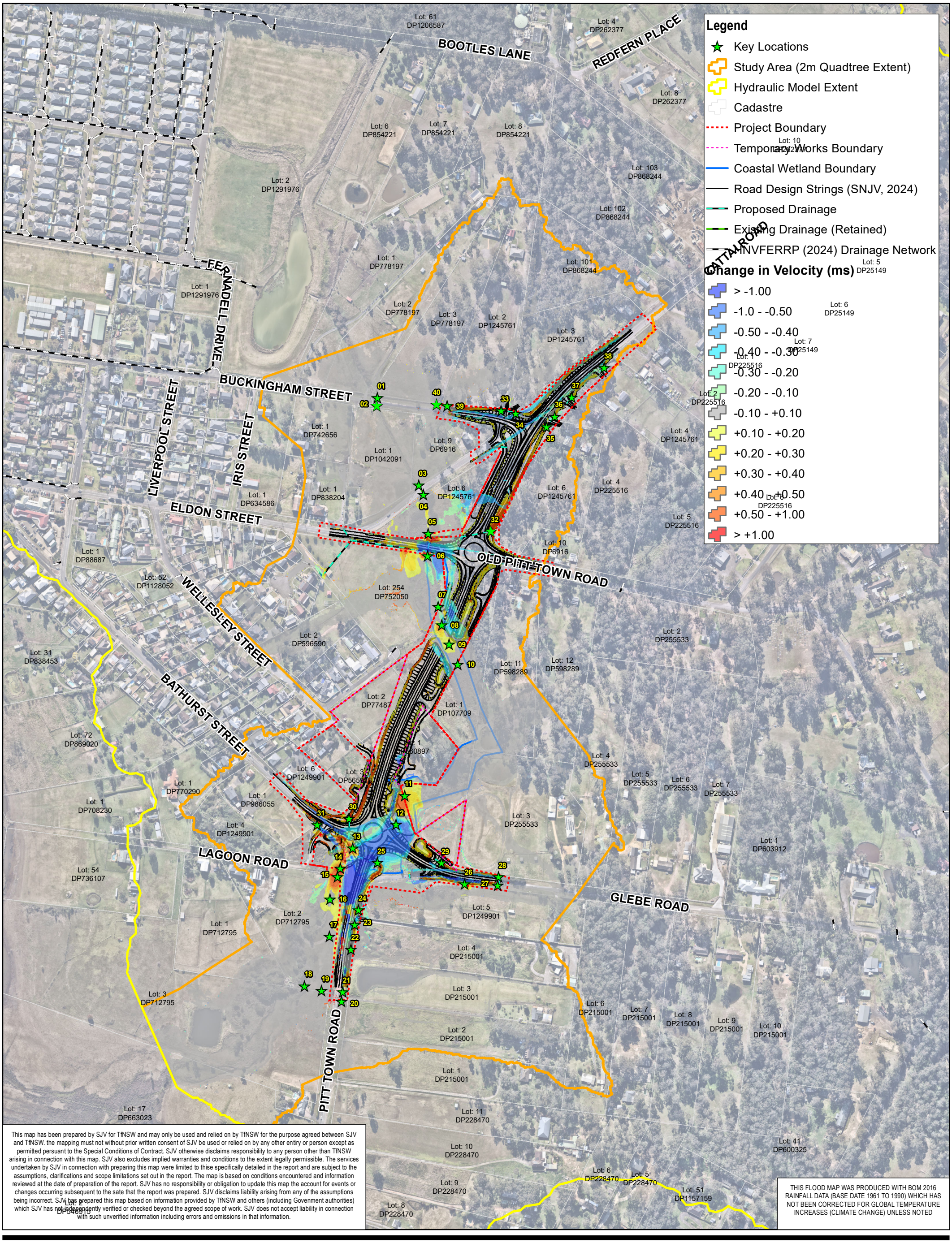

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

SUSTAINJV
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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Blockage Sensitivity Assessment
Flood Impacts (Design vs Existing)
1% AEP

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure D020

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D020_Change in Velocity_1pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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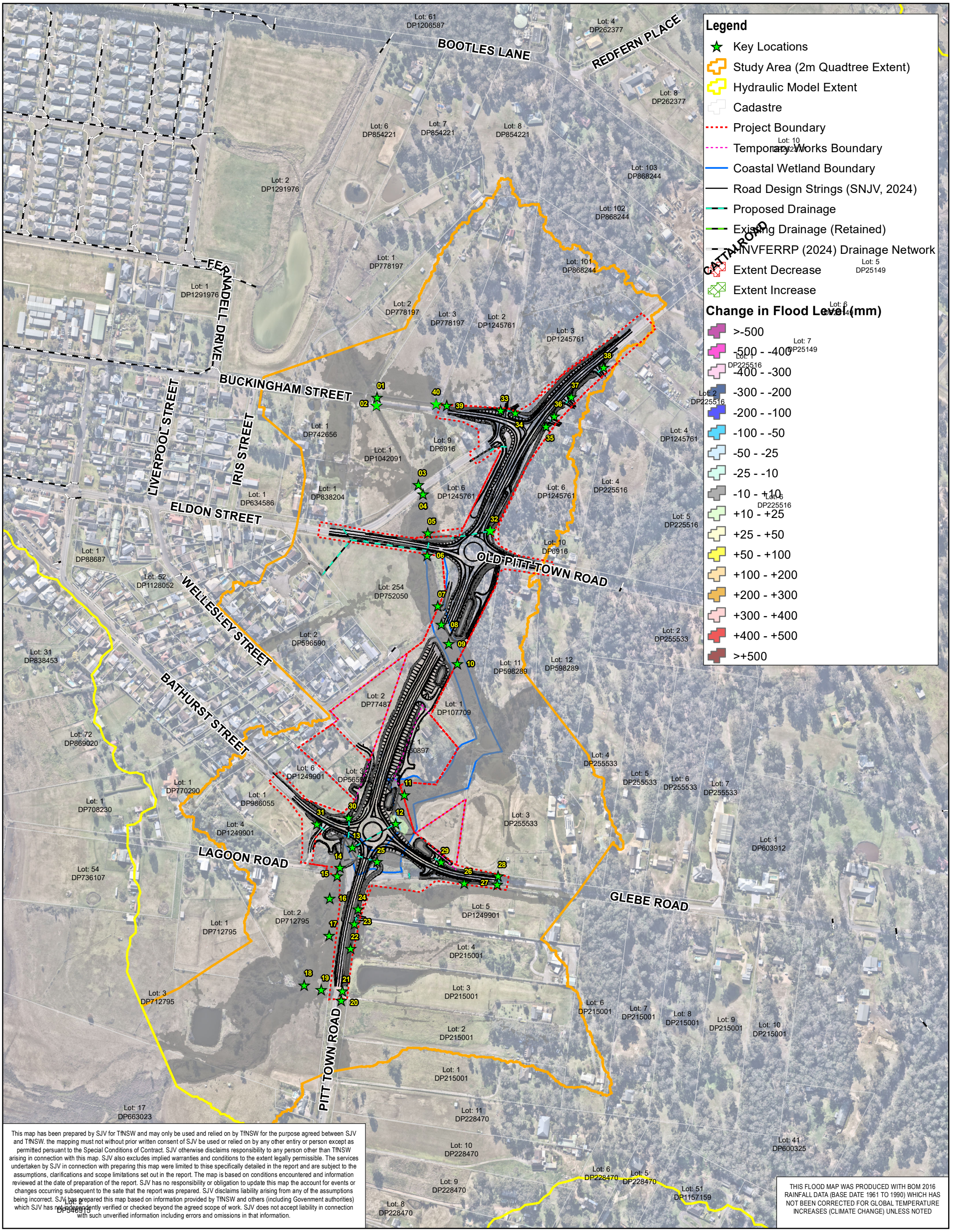

Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment

Relative Flood Impacts (Design with ARR2019 blockage vs Design)

20% AEP

Figure D021

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D021_Relative Change in Flood Level_20pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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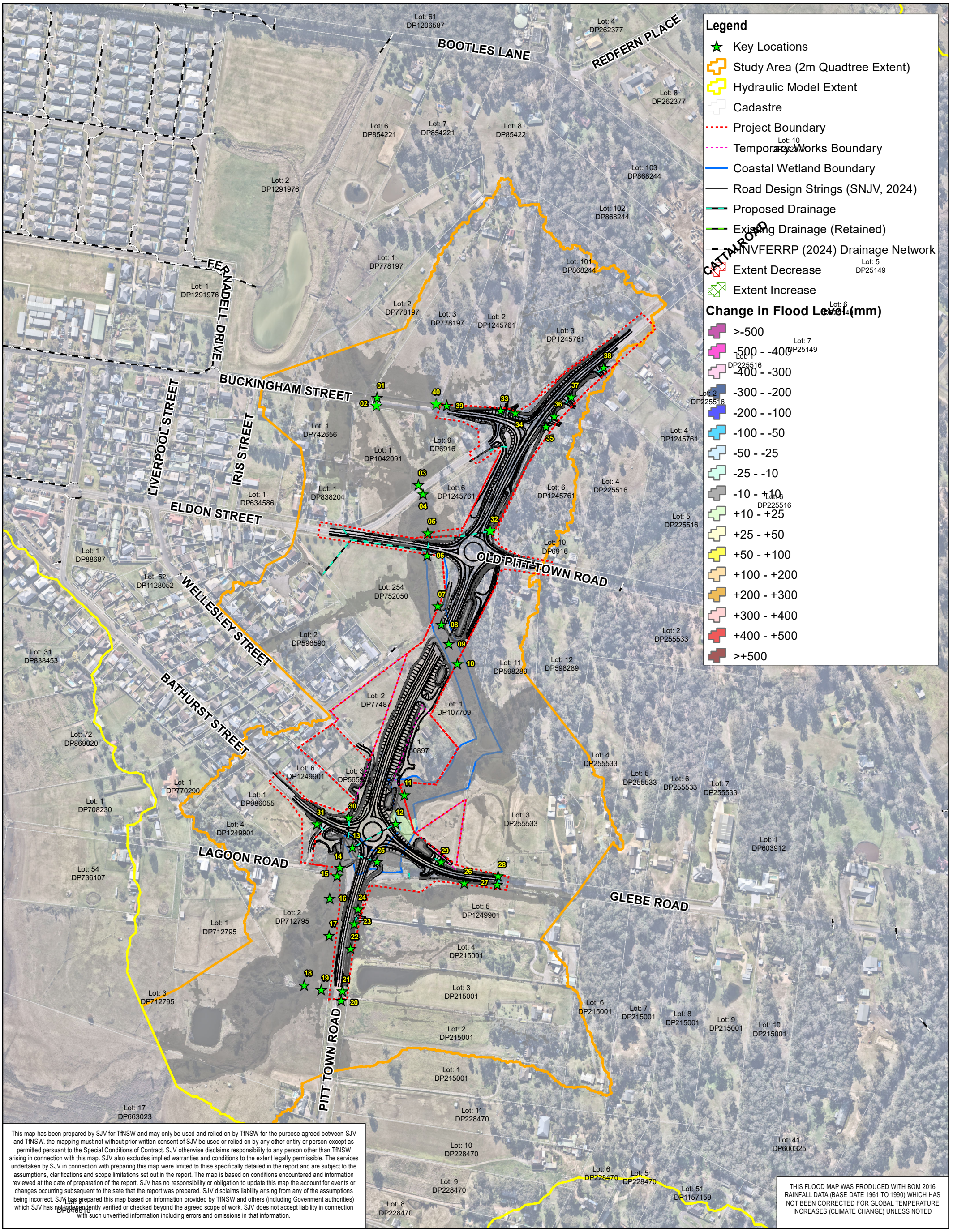

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. ESC - WO907
Revision No. A
Date 07/08/2024

Addendum REF - Blockage Sensitivity Assessment

Relative Flood Impacts (Design with ARR2019 blockage vs Design)

10% AEP

Figure D022

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D022_Relative Change in Flood Level_10pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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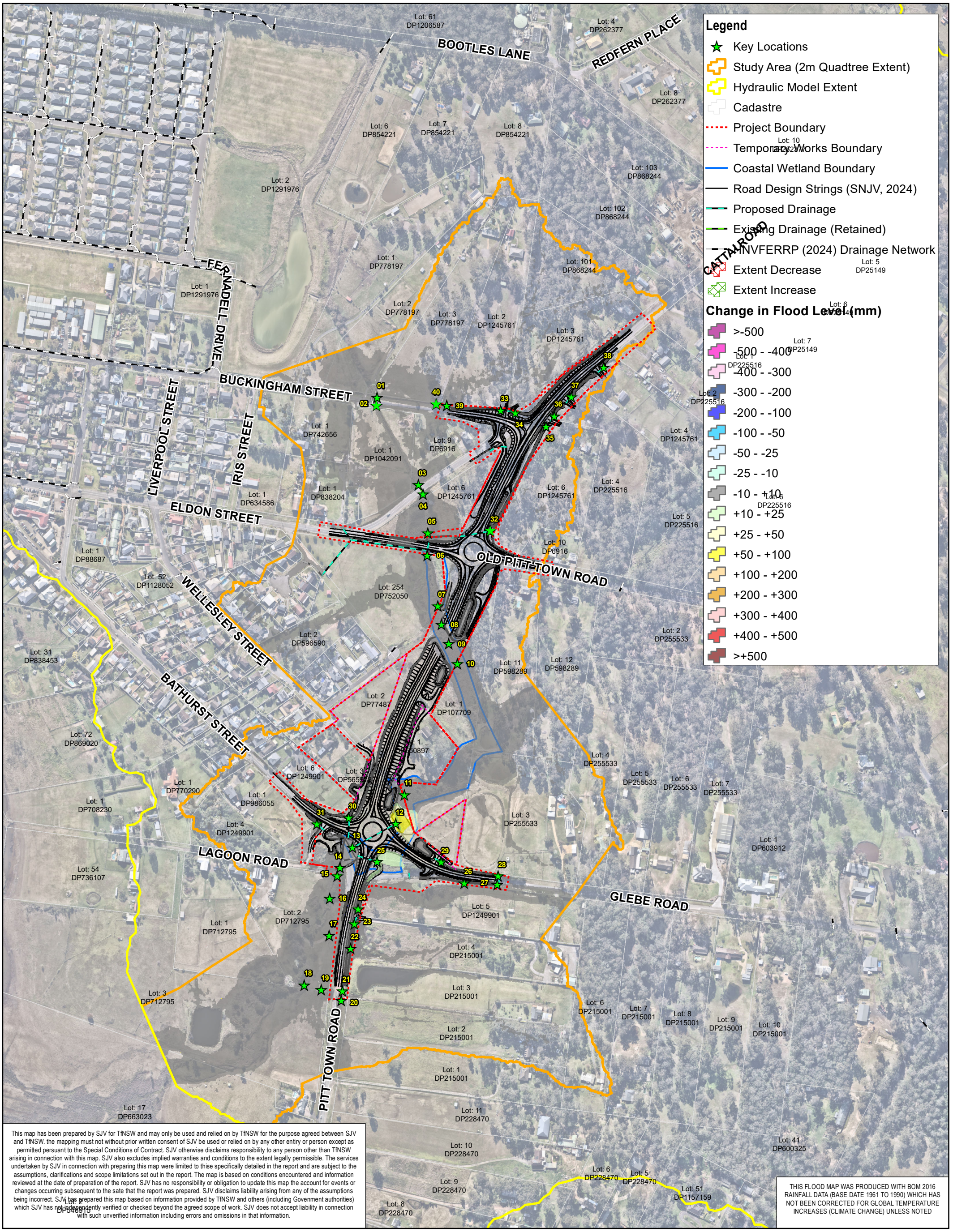

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment

Relative Flood Impacts (Design with ARR2019 blockage vs Design)

5% AEP

Figure D023

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D023_Relative Change in Flood Level_5pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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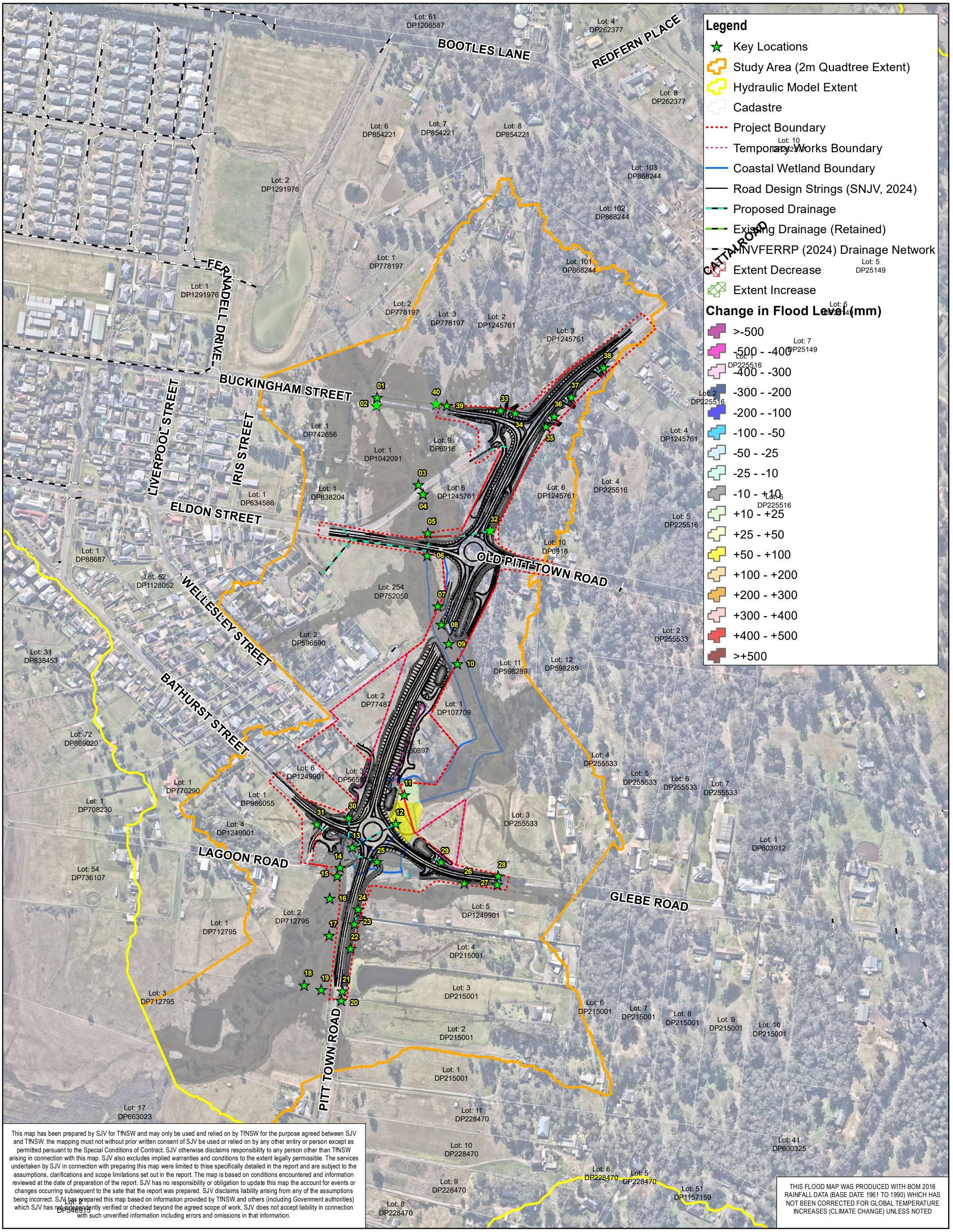

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment

Relative Flood Impacts (Design with ARR2019 blockage vs Design)

2% AEP

Figure D024

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D024_Relative Change in Flood Level_2pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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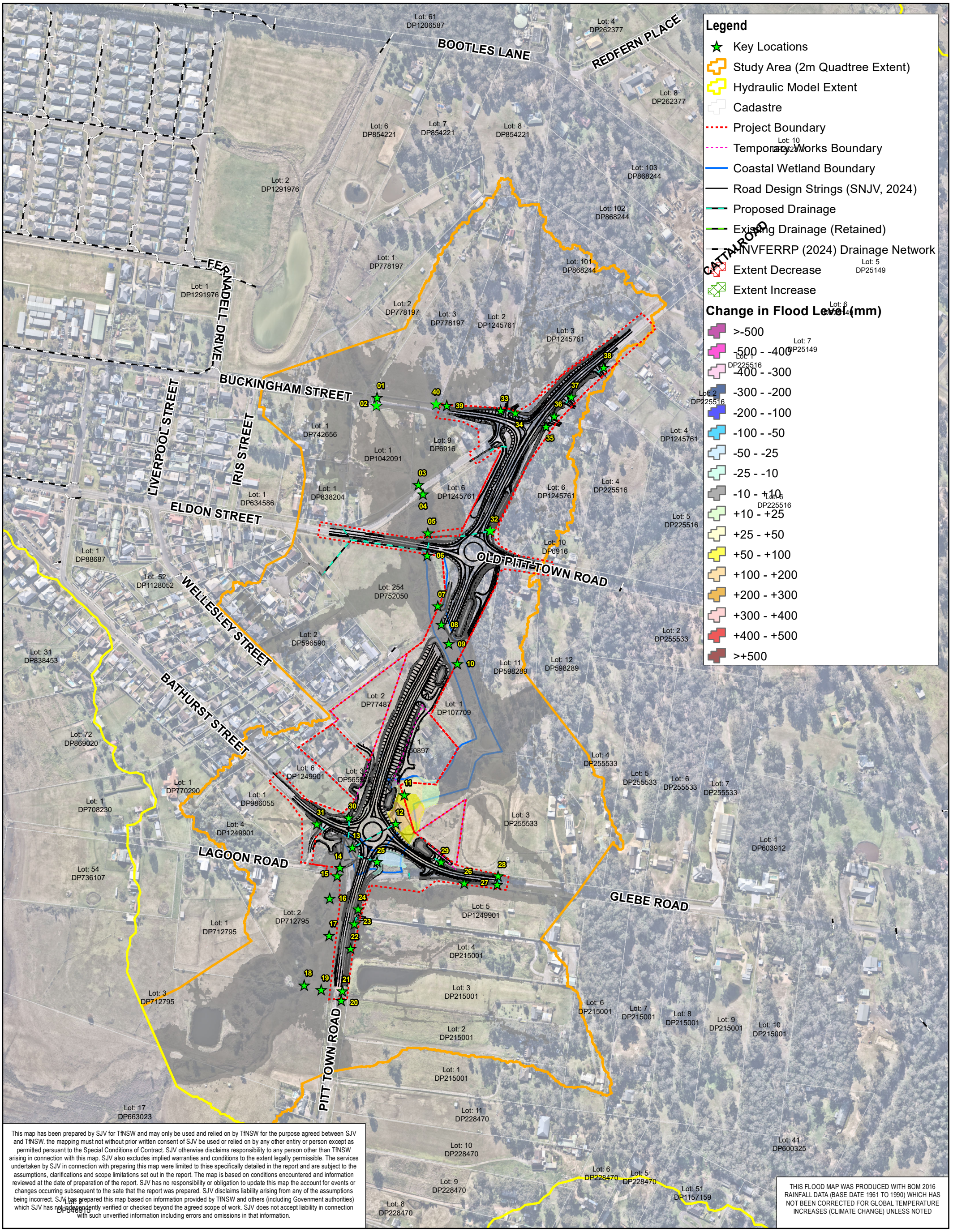

THIS FLOOD MAP WAS PRODUCED WITH BOM 2016 RAINFALL DATA (BASE DATE 1961 TO 1990) WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES (CLIMATE CHANGE) UNLESS NOTED

DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. ESC - WO907
Revision No. A
Date 07/08/2024

Addendum REF - Blockage Sensitivity Assessment

Relative Flood Impacts (Design with ARR2019 blockage vs Design)
1% AEP

Figure D025

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D025_Relative Change in Flood Level_1pct_Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_Des_BLK_Sens.mxd

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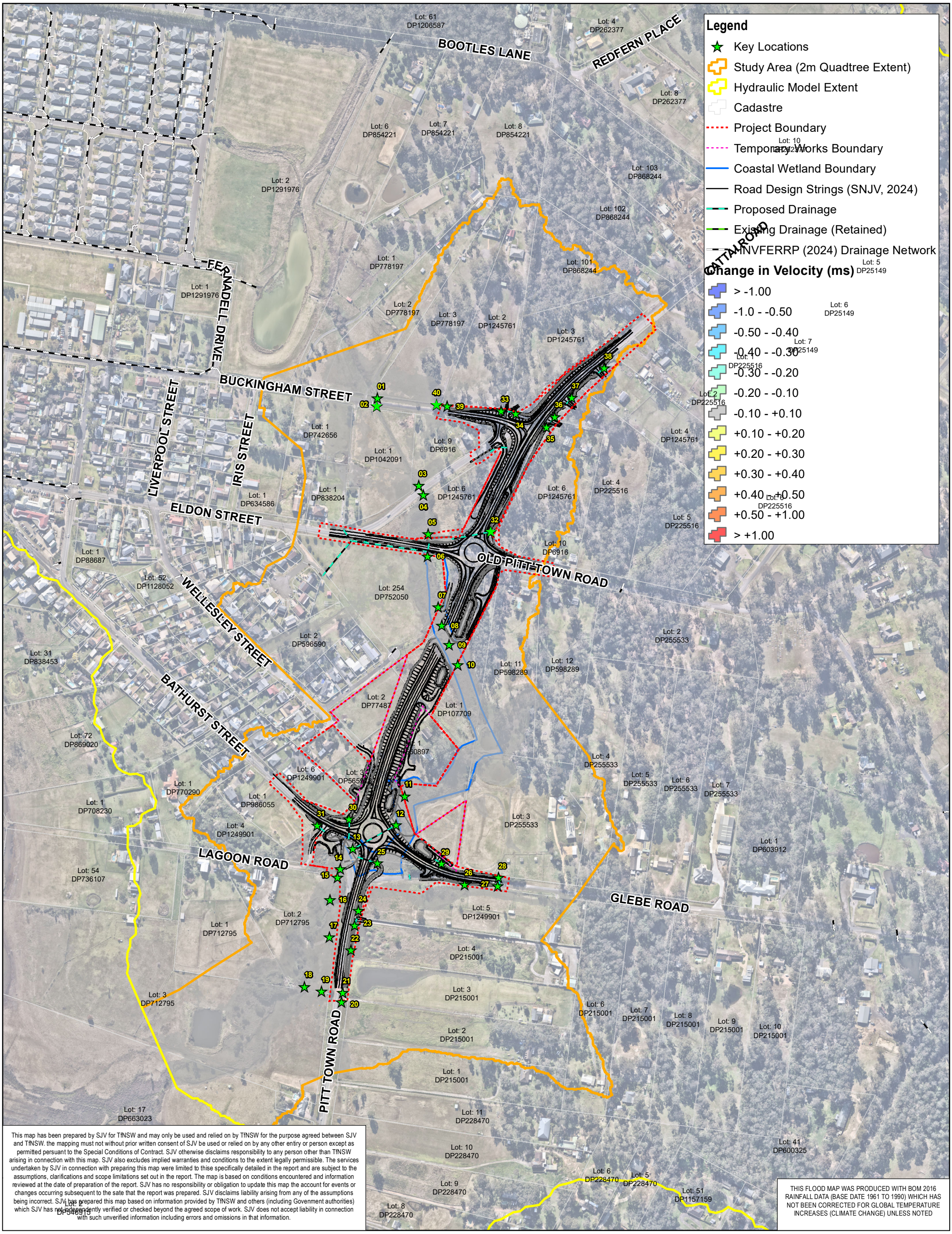

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment
Relative Flood Impacts (Design with ARR2019 blockage vs Design)
20% AEP

Figure D026

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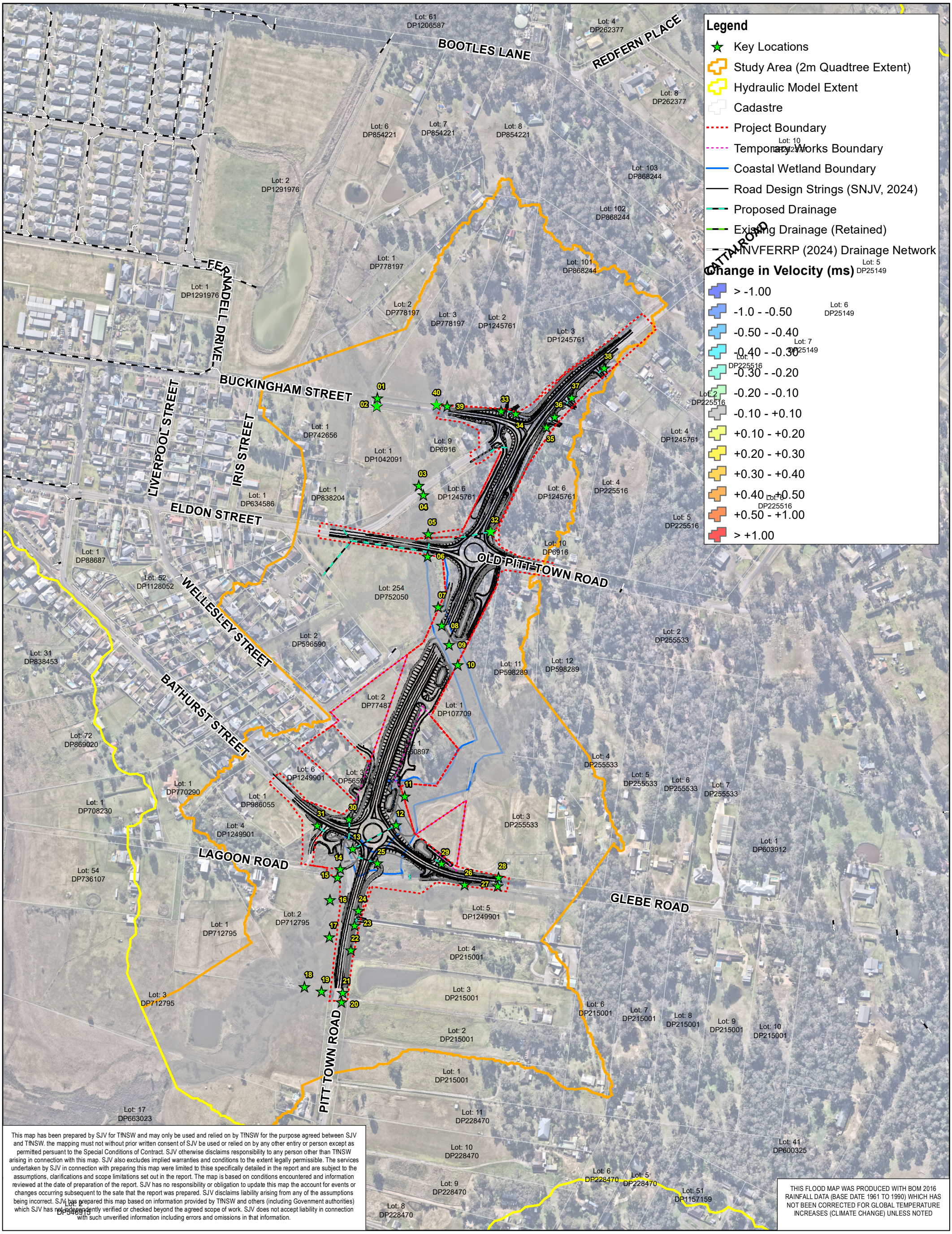

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DRAFT

Paper Size ISO A3

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment
Relative Flood Impacts (Design with ARR2019 blockage vs Design)
10% AEP

Figure D027

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D027_Relative Change in Velocity_10pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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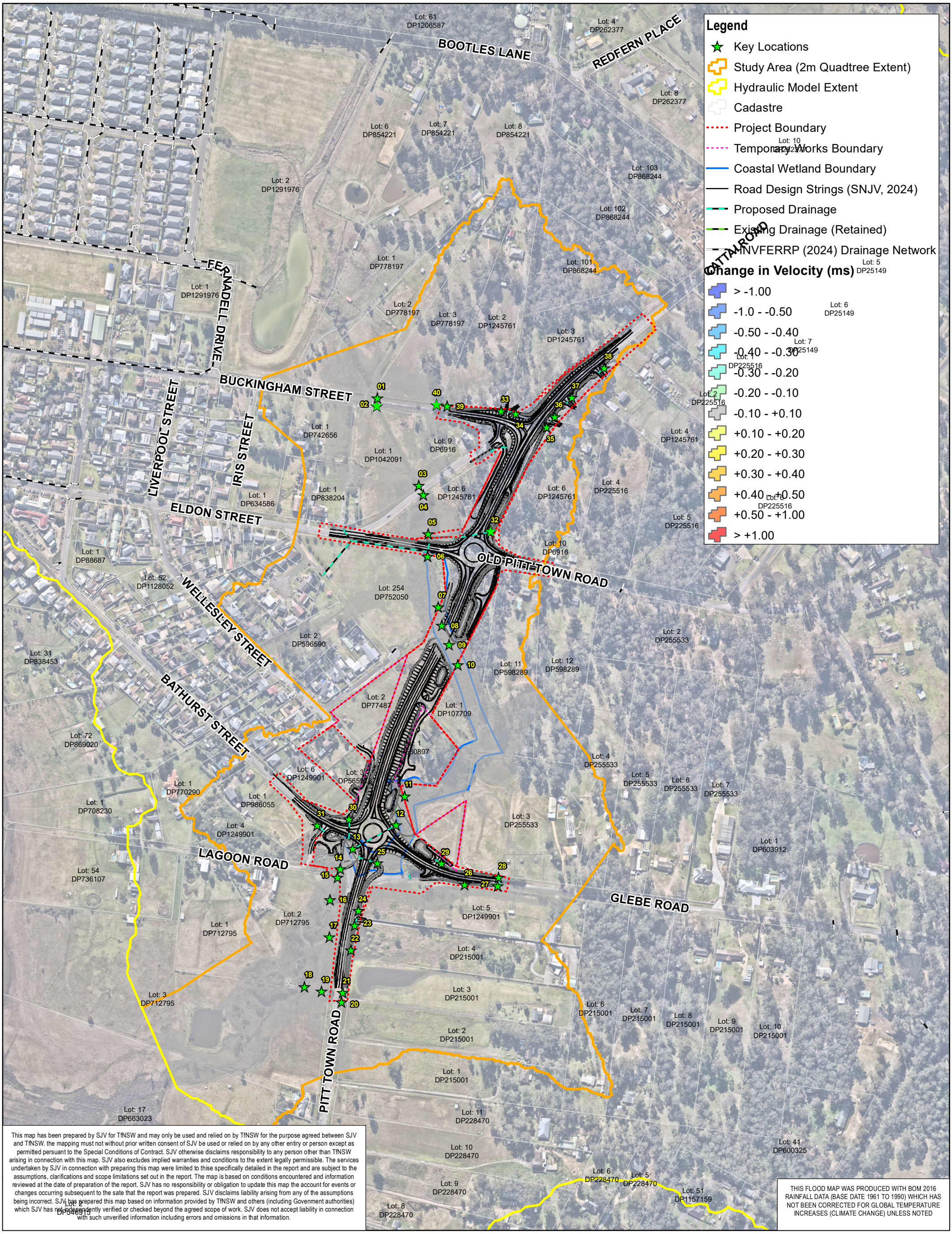

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment
Relative Flood Impacts (Design with ARR2019 blockage vs Design)
5% AEP

Figure D028

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D028_Relative Change in Velocity_5pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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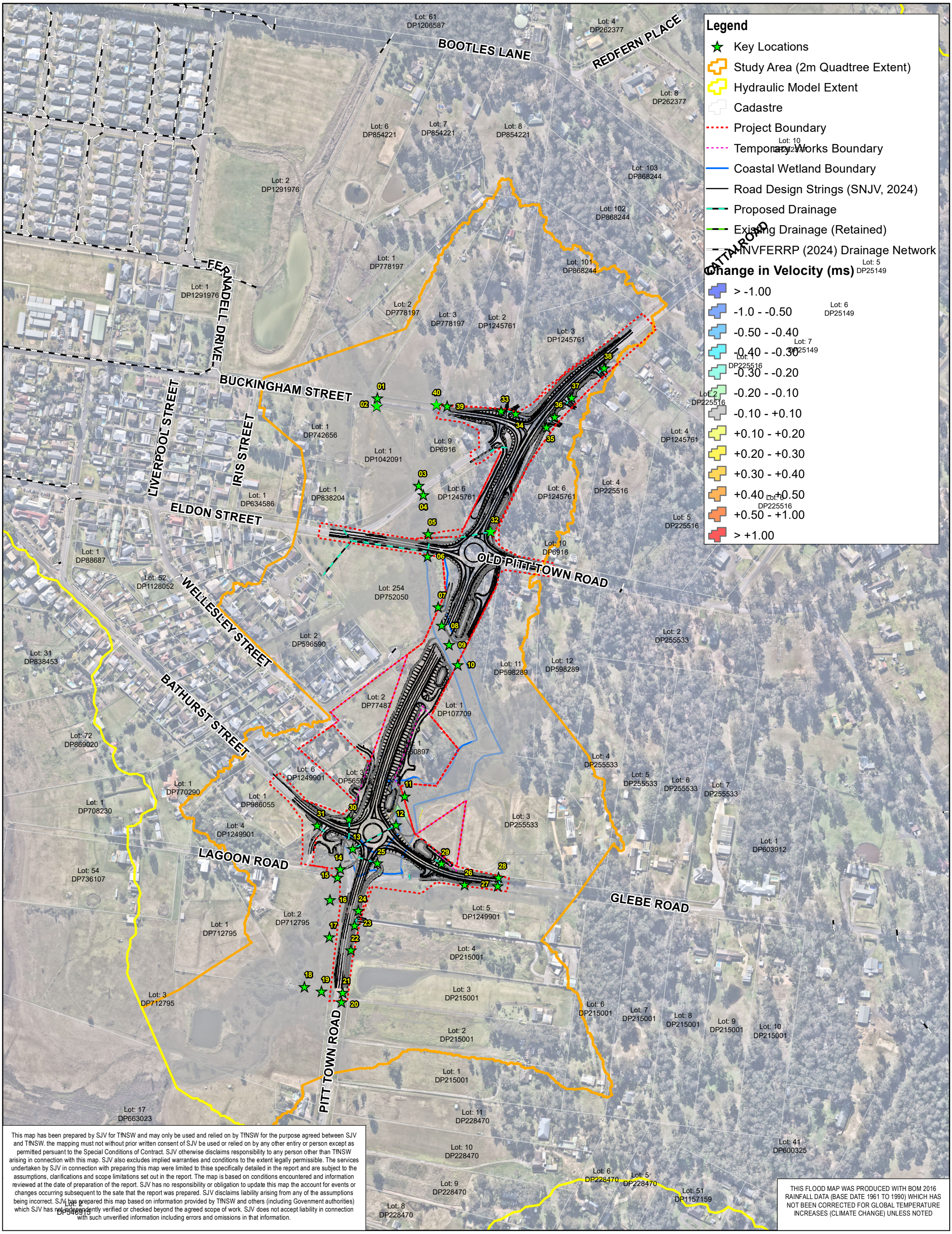

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Addendum REF - Blockage Sensitivity Assessment
Relative Flood Impacts (Design with ARR2019 blockage vs Design)
2% AEP

Figure D029

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D029_Relative Change in Velocity_2pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

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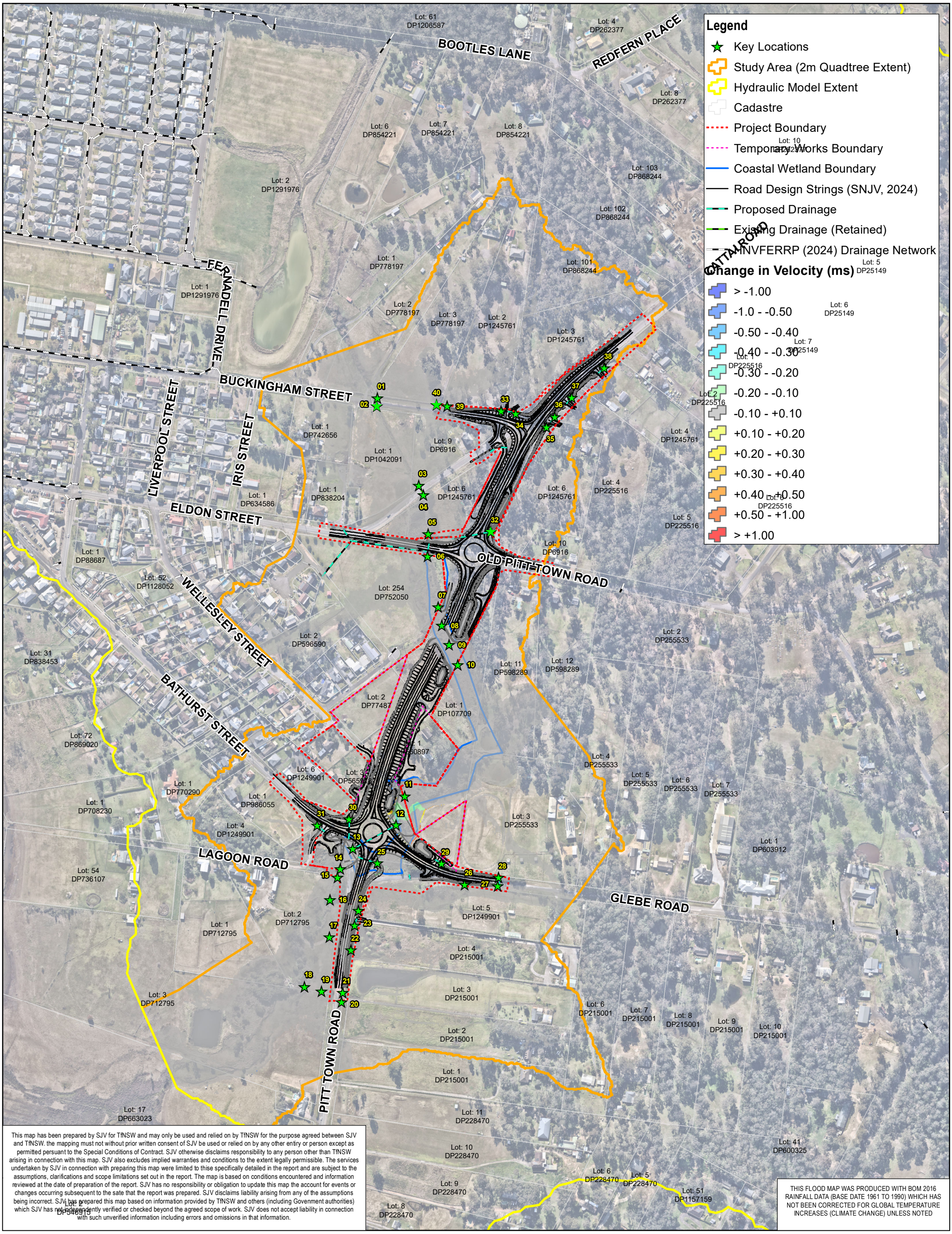

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

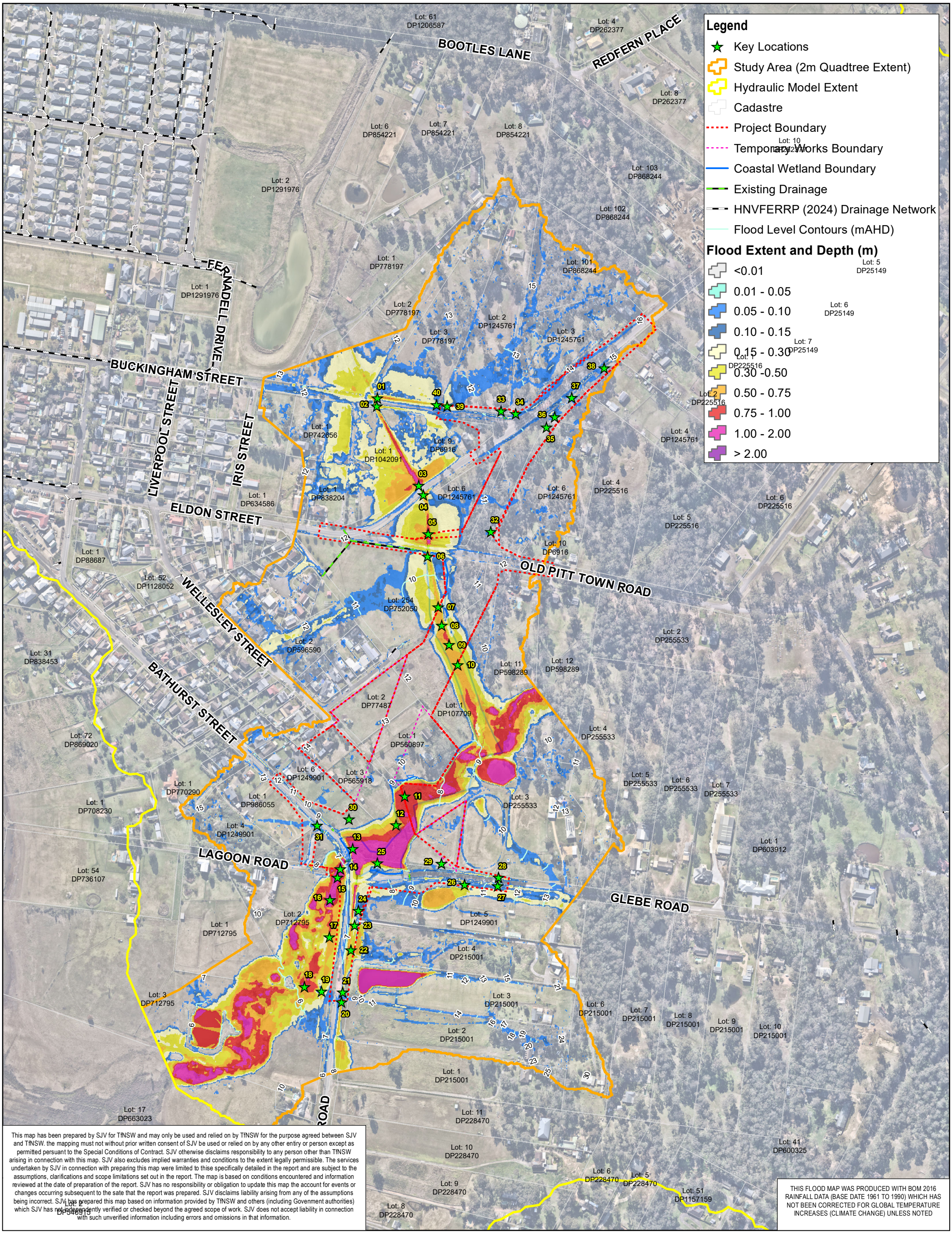
Addendum REF - Blockage Sensitivity Assessment
Relative Flood Impacts (Design with ARR2019 blockage vs Design)
1% AEP

Figure D030

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_D030_Relative Change in Velocity_1pct_Change in Velocity (ms)_SJV_Des_BLK_Sens.mxd

Data source: . Created by: sldouglas

APPENDIX F – CLIMATE CHANGE SENSITIVITY FLOOD MAPPING



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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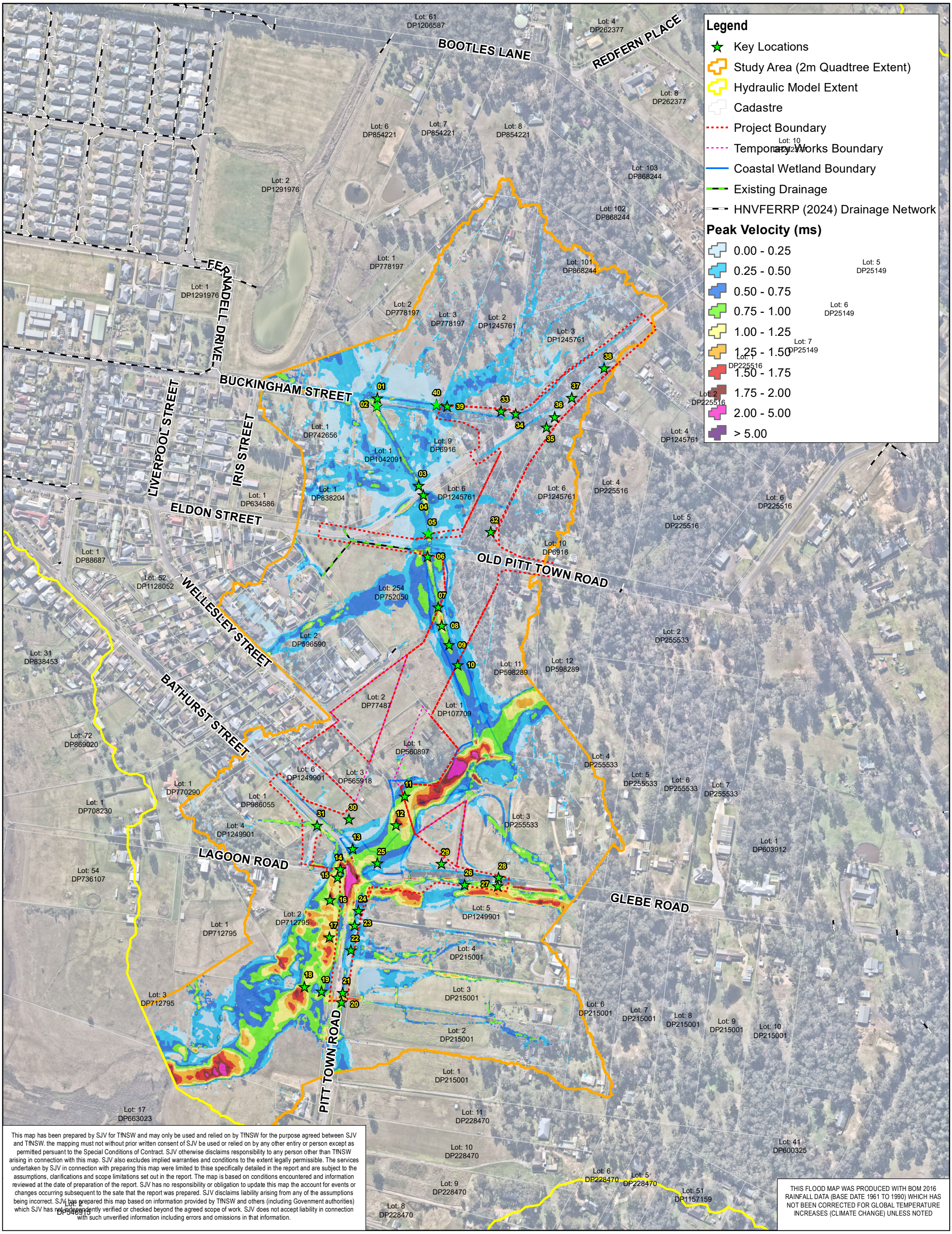
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
Existing Conditions
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E001

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E001_Flood Extent and Depth__Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_CC_SENS.mxd

Data source: . Created by: sldouglas



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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BETWEEN PITT TOWN ROAD AND CATTAI ROAD
Addendum REF
Existing Conditions
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E002

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E002_Peak Velocity__Peak Velocity (ms)_SJV_CC_SENS.mxd
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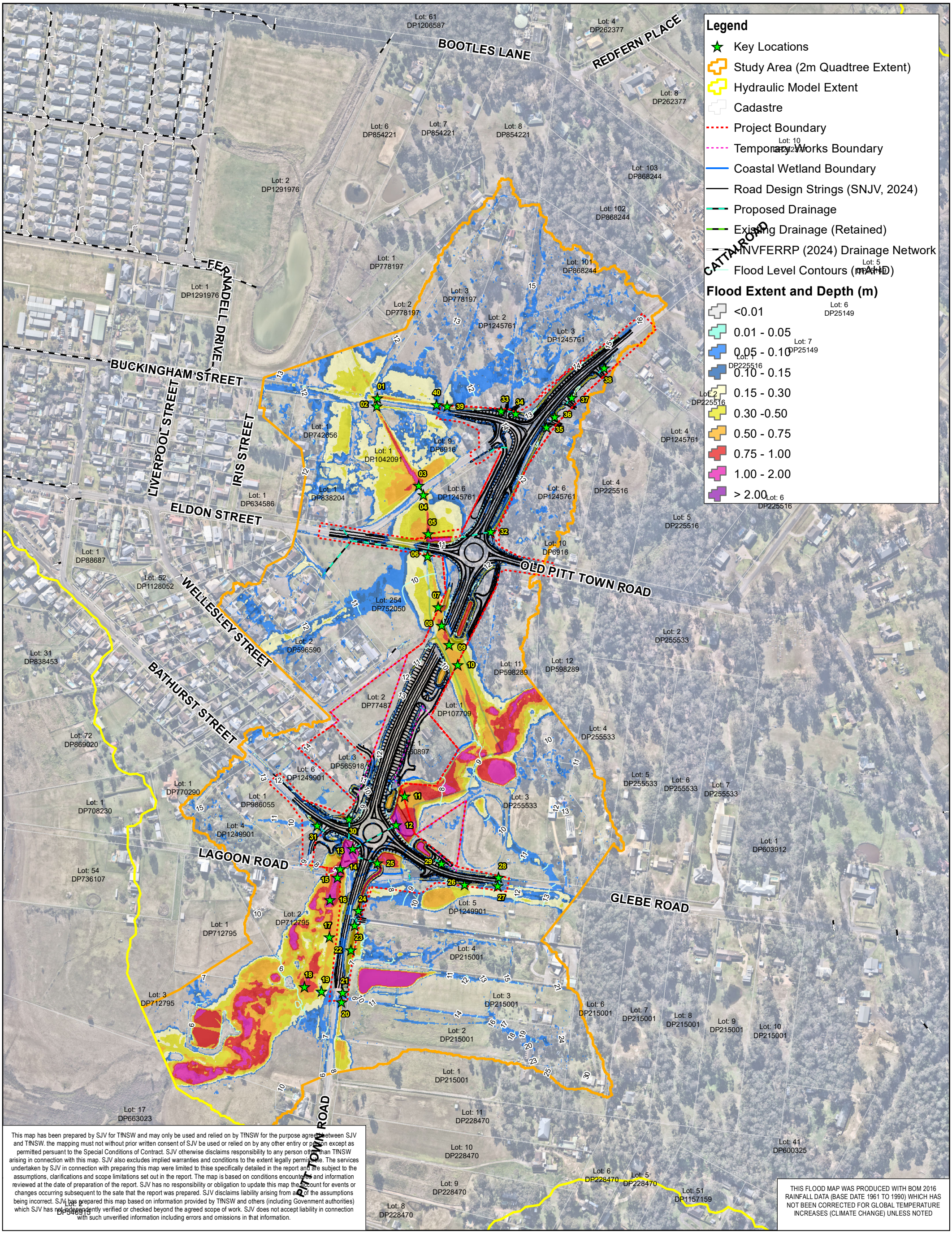

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

SUSTAINJV
Building a Sustainable Legacy

Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Climate Change Assessment
SJV Design
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E003

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E003_Flood Extent and Depth__Flood Extent and Depth (m)_Flood Level Contours (mAHD)_SJV_CC_SENS.mxd

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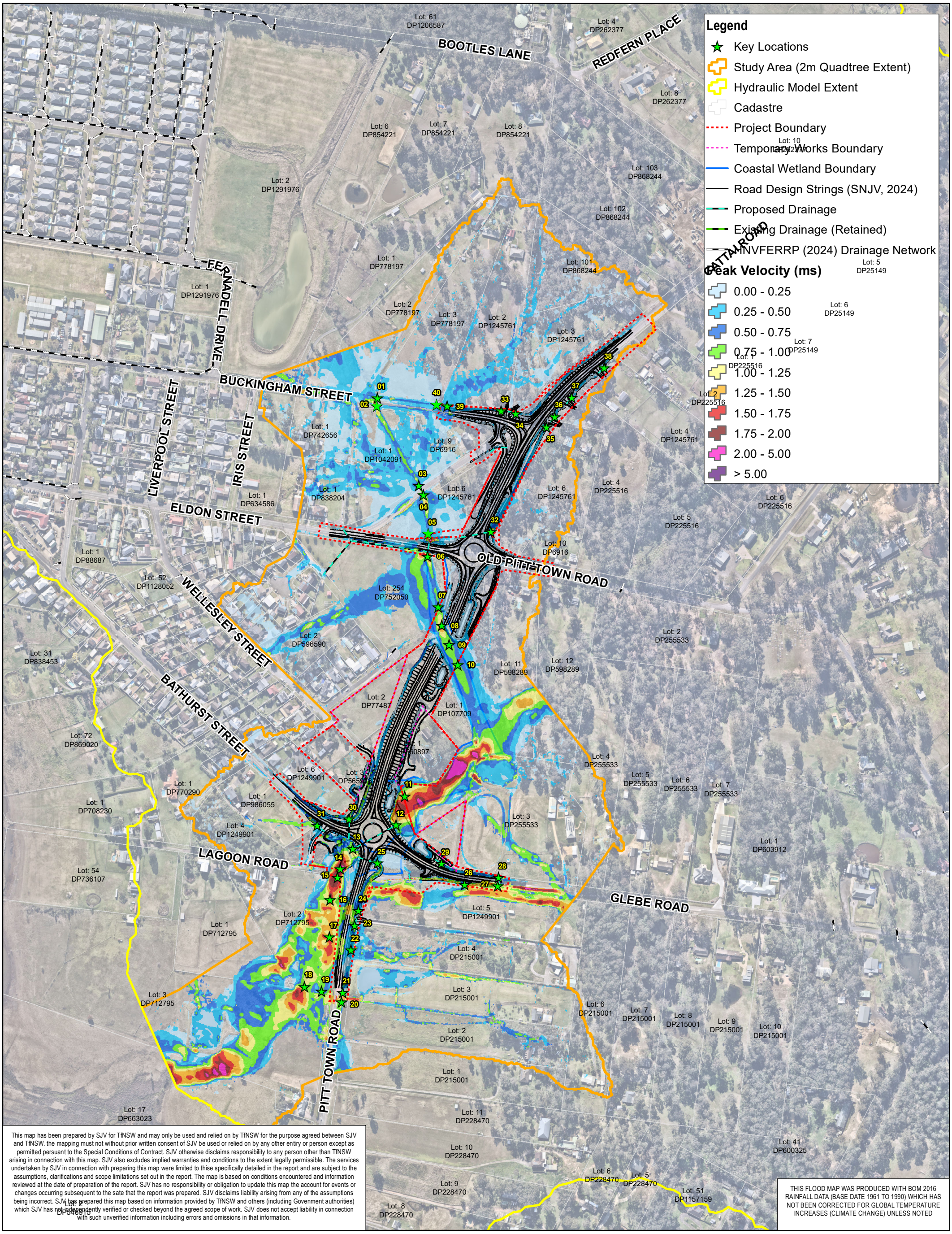

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

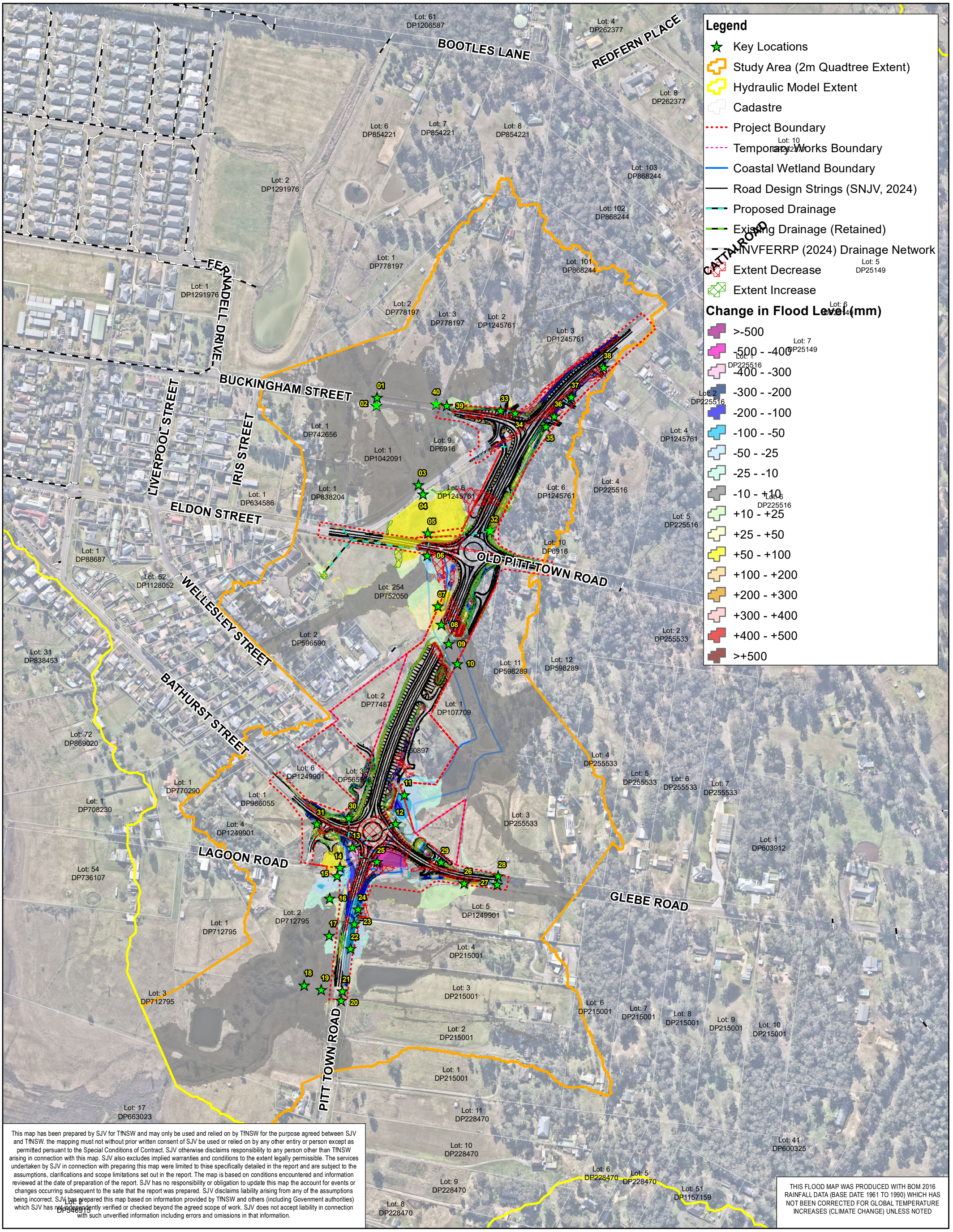
Addendum REF - Climate Change Assessment
SJV Design
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E004

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E004_Peak Velocity__Peak Velocity (ms)_SJV_CC_SENS.mxd
Print date: 07 Aug 2024 - 11:38

Data source: . Created by: sldouglas



Legend

- Key Locations
- Study Area (2m Quadtree Extent)
- Hydraulic Model Extent
- Cadastre
- Project Boundary
- Temporary Works Boundary
- Coastal Wetland Boundary
- Road Design Strings (SNJV, 2024)
- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network
- Extent Decrease
- Extent Increase

Change in Flood Level (mm)

- >-500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - -50
- -50 - -25
- -25 - -10
- -10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- >+500

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DRAFT

Paper Size ISO A3

0 50 100 150 200

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

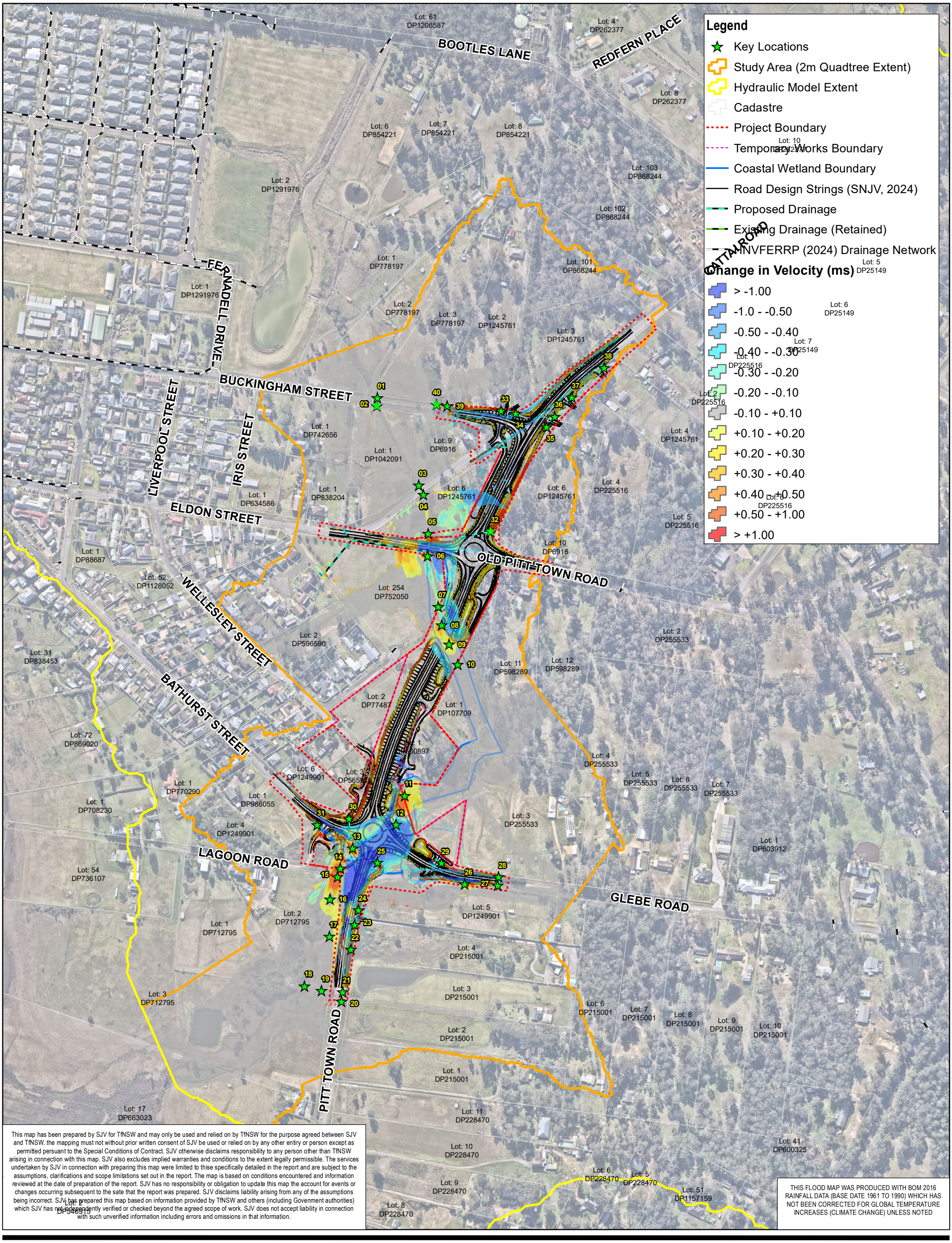
Addendum REF - Climate Change Assessment
Flood Impacts (Design vs Existing)
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E005

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E005_Change in Flood Level__Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_CC_SENS.mxd

Data source: . Created by: sldouglas



Legend

- Key Locations
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- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

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Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Arcadis Australia Pacific Pty Ltd & GHD Pty Ltd
WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

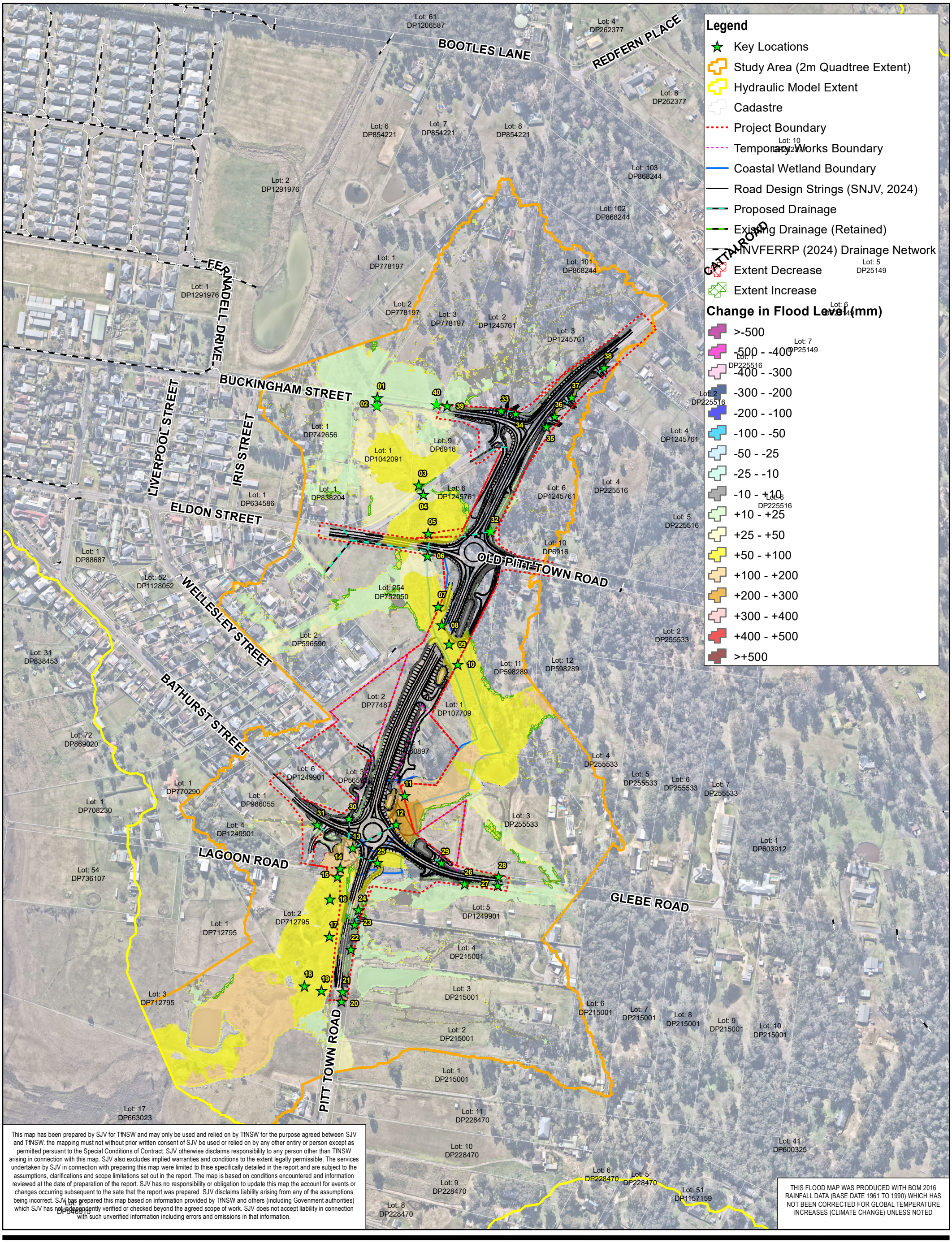
Addendum REF - Climate Change Assessment
Flood Impacts (Design vs Existing)
1% AEP (Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E006

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E006_Change in Velocity__Change in Velocity (ms)_SJV_CC_SENS.mxd
Print date: 07 Aug 2024 - 11:41

Data source: . Created by: sldouglas



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Meters

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Climate Change Assessment
Relative Flood Impacts
1% AEP (Climate Change) vs 1% AEP (without Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E007

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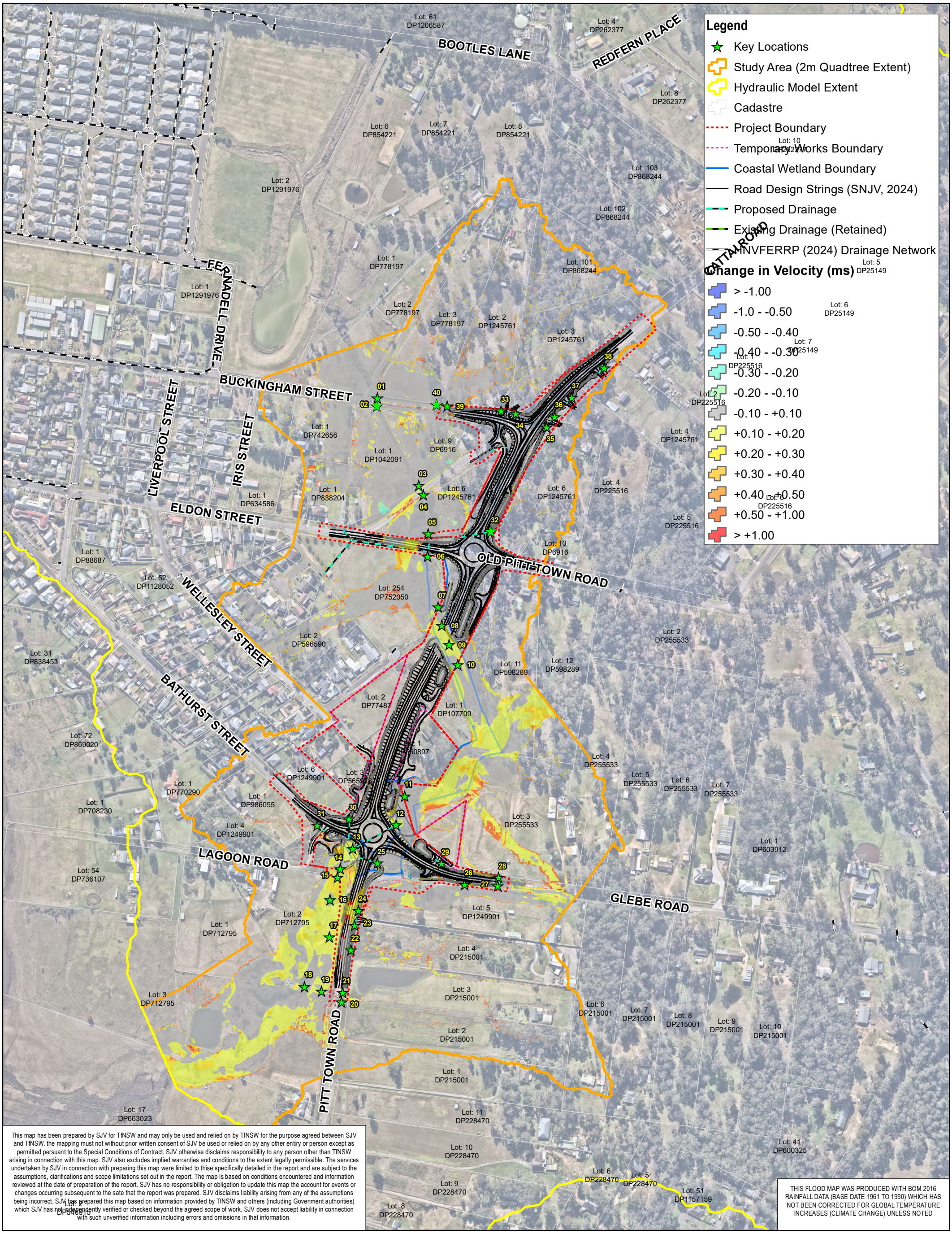
\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E007_Relative Change in Flood Level__Change in Flood Level (mm)_Extent Increase_Extent Decrease_SJV_CC_SENS.mxd



Legend

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- Proposed Drainage
- Existing Drainage (Retained)
- INVFERRP (2024) Drainage Network

Change in Velocity (ms)

- > -1.00
- -1.0 - -0.50
- -0.50 - -0.40
- -0.40 - -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - +0.10
- +0.10 - +0.20
- +0.20 - +0.30
- +0.30 - +0.40
- +0.40 - +0.50
- +0.50 - +1.00
- > +1.00

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Paper Size ISO A3

0 50 100 150 200

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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WO907 - PITT TOWN BYPASS
BETWEEN PITT TOWN ROAD AND CATTAI ROAD

Addendum REF - Climate Change Assessment
Relative Flood Impacts
1% AEP (Climate Change) vs 1% AEP (without Climate Change)

Project No. **ESC - WO907**
Revision No. **A**
Date **07/08/2024**

Figure E008

\\ghdnet\ghd\AU\Sydney\Projects\21\12565042\GIS\Maps\PDF\Flooding\PTB\20240807 - PTB Addendum REF\Fig_E008_Relative Change in Velocity__Change in Velocity (ms)_SJV_CC_SENS.mxd

Data source: . Created by: sldouglas