Pacific Highway Upgrade through Wyong Town Centre

Hydrology and Hydraulics Assessment Report

WTC-DR-001-REP-04

Prepared for: Roads and Maritime Services
Date: 1 July 2015

DOCUMENT CONTROL

Title	Hydrology and Hydraulics Assessment Report			
Prepared for	Roads and Maritime Services			
Project Ref	3001424 – Pacific Highway Upgrade through Wyong Town Centre			
	Name	**Position**	**Signed/Approved**	**Date**
Originator	Danny Duong	Drainage Engineer	DD	01/07/2015
Review	Joseph Clarke	Senior Drainage Engineer	JC	01/07/2015
Approval	Anthony Healey	Project Manager	AH	01/07/2015

Details of Revisions

Rev	Date	Description	WVR No.	Approved
1	06/05/2014	Issued as draft for Roads and Maritime/IV Review	0017	MC
2	29/10/2014	Re-issued as draft for Roads and Maritime/IV Review	0038	MC
3	02/04/2015	Issued as final for Roads and Maritime/IV Review	0059	MC
4	01/07/2015	Re-issued as final for inclusion in REF.	0067	AH

CONTACT DETAILS

SMEC Australia Pty Ltd | www.smec.com

Level 5, 20 Berry Street
North Sydney NSW 2060
Tel: 02 9925 5555
Fax: 02 9925 5566

Representative:
Name: Anthony Healey
P: 02 9925 5521
E: Anthony.Healey@smec.com

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Project Background 1
1.2 Scope of Design Lot 1
1.3 Limitations and Qualifications 1
1.4 Consultation with Authorities 2
1.4.1 Wyong Shire Council 2
1.4.2 Sydney Trains 2
1.4.3 Roads and Maritime 2
1.5 Flood Immunity Requirements 3
1.5.1 Flooding Impacts 3
1.6 Updates from Revision 01 to Revision 02 4
1.7 Updates from Revision 02 to Revision 03 4
1.8 Updates from Revision 03 to Revision 04 5
1.9 Other Considerations 5
1.9.1 Fish Passage Requirements 5
1.9.2 Navigational Clearance Requirements 5
1.9.3 Constructability and Staging 6
2. STUDY METHODOLOGY 7
2.1 Overview 7
2.2 Terminology 7
3. PREVIOUS STUDIES AND AVAILABLE INFORMATION 9
3.1 Previous Studies 9
3.1.1 Wyong River Catchment Flood Study (BMT WBM, January 2014) 9
3.1.2 Wyong CBD Trunk Culvert Flood Impact Assessment (Cardno, March 2014) 10
3.2 Wyong CBD Trunk Main Culvert 13
3.3 Available Survey Data 13
4. HYDROLOGY 14
4.1 Wyong River Catchment TUFLOW Model 14
4.1.1 Catchment Description 14
4.1.2 Design Rainfall 14
4.1.3 Model Parameters 14
4.1.4 Critical Duration 15
4.1.5 Climate Change 16
4.2 Wyong Town Centre TUFLOW Model 17
4.2.1 Catchment Description 17
4.2.2 Design Rainfall 17
4.2.3 Model Parameters 17
4.2.4 Critical Duration 18
4.2.5 Climate Change 20

4.3 South Tacoma Road Culvert 20
4.3.1 Catchment Description 20
4.3.2 Design Rainfall 21
4.3.3 Model Parameters 21
4.3.4 Critical Duration 21
4.3.5 Climate Change 21

5. HYDRAULICS 22

5.1 Wyong River Catchment TUFLOW Model 22
5.1.1 Software Version 22
5.1.2 Adopted Model Control Files 22
5.1.3 Model Calibration 22
5.1.4 Model Geometry 23

5.2 Wyong Town Centre TUFLOW Model 33
5.2.1 Software Version 33
5.2.2 Model Geometry 33
5.2.3 Design Road Alignment 36
5.2.4 Culverts 36
5.2.5 Model Parameters and Assumptions 38

5.3 South Tacoma Road Culvert Extension 42
5.3.1 Methodology 42
5.3.2 Model Parameters and Assumptions 42

6. MODEL RESULTS 43

6.1 Wyong River Catchment TUFLOW Model 43
6.1.1 Flood Level Impacts 43

6.2 Wyong Town Centre TUFLOW Model 49
6.2.1 Flood Level Impacts 49
6.2.2 Comparison of SOBEK and TUFLOW 51
6.2.3 Flood Immunity Impacts 54
6.2.4 Effects on Probable Maximum Flood 55
6.2.5 Effects on more Frequent Events 56

6.3 Impact on Rail Corridor 56
6.3.1 Wyong River 56
6.3.2 Wyong Town Centre 56

6.4 Impacts on Wyong Racecourse and Wyong Golf Course 57

6.5 South Tacoma Road Culvert 58

6.6 Future Railway Duplication at Wyong River 60

6.7 Bridge Scour and Erosion Protection 62
6.7.1 Scour Type 62
6.7.2 Scour Evaluation by HEC-18 (2001) in Sand/Gravel Bed Streams 63
6.7.3 Total Scour Depth Calculation Methodology 63
6.7.4 Bridge Scour Depths 63

7. CONCLUSION & RECOMMENDATIONS 65

7.1 Design Recommendations.....65
7.1.1 Flood Mitigation Measures.....65
7.1.2 Wyong Town Centre Culverts at Pacific Highway and Main North Line Railway....67
7.2 Further Work.....68
8. REFERENCES.....69

APPENDICES

APPENDIX A: FLOOD MAPS

APPENDIX B: TWIN ROAD BRIDGES OVER WYONG RIVER DRAWINGS

APPENDIX C: WYONG SHIRE COUNCIL CULVERT DRAWINGS AND FIGURES

APPENDIX D: WYONG TOWN CENTRE WBNM HYDROLOGY

APPENDIX E: CONSULTATION DOCUMENTATION

APPENDIX F: DESIGN DEPARTURES REGISTER

ABBREVIATIONS/GLOSSARY

ASCII	American Standard Code for Information Interchange
AEP*	Annual Exceedance Probability
ALS	Aerial Laser Survey
ARI*	Annual Recurrence Interval
AS/NZS	Australian Standards/New Zealand Standards
AR&R	Australian Rainfall and Runoff Guidelines
BOM	Bureau of Meteorology
CAD	Computer Aided Drafting
CBD	Central Business District
CH	Chainage
DEM	Digital Elevation Model
DTM	Digital Terrain Model
FHWA	Federal Highway Administration (United States Department of Transportation)
GIS	Geographic Information Systems
HEC-RAS	Hydrologic Engineering Centre River Analysis System river modelling software
HY-8	FHWA culvert hydraulic software
IFD	Intensity-Frequency-Duration

LiDAR	Light Detection And Ranging
NSW	New South Wales
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RAFTS-XP	Rainfall runoff routing model
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
RDG	Road Design Guide
REF	Review of Environmental Factors
Roads and Maritime	Roads and Maritime Services
SMEC	Snowy Mountains Engineering Corporation
SOBEK	1d/2d flood modelling suite
Stn.	Station
TUFLOW	Two-dimensional Unsteady FLOW flood modelling software
WBNM	Watershed Bounded Network Model hydrologic modelling software
WTC	Wyong Town Centre

* Refer Section 2.2 of the report for use of abbreviations ARI and AEP.

LIST OF TABLES

Table 1-1 – Wyong Town Centre Upgrade Flood Impact Requirements 3

Table 1-2 – Wyong Town Centre Upgrade Flood Immunity Requirements 3

Table 1-3 – Summary of existing Pacific Highway and railway culverts 5

Table 1-4 – Summary of Navigational Clearances Requirements 6

Table 2-1 – Summary of AEP vs. ARI 8

Table 4-1 – Wyong River RAFTS-XP Model Parameters 15

Table 4-2 – Wyong River TUFLOW critical duration storms for AEP events 15

Table 4-3 – Wyong Town Centre WBNM Model Parameters 17

Table 4-4 – Wyong Town Centre WBNM Model Rainfall Parameters 18

Table 4-5 – 100 year ARI Peak Flows – Proposed Conditions 18

Table 4-6 – 100 year ARI Peak Flood Levels – Proposed Conditions 19

Table 4-7 – Pacific Highway culverts TUFLOW critical duration storms for various ARI events 20

Table 4-8 – 100 year ARI Peak Flows – Proposed Conditions 21

Table 4-9 – Pacific Highway culverts TUFLOW critical duration storms for AEP events 21

Table 5-1 – Historical events used in calibration of BMT WBM's model 23

Table 5-2 – Summary of Model Alterations 24

Table 5-3 – Wyong River bridge parameters used in the TUFLOW model 26

Table 5-4 – HEC-RAS 1% AEP results for existing and proposed conditions at the Wyong River crossing 32

Table 5-5 – HEC-RAS 1% AEP results for existing conditions at the bridges 33

Table 5-6 – HEC-RAS 1% AEP results for proposed conditions at the bridges 33

Table 5-7 – TUFLOW Floodplain Roughness Parameters 35

Table 5-8 – Summary of existing Pacific Highway and railway culverts 37

Table 5-9 – Summary of proposed Pacific Highway and railway culverts 37

Table 5-10 – Peak discharge from Trunk Main Culvert (Cardno Report) 38

Table 5-11 – Comparison of SOBEK and TUFLOW Upstream of Existing Railway Culvert at Stn. 1940 40

Table 6-1 –Peak Flood Levels under Proposed Wyong River Bridge 43

Table 6-2 – 100 year ARI Peak Flood Locations – Proposed Conditions 48

Table 6-3 – Summary of 1% AEP existing condition results 49

Table 6-4 – Summary of 1% AEP proposed condition results 50

Table 6-5 – Summary of 1% AEP flood level impacts at Pacific Highway culverts 50

Table 6-6 – Comparison of SOBEK and TUFLOW Upstream of Existing Highway Culvert at Stn. 1690. 52

Table 6-7 – Comparison of SOBEK and TUFLOW Upstream of Existing Railway Culvert at Stn. 1940. 53

Table 6-8 – Summary of Flood Immunity and Conformance Evaluation 54

Table 6-9 – Overtopping Level at River Road and South Tacoma Road 55

Table 6-10 – Summary of Impacts at Rail Corridor at Wyong Town Centre 57

Table 6-11 – 100 year ARI Bridge Scour Depth Summary 64

Table 6-12 – 2000 year ARI Bridge Scour Depth Summary 64

LIST OF FIGURES

Figure 1-1 – Flood Immunity 3

Figure 4-1 – Wyong Town Centre TUFLOW Critical Duration Sample Locations 19

Figure 5-1 – Incremental backwater coefficient for piers (Hydraulics of Bridge Waterways, FHWA, 1978) 26

Figure 5-2 – TUFLOW 2d flow constriction soffit levels for proposed twin bridges over Wyong River 27

Figure 5-3 – TUFLOW 2d flow constriction bridge lines and polygons for design (magenta) and existing (cyan) bridges over Wyong River 28

Figure 5-4 – HEC-RAS plan layout at proposed twin road bridges over Wyong River 29

Figure 5-5 – HEC-RAS cross-section at proposed twin bridges over Wyong River (River Station 300.00) 30

Figure 5-6 – HEC-RAS cross-section at existing Pacific Highway bridge over Wyong River (River Station 290.00) 30

Figure 5-7 – HEC-RAS cross-section at existing Main North Line railway bridge over Wyong River (River Station 275.00) 31

Figure 5-8 – Wyong Town Centre TUFLOW Model Terrain 34

Figure 5-9 – Wyong Town Centre TUFLOW Cross-section – SOBEK vs. TUFLOW 34

Figure 5-10 – Typical TUFLOW Roughness Polygons Distribution 35

Figure 5-11 – Plan arrangement of proposed Pacific Highway culverts 36

Figure 5-12 – Typical TUFLOW Inflow Boundary.....39

Figure 5-13 – TUFLOW Downstream Boundary 40

Figure 6-1 – Time of Inundation Sample Locations for Wyong River catchment 45

Figure 6-2 – 1% AEP Stage Hydrograph at Sample Location A.....46

Figure 6-3 – 1% AEP Stage Hydrograph at Sample Location B.....46

Figure 6-4 – 1% AEP Stage Hydrograph at Sample Location C 47

Figure 6-5 – Wyong River TUFLOW Impact under Climate Change for 1% AEP Event (vs. 1% AEP without Climate Change) 48

Figure 6-6 – Wyong Northern TUFLOW Flood Extent vs. SOBEK Flood Extent for the 100 year ARI 52

Figure 6-7 – 1% AEP flows for South Tacoma Road DRAINS model 59

Figure 6-8 – Assumed Arrangement of Future Railway Duplication at Wyong River 61

Figure 7-1 – Proposed Excavation at 204-206 and 210 Pacific Highway, Tuggerah 66

Figure 7-2 – Typical Section of Proposed Excavation at 204-206 and 210 Pacific Highway, Tuggerah.....66

1. INTRODUCTION

1.1 Project Background

Roads and Maritime Services (Roads and Maritime) has undertaken a planning study to provide a basis for the future development of Wyong and to assist Wyong Shire Council with its planning. As part of this, Roads and Maritime has appointed SMEC to undertake the concept design of the Pacific Highway Upgrade through the Wyong Town Centre (known as the Wyong Town Centre Upgrade herein). The concept design works apply to a 2.4 kilometre section of the Pacific Highway between the intersections of Johnson Road and Cutler Drive, with a proposal to upgrade the current single lane in each direction to a dual carriageway, with two lanes in each direction separated by a central median. This is expected to improve traffic flow and increase safety for road users, including cyclists and pedestrians.

1.2 Scope of Design Lot

The purpose of this Hydrology and Hydraulics Assessment Report is to provide a flood impact assessment of the Wyong Town Centre Upgrade. This involves reviewing the available flooding assessments for the Wyong River catchment and then developing these studies further to account for the Wyong Town Centre Upgrade. Particular emphasis was placed on the usage of the existing hydraulic models developed by BMT WBM Pty Ltd (BMT WBM), prepared for Wyong Shire Council (Council), in the Wyong River Catchment Flood Study (2014).

This Hydrology and Hydraulics Assessment Report documents the investigation by SMEC of the flooding impacts associated with the proposed Wyong Town Centre Upgrade, including the construction of the new road earthworks and installation of the new twin road bridges over Wyong River.

This report also covers an assessment of the impact of the Pacific Highway upgrade from Wyong Town Centre to north of Cutler Drive. Existing flooding in this area is covered by the Wyong CBD Trunk Culvert Flood Impact Assessment (2014) carried out by Cardno for Wyong Council. However, this report does not consider the future highway widening in any detail. Modelling for this report was carried out using SOBEK. The Wyong CBD Trunk Culvert Flood Impact Assessment report has been used as a reference as part of SMEC's hydrologic and hydraulic analysis. A TUFLOW model has been developed by SMEC to assess the impact of the road widening in this area.

1.3 Limitations and Qualifications

The BMT WBM hydrological and hydraulic models used in the Wyong River Catchment Flood Study have been adopted by Council for floodplain management activities. On this basis, the modelling parameters utilised within those studies were retained in SMEC's assessment of the Wyong Town Centre Upgrade, where appropriate.

This Hydrology and Hydraulics Assessment Report has not addressed how the major watercourses and floodplains may change over time, particularly due to the unpredictable nature of development and environmental factors.

The assessment of the northern section of the upgrade between North Road and Cutler Drive has been carried out using 1D/2D TUFLOW modelling to establish the impact of the highway upgrade. This assessment is not intended to replace the existing SOBEK model produced by Cardno for Wyong Council, but to establish the relative impacts of the highway upgrade.

The assessment presented in this Hydrology and Hydraulics Assessment Report was relevant to the proposed design at the time of writing. Further alterations to the design will warrant an update to this study.

1.4 Consultation with Authorities

1.4.1 Wyong Shire Council

SMEC has been in regular consultation with Wyong Shire Council since commencing the Wyong Town Centre Upgrade.

A meeting with representatives from SMEC, Wyong Shire Council and Roads and Maritime was conducted on 24 June 2014. The content of the previous revision of this report was discussed and preliminary flood impact criteria and other parameters were agreed and accepted.

The meeting record from this stakeholder meeting is presented in Appendix E.

Correspondence regarding climate change and other matters has been ongoing throughout the project between SMEC, Roads and Maritime and Council.

1.4.2 Sydney Trains

Sydney Trains has been consulted by Roads and Maritime as part of the concept design. As a result, significant changes to the road geometry have been incorporated into the design in order to accommodate future rail corridor widening.

Sydney Trains is to review and provide comment on this and future revisions of this flooding report.

1.4.3 Roads and Maritime

In addition to the above consultation with regards to flooding aspects, Roads and Maritime have been approached with regards to navigational clearance requirements for the new bridge structure at Wyong River. These requirements have been incorporated into the concept design where necessary.

Internal stakeholders within Roads and Maritime will continue to be consulted throughout the concept design process.

Documentation of the consultation for navigational clearance is presented in Appendix E.

1.5 Flood Immunity Requirements

The adopted flooding impact and immunity requirements are summarised in Table 1-1 and Table 1-2.

The flood immunity criteria is shown in Figure 1-1.

1.5.1 Flooding Impacts

Table 1-1 – Wyong Town Centre Upgrade Flood Impact Requirements

Item	Description
Afflux within existing watercourses and Council land	< 300 mm
Afflux at residential, commercial and industrial buildings	< 10 mm (desirable) < 20 mm (absolute maximum)

Table 1-2 – Wyong Town Centre Upgrade Flood Immunity Requirements

Location	Immunity
Council roads	10 year ARI (Desirable) No worse than existing (Minimum)
Pacific Highway	100 year ARI

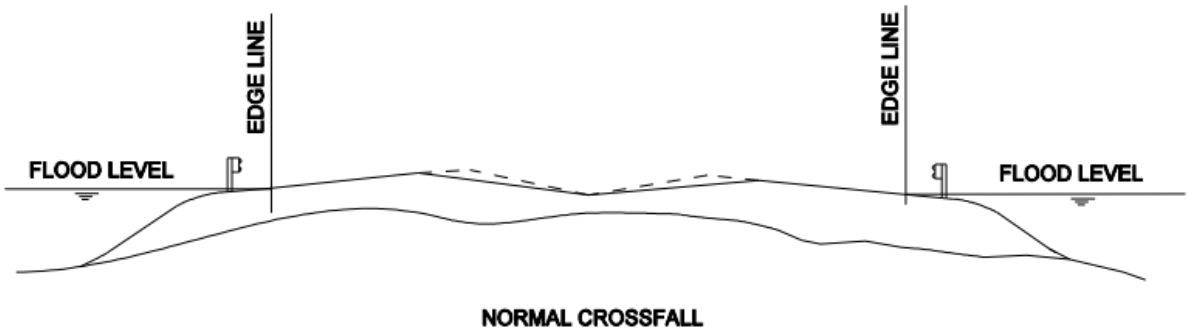


Figure 1-1 – Flood Immunity

1.6 Updates from Revision 01 to Revision 02

The following amendments have been incorporated since the previous issue of this document:

- Proposed Wyong Town Centre Upgrade (Revised 50 per cent Concept Design) arrangement has undergone significant changes including, but not limited to:
    - Provision of a roundabout at the intersection of the Pacific Highway and McPherson Road and associated local road connections
    - Provision of twin road bridges over the Wyong River
    - Demolition of the existing Wyong River bridge
    - Shifted alignment to the west to accommodate future rail corridor widening
    - Relocation of existing bus interchange to the east of the rail corridor
- South Tacoma Road culvert has been transferred to the Civil Design (WTC-RD-001) package. Due to significant design changes to the road alignment in this area, drainage arrangement will be covered in the Civil Design drainage package and incorporated into subsequent revisions of the flooding report.
- Wyong Town Centre culverts modelling updated to TUFLOW 2d hydraulic model.
    - Report section renamed from “Pacific Highway Culverts” to “Wyong Town Centre” for clarity.

1.7 Updates from Revision 02 to Revision 03

The following items have been addressed since the previous issue of this document:

- Catchment impervious parameter revision to account for future highway widening (between Cutler Drive and Brittania Drive) at the Wyong Town Centre culverts.
- Drainage design for South Tacoma Road culverts has been reinstated into the WTC-DR-001.
- Hydraulic modelling for 20 year and 2000 year flood events, as well as climate change scenario for Wyong River Catchment.
- Hydraulic modelling for all events (1 year, 5 year, 10 year, 50 year, 100 year and Probable Maximum Flood (PMF)) for Wyong Town Centre with 80% Concept Design.

The following items have been added to the report:

- Discussion relating to fish passage
- Discussions relating to 20 year flood event and climate change scenario (15% rainfall increase) for Wyong River Catchment.
- Discussions relating to future railway bridge duplication under the 100 year flood event for Wyong River Catchment.
- Discussions relating to frequent flood events (1 year, 5 year, 10 year and 50 year) for

Wyong Town Centre Upgrade.

- Discussion relating to navigational clearance requirements

1.8 Updates from Revision 03 to Revision 04

As per the independent verification and review process of this document, several reviewer comments were raised. Revision 04 of this document has addressed and closed out all of the relevant reviewer comments.

1.9 Other Considerations

The following issues have been considered as part of the concept design in the civil design report:

- Operational water quality
- Constructability and staging
- Integration with existing and proposed utilities
- Cover to culverts

1.9.1 Fish Passage Requirements

As per the design review, a preliminary evaluation of fish passage requirements in accordance with "Fish passage requirements for waterway crossings" (NSW Fisheries, 2003), has been undertaken and is summarised in Table 1-3 below.

Table 1-3 – Summary of existing Pacific Highway and railway culverts

Watercourse	Station	Fish Habitat	Proposed Treatment	Comments
Wyong River	-	Yes	Bridge	Bridge provides adequate fish passage
Unnamed (Upstream of SEPP 14 Wetland)	1940	No	Culvert	As per the design review, no fish habitat has been identified upstream of the railway

1.9.2 Navigational Clearance Requirements

A preliminary consultation on navigational clearances requirements with Road and Maritime has been undertaken and is summarised below in Table 1-4. The proposed twin road bridges over Wyong River have been designed to meet these requirements.

For details on the consultation refer to Appendix E.

Table 1-4 – Summary of Navigational Clearances Requirements

Item	Roads and Maritime Requirements
Navigation channels	Two existing 20m wide channels under existing bridges.
Vertical clearance	3 metre clearance between Mean High Water and the lowest bridge structure
Pier orientation	Align with existing pylons to maintain channel width
Lighting	-
Signage	Install signage on pylons (Preferred)
Vessels	Maximum vessel size of 10 metre, maximum weight of 3 tonnes and maximum speed of 4 knots.

It is noted that the proposed minimum clearance from the lowest bridge soffit to the Mean High Water level is greater than 3.5 metres. The climate change sensitivity analysis in Section 6.1.1.4 has indicated that the potential flood level rise at the proposed twin road bridges over Wyong River is up to 300 millimetres. Therefore, it is expected that the minimum vertical clearance requirement, of three metres, will continue to be satisfied under climate change conditions.

1.9.3 Constructability and Staging

A constructability and risk workshop was held on 4th November 2014. As an outcome of the workshop and discussion with Roads and Maritime, culvert C200 has been realigned.

Northern culverts can be constructed in stages to suit traffic management whilst maintaining positive drainage at all times.

The proposed culvert under Cutler Drive may need to be staged as night works.

2. STUDY METHODOLOGY

2.1 Overview

The approach adopted for preparing this Hydrology and Hydraulics Assessment Report is as follows:

a) Review available data

b) Review existing hydrology and hydraulic studies and models

c) Modify and update the hydrology and hydraulic models, where necessary, and verify the results.

   a. Wyong River Catchment – Assessed with TUFLOW hydraulic model using BMT WBM's base model and hydrology. Results verified against HEC-RAS.

   b. Wyong Town Centre – Assessed with TUFLOW hydraulic model and WBNM hydrology.

   c. South Tacoma Road Culvert – Assessed with DRAINS using WBNM hydrology. This is not an existing model.

d) Assess impacts of the Wyong Town Centre Upgrade

Refer to Section 4 and Section 5 for the detailed methodology for the hydrology and hydraulics assessments respectively. Section 6 and Section 7 of this report presents the results and recommendations respectively.

2.2 Terminology

Key terms used in this report to define flood events include:

- ARI (Annual Recurrence Interval)
  - *"The average, or expected, value of the periods between exceedances of a given rainfall total accumulated over a given duration."* (BOM)
- AEP (Annual Exceedance Probability)
  - *"The **probability** that a given rainfall total accumulated over a given duration will be exceeded in any one year."* (BOM)
- PMF (Probable Maximum Flood)

In this report, the terminology “ARI” and “AEP” will be used interchangeably. It is noted that the industry is moving towards using “AEP” to describe flooding events. A summary of the comparison between AEP and ARI is shown in Table 2-1.

Table 2-1 – Summary of AEP vs. ARI

AEP	ARI
60%[1]	1 year
20%[2]	5 year
10%	10 year
2%	50 year
1%	100 year
PMF	PMF

[1] AEP rounded down from 63.2%
[2] AEP rounded up from 18.1%

The term “PMF” is used to describe the largest flood that could occur at a particular location taking into the worst flood-producing catchment conditions. The PMF flood generally does not have an exact AEP/ARI equivalent but can vary from as low as a 10,000 year ARI event up to a 10,000,000 year ARI event depending on catchment conditions for estimation purposes.

3. PREVIOUS STUDIES AND AVAILABLE INFORMATION

3.1 Previous Studies

3.1.1 Wyong River Catchment Flood Study (BMT WBM, January 2014)

- Executive summary:
    - Wyong River Catchment Flood Study was prepared for Wyong Shire Council to define the existing flooding behaviour for the Wyong River catchment.
    - Hydrologic and hydraulic models have been developed and calibrated based on available information and the acquisition of additional information where necessary. Hydrologic modelling has been done in RAFTS-XP whereas the hydraulic modelling has been done in TUFLOW.
    - Flooding events considered include 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP and PMF.
    - Models were calibrated against five historical flood events (June 1949, June 1964, March 1977, February 1990 and June 2007) with good representation of flood behaviour.
- Section 4:
    - Channel topography in the model was defined using the LiDAR survey. There is good correlation to surveyed bed and water surface levels.
    - For areas where the water was deep and LiDAR was unreliable, such as at the lower reaches of the Wyong River catchment, hydrographic survey was used to better define the watercourses.
- Section 7.2.4
    - Wyong River catchment critical durations are:
        - 1% AEP: 36-hour storm.
        - PMF: 24-hour storm.

3.1.2 Wyong CBD Trunk Culvert Flood Impact Assessment (Cardno, March 2014)

- Section 1 - Introduction:
    - Flood impact assessment prepared for Wyong Shire Council to consider the effect of the proposed trunk main culvert drainage system in Wyong CBD.
    - The proposed trunk main culvert assessed was based off the drawings *Wyong CBD: Proposed Trunk Drainage Construction*.

      Refer to Appendix C, of this SMEC report, for a figure showing location of the proposed trunk drainage culvert and the relevant construction drawings.

      The proposed trunk main culvert indicated in the drawing is shown to be a twin-cell 2.7 metres wide x 1.2 metres high reinforced concrete box culvert (RCBC) transitioning to a single-cell 2.7 metres wide x 1.2 metres high RCBC and single-cell 3.3 metres x 1.2 metres RCBC at the outlet.
    - The existing and future scenario flooding behaviour was assessed for the 20% AEP, 10% AEP, 5% AEP, 1% AEP and PMF events.
    - A concept design for culverts crossing the Pacific Highway has been provided to Roads and Maritime for reference when Pacific Highway Upgrade through Wyong occurs.

      The location of these Pacific Highway culverts is at CH1690 (based on the Wyong Town Centre Upgrade road alignment), downstream of Council's trunk main culvert. SMEC's assessment of the Pacific Highway culverts is later discussed in this SMEC report.
- Section 2:
    - The SOBEK 1d/2d flood modelling suite was used to model both the existing and future scenarios.
        - The existing scenario model includes:
            - As-built culvert under the police station.
            - Inclusion of the police station in the terrain.
            - Removal of the proposed Arts Centre and Aldi store buildings
        - The future scenario model is as per the existing scenario model but includes:
            - Council's proposed trunk drainage culvert.
            - Removal of two buildings for construction of overland flow path.

- Section 2.2:
    - The design peak discharge from the trunk main culvert is:
        - 1% AEP = 10.0 m^3/s.
        - PMF = 12.0 m^3/s.
- Section 3 – Flood Impact Assessment:
    - Impacts on Peak Flood Levels
        - In the 1% AEP proposed condition, where the trunk main culvert has been upgraded, the peak flood level increases by 100 millimetres upstream of the Pacific Highway adjacent to the caravan park (near CH1940). In the PMF event, the flood level increase is 90 millimetres.
        - The 1% AEP flood level increases between the highway and railway line are between 100 millimetres to 200 millimetres but are considered by Cardno as being insignificant as property and infrastructure is not directly affected.
    - The proposed highway overtopping depths, over a length of 150 metres around the caravan park (near CH1940), are:
        - 1% AEP = 0.43 metres (0.31 metres in the existing condition)
        - PMF = 2.5 metres (2.4 metres in the existing condition)
- Section 4 – Highway Culvert Assessment:
    - The existing culvert under the Pacific Highway, downstream of Council's proposed trunk main culvert, is reported to be a twin 1.0 x 1.2 m box culvert.
    - Cardno investigated upgrading the existing Pacific Highway culvert by adding an additional four 1.0 m x 1.2 m cells, increasing the culvert opening to 6.0 m x 1.2 m.
    - The investigated option provides a 30 millimetres water level reduction in the 1% AEP, reducing the impact caused by the trunk main culvert upgrade to 70 millimetres from 100 millimetres. However, this reduction is minimal due to the ponding water between the highway and the railway. There is only a 75% increase in flow conveyance for a 300% increase in culvert size.
    - The investigated highway culvert upgrade is insufficient to prevent overtopping of the highway in the 1% AEP due to the tailwater effect caused by the railway culverts.

- Section 5 – Railway Culvert Assessment:
    - The existing culverts under the railway line, downstream of the above highway culverts are a set of five 1.2 m wide x 1.1 m high box culverts.
    - Cardno investigated upgrading the railway culverts, in addition to the upgrade of the highway culverts previously discussed, by doubling the number of cells to a 10-cell 1.2 m wide x 1.1 m high box culvert.
    - The investigated railway culvert upgrade reduced the peak 1% AEP flood levels along the Pacific Highway by 70 to 100 millimetres, compared to the upgraded main trunk culvert case, but still caused increases of between 20 millimetres to 30 millimetres. This suggested that augmentation of both the Pacific Highway and railway culverts, at North Road (CH1690), were not adequate for preventing overtopping of the highway in the 1% AEP.
- Section 6 – Removal of Highway Overtopping in the 1% AEP Event:
    - Options considered to remove the overtopping of the highway included:
        - Roads and Maritime raising the highway in a future upgrade.

          The highway will need to be raised by up to 300 millimetres for a length of 150 metres. It is suggested by Cardno that there would not be significant impacts on flood behaviour or peak flood levels.
        - Upgrading the capacity of the highway and railway culverts.

          In addition to the augmentation of the highway and railway culverts near North Road (at CH1690), the culverts at the caravan park (near CH1940) should be assessed. It is suggested by Cardno that increasing the capacity of the culverts may be sufficient to lower flood levels and prevent overtopping of the Pacific Highway.
    - Cardno recommends that the raising of the highway should be considered as the preferable option as the augmentation of the railway culverts is likely to be costly and disruptive.
- Section 7 – Conclusion
    - The proposed upgraded Council trunk drainage culvert reduces water levels within Wyong CBD for all AEP events whilst increasing peak levels at the Pacific Highway by 100 millimetres in the 1% AEP and 90 millimetres in the PMF event.
    - The proposed upgraded trunk drainage exacerbates the overtopping of the Pacific Highway at the location of the caravan park, by increasing the overtopping depth from 0.31 metres in the existing condition to 0.43 metres in the proposed condition. The caravan park is located at CH1940 (based on the Wyong Town Centre Upgrade road alignment).

- Augmentation of the existing highway culverts resulted in a minimal reduction in the overtopping depth by 30 millimetres. This was due to the tailwater effect between the highway and railway. Upgrading the railway culverts had a greater impact in reducing the peak flood level, by up to 70 millimetres, but overtopping of the highway still remained.
- Options recommended by Cardno to remove the overtopping of the Highway included:
  - Roads and Maritime raising the highway in a future upgrade.
  - Upgrading the capacity of the highway and railway culverts (at both CH1690 and CH1940).

It is noted that in Appendix C, of this SMEC report, Cardno's concept design sketch shows that the upgraded Pacific Highway culverts option (at CH1690) consists of a 4-cell 1.0 m wide x 1.2 m high culvert. This is contradictory to the information given in Section 4 of Cardno's report where the investigated size is documented as a 6-cell 1.0 m wide x 1.2 m high culvert. This does not affect SMEC's flooding assessment but should be noted by Cardno, Roads and Maritime and Council for their future reference.

SMEC has noted that the PMF flood levels shown in the flood maps in this report appear to significantly over estimate PMF flood levels upstream of the railway. It is recommended that Council requests that their consultant reviews these results taking particular note of the overtopping level of the railway embankment.

3.2 Wyong CBD Trunk Main Culvert

As discussed in Section 3.1.2, Council is upgrading the Wyong CBD trunk main culvert line. Drawings and figures for the Council trunk main culvert are shown in Appendix C.

The proposed works include replacement of the existing drainage system with new box culverts which discharge into an open channel upstream of the existing Pacific Highway box culverts at CH1690, near the intersection of North Road and the Pacific Highway. The proposed trunk main culverts include twin-cell 2.7 m wide x 1.2 m high RCBCs transitioning to a single-cell 2.7 m wide x 1.2 m high RCBC and single-cell 3.3 m x 1.2 m RCBC which outlet into the open channel.

3.3 Available Survey Data

Available ground level survey data for the flooding assessment included:

- Field survey along the corridor of the Wyong Town Centre Upgrade project
- LiDAR survey data from the Wyong River Catchment Flood Study (BMT WBM, 2014)
- Hydrographic survey from the Wyong River Catchment Flood Study (BMT WBM, 2014)

4. HYDROLOGY

4.1 Wyong River Catchment TUFLOW Model

4.1.1 Catchment Description

The Wyong River catchment is located on the NSW Central Coast. The 440 km^2 catchment drains towards Tuggerah Lake and the Tasman Sea via the Wyong River and Jilliby Jilliby Creek watercourses.

The upper Wyong River catchment is primarily undeveloped, with the bulk of this being forested areas. As the catchment moves further downstream, the land usage becomes a combination of rural pasturelands and urban developments. At the lower sections of the Wyong River catchment, particularly around the Wyong Town Centre Upgrade, the land usage is significantly developed.

Major transport routes crossing the catchment include the M1 Pacific Motorway (formerly F3 Freeway), the Pacific Highway and the Main North Railway Line.

4.1.2 Design Rainfall

The hydrological model utilised in the BMT WBM study was an RAFTS-XP model. This was subsequently adopted in this SMEC Wyong Town Centre Upgrade assessment, with no alterations made to the rainfall and catchment parameters.

The intensity-frequency-duration (IFD) rainfall curves and temporal patterns used for the design storms were indicated by BMT WBM to have been developed using the methods in AR&R (2001).

The hydrological modelling input parameters from the BMT WBM study have been reviewed and are deemed acceptable for the purposes of this SMEC report.

The 0.05% AEP (2000 year ARI) event has not been considered in BMT WBM's study. Based on methods outlined in AR&R (2001) the 0.05% AEP design flow was estimated to be equivalent to 0.44 times the PMF. Therefore, the design flows for the 0.05% AEP were obtained by factoring the BMT WBM flows for the PMF.

4.1.3 Model Parameters

The Wyong River Catchment Flood Study (BMT WBM, 2014), developed in conjunction with Council, has indicated that the floodplain risk management process includes the incorporation of future development and changes in land use. The Wyong Town Centre Upgrade hydraulic assessment has adopted the same models and parameters.

The RAFTS-XP hydrology model parameters adopted from the BMT WBM study are as shown in Table 4-1.

Table 4-1 – Wyong River RAFTS-XP Model Parameters

Parameter	Value	Comments
Initial Loss	15 mm	For upper catchment areas.
Continuing Loss Rate	2.5 mm/hr	For upper catchment areas. As per AR&R (2001) recommendation.
Urban/Swamp – Impervious Initial Loss	2 mm	For urban areas (higher impervious area) and lower catchment swamp areas.
Urban/Swamp – Continuing Loss Rate	0 mm/hr	For urban areas (higher impervious area) and lower catchment swamp areas.

4.1.4 Critical Duration

Critical duration storms are those which produce the highest peak flood conditions, including levels and flows, for the particular AEP event. In the BMT WBM study (2014), various duration storms were considered for each AEP event, eventually narrowing the storms down to a critical duration for each event. The critical duration for the 0.05% AEP event has been assumed to be similar with the PMF event. The adopted critical durations in this SMEC assessment are as presented in Table 4-2.

Table 4-2 – Wyong River TUFLOW critical duration storms for AEP events

AEP	ARI	Critical Duration Storm
5%	20 year	36 hours
1%	100 year	36 hours
0.05%	2000 year	24 hours
PMF	PMF	24 hours

4.1.5 Climate Change

BMT WBM (2014) has previously carried out modelling sensitivity analyses to assess climate change impacts in the Wyong River catchment. Results of this sensitivity testing show that the main flood impact issues to be managed for the Pacific Highway project are increased rainfall intensities and possible blockage of the bridge structures. Given that, allowances for flood impact due to climate change have been incorporated into the current design based on the Practical Consideration of Climate Change Guideline (DECCW, 2007).

A sensitivity assessment for the potential for climate change to impact on flooding has been undertaken for the 1% AEP event. To account for climate change conditions, the model was updated to include sea level rise of 0.4 metres by 2050 and increased rainfall intensities by 15%, as agreed with Roads and Maritime and Council. A 15% rainfall increase is at the upper limit of the advice provided in the NSW Climate Impact Profile (DECCW, 2010). The 36 hours storm event was adopted as the critical duration storm.

The 15% rainfall increase for climate change was adopted in the sensitivity analysis as the Wyong River catchment is affected by regional flooding.

4.2 Wyong Town Centre TUFLOW Model

4.2.1 Catchment Description

The Wyong Town Centre catchment is a subcatchment of the overall Wyong River catchment. The total Town Centre catchment area is approximately 105 hectares.

The catchment extends from Alison Road to Casey Drive and drains towards the Pacific Highway and Main North Railway Line towards the east.

The existing catchment land usage primarily consists of urban developments and local park areas. The impervious fraction of the catchments varies from 30% to 60%, depending on the distribution of roads, urban development and vegetated reserves.

An allowance for an increase in the impervious area from between Cutler Drive to Brittania Road has been included in the modelling of the proposed conditions. This is to account for the future road widening assumed with the next stage of the Pacific Highway upgrade proposed by Roads and Maritime.

Refer to Appendix D for more information on the catchment sub-areas.

4.2.2 Design Rainfall

The Pacific Highway and local road culverts were assessed using Watershed Bounded Network Model (WBNM) hydrology. WBNM is a network-based runoff routing model as discussed in AR&R Volume 1 - Book V – Estimation of Design Flood Hydrographs (2001).

4.2.3 Model Parameters

The WBNM hydrology model parameters are as shown in Table 4-3.

Table 4-3 – Wyong Town Centre WBNM Model Parameters

Parameter	Value	Comments
Lag Parameter C	1.6	WBNM documentation typical value is 1.6.
Impervious Lag Factor	0.1	WBNM documentation typical value is 0.1.
Initial Loss	2.5 mm	
Continuing Loss Rate	1 mm/hr	
Impervious Initial Loss	1 mm	

The Intensity-Frequency-Duration (IFD) information used to define the rainfall data for the WBNM model was obtained from the Bureau of Meteorology (BOM) database. The rainfall parameters used to define hydrology in the WBNM model are presented in Table 4-4.

Table 4-4 – Wyong Town Centre WBNM Model Rainfall Parameters

Location	Rainfall Intensity						Rainfall Parameters			Moisture Adjustment Factor
	2 yr 1 hr	2 yr 12 hr	2 yr 72 hr	50 yr 1hr	50 yr 12 hr	50 yr 72 hr	F2 Factor	F50 Factor	Skew Coefficient	MAF
Wyong	40.2	9.3	2.9	80.3	19.3	6.4	4.31	15.98	0.01	0.73

4.2.4 Critical Duration

To establish the critical duration storm event for the Wyong Town Centre TUFLOW model, the proposed condition model was run for the various storm durations to determine which event produces the highest peak flood levels and discharge.

The sample locations for the peak flood levels are as shown in Figure 4-1. Peak flood levels and flows are presented in Table 4-6 and Table 4-5 respectively.

The highest peak flood levels and peak flows occur for the 2 hour critical duration event. Therefore, for the 1% AEP storm, the 2 hour storm event was adopted as critical.

Table 4-5 – 100 year ARI Peak Flows – Proposed Conditions

Location	Peak Flow (m^3/s)						
	0.5 h	1 h	2 h	3 h	6 h	9 h	12 h
Culvert ex1690rail	5.96	6.22	6.14	5.84	5.36	5.12	5.21
Culvert ex1940rail	17.70	19.64	20.00	18.37	16.02	14.51	14.92

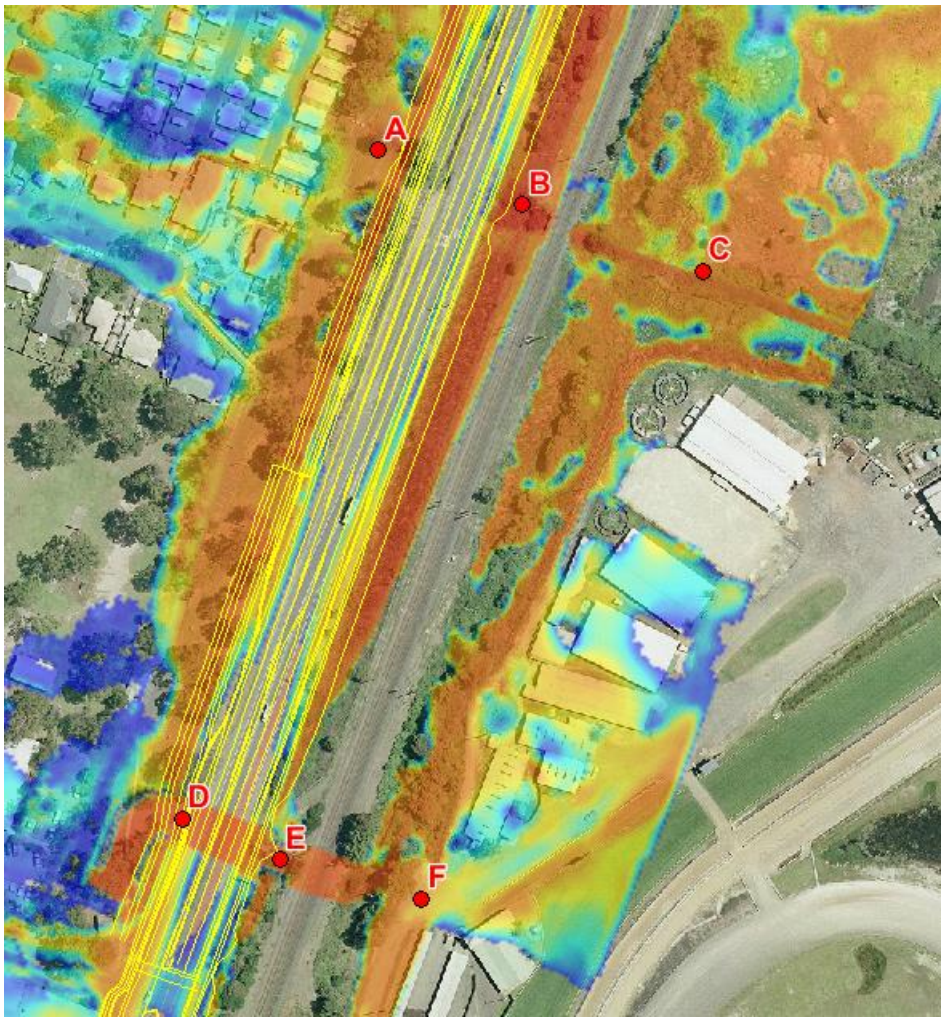


Figure 4-1 – Wyong Town Centre TUFLOW Critical Duration Sample Locations

Table 4-6 – 100 year ARI Peak Flood Levels – Proposed Conditions

Location	Peak Flood Level (m AHD)						
	0.5 h	1 h	2 h	3 h	6 h	9 h	12 h
A	3.66	3.84	3.87	3.74	3.55	3.49	3.49
B	3.60	3.76	3.79	3.67	3.51	3.38	3.42
C	2.51	2.54	2.55	2.53	2.50	2.47	2.48
D	3.88	3.89	3.91	3.88	3.78	3.68	3.73
E	3.23	3.32	3.33	3.22	3.18	3.18	3.18
F	2.89	2.92	2.92	2.89	2.88	2.88	2.88

Table 4-7 – Pacific Highway culverts TUFLOW critical duration storms for various ARI events

AEP	ARI	Critical Duration Storm
60%	1 year	2 hours
20%	5 year	2 hours
10%	10 year	2 hours
2%	50 year	2 hours
1%	100 year	2 hours
PMF	PMF	30 min

4.2.5 Climate Change

To account for design rainfall increases due to climate change, an increase of 10% by year 2050 was adopted for the IFD design curves.

As per the advice provided in the Department of Environment, Climate Change and Water's NSW Climate Impact Profile (2010), the predicted rainfall runoff for the Central Coast region will vary from current conditions by -4% to +16% by year 2050. Therefore, the selection of a design increase of 10% approximated the median of these estimates.

The 10% rainfall increase for climate change was adopted for design as the Wyong Town Centre is affected by local catchment flooding.

A shorter planning horizon has been adopted for the Wyong Town Centre flood model as future works to the rail line will alter the catchment flow conditions in the medium term.

4.3 South Tacoma Road Culvert

4.3.1 Catchment Description

The South Tacoma Road culvert drains the external and pavement catchments between Johnsons Road and Bluegum Close. The total catchment area draining to this culvert is approximately 4.7 hectares.

The existing catchment land usage primarily consists of urban and commercial developments. The impervious fraction of the catchments varies from 30% to 95%, depending on the distribution of roads, urban development and vegetated reserves.

4.3.2 Design Rainfall

The South Tacoma Road culvert was assessed using Watershed Bounded Network Model (WBNM) hydrology. WBNM is a network-based runoff routing model as discussed in AR&R Volume 1 - Book V – Estimation of Design Flood Hydrographs (2001).

4.3.3 Model Parameters

The WBNM hydrology model parameters utilised for the South Tacoma Road culvert are the same as those adopted for the Wyong Town Centre culverts as described in Section 4.2.3.

4.3.4 Critical Duration

The critical duration adopted for the South Tacoma Road culvert was the one that produced the highest discharge.

The highest peak flows occur for the 25 minute critical duration event. Therefore, for the 1% AEP storm, the 25 minute storm event was adopted as critical. These flows are presented in Table 4-8.

Table 4-8 – 100 year ARI Peak Flows – Proposed Conditions

WBNM Subarea	Peak Flow (m^3/s)						
	15 min	20 min	25 min	45 min	1 h	1.5 h	2 h
2	1.65	1.74	**1.80**	1.60	1.70	1.75	1.71
5	0.23	0.22	**0.23**	0.20	0.22	0.23	0.22
6	0.09	0.09	**0.09**	0.08	0.09	0.09	0.09
7	0.51	0.53	**0.53**	0.47	0.50	0.53	0.50

Table 4-9 – Pacific Highway culverts TUFLOW critical duration storms for AEP events

AEP	ARI	Critical Duration Storm
1%	100 year	25 minute

4.3.5 Climate Change

To account for design rainfall increases due to climate change, an increase of 10% by year 2050 was adopted for the IFD design curves. This is consistent with the 10% climate change rainfall increase adopted for the proposed longitudinal drainage that will drain into the South Tacoma Road culvert, as documented in design lot WTC-RD-001.

It should be noted that the adoption of a 10% rainfall increase allowance for climate change is also consistent with what is adopted for the Wyong Town Centre culverts discussed in Section 4.2.5.

5. HYDRAULICS

5.1 Wyong River Catchment TUFLOW Model

BMT WBM's Wyong River Catchment Flood Study TUFLOW modelling was adopted as the basis of SMEC's assessment of the proposed design. The Wyong River catchment model is a 1d/2d model with an 8 m terrain grid cell size. Major watercourses, particularly the Wyong River, were modelled within the 2d domain. Only culverts and certain smaller channels were modelled within the 1d domain.

5.1.1 Software Version

For assessing the Wyong River catchment flows, TUFLOW version 2012-05-AB-w64 was utilised. This is the version that was provided with the BMT WBM files.

5.1.2 Adopted Model Control Files

The TUFLOW model runs prepared by BMT WBM were adopted for the purposes of this study. It was deemed appropriate that the existing models would form the basis of being the reference existing base case model. This model would then be updated to accommodate the relevant geometry and parameters required to represent the Wyong Town Centre Upgrade design case.

For representing "Existing" conditions, the adopted TUFLOW control files (.tcf) and TUFLOW events files (.tef) were:

- Wyong_~e1~_~e2~_~e3~.tcf.
- Wyong_Design_Events.tef.

5.1.3 Model Calibration

As discussed in BMT WBM's study, the hydraulic models were calibrated to historical storm events, including one as recent as June 2007. It was assumed that the calibration undertaken by BMT WBM was sufficient and relevant to ensure that flood levels produced from the developed models were appropriate to the study.

The historical events in BMT WBM's study are as shown in Table 5-1.

Table 5-1 – Historical events used in calibration of BMT WBM's model

Rainfall Event
June 2007
February 1990
March 1977
June 1964
June 1949

5.1.4 Model Geometry

The base terrain provided in BMT WBM's TUFLOW model was treated as the existing pre-upgrade reference model. To model the proposed post-upgrade model, additional terrain and hydraulic elements were placed into the base model.

The TUFLOW model grid cell-size was retained at 8 metres.

5.1.4.1 2d Floodplain

The base terrain utilised in the assessment is as presented in BMT WBM's flood study. As indicated in that study, the majority of the topographic and hydrographic information was provided by Council. This dataset included:

- LiDAR survey (from 2007 to 2011).
- Hydrographic survey.
- Structure survey of the bridge crossings.

Although additional field survey was available around the upgrade corridor, it was decided not to include this information as this would potentially alter the existing condition results from BMT WBM's model. The intention of SMEC's assessment is to consider the relative impacts on the Wyong River catchment due to the Wyong Town Centre Upgrade; therefore it was unnecessary to include additional survey for the existing conditions model.

5.1.4.2 Design Road Alignment

The proposed Wyong Town Centre Upgrade road alignment was modelled in TUFLOW as an ASCII DEM grid, produced by triangulation within 12d model. This design road surface was layered directly on top of the base terrain to produce a model terrain representative of the proposed design surface.

5.1.4.3 Alterations to Previous Models

As discussed above, alterations were made to the base TUFLOW model. To ensure consistency and compliance with BMT WBM's models, the changes were restricted to what was necessary to model the Wyong Town Centre Upgrade earthworks and bridge.

The alterations are as summarised in Table 5-2.

Table 5-2 – Summary of Model Alterations

No.	Location	Description	Comment
1	Full-length of Wyong Town Centre Upgrade	Incorporated current proposed road embankment 12d triangulation into TUFLOW.	Triangulation carried out in 12d Model. Terrain exported as 1 m cell size digital elevation model and read into TUFLOW's run commands.
2	Proposed twin road bridges over Wyong River	Incorporated 2d flow constriction to represent bridge losses and blockage.	Bridge form losses based on FHWA Hydraulics of Bridge Waterways and HEC-RAS model verification.
3	204-206 and 210 Pacific Highway (Intersection of McPherson Rd and South Tacoma Rd)	Removed existing buildings and lowered building pads to suit.	Building pads lowered down to surrounding terrain levels. Lowering is necessary to minimise hydraulic constraint.

5.1.4.4 Bridges

The current proposed arrangement for the bridges over Wyong River includes:

- Provision of twin road bridges over the Wyong River.
- Demolition of the existing Wyong River road bridge.
- Retention of the existing Wyong River railway bridge.

The proposed twin road bridges over Wyong River each consist of four spans of approximately 32 metres each for a total deck length of 128 metres. The bridge consists of 1.50 metres deep Super-T girders supported on headstocks. At each headstock, two circular piers are arranged skewed to the bridge alignment. This pier configuration is adversely skewed against the flow by up to 30 degrees.

Note that the bridge geometry analysed as part of this report is based on the strategic option bridge geometry (May 2014). The reference bridge design drawings are shown in Appendix B.

As per the base model, the proposed twin road bridges over Wyong River were modelled as a 2d layered flow constriction shape. This allowed the bridge structure to be represented in the 2d domain through application of form losses and blockages at specific levels corresponding to the soffit, deck and parapet.

Blockage risk of the proposed twin road bridges was deemed to be lower than either of the existing bridges, particularly due to the design piers being more slender and providing high vertical clearance to the 1% AEP flood level, to allow for debris to pass under. However, in consultation with Council's representative, a 10% blockage allowance was applied at the proposed twin road bridges over Wyong River. This satisfies the advice provided in AR&R's Project 11 – Blockage of Hydraulic Structures (2013) that suggests consideration for "risk of debris rafts and large floating debris".

For the climate change sensitivity analysis scenario (15% rainfall increase), the proposed twin road bridges over Wyong River were modelled with 0% blockage as requested by Roads and Maritime.

Based on the guidance provided in FHWA's Hydraulics of Bridge Waterways (FHWA, 1978), the bridge form loss for the pier level was estimated to be approximately 0.3 through the use of Figure 5-1; this was selected based on the multiple cylinders arrangement for a pier area to waterway area ratio of 0.10 taking into account the proposed pier arrangement being skewed with respect to the direction of flow. For the purposes of the TUFLOW modelling, the pier level form loss applied was then 0.32 over the full-width of the proposed bridge. The adopted pier form loss parameters, particularly sensitive for the 1% AEP flood, was verified using HEC-RAS 1d river modelling software, as described in Section 5.1.4.5.

It was noted that the existing bridges, in BMT WBM's study, were modelled with a form loss coefficient of 0.16 across the bridge waterway. Across the existing Pacific Highway and Main North Railway Line bridges, the flow is less skewed than across the proposed twin road bridges. However, it is also noted that the existing bridge piers are large, at around 2 metres in diameter and also reduce the active waterway area. Based on Figure 5-1, it would be expected that the pier form loss coefficient would be 0.20 or greater for this arrangement.

A sensitivity check was conducted for the use a form loss coefficient of 0.30 for the existing highway bridge within the existing conditions model. It was found that the higher form loss coefficient would create upstream flood levels to be about 50 millimetres higher. However, this does not have a great consequence for the impact assessment as the reported relative upstream flood level impacts will be more conservative as a result. The absolute flood levels in the proposed case model, through which flood immunity is assessed, do not rely on the presence of the existing highway bridge as this is assumed to be demolished.

The parameters adopted for the bridges are as summarised in Table 5-3. Note that the soffit level varies for the proposed twin road bridges over Wyong River, as shown in Figure 5-2. The flow constriction lines and polygon objects for representing the bridges are as shown in Figure 5-3.

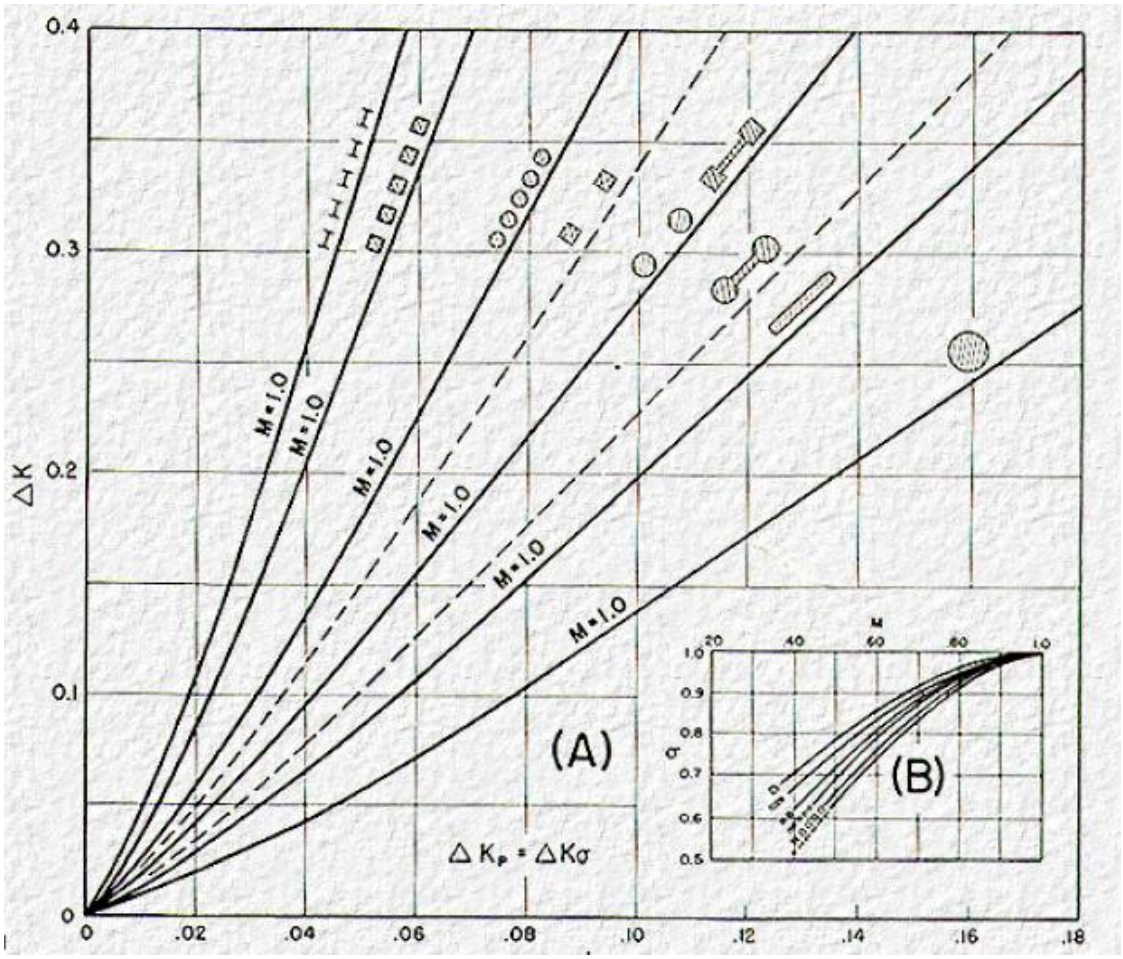


Figure 5-1 – Incremental backwater coefficient for piers (Hydraulics of Bridge Waterways, FHWA, 1978)

Table 5-3 – Wyong River bridge parameters used in the TUFLOW model

Bridge	Soffit Level (m AHD)	Blockage Form Loss Coefficient	Top of Deck Level (m AHD)	Blockage Form Loss Coefficient	Top of Railing Level (m AHD)	Blockage Form Loss Coefficient
Proposed Twin Road Bridges over Wyong River	5.90[A]	B = 10% FLC = 0.32	8.70[A] (including barrier)	B = 100% FLC = 0.4	9.10[A]	B = 100% FLC = 0.4
Existing Pacific Highway Bridge	3.35	B = 7% FLC = 0.16	6.03	B = 100% FLC = 0.4	7.15	B = 30% FLC = 0.4
Existing Main North Railway Line Bridge	5.44	B = 10% FLC = 0.16	7.94	B = 100% FLC = 0.4	BMT WBM has modelled the deck/railing as a single effective layer 100% blocked to 7.94 m AHD.	

[A] *Soffit level varies for the proposed twin bridges over Wyong River.*

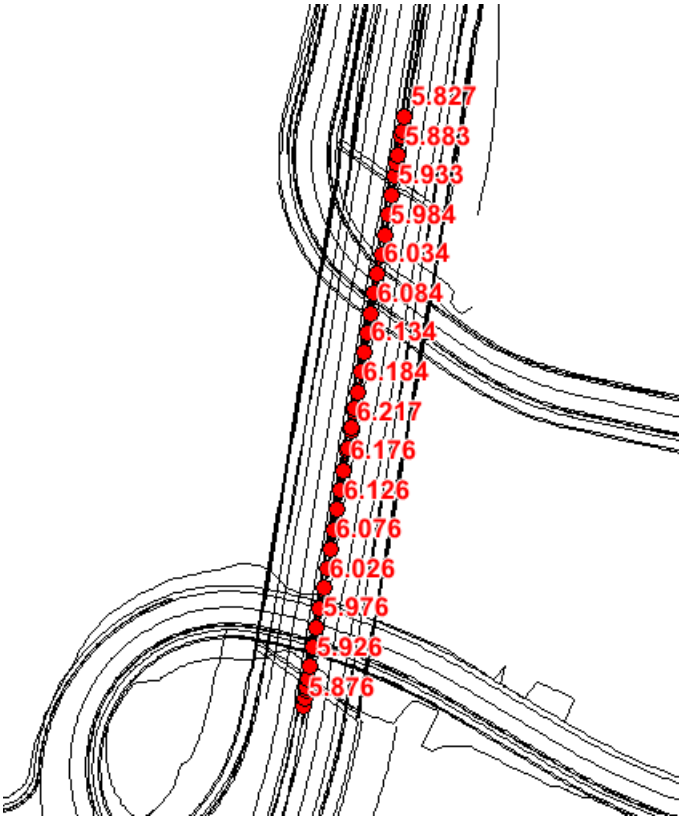


Figure 5-2 – TUFLOW 2d flow constriction soffit levels for proposed twin bridges over Wyong River

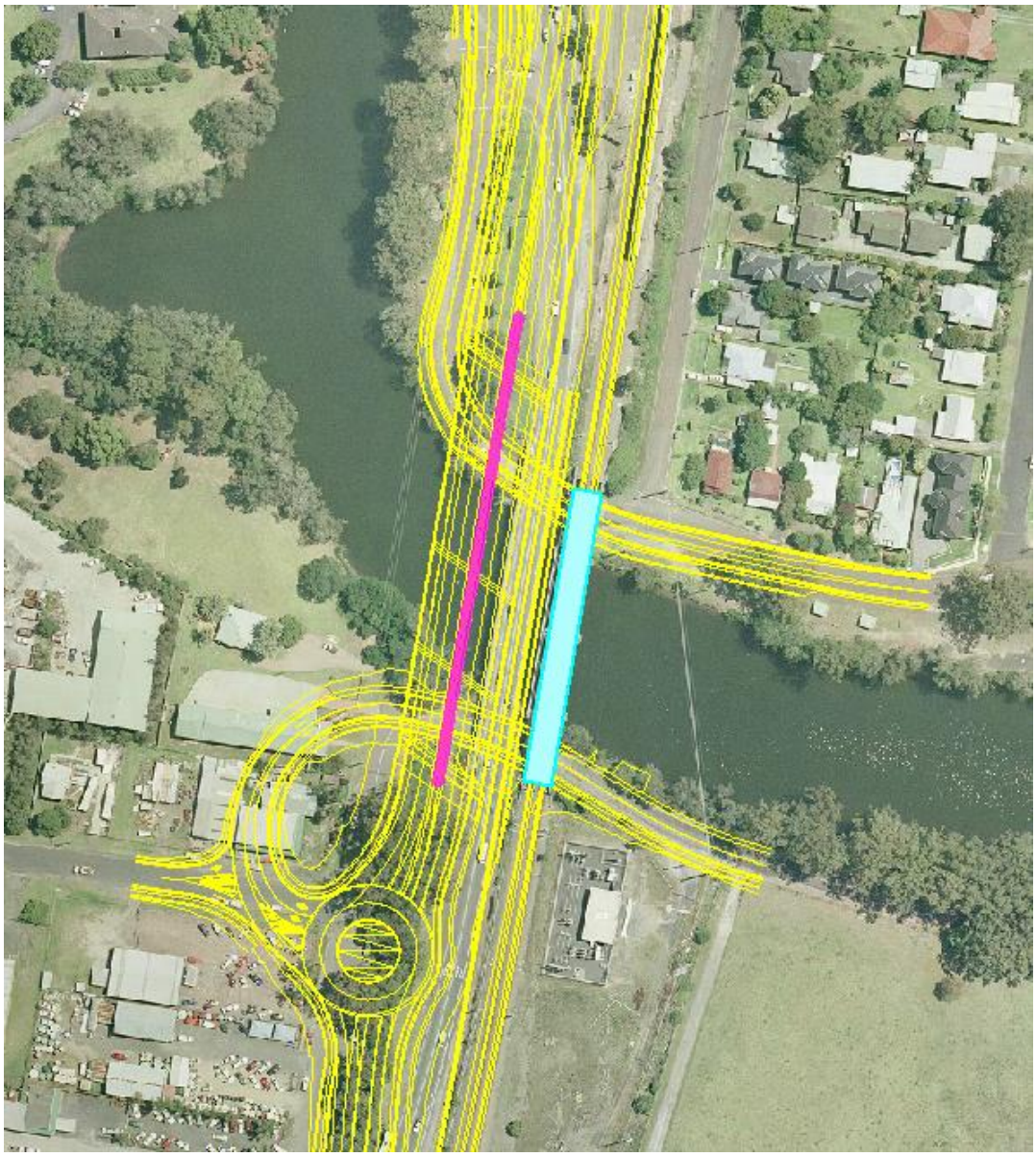


Figure 5-3 – TUFLOW 2d flow constriction bridge lines and polygons for design (magenta) and existing (cyan) bridges over Wyong River

5.1.4.5 HEC-RAS Model Verification

Verification of the bridge modelling parameters adopted for the new twin road bridges over Wyong River was carried out using the HEC-RAS 1d river modelling software.

The terrain used to prepare the HEC-RAS cross-sections was from the TUFLOW DEM produced at the end of the model run. This was to provide a degree of consistency between TUFLOW and HEC-RAS. The HEC-RAS layout is as shown in Figure 5-4.

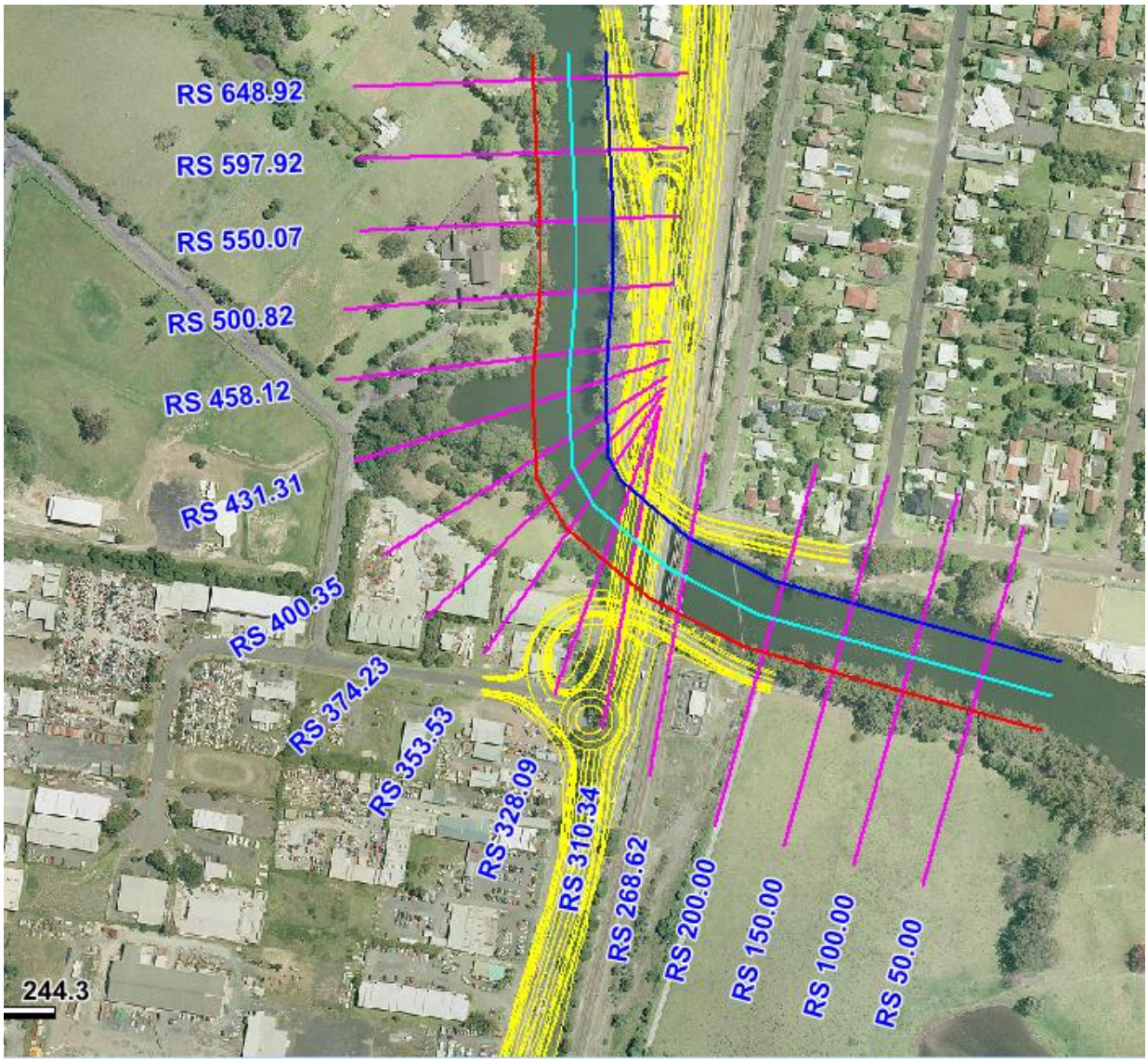


Figure 5-4 – HEC-RAS plan layout at proposed twin road bridges over Wyong River

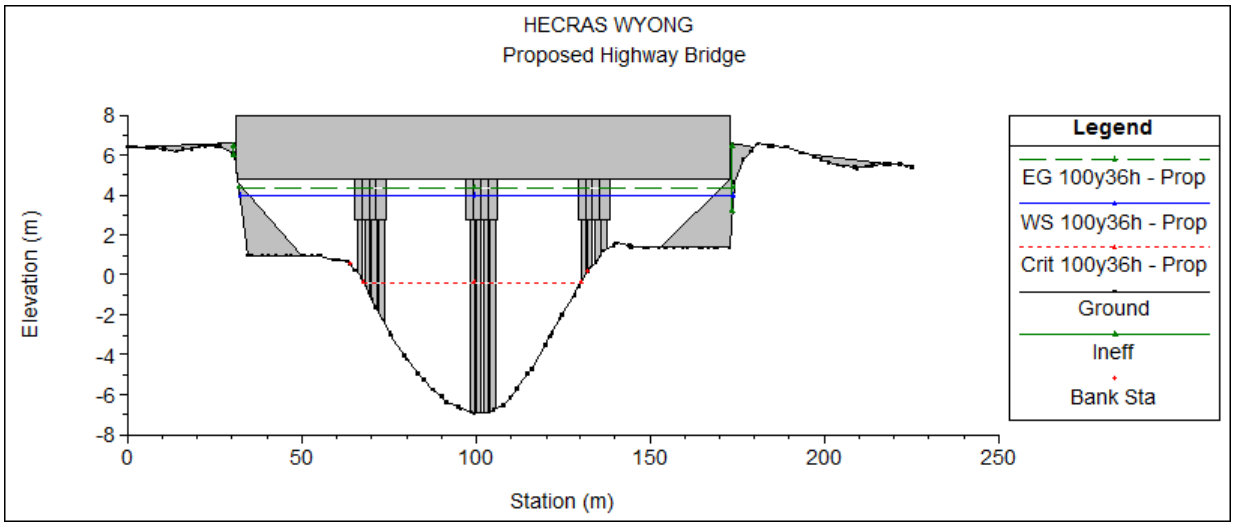


Figure 5-5 – HEC-RAS cross-section at proposed twin bridges over Wyong River (River Station 300.00)

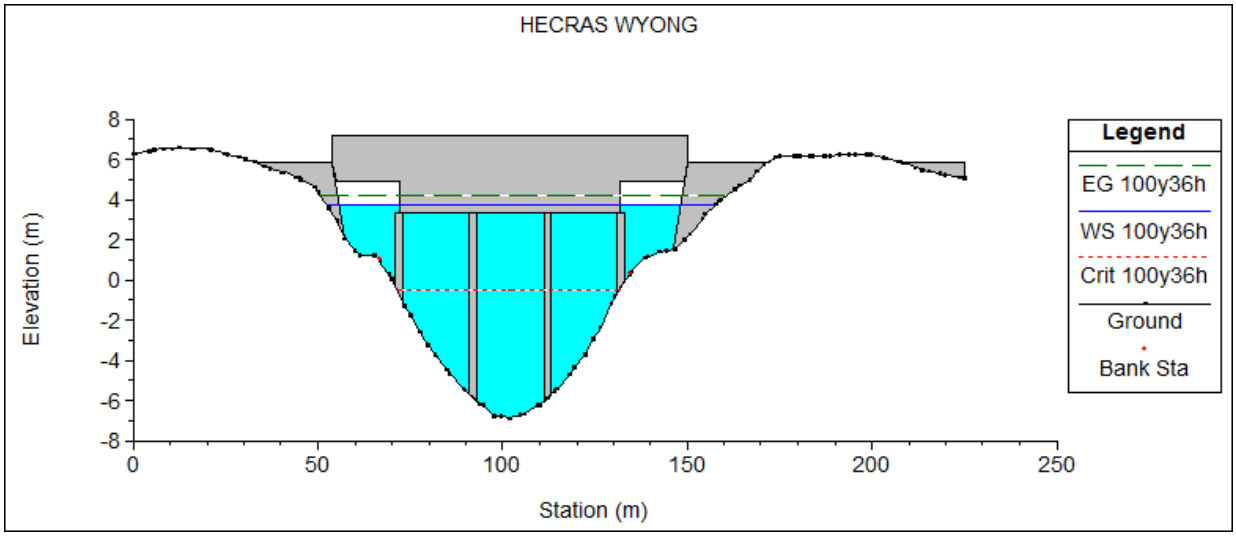


Figure 5-6 – HEC-RAS cross-section at existing Pacific Highway bridge over Wyong River (River Station 290.00)

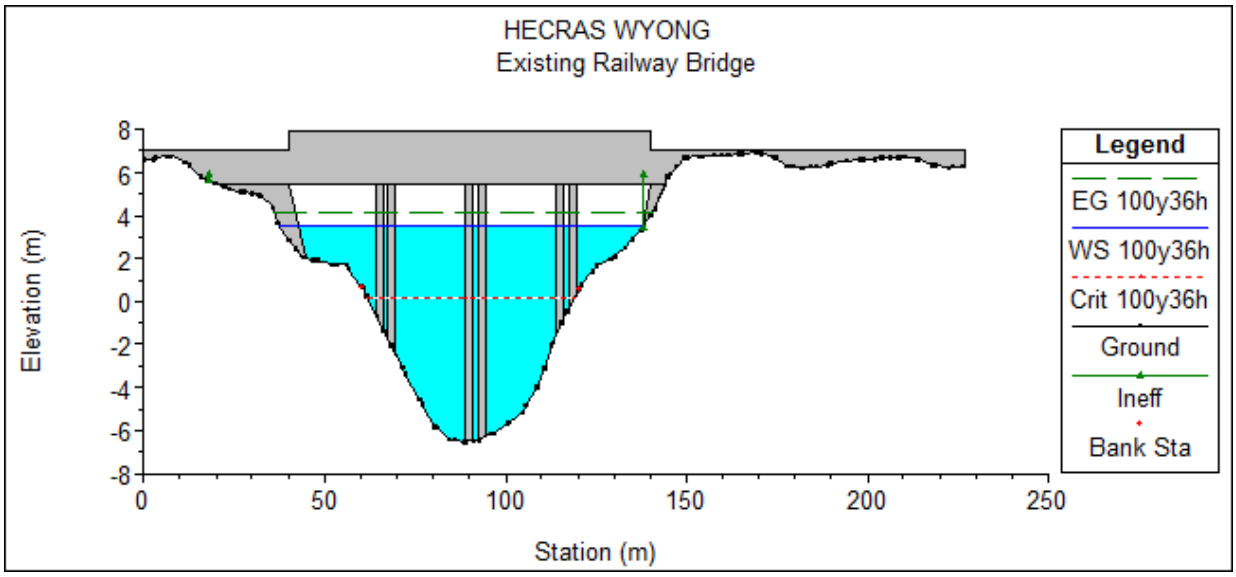


Figure 5-7 – HEC-RAS cross-section at existing Main North Line railway bridge over Wyong River (River Station 275.00)

To check for appropriate form loss parameters for the piers, the HEC-RAS model was run for the existing and proposed conditions cases. The factors affecting results include the additional form losses and blockage due to the proposed piers and also the removal of the existing bridge which is partially submerged for the 1% AEP event.

The results show a net water level reduction of up to 80 millimetres, as a result of the removal of the existing bridge; this is reasonably consistent with the local water level changes observed in TUFLOW and therefore confirms that the form loss parameters adopted for the design bridge were appropriate noting differences in 1d and 1d/2d modelling schemes between HEC-RAS and TUFLOW.

Refer to Figure 5-5, Figure 5-6 and Figure 5-7 for typical HEC-RAS cross-sections at the existing and proposed bridges at Wyong River.

The following scenarios were considered in the HEC-RAS runs:

1. Existing:
    a. Existing Pacific Highway bridge present
    b. Existing Main North Line railway bridge present
2. Proposed:
    a. Proposed twin bridges over Wyong River present
    b. Existing Pacific Highway bridge removed
    c. Existing Main North Line railway bridge present

The HEC-RAS results for the existing and proposed scenarios are as presented in Table 5-4. The results for the existing and proposed bridges are presented in Table 5-5 and Table 5-6. Note that the river station for the existing and proposed highway bridges are not the same due to differences in location.

Table 5-4 – HEC-RAS 1% AEP results for existing and proposed conditions at the Wyong River crossing

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
50	648.92	100y36h	Exg	1366	-5.74	4.18		4.64	0.000242	3.04	573.48	187.90	0.34
50	648.92	100y36h	Prop	1366	-5.74	4.10		4.57	0.000252	3.08	558.26	187.61	0.35
50	597.92	100y36h	Exg	1366	-5.95	4.16		4.62	0.000228	3.08	603.69	186.45	0.34
50	597.92	100y36h	Prop	1366	-5.95	4.08		4.56	0.000237	3.12	588.49	185.91	0.34
50	550.07	100y36h	Exg	1366	-6.05	4.15		4.61	0.000229	3.08	607.39	182.04	0.34
50	550.07	100y36h	Prop	1366	-6.05	4.07		4.54	0.000238	3.11	593.02	174.82	0.34
50	500.82	100y36h	Exg	1366	-6.27	4.18		4.59	0.000206	2.93	718.33	204.32	0.32
50	500.82	100y36h	Prop	1366	-6.27	4.10		4.52	0.000214	2.97	701.52	203.52	0.33
50	458.12	100y36h	Exg	1366	-6.47	4.26		4.54	0.000141	2.54	940.58	213.84	0.27
50	458.12	100y36h	Prop	1366	-6.47	4.18		4.47	0.000147	2.57	923.65	212.44	0.27
50	431.31	100y36h	Exg	1366	-6.65	4.26		4.53	0.000129	2.46	949.76	211.89	0.26
50	431.31	100y36h	Prop	1366	-6.65	4.19		4.46	0.000134	2.49	933.07	210.36	0.26
50	400.35	100y36h	Exg	1366	-6.75	4.25		4.53	0.000136	2.39	724.02	192.15	0.26
50	400.35	100y36h	Prop	1366	-6.75	4.17		4.46	0.000141	2.42	708.97	190.33	0.26
50	374.23	100y36h	Exg	1366	-6.74	4.18		4.52	0.000153	2.63	635.38	160.14	0.28
50	374.23	100y36h	Prop	1366	-6.74	4.10		4.45	0.000158	2.65	622.70	157.45	0.28
50	353.53	100y36h	Exg	1366	-6.80	4.15		4.51	0.000164	2.71	661.72	194.60	0.29
50	353.53	100y36h	Prop	1366	-6.80	4.07		4.44	0.00017	2.74	645.86	193.80	0.29
50	328.09	100y36h	Exg	1366	-6.82	4.20		4.49	0.000127	2.43	712.87	179.06	0.26
50	328.09	100y36h	Prop	1366	-6.82	4.12		4.42	0.000131	2.46	698.56	178.72	0.26
50	310.34	100y36h	Exg	1366	-6.90	4.21		4.48	0.000133	2.33	698.97	131.40	0.26
50	310.34	100y36h	Prop	1366	-6.90	4.15	-0.95	4.40	0.000129	2.28	778.18	141.79	0.25
50	297.33	100y36h	Exg	1366	-6.88	4.18	-0.83	4.48	0.000147	2.41	641.21	109.64	0.27
50	290.00			Bridge									
50	282.969*	100y36h	Exg	1366	-6.72	3.93	-0.61	4.28	0.000188	2.66	577.83	105.72	0.30
50	282.969*	100y36h	Prop	1366	-6.72	3.93	-0.61	4.28	0.000188	2.66	577.83	105.72	0.30
50	275.00			Bridge									
50	268.62	100y36h	Exg	1366	-6.55	3.61	-0.39	4.05	0.000248	2.96	518.63	101.39	0.34
50	268.62	100y36h	Prop	1366	-6.55	3.61	-0.39	4.05	0.000248	2.96	518.63	101.39	0.34
50	200.00	100y36h	Exg	1366	-5.90	3.55		4.02	0.000238	3.06	499.14	85.17	0.34
50	200.00	100y36h	Prop	1366	-5.90	3.55		4.02	0.000238	3.06	499.14	85.17	0.34
50	150.00	100y36h	Exg	1366	-5.72	3.56		4.00	0.00024	2.97	547.39	198.77	0.34
50	150.00	100y36h	Prop	1366	-5.72	3.56		4.00	0.00024	2.97	547.39	198.77	0.34
50	100.00	100y36h	Exg	1366	-5.54	3.53		3.99	0.000256	3.03	568.98	224.70	0.35
50	100.00	100y36h	Prop	1366	-5.54	3.53		3.99	0.000256	3.03	568.98	224.70	0.35
50	50.00	100y36h	Exg	1366	-5.31	3.55	-0.08	3.96	0.000255	2.87	595.86	233.34	0.35
50	50.00	100y36h	Prop	1366	-5.31	3.55	-0.08	3.96	0.000255	2.87	595.86	233.34	0.35

Table 5-5 – HEC-RAS 1% AEP results for existing conditions at the bridges

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(m)	(m)	(m)	(m)	(m)	(m)	(m3/s)	(m3/s)	(m3/s)	(m/s)
50	310.34	100y36h	4.48	4.21		0.00	0.00	131.40	13.29	1325.64	27.07	2.33
50	297.33	100y36h	4.48	4.18	-0.83	0.00	0.05	109.64	10.35	1337.80	17.85	2.41
50	290 BR U	100y36h	4.42	3.96	-0.38	0.02	0.02	28.69	27.45	1311.55	27.00	3.08
50	290 BR D	100y36h	4.38	3.83	-0.13	0.00	0.10	28.48	17.95	1324.61	23.44	3.32
50	282.969*	100y36h	4.28	3.93	-0.61	0.00	0.07	105.72	10.29	1341.94	13.76	2.66
50	275 BR U	100y36h	4.22	3.64	-0.07	0.01	0.03	82.01	20.89	1318.50	26.61	3.41
50	275 BR D	100y36h	4.17	3.49	0.10	0.00	0.12	80.98	25.85	1320.91	19.24	3.71
50	268.62	100y36h	4.05	3.61	-0.39	0.02	0.01	101.39	13.39	1343.16	9.44	2.96
50	200	100y36h	4.02	3.55		0.01	0.01	85.17	17.00	1342.52	6.48	3.06

Table 5-6 – HEC-RAS 1% AEP results for proposed conditions at the bridges

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(m)	(m)	(m)	(m)	(m)	(m)	(m3/s)	(m3/s)	(m3/s)	(m/s)
50	328.09	100y36h	4.42	4.12		0.00	0.01	178.72	20.55	1326.80	18.65	2.46
50	310.34	100y36h	4.40	4.15	-0.95	0.00	0.01	141.79	38.01	1285.53	42.46	2.28
50	300 BR U	100y36h	4.38	4.00	-0.39	0.02	0.02	106.48	60.55	1260.73	44.72	2.84
50	300 BR D	100y36h	4.34	3.79	-0.01	0.00	0.06	77.42	25.32	1326.34	14.34	3.33
50	282.969*	100y36h	4.28	3.93	-0.61	0.00	0.07	105.72	10.29	1341.94	13.76	2.66
50	275 BR U	100y36h	4.22	3.64	-0.08	0.01	0.03	82.01	20.89	1318.52	26.60	3.41
50	275 BR D	100y36h	4.17	3.49	0.10	0.00	0.12	80.98	25.85	1320.91	19.24	3.71
50	268.62	100y36h	4.05	3.61	-0.39	0.02	0.01	101.39	13.39	1343.16	9.44	2.96
50	200	100y36h	4.02	3.55		0.01	0.01	85.17	17.00	1342.52	6.48	3.06

5.2 Wyong Town Centre TUFLOW Model

TUFLOW hydraulic modelling has been adopted for representing flooding conditions. The Wyong Pacific Highway culverts TUFLOW model is a 1d/2d model with a 5 metres terrain grid cell size. For complex flow areas, including at culverts and drainage channels, the ESTRY 1d engine has been utilised to provide better representation where necessary. Overall, the 1d/2d representation of the catchment provides a better estimate of the redistribution of flows. The arrangement of the proposed culverts has been updated to reflect this.

5.2.1 Software Version

For assessing the Pacific Highway culverts, TUFLOW version 2013-12-AC-w64 was utilised.

5.2.2 Model Geometry

The base terrain used in the TUFLOW model was that extracted from the LiDAR survey data in the Wyong River Catchment Flood Study (BMT WBM, 2014).

Additional field survey was available around the project corridor. To provide better definition of the road surface, drainage channels and flood storage areas, the field survey was read into the TUFLOW model as breaklines for triangulation of the surface. The TUFLOW model terrain is shown in Figure 5-8.

It is noted that the base terrain in the TUFLOW model is different to that in Council's SOBEK model, particularly where there is additional field survey. Figure 5-9 shows an example cross-section across the existing Pacific Highway and railway line. The difference is surmised to be due to the LiDAR and field survey combination used in the TUFLOW model providing a better representation of the densely vegetated channels to the sides than in the SOBEK model. The terrain in the SOBEK model does not appear to effectively capture the invert of the channels, thereby reducing the effective flood storage.

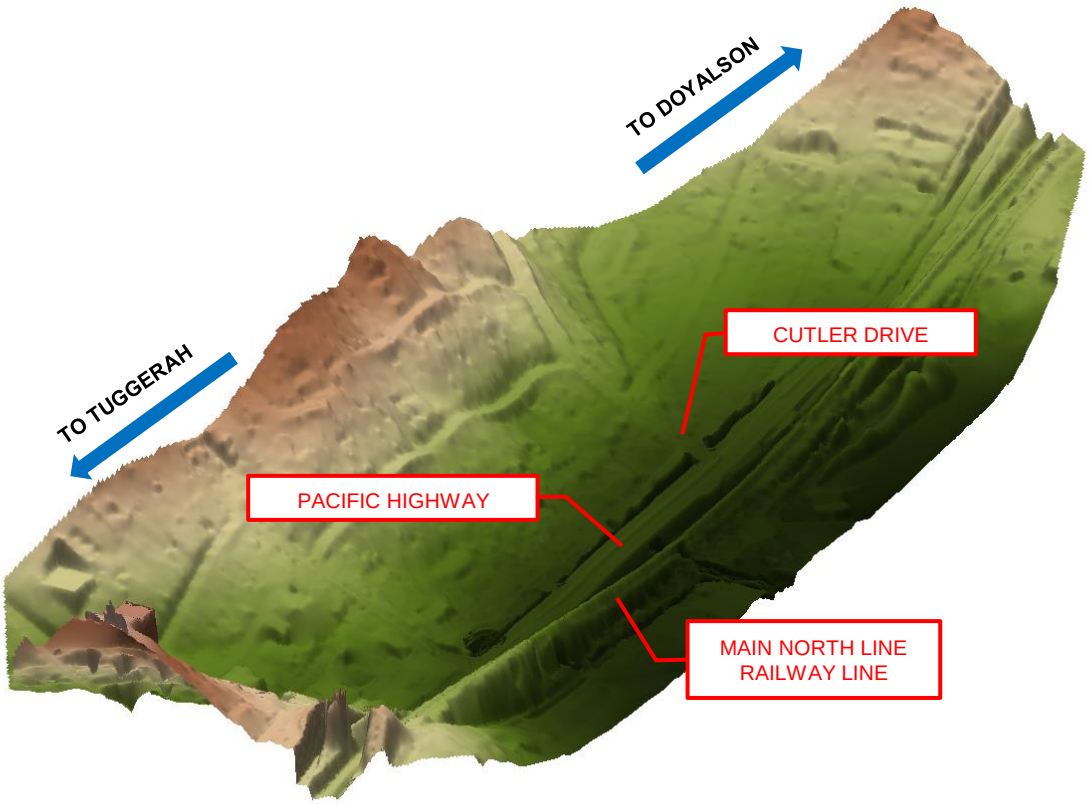


Figure 5-8 – Wyong Town Centre TUFLOW Model Terrain

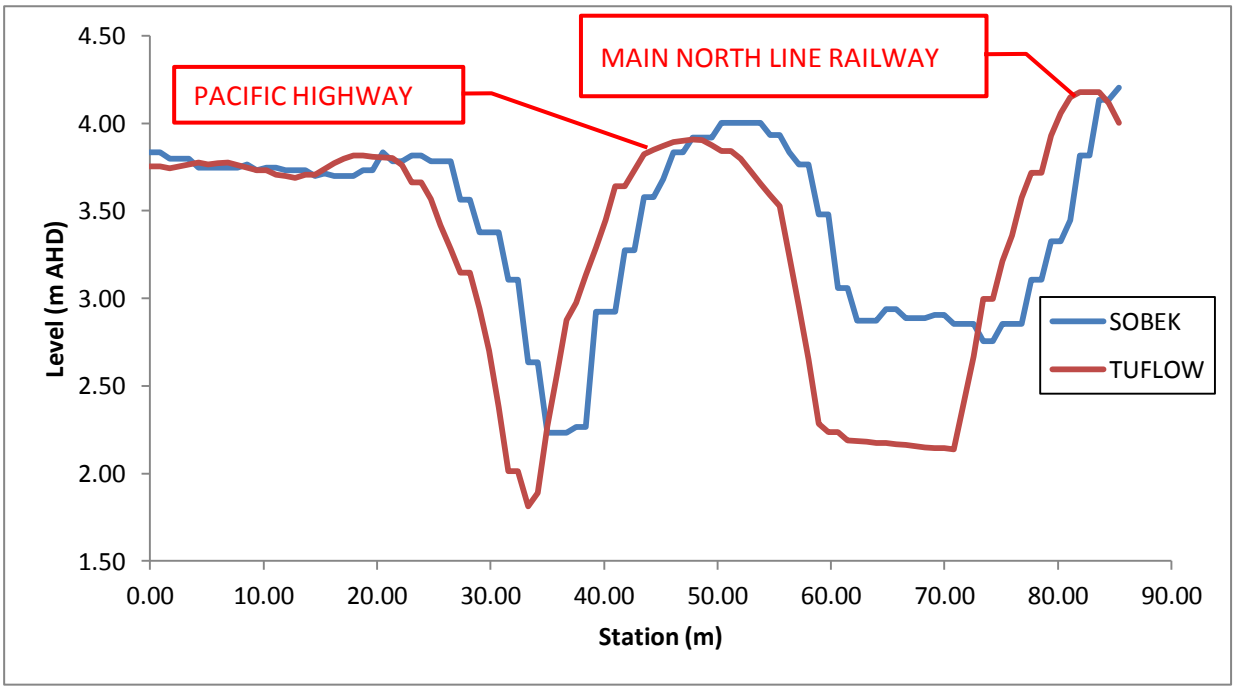


Figure 5-9 – Wyong Town Centre TUFLOW Cross-section – SOBEK vs. TUFLOW

The floodplain material roughness for the model was defined through the assistance of aerial photography. Roughness extent polygons were digitised into GIS, using MapInfo software. An example of the roughness polygons used is shown in Figure 5-10.

Council's SOBEK model was reviewed for the general distribution of urban blocks, roads and vegetation. However, it is noted that buildings were modelled as physical obstructions in the SOBEK model whereas buildings are represented as areas of high roughness in the TUFLOW modelling. In closer review of the two models, the overall local catchment flooding overland flow paths are generally consistent. Towards the area of interest, at the railway and highway, the overland flow paths are not particularly affected by the differences in building representation as these areas are primarily consist primarily of paved or grassed areas.

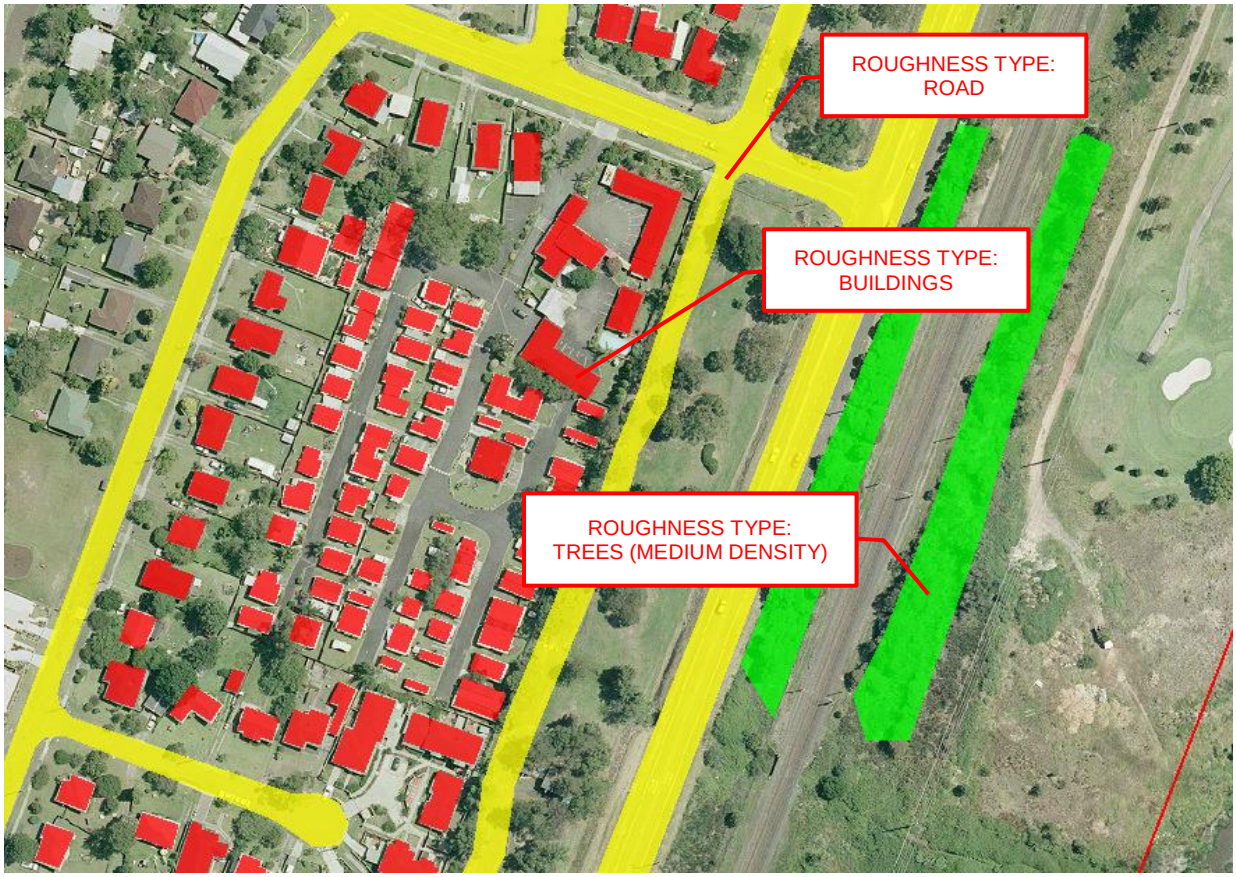


Figure 5-10 – Typical TUFLOW Roughness Polygons Distribution

The adopted TUFLOW roughness parameters are as shown in Table 5-7.

Table 5-7 – TUFLOW Floodplain Roughness Parameters

TUFLOW MATERIAL ID	Description	Roughness n
2	Roads / Asphalt Pavement	0.018
11	Buildings (at ground level, high roughness in flowpaths)	1.000
14	Urban Block (included grass, concrete, gardens and fences - no buildings)	0.070
24	Pasture (no scrub, high grass or mature row crops	0.035
29	Trees (medium density with fallen logs)	0.100

5.2.3 Design Road Alignment

The proposed Wyong Town Centre Upgrade road alignment was modelled in TUFLOW as an .FLT floating point grid. The source terrain model was triangulated within 12d Model and then exported as the grid. The design road surface was overlayed onto the base terrain to represent the proposed conditions surface.

5.2.4 Culverts

Drainage structures were embedded into the TUFLOW hydraulic model through the use of the ESTRY 1d modelling engine.

The plan arrangement of the proposed culverts is as shown in Figure 5-11.

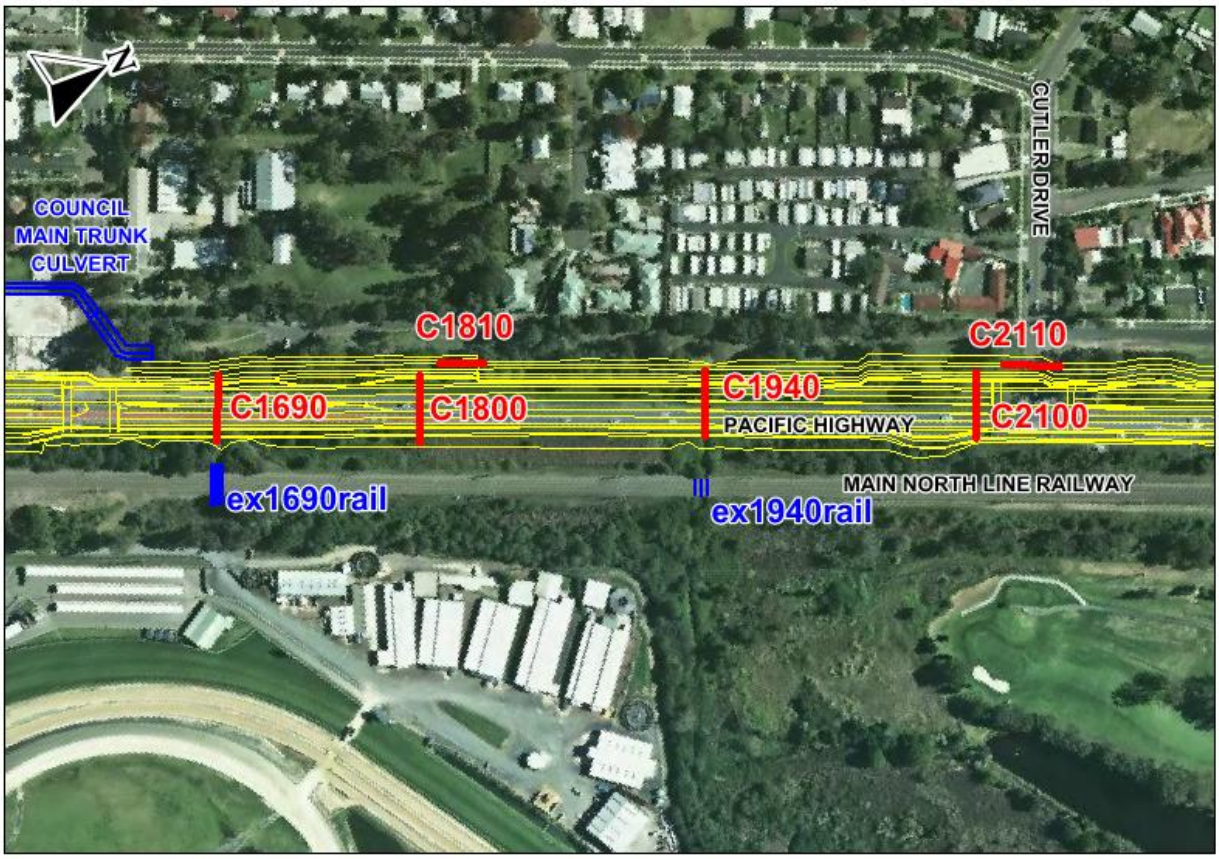


Figure 5-11 – Plan arrangement of proposed Pacific Highway culverts

A summary of the existing culverts is presented in Table 5-8.

Table 5-8 – Summary of existing Pacific Highway and railway culverts

No.	ID	Chainage (m)	Location	Type	Size
1	ex1690rail	1690	Main North Railway Line	RCBC	5 x 1.20 m wide x 1.10 m high
2	ex1940rail	1940	Main North Railway Line	RCBC	2 x 2.54 m wide x 1.60 m high
3	ex1690	1690	Existing Pacific Highway	RCBC	2 x 0.90 m wide x 0.90 m high
4	ex1940	1940	Existing Pacific Highway	RCBC	2 x 1.20 m wide x 1.20 m high
5	ex2110	2110	Cutler Drive	RCP	3 x Ø750 mm

Preliminary runs of the TUFLOW hydraulic modelling highlighted that it was necessary to rearrange the culverts across the Pacific Highway to minimise the impact caused by the Wyong Town Centre Upgrade.

A summary of the proposed culverts is presented in Table 5-9.

Table 5-9 – Summary of proposed Pacific Highway and railway culverts

No.	ID	Chainage (m)	Location	Type	Size	Comments
1	C1690	1690	Pacific Highway	RCBC	1 x 1.80 m wide x 1.20 m high	Replace existing 2 x 0.90 m wide x 0.90 m high RCBC with new 1 x 1.80 m wide x 1.20 m high RCBC
2	C1800	1800	Pacific Highway	RCBC	1 x 3.60 m wide x 1.05 m high	New flood relief culvert
3	C1940	1940	Pacific Highway	RCBC	3 x 3.60 m wide x 1.20 m high	Upgrade existing 2 x 1.20 m wide x 1.20 m high RCBC with new 3 x 3.60 m wide x 1.20 m high RCBC
4	C2100	2100	Pacific Highway	RCBC	2 x 4.20 m wide x 1.05 m high	New flood relief culvert
5	C1810	1810	Access Road	RCBC	1 x 2.10 m wide x 0.90 m high	New culvert under access road

No.	ID	Chainage (m)	Location	Type	Size	Comments
6	C2110	2110	Cutler Drive	RCBC	2 x 2.40 m wide x 0.90 m high	Upgrade existing 3 x Ø750 mm RCP with new 2 x 2.40 m wide x 0.90 m high RCBC

Note that in order to meet project Design Life criteria (i.e. 100 years for inaccessible drainage elements), all existing culverts will be replaced with new culverts listed above.

5.2.5 Model Parameters and Assumptions

5.2.5.1 Inflow Boundary Conditions

The WBNM hydrological model was used as the hydrology input for the Pacific Highway culverts TUFLOW model. The hydrology was incorporated into the TUFLOW model as a series of QT (flow vs. time) hydrograph boundaries. The QT boundaries were applied as nodes, lines and polygons to introduce the hydrology into the 2d model domain.

At the upgraded trunk main culvert, the local catchment hydrograph was factored to match the design flows from Council's SOBEK modelling. For example, for a 1% AEP local catchment peak flow of 12 m^3/s, a flow reduction factor was used such that a peak flow of 10 m3/s through the trunk main culvert was obtained to match Table 5-10; the remaining excess would remain as overland flow.

Table 5-10 – Peak discharge from Trunk Main Culvert (Cardno Report)

AEP	ARI	Peak Discharge (m^3/s)
20%	5 year	5
10%	10 year	6
5%	20 year	7
1%	100 year	10
PMF	PMF	12

A typical TUFLOW QT inflow boundary (green) is shown in Figure 5-12.

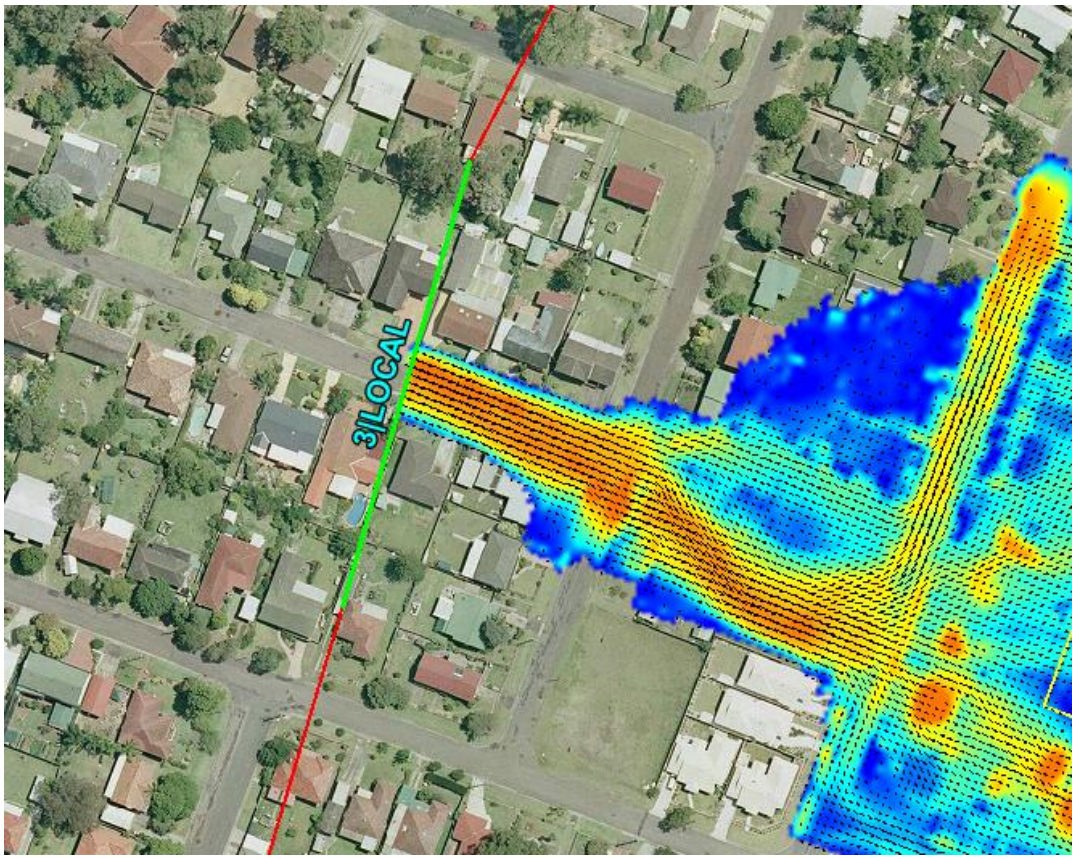


Figure 5-12 – Typical TUFLOW Inflow Boundary

5.2.5.2 Downstream Boundary Conditions

The TUFLOW downstream boundary was modelled using a HQ (water level vs. flow) boundary. This boundary automatically generates a stage-discharge curve based on the nominated hydraulic grade, Manning's roughness and terrain profile across the line. The line was defined perpendicular to the flow as TUFLOW assumes a constant water level across the boundary.

To prevent undesirable backwater effect caused by the downstream boundary, potentially influencing the results are the area of interest, the HQ boundary line was digitised 100 metres downstream of the railway line.

The TUFLOW HQ downstream boundary (green) is shown in Figure 5-13.

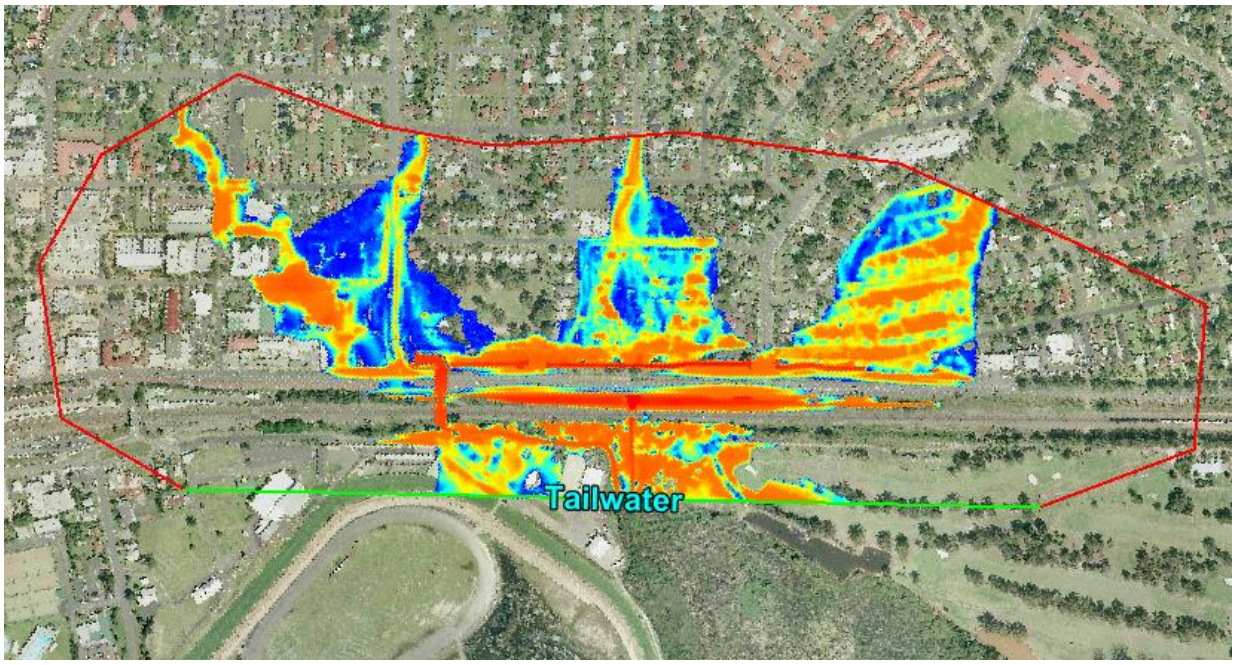


Figure 5-13 – TUFLOW Downstream Boundary

Council's SOBEK model locates the 2D downstream boundary along the existing railway line. To compare the effective tailwater level used in both the SOBEK and TUFLOW model, the flood level immediately upstream of the existing railway culvert at Stn. 1940 was extracted as this location is the furthest location downstream which is present in both models. A summary of the flood level comparison is presented in Table 5-11.

Table 5-11 – Comparison of SOBEK and TUFLOW Upstream of Existing Railway Culvert at Stn. 1940.

AEP	ARI	SOBEK Flood Level (m AHD)	TUFLOW Flood Level (m AHD)
20%	5 year	3.2	3.1
10%	10 year	3.4	3.2
1%	100 year	4.0	3.8
PMF	PMF	6.2	4.5

It is noted that the flood levels, in flood events up to the 100 year ARI, in the SOBEK model are generally 0.1 to 0.2 metres higher than that in the TUFLOW model immediately upstream of the railway culvert.

The peak PMF flood levels in this SMEC assessment is different to that presented in Council's SOBEK flood impact assessment of the Wyong CBD trunk main culvert. The difference in water level is close to 1.70 metres. The existing top of railway level is approximately 4 metres AHD; an overtopping depth of 2 metres does not appear probable, even for PMF conditions.

The difference in flood level is likely due to the differences in representation of the downstream topography immediately downstream of the railway. It is surmised that the channel cross-section that has been used within the SOBEK model is not wide enough to adequately represent the downstream channel, causing a "vertical wall" effect once the overbank of the modelled channel was exceeded. This would explain the significantly higher flood level estimated in the respective PMF flood model.

The downstream boundary in the TUFLOW model overcomes the "vertical wall" effect as the length of the boundary was digitised large enough to encompass the appropriate flood extent and not artificially raise tailwater levels.

It is recommended that Cardno's downstream boundary, as utilised in their SOBEK model, be reviewed and amended by Cardno and Council if it is to be relied upon in the future.

5.2.5.3 Blockage

As agreed with Roads and Maritime and Council, a 10% blockage has been applied at all bridges and major culverts.

Specific aspects of the drainage design to incorporate features to reduce the risk of blockage should be considered at the detailed design stage. Refer to design lot WTC-RD-001 for more information. In review of the upstream catchments, it has been identified that there is low likelihood of large floating debris arriving at the culverts. Therefore, it is not necessary to incorporate features to prevent the blockage of the culvert from large debris.

The primary blockage mechanism will be siltation due to the presence of the wetland downstream. Regular maintenance shall be undertaken by Roads and Maritime to prevent siltation.

5.2.5.4 Assumptions

To analyse the Wyong Town Centre Pacific Highway culverts, the following assumptions have been made.

- The reference base case condition will be for when the Wyong Shire Council has completed their culvert upgrade as per the "Wyong CBD – Proposed Trunk Drainage Construction" drawings.
- As per Cardno's Wyong Trunk Culvert Report (2014), the upgraded main trunk culvert conveys the flows as detailed in Table 5-10.
    - The culvert discharges into the basin upstream of the highway culverts. Therefore, the discharge from this culvert was included in the design approach flow for the existing highway culverts.

- It is noted that there is a 3-cell 1.2 m wide x 1.2 m high box culvert located to the south of where Council will be constructing the trunk drainage sediment basin. The assumption was made that this culvert is redundant in both the existing and proposed conditions as the incoming lines to this culvert will be deactivated once the main trunk drainage is upgraded.

5.3 South Tacoma Road Culvert Extension

5.3.1 Methodology

The South Tacoma Road culvert was hydraulically assessed through the use of DRAINS with hydrological input from WBNM modelling.

Due to the nature of regional flooding in the Wyong River catchment, it was not possible to assess the culvert using the water levels presented from the TUFLOW flood modelling. A 1% AEP water level of 3.9 metres AHD, upstream of the Pacific Highway, would effectively drown out the culvert system. Therefore, the South Tacoma Road culvert was only assessed for the local 1% AEP catchment flows. If the culvert was adequate for conveying the 1% AEP catchment flows, then it would behave similarly for more frequent events. For less frequent events, the behaviour would be as that documented for the Wyong River catchment assessment.

For the local catchment conditions, the culvert operates in conjunction with the longitudinal pavement drainage which is designed to cater for the 10% AEP event. The longitudinal drainage connects and discharges into the culvert system at various locations.

A peak 20% AEP (5 year ARI) tailwater of 2.0 metres AHD, in Wyong River, was adopted for design purposes.

5.3.2 Model Parameters and Assumptions

5.3.2.1 Blockage

An allowance of 10% blockage has been applied at the South Tacoma Road Culvert to satisfy the agreement with Roads and Maritime and Council.

In review of the upstream catchment, it has been identified that there is low risk of large floating debris arriving at the culverts. Therefore, features for prevention of large debris from entering the culverts are not required.

The primary blockage mechanism will be siltation due to the presence of the channels upstream and downstream. Regular maintenance shall be undertaken by Roads and Maritime to prevent siltation.

6. MODEL RESULTS

6.1 Wyong River Catchment TUFLOW Model

Refer to Appendix A for 5% AEP, 1% AEP, 0.05% AEP and PMF TUFLOW flood maps as discussed in the sections below.

6.1.1 Flood Level Impacts

Peak flood levels under the proposed twin bridges over Wyong River for all modelled events are presented in Table 6-1.

Table 6-1 –Peak Flood Levels under Proposed Wyong River Bridge

Storm Event	Peak Flood Level (mAHD)	Soffit Level (m)	Freeboard (m)
5% AEP	3.16	5.90	2.7
1% AEP	3.86	5.90	2.0
1% AEP with Climate Change	4.11	5.90	1.8
0.05% AEP	4.43	5.90	1.5
PMF	6.16	5.90	-

For reference, note that the lowest soffit level for the existing highway bridge is approximately 3.35 m AHD. The existing 100 year ARI flood level is 3.9 m AHD, which suggests a partial bridge submergence of approximately 0.5 metres.

6.1.1.1 1% AEP (100 year ARI)

The following proposed condition model results refer to the proposed twin road bridges over Wyong River configuration as shown in Appendix B.

The proposed twin road bridges over the Wyong River have soffit levels higher than the 1% AEP flood. Therefore, the flooding impacts caused by the bridges are primarily a function of the form losses caused by the bridge piers and allowances for additional blockages.

At the northern abutment of the proposed road bridges, at River Road, there are localised patches of afflux of up to 90 millimetres. This afflux is confined to the main Wyong River watercourse and the revised River Road alignment and does not affect nearby property. Therefore, this area of afflux is not of concern.

Immediately downstream of the railway bridge, there is an area of afflux with impacts of up to 50 millimetres. This area extends approximately 50 metres downstream of the railway bridge, with concentration along the South Tacoma Road alignment towards the southern overbank of the Wyong River. This area of afflux does not impact infrastructure and therefore is not of concern as it is primarily contained within the waterway.

At 210 Pacific Highway, located upstream of the southern abutment of the proposed road bridges, there is a localised flooding impact of up to 75 millimetres at the location of the existing residence. However, it should be noted that as a result of the revised proposed road

alignment in this area it is necessary to demolish and excavate the structures at 204-206 and 210 Pacific Highway. Therefore, in proposed conditions the impacts at this area will effectively not affect property.

At the car yard at 200-202 Pacific Highway, at the corner of McPherson Road and the Pacific Highway, there is afflux of up to 30 millimetres occurring within the property boundary; over McPherson Road this afflux increases to 100 millimetres. The flood level increase is a result of the proposed McPherson Road roundabout intersection acting as a constriction to floodwater approaching from the southerly direction. The proposed terrain lowering at 204-206 Pacific Highway, on the downstream face of McPherson Road, assists in reducing the flooding impact at the car yard but does not totally remove it.

As was discussed in BMT WBM's report, the flat nature of the Wyong River catchment causes the area to be very sensitive to changes such as blockage. The introduction of the proposed twin roads bridge over Wyong River is equivalent to introducing a small blockage on the Wyong River system. However, it is noted that there are no significant impacts beyond those areas already discussed above. This is as a result of the proposed twin road bridges having soffits higher than the 1% AEP flood level whereas the existing road bridge is partially submerged. The demolition and removal of the existing road bridge offsets the blockages introduced into the Wyong River as a result of the proposed bridges.

Beyond the localised impacts at the bridge, there are no additional 1% AEP downstream impacts as a result of the Wyong Town Centre upgrade and associated bridge works.

6.1.1.2 1% AEP Time of Inundation Impacts

Stage hydrographs have been produced for a number of locations within the Wyong River catchment upstream of the proposed upgrade. The sample locations are as shown in Figure 6-1. Location A is immediately upstream of the proposed upgrade, whilst Location B and Location C are within the Porters Creek wetland area which is sensitive to downstream changes.

Extracted stage hydrographs at the sample locations are shown in Figure 6-2, Figure 6-3 and Figure 6-4.

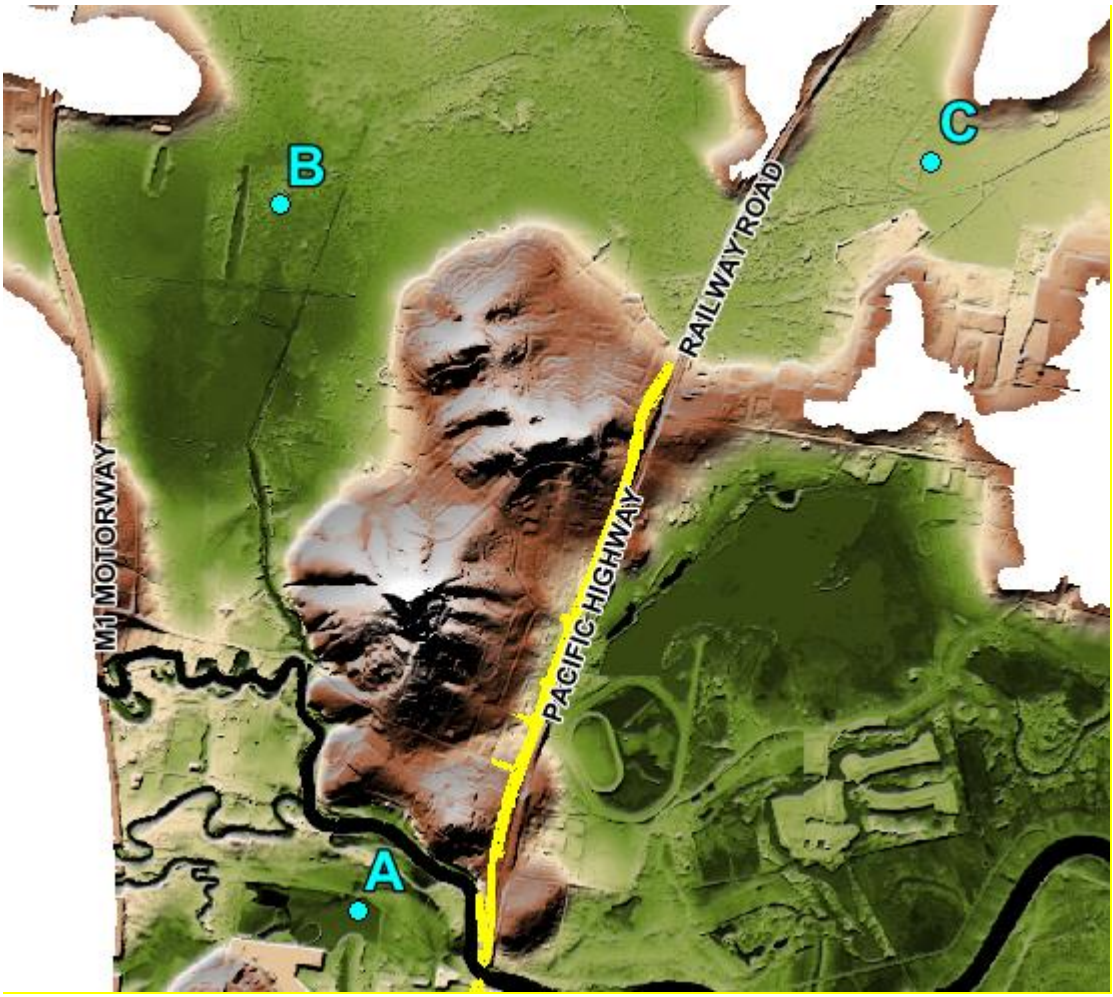


Figure 6-1 – Time of Inundation Sample Locations for Wyong River catchment

From the stage hydrographs, it was observed that there are negligible effects on the duration of flooding. Therefore it is appropriate to expect that the proposed Wyong Town Centre Upgrade does not adversely affect flood inundation times in the general Wyong River catchment and in particular the Porters Creek wetland area.

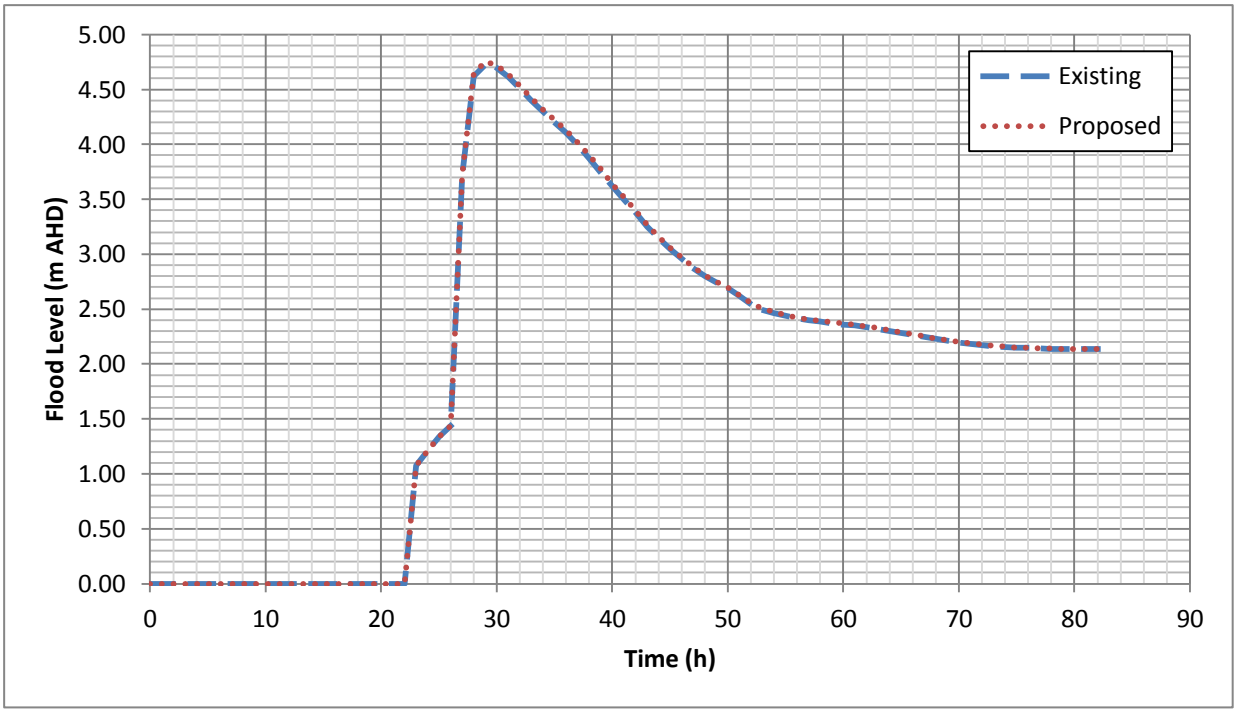


Figure 6-2 – 1% AEP Stage Hydrograph at Sample Location A

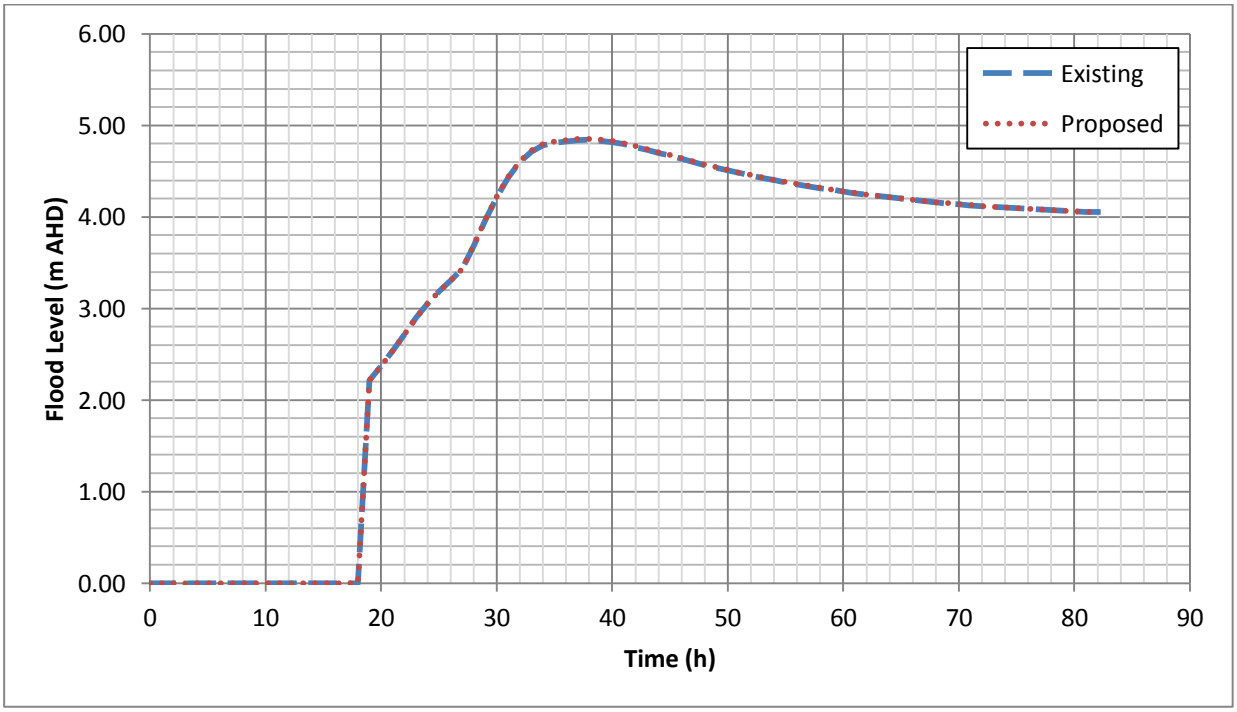


Figure 6-3 – 1% AEP Stage Hydrograph at Sample Location B

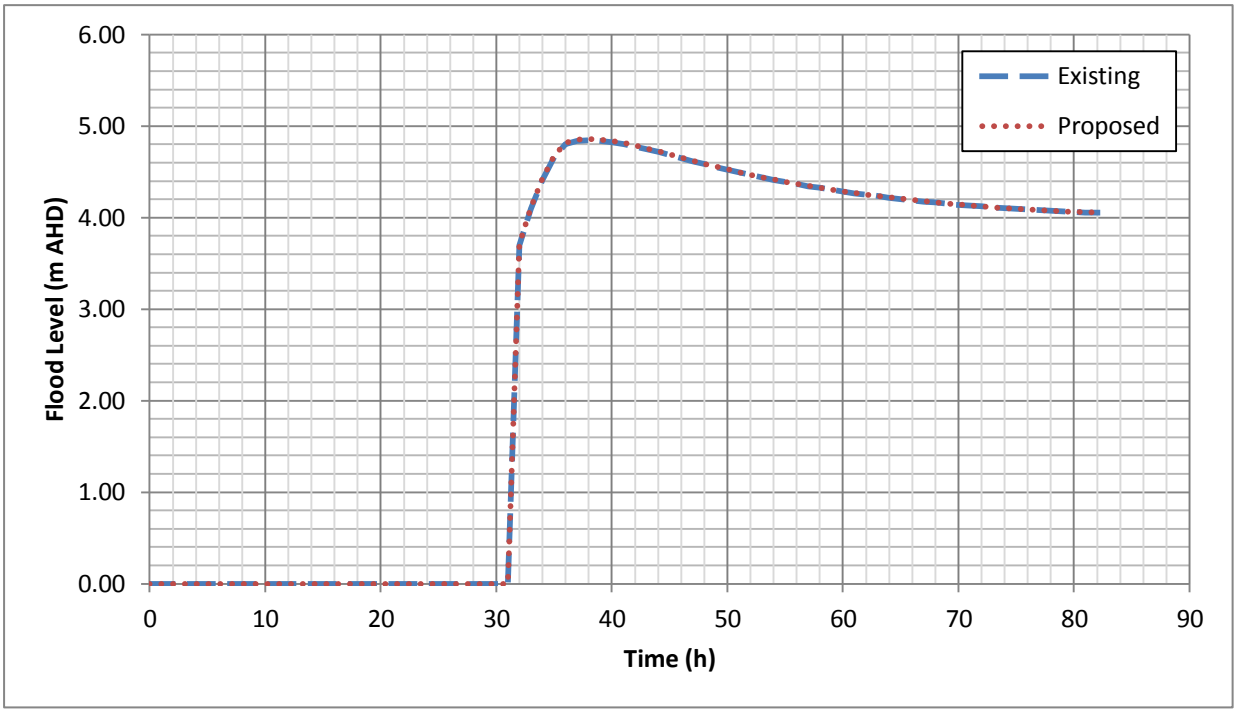


Figure 6-4 – 1% AEP Stage Hydrograph at Sample Location C

6.1.1.3 Effects on Probable Maximum Flood

Preliminary modelling indicates that there are flood level impacts on the Probable Maximum Flood (PMF).

Upstream of the bridges over Wyong River, there is a net reduction in water levels of approximately 120 millimetres. This extends a significant distance into the upstream Wyong River catchment up to 9 kilometres into the floodplain at Warnervale and Hamlyn Terrace.

Immediately downstream of the bridges over Wyong River, a patch of afflux of up to 200 millimetres occurs along South Tacoma Road. This patch is confined within the Wyong River and South Tacoma Rd, with no impact on properties. Further downstream, flood level impacts occur over a large area affecting Wyong and Tacoma and having the potential to affect properties. The majority of these flood level impacts are below 30 millimetres; towards the Wyong River alignment, the increases are up to 75 millimetres.

The flood impacts are a result of the upgraded twin bridges over Wyong River providing some additional flow through the bridge openings, due to the raised soffit, with this effect propagating downstream. Apart from the flood level increases, the extent of the PMF flood remains relatively unchanged and therefore there are no additional flood-prone properties as a result of the Wyong Town Centre Upgrade.

In the existing conditions, the existing Pacific Highway bridge and Main North Line railway bridge act as constrictions for the PMF flows. In the proposed conditions, the existing Pacific Highway bridge has been demolished and two new road bridges have been constructed in its place. Since the soffit levels of the new bridges are higher than the existing road bridge, the hydraulic conveyance area is larger and therefore more flows can be conveyed downstream. In the PMF event, this additional flow being conveyed downstream alleviates the flooding upstream but increases the water levels downstream as a consequence.

6.1.1.4 Impacts on Flooding due to Climate Change

Results of the modelling indicate that in the proposed conditions, 1% AEP flood under a climate change scenario would cause an increase in flood levels and extents compared to the 1% AEP flood without climate change.

Flood level increases of up to 300 millimetres (for the scenarios with and without climate change allowances) are observed over an area upstream and downstream of the bridges over Wyong River.

The sample locations for the peak flood levels with flood level increase contours as shown in Figure 6-5. Peak flood levels are presented in Table 6-2 .

Table 6-2 – 100 year ARI Peak Flood Locations – Proposed Conditions

Location	1% AEP Flood Levels (m AHD)	1% AEP Flood Levels under Climate Change (m AHD)	Flood Level Difference (mm)
A	3.66	3.87	210
B	3.98	4.21	230
C	4.23	4.48	250
D	3.64	3.82	180
E	3.51	3.67	160

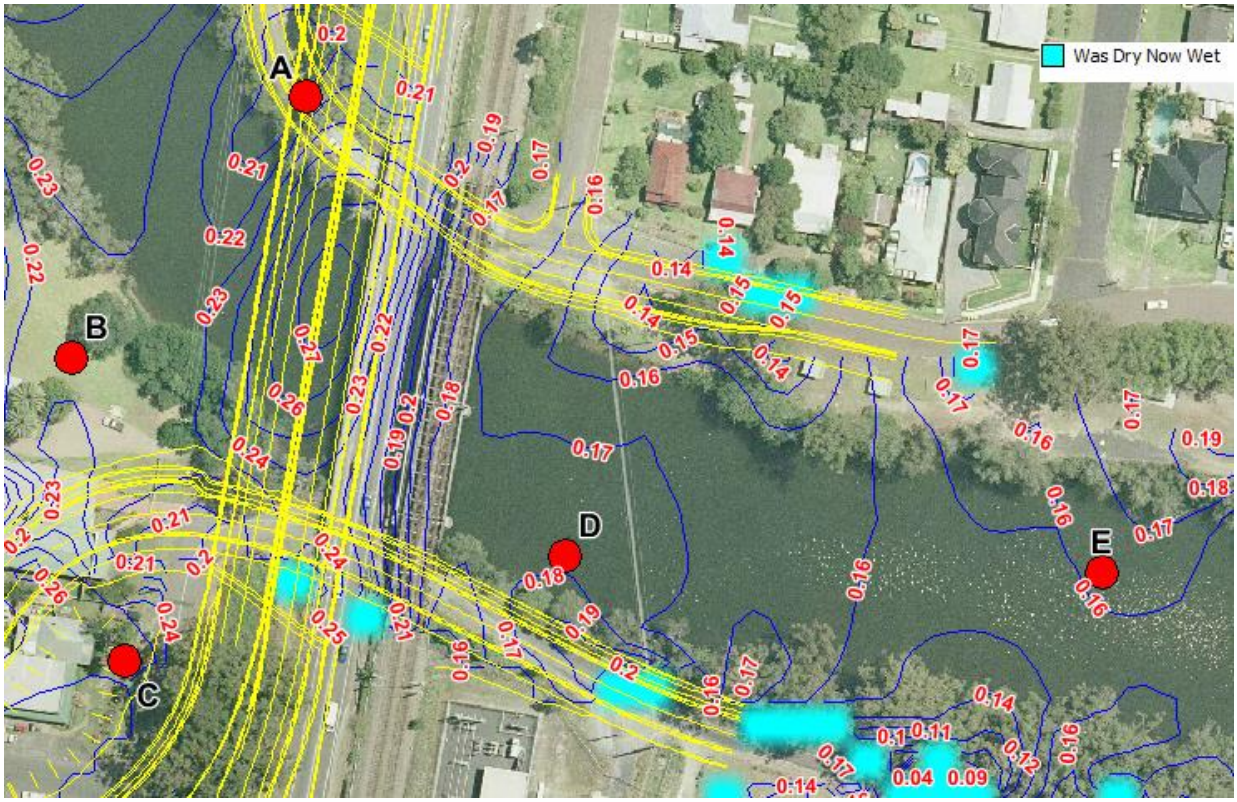


Figure 6-5 – Wyong River TUFLOW Impact under Climate Change for 1% AEP Event (vs. 1% AEP without Climate Change)

The highest 1% AEP peak flood levels under the climate change scenario at the proposed bridge is approximately 4.1 metres AHD, which is less than the obvert of the proposed bridge over Wyong River of 5.9 metres AHD. Under the climate change scenario, a freeboard of 0.8 metres is available.

6.1.1.5 Effects on more Frequent Events

Under the 5% AEP (20 year ARI) event, results of the modelling indicate that there are increases of flood levels of up to 30 millimetres upstream and downstream of the bridges over Wyong River as well as at the roundabout at the intersection of the Pacific Highway and South Tacoma Road.

Apart from these localised flood level increases, the flood levels and extent of the 5% AEP flood remains relatively unchanged. It is predicted that there are no additional properties affected by more frequent flood events as a result of the highway upgrade.

6.2 Wyong Town Centre TUFLOW Model

6.2.1 Flood Level Impacts

The results of the hydraulic assessment for the Pacific Highway culverts are presented in Table 6-3 and Table 6-4. Flood level impacts are shown in Table 6-5.

In the existing condition, the Wyong Town Centre catchments drain towards the drainage channels along Apex Park and drain into the highway culverts. However, the existing highway culverts are inadequate for conveying the 1% AEP catchment flows. At the intersection of Cutler Drive and the existing Pacific Highway, where the sag point is located, a flow of approximately 22 m^3/s overtops the road.

The existing culverts at the railway line act as a hydraulic constriction for the upstream catchment. Floodwaters pond up within the drainage channel between the road and railway and eventually discharge through the railway culverts. The flood level within this drainage channel controls the effectiveness of the upstream highway culverts in conveying flows.

Table 6-3 – Summary of 1% AEP existing condition results

ID	Chainage (m)	Culvert Flow (m^3/s)	Headwater Level (m AHD)	Tailwater Level (m AHD)
ex1690rail	1690	6.32	3.32	3.22
ex1940rail	1940	20.09	3.81	3.18
ex1690	1690	3.84	3.99	3.32
ex1940	1940	7.10	3.90	3.81
ex2010	2010	2.07	3.98	3.91

In the proposed condition, the highway drainage culverts have been sized such that there are no impacts at upstream residential properties. It is noted that the upstream water level impacts are confined to the Apex Park corridor and do not adversely affect the nearby Central Coast

Mobile Village, Wyong Grove Public School or other adjacent residential properties.

It is observed that the flood mapping indicates a minor flood level impact, up to 40 mm, at the Aldi development at the corner of North Road and the Pacific Highway. However, it is assumed that discharges from the Aldi development will be conveyed via the Hardware Lane culvert which discharges into Apex Park. The proposed design reduces water levels downstream of the Hardware Lane culvert (upstream of C1690) by 10 to 50 mm. Therefore, there are no expected negative impacts at the Aldi development and other properties discharging to the Hardware Lane culvert; the flood impact shown on the mapping is considered a discrepancy. The local longitudinal drainage on the highway should be consolidated during the detailed design phase to remove this discrepancy.

Due to the hydraulic limitations in conveyance through the existing culverts at the railway embankment, there is no additional benefit in providing more culvert cells under the highway without alleviating the constriction at the railway. The proposed culverts under the highway are somewhat inefficient due to tailwater caused by the railway culverts. However, it is beyond the scope of the Wyong Town Centre Upgrade project to upgrade the railway culverts.

Table 6-4 – Summary of 1% AEP proposed condition results

ID	Chainage (m)	Culvert Flow (m^3/s)	Headwater Level (m AHD)	Tailwater Level (m AHD)
C1690	1690	5.96	3.94	3.36
C1800	1800	3.90	3.89	3.81
C1940	1940	15.13	3.87	3.80
C2100	2100	8.63	3.94	3.85
C2110	2110	6.51	4.07	3.95

Table 6-5 – Summary of 1% AEP flood level impacts at Pacific Highway culverts

No.	Location	Existing (m AHD)	Proposed (m AHD)	Difference (mm)
1	Upstream of culvert C1690	3.99	3.94	-50
2	Upstream of culvert C1800	3.91	3.89	-20
3	Upstream of culvert C1940	3.90	3.87	-30
4	Upstream of culvert C2100	3.89	3.94	+50
5	Upstream of culvert C2110 (Cutler Drive)	4.10	4.07	-30

Upstream of proposed culvert C1690, there is a net water level reduction of approximately 50 millimetres. At C1800, there is also a net water level reduction of approximately 20 millimetres.

Upstream of proposed culvert C1940, there is a net water level reduction of approximately 30 millimetres. Further north, within the proposed drainage channels linking the culverts, there is afflux of up to 60 millimetres. However, this is confined to Apex Park and does not affect upstream property. At proposed culvert C2100, upstream flood level increases of approximately 50 millimetres occurs but again is confined to the Apex Park drainage channel.

Upstream of culvert C2110, at Cutler Drive, there is a decrease in water level of about 30 millimetres. This drop in water level is as a result of the lowered sag point along Cutler Drive allowing more water to overtop the intersection and discharge to Apex Park.

Over the Pacific Highway, at the Cutler Drive intersection, there is a net flood level increase of approximately 120 millimetres. It should be noted that this impact is as a result of the upgraded highway being higher than the existing drainage channels in this area and that the overall impact is of lessened concern.

Downstream of the Main North Line railway, there are zero impacts to the flood level. Therefore, the Wyong Racecourse and Showground are not expected to be affected by the current proposed arrangement.

The water level impacts upstream of the Pacific Highway culverts are up to 50 millimetres in the proposed case. This occurs as a result of the upgraded highway alignment acting as an obstruction to the catchment flows. In the existing conditions, a significant amount of flow, of up to 22 m^3/s, overtops the highway at the intersection with Cutler Drive near the mobile home park. In the proposed conditions, this flow is channelled towards the upstream side in Apex Park due to the raised crown geometry. Due to the flood storage effect of the channel between the Pacific Highway and existing railway, the upstream levels are unlikely to be reduced to match existing levels without an unfeasible amount of culverts.

It should be noted that current modelling configuration did not account for the local drainage network, therefore the flood impacts and depths are high level representation of overland flows only.

6.2.2 Comparison of SOBEK and TUFLOW

A comparison of the results from the SOBEK and TUFLOW modelling has been carried out. The 100 year ARI flood extent, for depths greater than 150 millimetres, for the SOBEK and TUFLOW models are shown in Figure 6-6. It can be seen that the main overland flow paths in both models are reasonably consistent. Towards the area of interest, that is the highway and railway, the flood extents show a good match.

It is noted that there are some minor discrepancies in the minor overland flow paths around buildings are as a result of the differences in modelling approach for the buildings. Since the SOBEK model has modelled the buildings as “blockages”, minor diversion of flows occur due to the obstruction. In the TUFLOW model, the buildings have been represented with higher roughness to account for additional flood storage. Overall, the major overland flow paths are captured in both models.

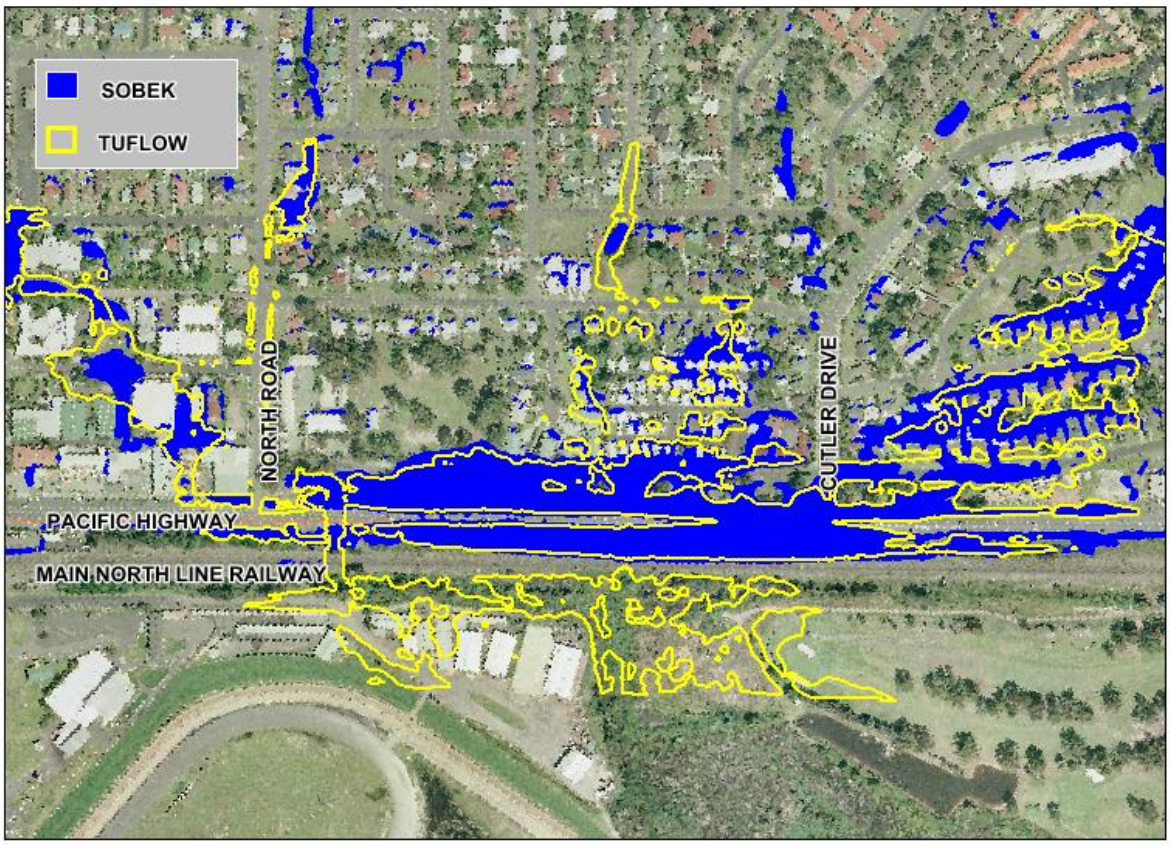


Figure 6-6 – Wyong Northern TUFLOW Flood Extent vs. SOBEK Flood Extent for the 100 year ARI

Comparisons of the upstream flood levels at the existing highway culverts are shown in Table 6-6 and Table 6-7.

As discussed in 5.2.5.2, the significant difference between SOBEK And TUFLOW for the PMF flood level is due to the arrangement of the boundary condition in the SOBEK model not being appropriate for representing larger flows.

Table 6-6 – Comparison of SOBEK and TUFLOW Upstream of Existing Highway Culvert at Stn. 1690.

AEP	ARI	SOBEK Flood Level (m AHD)	TUFLOW Flood Level (m AHD)
20%	5 year	3.85	3.77
10%	10 year	3.89	3.85
1%	100 year	4.08	4.00
PMF	PMF	6.22	4.47

Table 6-7 – Comparison of SOBEK and TUFLOW Upstream of Existing Railway Culvert at Stn. 1940.

AEP	ARI	SOBEK Flood Level (m AHD)	TUFLOW Flood Level (m AHD)
20%	5 year	3.85	3.70
10%	10 year	3.89	3.76
1%	100 year	4.08	3.90
PMF	PMF	6.22	4.46

For the more frequent flooding events, the flood levels upstream of the highway are controlled by the flood level within the storage between the highway and railway. As shown in Section 5.2.2, the TUFLOW model contains better definition of the storage upstream of the railway obtained from field survey. The storage in the TUFLOW model is deeper and larger than that presented in the SOBEK model which in turn creates lower flood levels in the system. Therefore, the TUFLOW flood levels are behaving as expected noting the differences in tailwater at the highway and railway when compared against the SOBEK models as a result of the availability of field survey.

6.2.3 Flood Immunity Impacts

Table 6-8 below summarises the existing and proposed flood immunity, as well as the conformance evaluation for the project.

Table 6-8 – Summary of Flood Immunity and Conformance Evaluation

Location	Existing Immunity	Proposed Immunity	Required Immunity	Compliance (Y/N)
Pacific Highway – Johnson Road to Bridges over Wyong River	10 years	10 years	100 years	N
Pacific Highway - Bridges over Wyong River	100 years	100 years	100 years	Y
Pacific Highway - Bridges over Wyong River to North Road	100 years	100 years	100 years	Y
Pacific Highway - North Road to north of Cutler Drive	<1 year	10 years[1] 100 years[2]	100 years	N
South Tacoma Road	<5 years[3]	<5 years[3]	No worse than existing	Y
River Road	<5 years[3]	<5 years[3]	No worse than existing	Y
Panonia Road (to Howarth Street)	10 years	10 years	No worse than existing	Y
Cutler Drive	<1 year	1 year	No worse than existing	Y

Note:
[1] Through-lanes are not inundated in the 10 year ARI.
[2] Northbound carriageway is inundated in the 100 year ARI but median is not overtopped.
Maximum depth of ponding:
Lane 1 (turning lane) = 500 mm
Lane 2 = 300 mm
Lane 3 = 150 mm

[3] Based on flood results in Council's Wyong River Catchment Study (BMT WBM)

Modelling has suggested that the proposed Pacific Highway upgrade does not fully achieve the required 100 year ARI flood immunity as per Table 1-2. Refer to Appendix F.

The above table is intended as a guide to demonstrate that there is no reduction in flood immunity as a result of the upgrade. Further modelling of low ARI events will be undertaken at subsequent design stages to confirm final immunity provision.

At the North Road intersection, the flood modelling indicates some inundation of the westernmost trafficable lane for all ARI events assessed. However, this is as a result of the proposed longitudinal drainage system, which is designed to cater up to the 10 year ARI storm event, not being incorporated in the flood model for reduced complexity. In review of the 100

year ARI flood levels, there is a water level head difference of up 0.6 metres. Therefore, there is scope in the detailed design phase to consolidate the drainage in this area to provide greater flooding immunity in excess of the 10 year ARI and potentially up to the 100 year ARI.

At the Cutler Drive intersection, the flooding immunity on the highway is for the 10 year ARI event with no encroachment of the trafficable lanes. The central trafficable lanes are expected to be trafficable up to the 100 year ARI event. Due to high downstream flood levels at the Cutler Drive intersection, there is minimal scope to provide improved immunity using the longitudinal drainage. In the detailed design phase, there may be some scope to provide additional immunity by raising the highway at this location. However, this may be offset by additional upstream flood impacts which will then need to be mitigated and needs to be taken in to consideration.

The Cutler Drive crossing is expected to have a proposed flood immunity of 1 year ARI once the local longitudinal drainage is consolidated with the proposed design.

The flood immunity of River Road and South Tacoma Road is dictated by the overtopping level at the sag point located underneath the location of the existing highway bridge. The existing and proposed overtopping levels at the respective roads is summarised in Table 6-9.

Table 6-9 – Overtopping Level at River Road and South Tacoma Road

Location	Existing Overtopping Level (m AHD)	Proposed Overtopping Level (m AHD)
South Tacoma Road	1.1	1.2
River Road	1.1	1.1

Whilst it is noted that some sections of River Road and South Tacoma Road are located in cut, which causes it to be lower than the existing road, the critical overtopping level at the sag point is either unchanged or marginally higher. Therefore, the effective flood access immunity at these roads will not be any worse than that in the existing condition.

6.2.4 Effects on Probable Maximum Flood

Modelling indicates that there are flood level impacts on the Probable Maximum Flood (PMF).

Upstream of the highway, the peak flood level increases from between 0 millimetres to 120 millimetres. The extent of this flooding impact encroaches into some residential properties at the cul-de-sac in Ingram Street and several structures at the Central Coast Mobile Village. However, it is noted that whilst flood level increases are observed, the extent of the PMF flooding does not increase and therefore additional flood-prone properties are not generated as a result.

Upstream of the railway, there are minor increases in flood level of about 30 millimetres. Taking into consideration the magnitude of the PMF flooding event, this flood level increase at the railway is negligible as it doesn't cause additional overtopping.

Downstream of the railway, at the Wyong Racecourse and Showground, flooding impacts are not observed. Therefore, there are no additional PMF flooding impacts as a result of the Wyong Town Centre Upgrade in this area.

6.2.5 Effects on more Frequent Events

Modelling indicates no additional impacts on properties for the lower AEP events (1 year to 50 year ARI) both upstream and downstream of the highway.

Therefore the behaviour of the more frequent events are considered to be similar to that for the 1% AEP (100 year ARI) flooding event.

6.3 Impact on Rail Corridor

6.3.1 Wyong River

At Wyong River, there are no additional 1% AEP flooding impacts on the rail corridor as a result of upgraded Pacific Highway alignment and construction of the twin road bridges over Wyong River.

The Pacific Highway alignment lies to the upstream side of the Wyong River flooding and therefore shields the railway from the effects of raising the road.

The pavement surface drainage will be designed such that the railway corridor is not adversely affected beyond what is already experienced in the existing conditions. Additional surface water as a result of the highway upgrade is to be discharged into systems which divert water into Wyong River and therefore the railway is not directly affected at this location.

6.3.2 Wyong Town Centre

At Wyong Town Centre, there are no significant 1% AEP impacts on the rail corridor as a result of the upgraded Pacific Highway alignment and associated drainage works.

The railway generally experiences a reduction in upstream water levels along the drainage channel between the highway and the railway. The large proportion of the overtopping flows at the Cutler Drive intersection is now conveyed through the four banks of culverts (C1690, C1800, C1940 and C2100) distributed along the highway.

At proposed culvert C1940, there is a minor increase in water level of 20 millimetres. However, considering the existing depth of flooding and the extent of the level increase, this is regarded as negligible. The railway remains immune to the 1% AEP at this location in the proposed conditions and the top of rail formation is not expected to be affected beyond existing conditions.

The flooding assessment already takes into account the additional surface water runoff as a result of the larger impervious pavement area due to the road widening.

6.3.2.1 Effects on more Frequent Events

For events more frequent than the 1% AEP (100 year ARI), there are increases in water level upstream and downstream of the railway corridor. Since the Wyong Town Centre culvert system has been sized to convey the 1% AEP flows, to offset any impacts caused by the road upgrade, the changes to impacts to the flooding conditions in more frequent events are expected.

The flood impacts at the railway are summarised in Table 6-10.

Table 6-10 – Summary of Impacts at Rail Corridor at Wyong Town Centre

	Peak Flood Level Difference (mm)					
Location	**1 year ARI**	**5 year ARI**	**10 year ARI**	**50 year ARI**	**100 year ARI**	**PMF**
Upstream of railway	370	250	160	60	<10	20
Downstream of railway	80	110	100	30	<10	20

It can be seen from the results that the 1% AEP and PMF flood level impact is of a lower magnitude, of less than 20 millimetres, and shows that the difference between the existing and proposed conditions are minimal.

For more frequent events, it can be seen that the peak flood level impacts increase the more frequent the event is. Due to the added conveyance capacity as a result of the proposed culvert upgrades, which has been sized for the 1% AEP event, the peak flow arriving at the railway corridor is higher than in the existing conditions.

However, it should be noted that the flood level increases are confined to existing flooded areas, specifically the upstream channel at the railway and the existing watercourse between Wyong Racecourse and Wyong Golf Course. Therefore, the overall effect of these increases are not expected to be significant as no additional properties are affected as a result. The 1% AEP impact on the railway corridor is below 10 millimetres and is therefore still in compliance with the requirements.

As highlighted in Section 7.2, the effect of the flood impacts in more frequent events on drainage infrastructure should be considered in the detailed design phase.

6.4 Impacts on Wyong Racecourse and Wyong Golf Course

In review of the flooding impact maps for all of the storm events assessed, the Wyong Racecourse is shown to not experience any adverse impacts as a result of the Wyong Town Centre upgrade. Flooding impacts in the near vicinity are confined to the existing channel downstream of culvert C1690 and C1940 and are not expected to cause any worsening of flooding at the location of the racecourse buildings and racecourse. However, for the detailed design stage, it is recommended that the existing drainage infrastructure within Wyong Racecourse be assessed for the more frequent flooding events to confirm that the it is not affected by the minor increases in flood level in the channel.

At the Wyong Golf Course some flood level impacts (in events more frequent than 1% AEP), of up to 100 millimetres, are expected at the southern end of the course. This is as a result of the flooding level increases within the watercourse downstream of C1940 and C2100. In review of the PMF flood extent, there is no change to the flood-prone category for the Wyong Golf Course, as it is flooded in both the existing and proposed cases. For the more frequent events, the golf course is expected to retain a flood-free surface to the north as the terrain increases significantly when compared against the levels for the watercourse towards the southern edge. Therefore, flood access from the Wyong Golf Course is not expected to

change as a result of the Wyong Town Centre upgrade.

Overall, the flooding impacts for the Wyong Racecourse and Wyong Golf Course are regarded as minimal as the existing flood access is expected to be retained.

6.5 South Tacoma Road Culvert

The South Tacoma Road culvert was assessed for the 1% AEP event in DRAINS by application of the design flows calculated from WBNM. This design flow includes flow from the proposed longitudinal drainage network.

A plan layout of the DRAINS 1% AEP results is presented in Figure 6-7.

The proposed pipe culverts are capable of conveying the 1% AEP flow without the upstream headwall being overtopped. It is to be noted that this includes an allowance for blockage of greater than 10 per cent. Flows are predicted to remain within the drainage channel feeding into the culvert.

For more frequent flooding events, the behaviour is expected to be the same as that for the 1% AEP event. That is, will be contained within the proposed drainage channels and are then conveyed through the culvert system towards Wyong River without surcharge.

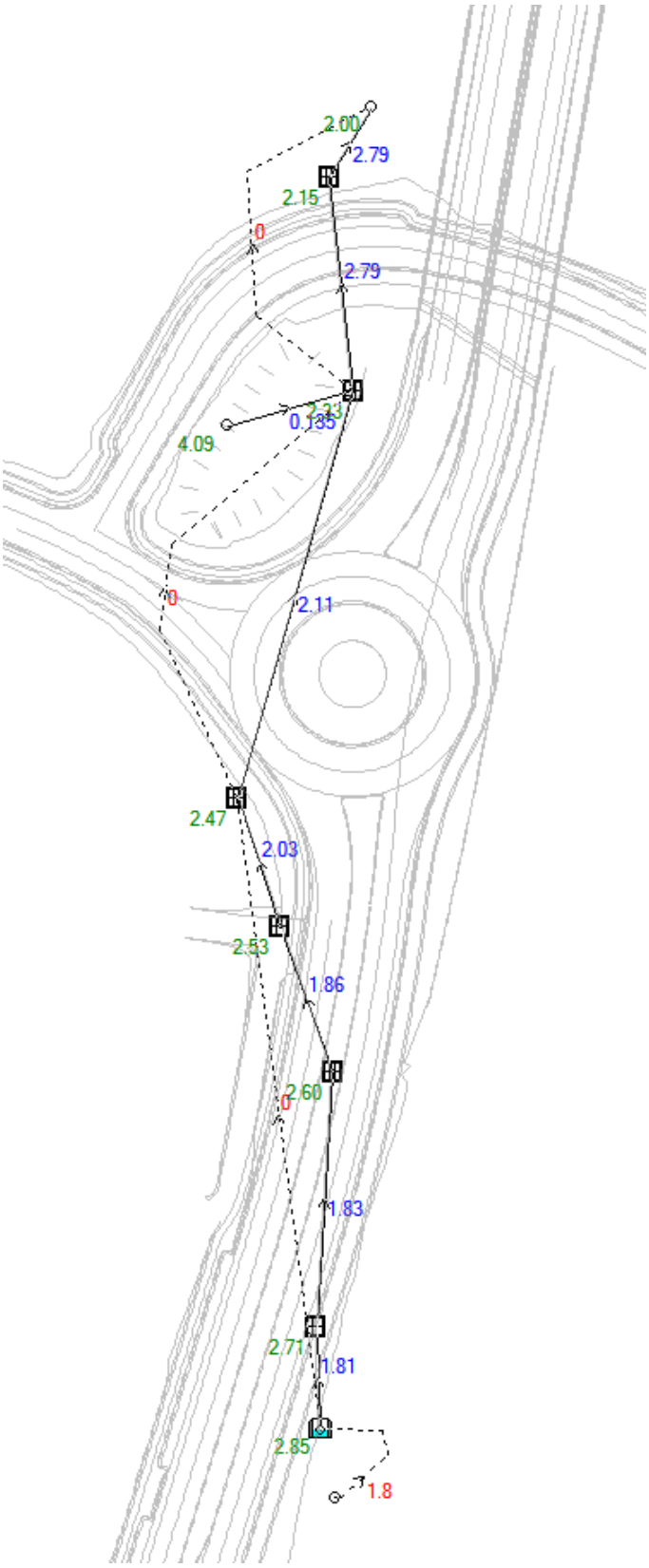


Figure 6-7 – 1% AEP flows for South Tacoma Road DRAINS model

6.6 Future Railway Duplication at Wyong River

Although not within the scope of works of the Wyong Town Centre Upgrade, additional hydraulic modelling was undertaken to investigate the potential impacts for the future railway bridge upgrade on Wyong River for the 1% AEP event. The assumed arrangement for hydraulic modelling of the Wyong River Railway Bridge upgrade is shown in Figure 6-8, where new single rail over-bridges will be installed on each side of the existing double rail bridge across Wyong River.

Preliminary modelling indicates that as a result of the assumed future railway bridge upgrade, there will be a localised increase in water level up to 90 millimetres upstream of the Wyong River Bridge with no additional impacts on properties.

It is noted that the area immediately upstream of the upgraded railway bridge, underneath the existing highway bridge, shows a net decrease in flood level. However, this is as a result of the demolition of the partially submerged existing highway bridge. Overall, the railway duplication works will cause impacts above and beyond that created by the Wyong Town Centre Upgrade.

Refer to the figures presented in Appendix A for the railway duplication results.

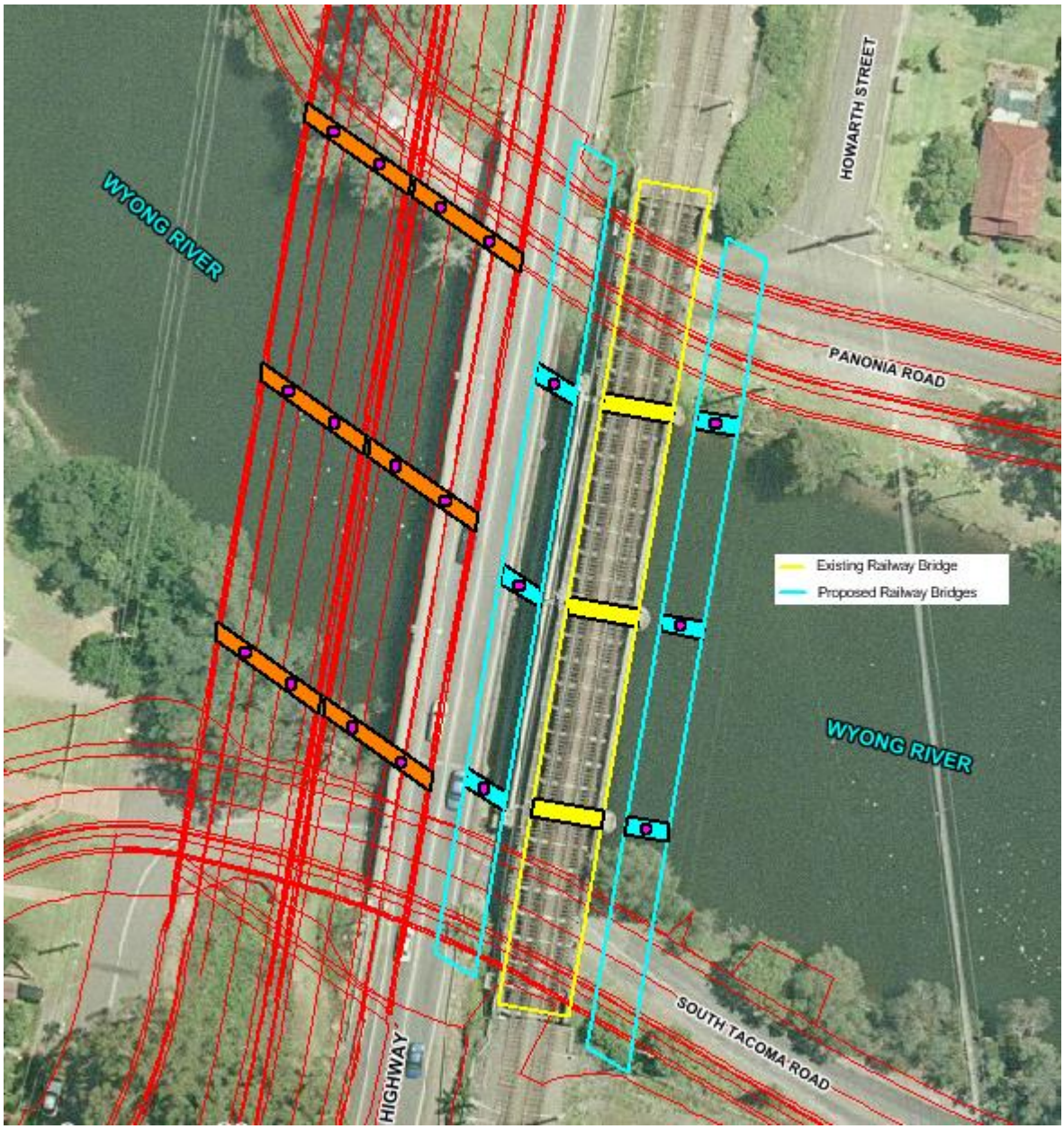


Figure 6-8 – Assumed Arrangement of Future Railway Duplication at Wyong River

6.7 Bridge Scour and Erosion Protection

6.7.1 Scour Type

The hydraulics through the twin bridges over Wyong River, including flows, velocities and water surface profiles, have been examined using the two dimensional TUFLOW hydraulic model. Using these hydraulic parameters, depths of scour can be estimated for the bridge main channel, piers and abutments. The total scour at the bridge crossing comprises contraction scour and local scour at piers and abutments:

- **Contraction scour** is the scour caused by the contraction of the floodplain flow through the bridge opening, and depends on the flow velocity, depth, and grain size of the soil under the bridge. For bridges over river channels, contraction scour is highest in the main channel area, and much lower in the overbank areas where velocities are lower. Contraction scour can be either clear water scour (with scoured material not being replaced by bed load from upstream), or live bed scour (assuming that the bed is mobile and that scour holes are continuously refilled by bed-load material from upstream).
- **Abutment scour** is dependent on the length of embankment projecting into the flow at each abutment, the depth of flow at each abutment, and the flow velocities at the abutment toe.
- **Pier scour** is caused by localised flow patterns around the piers, and depends on factors such as pier shape, depth, flow velocity and pier configuration. Other important factors are pier width and angle to the flow. For complex pier arrangements, differing scour components are caused by the pier stem, pile cap and pile group.
- **General scour** is the general aggradation or degradation of the watercourse not as a result of obstructions. Creeks without obstructions, such as a bridge, will scour to this level. Contraction scour and local scour depths calculated from this level.

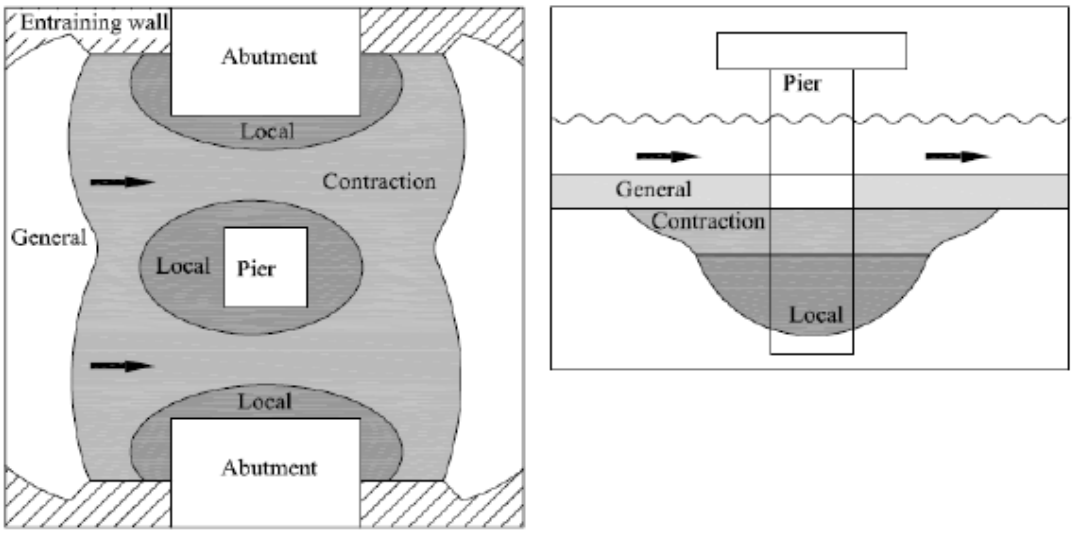


Figure 6-9 – Types of Scour at a Bridge (Whitbred et al, 2000)

These three scour components are combined to estimate the total scour at a bridge, as shown in Figure 6-9. Procedure and scour estimation equations used in this analysis are HEC-18 (2001).

6.7.2 Scour Evaluation by HEC-18 (2001) in Sand/Gravel Bed Streams

Scour depths for the abutments, main channel and piers of the bridge have been estimated in accordance with the procedures outlined in the U.S. Department of Transportation Hydraulic Engineering Circular No. 18 (HEC 18, 2001). The techniques in this document have been developed for non-cohesive material.

The erosion of non-cohesive sediments depends on factors such as the grain size distribution, the shape and the density of individual grains.

6.7.3 Total Scour Depth Calculation Methodology

The scour depth for the 100 year ARI and 2000 year ARI events have been calculated using HEC-18. The size of rock rip rap protection has been calculated using HEC-23 Volume 2 - Design Guideline 14: Rock Riprap at Bridge Abutments.

Scour depths were calculated for the 2000 year ARI event that is required for the Ultimate Limit State analysis for the bridge.

Borehole logs show that the soils are generally made up of a mixture of cohesive and non-cohesive soils. The logs show a transition from fine sands, near the surface, to sandstone/shale beyond three metres depth. The scour depth has been calculated based on a D_{50} grain size of 0.2 mm, which is within the range for fine sands. The scour depth is limited to the lesser of either the total predicted scour depth or at the interface of the sandstone rock layer.

6.7.4 Bridge Scour Depths

Bridge scour depths as determined through the calculations are summarised in Table 6-11 and Table 6-12.

It should be noted that the scour depths presented are with the assumption that the adopted soil grain size extends indefinitely. However, in reality the scour depth will be limited once the bed rock level is approached. Structural and geotechnical design of the bridge foundations should take into account the limiting rock depth.

The total scour depth specified for structural design is the sum of the contraction scour and the largest local scour component (either pier or abutment).

Table 6-11 – 100 year ARI Bridge Scour Depth Summary

Bridge	100 year ARI Bridge Scour Depth (m)				
	Contraction	Local (Pier)	Local (Abutment)	Total (Pier)	Total (Abutment)
Twin Bridges over Wyong River	0.73	4.51	1.80	5.24	2.53

Table 6-12 – 2000 year ARI Bridge Scour Depth Summary

Bridge	2000 year ARI Bridge Scour Depth (m)				
	Contraction	Local (Pier)	Local (Abutment)	Total (Pier)	Total (Abutment)
Twin Bridges over Wyong River	2.88	4.92	2.60	7.80	5.48

7. CONCLUSION & RECOMMENDATIONS

This SMEC report has assessed the hydraulic impact of the Wyong Town Centre Upgrade. This includes the construction of the proposed road embankment, major transverse drainage structures and the proposed twin road bridges over Wyong River.

7.1 Design Recommendations

Design recommendations below were made with regards to improving the design to minimise hydraulic impacts due to the proposed upgrade. However, feasibility and cost-benefit analyses should be considered in combination with the advice below to provide an acceptable solution.

7.1.1 Flood Mitigation Measures

7.1.1.1 Existing car yard at 200-202 Pacific Highway, Tuggerah and McPherson Road

Flood mitigation measures are not required at this location.

The car yard at 200-202 Pacific Highway, Tuggerah experiences some minor afflux of up to 30 millimetres. However, it should be noted that this lot has been indicated for property acquisition by Roads and Maritime. Therefore, flood mitigation measures will not be necessary as this impact will be contained within the public reserve.

The impact over McPherson Road, observed to be approximately 100 millimetres, falls within the Council road reserve. This is within the 300 millimetres impact limit that has been nominated for Council land (i.e. not at properties) as per Table 1-1. Therefore, flood mitigation measures are not necessary for this area.

7.1.1.2 Excavation at 204-206 and 210 Pacific Highway, Tuggerah

The removal of the existing drainage channel along South Tacoma Road and the construction of the new roundabout intersection at McPherson Road causes adverse flood level impacts, greater than 10 millimetres, that propagate up to a kilometre into the buildings in the south-westerly direction.

To offset the flood level impacts, it is necessary to demolish the existing buildings and grade the terrain at 204-206 and 210 Pacific Highway, Tuggerah. With the current arrangement of the McPherson Road roundabout, the buildings at this location are already proposed to be demolished. The existing building pads need to be excavated down such that there is grading between McPherson Road and the Wyong River, such that flood water can be conveyed towards the river.

As a result of the flood mitigation building demolition and excavation works, 100 year ARI flood level impacts are confined to below 10 millimetres at the properties south-west of the McPherson Road roundabout intersection.

The extent of the required excavation is shown in Figure 7-1. A typical section showing the intention of the excavation is shown in Figure 7-2.

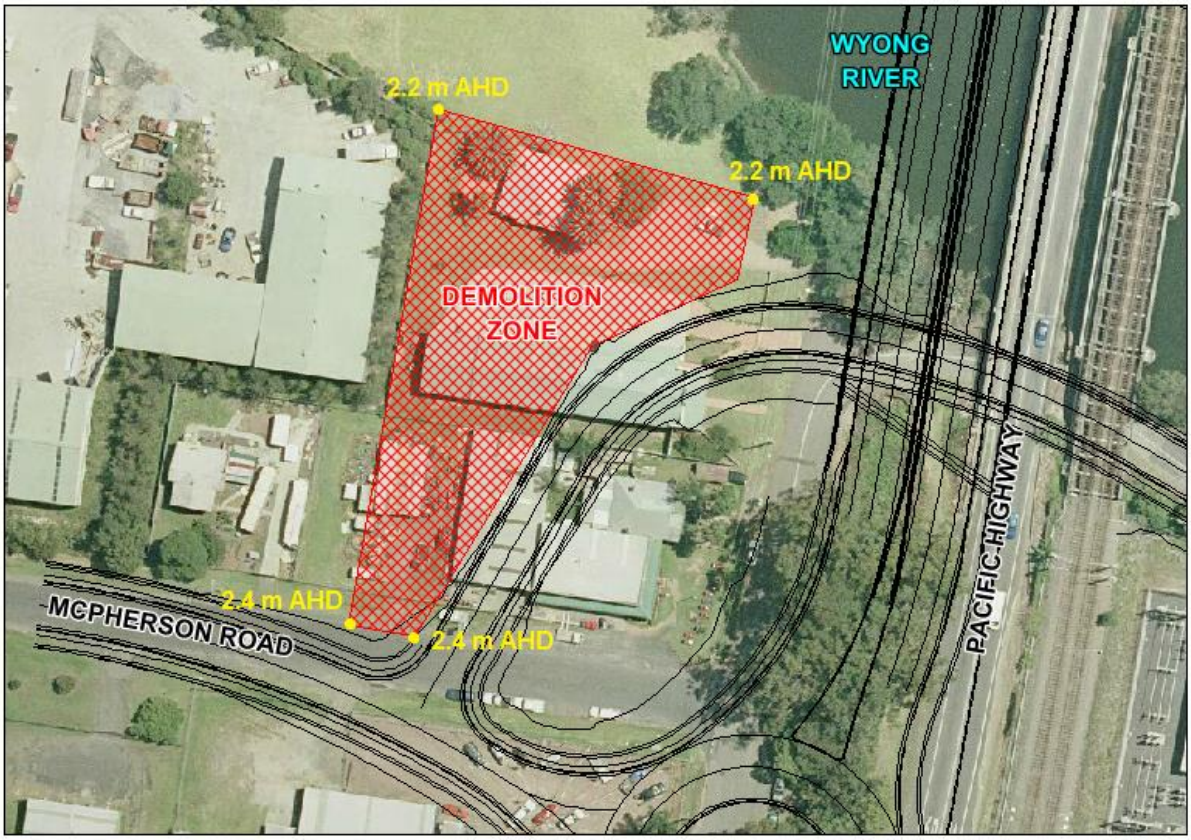


Figure 7-1 – Proposed Excavation at 204-206 and 210 Pacific Highway, Tuggerah

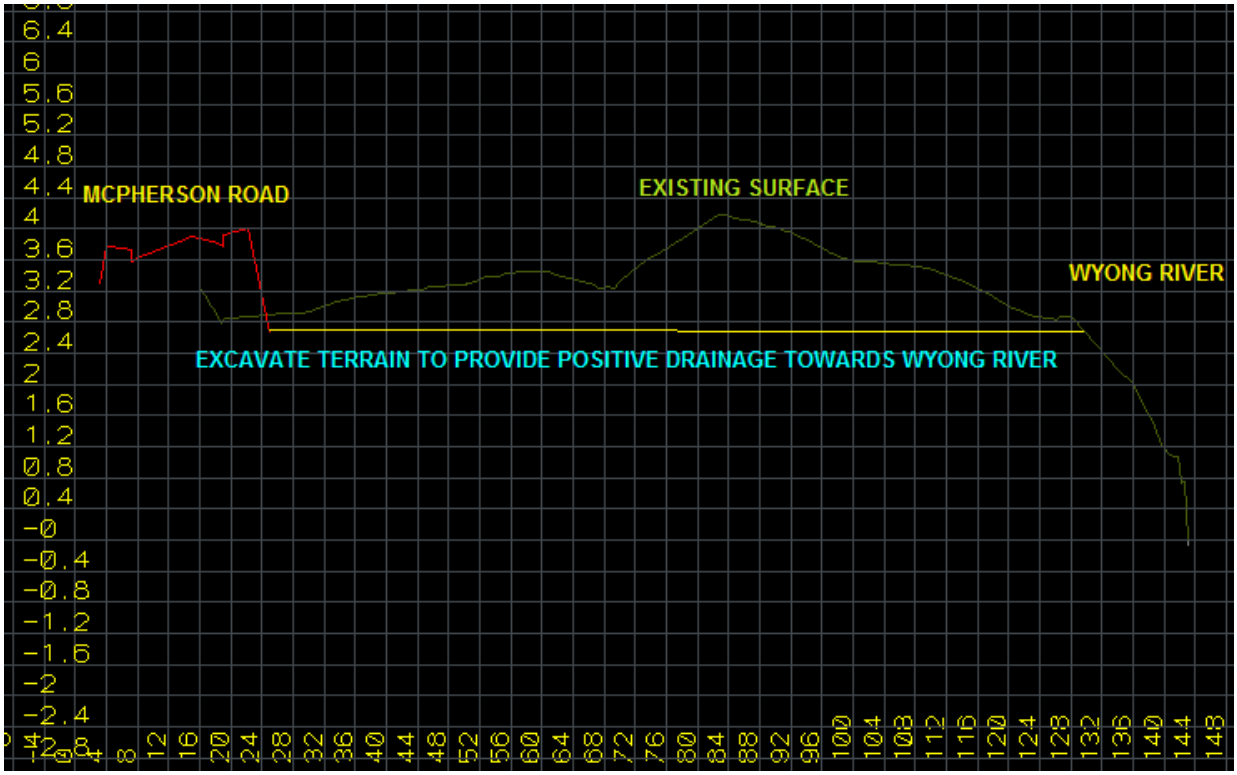


Figure 7-2 – Typical Section of Proposed Excavation at 204-206 and 210 Pacific Highway, Tuggerah

7.1.2 Wyong Town Centre Culverts at Pacific Highway and Main North Line Railway

The required culverts presented in the previous sections have been determined on the assumption that new drainage structures will only be constructed along the upgraded Pacific Highway alignment for the Wyong Town Centre Upgrade project. It does not take into account future widening of the existing railway.

The flood levels upstream to the Pacific Highway, along Apex Park, is largely controlled by the culverts across both the highway and existing railway. This drainage system includes the channel between the highway and railway which operates as flood storage in the current conditions. Future widening of the railway will need to cater for the loss of the above flood storage.

7.1.2.1 Future Railway Widening

If the existing Main North Railway Line is widened at the location of Apex Park, the following items will need to be considered:

- Loss of the drainage channel between the road and railway
- Construction of new railway culverts to suit the upgraded culverts at the Pacific Highway, constructed for the Wyong Town Centre Upgrade, to minimise upstream impacts.
- Constructability of culverts and transition structures at the railway

To optimise the required number of transverse culverts across the highway and railway, to account for a future railway widening, it may be feasible to consider upgrading the railway drainage at the same time as the Wyong Town Centre Upgrade.

If the culverts under the railway are upgraded, then it is expected that upstream flood levels will be reduced as a result. The number of highway culverts required to minimise upstream flood impacts will be lower than that currently presented as the adopted option in this report.

7.2 Further Work

Items for consideration at detailed design include:

- Condition survey of existing culverts which are to be retained
- Field survey along the road corridor is available. This information has not been included in the Wyong River TUFLOW model to prevent alteration to the Council-approved flood levels. A review of the effect of this additional survey should be conducted to check whether this information will enhance the understanding of flooding in this area.
- Flood impacts in more frequent events, including the 20% and 10% AEP events, may require assessment for the Wyong River TUFLOW model.
- The consolidation of the longitudinal drainage with the transverse drainage should be carried out to mitigate minor design departures reported in this assessment.
    - Flood immunity at the North Road intersection
    - Flood immunity at the Cutler Drive intersection
- The effect of flooding impacts in storm events more frequent than the 1% AEP on existing drainage infrastructure should be considered for effective drainage.
- The design of scour protection should be considered in the detailed design based on the final pier and abutment arrangement. Any scour protection should be developed in consultation with Fisheries NSW.
- Incorporation of structures to minimise blockage potential of culverts should be considered.

8. REFERENCES

Cardno (NSW/ACT) Pty Ltd (Cardno) 2014, *Wyong CBD Trunk Culvert – Flood Impact Assessment*, Cardno, St Leonards, NSW.

Bradley, J N 1978, *Hydraulics of Bridge Waterways*, Dept. of Transportation, Federal Highway Administration (FHWA), Washington, D.C.

BMT WBM Pty Ltd (BMT WBM) 2014, *Wyong River Catchment Flood Study – Draft Report*, BMT WBM, Broadmeadow, NSW.

Bureau of Meteorology (BOM) 2014, *AR&R87 IFDs: Intensity-Frequency-Duration: Design Rainfalls*, BOM, viewed 25 March 2014, http://www.bom.gov.au/water/designRainfalls/ifd-arr87/index.shtml

Department of Environment, Climate Change and Water (DECCW) 2010, *NSW Climate Impact Profile*, DECCW, Sydney, NSW.

Department of Environment, Climate Change and Water (DECCW) 2007, *Practical Consideration of Climate Change Guideline*, DECCW, Sydney, NSW.

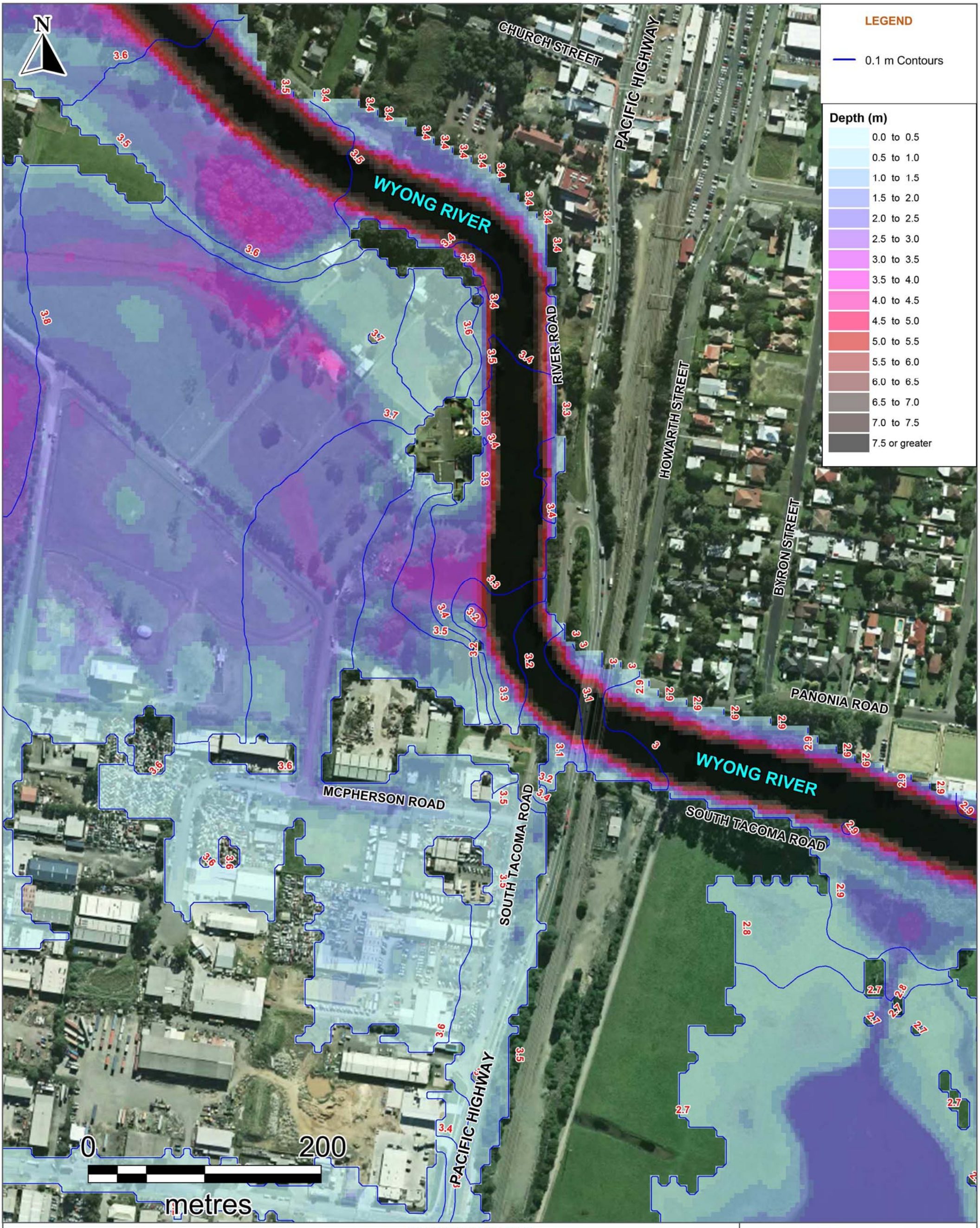
Fairfull, S 2003, *Fish passage requirements for waterway crossings*, NSW Fisheries, Cronulla, NSW

Pilgrim, D H (ed.) 1987, *Australian Rainfall and Runoff: A Guide to Flood Estimation,* Vol. 1, 1987 edn, The Institution of Engineers, Australia, Barton, ACT.

Pilgrim, D H (ed.) 1987, *Australian Rainfall and Runoff: A Guide to Flood Estimation,* Vol. 1, reprinted 2001 edn, The Institution of Engineers, Australia, Barton, ACT.

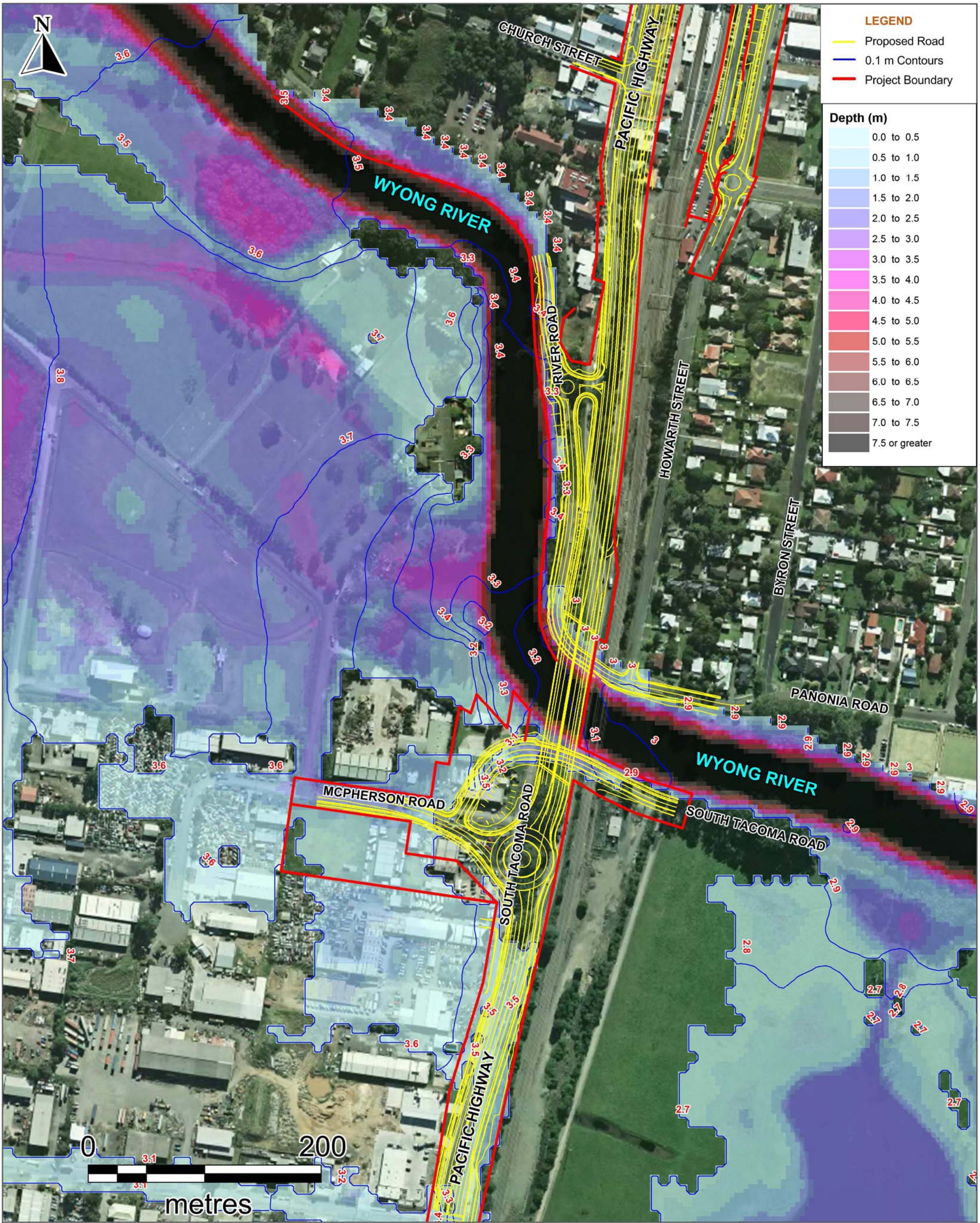
APPENDIX A: FLOOD MAPS

Page intentionally left blank



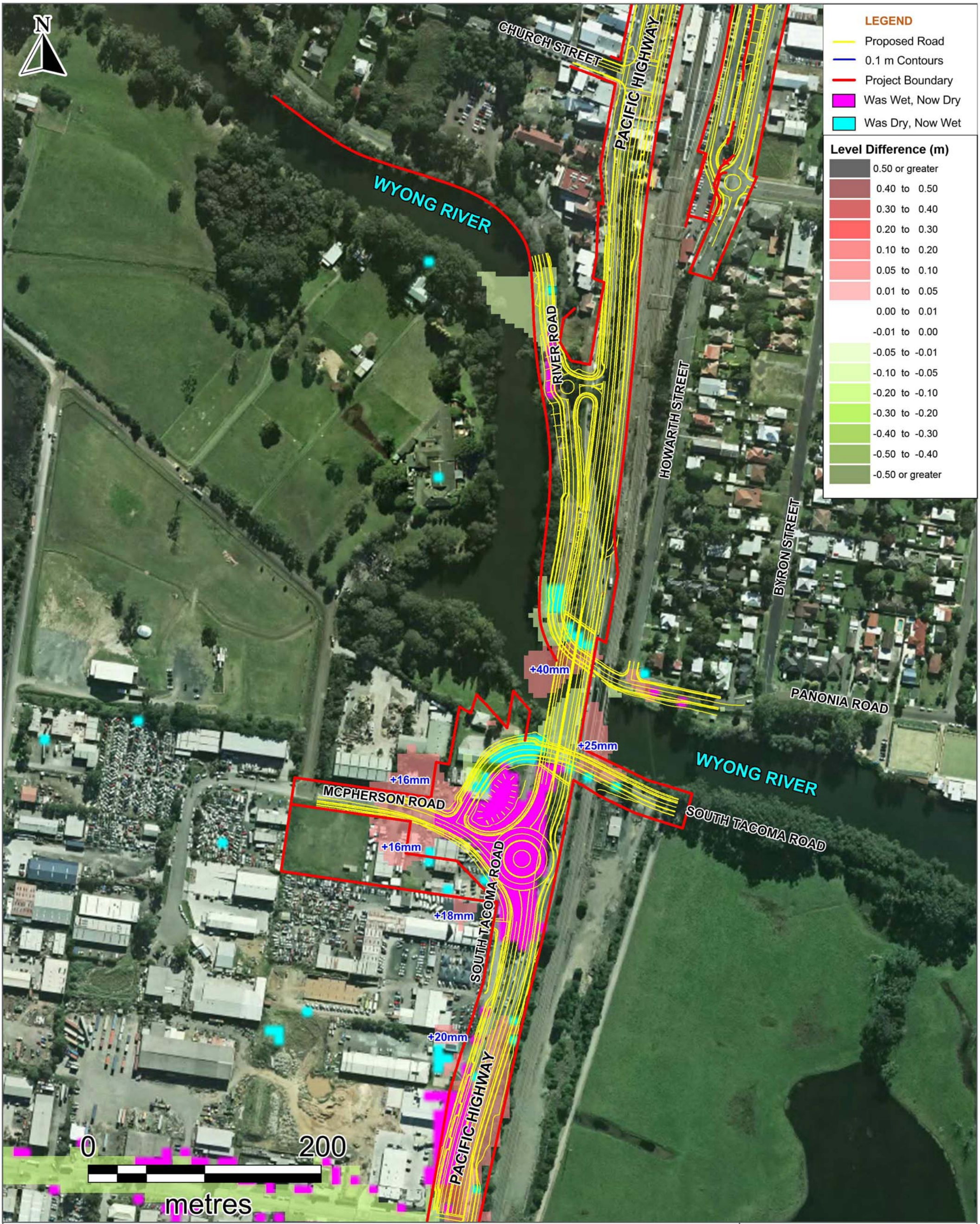
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1A-20y36h	**FIGURE TITLE**	Wyong River - Existing Water Surface Level and Flood Depth (At Wyong River Bridge) 20 Year ARI 36 hour Duration Flood Event - 20 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



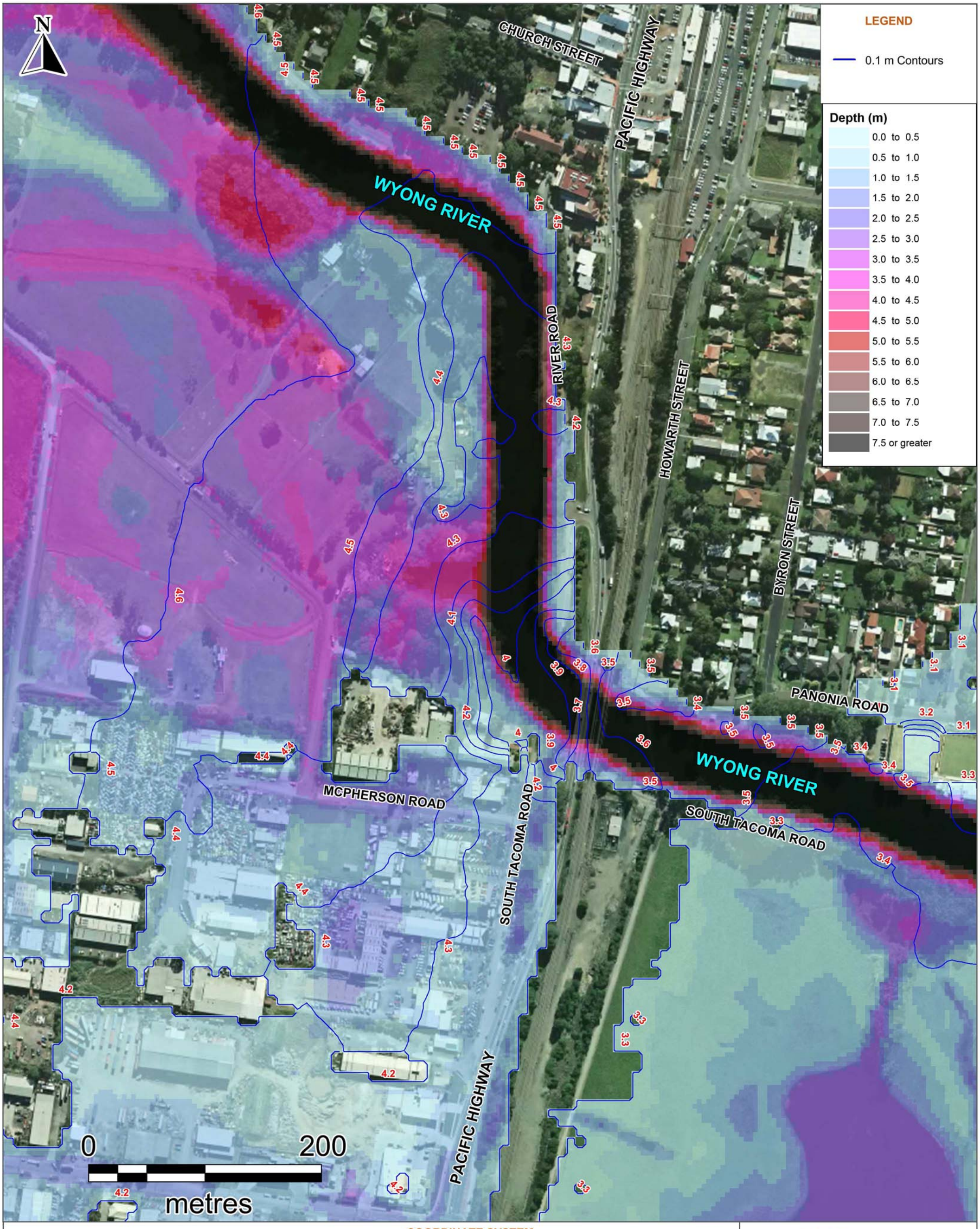
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-20y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (At Wyong River Bridge) 20 Year ARI 36 hour Duration Flood Event - 20 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



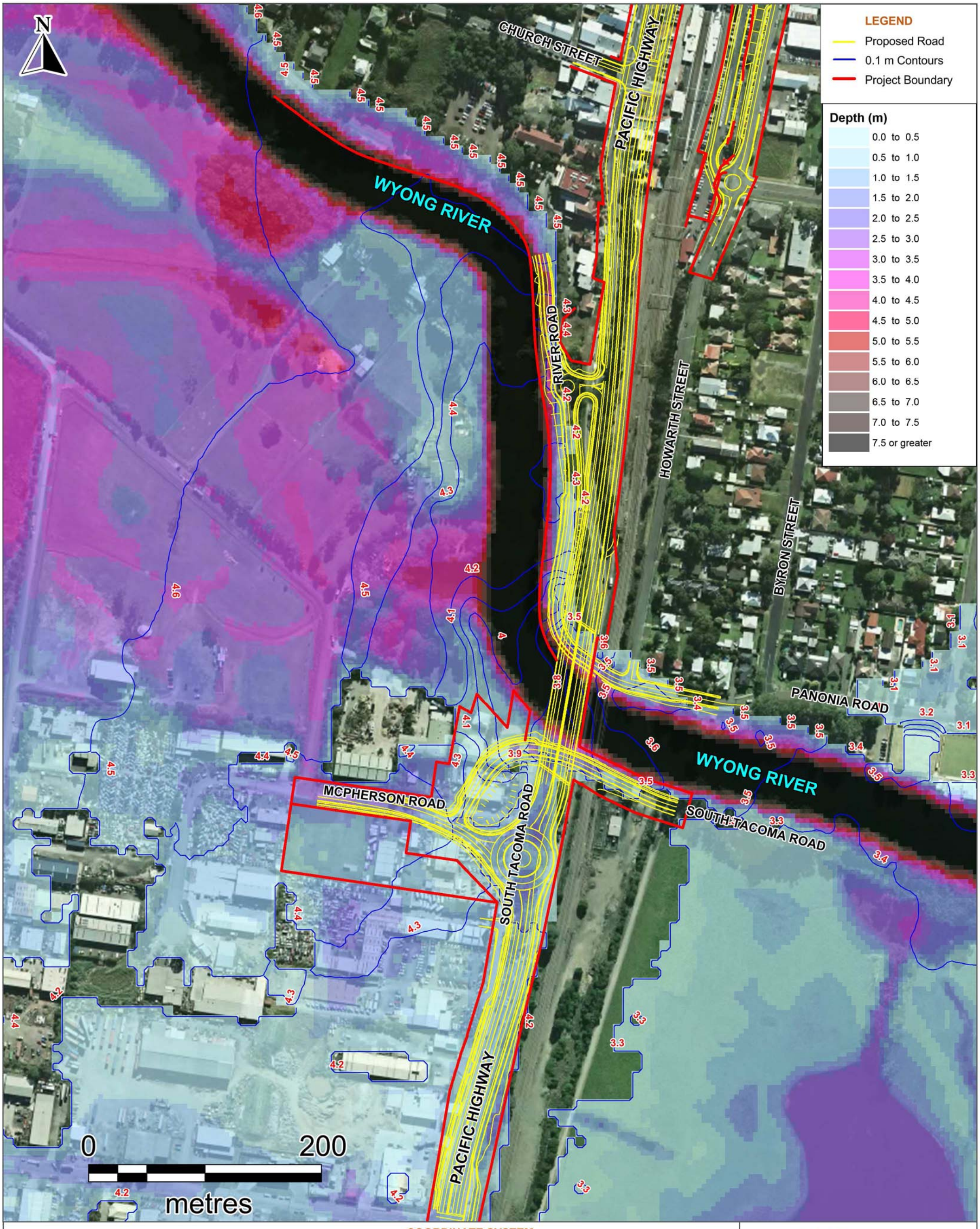
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1C-20y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level Difference (At Wyong River Bridge) 20 Year ARI 36 hour Duration Flood Event - 20 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



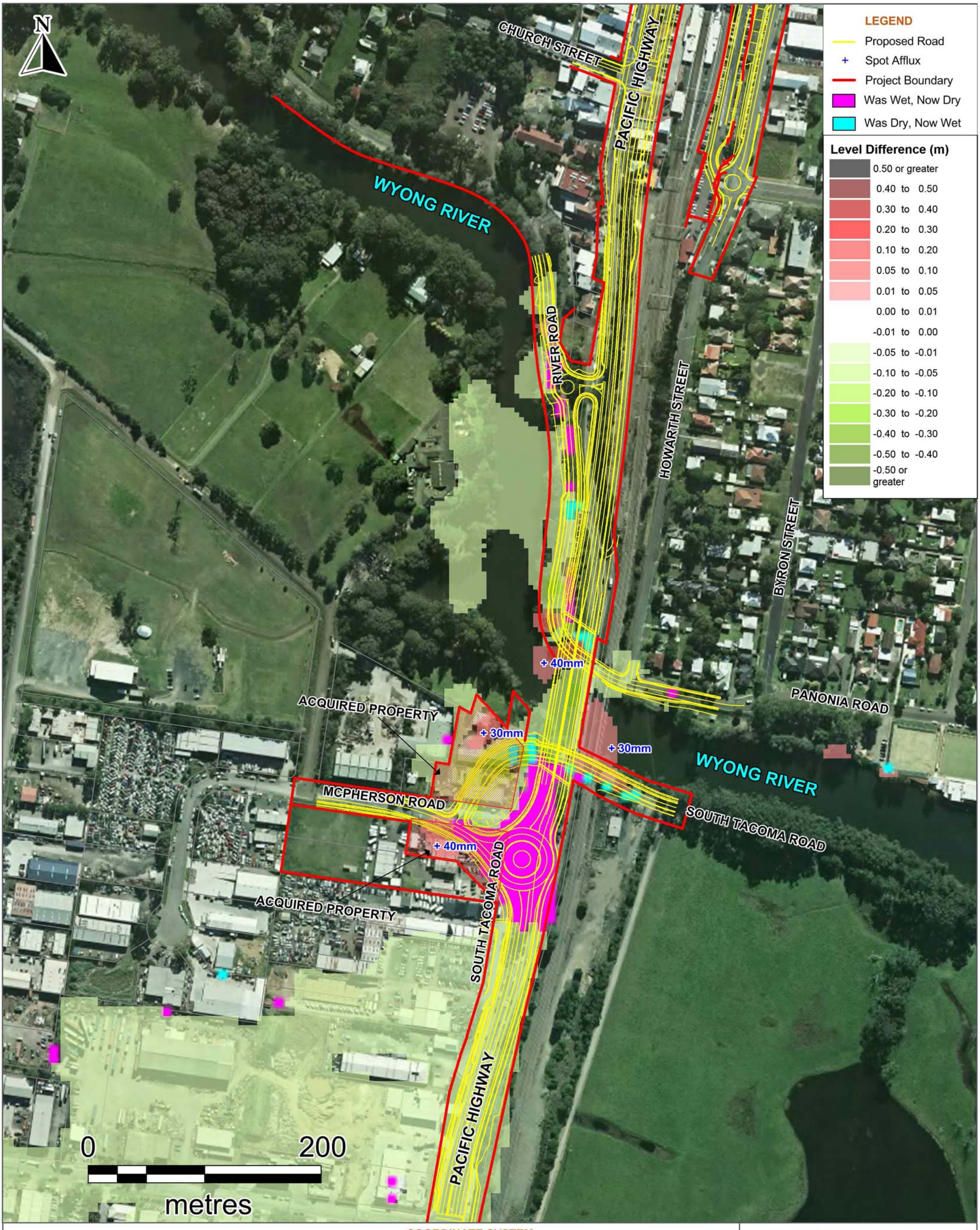
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1A-100y36h	**FIGURE TITLE**	Wyong River - Existing Water Surface Level and Flood Depth (At Wyong River Bridge) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



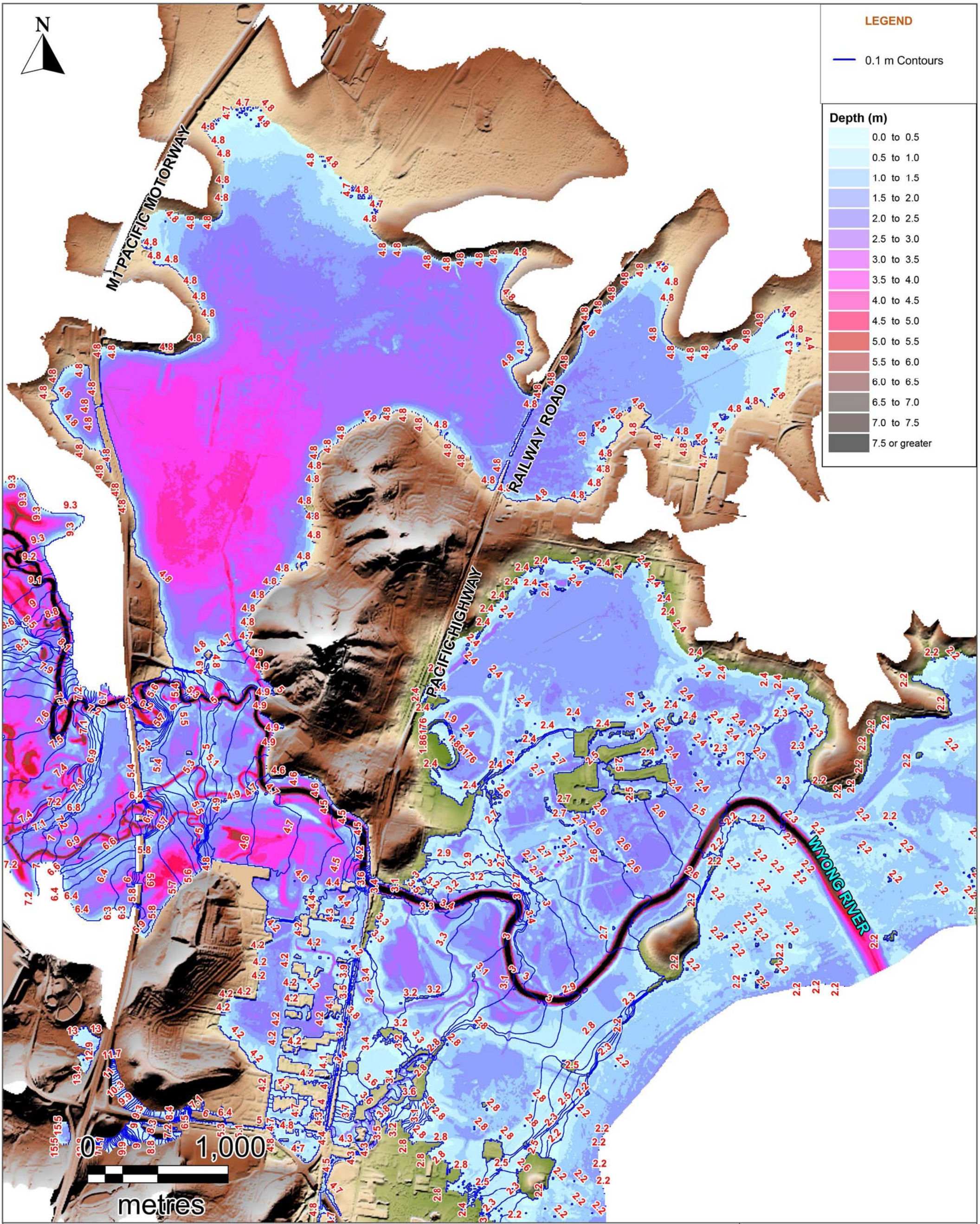
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-100y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (At Wyong River Bridge) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1C-100y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level Difference (At Wyong River Bridge) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1D-100y36h	**FIGURE TITLE**	Wyong River - Existing Water Surface Level and Flood Depth (Catchment Wide) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

LEGEND

- Proposed Road
- 0.1 m Contours
- Project Boundary

Depth (m)

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 3.0
- 3.0 to 3.5
- 3.5 to 4.0
- 4.0 to 4.5
- 4.5 to 5.0
- 5.0 to 5.5
- 5.5 to 6.0
- 6.0 to 6.5
- 6.5 to 7.0
- 7.0 to 7.5
- 7.5 or greater

0 1,000

metres

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1E-100y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (Catchment Wide) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC

Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

LEGEND

- Proposed Road
- 0.1 m Contours
- Project Boundary
- Was Wet, Now Dry
- Was Dry, Now Wet

Level Difference (m)

- 0.50 or greater
- 0.40 to 0.50
- 0.30 to 0.40
- 0.20 to 0.30
- 0.10 to 0.20
- 0.05 to 0.10
- 0.01 to 0.05
- 0.00 to 0.01
- -0.01 to 0.00
- -0.05 to -0.01
- -0.10 to -0.05
- -0.20 to -0.10
- -0.30 to -0.20
- -0.40 to -0.30
- -0.50 to -0.40
- -0.50 or greater

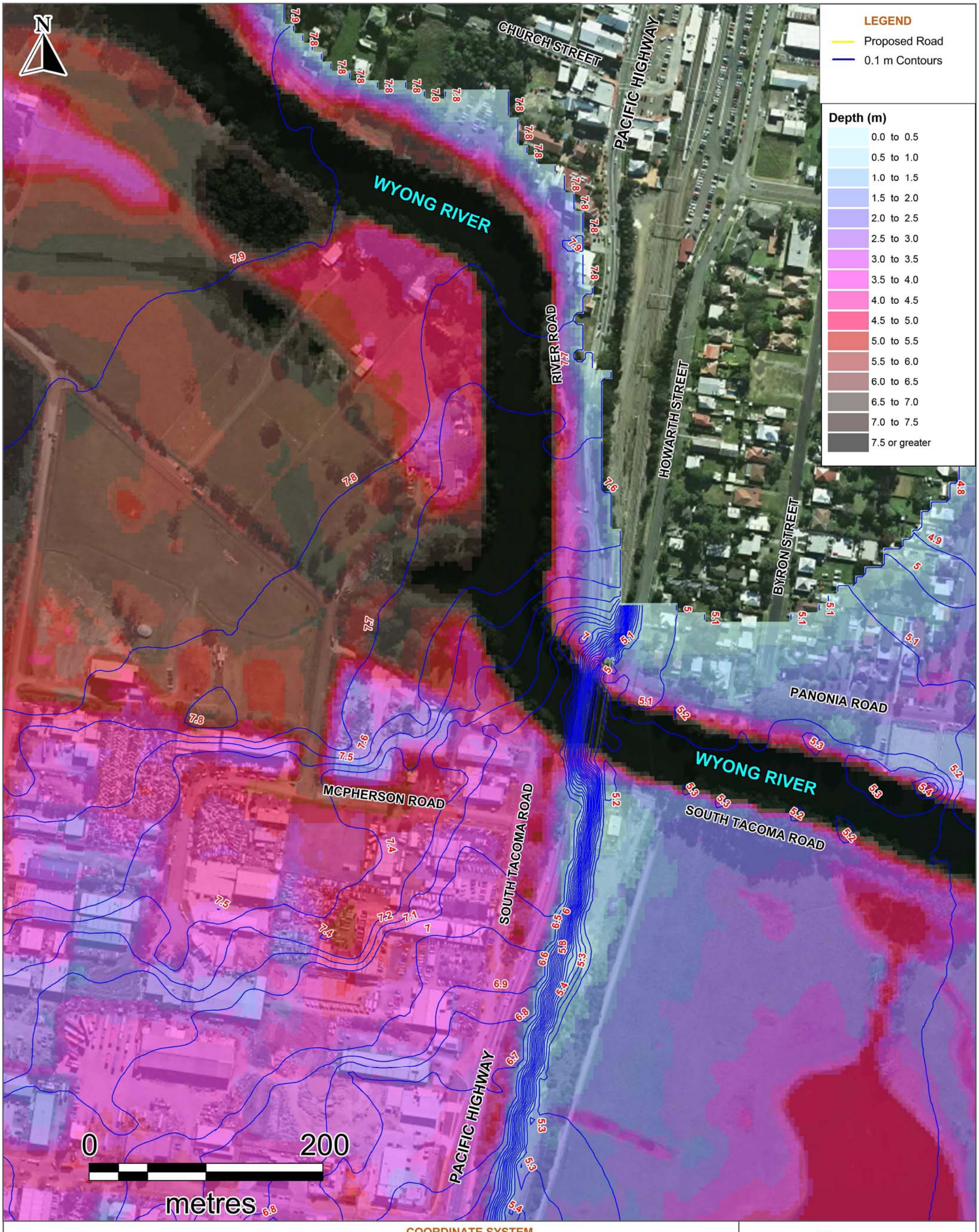
0 1,000

metres

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1F-100y36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level Difference (Catchment Wide) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

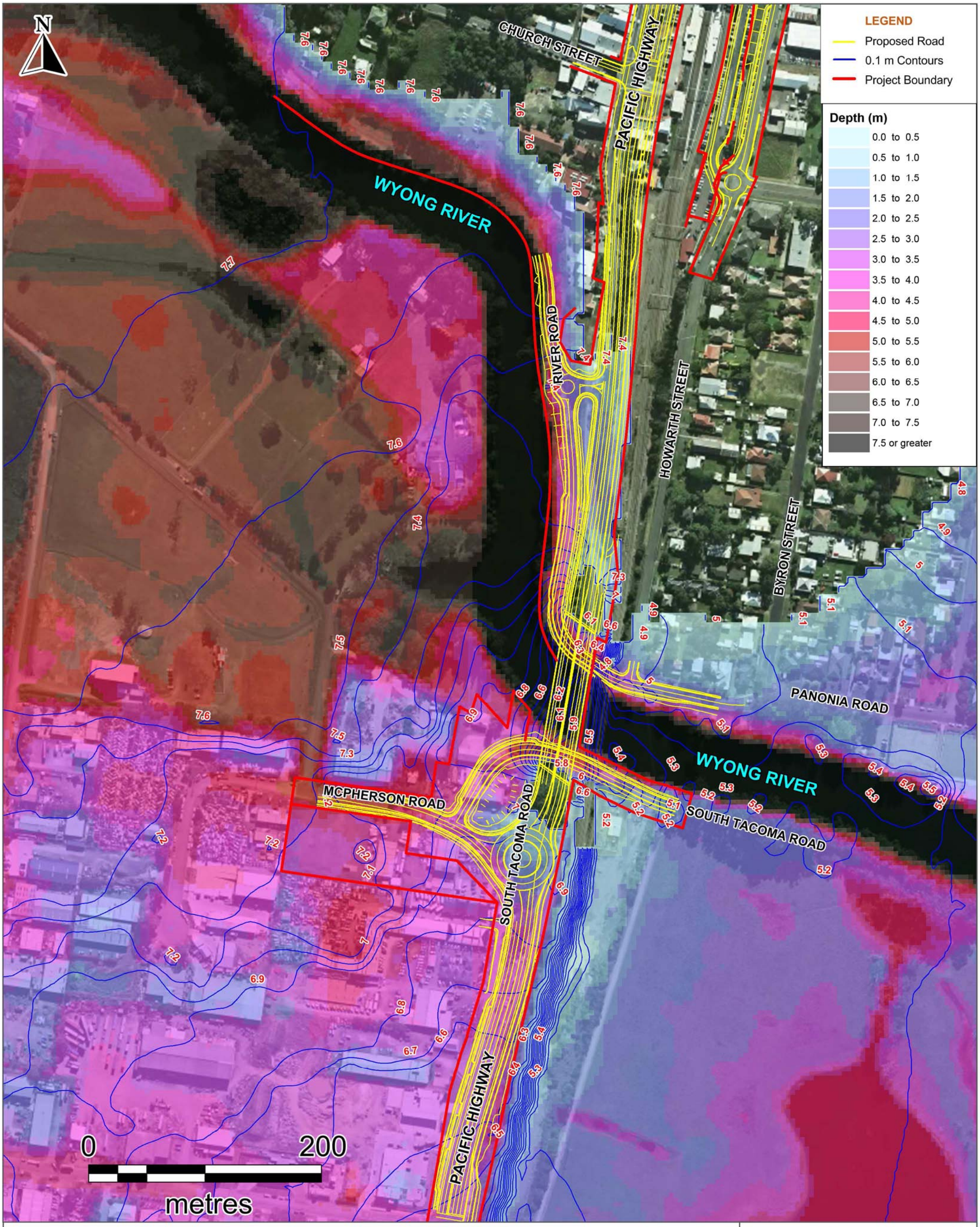
SMEC

Local People. Global Experience.



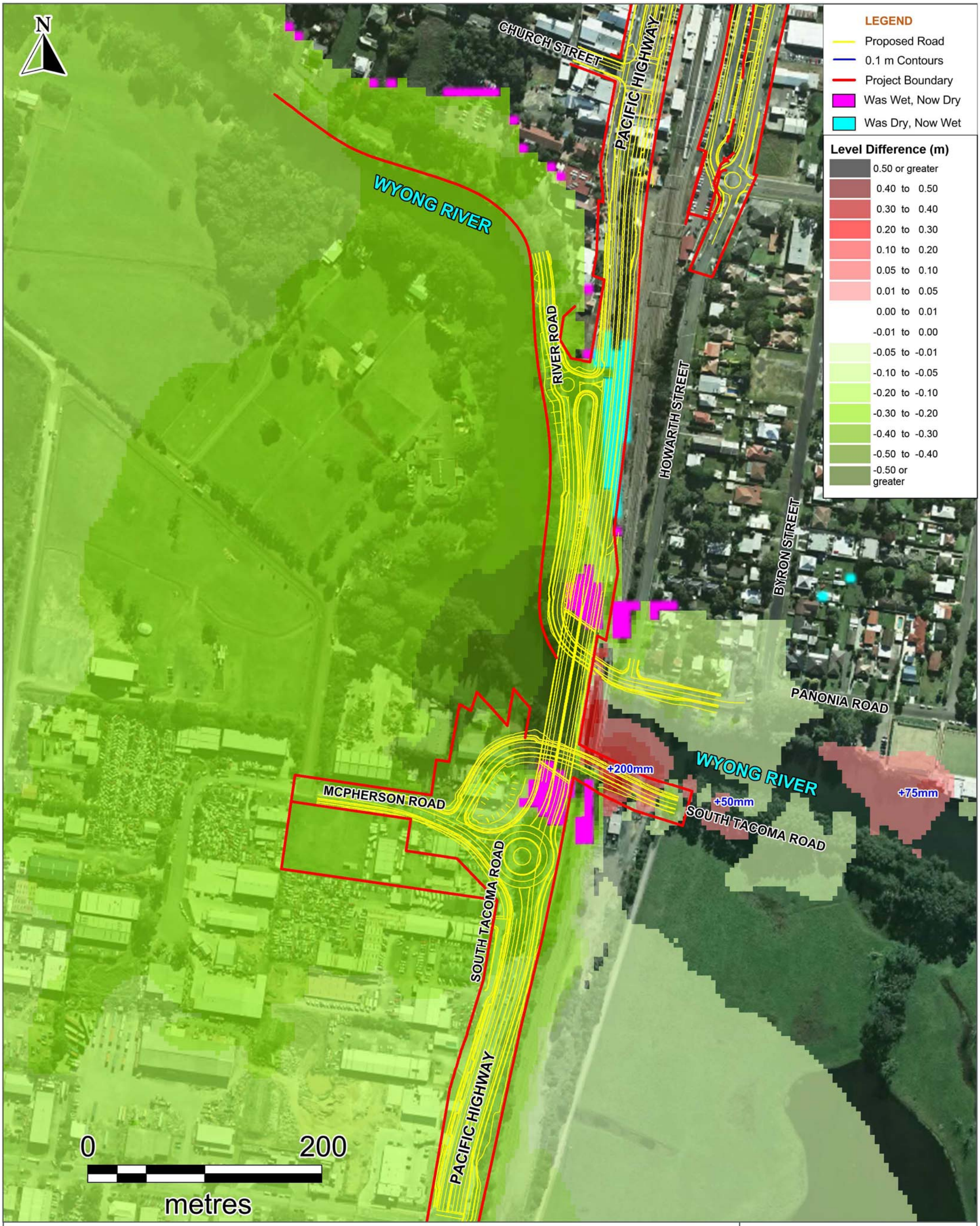
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1A-PMF24h	**FIGURE TITLE**	Wyong River - Existing Water Surface Level and Flood Depth (At Wyong River Bridge) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-PMF24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (At Wyong River Bridge) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1C-PMF24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level Difference (At Wyong River Bridge) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

0 1,000

metres

LEGEND

Proposed Road

0.1 m Contours

Depth (m)

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 3.0
- 3.0 to 3.5
- 3.5 to 4.0
- 4.0 to 4.5
- 4.5 to 5.0
- 5.0 to 5.5
- 5.5 to 6.0
- 6.0 to 6.5
- 6.5 to 7.0
- 7.0 to 7.5
- 7.5 or greater

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1D-PMF24h	**FIGURE TITLE**	Wyong River - Existing Water Surface Level and Flood Depth (Catchment Wide) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC

Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

LEGEND

- Proposed Road
- 0.1 m Contours
- Project Boundary

Depth (m)

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 3.0
- 3.0 to 3.5
- 3.5 to 4.0
- 4.0 to 4.5
- 4.5 to 5.0
- 5.0 to 5.5
- 5.5 to 6.0
- 6.0 to 6.5
- 6.5 to 7.0
- 7.0 to 7.5
- 7.5 or greater

0 1,000

metres

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1E-PMF24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (Catchment Wide) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC

Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

+25mm

+25mm

+20mm

+200mm

+75mm

+30mm

+20mm

0 1,000

metres

LEGEND

- Proposed Road
- 0.1 m Contours
- Project Boundary
- Was Wet, Now Dry
- Was Dry, Now Wet

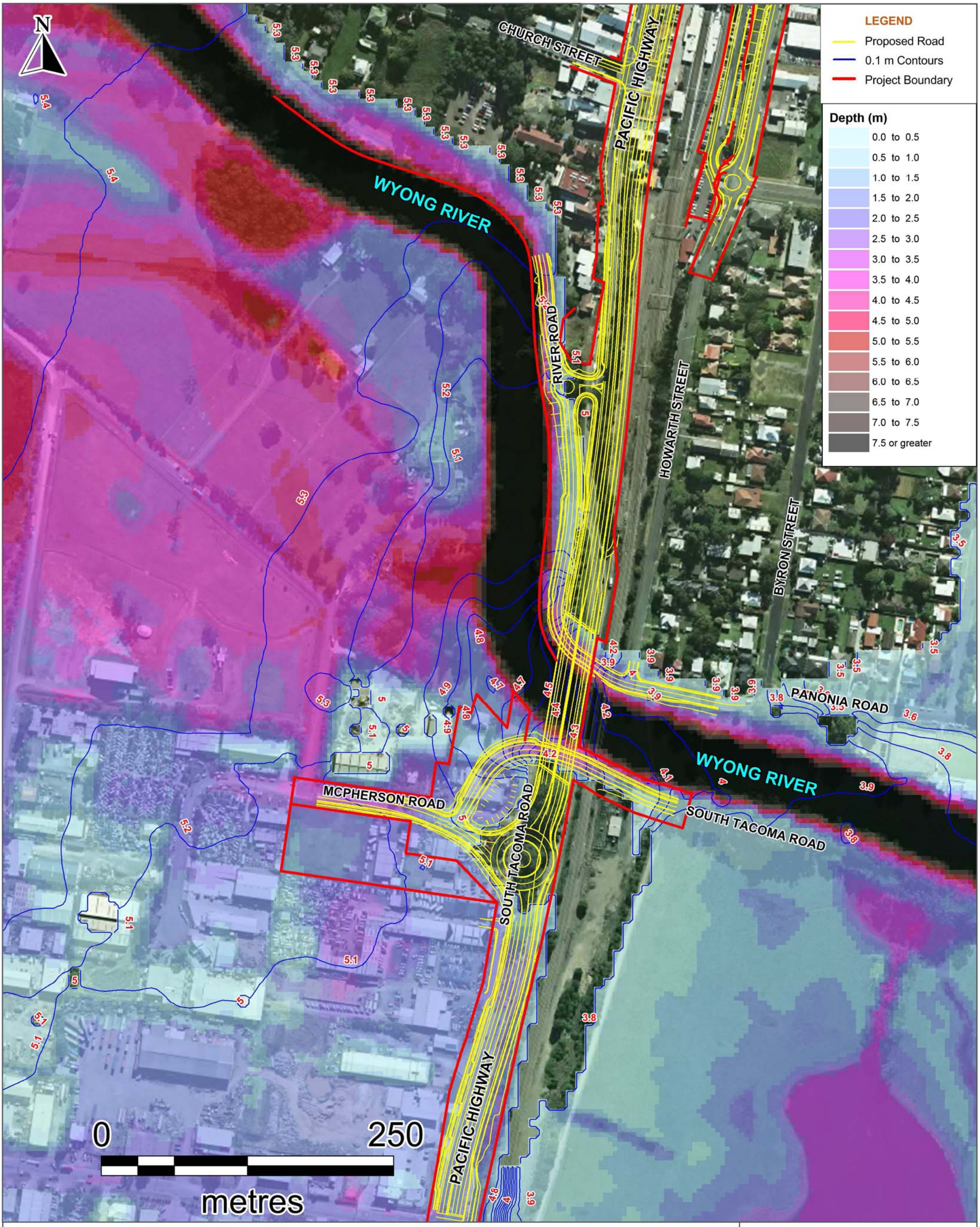
Level Difference (m)

- 0.50 or greater
- 0.40 to 0.50
- 0.30 to 0.40
- 0.20 to 0.30
- 0.10 to 0.20
- 0.05 to 0.10
- 0.01 to 0.05
- 0.00 to 0.01
- -0.01 to 0.00
- -0.05 to -0.01
- -0.10 to -0.05
- -0.20 to -0.10
- -0.30 to -0.20
- -0.40 to -0.30
- -0.50 to -0.40
- -0.50 or greater

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1F-PMF24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level Difference (Catchment Wide) PMF 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC

Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-2000y24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (At Wyong River Bridge) 2000 Year ARI 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.

N

M1 PACIFIC MOTORWAY

RAILWAY ROAD

PACIFIC HIGHWAY

WYONG RIVER

LEGEND

- Proposed Road
- 0.1 m Contours
- Project Boundary

Depth (m)

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 3.0
- 3.0 to 3.5
- 3.5 to 4.0
- 4.0 to 4.5
- 4.5 to 5.0
- 5.0 to 5.5
- 5.5 to 6.0
- 6.0 to 6.5
- 6.5 to 7.0
- 7.0 to 7.5
- 7.5 or greater

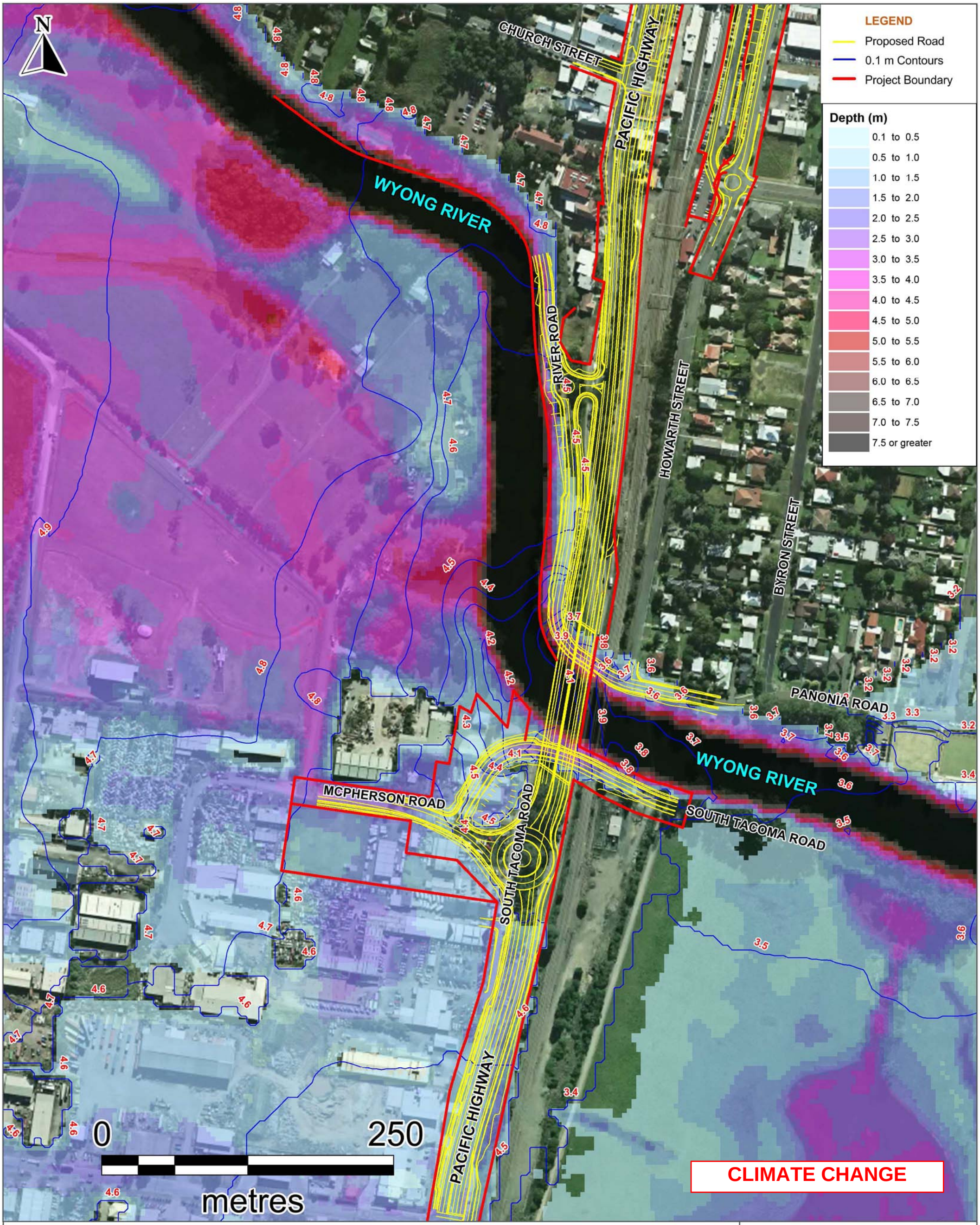
0 1,000

metres

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1E-2000y24h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (Catchment Wide) 2000 Year ARI 24 hour Duration Flood Event - Extreme Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

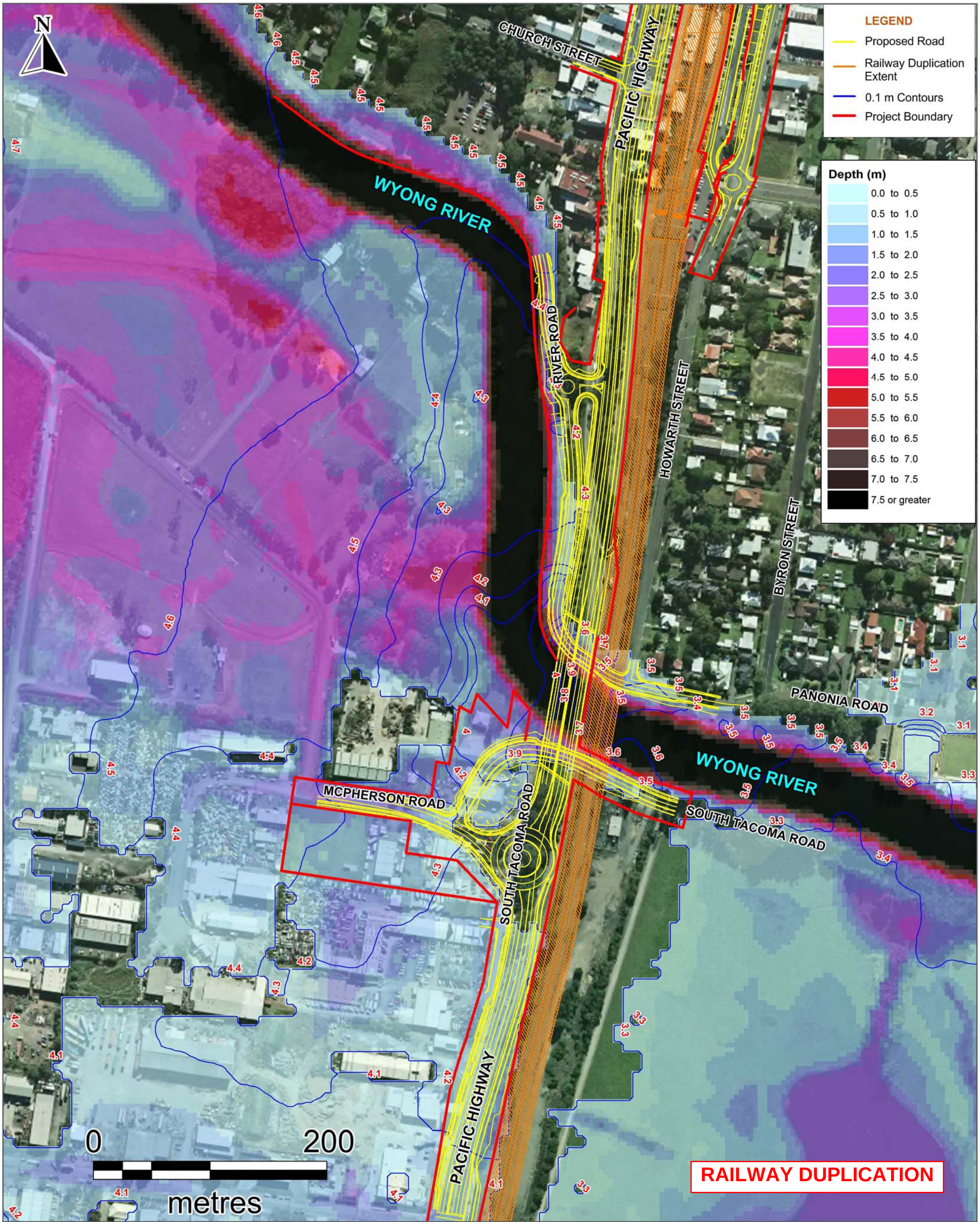
SMEC

Local People. Global Experience.



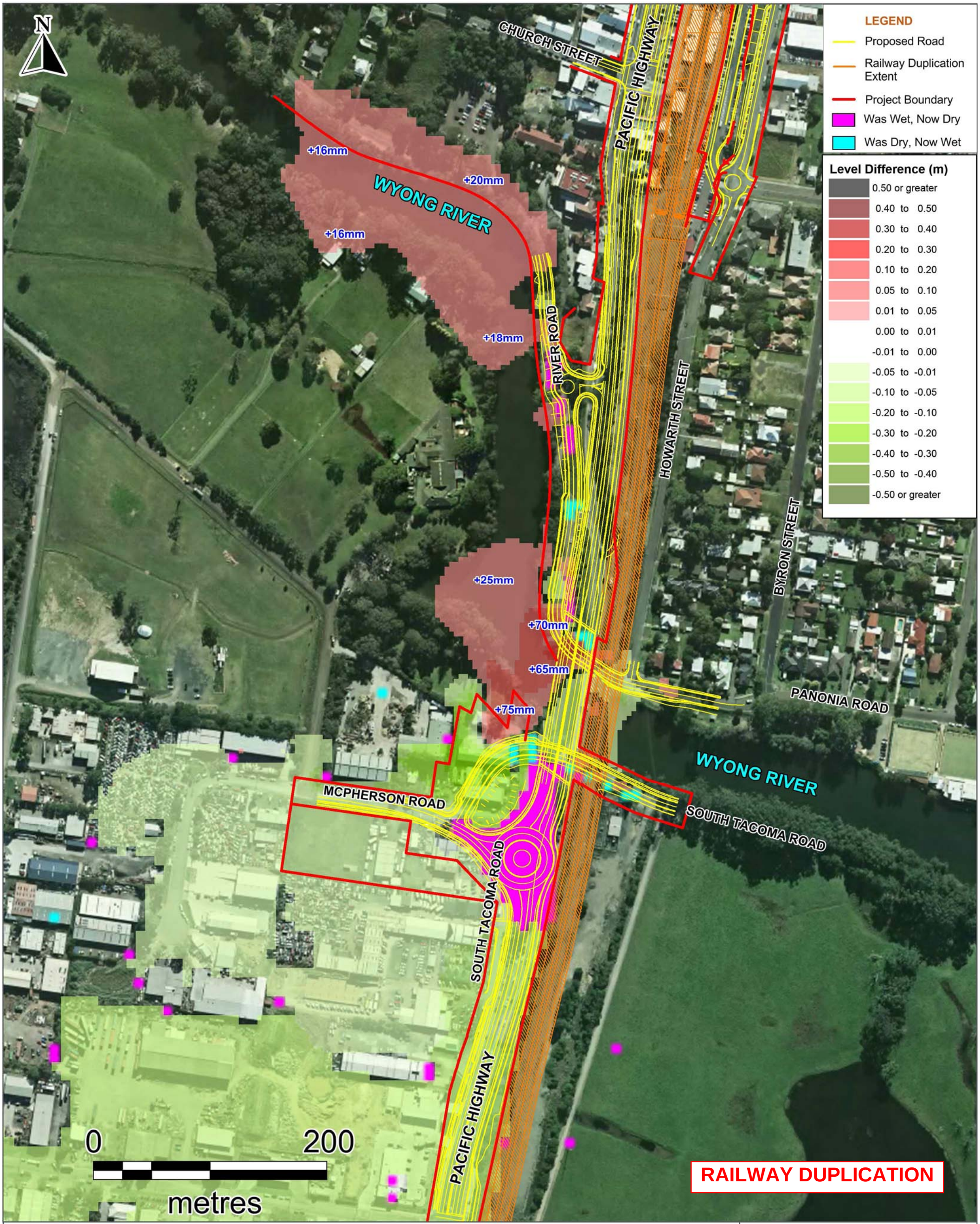
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-100yCC36h	**FIGURE TITLE**	Wyong River - Proposed Water Surface Level and Flood Depth (At Wyong River Bridge) 100 Year ARI 36 hour Duration Climate Change Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1B-100y36h-RAIL	**FIGURE TITLE**	Wyong River - Proposed With Railway Duplication Water Surface Level and Flood Depth (At Wyong River Bridge) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.

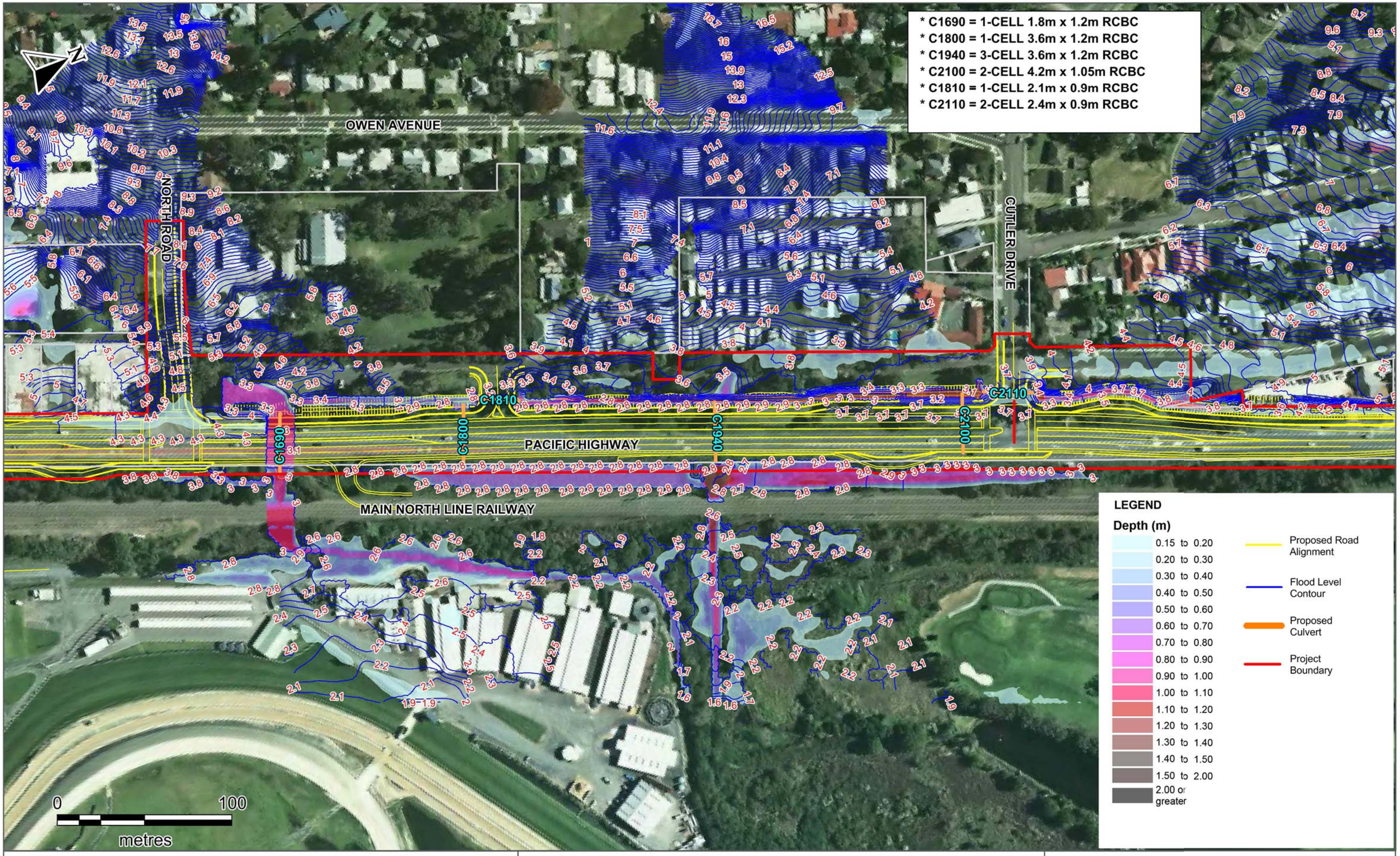


DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade - Between Johnson Road and Cutler Drive
FIG NO.	L1C-100y36h-RAIL	**FIGURE TITLE**	Wyong River - Proposed with Railway Duplication Water Surface Level Difference (At Wyong River Bridge) 100 Year ARI 36 hour Duration Flood Event - 100 Year ARI Tailwater
CREATED BY	D. Duong	**LOCATION**	T:\Projects\3001424\

SMEC
Local People. Global Experience.

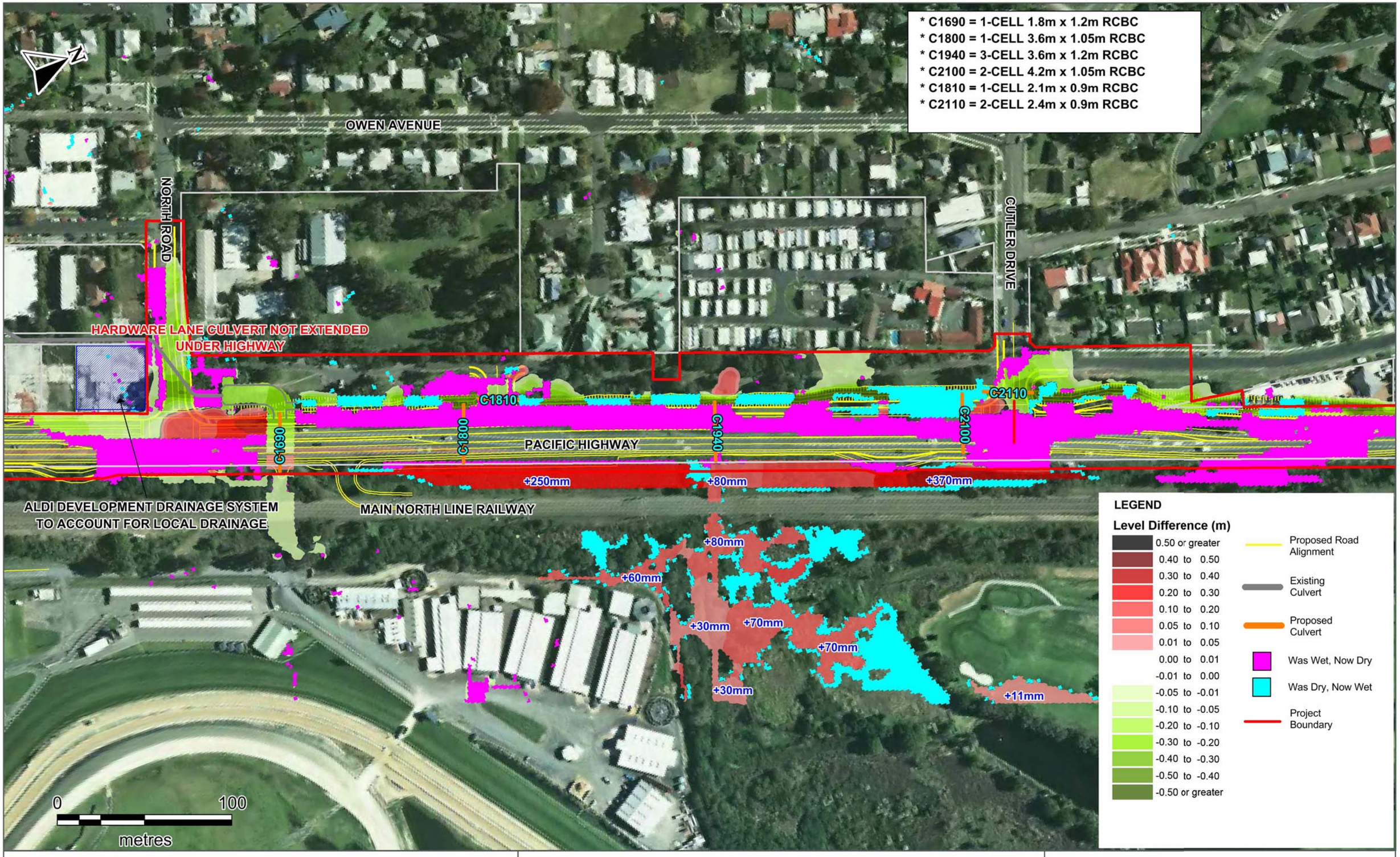
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-1yr-120min-A1
FIGURE TITLE	Wyong Town Centre - Flood Depth and Levels 1 year ARI 120 min duration Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.



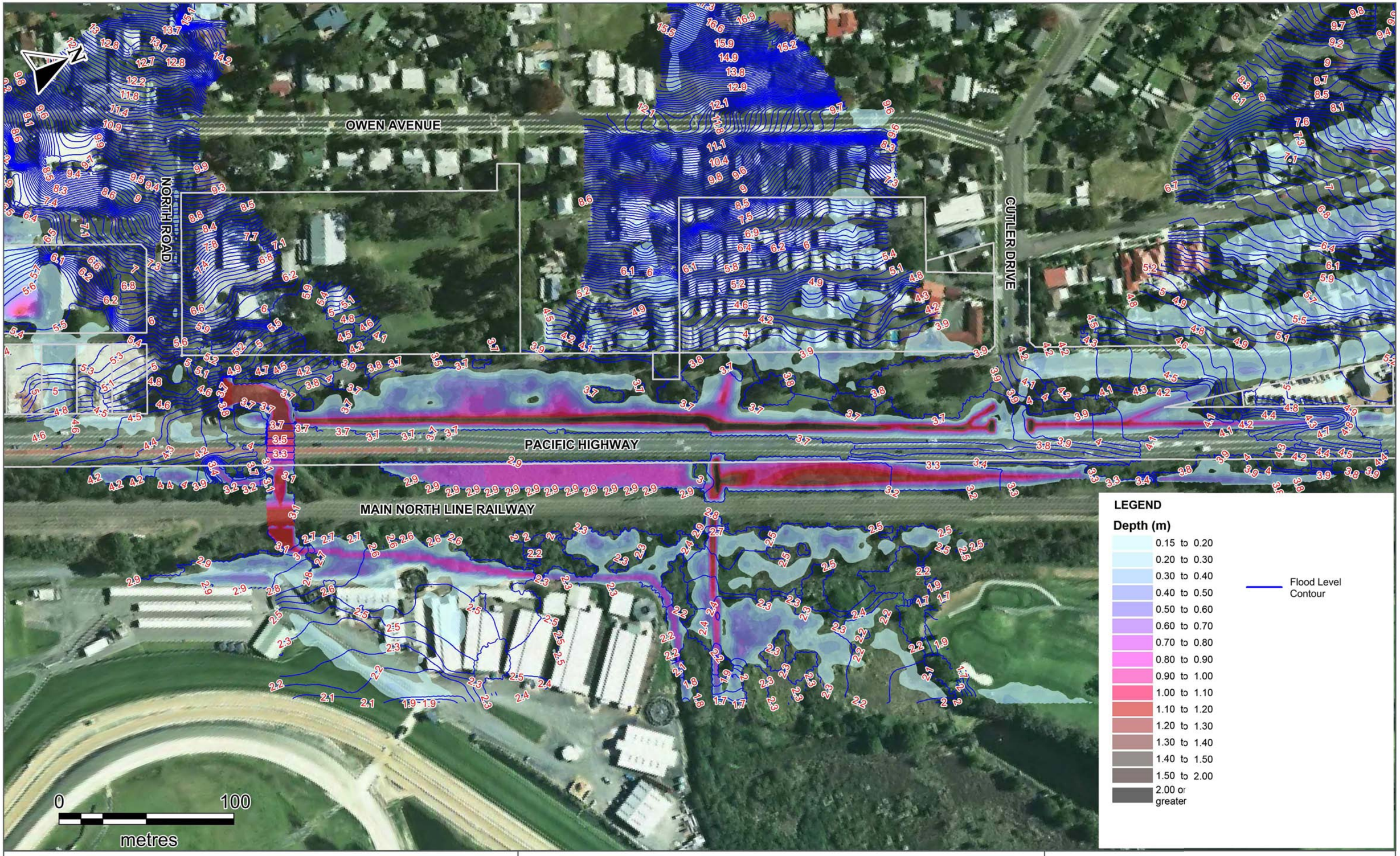
DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-1yr-120min-A2	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 1 year ARI 120 min duration Proposed Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-1yr-120min-A3
FIGURE TITLE	Wyong Town Centre - Flood Level Difference 1 year ARI 120 min duration Proposed Conditions vs. Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.



DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-5yr-120min-A1	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 5 year ARI 120 min duration Existing Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-5yr-120min-A2	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 5 year ARI 120 min duration Proposed Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE

NORTH ROAD

CUTLER DRIVE

HARDWARE LANE CULVERT NOT EXTENDED UNDER HIGHWAY

C1810

C1690

C1800

C1940

C2100

C2110

PACIFIC HIGHWAY

+250mm

+130mm

+150mm

ALDI DEVELOPMENT DRAINAGE SYSTEM TO ACCOUNT FOR LOCAL DRAINAGE

MAIN NORTH LINE RAILWAY

+110mm

+25mm

+80mm

+60mm

0 100 metres

LEGEND

Level Difference (m)

- 0.50 or greater
- 0.40 to 0.50
- 0.30 to 0.40
- 0.20 to 0.30
- 0.10 to 0.20
- 0.05 to 0.10
- 0.01 to 0.05
- 0.00 to 0.01
- -0.01 to 0.00
- -0.05 to -0.01
- -0.10 to -0.05
- -0.20 to -0.10
- -0.30 to -0.20
- -0.40 to -0.30
- -0.50 to -0.40
- -0.50 or greater

Proposed Road Alignment

Existing Culvert

Proposed Culvert

Was Wet, Now Dry

Was Dry, Now Wet

Project Boundary

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-5yr-120min-A3
FIGURE TITLE	Wyong Town Centre - Flood Level Difference 5 year ARI 120 min duration Proposed Conditions vs. Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC

Local People. Global Experience.

DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-10yr-120min-A1	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 10 year ARI 120 min duration Existing Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE
NORTH ROAD
CUTLER DRIVE
PACIFIC HIGHWAY
MAIN NORTH LINE RAILWAY
C1690
C1800
C1940
C1810
C2100
C2110

LEGEND

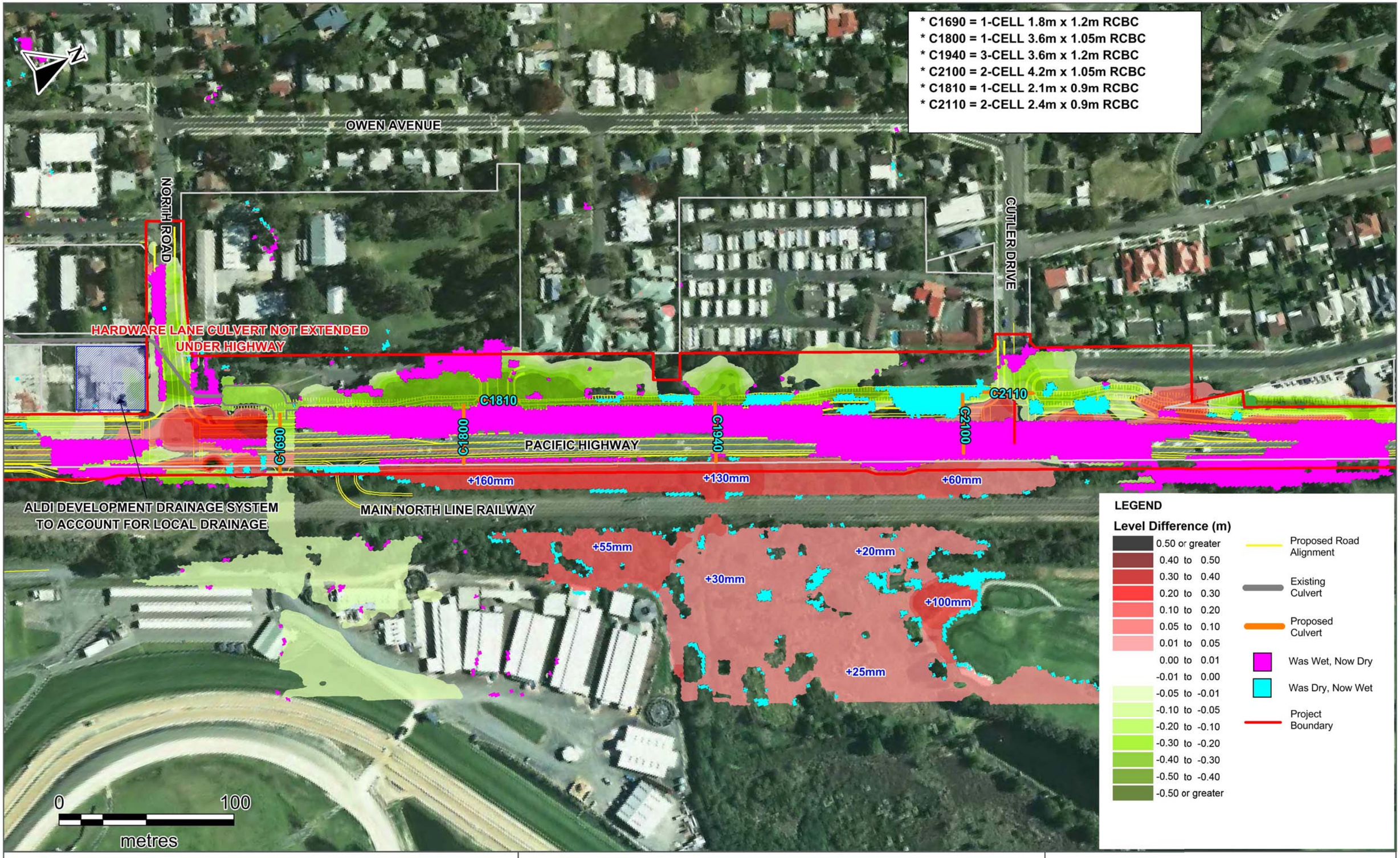
Depth (m)

0.15 to 0.20	Proposed Road Alignment
0.20 to 0.30	
0.30 to 0.40	Flood Level Contour
0.40 to 0.50	
0.50 to 0.60	Proposed Culvert
0.60 to 0.70	
0.70 to 0.80	Project Boundary
0.80 to 0.90	
0.90 to 1.00	
1.00 to 1.10	
1.10 to 1.20	
1.20 to 1.30	
1.30 to 1.40	
1.40 to 1.50	
1.50 to 2.00	
2.00 or greater	

0 100
metres

DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-10yr-120min-A2	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 10 year ARI 120 min duration Proposed Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.



DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-10yr-120min-A3	**FIGURE TITLE** Wyong Town Centre - Flood Level Difference 10 year ARI 120 min duration Proposed Conditions vs. Existing Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-50yr-120min-A1
FIGURE TITLE	Wyong Town Centre - Flood Depth and Levels 50 year ARI 120 min duration Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE

NORTH ROAD

CUTLER DRIVE

C1810

C1800

C1690

C1940

C2100

C2110

PACIFIC HIGHWAY

MAIN NORTH LINE RAILWAY

0 100

metres

LEGEND

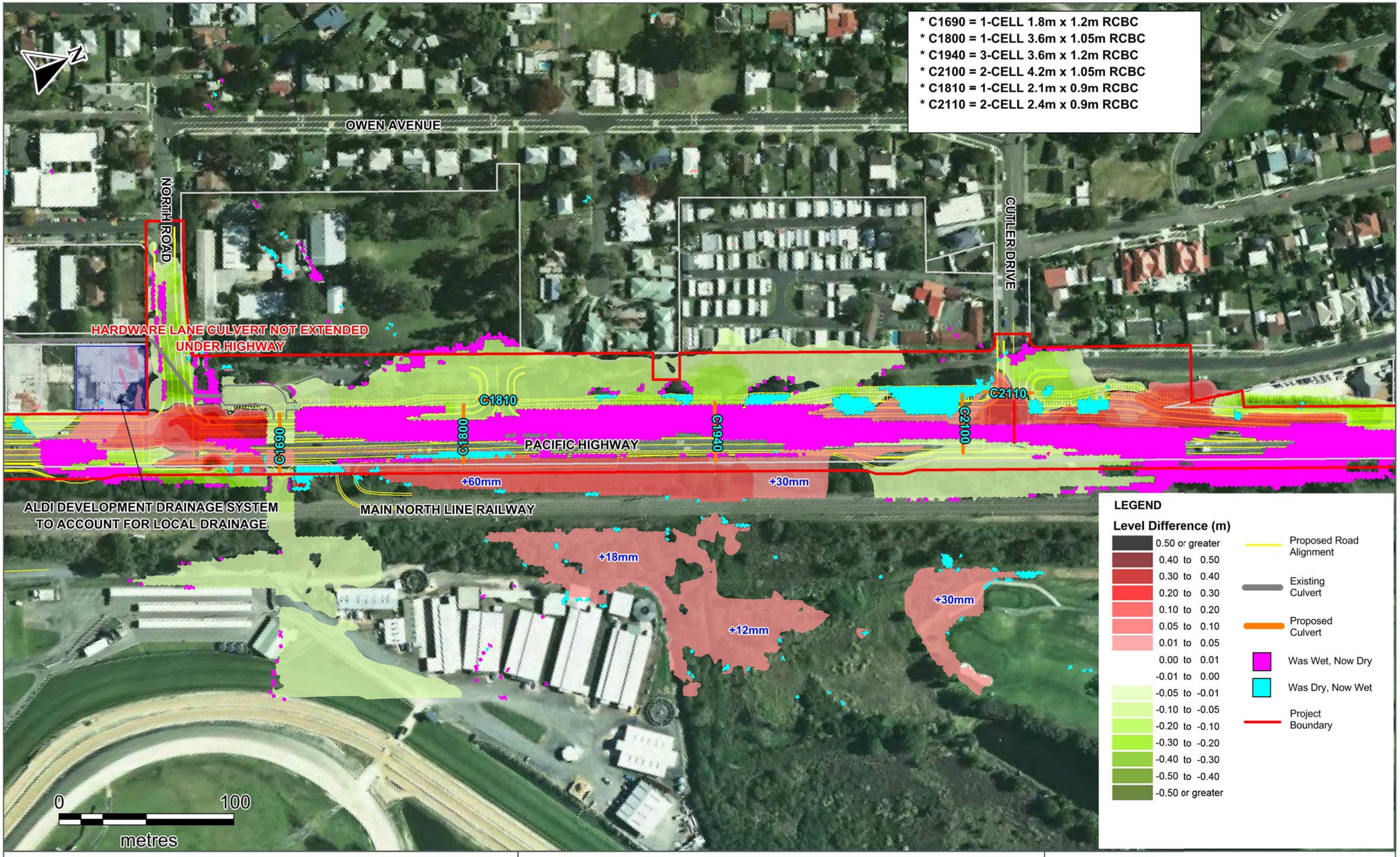
Depth (m)

0.15 to 0.20	Proposed Road Alignment
0.20 to 0.30	
0.30 to 0.40	Flood Level Contour
0.40 to 0.50	
0.50 to 0.60	Proposed Culvert
0.60 to 0.70	
0.70 to 0.80	Project Boundary
0.80 to 0.90	
0.90 to 1.00	
1.00 to 1.10	
1.10 to 1.20	
1.20 to 1.30	
1.30 to 1.40	
1.40 to 1.50	
1.50 to 2.00	
2.00 or greater	

DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-50yr-120min-A2
FIGURE TITLE	Wyong Town Centre - Flood Depth and Levels 50 year ARI 120 min duration Proposed Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

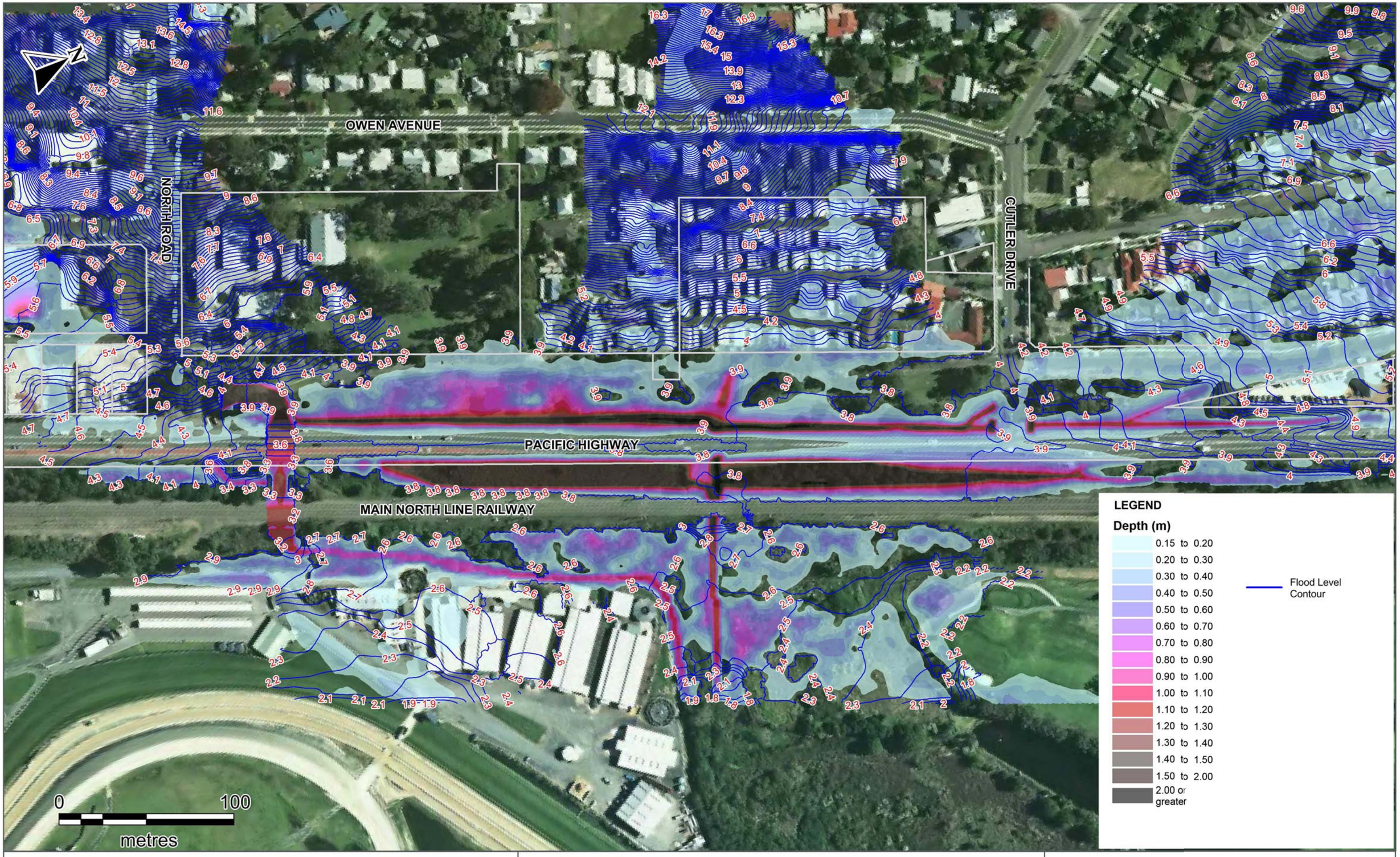
SMEC

Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-50yr-120min-A3
FIGURE TITLE	Wyong Town Centre - Flood Level Difference 50 year ARI 120 min duration Proposed Conditions vs. Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-100yr-120min-A1
FIGURE TITLE	Wyong Town Centre - Flood Depth and Levels 100 year ARI 120 min duration Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE

NORTH ROAD

CUTLER DRIVE

C1810

C1690

C1800

C1940

C2100

C2110

PACIFIC HIGHWAY

MAIN NORTH LINE RAILWAY

0 100 metres

LEGEND

Depth (m)

- 0.15 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- 1.00 to 1.10
- 1.10 to 1.20
- 1.20 to 1.30
- 1.30 to 1.40
- 1.40 to 1.50
- 1.50 to 2.00
- 2.00 or greater

Proposed Road Alignment

Flood Level Contour

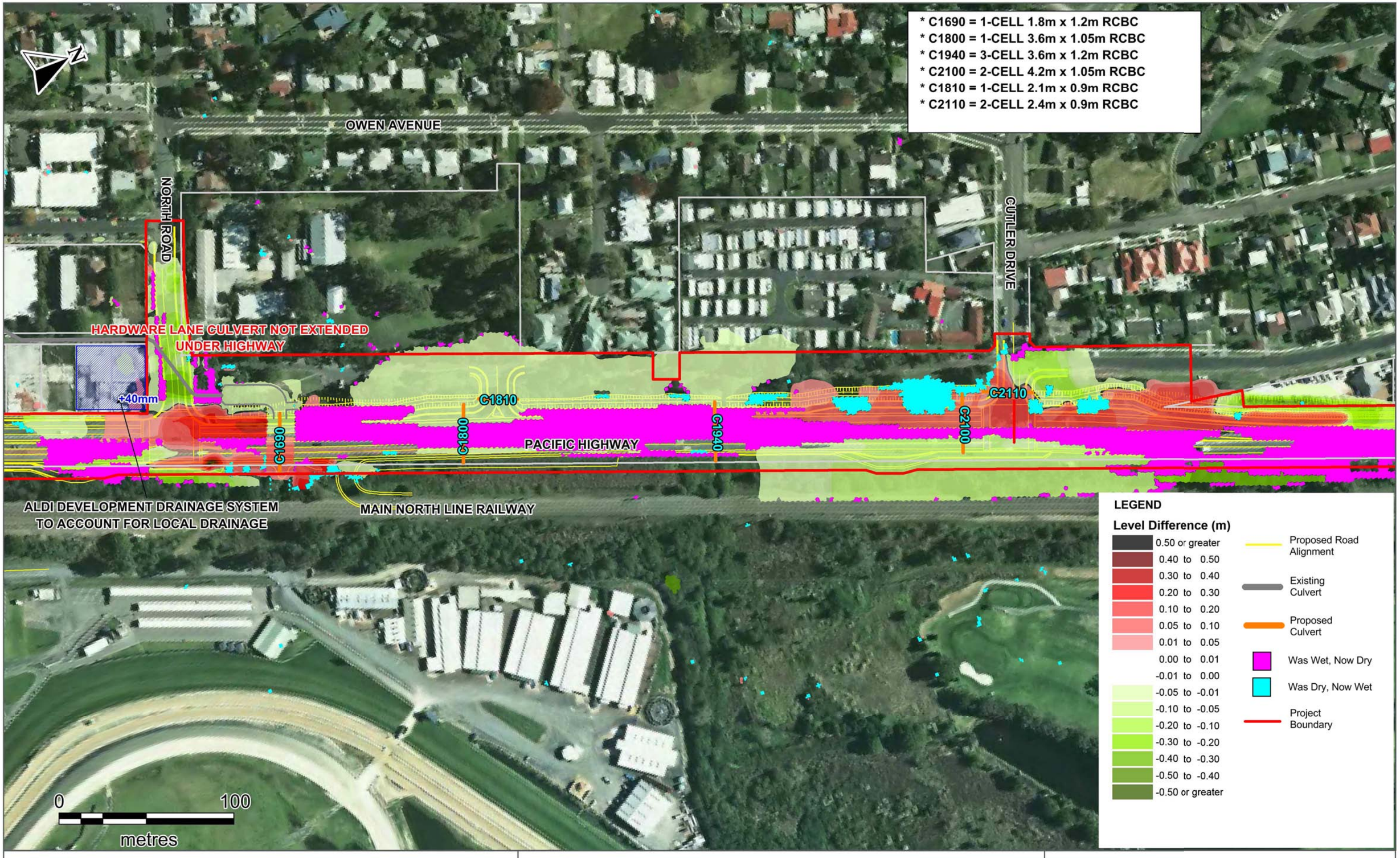
Proposed Culvert

Project Boundary

DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-100yr-120min-A2	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels 100 year ARI 120 min duration Proposed Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

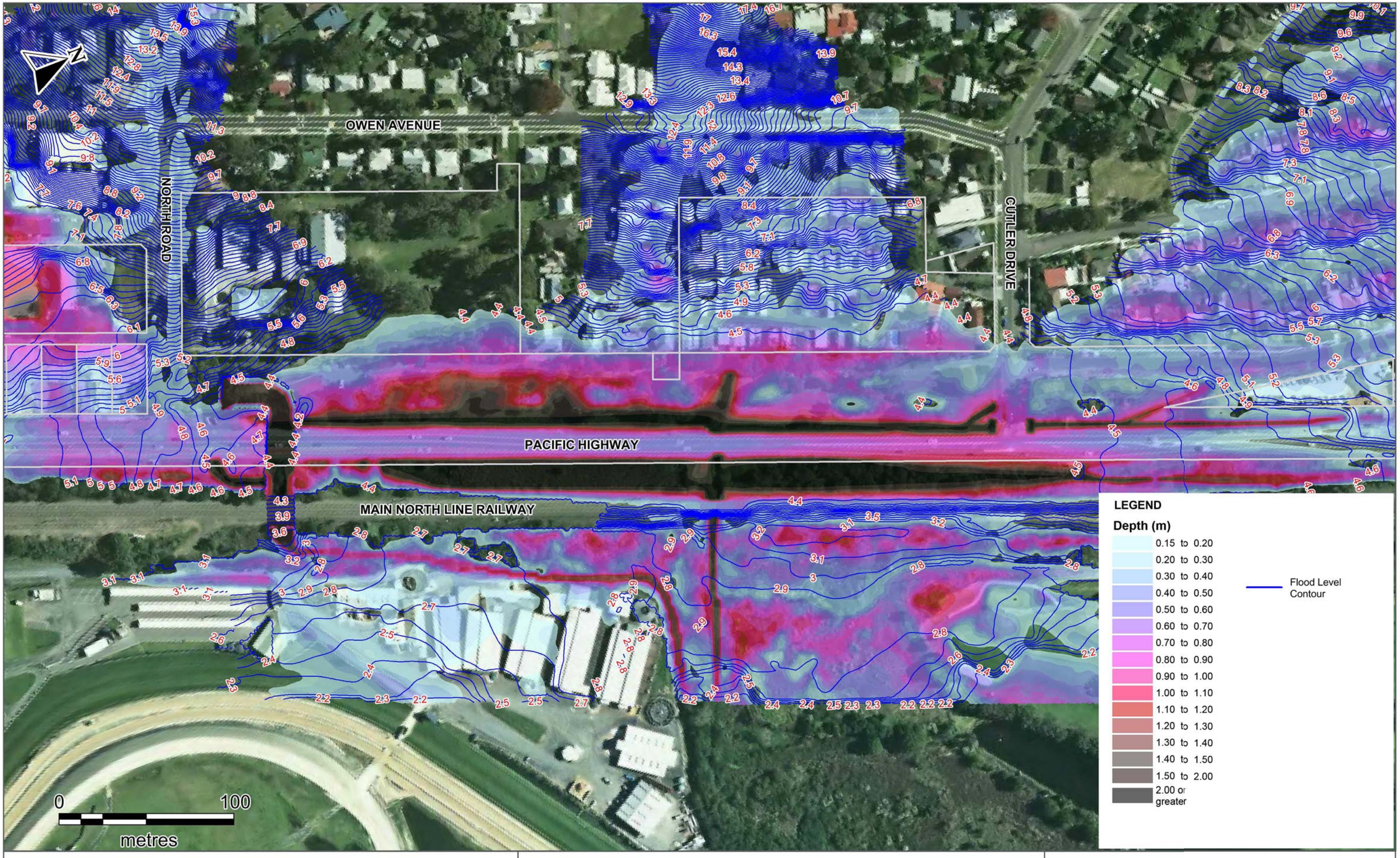
SMEC

Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-100yr-120min-A3
FIGURE TITLE	Wyong Town Centre - Flood Level Difference 100 year ARI 120 min duration Proposed Conditions vs. Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.



DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-PMF-30min-A1
FIGURE TITLE	Wyong Town Centre - Flood Depth and Levels PMF 30 min duration Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE

NORTH ROAD

CUTLER DRIVE

HARDWARE LANE CULVERT NOT EXTENDED UNDER HIGHWAY

C1690

C1800

C1810

C1940

C2100

C2110

PACIFIC HIGHWAY

MAIN NORTH LINE RAILWAY

0 100 metres

LEGEND

Depth (m)

- 0.15 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- 1.00 to 1.10
- 1.10 to 1.20
- 1.20 to 1.30
- 1.30 to 1.40
- 1.40 to 1.50
- 1.50 to 2.00
- 2.00 or greater

- Proposed Road Alignment
- Flood Level Contour
- Proposed Culvert
- Project Boundary

DATE 16/06/2015	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-PMF-30min-A2	**FIGURE TITLE** Wyong Town Centre - Flood Depth and Levels PMF 30 min duration Proposed Conditions
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

* C1690 = 1-CELL 1.8m x 1.2m RCBC
* C1800 = 1-CELL 3.6m x 1.05m RCBC
* C1940 = 3-CELL 3.6m x 1.2m RCBC
* C2100 = 2-CELL 4.2m x 1.05m RCBC
* C1810 = 1-CELL 2.1m x 0.9m RCBC
* C2110 = 2-CELL 2.4m x 0.9m RCBC

OWEN AVENUE

NORTH ROAD

CUTLER DRIVE

HARDWARE LANE CULVERT NOT EXTENDED UNDER HIGHWAY

+15mm

+25mm

+18mm

+15mm

+30mm

C1810

C1690

C1800

C1940

C2100

C2110

PACIFIC HIGHWAY

+100mm

+20mm

+20mm

+20mm

ALDI DEVELOPMENT DRAINAGE SYSTEM TO ACCOUNT FOR LOCAL DRAINAGE

MAIN NORTH LINE RAILWAY

0 100

metres

LEGEND

Level Difference (m)

- 0.50 or greater
- 0.40 to 0.50
- 0.30 to 0.40
- 0.20 to 0.30
- 0.10 to 0.20
- 0.05 to 0.10
- 0.01 to 0.05
- 0.00 to 0.01
- -0.01 to 0.00
- -0.05 to -0.01
- -0.10 to -0.05
- -0.20 to -0.10
- -0.30 to -0.20
- -0.40 to -0.30
- -0.50 to -0.40
- -0.50 or greater

Proposed Road Alignment

Existing Culvert

Proposed Culvert

Was Wet, Now Dry

Was Dry, Now Wet

Project Boundary

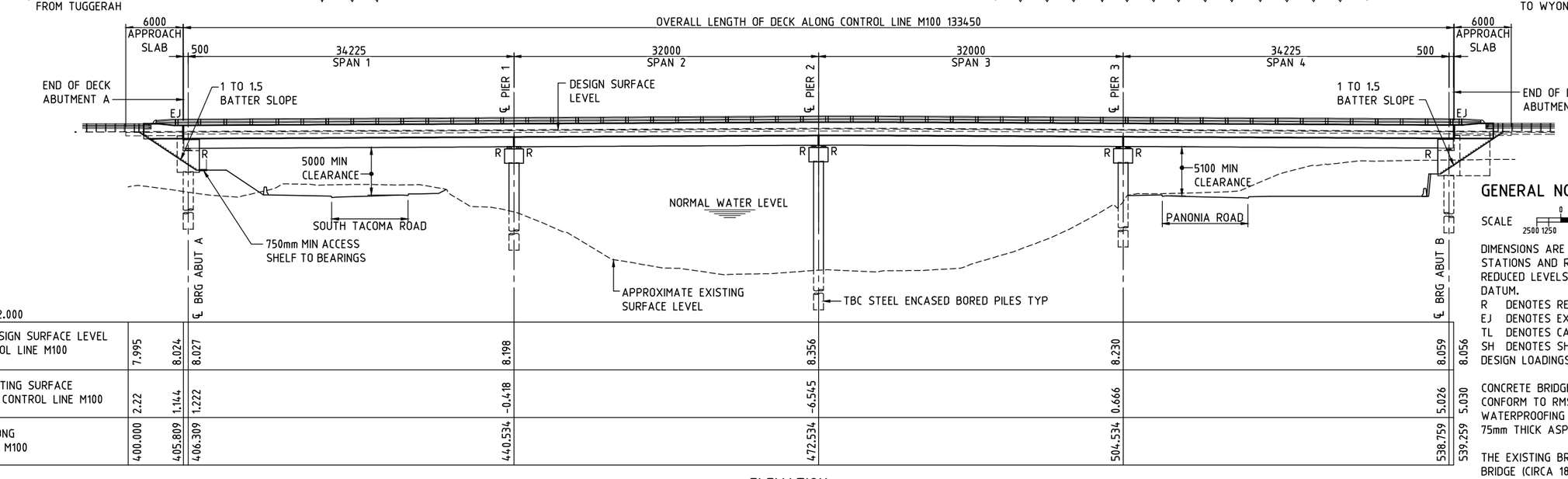
DATE	16/06/2015	**COORDINATE SYSTEM**	MGA 94 Zone 56	**FIG NO.**	WY-PMF-30min-A3
FIGURE TITLE	Wyong Town Centre - Flood Level Difference PMF 30 min duration Proposed Conditions vs. Existing Conditions				
PROJECT NO.	3001424	**PROJECT TITLE**	Wyong Town Centre Upgrade	**CREATED BY**	D. Duong
LOCATION	T:\Projects\3001424\				

SMEC

Local People. Global Experience.

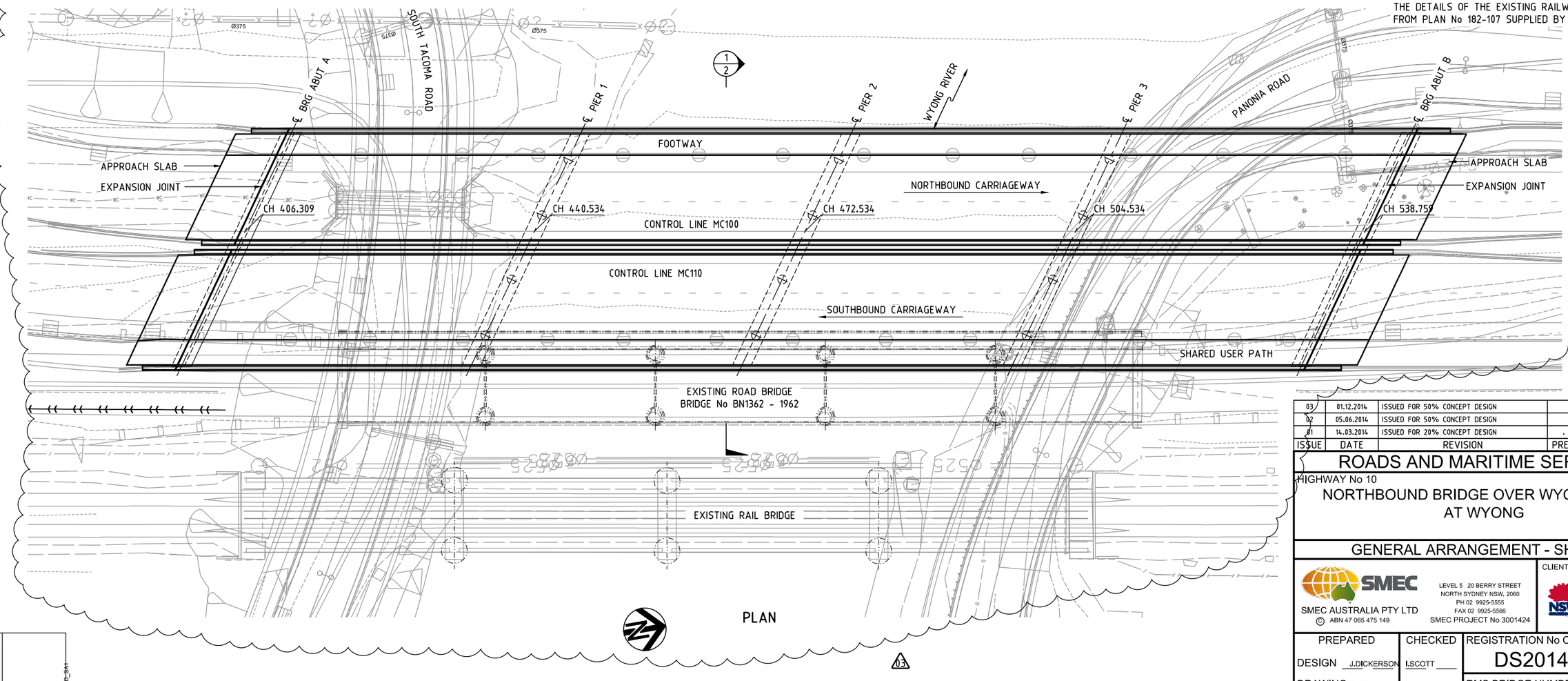
APPENDIX B: TWIN ROAD BRIDGES OVER WYONG RIVER DRAWINGS

Page intentionally left blank



PROPOSED DESIGN SURFACE LEVEL ALONG CONTROL LINE M100	7.995	8.024	8.027	8.198	8.356	8.230	8.059	8.056
APPROX. EXISTING SURFACE LEVEL ALONG CONTROL LINE M100	2.22	1.144	1.222	-0.418	-6.545	0.666	5.026	5.030
CHAINAGE ALONG CONTROL LINE M100	400.000	405.809	406.309	440.534	472.534	504.534	538.759	539.259

ELEVATION



PLAN

GENERAL NOTES

SCALE 0 5000 10000mm (2500 1250) OR AS SHOWN

DIMENSIONS ARE IN MILLIMETRES.
STATIONS AND REDUCED LEVELS ARE IN METRES.
REDUCED LEVELS ARE RELOCATED TO AUSTRALIAN HEIGHT DATUM.
R DENOTES RETRAINED BEARING
EJ DENOTES EXPANSION JOINT
TL DENOTES CARRIAGEWAY TRAFFIC LANE
SH DENOTES SHOULDER.
DESIGN LOADINGS: - AS 5100 BRIDGE DESIGN CODE.

CONCRETE BRIDGE DECK WATERPROOFING MEMBRANE SHALL CONFORM TO RMS SPECIFICATION B344 OR BPC2005/02. WATERPROOFING MEMBRANE SHALL BE OVERLAYED WITH 75mm THICK ASPHALT

THE EXISTING BRIDGE (BN1362) BUILT AS A RAILWAY BRIDGE (CIRCA 1890) WAS CONVERTED TO A ROAD BRIDGE IN 1962. PLANS REG No 0010 505 BC 0469.
THE DETAILS OF THE EXISTING RAILWAY BRIDGE OBTAINED FROM PLAN No 182-107 SUPPLIED BY RAILCORP.

NOT FOR CONSTRUCTION

ISSUE	DATE	REVISION	PREP	CHECK	AUTH	WVR
03	01.12.2014	ISSUED FOR 50% CONCEPT DESIGN				0043
02	05.06.2014	ISSUED FOR 50% CONCEPT DESIGN				0021
01	14.03.2014	ISSUED FOR 20% CONCEPT DESIGN	.	.	.	0011

ROADS AND MARITIME SERVICES

HIGHWAY No 10 — SHIRE OF WYONG

NORTHBOUND BRIDGE OVER WYONG RIVER AT WYONG

GENERAL ARRANGEMENT - SHEET A

SMEC AUSTRALIA PTY LTD
© ABN 47 065 475 149
LEVEL 5 20 BERRY STREET
NORTH SYDNEY NSW, 2060
PH 02 9925-5555
FAX 02 9925-5566
SMEC PROJECT No 3001424

CLIENT: Transport Roads & Maritime Services NSW GOVERNMENT

PREPARED	CHECKED	REGISTRATION No OF PLANS
DESIGN J.DICKERSON	I.SCOTT	DS2014/000000
DRAWING G.VISWASAM		RMS BRIDGE NUMBER B00000
APPROVED DESIGN QA RECORDS		ISSUE STATUS: 50% CONCEPT DESIGN
DIRECTOR		SHEET No 1 ISSUE 03

V:_Vault\Projects\3001424\CAD\DWG\21_SB_Struct_Bridges\Wyong_River\3001424-DSB-0001.dwg

THIS DRAWING IS CONFIDENTIAL AND SHALL ONLY BE USED FOR THE PURPOSE OF THE NOMINATED PROJECT

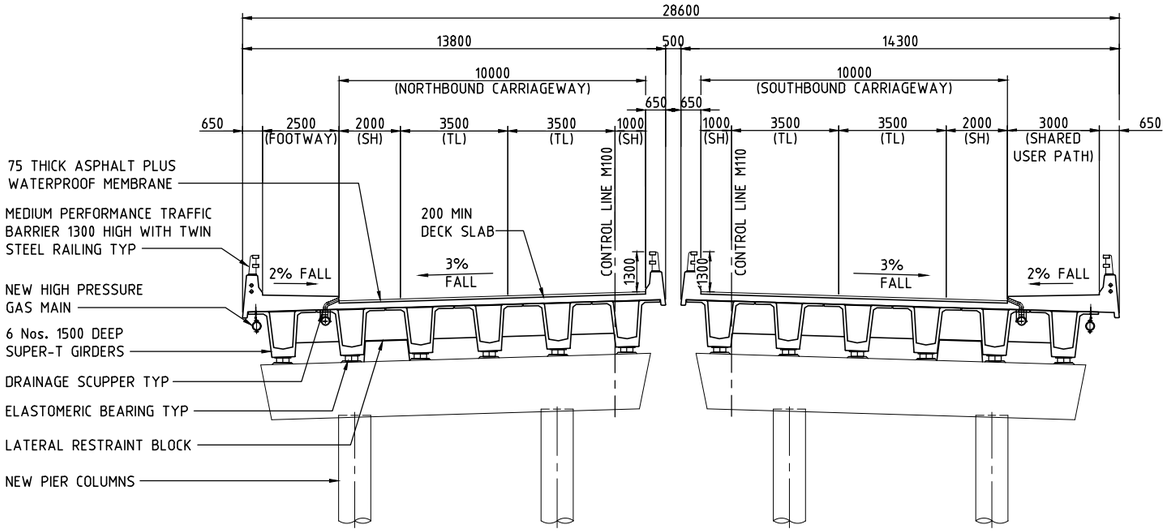
PLOT DATE 01 Dec 2014 TIME 15:45:07

150 mm ON ORIGINAL A1

EXTERNAL REFERENCE FILES
X_BDRY
X_DES_CTRL_UG
X_DES_GR
X_DES_UG
X_DRAIN_EXIST
X_DRL
X_DRT
X_SURV
X_3001424_SMEC_3YR_3941

WESTERN SIDE

EASTERN SIDE



SECTION 1/1

0 1000 2000 3000 4000 5000mm
1000 500

03

GENERAL NOTES

SCALE 0 1000 2000 3000 4000 5000mm (1000 500) OR AS SHOWN

FOR OTHER GENERAL NOTES RELATING TO THIS SHEET, REFER TO SHEET No 1.

ISSUE	DATE	REVISION	PREP	CHECK	AUTH	WVR
03	01.12.2014	ISSUED FOR 50% CONCEPT DESIGN				0043
02	05.06.2014	ISSUED FOR 50% CONCEPT DESIGN				0021
01	14.03.2014	ISSUED FOR 20% CONCEPT DESIGN	.	.	.	0011

ROADS AND MARITIME SERVICES

HIGHWAY No 10 — SHIRE OF WYONG

NORTHBOUND BRIDGE OVER WYONG RIVER AT WYONG

GENERAL ARRANGEMENT - SHEET B

SMEC AUSTRALIA PTY LTD
ABN 47 065 475 149
LEVEL 5 20 BERRY STREET
NORTH SYDNEY NSW, 2060
PH 02 9925-5555
FAX 02 9925-5566
SMEC PROJECT No 3001424

CLIENT: NSW Transport Roads & Maritime Services

PREPARED	CHECKED	REGISTRATION No OF PLANS
DESIGN J.DICKERSON	I.SCOTT	DS2014/000000
DRAWING G.VISWASAM		RMS BRIDGE NUMBER B00000
APPROVED DESIGN QA RECORDS		ISSUE STATUS: 50% CONCEPT DESIGN
DIRECTOR		SHEET No 2 / ISSUE 03

NOT FOR CONSTRUCTION

V:_Vault\Projects\3001424\CAD\DWG\21_SB_Struct_Bridges\Wyong_River\3001424-DSB-0002.dwg

PLOT DATE 01 Dec 2014 TIME 15:55:03

EXTERNAL REFERENCE FILES
X_3001424_SMEC_SYD_SA1

150 mm ON ORIGINAL A1

APPENDIX C: WYONG SHIRE COUNCIL CULVERT DRAWINGS AND FIGURES

Page intentionally left blank

Figure 2-12

Proposed Trunk Culvert

WYONG CBD
TRUNK CULVERT FIA

- Cadastre
- Existing Cuvlert
- Proposed Culvert
- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe

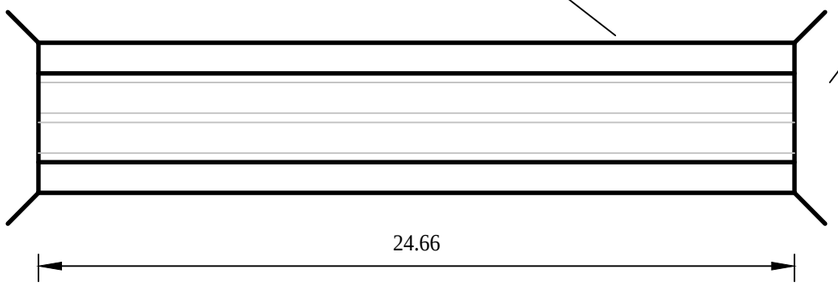
Cardno

Map Produced by Cardno NSW/ACT Pty Ltd
Date: December 2013
Coordinate System: MGA Zone 56

CULVERTS 1.2m x 1.1m
5 EXISTING
5 PROPOSED

UPGRADE ALL
HEADWALLS TO
SUIT NEW CULVERTS

CULVERTS 1.0m x 1.2m
2 EXISTING
2 PROPOSED



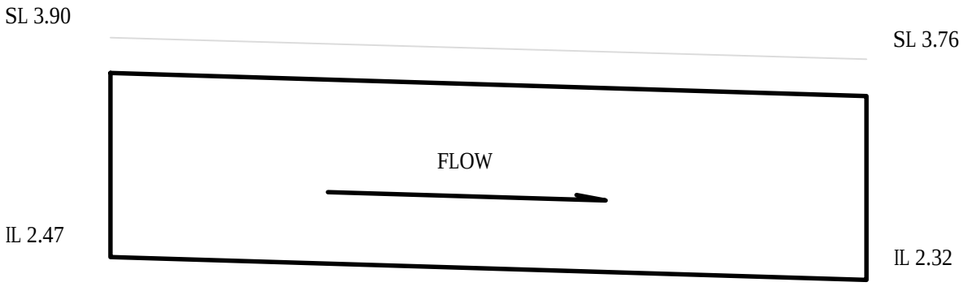
HIGHWAY CULVERT: PLAN

RAILWAY CULVERT: PLAN

EXISTING

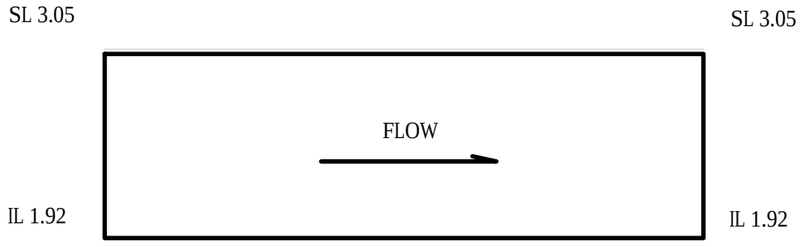
PROPOSED

NATURAL SURFACE



HIGHWAY CULVERT: TYPICAL SECTION

1H : 5V



RAILWAY CULVERT: TYPICAL SECTION

1H : 5V

Rev	Date	Description	Des.	Verif.	Appd.
1	27/02/2014	Preliminary issue for Council review	LRE	BK	LRE

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 11, 515 St Paulis Terrace
Fortitude Valley, QLD 4006
Tel: 07 3369 9822 Fax: 07 3369 9722
Web: www.cardno.com.au

		Date
Drawn	LRE	26/02/2014
Checked	BK	26/02/2014
Designed	LRE	26/02/2014
Verified	BK	26/02/2014
Approved	1	
	L Evans	27/02/2014

Client: WYONG SHIRE COUNCIL

Project: WYOND CBD
TRUNK DRAINAGE CULVERT
FLOOD IMPACT ASSESSMENT

Title: HIGHWAY & RAILWAY CULVERTS
UPGRADE DETAILS

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Datum	Scale	Size
mAHD	####	A3

Drawing Number: 59914080-DWG-001

Revision: 1

LEGEND

Existing edge of bitumen		Telstra cables/Manhole	—T—
Existing kerb		Water main/Hydrant/Stop valve	—W—
Existing drainage		Water meter	
Proposed pipes		Power pole	
Proposed box culverts		Light pole	
Gas main	—G—	Access	
Sewer/Manhole	—S—	Survey station	
Proposed sewer	—S—	Tree	
Temporary sewer	—S—	Tree to be removed	
Sewer rising main	—SRM—	Drainage pit & line No.	L6/18

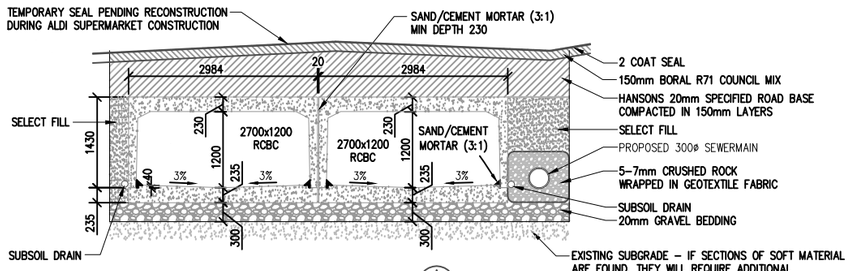
MGA

CONSTRUCTION NOTES:

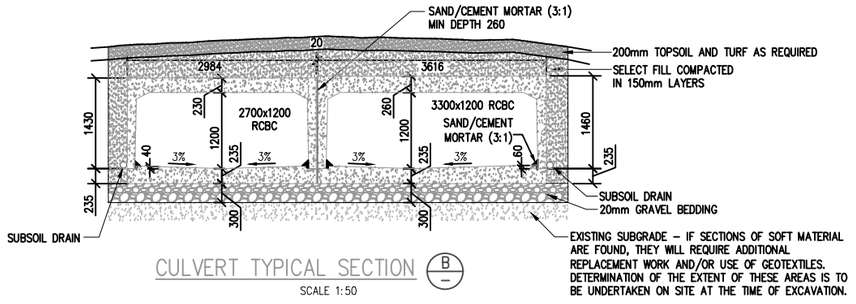
1. MITIGATION MEASURES OUTLINED IN THE PROJECT ENVIRONMENTAL ASSESSMENT AND/OR CEMP ARE TO BE ADHERED TO PRIOR TO AND DURING CONSTRUCTION.
2. EROSION AND SEDIMENTATION CONTROLS TO BE INSTALLED PRIOR TO COMMENCEMENT OF CONSTRUCTION IN ACCORDANCE WITH THE EROSION AND SEDIMENTATION CONTROL PLAN.
3. ALL TRAFFIC CONTROL OPERATIONS SHALL COMPLY WITH AS1742.3 – 2009 AND WSC's TRAFFIC CONTROL AT WORK SITES MANUAL.
4. DESIGN OFFICE TO BE ADVISED IF CONSTRUCTION ACTIVITY WILL DISTURB SURVEY CO-ORDINATION MARKS (PMs AND SSMs).
5. ALL SERVICES TO BE EXPOSED IN THE AFFECTED AREA PRIOR TO COMMENCEMENT OF CONSTRUCTION.
6. ONLY TREES IDENTIFIED TO BE REMOVED HAVE BEEN APPROVED FOR REMOVAL.

INTERCEPT FLOW FROM EXISTING 900ø PIPES AND DIRECT TO EXISTING BOX CULVERT USING TEMPORARY 750ø PIPES. RE-DIRECT TO NEW BOX CULVERTS AT COMPLETION OF STAGE.
LIMIT OF STAGE 2
CENTRELINK 25 HELY STREET LOT 67 DP 1009123
ENSURE ENOUGH CLEARANCE TO PROPOSED SEWER MANHOLE
REMOVE EXISTING 3000 x 900 BOX CULVERTS
DISMANTLE DECK. TO BE REBUILT BY OTHERS AT COMPLETION OF CONSTRUCTION
REMOVE EXISTING 900ø PIPES
SEE PIT DETAILS ON SHEET 20
FOR STAGE 3 CONSTRUCTION DETAILS REFER TO SHEET 6
STN 38 STPK RL 5.932
RELOCATE: 50mm NY GAS MAIN TO BE REMOVED FROM LANE DURING CONSTRUCTION
RELOCATE: 225mm VC SEWERMAIN TO BE RELOCATED DURING CONSTRUCTION REFER TO PLAN No. 13810
REMOVE AND/OR SEAL EXISTING SEWER MAIN
OASIS YOUTH CENTRE 15 HELY STREET LOT 5 SECTION 1 DP 3136
REMOVE FENCES AS REQUIRED
RE-INSTATE EXISTING KERB
SEE PIT DETAILS ON SHEET 20
RE-DIRECT EXISTING DRAINAGE TO PIT
REMOVE LARGE PIT
29 HELY STREET LOT 8 SECTION 1 DP 3136
31 HELY STREET LOT 9 SECTION 1 DP 3136
33 HELY STREET LOT 112 DP 555924
FIRST TEMPORARY SEWER DIVERSION TO BE LAID DURING CONSTRUCTION
INSERT EXISTING DRAINAGE INTO BOX CULVERT AT CENTRE OF UNIT
RELOCATE: 50mm NY GAS MAIN TO BE REMOVED FROM LANE DURING TO CONSTRUCTION
INSERT 300ø STUB INTO BOX CULVERT AT CENTRE OF UNIT SEE DETAILS ON SHEET 20
STN 25 DH&W IN PATH RL 5.504
LOT 1 DP 123075 WYONG GROVE PUBLIC SCHOOL (CLOSED)
CAUTION: 150mm STEEL HIGH PRESSURE GAS MAIN
RELOCATE: 100mm AC WATERMAIN TO BE REMOVED DURING CONSTRUCTION AND REPLACED AT COMPLETION OF WORKS
RELOCATE: 225mm VC SEWERMAIN TO BE UPGRADED AND RELOCATED DURING CONSTRUCTION REFER TO PLAN No. 13810
CAUTION: 300mm PP SEWERMAIN INV RL 2.95 REFER TO PLAN 13810 PROVIDE CONCRETE SUPPORT CRADLES
HARDWARE LANE
LINE 1
ROAD
675ø
PROPOSED DRAINAGE EASEMENT
REMOVE KERB
STN 32 GIN RL 5.337
STN 36 GIN RL 5.402
REGRADE AND PROVIDE ROAD BASE FOR TURNING AREA
RELOCATE: 150mm VC SEWERMAIN TO BE RELOCATED DURING CONSTRUCTION REFER TO PLAN 13810
STN 28 NAIL RL 5.169
SEE PIT DETAILS ON SHEET 20
SEAL 900ø DRAINAGE AT COMMENCEMENT OF CONSTRUCTION
SEAL 900ø DRAINAGE AT COMPLETION OF CONSTRUCTION
PROPOSED DRAINAGE EASEMENT
REMOVE EXISTING DRAINAGE
SECOND TEMPORARY SEWER DIVERSION TO BE LAID DURING CONSTRUCTION
SEE PIT DETAILS ON SHEET 20
CAUTION: 100mm AC TELSTRA TO BE FULLY SUPPORTED DURING CONSTRUCTION REFER TO WORK METHOD STATEMENT
RELOCATE: POWER POLE TO BE RELOCATED PRIOR TO CONSTRUCTION
RESTORE KERB & LAYBACKS TO EXISTING LEVELS
REMOVE EXISTING DRAINAGE
RESTORE KERB & LAYBACKS TO EXISTING LEVELS
CAUTION: 150mm STEEL HIGH PRESSURE GAS MAIN
RELOCATE: SERVICE POLE TO BE RELOCATED RELOCATED PRIOR TO CONSTRUCTION
SEE PIT DETAILS ON SHEET 20
LINE 8
RECONSTRUCT EXISTING ACCESS
JOINS SHEET 5
144 PACIFIC HIGHWAY LOT 2 DP 1041502
144 PACIFIC HIGHWAY LOT 1 DP 1041502
146 PACIFIC HIGHWAY LOT 14 DP 658934
146 PACIFIC HIGHWAY LOT 13 DP 658933
FUTURE ALDI SUPERMARKET
148 PACIFIC HIGHWAY PT LOT 12 SECTION 1 DP 3136
148 PACIFIC HIGHWAY PT LOT 11 SECTION 1 DP 3136
NORTH
CAUTION: MINOR TELSTRA NOT LOCATED
2 x 525ø
STN 100 GIN RL 4.328
RELOCATE: WATER SERVICE TO BE RELOCATED DURING CONSTRUCTION
375ø
BOX CULVERT 1.2 WIDE
3 BOX CULVERTS 1.2 WIDE
PACIFIC HIGHWAY

PLAN – STAGE 2
SCALE 1:200



CULVERT TYPICAL SECTION (A)
SCALE 1:50



CULVERT TYPICAL SECTION (B)
SCALE 1:50

NOTES ON CONSTRUCTION SEQUENCE:

1. LAY 375mm SEWERMAIN FROM DOWNSTREAM END TO MANHOLE IN NORTH ROAD. CONTINUE WITH 300mm SEWERMAIN ALONG HARDWARE LANE FOR 10.4m AND CUT-IN TO EXISTING SEWERMAIN IN HARDWARE LANE WITH FIRST 225mm TEMPORARY SEWER DIVERSION. CUT-IN TO EXISTING SEWERMAIN AT DOWNSTREAM END. REFER TO PLAN 13810.
2. SEAL OFF 900ø DRAINAGE PIPE IN LARGE PIT IN HARDWARE LANE TO DIRECT ALL FLOW DOWN 900ø DRAINAGE PIPE THROUGH PROPOSED ALDI SUPERMARKET SITE.
3. CONSTRUCT BASIN AND INSTALL BOX CULVERTS AS FAR AS HARDWARE LANE, PLACING BASE SLAB ADJACENT TO FIRST TEMPORARY SEWER DIVERSION. LAY SECOND 225mm TEMPORARY SEWER DIVERSION ACROSS BASE SLAB, THROUGH ALDI SITE, AND CUT-IN TO EXISTING SEWERMAIN UPSTREAM OF PROPOSED SEWER MANHOLE. CONNECT EXISTING HOUSE SERVICE LINES TO THIS TEMPORARY DIVERSION.
4. CONTINUE WITH BOX CULVERT INSTALLATION, REMOVE EXISTING SEWERMAIN AND DRAINAGE, AND LAY ADJACENT SEWERMAIN PROGRESSIVELY. CONNECT SEWER HOUSE SERVICE LINES WHEN REQUIRED.
5. ONCE PIT 16 IS REACHED, INTERCEPT FLOW FROM EXISTING 900ø PIPES WITHIN OASIS CENTRE AND DIRECT TO EXISTING BOX CULVERT WITHIN CENTRELINK PROPERTY USING TEMPORARY 750ø PIPES. ENSURE ENOUGH CLEARANCE TO PROPOSED SEWER MANHOLE.
6. REMOVE CENTRELINK REAR AND SIDE FENCES AS REQUIRED, DISMANTLE DECK, REMOVE TREES AND CLEAR VEGETATION. REMOVE EXISTING 900ø PIPES ACROSS CENTRELINK AND REMOVE LARGE PIT IN HARDWARE LANE. FINISH LAYING 300ø SEWERMAIN THROUGH CENTRELINK.
7. CONNECT CENTRELINK SERVICE LINE AND CUT IN TO EXISTING SEWERMAIN. REMOVE SECTION OF EXISTING BOX CULVERTS WITHIN CENTRELINK TO ALLOW CONSTRUCTION OF NEW 150ø SEWERMAIN.
8. CONSTRUCT NEW 150ø SEWERMAIN, CUT IN TO EXISTING SEWERMAIN IN HARDWARE LANE, AND DISCONNECT TEMPORARY SEWER DIVERSION. FULLY REMOVE TEMPORARY SEWER DIVERSION FROM ALDI SITE. CONTINUE INSTALLATION OF NEW BOX CULVERTS ALONG HARDWARE LANE AND THROUGH CENTRELINK, REMOVING EXISTING DRAINAGE AND SEWERMAIN AS CONSTRUCTION PROGRESSES.
9. RE-DIRECT TEMPORARY 750ø PIPES IN OASIS CENTRE TO NEW BOX CULVERT ONCE THE LIMIT OF STAGE 2 IS REACHED. SEAL OFF BOX CULVERT OPENINGS AND BACKFILL UNTIL COMMENCEMENT OF STAGE 3 CONSTRUCTION.

REV.	DATE	AMENDMENT	DESIGNER'S INITIALS	DESIGN MGR INITIALS

APPROVED BY
FOR DIRECTOR OF INFRASTRUCTURE AND OPERATIONS
FINAL
24/03/14

Surveyed . . BARRY HUNT ASSOCIATES
Surveyor's Ref
Designed . . . . . DAVID FOGG
Structural Design
Drawn . . . . . DIANE MILLER
Passed
Design & Projects Manager

ORIGINAL SHEET SIZE A1
SCALE 0 2 4 8 12 16 1:200

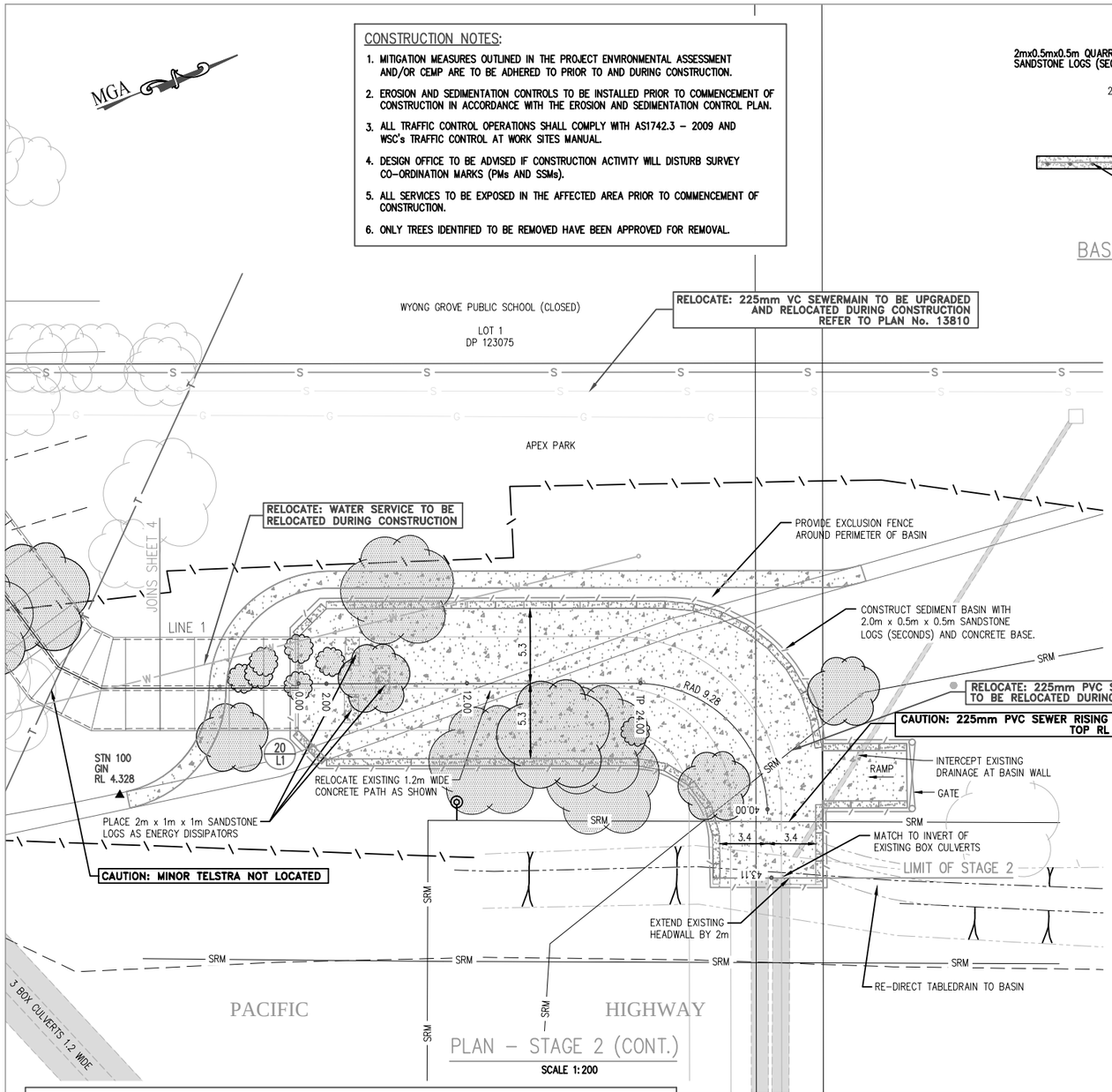
WYONG SHIRE COUNCIL
ABN 47 054 613 735
INFRASTRUCTURE AND OPERATIONS

WYONG CBD
PROPOSED TRUNK DRAINAGE CONSTRUCTION
PLAN – STAGE 2

TRIM FOLDER No.	DESIGN PROJECT No.	DATUM	SHEET No.	No. OF SHEETS	PLAN No.	REVISION
F2008/02050		AHD	4	30	13813	

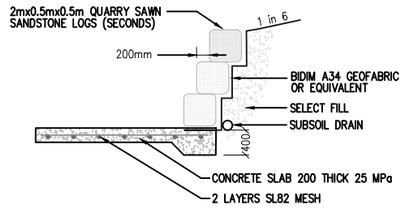
CONSTRUCTION NOTES:

1. MITIGATION MEASURES OUTLINED IN THE PROJECT ENVIRONMENTAL ASSESSMENT AND/OR CEMP ARE TO BE ADHERED TO PRIOR TO AND DURING CONSTRUCTION.
2. EROSION AND SEDIMENTATION CONTROLS TO BE INSTALLED PRIOR TO COMMENCEMENT OF CONSTRUCTION IN ACCORDANCE WITH THE EROSION AND SEDIMENTATION CONTROL PLAN.
3. ALL TRAFFIC CONTROL OPERATIONS SHALL COMPLY WITH AS1742.3 – 2009 AND WSC's TRAFFIC CONTROL AT WORK SITES MANUAL.
4. DESIGN OFFICE TO BE ADVISED IF CONSTRUCTION ACTIVITY WILL DISTURB SURVEY CO-ORDINATION MARKS (PMs AND SSMs).
5. ALL SERVICES TO BE EXPOSED IN THE AFFECTED AREA PRIOR TO COMMENCEMENT OF CONSTRUCTION.
6. ONLY TREES IDENTIFIED TO BE REMOVED HAVE BEEN APPROVED FOR REMOVAL.



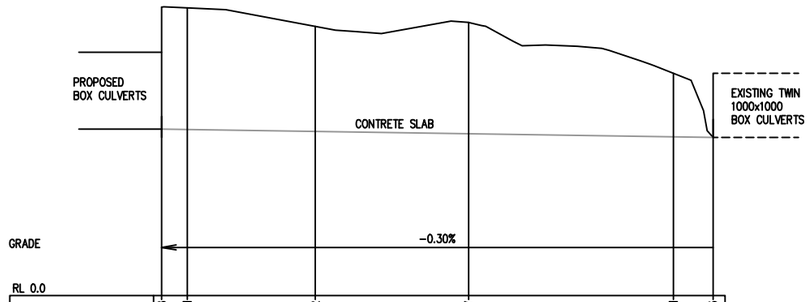
PLAN – STAGE 2 (CONT.)

SCALE 1:200



BASIN WALL DETAILS

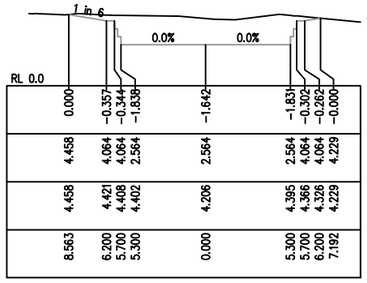
SCALE 1:50



CUT/FILL	-1.908	-1.901	-1.642	-1.737	-0.991	-0.283
DESIGN SURFACE	2.600	2.594	2.564	2.528	2.481	2.471
NATURAL SURFACE	4.508	4.495	4.206	4.266	3.472	2.754
CHAINAGE	0.000	2.000	12.000	24.000	40.000	43.113

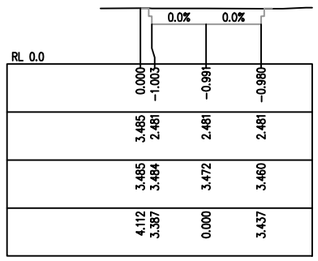
BASIN LONG SECTION

SCALE H 1:250 V 1:50



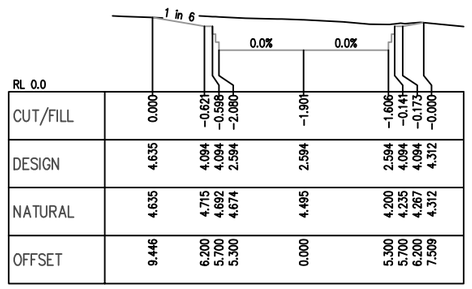
	0.000	-0.357	-0.344	-1.838	-1.642	-1.831	-0.302	-0.262	-0.000
	4.458	4.064	4.064	2.564	2.564	2.564	4.064	4.064	4.229
	4.458	4.421	4.408	4.402	4.206	4.395	4.366	4.326	4.229
	8.563	6.200	5.700	5.300	0.000	5.300	5.700	6.200	7.192

12.000



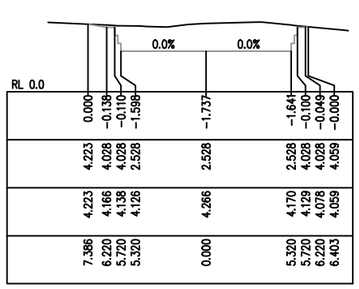
	0.000	-1.003	-0.991	-0.980
	3.485	2.481	2.481	2.481
	3.485	3.484	3.472	3.460
	4.112	3.387	0.000	3.437

40.000



CUT/FILL	0.000	-0.621	-0.598	-2.080	-1.901	-1.606	-0.141	-0.173	-0.000
DESIGN	4.635	4.094	4.094	2.594	2.594	2.594	4.094	4.094	4.312
NATURAL	4.635	4.715	4.692	4.674	4.495	4.200	4.235	4.267	4.312
OFFSET	9.446	6.200	5.700	5.300	0.000	5.300	5.700	6.200	7.509

2.000



	0.000	-0.139	-0.110	-1.599	-1.737	-1.644	-0.100	-0.049	-0.000
	4.223	4.028	4.028	2.528	2.528	2.528	4.028	4.028	4.059
	4.223	4.166	4.138	4.126	4.266	4.170	4.129	4.078	4.059
	7.386	6.220	5.720	5.320	0.000	5.320	5.720	6.220	6.403

24.000

BASIN CROSS SECTIONS

SCALE 1:200(NAT)

NOTES ON CONSTRUCTION SEQUENCE:

1. LAY 375mm SEWERMAIN FROM DOWNSTREAM END TO MANHOLE IN NORTH ROAD. CONTINUE WITH 300mm SEWERMAIN ALONG HARDWARE LANE FOR 10.4m AND CUT-IN TO EXISTING SEWERMAIN IN HARDWARE LANE WITH FIRST 225mm TEMPORARY SEWER DIVERSION. CUT-IN TO EXISTING SEWERMAIN AT DOWNSTREAM END. REFER TO PLAN 13810.
2. SEAL OFF 900ø DRAINAGE PIPE IN LARGE PIT IN HARDWARE LANE TO DIRECT ALL FLOW DOWN 900ø DRAINAGE PIPE THROUGH PROPOSED ALDI SUPERMARKET SITE.
3. CONSTRUCT BASIN AND INSTALL BOX CULVERTS AS FAR AS HARDWARE LANE, PLACING BASE SLAB ADJACENT TO FIRST TEMPORARY SEWER DIVERSION. LAY SECOND 225mm TEMPORARY SEWER DIVERSION ACROSS BASE SLAB, THROUGH ALDI SITE, AND CUT-IN TO EXISTING SEWERMAIN UPSTREAM OF PROPOSED SEWER MANHOLE. CONNECT EXISTING HOUSE SERVICE LINES TO THIS TEMPORARY DIVERSION.
4. CONTINUE WITH BOX CULVERT INSTALLATION, REMOVE EXISTING SEWERMAIN AND DRAINAGE, AND LAY ADJACENT SEWERMAIN PROGRESSIVELY. CONNECT SEWER HOUSE SERVICE LINES WHEN REQUIRED.
5. ONCE PIT 16 IS REACHED, INTERCEPT FLOW FROM EXISTING 900ø PIPES WITHIN OASIS CENTRE AND DIRECT TO EXISTING BOX CULVERT WITHIN CENTRELINK PROPERTY USING TEMPORARY 750ø PIPES. ENSURE ENOUGH CLEARANCE TO PROPOSED SEWER MANHOLE.
6. REMOVE CENTRELINK REAR AND SIDE FENCES AS REQUIRED, DISMANTLE DECK, REMOVE TREES AND CLEAR VEGETATION. REMOVE EXISTING 900ø PIPES ACROSS CENTRELINK AND REMOVE LARGE PIT IN HARDWARE LANE. FINISH LAYING 300ø SEWERMAIN THROUGH CENTRELINK.
7. CONNECT CENTRELINK SERVICE LINE AND CUT IN TO EXISTING SEWERMAIN. REMOVE SECTION OF EXISTING BOX CULVERTS WITHIN CENTRELINK TO ALLOW CONSTRUCTION OF NEW 150ø SEWERMAIN.
8. CONSTRUCT NEW 150ø SEWERMAIN, CUT IN TO EXISTING SEWERMAIN IN HARDWARE LANE, AND DISCONNECT TEMPORARY SEWER DIVERSION. FULLY REMOVE TEMPORARY SEWER DIVERSION FROM ALDI SITE. CONTINUE INSTALLATION OF NEW BOX CULVERTS ALONG HARDWARE LANE AND THROUGH CENTRELINK, REMOVING EXISTING DRAINAGE AND SEWERMAIN AS CONSTRUCTION PROGRESSES.
9. RE-DIRECT TEMPORARY 750ø PIPES IN OASIS CENTRE TO NEW BOX CULVERT ONCE THE LIMIT OF STAGE 2 IS REACHED. SEAL OFF BOX CULVERT OPENINGS AND BACKFILL UNTIL COMMENCEMENT OF STAGE 3 CONSTRUCTION.

LEGEND

Existing edge of bitumen		Water main/Hydrant/Stop valve	W
Existing kerb		Water meter	
Existing drainage		Power pole	
Proposed pipes		Light pole	
Proposed box culverts		Access	
Gas main	G	Survey station	
Sewer/Manhole	S	Tree	
Proposed sewer	S	Tree to be removed	
Sewer rising main	SRM	Drainage pit & line No.	L6 18
Telstra cables/Manhole	T		

REV.	DATE	AMENDMENT	DESIGNER'S INITIALS	DESIGN MGR INITIALS

APPROVED BY

FOR DIRECTOR OF INFRASTRUCTURE AND OPERATIONS

FINAL

24/03/14

Surveyed . . BARRY HUNT ASSOCIATES . . . . .
Surveyor's Ref . . . . . .
Designed . . . . . DAVID FOGG . . . . . .
Structural Design . . . . . .
Drawn . . . . . DIANE MILLER . . . . . .
Passed for Design & Projects Manager . . . . . .

ORIGINAL SHEET SIZE A1

SCALE 0 2 4 8 12 16 1:200

WYONG SHIRE COUNCIL

ABN 47 054 613 735

INFRASTRUCTURE AND OPERATIONS

Wyong Shire Council CENTRAL COAST

WYONG CBD

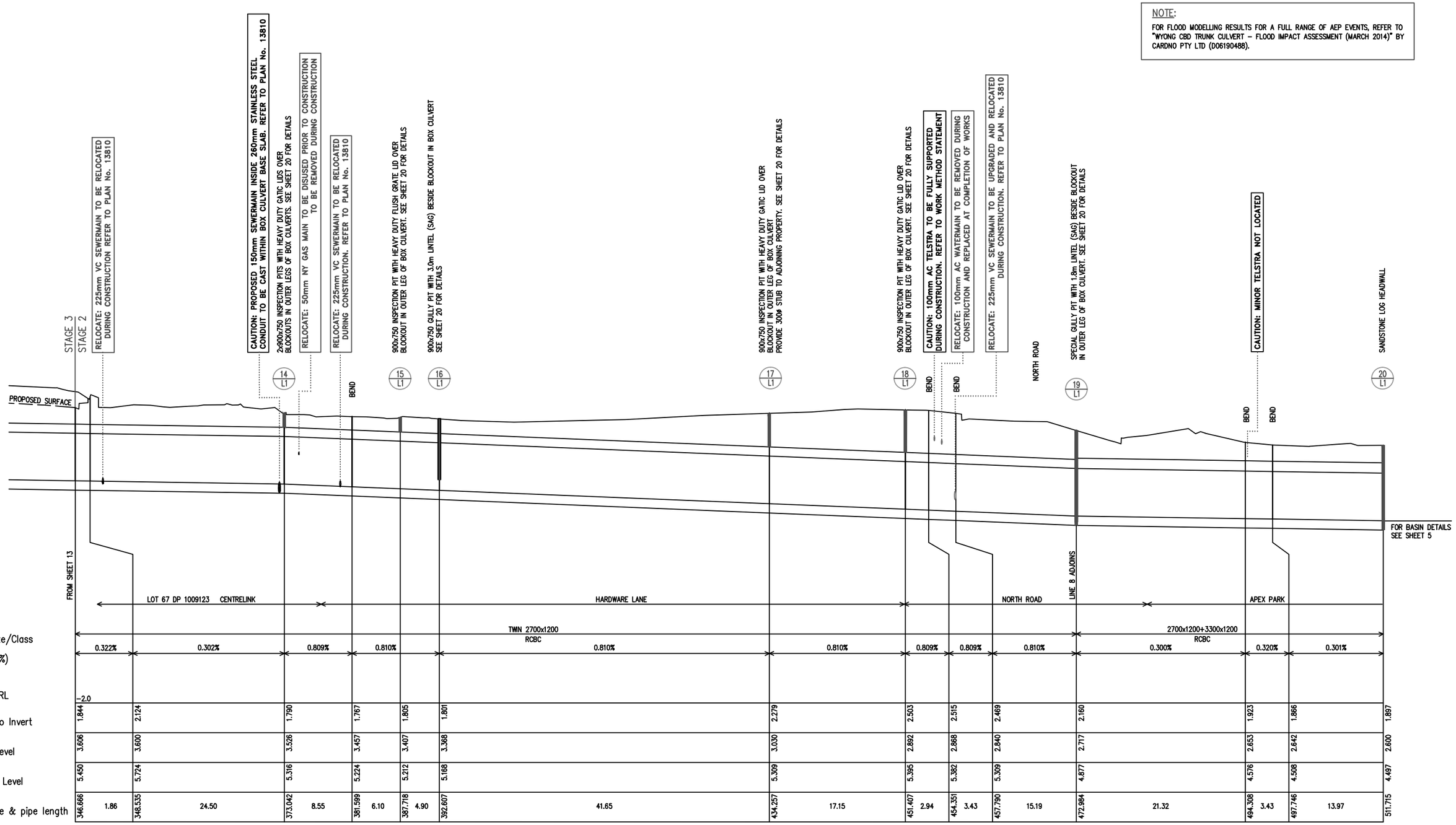
PROPOSED TRUNK DRAINAGE CONSTRUCTION

PLAN STAGE 2 (CONT.) AND BASIN LONG SECTION AND CROSS SECTIONS

TRIM FOLDER No.	DESIGN PROJECT No.	DATUM	SHEET No.	No. OF SHEETS	PLAN No.	REVISION
F2008/02050		AHD	5	30	13813	

NOTE:

FOR FLOOD MODELLING RESULTS FOR A FULL RANGE OF AEP EVENTS, REFER TO "WYONG CBD TRUNK CULVERT – FLOOD IMPACT ASSESSMENT (MARCH 2014)" BY CARDNO PTY LTD (D06190488).



LINE 1 (STAGE 2)

SCALE: H 1:250
V 1:50

REV.	DATE	AMENDMENT	DESIGNER'S INITIALS	DESIGN MGR INITIALS

APPROVED BY
FOR DIRECTOR OF INFRASTRUCTURE AND OPERATIONS
FINAL
24/03/14

Surveyed . . BARRY HUNT ASSOCIATES . . . . .
Surveyor's Ref . . . . . .
Designed . . . . . DAVID FOGG . . . . . .
Structural Design . . . . . .
Drawn . . . . . DIANE MILLER . . . . . .
Passed for
Design & Projects Manager . . . . . .

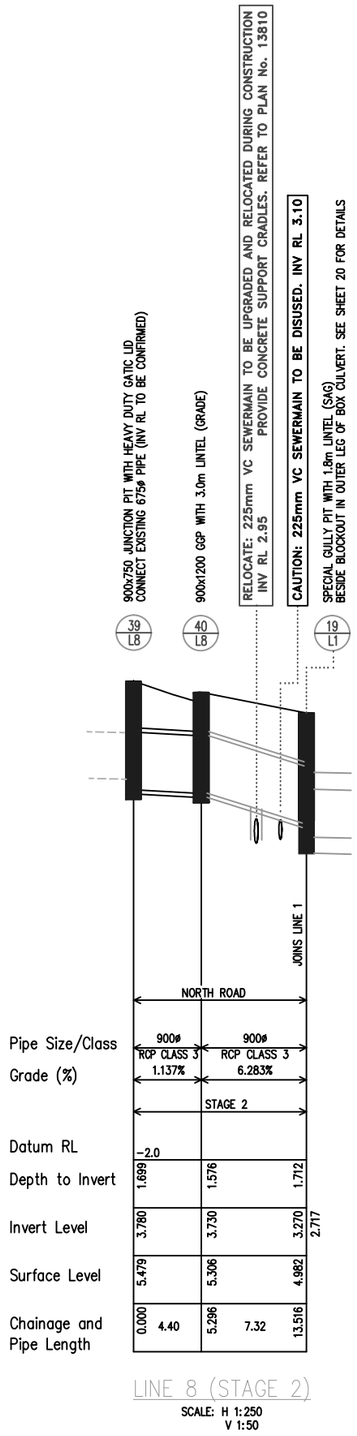
ORIGINAL SHEET SIZE A1

SCALE 0 2.5 5 10 15 20 1:250
0 0.5 1 2 3 4 1:50

WYONG SHIRE COUNCIL
ABN 47 054 613 735
INFRASTRUCTURE AND OPERATIONS

WYONG CBD
PROPOSED TRUNK DRAINAGE CONSTRUCTION
DRAINAGE LONG SECTION LINE 1 (STAGE 2)

TRIM FOLDER No.	DESIGN PROJECT No.	DATUM	SHEET No.	No. OF SHEETS	PLAN No.	REVISION
F2008/02050		AHD	14	30	13813	



LINE 8 (STAGE 2)

SCALE: H 1:250
V 1:50

NOTE:

FOR FLOOD MODELLING RESULTS FOR A FULL RANGE OF AEP EVENTS, REFER TO "WYONG CBD TRUNK CULVERT – FLOOD IMPACT ASSESSMENT (MARCH 2014)" BY CARDNO PTY LTD (D06190488).

REV.	DATE	AMENDMENT	DESIGNER'S INITIALS	DESIGN MGR INITIALS

APPROVED BY

FOR DIRECTOR OF INFRASTRUCTURE AND OPERATIONS

FINAL

24/03/14

Surveyed . . BARRY HUNT ASSOCIATES . . . . .
Surveyor's Ref . . . . . .
Designed . . . . . DAVID FOGG . . . . . .
Structural Design . . . . . .
Drawn . . . . . DIANE MILLER . . . . . .
Passed for
Design & Projects Manager . . . . . .

ORIGINAL SHEET SIZE A1

SCALE 0 2.5 5 10 15 20 1:250
0 0.5 1 2 3 4 1:50

WYONG SHIRE COUNCIL
ABN 47 054 613 735
INFRASTRUCTURE AND OPERATIONS

WYONG CBD
PROPOSED TRUNK DRAINAGE CONSTRUCTION
DRAINAGE LONG SECTION LINE 8 (STAGE 2) AND PIT SCHEDULE

TRIM FOLDER No.	DESIGN PROJECT No.	DATUM	SHEET No.	No. OF SHEETS	PLAN No.	REVISION
F2008/02050		AHD	15	30	13813	

APPENDIX D: WYONG TOWN CENTRE WBNM HYDROLOGY

The Wyong Town Centre catchment has been assessed using the Watershed Bounded Network Model (WBNM) hydrological modelling program. The catchment covers an area of approximately 105 hectares.

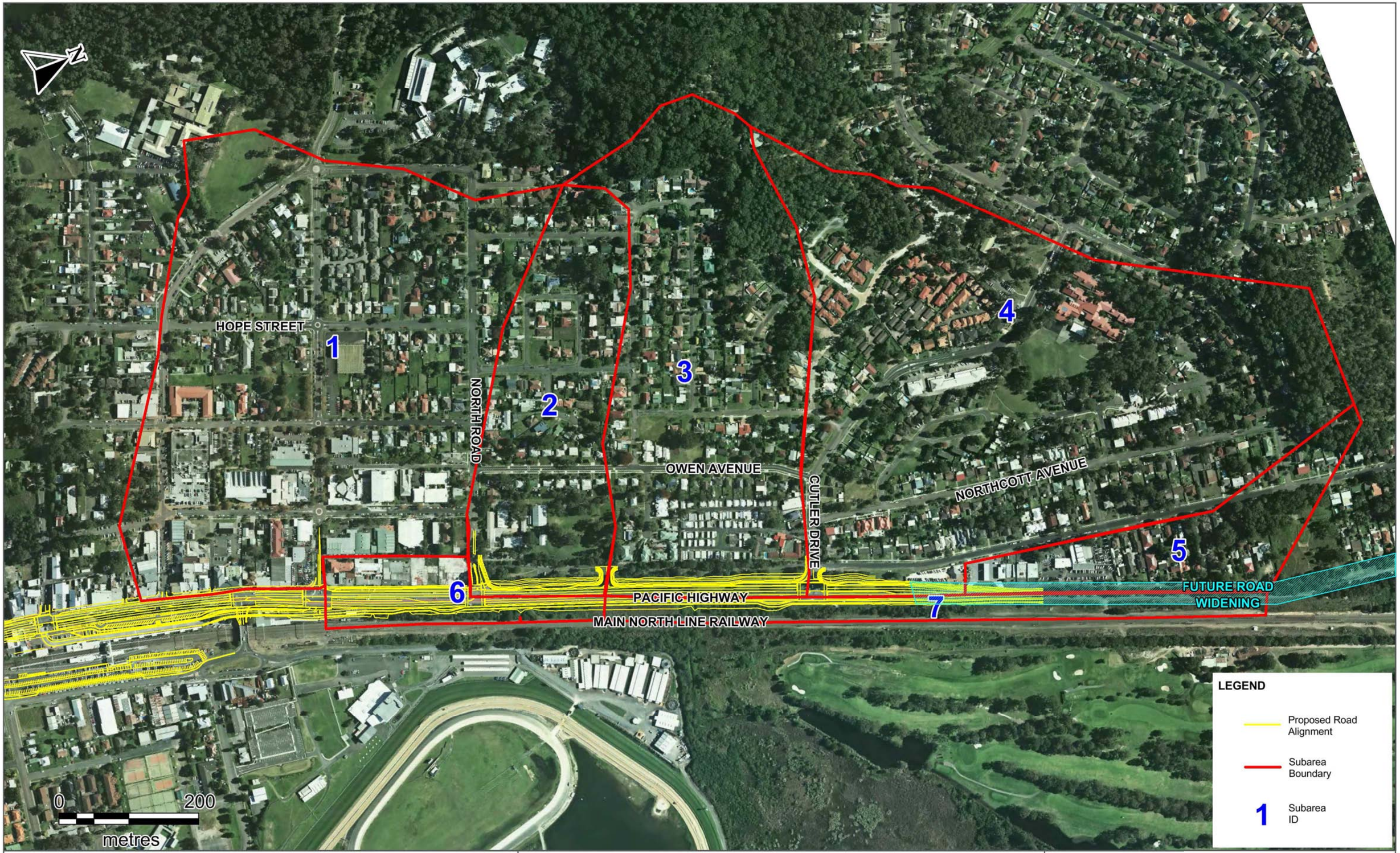
The main catchment was delineated into sub-catchment areas, referred to as “subareas” in WBNM.

The WBNM hydrology model sub-catchment areas are shown in Table D-1. Refer to the attached figure for the layout of the WBNM sub-catchments.

Table D-1 – Summary of Model Alterations

Subarea Name	Downstream Subarea	Area (ha)	Impervious Fraction	Comment
1	2	29.47	60%	
2	COMBHWY	10.00	50%	
3	COMBHWY	18.00	50%	
4	3	33.20	60%	
5	4	5.40	50%/60%	50% in the existing base-case 60% in the proposed case includes provision for future road widening (i.e. next stage of Pacific Highway upgrade)
6	COMBRAIL	2.60	40%	
7	COMBRAIL	3.40	30%	
COMBHWY	COMBRAIL	0.1	50%	Dummy subarea for receiving total flows upstream of highway.
COMBRAIL	SINK	0.1	50%	Dummy subarea for receiving total flows upstream of railway.
TOTAL		**105**		

Page intentionally left blank



DATE 09/10/2014	**COORDINATE SYSTEM** MGA 94 Zone 56	**FIG NO.** WY-LAYOUT-A1	**FIGURE TITLE** Wyong Town Centre WBNM Model Sub-catchment Layout
PROJECT NO. 3001424	**PROJECT TITLE** Wyong Town Centre Upgrade	**CREATED BY** D. Duong	**LOCATION** T:\Projects\3001424\

SMEC
Local People. Global Experience.

APPENDIX E: CONSULTATION DOCUMENTATION

Page intentionally left blank

MEETING RECORD

PROJECT NAME: Pacific Highway Upgrade through Wyong Town Centre
SMEC PROJECT NUMBER: 3001424
CLIENT PROJECT NUMBER: 13.2533.1992

MEETING TITLE: WTC-PM-016-MINX-01 – Wyong Flood Modelling

VENUE:	Wyong Shire Council Civic Centre	**START TIME:**	2:00 PM
MEETING DATE:	24/06/2014	**FINISH TIME:**	3:00 PM
DISTRIBUTION:	Attendees + key project team	**RECORDER:** MC	**CHECKED BY:** AJ

ATTENDEES	NAME		ORGANISATION	NAME		ORGANISATION
	Joe Clarke	JC	SMEC	Adam Mularkzyk	AM	WSC
	Michael Corrigan	MC	SMEC	Pete Styles	PS	RMS
	Peter Sheath	PS2	WSC			

RECORD OF DISCUSSION

ITEM	DETAILS	ACTION BY	DATE
1.0	**Project Overview/Status**		
1.1	PS provided an update on the current project status including a description of the following ongoing design activities which will lead to significant changes from the strategic design previously issued to Wyong Shire Council: → Allowance for future rail quadruplication from Tuggerah to Warnervale - Town centre strategic optioneering. → Provision of twin road bridges over Wyong River (to deal with flooding impacts).	Note	
2.0	**Hydrology and Hydraulics Report**		
2.1	PS2 has reviewed the Draft Flooding Assessment and had the following comments: → Afflux impacts on upper catchment include a SEPP 14 wetland and future release industrial area. → Afflux impacts also affect nursing home and local school (Wyong Christian Community School (SES flood evacuation plan which includes nursing home and school was tabled by PS2).	Note	
2.2	JC gave a description of the modelling methodology and results of updates to the Town Centre flood model. → PS suggested that the Pacific Highway be graded to provide 100mm freeboard above the 1 in 100 year flood event. → PS2 was concerned that Apex Park model is only 1D. → PS has asked SMEC to advise the additional effort to convert the Town Centre model to 2D.	MC/JC	
3.0	**Design ARI's and allowable afflux limits**		
3.1	PS2 has requested to see 1 in 10 flood impacts as part of the assessment. PS2 is also interested in 1 in 200 event. JC explained that the brief calls for ARI 1, 5, 10, 50, 100 and Probable Maximum Flood. PS suggested that SMEC model the 1 in 200 event in addition to the events required from the brief.	JC	
3.2	PS2 confirmed that the modelling tolerances for afflux (10 – 20mm) would be at the upper limit acceptable by council.	Note	
3.3	Downstream impacts of up to 10mm afflux are acceptable.	Note	

MEETING RECORD (Cont'd)

RECORD OF DISCUSSION			
ITEM	**DETAILS**	**ACTION BY**	**DATE**
4.0	**Allowance for Blockage**		
4.1	JC explained that the current flood modelling has assumed no blockage. PS2 advised that 10% blockage of bridges and major culverts should be assumed.	JC	

FUTURE MEETINGS			
SUBJECT	**VENUE**	**TIME**	**DATE**

WYONG RIVER - NAVIGATION REQUIREMENTS

From: Stephen Brown [mailto:Stephen.Brown@rms.nsw.gov.au]
Sent: Wednesday, 2 April 2014 11:16 AM
To: Scott, Irene
Cc: Jackson, Antony; Corrigan, Michael; WTCupgrade
Subject: RE: Wyong River navigation requirements
Importance: High

Good Morning Irene

As requested I have provided comment to your questions regarding the proposed new bridge structure for Wyong.

- **Number of navigation channels under the bridge:** Currently we have two navigable channels under the existing bridges, even though the existing pylons are not in line it has not been a real problem for navigation as the boating traffic that frequents the area are small vessels up to 10m with low cabin height so they can transit under the bridge, the river is speed gazetted to 4 knots.

- **The width of each of the navigation channels:** The existing channels between the pylons and shore is approximately 20m in width.

- **The vertical clearance required:** The reported clearance between Mean High Water (highest tidal water) and the lowest bridge structure is 3.0m; any proposed new structure must not further reduce this height as small half cabin/BBQ pontoon style vessel transit this area and currently just make it under the existing bridges.

- **Preferred pier orientation:** RMS preferred in water pylon placement would be to align with one of the existing in water pylons (Road /Rail Bridge) in order to maintain a channel as per the current channel widths.
-
- **Navigational lighting requirements – type of lights, and location**: currently RMS do not have any marked preferred channel through these structures as the boating traffic that frequents this area is generally minimal. If RMS was to formalise the upstream and downstream channels we would only sign post with Port and Starboard day shapes.

- **Navigational signage requirements – type of sign and location**: If possible RMS would request approval to install 4 knot and No Wash signage on the bridge pylons in order to make these signs highly visible.

- **Type of vessels that use the river**: Wyong River is used mainly by small recreational craft, passive craft (canoes/kayaks/rowing skulls) and commercial fishing vessels (again small open runabouts).

- **The size:** The maximum size vessel would be up to 10m (pontoon style craft), the **maximum weight:** approximately 3 tonnes, maximum **speed** of vessels that use the river is 4 knots.

Regards

Stephen Brown
Manager Operations Hawkesbury River/Broken Bay
Sydney Area **|** Boating Operations Branch
T 02 9477 6429 F 02 94773418 M 0418 869 264
www.rmservices.nsw.gov.au

Roads and Maritime Services
4 Bridge Road HORNSBY NSW 2077
PO Box 965 HORNSBY NSW 1630

From: Scott, Irene [mailto:Irene.Scott@smec.com]
Sent: Tuesday, 1 April 2014 4:17 PM
To: Stephen Brown
Cc: Jackson, Antony; Corrigan, Michael; WTCupgrade
Subject: RE: Wyong River navigation requirements

Hi Stephen,

Can you please advise how you are going with determining the information requested?

From a recent meeting with RMS Bridge Branch it seems that the River is only used by private boats, not commercial vessels. Can you confirm this?

Thank you.

Kind regards
Irene Scott | Principal Engineer - Bridges
SMEC Australia
T +61 2 9900 7040 | **M** +61 400 688 072

From: Scott, Irene
Sent: Wednesday, 19 March 2014 3:59 PM
To: 'stephen.brown@rms.nsw.gov.au'

Cc: Jackson, Antony; Corrigan, Michael; WTCupgrade
Subject: Wyong River navigation requirements

Hi Stephen,

This email is a follow up from our brief discussion on the phone this afternoon.

SMEC has been commissioned by RMS to undertake the concept design for the Wyong Town Centre Upgrade. Part of the project scope is to provide a concept design of a new bridge over the Wyong River, which is on the western side of the existing road bridge.

The proposed bridge spans are 32 metres in length. The proposed bridge currently has three piers – two on the edge of the bank and one in the river. We have positioned Pier 2 approximately in the centre of the river, however, if we are to line up the piers, we will have two piers completely in the river. It is probable that the orientation of the piers may be changed to accommodate the river flow direction.

The piers of all three bridges do not currently line up.

The span lengths of the existing road bridge is: 16.76m, 20.12m, 20.12m, 20.12m, 16.76m
The span lengths of the existing rail bridge is: 25m, 25m, 25m and 25m

I have attached some preliminary drawings for your information. Please note that these drawings are confidential and are not to be forwarded on to Council or other stakeholders.

Can you please provide the following navigation requirements:

- Number of navigation channels under the bridge
- The width of each of the navigation channels
- The vertical clearance required
- Preferred pier orientation
- Navigational lighting requirements – type of lights, and location
- Navigational signage requirements – type of sign and location
- Type of vessels that use the river
- The size, the maximum weight, maximum speed of vessels that use the river

Kind regards,

Irene Scott | Principal Engineer - Bridges
SMEC Australia
Level 5, 20 Berry Street, North Sydney, NSW, 2060, Australia
(PO Box 1052, North Sydney, NSW, 2060, Australia)
T +61 2 9900 7040 | **F** +61 2 9925 5566 | **M** +61 400 688 072
irene.scott@smec.com | www.smec.com | LinkedIn

SMEC SNOWY MOUNTAINS ENGINEERING CORPORATION

Local People. Global Experience.

APPENDIX F: DESIGN DEPARTURES REGISTER

Page intentionally left blank

Pacific Highway Upgrade through Wyong Town Centre

Design Departures Register

Description of Services - Agreed Exceptions										
Item	**Description of Services Reference**	**Design Lot**	**Discipline**	**Location**	**Description of design criteria**	**Description of the non-conformance or departure from standard**	**Action**	**Date Issued**	**Date Closed Out**	**Status**
27	Description of Services - Pacific Highway Upgrade through Wyong Town Centre 3.4 Hydrology and hydraulics 3.4.3 Performance requirements	WTC-DR-001	Hydrology	Johnson Road to McPherson Road	Carriageway flood immunity requirement	Carriageways are to be designed to not be inundated for the 100 year ARI flood event. The Pacific Highway between Johnson Road and McPherson Road is inundated by the 100 year ARI Wyong River flooding.	The Pacific Highway at this location is to be designed to have an immunity no less than the existing condition.	10/10/2014		
28	Description of Services - Pacific Highway Upgrade through Wyong Town Centre 3.4 Hydrology and hydraulics 3.4.3 Performance requirements	WTC-DR-001	Hydrology	North Road to Cutler Drive	Carriageway flood immunity requirement	Carriageways are to be designed to not be inundated for the 100 year ARI flood event. The Pacific Highway between North Road and Cutler Drive is inundated by the 100 year ARI local catchment flooding.	The Pacific Highway at this location is to be designed to have an immunity no less than the existing condition. Trafficable lanes in the 100 year ARI flood event are to be provided where feasible.	10/10/2014		
29	Description of Services - Pacific Highway Upgrade through Wyong Town Centre 3.4 Hydrology and hydraulics 3.4.3 Performance requirements	WTC-DR-001	Hydrology	North Road	Serviceability effects of afflux on adjacent properties	Council has specified a requirement for a maximum of 10 mm afflux at properties. At North Road, there is localised afflux of up to 40 mm indicated for the adjacent property in the 100 year ARI event.	The proposed WTC Upgrade reduces water levels downstream of the Hardware Lane culvert (i.e. upstream of culvert C1690) by 10 to 50 mm. Therefore, there is adequate capacity to drain this area. The local drainage and road design may be consolidated to remove the localised afflux.	12/06/2015		
30	Description of Services - Pacific Highway Upgrade through Wyong Town Centre 3.4 Hydrology and hydraulics 3.4.3 Performance requirements	WTC-DR-001	Hydrology	North Road and Cutler Drive	Carriageway flood immunity requirement	Carriageways appear partially inundated by local for events as low as 5 year ARI at these locations. The (desirable) requirement for pavement drainage is nil width of flow in the 10 year ARI.	The longitudinal drainage will need to be consolidated with the hydraulic modelling to improve the apparent flooding immunity. Localised increase in road level may need to be investigated to achieve this.	12/06/2015		
31	Description of Services - Pacific Highway Upgrade through Wyong Town Centre 3.4 Hydrology and hydraulics 3.4.3 Performance requirements	WTC-DR-001	Hydrology	McPherson Road Car Yard	Serviceability effects of afflux on adjacent properties	Council has specified a requirement for a maximum of 10 mm afflux at properties. At the McPherson Rd car yard, there is localised afflux up to 20 mm indicated in the 20 year ARI event.	The local drainage and road design may be consolidated to remove the localised afflux.	12/06/2015		