Corridor Options Report
Corridor Options Report

Client: Australian Rail Track Corporation Limited
ABN: 75081455754

Prepared by
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Quality Information

Document | Corridor Options Report
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Ref | 60492124
Date | 21-Apr-2017
Prepared by | Lindsay Klein
Reviewed by | Luke Smith

Revision History

<table>
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<tr>
<th>Rev</th>
<th>Revision Date</th>
<th>Details</th>
<th>Authorised Name/Position</th>
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<td>21-Apr-2017</td>
<td>For Client Issue</td>
<td>Robert Green</td>
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<td>Technical Director - Rail</td>
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Appendix A

PRG Terms of Reference
Yelarbon to Gowrie
Project Reference Group

Purpose of the Group

A Project Reference Group (PRG) will be established for the Yelarbon to Gowrie section of Inland Rail. The purpose of the PRG will be to provide local, representative input in the review of alignment options for this section of the project, specifically (map attached for reference):

- current route (endorsed in 2015 by the Inland Rail Implementation Group) from Inglewood through Millmerran
- a route through Karara and Leyburn
- a route closer to Warwick.
- a route or connection to the Charlton and Wellcamp areas

The PRG’s key role will be to:

- **Review and comment on the commissioned investigation work** on the alternative routes, raising any concerns or suggesting feasible enhancements to the proposed approach, method, inclusions and process – the purpose of this review is to ensure the investigations are viewed as rigorous and valid by the community and that potential gaps in approach are not identified at a later time.

- **Provide feedback on investigation findings** as they are shared, including commentary on perceived validity of the results, additional information required and any associated issues that may be raised as a result of these findings.

- **Provide local input into investigations**, particularly where anecdotal data and local knowledge will assist in enhancing investigations or shaping the process.

- **Seek feedback and input from local networks** on specific issues as requested, including taking information back to their individual networks for discussion and formal response.

- **Provide formal commentary to media through the Chair** on the progress of the review process to update the community.

- **Provide recommendations on the alignment** and endorsement of the rigor behind the comparative analysis of the various options.

The PRG will operate as a minimum for the lifespan of the alternative route analysis, but may be extended or expanded for ongoing or later use during Phase 2 (Environment and Planning Approvals).

Roles

The following key roles will support the management of the PRG:
**Chair**

The Chair will be appointed by the Minister for Infrastructure and Transport.

The Chair will be responsible for ensuring all member issues and interests are captured on the agenda for each meeting, that full and complete discussion is facilitated in each meeting and that an open and transparent process is implemented.

The Chair will work with the Secretariat to prepare an agenda for each meeting that captures both community and project interests.

The Chair will provide a Report to the Minister on the outcomes of the PRG.

**Members**

Due to the short timeframe for both establishment and operation of this group, it has been open to representatives of identified local industry bodies.

Local industry bodies were identified across each alternative alignment geographic area and contacted to identify their interest in providing a representative to sit on the group. A follow up email explaining the purpose and time commitment of the group will be sent. For the purpose of this investigation, local industry groups include:

- Farming peak bodies and organisations
- Chambers of Commerce and business groups
- Environmental and conservation organisations
- Community and progress associations.

The size of the group will be subject to finalisation with the Chair.

**Observers**

In addition, representatives of each Council (Toowoomba, Goondiwindi, Southern Downs), each State and Federal MP, as well as TMR, DAF and DEHP, were invited to attend each meeting in the capacity of an observer. The purpose of these observers is to ensure direct transparency back to these elected representatives, to respond to any legislative or local law question as appropriate and to provide a direct line of communication for requests of information back to elected officials. It is not anticipated that the observers will participate directly in discussion of agenda items, unless specifically requested as their role is more around transparency and reporting and inputting.

Should it be desired to maintain the group longer term or to expand its membership for future use, Expressions of Interest will be taken at upcoming Community Information Sessions to enable broader community and landowner involvement post completion of this route investigation.

**Terms of Reference**

The Terms of Reference (TOR) will be discussed and signed off by all PRG members at the first meeting to ensure agreement to their inclusions.

Members of the PRG will undertake to participate under the following key principles:

1. **Commitment to constructive discussion** – open and honest dialogue that aims to add value and problem solve, not detract or criticise
2. **Commitment to share information as appropriate** – take update information back to member networks as a mechanism for broader community awareness of the investigations, process and findings and seek feedback from these communities as requested.

3. **Commitment to a like for like determination on the alignments** – open and transparent review of information based on technical, engineering and economic principles as well as the benefits and impacts on communities.

4. **Commitment to confidentiality as requested** – where information discussed has the potential to cause distress to individuals or communities (for example any detailed alignment impacts that are not yet confirmed) members may be requested to keep this confidential. This is not to reduce the openness or transparency of the meetings but to protect other community members for unnecessary angst from an impact that may not be realised due to the final route and detailed planning not yet being confirmed. Members will be advised prior to and post discussion of any confidential item; this will ensure their awareness of any confidentiality requirements.

5. **Review, feedback and information gathering body** – the role of the PRG is to review, challenge, collect and share data and input community views.

6. **Commitment to delivering a final report through the Chair** with recommendations on the review of the alignments and endorsement of the comparative analysis behind these recommendations. The final Inland Rail alignment will be a decision of the Commonwealth Government.
Appendix B

Corridor Maps
LEGEND

- Place names gazetteer
- Base Case Modified
- Wellcamp-Charlton
- Karara-Leyburn
- Warwick
- Existing Railway
- Main Roads

PRELIMINARY. NOT FOR CONSTRUCTION. FOR INFORMATION PURPOSES ONLY. ROUTES ARE APPROXIMATE ONLY.

ARTC

PROJECT OVERVIEW
CONCEPTUAL CORRIDOR ROUTES

Yelarbon to Gowrie (Y2G) Project

Data sources: © State of Queensland
Department of Environment and Heritage Protection 2016
StreetPro © 2014 Pitney Bowes Software Pty Ltd
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AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so... AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.
Appendix C

PRG Inputs
## Information Received from PRG

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<td>Millmerran Rail Group</td>
<td>Guided tour of Condamine River floodplain</td>
<td>18-Jan-17</td>
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<td>Millmerran Rail Group</td>
<td>Evaluation of flood and waterway impacts</td>
<td>30-Jan-17</td>
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<td>Millmerran Farmers Group</td>
<td>Hydrology data package</td>
<td>6-Feb-17</td>
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<td>Condamine Alliance</td>
<td>2 x Summary of environmental and planning data sets</td>
<td>8-Feb-17</td>
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<td>Paul and Cate Cousen</td>
<td>Video and photos of Walingford Rd flooding</td>
<td>8-Feb-17</td>
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<td>Millwood Landholders</td>
<td>Submission re: option assessment and MCA process</td>
<td>8-Feb-17</td>
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<td>Friends of Felton</td>
<td>Submission re: option assessment process</td>
<td>10-Feb-17</td>
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<td>Millmerran Rail Group</td>
<td>Submission re: option assessment and MCA process</td>
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<td>Millwood Farmers Group: Wayne Saal</td>
<td>Submission re: community and property impacts, MCA workshop, drop in sessions and PRG 2 presentation</td>
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<td>Heavy Vehicle Transport Association: Ross Fraser</td>
<td>Submission re: option assessment process</td>
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<td>Warwick Chamber of Commerce: Gary Hayes</td>
<td>Submission re: property access</td>
<td>16-Feb-17</td>
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<td>Queensland Murray-Darling Committee Inc</td>
<td>Submission re: route mapping and natural assets</td>
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<td>Warwick Chamber of Commerce: Gary Hayes</td>
<td>Hardcopy sketch of alternative Warwick bypass route</td>
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<td>Millwood Farmers Group: Wayne Saal</td>
<td>Question post-PRG 3 regarding the source of land use data</td>
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<td>Millmerran Rail Group</td>
<td>Photos of flooding around Doug Hall Poultry</td>
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<td>Friends of Felton</td>
<td>Submission re: Rating of Karara-Leyburn-Felton (KLF) Y2G Alignment Relative to Base Case and Several Criteria Critical to KLF Community</td>
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### Post Drop-In Session submissions to DIRD

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<td>Gary Cousen</td>
<td>Letter re: Inland Rail Brookstead to Mt Tyson</td>
<td>16-Mar-17</td>
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<td>Vicki Green</td>
<td>Feedback Form: Offer to host farm visit to Ellangowan</td>
<td>17-Mar-17</td>
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<td>Lisa and Daniel Cavanagh</td>
<td>Letter re: Letter of Concern regarding inland rail Yelarbon to Gowrie Project Reference Group</td>
<td>17-Mar-17</td>
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<td>Ian and Karen Kronk</td>
<td>Letter re: Inland Rail Project – Proposed Brookstead to Mt Tyson Section</td>
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Appendix D

Drop-In Sessions Advertisement
INLAND RAIL - YELARBON TO GOWRIE
Community Drop-In Sessions

Inland Rail is a new 1700km freight rail connection between Melbourne and Brisbane, via regional Victoria, New South Wales and Queensland.

The Inland Rail Queensland Community Advisor, Mr Bruce Wilson AM, invites you to attend a community drop-in session about the Inland Rail alignment review between Yelarbon and Gowrie.

Mr Wilson will give an update on the current status of the review and answer your questions.

For more information about Inland Rail, visit www.inlandrail.com.au

COMMUNITY DROP-IN SESSIONS
Time: 1-4pm, Wednesday 8 March 2017
Venue: Millwood Hall, Millmerran Inglewood Road, Millwood

Time: 10am-1pm, Thursday 9 March 2017
Venue: Brookstead Hall, Madelaine Street, Brookstead

Time: 5-8pm, Thursday 9 March 2017
Venue: Felton Hall, 2775 Toowoomba-Karara Road, Felton
Appendix E

Project Risk Register
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<th>Name</th>
<th>Number</th>
<th>Event Type</th>
<th>Risk Location</th>
<th>Event Details</th>
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<th>Actions</th>
<th>Planned Start Date</th>
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<th>Date</th>
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<td>1453</td>
<td>Major Risk</td>
<td>NSW/QLD border to Gowrie</td>
<td>Bridges and Structures Construction workers and equipment in close proximity to existing operational construction vehicles on embankment</td>
<td>Manager (RIM)</td>
<td>Perform blockage assessment and hydrologically stable assessment</td>
<td>2014-05-01</td>
<td>Manager (RIM)</td>
<td>2017-04-01</td>
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<td>Risk 2</td>
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<td>NSW/QLD border to Gowrie</td>
<td>Track and Civil Operations Flooding overtopping rail formation. Track under water. Failure of formation during a new flood event.</td>
<td>Manager (RIM)</td>
<td>Provide flood protection structures (eg. rock mattresses) to slow velocities and maintain culverts before and after events.</td>
<td>2014-05-01</td>
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<td>Track and Civil Operations Erosion of embankment adjacent to creek Flooding. Poor soils. Increased velocities ensuring soil stability adjacent to creek channels.</td>
<td>Manager (RIM)</td>
<td>Perform earthwork stability assessment.</td>
<td>2014-05-01</td>
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<td>Risk 5</td>
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<td>NSW/QLD border to Gowrie</td>
<td>Track and Civil Design Initial design does not allow safe future construction access Rail corridor bounded by roads either side.</td>
<td>Manager (RIM)</td>
<td>Review initial design with a view to future rail corridor during construction.</td>
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<td>Review construction access route during construction.</td>
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<td>Track and Civil Operations Collision with road traffic and farm equipment Bifurcation of existing farms.</td>
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<td>Review crossing location and construction works.</td>
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<td>Track and Civil Construction Fatigue/Exposure to weather Remote site works requiring intensive onsite labour.</td>
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Appendix F
Alignment Plan and Profiles
Appendix G

Road Crossings
Appendix H

PUP Crossings
ARTC

BASE CASE MODIFIED ALIGNMENT
PUBLIC UTILITY PLANT CROSSINGS
Yelarbon to Gowrie (Y2G) Project

Legend

- Base Case Modified
- Existing Railway
- Main Roads

UTILITY CROSSINGS

- Gas
- Telecommunications
- Water
- Power

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator

Data sources: © State of Queensland
Base maps of Geographic Information Systems 2014
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LAST MODIFIED: 04/03/17
VERSION: 1

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Appendix I

Condamine River Hydraulic Assessment Report - Modified Base Case and Wellcamp
Condamine River - Hydraulic Assessment Report

Base Case Modified and Wellcamp - Charlton Alignment Options
Condamine River - Hydraulic Assessment Report

Base Case Modified and Wellcamp - Charlton Alignment Options

Client: Australian Rail Track Corporation Limited
ABN: 75081455754

Prepared by

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31-Mar-2017

Job No.: 60492124

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Quality Information

Document: Condamine River - Hydraulic Assessment Report
Ref: 60492124
Date: 31-Mar-2017
Prepared by: Brijesh Mehta
Reviewed by: Martin Boshoff & Jennifer Ahern

Revision History

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1.0 Introduction

1.1 The Project and Study Area

As part of the Corridor Options Assessment for Inland Rail – Yelarbon to Gowrie (the Project), AECOM was commissioned by Australian Rail Track Corporation Ltd (ARTC) to undertake a hydraulic assessment of the Condamine River and floodplain at its intersection with the proposed Base Case Modified and Wellcamp - Charlton rail corridor options.

The hydraulic assessment was undertaken to establish the existing flood conditions, determine potential flood impacts, and inform the design of cross drainage infrastructure to establish comparative cost estimates and enable a Multi-Criteria Analysis (MCA) of the four corridor options. The four corridor options are:

- Base Case Modified
- Wellcamp - Charlton
- Karara - Leyburn
- Warwick.

The proposed Base Case Modified and Wellcamp - Charlton alignment options cross the Condamine River approximately 10 km north-east of Millmerran (Map 1, Appendix A). At this location, the two alignments are identical and are assessed by the same hydraulic model presented in this report. During high flow events, the Condamine River at this location breaks out into a complex floodplain covering an area of around 13 km wide. The floodplain is formed by three main branches, namely the Northern Branch, Main Branch and Southern Branch (also known as Grasstree Creek). Three viaducts/bridges and a series of balancing culverts are proposed at these crossings and along the floodplain as part of the Project.

Construction of a new rail embankment within the floodplain and the establishment of new river crossings have the potential to change existing flooding patterns and impact properties and infrastructure in the vicinity of the rail alignment. This impact is assessed by two-dimensional (2D), hydrodynamic modelling.

1.2 Study Objectives

The aims of this hydraulic assessment were to:

- establish a 2D hydrodynamic model in TUFLOW for the Study Area (Map 2, Appendix A)
- estimate the flood extent, level and velocities of the Condamine River for the existing condition in 10% and 1% Annual Exceedance Probability (AEP) flood events
- determine the cross drainage infrastructure (viaducts/bridges and balancing culverts) to achieve the project design criteria
- assess potential impacts to existing case flooding in 10% and 1% AEP events.

1.3 Design Criteria

ARTC have provided design values for the entire Melbourne to Brisbane Inland Rail project, including this Yelarbon to Gowrie section. These are:

- 1% AEP flood immunity for the rail
- no change in flood inundation footprint
- no redistribution of flood flows
- minimise changes in flood peak timing
- consider critical infrastructure
- minimise changes in flood levels with an aim of no net worsening
- minimise downstream erosion and minimise changes in flow velocities.

In future stages, the Project will have specific design criteria set during the Environmental Impact Statement (EIS) process. In the absence of these site specific design criteria, typical conditions for other recent rail projects in Queensland have been used to assess each alignment corridor option. This ensures areas of potential impact are similar for each alignment option, and therefore suitable for the comparative purposes of the cost estimate and MCA corridor option selection process.

The following criteria are an example of a recent Queensland Rail project extracted from Co-ordinator General Conditions of Approval document:

(a) A suitably qualified person must document and certify that the design and construction of the rail component of the project:
   i. is in accordance with the design criteria in the Department of Transport and Main Roads (March 2010) Road Drainage Manual 2nd edition
   ii. meets the following criteria for a two per cent Annual Exceedance Probability rainfall event (50 year Annual Recurrence Interval):
      1. not cause, or have the potential to increase flood damage at a residential premises or occupied commercial workplace
      2. a maximum increase in afflux of 0.1 m at a residential premises or occupied commercial workplace
      3. a maximum increase in afflux of 0.2 m at infrastructure
      4. a design objective of an increase in afflux of 0.3 m, with a maximum increase in afflux of 0.5 m at other locations
      5. a maximum culvert outlet velocity of 2.5 m/s
      6. any increase in duration of floodplain inundation is not to exceed 72 hours or 20 per cent of existing flood duration (whichever is greater)
      7. any increase in duration of inundation must not alter rural land uses or result in significant impacts upon valued pasture land, other valued agricultural land uses such as cultivated ground or flood-free ground and evacuation access for cattle.

(b) Relevant land owners likely to be impacted by changes to the existing flooding/drainage system must be consulted prior to completion of the final design for the rail component of the project.
2.0 Available Data

2.1 Previous Studies

2.1.1 Upper Condamine River Flood Study, TRC (2013)

In 2013, SKM undertook a 2D flood study for the Upper Condamine River catchment on behalf of Toowoomba Regional Council (TRC). This flood study included historical and design event modelling and was based on an URBS hydrological model. The hydraulic model utilised a 60 m grid due to lack of LiDAR (Light Detection and Ranging Survey) information at the time.

The Bureau of Meteorology (BoM) developed a number of URBS models for the use in its flood forecasting and flood warning system in 2003. The model was calibrated to the 1976 flood event. SKM undertook a review and revision of the BoM URBS model and developed a new Upper Condamine URBS model in 2012. This model was calibrated to a number of flood events including the 2010/11 event.

In 2013, an URBS model for TRC was developed by extending the 2012 Upper Condamine URBS model to Cecil Plains using catchment data from the BoM 2003 URBS model. The extended URBS model was validated against the 1976 and 2010/11 flood events. In 2013, SKM used the extended URBS model to derive the design flows for a number of design events (10, 5, 1 and 0.2% AEP) for the input into the hydraulic model. The critical duration of the design events was identified as 72 hours.

Information regarding observed flood extents during the December 2010/January 2011 flood event was collected around the township of Ellangowan, located approximately 5 km upstream of the SKM model extent as part of a community consultation process. This information was used to validate the results for this assessment.

2.1.2 Condamine River Flood Study, TRC (2015)

Water Modelling Solutions (WMS) built a new hydraulic model of the Upper Condamine River catchment using the MIKEFLOOD FlexiMesh software on behalf of TRC in 2015. This model used LiDAR data and extended the SKM model domain to include the township of Ellangowan. The model domain extends from approximately 10 km south of Ellangowan to approximately 14 km north of Cecil Plains, and includes the Study Area for this assessment.

TRC supplied the MIKEFLOOD model and results files to support this assessment. The model includes cross-drainage structures under the Gore Highway downstream of the proposed rail alignment. Dimensional data for these structures were used in the development of the TUFLOW model for this assessment.

The MIKEFLOOD model had been validated against observed records for the Upper Condamine River catchment by WMS. The model results had reasonable (-0.25 m) fits against observed records at the DNRM gauge (422347 – North Condamine River at Pampas) within the Study Area.

There remains a discrepancy of -0.25 m in the calculated and observed flood levels at Pampas which require further investigation and validation that is beyond the scope of this report.

It is possible that the current TRC hydrological modelling underestimates the flow of the Condamine River North Branch. The hydrology for the north branch may require further refinements to better represent historical flood levels in the immediate vicinity of Pampas.

The validated model was used to estimate design peak flood surface elevations, peak water depths, hazard and hydraulic categories for the 10, 5, 1 and 0.2% AEP design events.

2.1.3 Topographic Data

LiDAR data covering a corridor of approximately 12 km wide was provided by ARTC.

2.1.4 Proposed Rail Alignment

The rail formation for the proposed Base Case Modified and Wellcamp - Charlton alignment options was provided as a 12d earthworks model for input into the developed case scenario TUFLOW model.
3.0 Hydrological Assessment

The hydrology inflows adopted for this assessment for the Condamine River and its tributaries are based on flow hydrographs extracted from this WMS MIKEFLOOD model. The WaterRide software package was used to extract the flow hydrographs at the upstream model boundary locations for the North Branch, Main Branch and South Branch, respectively.

In addition, a flow hydrograph representing a local inflow was taken from the MIKEFLOOD boundary file. Peak flows adopted in the model are summarised in Table 1.

Table 1 Peak Hydrology Inflows

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<th>Waterways</th>
<th>Peak Flow (m³/s)</th>
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<td>10% AEP</td>
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<td>North Branch</td>
<td>253</td>
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<tr>
<td>Main Branch</td>
<td>1,420</td>
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<td>South Branch (Grasstree Creek)</td>
<td>454</td>
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<td>Tributaries</td>
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4.0 Hydraulic Assessment

4.1 Model setup

A hydrodynamic flood model was developed and simulated using the TUFLOW software package (Version 2013-03-AE-w64). The model was used to provide an estimate of existing flood levels, extents and velocities; inform the design of the cross drainage solutions for the Project; and estimate any potential impacts on flooding as a result of the Project.

4.1.1 Model Extent

The spatial extent of the TUFLOW model was selected to ensure that flood behaviour of the Condamine River within the Study Area is adequately captured. The model extent covers a 12 km long reach of Condamine River as shown in Map 2 in Appendix A.

4.1.2 Model Terrain

The topography within the TUFLOW model was based on the LiDAR data for the 12 km corridor, and a small portion was based on WMS’ Fleximesh terrain. The total modelling extent covers an area of 238 km². A 10m x 10m grid size was adopted. The model’s Digital Terrain Model (DTM) is shown in Map 2 in Appendix A.

4.1.3 Boundary Conditions

The TUFLOW model was run dynamically using hydrograph inflows extracted from WMS’ MIKEFLOOD model as described in Section 3.0. The downstream boundary conditions were modelled as ‘normal depth’.

4.1.4 Roughness

Areas with similar land use and vegetation cover types were defined within the 2D domain and assigned appropriate roughness values (Manning’s ‘n’ coefficients). These areas include the waterway, light vegetation, floodplains, dense vegetation, and road.

The roughness values were assigned at a block-scale, and are typically representative of the average roughness across each category and account for obstructions to flow. Table 2 provides the Manning’s ‘n’ roughness coefficients adopted for different land use types in the Study.

It is possible that the current flood levels are underestimated at Pampas as no allowance has been made for separate housing land use. Adopting a roughness coefficient for housing 0.2 may be considered in future phases of the project.
4.1.5 Existing Drainage Structures

Existing culverts were modelled as 1D elements, nested within the 2D domain. The existing bridges were modelled in the 2D domain. Table 3 provides details of the existing drainage structures modelled. Structure dimensions were taken from the WMS MIKEFLOOD model.

Table 3 Existing Cross Drainage Structures

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<th>Existing Culvert</th>
</tr>
</thead>
<tbody>
<tr>
<td>95m Bridge on Condamine River</td>
<td>8/2.4mx1.2m RCBC - North Branch</td>
</tr>
<tr>
<td></td>
<td>8/2.4mx 1.2m RCBC - Floodplain</td>
</tr>
<tr>
<td></td>
<td>2/2.4mx 1.2m RCBC - Floodplain</td>
</tr>
<tr>
<td></td>
<td>8/2.4mx 1.2m RCBC - Floodplain</td>
</tr>
<tr>
<td></td>
<td>3/2.4mx 1.2m RCBC - Floodplain</td>
</tr>
</tbody>
</table>

4.2 Model Validation

4.2.1 WMS MIKEFLOOD Modelling

The TUFLOW model results were validated against the water levels estimated with WMS’ MIKEFLOOD model for a 1% AEP design event.

The model was calibrated by adjusting the Manning’s ‘n’ roughness values and boundary locations until a satisfactory match to the peak MIKEFLOOD flood levels was achieved. Land use categories and their associated Manning’s ‘n’ roughness values as adopted in the model calibration are shown in Table 2, and are within accepted industry standards for Manning’s ‘n’ values.

Map 3 in Appendix A displays the comparison of the peak water levels estimated by the two models for a 1% AEP design event. The flood extent of the two models is mostly the same. The difference in peak water levels at the proposed alignment is mostly within ±0.05 m. In the remaining floodplain area, the difference is typically within ±0.15 m.

Table 4 provides the comparison of peak water levels estimated by the two models at the intersection of the three waterways and the proposed rail alignment. The difference in estimated peak water levels from the two models is within ±0.02 m.

The differences in results estimated by the two models can be attributed to the finer grid size adopted for TUFLOW. However, the differences in results are minimal in the vicinity of the proposed alignment.

Table 4 Comparison of the Results of TUFLOW Model and MIKEFLOOD FlexiMesh Model – 1% AEP

<table>
<thead>
<tr>
<th>Location</th>
<th>Peak Flood Level (m AHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WMS MIKEFLOOD</td>
</tr>
<tr>
<td>Main Branch</td>
<td>380.20</td>
</tr>
<tr>
<td>North Branch</td>
<td>382.48</td>
</tr>
<tr>
<td>South Branch</td>
<td>380.38</td>
</tr>
</tbody>
</table>
Table 5 shows the results of model calibration against the 2010/11 event. Simulated flood levels were predicted to match very well with the observed water level records at the DNRM Pampas gauging station. The 2010/211 flood event was smaller than a 2% AEP (or between 5% and 2% AEP) based on 54 years historical records of flow data at Tummaville Station (422323) on the Condamine River located approximately 1 km upstream of the Study Area.

Table 5  Simulated Flood Levels by TUFLOW and Observed Levels for 2010/11 Event

<table>
<thead>
<tr>
<th>Location</th>
<th>Observed 2010/11 Level</th>
<th>Simulated 2010/11 Event Flood Level</th>
<th>Difference (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pampas 422347B- North Condamine River</td>
<td>382.59</td>
<td>380.56</td>
<td>-0.03</td>
</tr>
<tr>
<td>Flood Mark 1 (FM1) Pampas</td>
<td>382.30</td>
<td>382.14</td>
<td>-0.16</td>
</tr>
<tr>
<td>Flood Mark 2 (FM2) Pampas</td>
<td>382.21</td>
<td>382.41</td>
<td>+0.20</td>
</tr>
<tr>
<td>Flood Mark 3 (FM3) Pampas</td>
<td>382.11</td>
<td>382.14</td>
<td>+0.03</td>
</tr>
</tbody>
</table>

4.2.2  Site Visit

A guided tour of the Base Case Modified and Wellcamp - Charlton alignment options was undertaken on 18 January 2017 with 23 landholders along the alignments. Historical water depths from 2010/11 flood and debris markers were photographed, measured and recorded. These water depths were compared against the results of the TUFLOW flood model simulating the 2010/11 flood. This comparison is shown in Map 4 in Appendix A. The comparison shows that the 2010/11 flood model results are within a reasonable level of accuracy to observed flood markers, generally within ±0.1 m. At locations shown, the greatest difference in model results is ±0.66 m near the Southern Branch (Grasstree Creek). It is believed that this difference could be attributed to timing of coincident flood peaks between Back Creek and Grasstree Creeks, and associated backwater effects. Calibration in this location should be considered in more detail during future design development stages.

4.3  Modelled Scenarios

The following two scenarios were simulated:

- Existing Condition

The existing condition is represented by the existing drainage structures under the Gore Highway and the existing terrain. Table 3 provides details of the existing drainage structures.

- Developed Condition

The developed condition model includes the following elements in addition to the existing condition model:

- Design earthworks model to represent the proposed rail embankment.
- Proposed cross drainage viaducts/bridges and balancing culverts shown in Table 6. The structure configuration includes an allowance for a minimum of 20% blockage of culverts due to debris, such as hay bales. (Refer Section 4.3.1 for more details.)

The proposed cross drainage structures shown in Table 6 were determined through iterative model runs to achieve 1% AEP flood immunity for the rail and comparable areas of potential impact for each of the corridor alignment options. In the absence of site specific design criteria, this allows for the like-for-like comparison of alignments in terms of cross drainage infrastructure, cost estimates and potential impacts as a result of the Project.
Table 6 Proposed Cross Drainage Structures for Modified Base Case and Wellcamp - Charlton Alignment Options

<table>
<thead>
<tr>
<th>Proposed Viaducts/Bridges</th>
<th>Proposed Balancing Culverts</th>
</tr>
</thead>
<tbody>
<tr>
<td>750m – Main Branch</td>
<td>590/1.8m RCP</td>
</tr>
<tr>
<td>750m – South Branch</td>
<td>310/2.1m RCP</td>
</tr>
<tr>
<td>300m – North Branch</td>
<td>(Total 900 Culverts)</td>
</tr>
<tr>
<td></td>
<td>30/3.6mx1.5m RCBC (at Pampas)</td>
</tr>
</tbody>
</table>

Note: Bridge soffit levels assumed to be above the 1% AEP.

4.3.1 Blockage

Australian Rainfall and Runoff (ARR 2016) Project 11 – Blockage of Hydraulic Structures was used as a basis for determining blockage factors to apply to the structures. The ARR approach is a site specific risk based approach which determines:

- debris availability
- debris transportability
- debris Mobility
- size of the debris versus the structure type.

Typically blockage would be considered in later design phases. At this time, a site inspection would be undertaken to review site specific conditions and determine the appropriate blockage factor to apply to different catchments. For the purpose of this assessment, for comparative purposes, an indicative blockage assessment was undertaken for all crossings. This assessment resulted in a blockage factor to be applied to the structures of 20%. This is in agreement with the Queensland Urban Drainage Manual (QUDM, 2013) that provides guidance that, in the absence of site specific catchment data, a blockage factor of 20% should be applied.

The 20% blockage factor was applied to the balancing culverts in the TUFLOW models for the developed case option for each alignment. In addition, the balancing culvert sizes were increased in the model to account for the impact of blockage.

4.4 Existing Condition Results

Flood inundation maps of the Condamine River for the existing condition are presented in Map 5 and 6 in Appendix A for the 10% and 1% AEP events respectively. This flood inundation map visually represents flood depth and flood extent information. Flood extent along the proposed alignment is approximately 12.2 km and 12.5 km wide during the 10% and 1% AEP events, respectively. Estimated water depths vary between less than 0.5 m in floodplain areas to over 7 m within the channel of the main Condamine River branch.

Map 7 and 8 in Appendix A show a graphical representation of estimated flood levels in the Condamine River and floodplain for the existing conditions.

Map 9 and 10 in Appendix A show a graphical representation of estimated peak flow velocities for the 10% and 1% AEP events in the Condamine River and floodplain for the existing conditions. The estimated peak velocity in the Condamine River floodplain is mostly less than 1.0 m/s.
4.5 Impact Assessment

Potential impacts to flooding were assessed for the Condamine River by comparing the TUFLOW model results for the developed case against the results of the existing case model.

The assessment of impacts included the comparison of peak flood levels and peak velocities to confirm potential impacts on flooding were similar for each alignment in the 1% AEP. In the absence of site specific design criteria, this allows for the like-for-like comparison of alignments in terms of cross drainage infrastructure, cost estimates and potential impacts as a result of the Project.

An assessment was also made of changes in flooding extent and duration between the existing and developed case scenarios. The results found that there was negligible change to both flooding extent and total duration in flooding.

4.6 Future Design Stages

In future stages, as outlined in Section 1.3, the Project will have specific design criteria set during the Environmental Impact Statement (EIS) process that will govern design considerations such as allowable flood impacts, flood immunity, blockage considerations etc. Also, additional detailed topographic data will be acquired in future design stages in the form of topographic field survey.

Further, more refined flood modelling will therefore be required as part of future design development stages to update flood models with actual survey data, and to consider project specific design criteria that will inform appropriate mitigation measures.
Appendix A

Flood Maps
Model Extent

Legend:
- Place Name
- Waterway
- Existing Railway Line
- Road
- Model Extent
- Toowoomba LGA
- National Park
- State Forest

Project Location:

- Dalby
- Esk
- Toowoomba

Inland Rail - Yelarbon to Gowrie

Data sources:
1. Existing Railway, Drainage Line and Areas © Street Pro, 2011
2. Protected areas of Queensland © State of Queensland (Department of National Parks, Sport and Racing) 2016
3. Canvas/World_Light_Gray_Base © Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
4. Local government area boundaries - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
5. Place names gazetteer - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017

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LAST MODIFIED: 28/03/2017
VERSION: 3

LEGEND
- Waterway
- Highway
- Proposed Railway
- Existing Culverts
- Existing Bridge
- Model Extent

Peak Velocity (m/s)
- < 0.25
- 0.25 - 0.5
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- >3.00

Peak Velocity (m/s)
- 0.25 - 0.5
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- >3.00

Coordinate System: GDA 1994 MGA Zone 56

Data sources:
1. Place names gazetteer - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
2. Ordered drainage 100K - Queensland © State of Queensland (Department of Natural Resources and Mines) 2014
3. Emergency Locations, Existing Bridge, Existing Culverts, Proposed Rail, Water Model © AECOM, 2017
4. SEQ Regional 30 cm Imagery © SISP, 2013
5. Protected areas of Queensland © State of Queensland (Department of National Parks, Sport and Racing) 2016
5. Water Model based on ALS data from 1m DEM © TRC through Aurecon, 30 August 2014

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Peak Velocity (m/s)

- < 0.25
- 0.25 - 0.5
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- >3.00

Inland Rail - Yelarbon to Gowrie

Condamine River Base Case Modified / Wellcamp - Charloion Option

1% AEP Estimated Peak Velocity

Existing Condition

Data sources:
1. Place names gazetteer - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
2. Ordered drainage 100K - Queensland © State of Queensland (Department of Natural Resources and Mines) 2014
3. Emergency Locations, Existing Bridge, Existing Culverts, Proposed Rail, Water Model © AECOM, 2017
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Appendix J

Condamine River Hydraulic Assessment Report - Karara-Leyburn