BULLER RIVER

December 2017

Update of Hydraulic Model

Report prepared for West Coast Regional Council

by Matthew Gardner

Land River Sea Consulting Ltd

www.landriversea.com

BULLER RIVER

UPDATE OF HYDRAULIC MODEL

REVISION HISTORY

Author:	Matthew Gardner
Signature:	M Gardner
Date:	7/12/2017
Revision:	03
Authorised by:	Randal Beal
Signature:	
Organisation:	West Coast Regional Council
Date:	

Land River Sea Consulting Limited
Po Box 27121
Shirley
Christchurch 8640

T: +64 3 967 0549
M: +64 27 318 9527
E: matthew@landriversea.com
W: landriversea.com

TABLE OF CONTENTS

1. INTRODUCTION

BACKGROUND

Land River Sea Consulting Limited was commissioned by the West Coast Regional Council in 2014 to build a hydraulic model of the Buller River system, in order to identify the likely extent of flooding for a range of return period events, as well as to be able to use the model for investigating potential flood mitigation options. This modelling was completed in 2015 and is detailed in the modelling report (Gardner, 2015).

During the model schematisation, model build and calibration processes, regular advice was sought from DHI and then prior to publication of the final report in August 2015 a more detailed review of the modelling was requested from DHI. Findings and conclusions of that review were provided on 19 July 2015 and were included as an appendix to the modelling report (Gardner, 2015).

In 2017, the West Coast Regional Council has requested a formal review of the model so that the flood maps can be published and formally adopted. This report was published on the 15th of September 2017 and is included in Appendix B of this report.

This report outlines the changes which have been made to the model as a result of the peer review and provides reasoning for why some changes have not been carried out. Updated flood maps based on the changes have also been produced for all scenarios presented in the original modelling report.

2. PEER REVIEW CONCLUSIONS / RESPONSE

The following recommendations / comments were made in the peer review:

DHI COMMENT 1

Most significantly, the design scenarios only apply 95% of the required design flows. That requires a simple fix, but does mean that all design scenarios will need to be rerun and the resulting flood maps reproduced.

Land River Sea Response:

This error in the boundary files has been confirmed and as a result all of the design runs have been reproduced with the full design flow applied along with further modification to the model outlined below.

DHI COMMENT 2

Include recent surveyed river cross-sections (between cross-sections 2 and 4) in the model, if not done already.

Land River Sea Response:

The entire set of cross sections was surveyed in May 2017 with three additional cross sections surveyed in July 2017 on our request. These cross sections provide extra detail in the area downstream from the State Highway Bridge and have now been included in the model.

The location of the additional cross sections is presented in below.

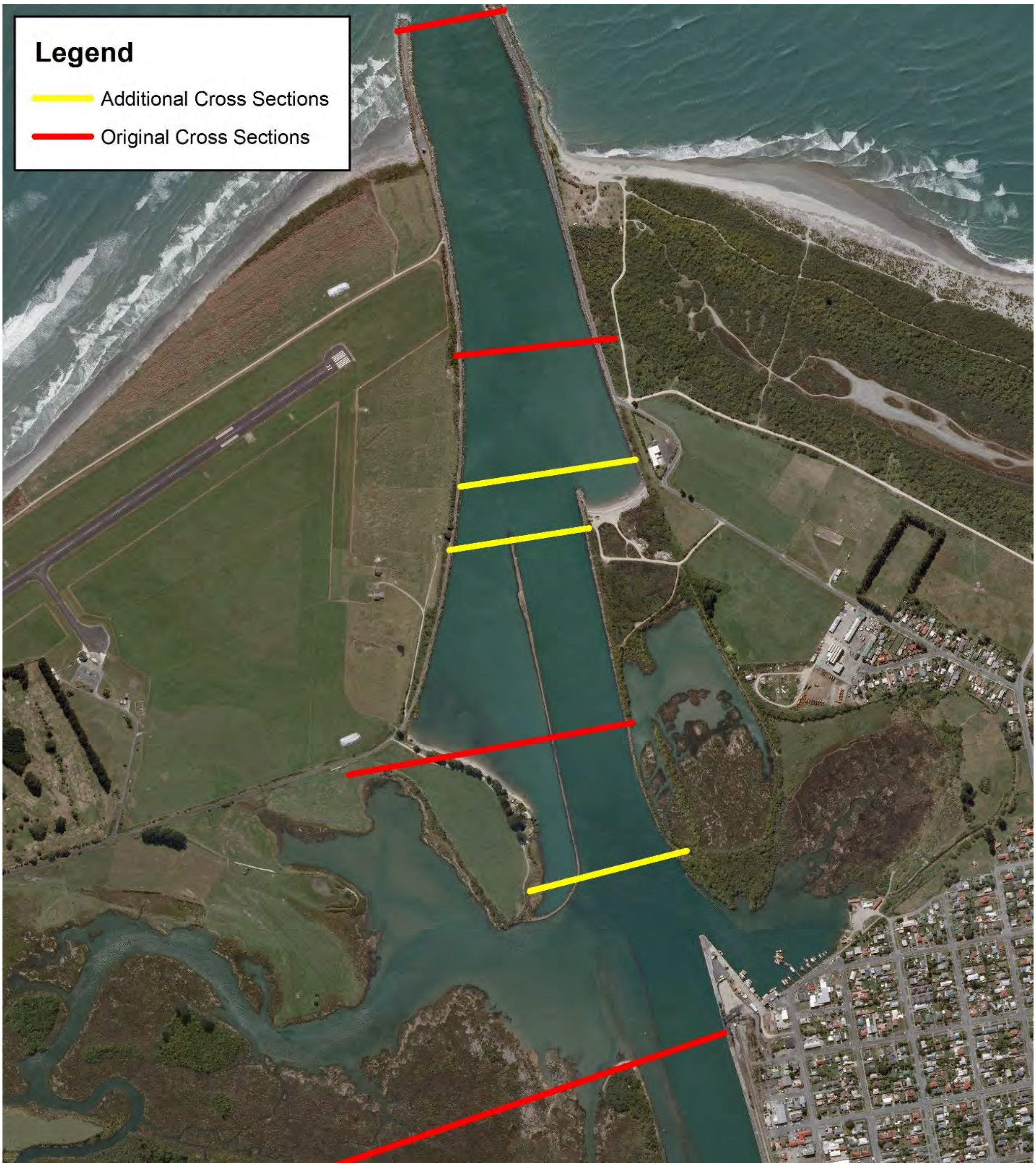


Figure 2-1 – Location of additional surveyed cross sections

The model has been updated to include all of the 2017 surveyed cross sections.

DHI COMMENT 3

The model topography for the left bank pocket of floodplain, before the river turns to the north, should be reassessed. That may require additional survey.

Land River Sea Response:

As extra survey information was not immediately available, this has not been included for now and it is recommended that flood extents are only presented for areas downstream from this location.

DHI COMMENT 4

Additional survey would be useful to better define the right bank channel edge for the upstream-most lateral link.

Land River Sea Response:

It is agreed that extra survey information would be useful here, however as it was not available has not been included. It is felt that including this area with limited survey information will still improve the accuracy of the model compared to not including this area at all as was the case in the NIWA modelling.

DHI COMMENT 5

Land cells should be redefined in locations along the right bank where some flow can pass to a strip to the river side of the lateral link. This leads to some minor double-counting of river channel conveyance.

Land River Sea Response:

Land cells have been examined in detail and redefined in all locations where there was a discrepancy between the MIKE11 and MIKE21 models. There will no longer be any double-counting of conveyance as was occurring in a number of small areas in the model.

DHI COMMENT 6

The area removed from the 2D model extent for the Buller River channel appears to be typically a little narrower than represented in the MIKE 11 model, again leading to minor double-counting of conveyance.

Land River Sea Response:

This has now been remedied as per comment 5.

DHI COMMENT 7

Consideration should be given to extending the model up to cross-section 25 and downstream of cross-section 1.

Land River Sea Response:

The model has now been extended upstream to cross section 25, however has not been extended downstream of cross section 1. During the model build stage, effort was put into extending the model downstream from cross section 1, however model instabilities were encountered and this approach was abandoned due to anomalies in the modelled water levels.

DHI COMMENT 8

Refinement of the model to incorporate survey data for larger culverts on the floodplain is recommended, or failing that, test sensitivity of results to culvert dimensions.

Land River Sea Response:

The availability of survey data for modelled culverts would improve the results, however care was taken during model setup to visit the locations of the culverts and use best judgement to represent the onsite conditions.

DHI COMMENT 9

Default momentum transfer and exponential smoothing parameters for all standard links should be restored, unless this causes model instabilities.

Land River Sea Response:

The only changes which have been made to the default momentum transfer and exponential smoothing parameters for standard links have been made for model stability purposes. All changes have been made based on guidance contained in the DHI MIKE Flood user manual. The sensitivity of this model to these parameters is likely due to the very large flows encountered in this model (the largest in any New Zealand river).

DHI COMMENT 10

Likewise, future modelling should aim to use latest recommendations for MIKE 11 and MIKE 21 numerical parameters, unless these cause model instabilities.

Land River Sea Response:

All parameters adopted in the modelling have been based on DHI recommendations except where model instability proved to be an issue. Any changes to default values were only made after a detailed reading of the DHI guidelines ensuring that any changes will not adversely effect on the models accuracy,

DHI COMMENT 11

The impact of contributing flow from the Orowaiti catchment could be tested.

Land River Sea Response:

This was originally discussed with WCRC staff in 2015 and was not considered to be necessary due to the fact that flows from the Buller River will be significantly greater than any flow in the Orowaiti Catchment and also that the timing of flows in unlikely to coincide due to the differing geographical locations of the contributing catchments.

DHI COMMENT 12

Sensitivity tests of river channel resistance should be considered for design scenarios.

Land River Sea Response:

Except for the tests during the calibration stage of the model build, sensitivity to channel resistance has not been carried out, however can be carried out in the future if desired. Freeboard has not been applied to the flood maps to date and any sensitivity tests could be incorporated into model freeboard.

DHI COMMENT 13

Flood data should be collected if and when any significant flood events occur, for further verification of the model.

Land River Sea Response:

This is considered to be a sensible recommendation if and when further flood events occur.

3. UPDATED MODEL CALIBRATION

In order to confirm that the model changes have not significantly altered the validity of the model calibration, the model has been rerun for the July 2012 flood event which was used as the primary calibration event in the 2015 study. The results show a very similar flood extent to that observed and only minor differences in water level with the average absolute error changing by only 0.01m. This is considered to be a reasonable level of calibration for a floodplain calibration. The results are presented in tabular format in Table 3-1 below.

Table 3-1 – Comparison of modelled water levels with recorded debris levels for the July 2012 event.

	Difference from recorded Debris Levels (m)	
PointID	**2015 Results**	**2017 Results**
FL1	-0.25	-0.26
FL2	-0.35	-0.36
FL5	0.01	-0.02
FL6	0.33	0.31
FL7	-0.05	-0.09
FL8	-0.10	-0.12
FL9	0.00	0.17
FL10	0.15	0.28
FL11	-0.49	-0.25
FL21	-0.09	0.05
FL22	0.25	0.31
FL23	0.02	0.10
FL24	-0.05	-0.02
FL25	0.19	0.20
FL26	0.20	0.20
FL27	0.20	0.20
FL28	0.25	0.24
FL29	0.01	-0.01
FL30	0.15	0.14
FL31	-0.01	-0.03
Post FL1	0.23	0.21
Pump Station	0.08	0.18
Average Error	**0.03**	**0.06**
Absolute Average Error	**0.16**	**0.17**

The difference between the modelled water levels and the recorded debris levels are presented in Figure 3-1 below.

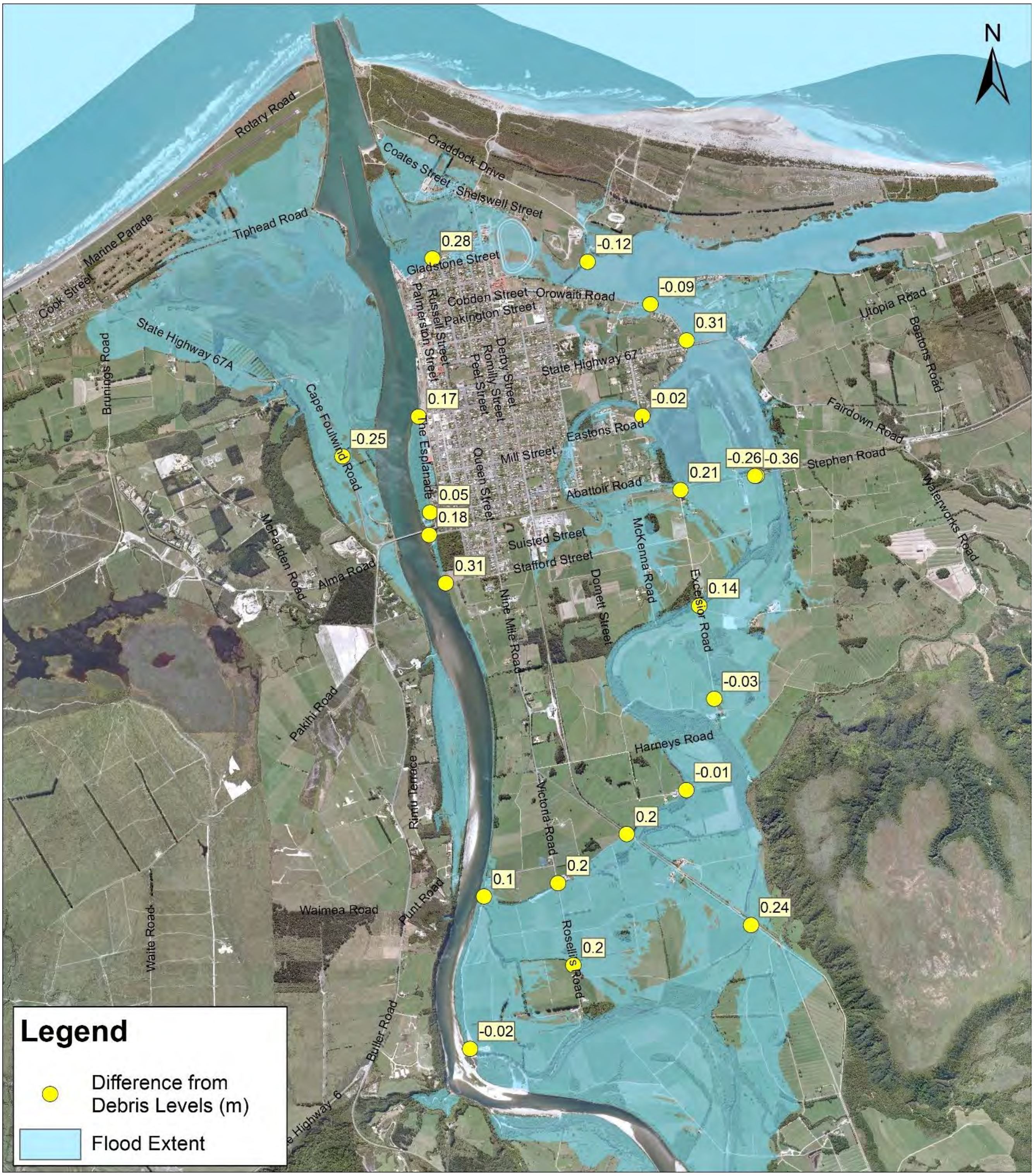


Figure 3-1 – Comparison of modelled water levels with recorded debris levels.

4. DESIGN RUNS

The same design runs that were simulated in the 2015 study have been reproduced here, however with the full flows applied, rather than 95% of the flow as was accidentally applied in the 2015 study.

Design maps have been produced for 50 year and 100 year rainfall events both with and without the predicted effects of climate change. Three separate blockage scenarios have been applied.

No Blockage: This scenario assumes that no significant amount of debris builds up on any of the bridge piers.

Medium Blockage: This scenario allows for a moderate degree of blockage on the Buller River and Nine Mile Road Bridges. This scenario simulates the Buller River waterway being blocked by a further 10% and the level of the bridge soffit has been lowered by 0.5m, it also allows for a 5% blockage of the Nine Mile Road Bridge (Rail Bridge).

High Blockage: This scenario simulates a more significant degree of blockage on the Buller River and Nine Mile Road Bridges. This scenario simulates the Buller River waterway being blocked by further 15% and the level of the bridge soffit has been lowered by 0.75m. It also allows for a 10% blockage of the Nine Mile Road Bridge (Rail Bridge).

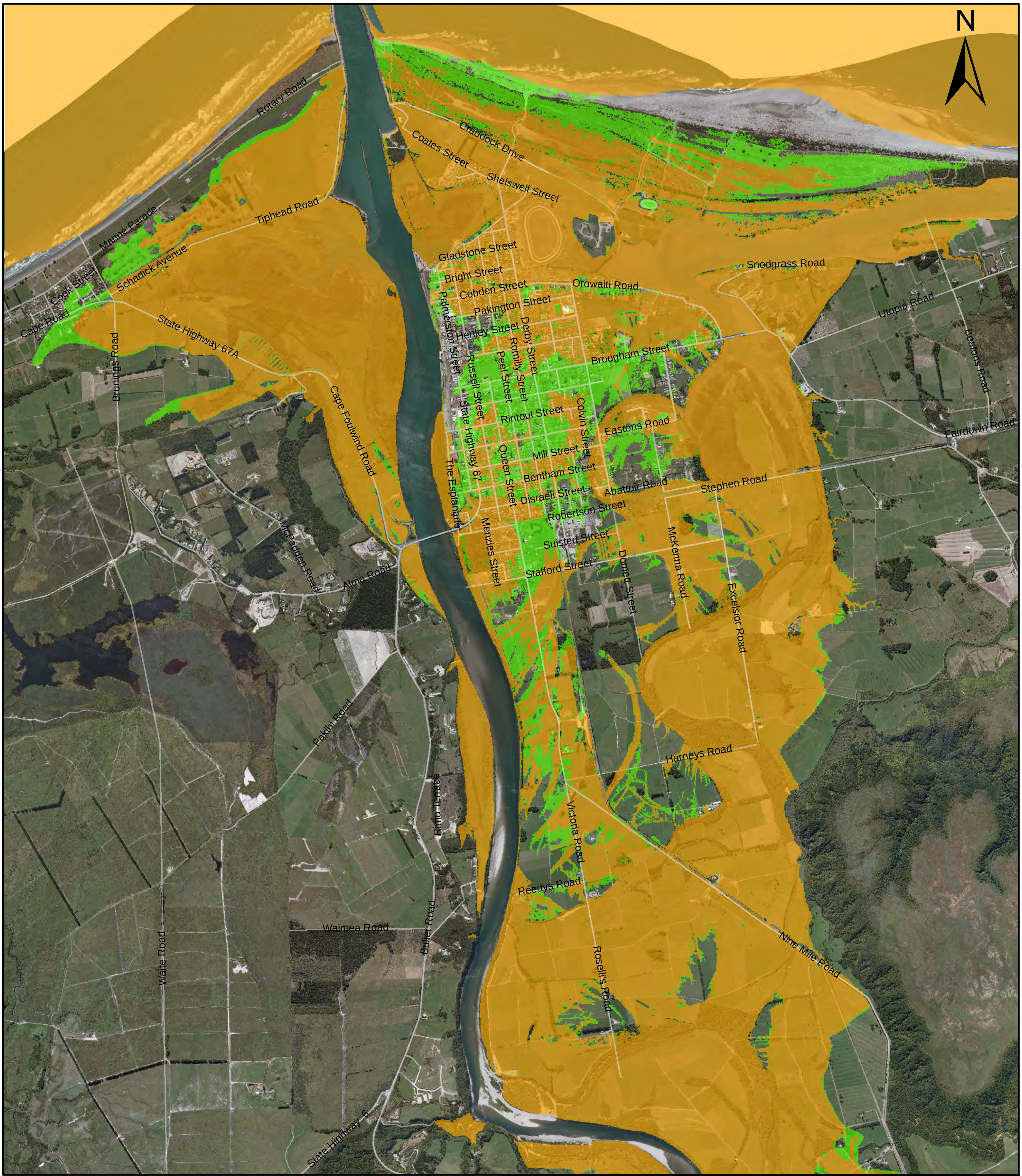
NB: During the 1926 Flood it has been recorded that a 32m long tree truck got stuck across two of the piers)

The following scenarios have been simulated with flood extent / depth maps presented in Appendix A of this report.

1. 50 Year Flood, Current Climate, No Blockage
2. 50 Year Flood, Current Climate, 10% Blockage State Highway Bridge. 5% Blockage Rail Bridge
3. 50 Year Flood, Current Climate, 15% Blockage State Highway Bridge. 10% Blockage Rail Bridge
4. 100 Year Flood, Current Climate, No Blockage
5. 100 Year Flood, Current Climate, 10% Blockage State Highway Bridge. 5% Blockage Rail Bridge
6. 100 Year Flood, Current Climate, 15% Blockage State Highway Bridge. 10% Blockage Rail Bridge
7. 50 Year Flood including Climate Change, 0.7m Sea Level Rise, No Blockage
8. 50 Year Flood including Climate Change, 0.7m Sea Level Rise, 10% Blockage State Highway Bridge. 5% Blockage Rail Bridge
9. 50 Year Flood including Climate Change, 0.7m Sea Level Rise, 15% Blockage State Highway Bridge. 10% Blockage Rail Bridge
10. 100 Year Flood including Climate Change, 0.7m Sea Level Rise, No Blockage
11. 100 Year Flood including Climate Change, 0.7m Sea Level Rise, 10% Blockage State Highway Bridge. 5% Blockage Rail Bridge
12. 100 Year Flood including Climate Change, 0.7m Sea Level Rise, 15% Blockage State Highway Bridge. 10% Blockage Rail Bridge
13. 100 Year Flood including Climate Change, 1m Sea Level Rise, No Blockage
14. 100 Year Flood including Climate Change, 1m Sea Level Rise, 10% Blockage State Highway Bridge. 5% Blockage Rail Bridge
15. 100 Year Flood including Climate Change, 1m Sea Level Rise, 15% Blockage State Highway Bridge. 10% Blockage Rail Bridge

5. COMPARISON OF RESULTS WITH PREVIOUS MODELLING

In order to determine the significance of the changes in the inflow hydrology as well as the other minor changes to the model as comparison has been made between the modelled flood extents. A comparison between the results of Scenario 2 and Scenario 5 (50 and 100 year floods with medium blockage) have been presented in the following figures.



SCALE BAR

0 0.25 0.5 1 Kilometers

PROJECT

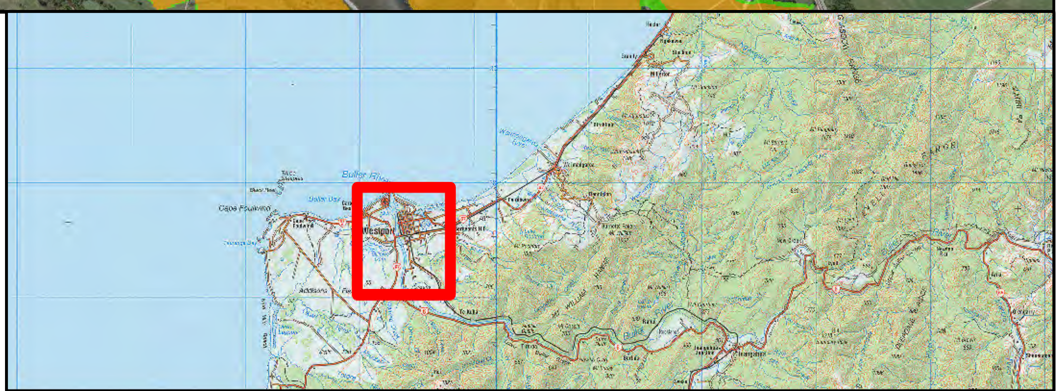
Buller River Modelling

Legend

Flood Extent

Aug 2015

Nov 2017



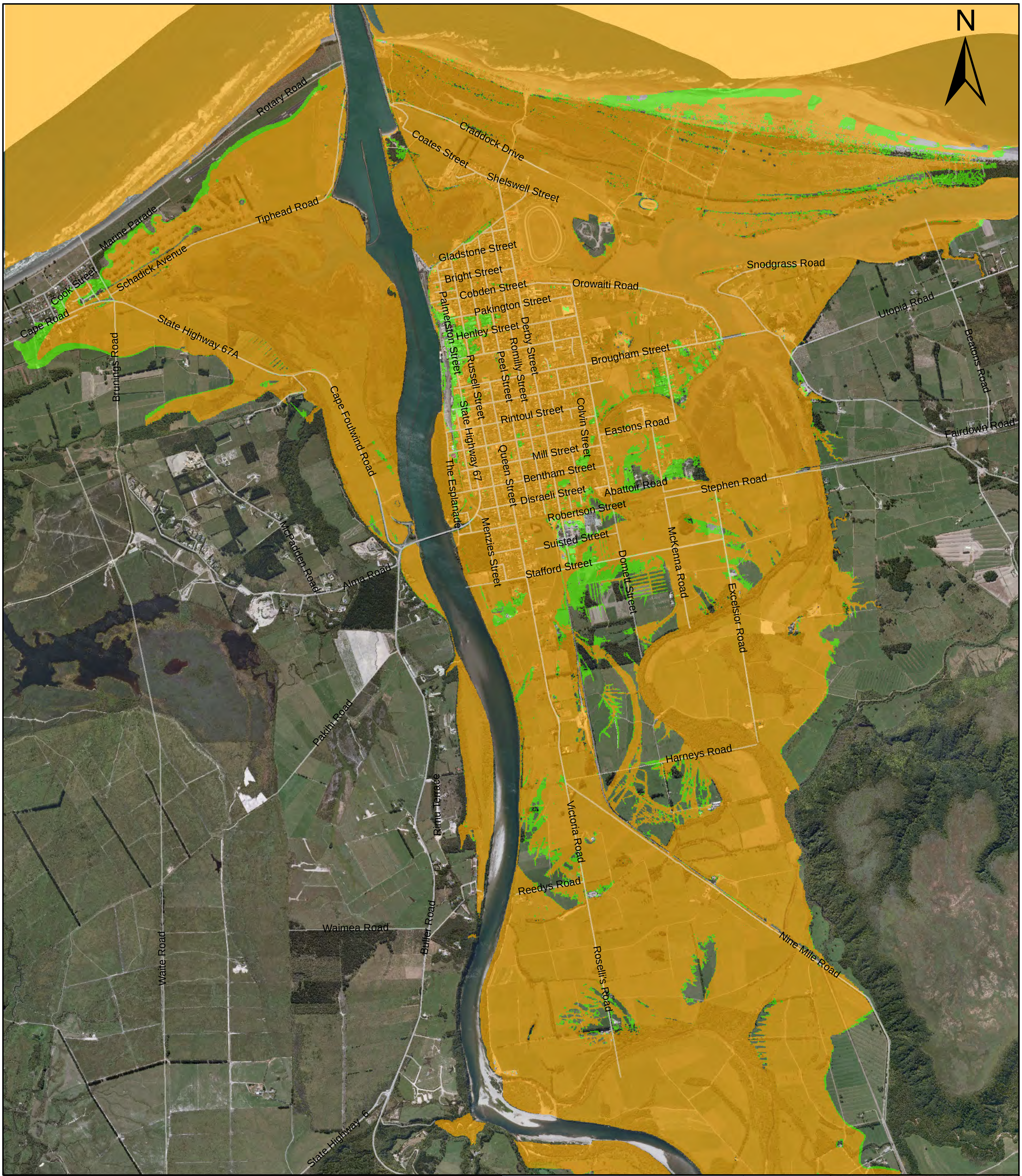
TITLE

Comparison of 2015 and 2017 modelled flood extents
50 Year Current Climate
(10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01



SCALE BAR

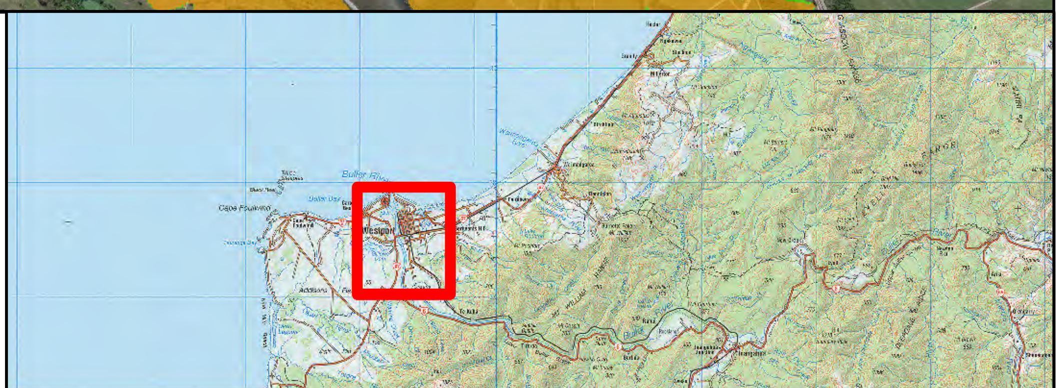
0 0.25 0.5 1 Kilometers

Legend

Flood Extent

Aug 2015

Nov 2017



PROJECT

Buller River Modelling

TITLE

Comparison of 2015 and 2017 modelled flood extents
100 Year Current Climate
(10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

6. CONCLUSIONS / RECOMMENDATIONS

As a result of the peer review carried out by DHI in September 2017, the hydraulic model of the Buller River has been updated to incorporate the recommended changes as well as incorporate the most recent channel survey information. Where changes have not been made, the rationale has been outlined in section 2 of this report.

The model calibration has been rerun and was not found to change significantly in regards to flood levels or extent.

15 design scenarios have been simulated for a range of return periods, tidal conditions and blockage scenarios.

It is recommended that the medium blockage scenarios (10% blockage of State Highway bridge and 5% blockage of the railway bridge) are used for design / publication purposes.

APPENDIX A – DESIGN FLOOD MAPS

SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0

PROJECT

Buller River Modelling

TITLE

Scenario 01 - 50 Year Flow Current Climate (No Blockage)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

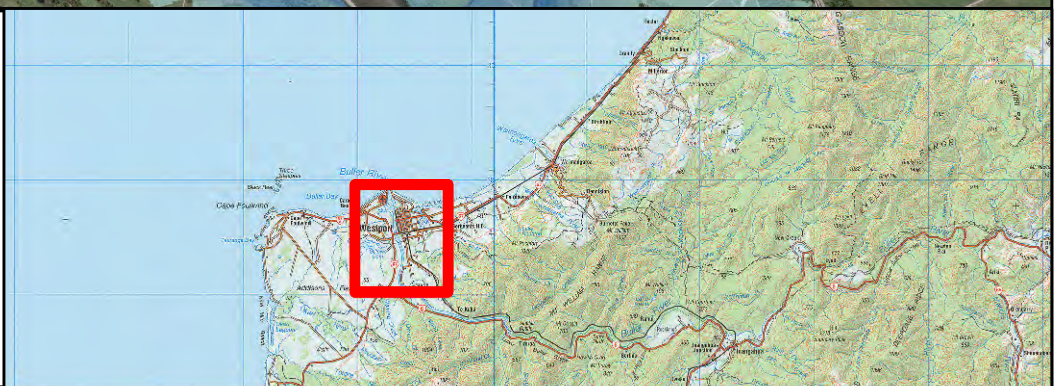
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 2 - 50 Year Flow Current Climate (10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

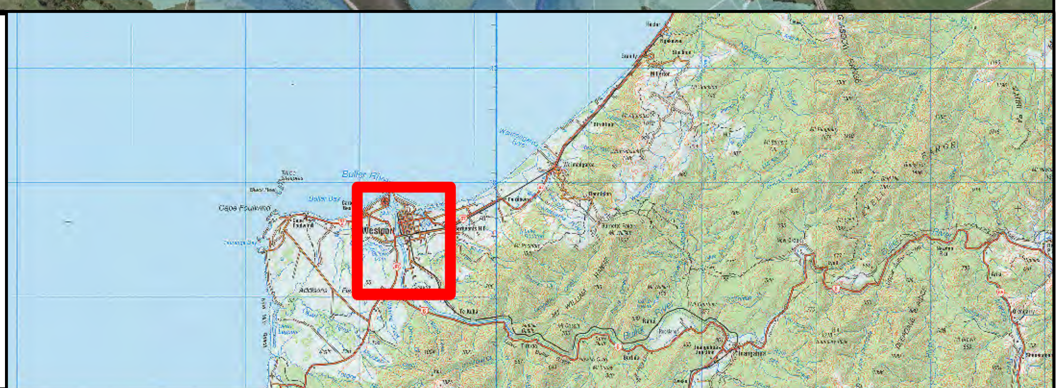
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 3 - 50 Year Flow Current Climate (15% Blockage SH Bridge, 10% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

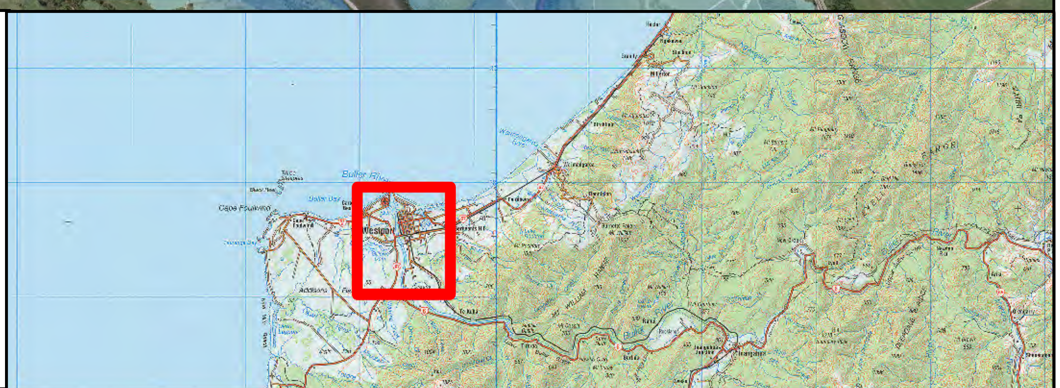
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 04 - 100 Year Flow Current Climate (No Blockage)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

SCALE BAR

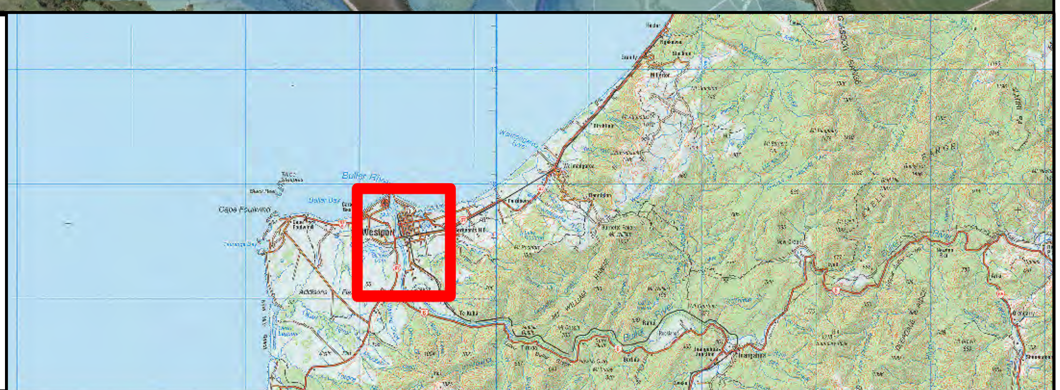
0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6

0



PROJECT

Buller River Modelling

TITLE

Scenario 5 - 50 Year Flow Current Climate
(10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

SCALE BAR

0 0.25 0.5 1 Kilometers

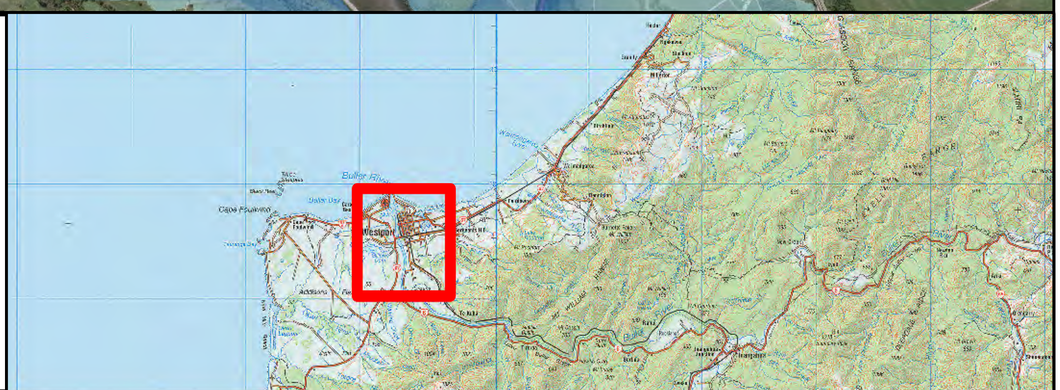
Legend

Value

12.6 0

PROJECT

Buller River Modelling



TITLE

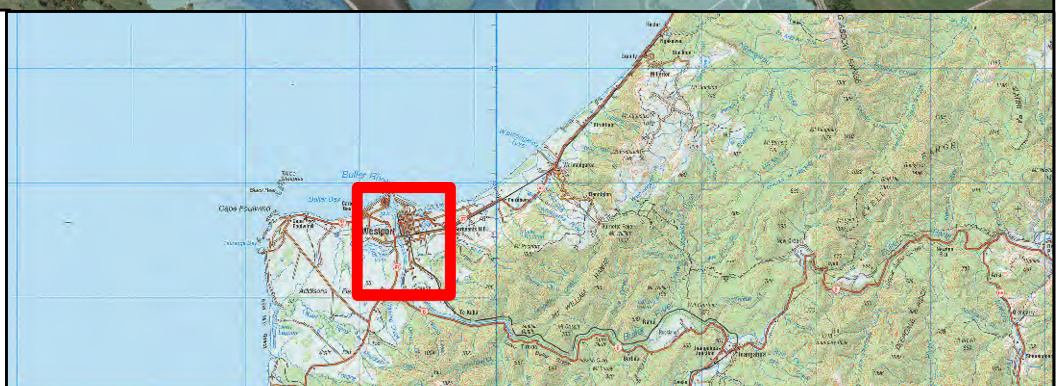
Scenario 6 - 100 Year Flow Current Climate (15% Blockage SH Bridge, 10% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

SCALE BAR	Legend
0 0.25 0.5 1 Kilometers	Peak Depth (m) 12.6 – 0



PROJECT

Buller River Modelling

TITLE
Scenario 07 - 50 Year Flow including Climate Change (0.7m Sea Level Rise - No Blockage)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

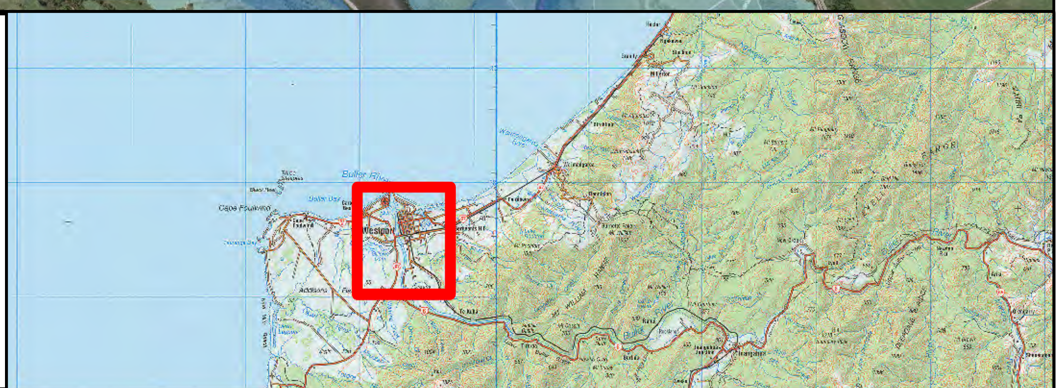
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Value

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 8 - 50 Year Flow including Climate Change (0.7m Sea Level Rise - 10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

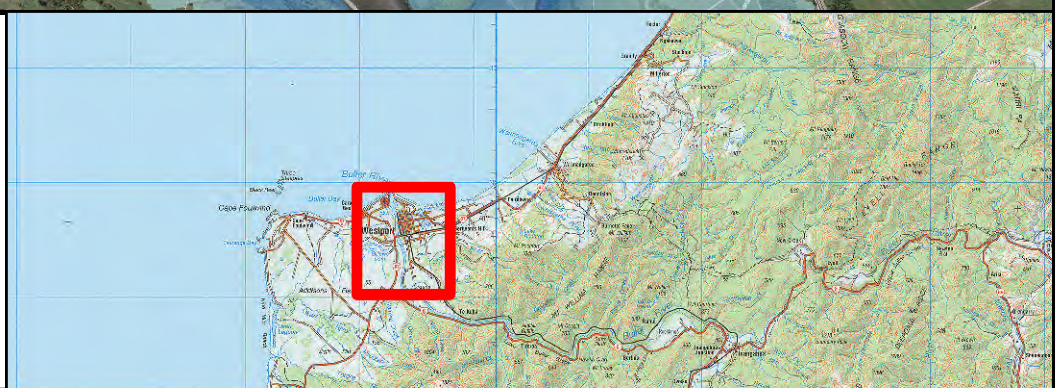
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 9 - 50 Year Flow Including Climate Change (0.7m Sea Level Rise - 15% Blockage SH Bridge, 10% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

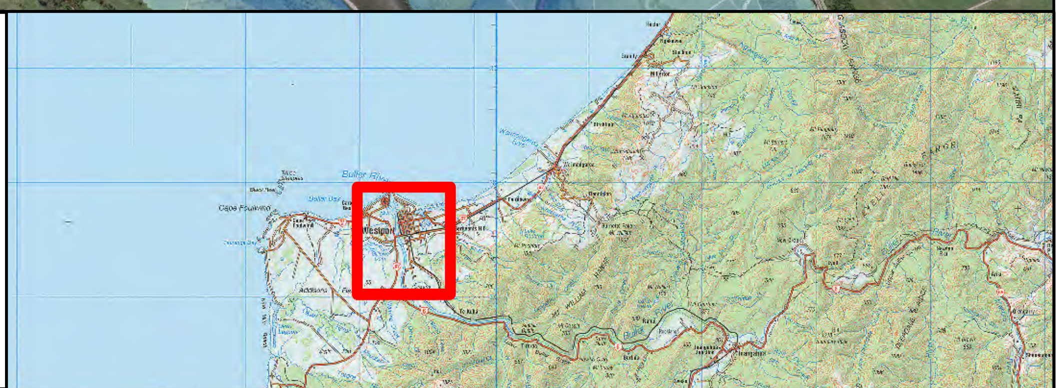
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Depth (m)

12.64 0



PROJECT

Buller River Modelling

TITLE

Scenario 10 - 100 Year Flow Including Climate Change (0.7m Sea Level Rise - No Blockage)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

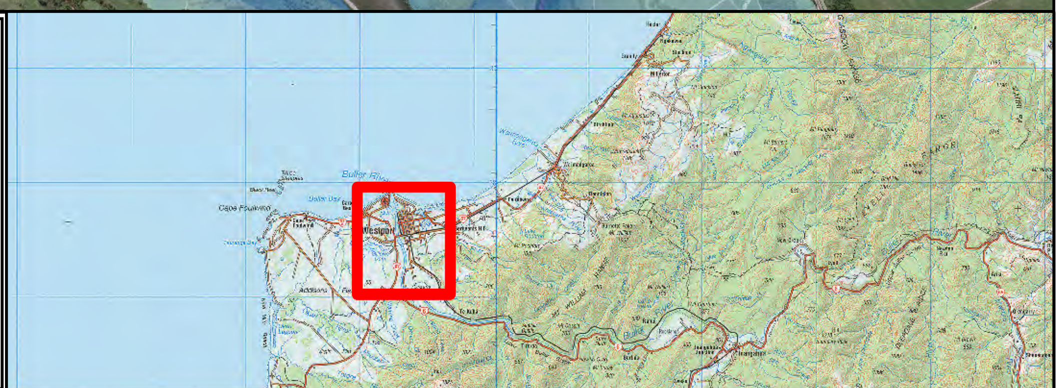
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 — 0



PROJECT

Buller River Modelling

TITLE

Scenario 11 - 100 Year Flow Including Climate Change (0.7m Sea Level Rise - 10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

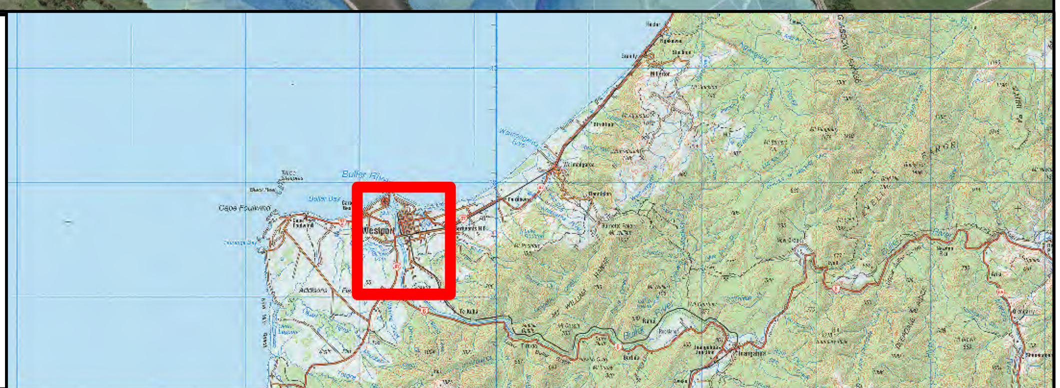
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 12 - 100 Year Flow Including Climate Change (0.7m Sea Level Rise - 15% Blockage SH Bridge, 10% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

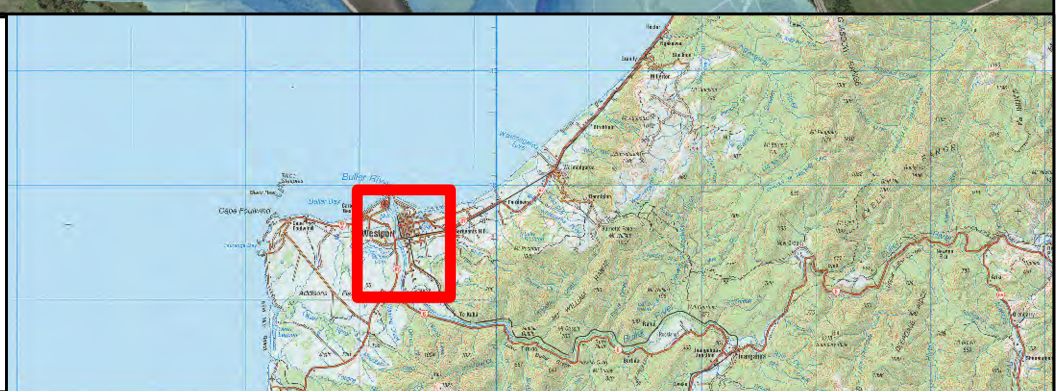
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 13 - 100 Year Flow including Climate Change (1m Sea Level Rise - No Blockage)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

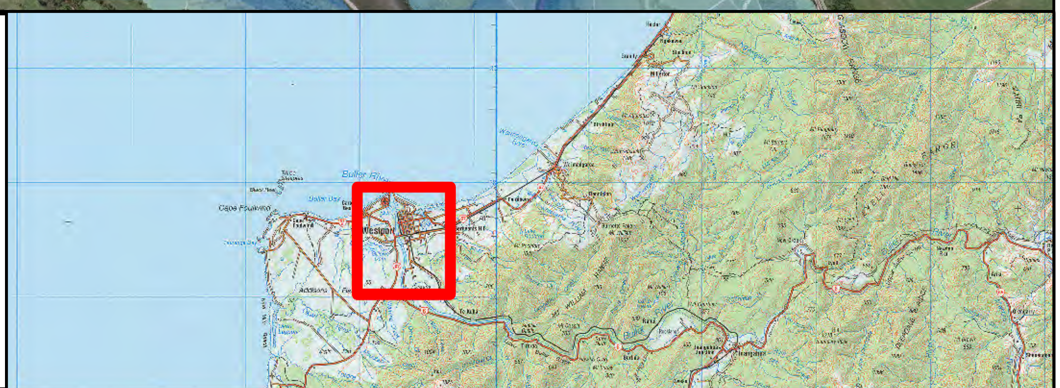
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 — 0



PROJECT

Buller River Modelling

TITLE

Scenario 14 - 100 Year Flow including Climate Change (1m Sea Level Rise - 10% Blockage SH Bridge, 5% Blockage Rail Bridge)

LANDRIVERSEA CONSULTING

THE WEST COAST REGIONAL COUNCIL

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

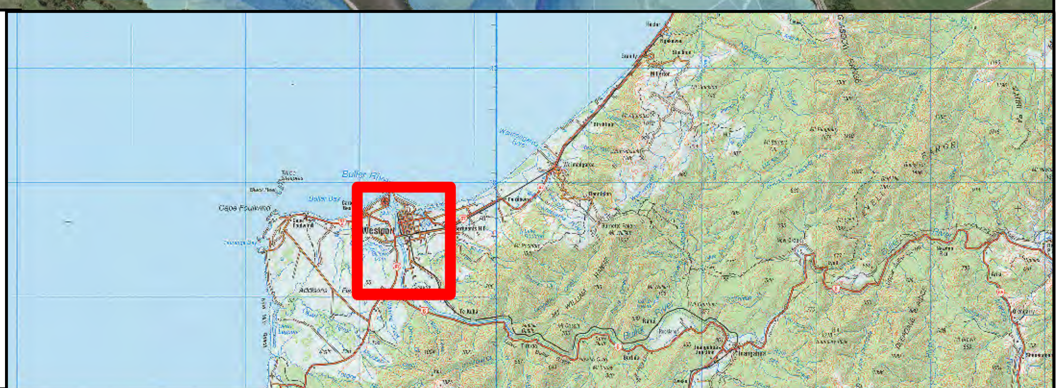
SCALE BAR

0 0.25 0.5 1 Kilometers

Legend

Peak Depth (m)

12.6 0



PROJECT

Buller River Modelling

TITLE

Scenario 15 - 100 Year Flow Including Climate Change (1m Sea Level Rise - 15% Blockage SH Bridge, 10% Blockage Rail Bridge)

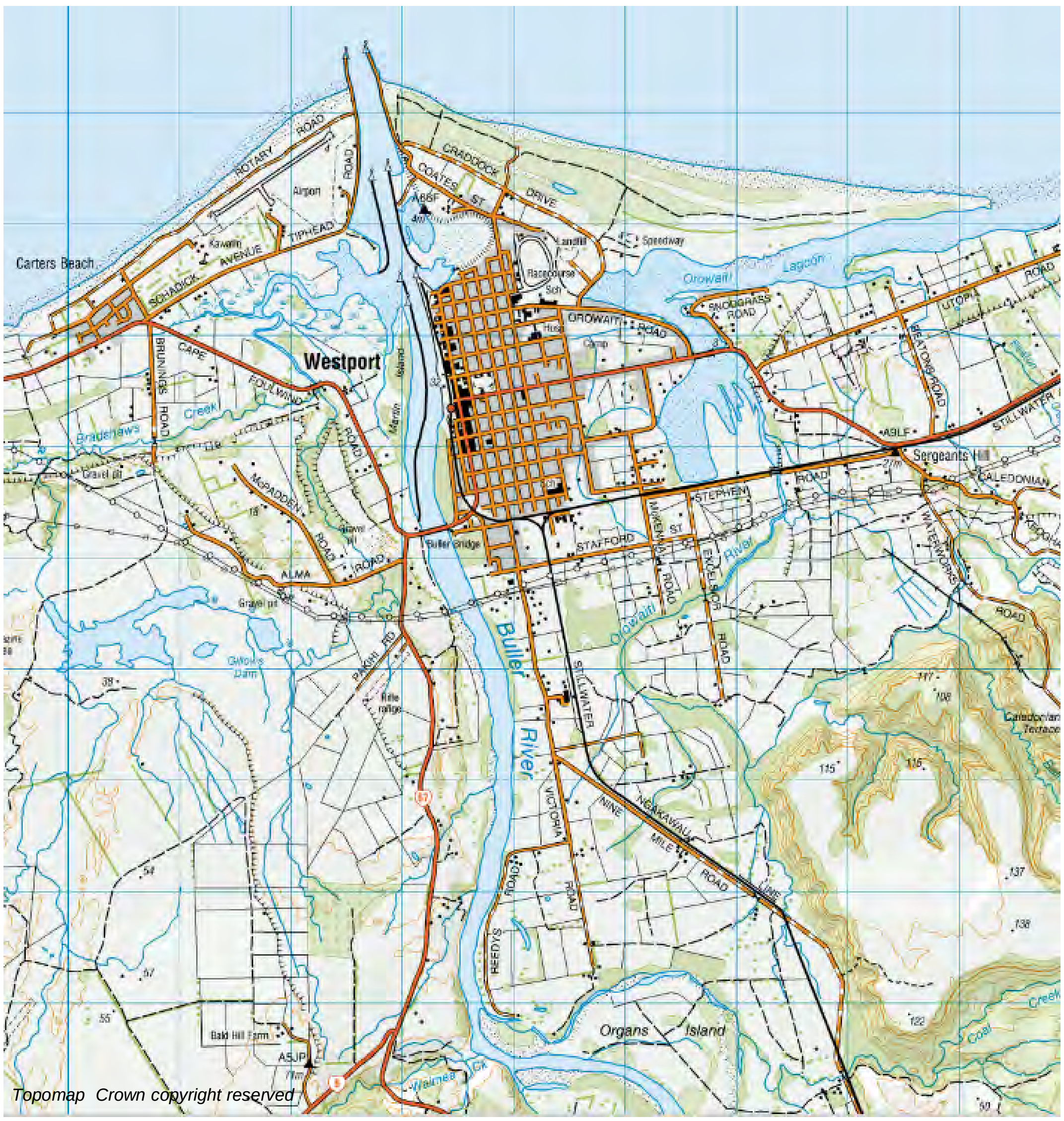
LANDRIVERSEA CONSULTING

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	8 December 2017	WCRC005	1:30,000	01

THE WEST COAST REGIONAL COUNCIL

APPENDIX B – DHI PEER REVIEW REPORT

Review of Buller MIKE FLOOD model



West Coast Regional Council

Report / Technical Note

September 2017

The expert in **WATER ENVIRONMENTS**

This report has been prepared under the DHI Business Management System certified by Telarc to comply with
Quality Management
ISO 9001
Quality System Quality Endorsed Company

West Coast Regional Council

Report / Technical Note

September 2017

The expert in **WATER ENVIRONMENTS**

DHI Water and Environment Ltd• Level 6, 5 Willeston St, Wellington, New Zealand•
Telephone: +64 9 912 9638 • Telefax: • info.nz@dhigroup.com• www.dhigroup.com

Review of Buller MIKE FLOOD model

Prepared for	West Coast Regional Council
Represented by	Randal Beal

Westport and Buller River
Topomap background sourced from LINZ.
Crown copyright reserved

Project manager	Philip Wallace

Project number	44800668-3
Approval date	15 September 2017
Revision	Final 1.0
Classification	Restricted

CONTENTS

FIGURES

1 BACKGROUND TO THIS REVIEW

1.1 Brief

Land River Sea Consulting Limited (Land River Sea) was engaged by the West Coast Regional Council (WCRC) in 2014 to prepare a hydraulic model of the Buller River and floodplain around Westport. The aim of the modelling was to understand the existing flood hazard to Westport and to aid in assessing flood mitigation options.

WCRC requires that the model is robust enough to confidently use the model findings and results for planning purposes. To this end, WCRC wishes to have a robust review of the model. DHI has been engaged to provide such a review.

1.2 The Buller River and Westport floodplain

The Buller River is fed by a catchment of nearly 6400 km^2 extending up into the Southern Alps. In its lower 10 km, it passes through Westport, with the main township on the true right (east) bank. Flood flows are large and the largest observed flood flow in New Zealand was in the Buller River (in 1926). Westport has a history of significant flooding, exacerbated by the Orowaiti Stream that bounds the town on its eastern side. The Orowaiti is an old channel of the Buller River and also now acts as an overflow channel of the Buller. It discharges to the sea a few kilometres east of the Buller River mouth

1.3 Scope of peer review

The peer review process is based on established quality-check items, the reviewer's knowledge of modelling process and experience with the modelling platform (MIKE FLOOD) and the reviewer's knowledge of river flood investigations in general. Conclusions are based on the overall behaviour of the model, key parameters and spot-checks of the model setup and outputs. While professional care and thoroughness has been applied throughout the review process, it has not been feasible to test and verify all components of the model (including confirmation of data sources) as this would require an effort comparable to the model build itself.

The review has been limited to the hydraulic modelling. The hydrological assumptions and inputs (generally the work of NIWA rather that Land River Sea) have not been reviewed, nor has an associated flood damages assessment carried out by Land River Sea been reviewed.

1.4 Review process

Land River Sea sought regular modelling advice from DHI during the early stages (May – July 2014) of the model schematisation, model build and calibration processes.

In October 2014, DHI carried out a review of the modelling as it stood at that point in time. DHI carried out a further review of the modelling and model report in July 2015. Findings and conclusions of that second review were provided to Land River Sea on 19 July 2015. These are appended to this current report (Appendix A).

Land River Sea provided a response to that second review. Both the review and the response were appended to a final report on the modelling by Land River Sea, dated August 2015 (the “model report”).

Most recently, in 2017, WCRC has requested more formal documentation of a model review, the subject of this current report.

A summary of the review process is provided in Table 1-1.

Table 1-1 Model review process

Date	Milestone
May 2014	Land River Sea commissioned by WCRC and commences modelling
May – July 2014	Land River Sea seeks occasional advice from DHI on model schematisation and build (via emails and phone conversations)
October 2014	DHI reviews model as it stood at that time and a draft report. Comments provided to Land River Sea
July 2015	DHI reviews revised model and updated draft report. Comments provided to Land River Sea.
August 2015	Final report prepared by Land River Sea
2017	WCRC seeks further confirmation regarding review of model. Further checks of final model.

2 Review of the model files

2.1 Overall schematisation

The model has been built with MIKE FLOOD software, an "industry-standard"[1] hydraulic modelling package with wide-spread usage. Within New Zealand, it is arguably the most commonly adopted flood modelling software.

In this application, the MIKE FLOOD model incorporates MIKE 11 (one dimensional or 1D flow equations, representing river and stream channels) and MIKE 21 (two dimensional or 2D flow equations, representing the floodplain). These two components are dynamically linked with the MIKE FLOOD model, so that flow can pass between the river and floodplain, and vice versa, as conditions dictate.

The MIKE 11 component covers the Buller River from cross-section 24, approximately 15km upstream of the mouth, at the gorge. The MIKE11 model also includes several bridge and culvert structures on the floodplain.

Overland flow has been modelled in MIKE 21 using a rectangular grid ("classic" MIKE 21) with a cell size of 4.8 m. The grid covers an extent of approximately 12.6 km (north-south) by 9.3 km (east-west), although flow in a portion of the grid in the south-west is precluded (it being high ground).

The model has been schematised so that overland flow can also pass directly to sea, along the coast or via Orowaiti Estuary.

Figure 2-1 shows the extent of the MIKE FLOOD model.

[1] For example, see Environment Agency (UK) and FEMA (USA) references listed at the end of this report

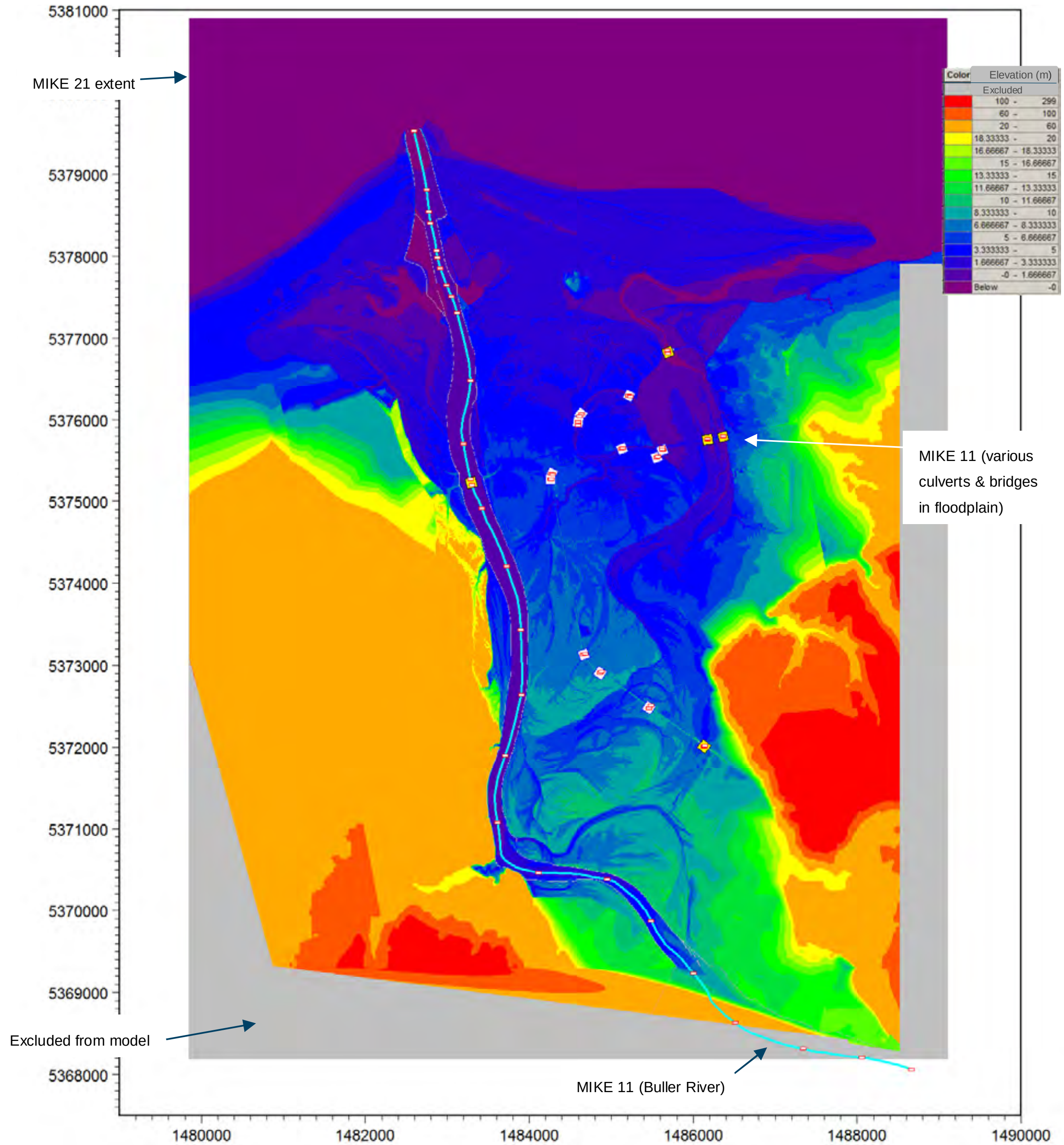


Figure 2-1 Model extent

Comment on these elements of the model is provided below. In general however, the modelling software used and overall approach is appropriate, given the study objectives.

2.2 1D channel flow model (MIKE 11)

2.2.1 Model extent

Ideally, the upstream end of the model would be at the Te Kuha river recorder site, the source of the calibration and design inflows. That would have required river cross-sections to have been surveyed and available between the upstream end of the model (cross-section 24) and the Te Kuha river recorder site, about 3.5 km upstream. It is also noted that cross-section 25, was not included in the model. However, the effect of starting the model at cross-section 24 rather than cross-section 25 or Te Kuha will be minimal, given the relatively short distance involved and the lack of floodplain in that reach.

At the downstream end, the model stops at cross-section 1, at the downstream end of the training walls at the mouth. Tidal boundary conditions have been applied at this location. In large flood events, the river discharge at this location would be expected to raise the water level and a more appropriate location would be slightly out to sea. That may require the assumption of an artificial cross-section shape, in the absence of any river or bathymetric survey.

However, the significance of applying the tidal boundary conditions at cross-section 1, rather than further offshore, would diminish upstream and can be expected to be small in the main area of interest (the township). Furthermore, the model calibration suggests some minor overprediction of flood levels in any case (Figure 26 of the model report).

2.2.2 Representation of hydraulic structures including any bridges, culverts

There are five bridges that have been modelled as such: the main road access to Westport over the Buller River (SH67) and four others over the Orowaiti.

The Buller River bridge has been modelled with the USBPR method, a well-established method. Piers have been allowed for, as has bridge submergence and overtopping. It is noted that the model predicted levels upstream and downstream of the bridge that were very close to observed levels for the calibration event.

The other bridges were modelled with the simpler “energy equation” method, a common and recommended approach for this sort of modelling (e.g. DHI, 2016a). One minor correction that could be considered to the set-up would be to allow overflow for the western-most bridge structure on Stephens Road (“Stephens Road Bridge 1” in the model). However at present, the model would simply divert flow around the structure if water levels got high enough and the impacts of the assumption would be very localised.

Additional simulations with debris blockage on the Buller River and Nine Mile Road Bridge were performed. Modelling of such scenarios is commendable. However, a comment made on the July 2015 draft report was not acted upon and the wording used in the final report remains ambiguous. It would be clearer to state that the three scenarios assume that the pier blockage ratio is 4.5% (no additional blockage), 14.5% and 19.5%, respectively.

There are 11 structures modelled as culverts. It is understood, from a response from the 2014 review, that assumed rather than surveyed invert levels were generally used. This has not been noted in either the final report or the model files. In the absence of survey data, such assumptions are reasonable, although sensitivity tests on some of the larger culverts might be worthwhile. A recommendation for future modelling work would be to be obtain survey data (if not done since the modelling in 2015).

Following earlier review comments, noting the double-counting of some bridge overtopping flows with the use of weir structures, the weirs were removed from the final model.

2.2.3 Cross section locations and properties

Buller River cross-sections are spaced at about 700 m - 800 m on average and date from April 2014. This generally provides reasonable definition for modelling the flow characteristics of the large and wide channel.

However, the definition around the port area, between cross-sections 2 and 4 (refer to Figure 4 of the August 2015 report) where training walls and side lagoons lead to non-uniformity in the main channel, was lacking with the available cross-sections. The initial model set-up incorporated extra cross-sections, created from interpolation of surveyed sections with modifications in accordance with information from aerial photographs. Comment was made in the 2014 review that additional interpolated cross-sections were required, however. This was acted upon in the final modelling as described in the August 2015 report.

It is understood that more recently, additional cross-sections were surveyed between cross-sections 2 and 4 and these included in an updated model. That will have provided additional confidence in model results.

2.2.4 Boundary conditions

2.2.4.1 Downstream boundary: sea level

Downstream boundary conditions for the calibration have been taken from the nearby Charleston sea level recorder. That is a suitable time series to use.

For design scenarios, a storm surge of 0.4 m coinciding with a Mean High Water Spring (MHWS) tide, adjusted to Lyttleton 1937 Vertical Datum, has been assumed. The tide has been timed so that it peaks approximately at the time of the arrival of the river flood near the mouth. This will be sufficiently conservative for design purposes.

Additional climate change scenarios with sea level rises of 0.7 m and 1 m have been modelled.

One additional comment is that it is incorrect to state that MHWS is defined as the tide level which is likely to be exceeded 10% of the time (p12 of the August 2015 report). A correct definition is as on p42 of the report.

2.2.4.2 Upstream boundaries and other flow inputs

The upstream MIKE 11 boundary conditions for the Buller River are derived from the Te Kuha recorder (for the calibration event) and from previous work by NIWA (for design scenarios). For the scenarios where climate change has been assumed, the adjustments are based on additional work by NIWA. Review of the NIWA results is beyond the scope of this current review.

However, DHI concurs with the observation made on p11 of the August report that a peak flow increase of 9% for an increase in rainfall intensity of 16% under the climate change scenarios is less than estimated elsewhere in other New Zealand catchments.

It is noted however that a scale factor of 95% has been applied to the design flows for all design scenarios. Hence modelled flows are only 95% of the values indicated in Table 2 of the August 2015 report. It is suspected that this is an inadvertent carry-over from earlier calibration tests where flows were scaled by 95% in an attempt to improve calibration. The scale factor needs to be reset to one and the design scenarios rerun.

No allowance has been made in the modelling for any local runoff in the Orowaiti catchment. The overflow from the Buller River will no doubt be by far the biggest determinant of inundation on the floodplain, and the relative scale of the Orowaiti and Buller catchments is such that the timing of inflows from each will likely be offset. Nevertheless the Orowaiti is not a small catchment, being around 50-60 km^2 and including some steep hill country. Sensitivity tests with some allowance for inflow from that catchment are recommended for future investigations.

2.2.5 Numerical parameters

- The wave approximation method has been set to ""High order fully dynamic". This is the most precise, and the most demanding of computational time.
- The time-weighting coefficient (""delta" in DHI terminology) for the finite difference scheme has been set to 1. This is the maximum possible value, favouring a stable model over maximum precision. A high value is generally recommended (0.8 or higher) for a MIKE FLOOD model, to minimise the risk of numerical instability, although a value of 0.5 (the minimum possible) does in theory give more accurate results. The potential impact on model accuracy (e.g. dampening out real perturbations) would be minimal and acceptable with the small timestep used in the simulation (0.25 s).
- The number of iterations per timestep has been set to three. This is the maximum allowed and will in general improve model stability and accuracy of results, although it can potentially slow the computation.
- Various other parameters are all at their default values.

Overall, the numerical parameters adopted are reasonable. Nonetheless, while it is understood that the high delta value was required for stability reasons, a slight reduction in the value in any future modelling could be trialled. It is possible that other making changes suggested in this review would obviate the need for a delta value of 1.

The spacing (dx) between computational points is typically 4.8 m. This matches the MIKE 21 grid and as such it is in line with recommended practice (that the dx in the MIKE 11 channels be approximately of the same order as the MIKE 21 cell size). For the Buller River channel, the dx could likely be relaxed a little (i.e. increased) without any adverse effect on results. That would also be expected to give some reduction in simulation times

2.2.6 Channel resistance

The bed resistance of the Buller River is one of the key calibration parameters. The values adopted (Manning's n of 0.028 -0.033) are within the expected range of values for such a river.

Although the model sensitivity would have been investigated during the calibration process, it would have been useful to have carried out tests on the sensitivity of design scenario results to Manning's n values. This is especially so given the inclusion of a comment in the model report (p44) regarding findings from a Manawatu River modelling exercise.

2.3 2D overland flow model (MIKE 21)

2.3.1 Model bathymetry (2D DTM)

The 2D model extent is as shown in Figure 2-1. The extent is reasonable, given the limited extent of LiDAR and other data.

Parts of the upper areas of topography are misleading, a product of the interpolation process where no topography data exists. An example is in the area to the south and west of the white line in Figure 2-2. Although most of this area will not be flooded from the river, flood maps in the

August 2015 report do show some overflow into the left bank floodplain (in the green area identified as misleading in Figure 2-2). For that left bank pocket of floodplain, it is possible that the model topography overestimates actual ground levels, reducing the available floodplain storage in the model. Further effort in the defining the model topography in this area is recommended, if necessary by commissioning some site survey. In other areas where river flooding would not occur, it would be best to remove the misleading topography from the model.

The model resolution adopted is 4.8 m. This value is that adopted in earlier modelling by NIWA, and gives a good compromise between adequate resolution of the floodplain topographical features and model runtime. Some sub-grid features, e.g. drains and crests of minor road embankments, will be missed, with potential localised impacts on results, but inspection of the model topography indicates that most significant features have been picked up and that the resolution is appropriate for the large flood events under investigation.

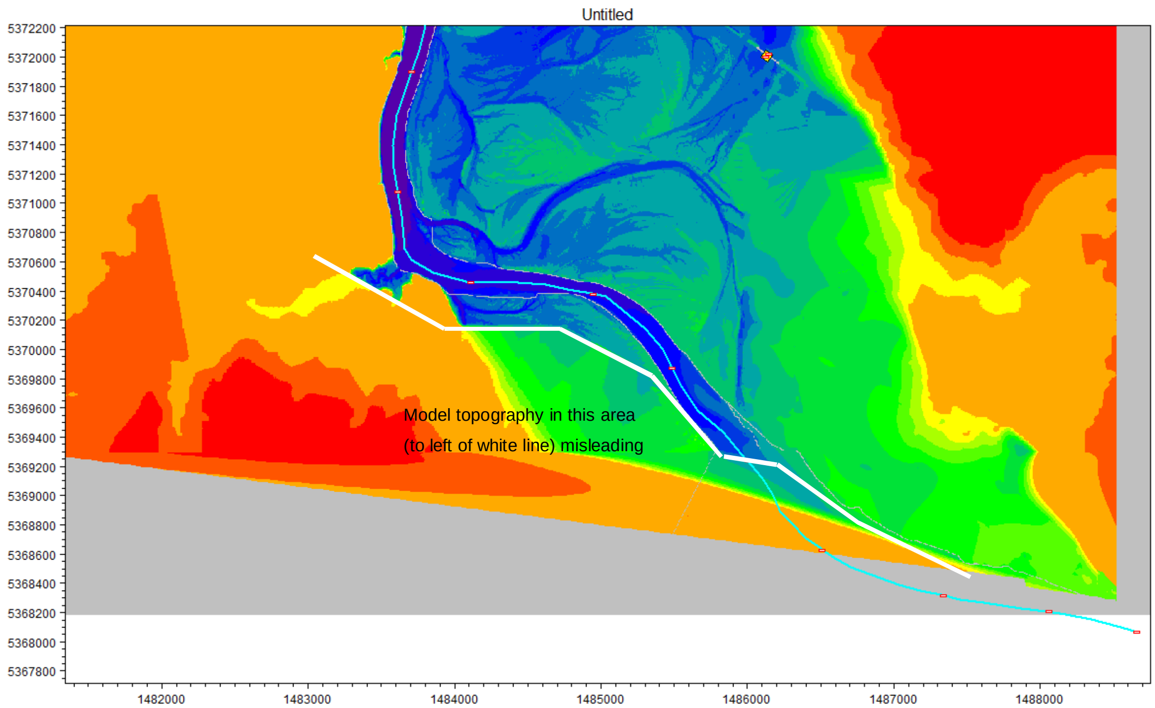


Figure 2-2 Part of model topography

It is noted in the August 2015 report that the LiDAR data have been shifted vertically by 0.15 m, to match ground survey information. Such manipulation of LiDAR has sometimes been found necessary in other studies. Nonetheless, documentation of the checks, or examples of them, within the report would have been useful for the review.

2.3.2 Flow resistance

A spatially-varying resistance floodplain has been assumed. The Manning's n values given in Table 3 of the August 2015 report are reasonable. From experience, results of this type of model are not very sensitive to the choice of values in any case, provided that they are within the general ballpark of common estimates.

2.3.3 Boundary conditions

The 2-dimensional MIKE 21 model has an open boundary along its northern edge, to deal with overland flow entering the sea along the coast or exiting from Orowaiti Estuary. The boundary condition for each scenario is the same as used in the MIKE 11 component at the river mouth.

2.3.4 Numerical parameters

- The timestep adopted is 0.25 s. This is typical for this sort of model and cell size (4.8 m)
- Initial water level values are the higher of a sea level of 0.8 m or the topography ground level (i.e. zero depth). This is reasonable.
- The flood (0.05 m) and dry (0.01 m) values adopted are acceptable, although typically a smaller flood value would be used.
- The eddy viscosity adopted is a velocity-based constant value of 1.84. The value has been calculated from the formula $0.02dx^2/dt$. This formula is more aimed at guidance for flux-based eddy viscosity and a lower value of perhaps 0.5 would be more appropriate for velocity-based viscosity. Recent guidelines (DHI, 2016b) recommend the use of flux-based rather than velocity-based values. However, in practice results tend not to be sensitive to the eddy viscosity parameters.

Overall, the numerical parameters adopted are reasonable, but again future modelling should aim to take the above comments into account.

2.4 Coupling of 1D and 2D flow models (MIKE FLOOD)

2.4.1 Standard links

There are 32 standard links at the ends of MIKE 11 channels. These particular channels are short fragments embedding a culvert or bridge, for which a standard link is needed to connect the channel ends to the floodplain

Comment on the reduction of the momentum factor for a few of the links was made in the July 2015 review, with the response that results were unaffected by this assumption. Nonetheless, for any future model refinements and simulations, the momentum factor could be restored to the default value of 1. Likewise, the "exponential smoothing" could be restored to default values (no smoothing) for those particular links.

2.4.2 Lateral links

Along the Buller River channel edges, lateral links between the 1-D and 2-D models are allowed for.

The links are "Weir 1" type, with the crest level usually appropriately set to the MIKE 21 terrain. A query on regarding the use of a "MIKE 11" control for the upstream-most right bank was made in the July 2015 review, with a response as given in Appendix B of this report. Nonetheless, this does highlight the limitations of the 2D model grid in that area, similar to those discussed in 2.3.1 above.

In some locations the lateral links are not adjacent to "land" cells, with the result that 2D flow is allowed on the river side of the lateral link, leading to some minor double-counting of flow. An example is along a length of the right bank near the western end of Nine Mile Road.

Limited spot checks of the Buller River MIKE 11 channel widths and the area blocked out from the MIKE 21 channel suggest that typically the MIKE 11 channel widths are slightly wider, further indicating a small amount of double-counting of river channel flow.

These last two matters should ideally be tidied up, although the overall impact on flood maps is likely to be fairly minor.

2.5 Model simulation test

As a final and additional check on the model, the MIKE FLOOD model was found to successfully start. This indicates that all model input files were saved and available, and that there are no fatal errors due to, for instance, obvious inconsistencies in the model input data and set-up.

3 Calibration

Model calibration was to the 15 July 2012 flood event, estimated to have a return period of around 20 years. That is a reasonable size event for calibration purposes.

Two sets of assumptions and associated results are presented: Buller River flows (at Te Kuha) as recorded, and 95% of those flows. The text and the response to the July 2015 review (as given in Appendix C of the model report) are a little ambiguous as to which set was adopted for the calibration, although this current review has assumed that the 100% case (i.e. flows as recorded) was the final assumption.

For that latter assumption, the average error (i.e. the difference between model predictions and surveyed flood levels) was 3 cm, and the average absolute error (not the absolute average error as stated in Table 4 of the model report) was 16 cm. Although there are some locations where the discrepancy was higher than one would prefer, overall these values are acceptable.

The comparison of model results with the aerial flood photographs, presented in the model report, shows at least a very rough match although it is difficult to be too confident with the comparison.

It is appreciated that data from other recent flood events, for model verification, is limited or non-existent. Should significant flood events occur in the future, it is recommended that such data be collected (e.g. flood levels along river and on floodplain, flood photographs) and used for model calibration purposes.

4 Conclusions

Overall, the modelling approach and schematisation for the Buller River model has been sound. Appropriate software has been used, the model extent is adequate and the model has been calibrated to an acceptable standard given the limitations of observed data.

However there is one particular issue that needs addressing, and other less significant issues that could also be addressed at the same time:

- Most significantly, the design scenarios only apply 95% of the required design flows. That requires a simple fix, but does mean that all design scenarios will need to be rerun and the resulting flood maps reproduced.
- Include recent surveyed river cross-sections (between cross-sections 2 and 4) in the model, if not done already.
- The model topography for the left bank pocket of floodplain, before the river turns to the north, should be reassessed. That may require additional survey.
- Additional survey would be useful to better define the right bank channel edge for the upstream-most lateral link.
- Land cells should be redefined in locations along the right bank where some flow can pass to a strip to the river side of the lateral link. This leads to some minor double-counting of river channel conveyance.
- The area removed from the 2D model extent for the Buller River channel appears to be typically a little narrower than represented in the MIKE 11 model, again leading to minor double-counting of conveyance.
- Consideration should be given to extending the model up to cross-section 25 and downstream of cross-section 1.
- Refinement of the model to incorporate survey data for larger culverts on the floodplain is recommended, or failing that, test sensitivity of results to culvert dimensions.
- Default momentum transfer and exponential smoothing parameters for all standard links should be restored, unless this causes model instabilities.
- Likewise, future modelling should aim to use latest recommendations for MIKE 11 and MIKE 21 numerical parameters, unless these cause model instabilities
- The impact of contributing flow from the Orowaiti catchment could be tested.
- Sensitivity tests of river channel resistance should be considered for design scenarios.
- Flood data should be collected if and when any significant flood events occur, for further verification of the model.

Minor suggestions for clarification and corrections within the model report text have also been made, in the event that the report is updated.

5 References

/1/ Land River Sea Consulting Ltd (2015). *Buller River: Hydraulic Modelling Study*. Report prepared for West Coast Regional Council. August 2015

/2/ https://www.fema.gov/hydraulic-numerical-models-meeting-minimum-requirement-national-flood-insurance-program

/3/ Néelz, S. and Pender, G. (2009) *Desktop Review of 2D Hydraulic Modelling Packages.* Environment Agency, Science Report SC080035.

/4/ Néelz, S. and Pender, G. (2013) *Benchmarking the latest generation of 2D Hydraulic Modelling Packages.* Environment Agency, Science Report SC120002.

/5/ DHI (2016a); *MIKE 11: Bridge Modelling using Bridge Module.* The Academy by DHI, Training material.

/6/ DHI (2016b); *MIKE 21 Flow Model, Hydrodynamic Module: User Guide. .*

APPENDICES

APPENDIX A

Peer Review Comments October 2014

A Peer Review Comments October 2014

Following are peer review comments from Philip Wallace (DHI) to Matthew Gardner (Land River Sea) in October 2014. Subsequent responses from Land River Sea are given in red.

Hi Matt,
I've had a look over your report and model. Attached is a copy of the report with my comments – mostly a few things to remove some ambiguity from the text. Fig 8 is missing so I can't comment on what you've said re NIWA vs your plots. I assume also that you will add in the details for the references that you have used.

Obviously we have had many discussions over the model in recent months, and I have also run the model for you on our computers. So there has been some informal "review" during this process.
However, going back into the model now, there are a few things I have noticed:

Weirs in the model:

- I noted that the weir width for RailCulvert 1 was a lot wider than the xs there. Looking at this, I am not sure why you have a weir there. I can't see any channel around there in the aerials or in the topo dfs2 file. And in any case, the weir as such is not blocked out in the dfs2, meaning that the flow over it is double-counted (m11 + m21).
- The same applies to RailCulvert2.
- And for all the other weirs, the flow is double-counted

I have now removed all weirs from the model except those modelled within the bridge module.

Bridges:

- Stephens Rd Bridge 1. Again, flow over the top is double-counted
- Any thought about debris on the bridges – in particular the Buller River bridge? Might be worth a sensitivity test? (forested catchment)

I have blocked out flows through bridges in the dfs2 and modelled in the bridge module using surveyed levels.

I plan to run 3 different blockage scenarios – one scenario with no blockage –
One scenario with 0.5m lowered soffit and 10% blockage on buller but no blockage on nine mile road bridge and 3rd scenario soffit on Buller Bridge lowered by 0.75 and also added reduced opening width by 15%. Nine mile road bridge overflow also blocked by 10%. I decided to run 3 scenarios as the model is actually quite sensitive to the blockage and I wanted to demonstrate that.

Culverts –

- for future reference, it maybe worthwhile noting in the nwk file or in the report if/where the invert levels and diameters have been assumed or surveyed. I'm presuming several of these are assumptions.

All culvert inverts are assumed and based on lidar levels, this is now mentioned in the main body of the report.

- I would set the momentum factor in the couple file to be 1 rather than zero, where the culverts are linked via standard links to the m21 model. (zero tends to give more stable results if this is a concern though)

The only culverts that do not have a momentum factor of 1 were causing instabilities in original runs with 0.5sec timestep..I could potentially increase now that final runs are 0.25 however don't want to risk loss of time and is unlikely to impact significantly.

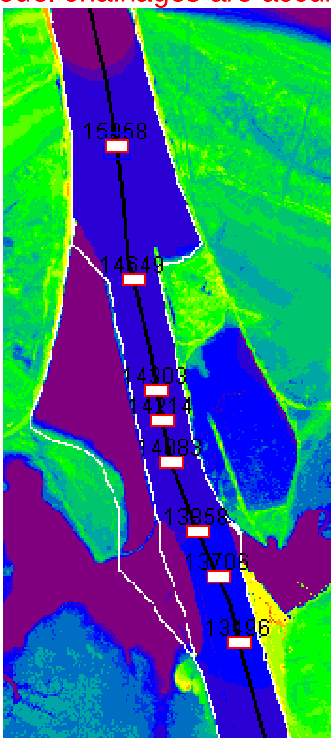
River XS – interpolation

- I can't recall exactly what we agreed or discussed on this, but I would consider inserting another interpolated xs between xs 2 and 2a, downstream of the training wall and the expansion.

Done

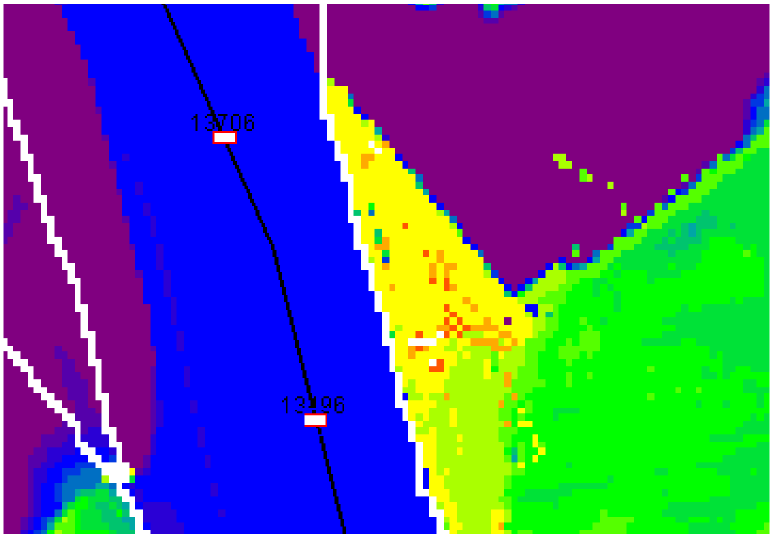
- I know that you didn't have a reliable bathymetry other than the xs, - if you did then a 2-d representation of the river between xs 2 and 4 would have been worth considering.
- I'm not sure how well the model xs and chainages tie up – I don't have the river xs as a shape file immediately to hand. There might be some minor discrepancies, by my measurements of the xs widths and the following plot of the nwk file, although these would not have much impact.

The model chainages are accurately determined in GIS and match up well.



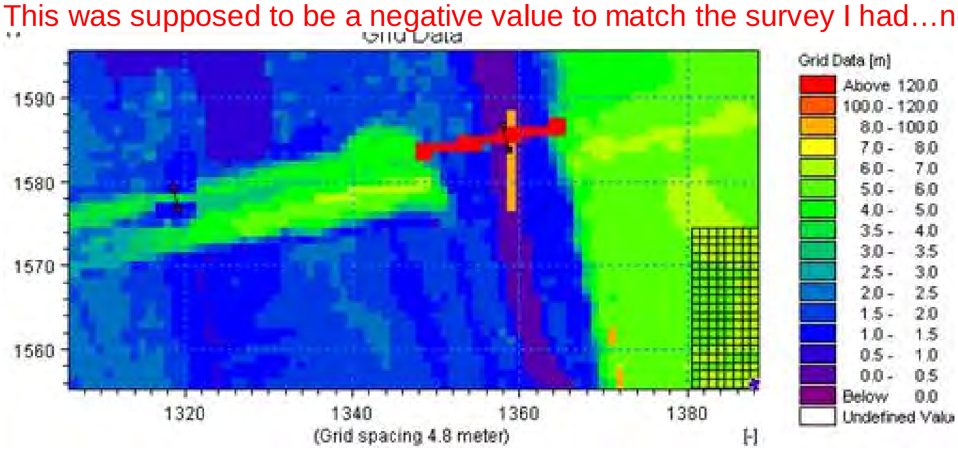
- Why does xs 4 not have a right bank up to/above the WL – see this plot:

This has been rectified.



Topo – in the file I have, there is a short section either side of the Stephens Road Main Bridge that has high cells in the topo –presumably an error (but of no real consequence for results). See plot:

This was supposed to be a negative value to match the survey I had…now rectified



Orowaiti outfall.

- I would definitely try a momentum factor of 1 for this standard link in the couple file, in the first instance. If instabilities result, (I wouldn't expect that though), then might look at reducing it a bit. However zero is unrealistic.

Orowait outfall now included in 2D model so no longer relevant.

- Your report says that bed levels seem to be static in the lagoon – but how sensitive are results to the size of the mouth xs there? Photos show some differences in the mouth over time, and your mouth xs seem to be taken from a snapshot at the time of the lidar survey? Something to think about at least?

  Mouth has now been widened based on assumptions made by NIWA. This section of their DEM has been extracted and added into my DEM.. The NIWA DEM based assumptions on site visits and inspection of historic aerial imagery. I note that I forgot to smooth the transition at the intersection and there is a steep dropoff in the DEM near the mouth however the model did not go unstable and a sensitivity test showed that water levels did not differ by more than 0.03 metres in the vicinity of the Orowaiti Bridge when compared with previous model with the mouth in 1D. This is due to the fact that there are several kilometres between the lagoon area and the mouth.

- 

I hope these comments are helpful. It may be that I have not quite understood some things, or forgotten earlier conversations, so feel free to get back to me if you want to discuss.

APPENDIX B

Peer Review Comments July 2015

B Peer Review Comments July 2015

Following are peer review comments from Philip Wallace (DHI) to Matthew Gardner (Land River Sea) in July 2015. Subsequent responses from Land River Sea are provided in Appendix C of the August 2015 report by Land River Sea.

Hi Matt,
Thanks for your email and instructions.

I've been over the latest version of the report and the model files. My comments are as follows:

Buller River Modelling Report July 2015.docx
I've made various track-changes comments on the document. I've attached a track-change copy of the report with these comments.
My main comment is in regard to the calibration and the inference that calibration using 95% of recorded flows gives better results than using 100% of recorded flows. I'm not convinced, although I note that this wouldn't change your design flow results.
There are a number of spelling/grammatical things to fix – I'm sure you are aware of that and so I haven't pointed these out.

Model files

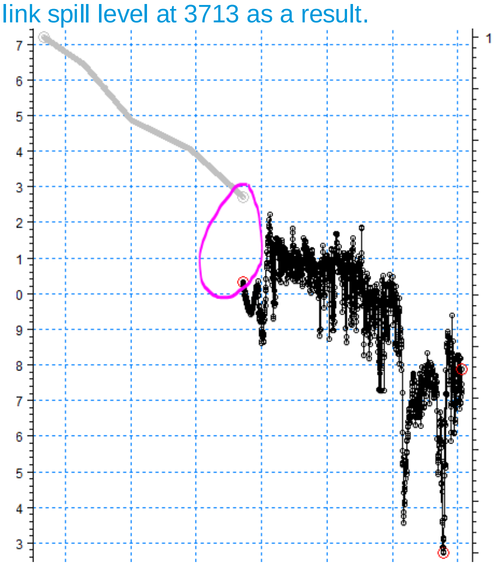
Nine Mile Rail Bridge
I see that you have put more detail in the Nine Mile Rail bridge cross-section. Although I'm not familiar with the layout (aerial photos and topo dfs2 not detailed enough to tell), and I note that your records say the bridge is 180m wide, I don't think I would have made the cross-section and standard links so wide – I would probably restrict this to the stream channel, ie 20-30m wide. Is it the road rather than the rail that restricts the flow? Also, the dfs2 either side is such that in effect the waterway wouldn't flow until WL > 6.6m RL, so there is in effect an additional degree of blockage you would not have intended. I'm not sure how significant this is, but I do note that you talk in your report about the differences between NIWA's and your results being in part due to how that bridge cross-section allows flow into either Westport or Orowaiti Lagoon.

Lower River cross-sections
I know we had some discussions on this previously and the complications that the training walls present. One thing I note is that the training wall seems to be at about RL 1m. This wall ties into the left bank at around interpolated xs3c. So as the tide drops below 1m, there is no longer any physical connection in the left embayment between xs 4 and xs 3b for instance – but the model does assume that there is, ie that the left embayment contributes to the overall conveyance. At high flows this may not be such an issue, depending on the level of accuracy required, although I think it would still have some impact on results.
This might also be an issue for the training wall between xs 4 and the bridge in low flow situations – although I know that we aren't interested in that here.
There could be some expansion losses eg around xs2a. With the 1-d representation, in lieu of having such losses in the model, there could be a case for increasing roughness instead?

I note though that from your results, most of the overland flow in Westport arrives from further upstream, and as there is a reasonable slope on the main river channel, the model schemetisation in this lower reach is not really going to affect your conclusions.
At the least, I'd qualify your report to note that there are limitations in the model schemetisation in this lower reach (ie d/s of bridge) and that In an ideal world, you'd have more bathymetric survey over this area of the model, and calibration data. Recommend to client that this be collected in the future?

Other model comments

Any reason why RB link 668 is M11 rather than M21 controlled? Also note that there is a large step in the lat link spill level at 3713 as a result.



Momentum factor for standard links - I take your point about how this has only been reduced for previously troublesome links – but might want to do an additional run now to confirm this has no significant impact . Stephens Rd/rail ridge is one I would look at. Might also reconsider the Railway Embankment Bridge in light of comments above.

Bathymetric survey – jump at end of the Orowaiti Lagoon – I agree that this is not important for most cases, but in low tide it might be – you've looked at tides going down to approx -0.5m. So maybe only 300mm deep at that point, then next cell is drop of 2.5m. You could have made assumptions re the transition from end of the bathy survey to the off-shore bathy (not sure where that is from) – eg interpolate over a number of cells. Of course the actual bathymetry through the throat and over the bar is unknown/forever changing, so there will always need to be assumptions.

Conclusions

Overall the model looks well set-up and appropriate. I would suggest however that you consider the above points to satisfy yourself that the model results and your conclusions are not sensitive to the approximations you have made. Also, as per the comments I've shown as track-changes in your report, a reconsideration of the reduction in calibration flows might be in order, or at further justification for reducing it.

I trust these comments are helpful. Please get in touch if you wish to discuss.

Kind regards
Phil