



Current State Analysis Report (Task 2-3, FVA)

February 2026

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February 2026
Report No. 2026/EXT/1997
ISBN. 978-1-991448-01-9

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HORIZONS FLOOD VULNERABILITY ASSESSMENT CURRENT STATE ANALYSIS

30/06/2025

CONFIDENTIAL



HORIZONS FLOOD VULNERABILITY ASSESSMENT

CURRENT STATE ANALYSIS

Horizons Regional Council

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REV	DATE	DETAILS
01	20/12/2024	Draft for review
02	16/04/2025	Updated report for review
03	24/06/2025	Final for issue
04	30/06/2025	Revised final for issue

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This report ('Report') has been prepared by WSP exclusively for Horizons ('Client') in relation to Horizons Flood Vulnerability Study ('Purpose') and in accordance with the [Horizons Flood Vulnerability Study Contract with the Client dated 16 July 2024]. The findings in this Report are based on and are subject to the assumptions specified in the Report [and Horizons Flood Vulnerability Study Contract with the Client dated 16 July 2024]. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.



TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	EXISTING MODEL REPORTS.....	2
2.1	EXISTING MODEL REPORTS	2
2.1.1	SUMMARY OF MODEL REPORTS	3
2.2	EXISTING ASSET DATA AND DOCUMENTATION	7
3	HYDRAULIC MODEL METHODOLOGY FRAMEWORK.....	10
4	RECOMMENDATIONS	15
4.1	MODEL RECOMMENDATIONS.....	15
5	LIMITATIONS.....	16
	APPENDIX A – REGIONAL FLOOD MODELLING FRAMEWORK.....	17
	APPENDIX B – HRC MODELLING REVIEW SPREADSHEET (REFER TO SEPARATE FILE).....	19
	LIST OF TABLES	
	TABLE 1: REGIONAL FLOOD MODELLING FRAMEWORK APPLIED TO EXISTING HORIZONS’ MODELS.....	4
	TABLE 2: REPORTS RELATING TO FLOOD ASSET MANAGEMENT PROVIDED TO WSP BY HORIZONS.....	8
	TABLE 3: FLOOD ASSET DATA PROVIDED TO WSP FROM HORIZONS.....	9
	TABLE 4 HYDRAULIC MODEL METHODOLOGY FRAMEWORK.....	10
	LIST OF FIGURES	
	FIGURE 1: HIGH LEVEL OVERVIEW OF GEOSPATIAL DATA OF FLOOD INFRASTRUCTURE ASSET LOCATIONS RECEIVED FROM HORIZONS.....	7

1 INTRODUCTION

WSP and the National Institute of Water and Atmospheric Research (NIWA) have been engaged by Horizons Regional Council (Horizons) to produce a comprehensive Flood Vulnerability Study for the region. The Horizons Flood Vulnerability Project aims to comprehensively assess flood risks across various regions by integrating all available flood information, data, and models.

This Current State Analysis Report presents an overview of the current state of the data provided to WSP for this project. Existing flood modelling reports have been provided to WSP and reviewed against a range of parameters including input data, modelling scenarios, extent and types of outputs, and calibration methods. The reports have also been reviewed against the Regional Flood Modelling Framework that has been developed collaboratively between WSP and Horizons. This will help determine the relevance and applicability of the current models and identify if major changes or model re-runs are recommended. By establishing a solid baseline, this project will highlight how existing models, data, and maps can be effectively utilised and identify any gaps that need addressing. This report also will present a summary of the existing asset data and documentation provided by Horizons.

2 EXISTING MODEL REPORTS

2.1 EXISTING MODEL REPORTS

WSP has reviewed 59 historic and existing hydraulic modelling reports provided by Horizons for the East Coast, Horowhenua, Lower Manawatū, Rangitikei, Upper Manawatū, Whangaehu and Whanganui localities used over the period of 1997-2024. Model coverage for this period focused on risk to townships located along major waterways including the Manawatū and Rangitikei rivers, nearby tributaries, as well as risk to significant flood protection and storage infrastructure.

Our assessment of hydraulic model reports identified that the core purposes for models to be developed include *flood risk assessment and hazard mapping, flood event and extent modelling, flood frequency analysis, planning and development* and *stormwater modelling and management*. To understand the functionality and applications of the existing models for these purposes, the model reports were reviewed and assessed for the following (with associated recommendations):

- Input data
- Type, scale extent of model data and model outputs
- Range of events/scenarios modelled
- Standard of service for assets mentioned
- Consideration of climate change
- Hydrological empirical data available and time scale
- Hydrological method
- Model software, version, boundary conditions
- Calibration of model
- Validation of model and historic flood data availability
- Modelled structures/stormwater network
- Provision of user specific maps, GIS, model interfaces, if yes which scenarios?
- Inclusion of modelled stormwater network and/or assets.

The model reports were also reviewed against the Regional Flood Modelling Framework that WSP has collaboratively developed with Horizons. The framework, presented in Appendix A, includes the output features for each level of modelling, and is linked to indicative key uses. The comparison of the model reports against the framework considered the input data, level of calibration, validation and sensitivity, extent of the model, and the scale and types of outputs. Based on this assessment, an indicative level of modelling has been assigned to each flood model to guide its appropriate use in supporting council functions and decision-making. The indicative levels are reflective of the underlying input data, modelling methodology and outputs (as per Table 4 Hydraulic Model Methodology Framework), and are intended to provide guidance on suitable applications rather than to represent a definitive assessment of model performance.

The Excel spreadsheet (Appendix B) contains more details than the summary table provided on Table 1. Please refer to the Excel spreadsheet (Appendix B) if more information is required.

2.1.1 SUMMARY OF MODEL REPORTS

Outputs of the reviewed flood model reports show that the risk assessments typically included township scale maps of the flood depths, levels, velocities and hazard zones for the 1 in 50, 1 in 100 and 1 in 200 year Average Recurrence Interval events at the time of model. Water levels for breach scenarios of flood protection and storage assets were typically provided for event scenarios in temporal hydrographic or tabular format. The accessibility of these outputs vary amongst model files, pdf mapped outputs and rudimentary GIS viewers.

A significant proportion of the assessments were undertaken between 2008-2013 where LiDAR was typically 10 m of grid size, compared to < 1 m resolution of currently available LiDAR quality. Additionally, LiDAR from this period may not reflect changes in the catchment such as urban growth or stormwater network growth. Until 2019, flood risk assessment provided to Horizons typically did not include modelling or discourse about the influence of climate change scenarios. Models developed over the past 5 years typically included recent climate change adjusted input data. There were many simplistic, small-scale models completed over the past 5 years, that were well calibrated for specific asset risk scenarios such as dam or stopbank breaches and local scale hazard zone maps which were fit for purpose at the time of commission. Few reports discussed decisions to ensure confidence with the model or incorporation of uncertainty through the use of freeboard.

It is noted that the standard of service was not typically mentioned in most flood risk assessment of the ones reviewed. Where stormwater infrastructure networks and condition have evolved since the time of assessment it may be helpful to see the impact of storm events reflected in the flood modelling.

The modelling reports provided to WSP were compared against the Regional Modelling Framework (presented in Appendix A) to provide indicative levels to guide use and applications of the flood models. 59 reports were submitted, 47 were assessed. 12 were not assessed; as these were duplicates, not reports, or had a superseded version. Table 1 presents the results of this comparison, highlighting the level of modelling detail appropriate for each report. This will enable Horizons to understand where it is advantageous to apply each report and identify areas where in-depth modelling or improvements may be necessary. The level assigned for each report intends to represent the minimum identified standard of the modelling assessment based on the specified modelling report, relative to the Regional Modelling Framework and Table 4 Hydraulic Model Methodology Framework. For example, this means that a Level C model report should have most of the elements of the Level C standards and might have some Level D elements, though not sufficiently to be defined as Level D. Of the 47 reports reviewed, 2 reports were Level A, 10 were Level B, 34 were Level C, and 1 was Level D.

Table 1: Regional Flood Modelling Framework applied to existing Horizons' models.

FLOOD MODEL REPORT	LEVEL A	LEVEL B	LEVEL C	LEVEL D
<i>Memorandum on Totara Reserve Options (2024)</i>			X	
<i>Rangitawa Stream Modelling (2024)</i>			X	
<i>Reid Line Spillway Preliminary Design Report (2024)</i>			X	
<i>Woodville Hydraulic Model build update report (2024)**</i>			X	
<i>Cyclone Gabrielle Design Options at Saddle Rd - Pohangina River (2023)</i>			X	
<i>Flood Modelling and Mapping of Pahiatua Township (2023)</i>			X	
<i>Ohakune Flood Modelling (2023)**</i>			X	
<i>Oroua River - Almadale to Downstream of Aorangi Bridge and Adjacent Eastern Rural Area (2023)</i>			X	
<i>Flood modelling of the Makirikiri Stream - Model build and results report (2022)</i>			X	
<i>Ashhurst Drainage Scheme - Flood Hazard Assessment (2021)</i>			X	
<i>Flood Modelling of the Mangaone Stream and East of Levin (2021)</i>			X	
<i>Foxton East Drainage System Issues and Options (2021)</i>			X	
<i>Manawatū Drainage Scheme (2021)</i>			X	
<i>Ohau-Manakau: Flood Modelling & Level of Service Assessment (2021)</i>			X	
<i>Ohura Flood Modelling (2021)</i>		X		
<i>Raparapawai 1D Modelling (2021)</i>		X		
<i>Sluggish Creek Technical Memo (2021)</i>		X		
<i>Woodville Hydraulic Model build report (2021)</i>			X	
<i>Koputaroa 1D and 2D HEC RAS v1 (2020)</i>			X	

FLOOD MODEL REPORT	LEVEL A	LEVEL B	LEVEL C	LEVEL D
<i>Koputaroa Pumpstations 1D v3 (2020)</i>			X	
<i>Mangaone Stream HEC RAS 1D (2020)</i>			X	
<i>Sinclair's Creek Diversion Channel HEC RAS 1D v2 (2020)</i>		X		
<i>Flood Modelling of Reid Line Spillway (2019)</i>			X	
<i>Flood Modelling of Feilding West Area (2017)</i>		X		
<i>Flood Modelling of the Makowhai / Piakatutu Catchment (2017)</i>		X		
<i>Flood Modelling of the Ohakea Air Base and environs (2017)</i>		X		
<i>Ohakune Township Flood Modelling Addendum Report (2017)</i>			X	
<i>Lower Whanganui River Flood Protection Investigations - Review of the June 2015 Flood and Update of Design Flood Level Estimates (2016)</i>			X	
<i>Floodplain Mapping Feilding Township and Adjacent areas (2013)</i>			X	
<i>Palmerston North City Flood Mapping Composite Map Creation (2013)</i>	X			
<i>Herbertville - Flood Risk Assessment Report (2012)</i>		X		
<i>Piriaka Flood Plain Mapping (2011)</i>			X	
<i>Ohakune Township Flood modelling Study Report (2010)</i>		X		
<i>Pahiatua Township Flood Study Report (2010)</i>			X	
<i>Pohangina River Flood and Hazard Mapping (2010)</i>			X	
<i>Taumarunui Flood Mapping (2010)</i>				X
<i>Whangaehu and Turakina Rivers Flood and Hazard Mapping (2010)</i>			X	
<i>Manawatū Gorge Floodplain Mapping and Website development (2009)</i>			X	
<i>Manawatau and Rangatikei Rivers Flood Hazard Assessment (2008)</i>			X	

<i>FLOOD MODEL REPORT</i>	<i>LEVEL A</i>	<i>LEVEL B</i>	<i>LEVEL C</i>	<i>LEVEL D</i>
<i>Mangatainoka and Makakahi Floodplain Mappy and website development (2008)</i>			X	
<i>Oroua River Flood Hazard Assessment (2008)</i>			X	
<i>Tutaeunui Stream Floodplain Hazard Assessment (2008)</i>			X	
<i>Upper Mangaone Stream (2008)</i>			X	
<i>Waikawa and Manukau Streams Floodplain Assessment (2008)</i>			X	
<i>Mangaone Stream and Taonui Basin Floodplain Hazard Assessment (2007)</i>			X	
<i>Hydraulic Modelling of Rangitikei River: Kakariki Bridge to Mouth (2005)</i>		X		
<i>Horowhenua District Flood Maps: Information Sources and Methodology (1997)</i>	X			

** refers to reports commissioned by Territorial Authorities; however, was provided to WSP by HORIZONS and have been reviewed as part of this project.

2.2 EXISTING ASSET DATA AND DOCUMENTATION

To support the Flood Vulnerability Assessment and Asset Condition Report, WSP and NIWA have received a range of data and documentation relating to Horizons' flood assets. This includes asset management plans, infrastructure strategies, and datasets provided in both excel and geospatial formats. These resources form the foundation for assessing the inspection and monitoring methodologies that Horizons could utilise to enhance understanding of their asset conditions and also informing the flood vulnerability assessment. A summary of the documentation reviewed is provided in Table 2, while Table 3 and Figure 1 present an overview of the asset data received, including point, polyline and polygon geospatial features. The data encompasses flood protection assets and can be linked to other datasets through the asset ID fields.

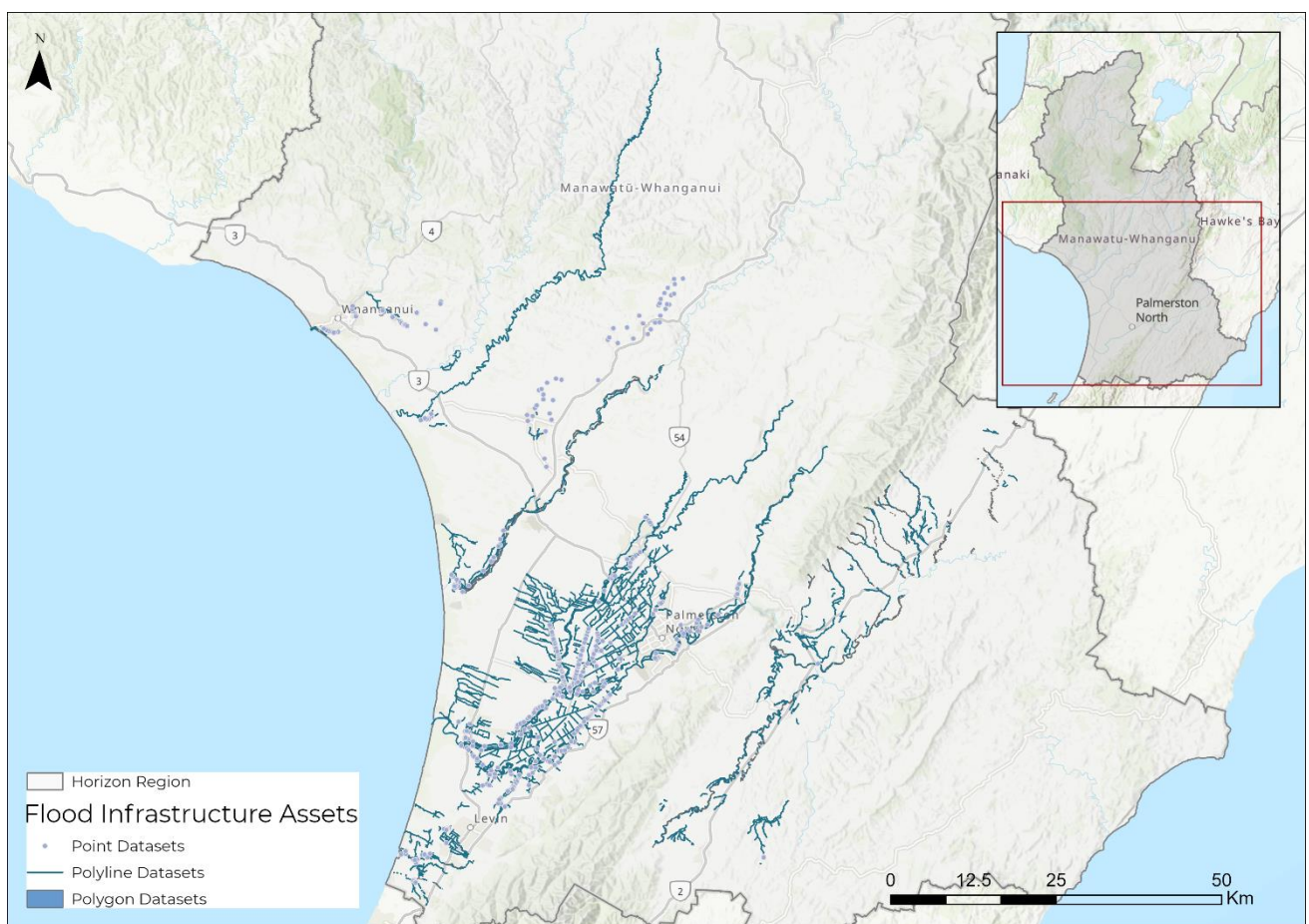


Figure 1: High level overview of geospatial data of flood infrastructure asset locations received from HORIZONS.

Table 2: Reports relating to flood asset management provided to WSP by Horizons.

DOCUMENT/DATA	SUMMARY	PUBLICATION DATE
Infrastructural Asset Management Plan Part A	Asset Management Plan - Part A: Base Plan Sets out the policies, processes and procedures which are common across all river and drainage schemes.	July 2018
Asset Management Plan for each scheme includes: Central - 3 Eastern - 4 Southern - 9 Northern - 11	Asset Management Plan Part B: Scheme Specific Defines for each scheme – the standard of flood/erosion protection to be provided for each scheme; the risks to the assets; and the monitoring/reporting required. Aim to ensure the effective management of the scheme's infrastructure assets.	June to July 2021
Rivers Management Infrastructure Asset Management Plan	Decision making framework for the financial management of Horizons' River Management Infrastructure Assets from FY2024-2025 to FY2034-2035	October 2024
Horizons Infrastructure Strategy	Document details Horizons faces over the next 30 years for its river management, flood protection and drainage infrastructure. The strategy assesses potential options for managing these issues and identifies the preferred approach.	2024
River Management and Drainage Infrastructure Asset Management Plan	Updated and current Asset Management Plan. Outlines the decision making framework for the operational management of Horizons' Rivers Management infrastructure assets over the 10 year period from FY2024-2025 to FY2034-2035.	March 2025
Horizons Flood Protection Asset Inspection Guide	Asset inspection guide with condition grading for stopbanks, floodgates/culverts, pump stations and floodwalls.	April 2025

Table 3: Flood asset data provided to WSP from Horizons.

Data	Summary	Date Data Exported
Asset Inspection Condition Rating Scores – includes a total of 3,837 assets	Excel list with all assets (including ID and scheme) with their criticality and condition rating. A summary is also provided by scheme, with the number of critical and high assets and the rate of inspections	30 June 2024
AP Asset Quantities – includes a total of 3,873 assets	Excel list with all assets (including ID and scheme) with the dimensions, material, quantities and replacement value of assets	2 July 2024
Geospatial Data – includes: 769 points 2951 lines 758 polygons	Geospatial points, lines and polygons of the assets. Data includes the scheme, asset type and asset ID. Assets have not been matched to criticality or condition rating.	N/A

3 HYDRAULIC MODEL METHODOLOGY FRAMEWORK

This is the proposed new categorisation for hydraulic models to support the Regional Flood Modelling Framework. The model feature headings are based on the different model inputs, parameters and modelled scenarios. Depending on the scope of each project, the level of detail required per model feature can be adapted and selected from a lower category if more relevant to the study area. This report is accompanied by a detailed analysis of each flood model report in an Excel workbook (Horizons Modelling Review Checklist).

Table 4 Hydraulic Model Methodology Framework.

MODEL FEATURE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
Data Methodology	<ul style="list-style-type: none"> Basic desktop data, limited review. Reporting describes data used. 	<ul style="list-style-type: none"> Some data review, limited justification. Reports describes data and sources. 	<ul style="list-style-type: none"> Good data review, some limitations noted by considering quality of data and reliability of data sources. 	<ul style="list-style-type: none"> Comprehensive data review. Assesses and justifies use of all data sources, detailing any limitations or uncertainties and impact on purpose of study.
Asset Surveying	<ul style="list-style-type: none"> Assets and structures not surveyed. Levels unknown. 	<ul style="list-style-type: none"> Key structures or assets have some survey, but it might be outdated or key dimensions missing. Some assumptions or extrapolation accompany surveyed data. 	<ul style="list-style-type: none"> Most key structures surveyed with all dimensions included. Survey is recent and/or representative of existing situation. Only structures not surveyed are those not considered important enough to model (i.e., do not impact to hydraulic mechanisms). 	<ul style="list-style-type: none"> All structures included have been surveyed with all key dimensions included. Comprehensive survey brief developed for structures that are missing dimensions. All exceptions should include justification.
Channel Surveying	<ul style="list-style-type: none"> Channels not surveyed. Levels unknown. 	<ul style="list-style-type: none"> Channels unlikely to be surveyed. Disparate cross-section data might be available and could be outdated. Model likely to use DEM surfaces to define channels. 	<ul style="list-style-type: none"> Surveyed cross-sections or interpolated surfaces using cross-sections. Larger watercourses might rely on DEM to define channel. 	<ul style="list-style-type: none"> Regularly-spaced (depending on watercourse length), up-to-date (<2 years, depending on morphology) cross-section survey undertaken. Bathymetric survey undertaken for the most detailed models.

MODEL FEATURE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
Hydrological Methodology	<ul style="list-style-type: none"> Hydrological Assessment not undertaken – only basic hydrological inputs used to support modelling. Examples might include steady state peak flow taken from NIWA Flood Statistics (Henderson & Collins), single rainfall depth from HIRDS or fixed water level boundaries. 	<ul style="list-style-type: none"> Hydrological Assessment is basic, reporting of simple approach to application of rainfall, inflows and boundaries. Examples might include uniformly distributed rainfall hyetograph for single storm duration or basic hydrograph from rainfall-runoff model like HEC-HMS, or a static tidal boundary or normal-depth boundary downstream. 	<ul style="list-style-type: none"> Hydrological Assessment covers more detailed analysis, considering the most appropriate hydrological control on catchment flooding, perhaps more than one source of inflow (i.e., rainfall and flow hydrograph). Considers multiple hydrological methods such as the Rational Method, Statistical Flood Frequency Analysis (Gauged and Ungauged), rainfall-runoff models. Starting to look at specific events. Examples include normalised hydrographs from event analysis, determining critical storm durations, undertaking gauge analysis (e.g., rating curves). 	<ul style="list-style-type: none"> Most or all of Level C, plus validating and calibrating the input parameters of hydrological models to observed data or events, where appropriate. Examples include runoff coefficients, time of concentration (time to peak), combined probability of flow / rainfall / tidal scenarios, rating curve analysis, baseflow, initial catchment wetness, infiltration losses.
Flood Events and Climate Change	<ul style="list-style-type: none"> Single AEP event, water level or threshold considered. Perhaps single historic flood event. 	<ul style="list-style-type: none"> Multiple AEPs, perhaps single historic event modelled or basic validation/comparison of AEPs to observed flooding. New models might include climate change. 	<ul style="list-style-type: none"> Full suite of AEPs covering range of flooding mechanisms. Single historic event modelled and validated to historic data including one or all of flood extents, photographs, debris levels. New models include climate change. 	<ul style="list-style-type: none"> Full suite of AEPs covering range of flooding mechanisms. Multiple historic events modelled and validated/calibrated to historic data including flow and water level gauges, flood extents, photographs, debris levels. Includes at least one climate change scenarios, possibly two or three.
Terrain	<ul style="list-style-type: none"> Terrain defined by low-resolution Digital Elevation Model (DEM) or Digital Surface Model (DSM). Simple terrain representation accepted as part of methodology. 	<ul style="list-style-type: none"> DEM surfaces prioritised over DSM, aiming for higher resolution (below 10 m) which is suitable for catchment level flood risk assessment. Terrain might be outdated and commentary would 	<ul style="list-style-type: none"> Terrain defined by high-resolution (below 5 m) DEM which is recent (<5 years old). DEM resolution should be high enough to pick up all key features which impact flooding 	<ul style="list-style-type: none"> Terrain defined by high-resolution (below 5 m) DEM which is recent (<5 years old). DEM resolution should be high enough to pick up all key catchment to local-level topographic

MODEL FEATURE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
	<ul style="list-style-type: none"> Source of terrain data disclosed in reporting. 	<ul style="list-style-type: none"> be included to discuss suitability of data. Source of terrain data should prioritise LINZ-quality data but best available might be sourced elsewhere. 	<ul style="list-style-type: none"> mechanisms (catchment to local-level topographic scale). Source of terrain data should prioritise LINZ-quality data. 	<ul style="list-style-type: none"> features which impacts flooding mechanisms. LiDAR data validated against topographic survey; systematic offsets corrected where necessary. Project-specific topographic survey commissioned to fill in gaps.
Land Cover	<ul style="list-style-type: none"> Spatial variation in land cover not considered. Roughness may or may not be modelled or considered explicitly depending on modelling methodology. At best roughness might be simplified to a single value. 	<ul style="list-style-type: none"> Spatial variation in land cover unlikely to be considered. Roughness implemented as at least two values at a minimum. 	<ul style="list-style-type: none"> Spatial variation in land cover using latest Land Cover Database (e.g., V5.0), assigning roughness values to each land use. Roughness values typical of industry standards, values approximated. Similar or homogeneous land uses might be grouped together in the same roughness value. Hydrological methodology should consider infiltration losses based on land-use type if a rain-on-grid model is used. 	<ul style="list-style-type: none"> Spatial variation in land cover using latest Land Cover Database (e.g., V5.0), assigning roughness values to each land use. Sensitivity testing, validation or calibration should confirm roughness values particularly for channels. Depth-varying roughness is used for applicable land use types like buildings. Hydrological methodology will consider infiltration losses based on land-use type if a rain-on-grid model is used. Sensitivity testing, validation or calibration should confirm infiltration values implemented.
Cell Size / Resolution	<ul style="list-style-type: none"> Very low-resolution (>25 m) fixed grid with low-resolution cell definition i.e., no Sub-Grid-Sampling (SGS) in TUFLOW models. Cell sizes and resolution possibly not considered, for example super-imposing water level on terrain grid. 	<ul style="list-style-type: none"> Low-resolution (10-25 m) fixed grid with low-resolution cell definition i.e., no Sub-Grid-Sampling (SGS) in TUFLOW models. 1D models use unevenly spaced cross-sections, relying on linear interpolation to account for meandering and spatially-dynamic systems. 1D cross-sections might 	<ul style="list-style-type: none"> Higher-resolution (2-5 m) fixed grid cell definition. Lower-resolution possible with flexible mesh (e.g., TUFLOW Quadtree) and high-resolution (1-5 m) SGS cell definition. In locations of volume-driven floodplains, terrain might be defined by large-cell sizes (>25 m) if sub-cell resolution is high (1-5 m). 	<ul style="list-style-type: none"> Very high-resolution (<1-2 m) cell definition in area of interest. Larger cell sizes (>10 m) are acceptable in locations of appropriate sub-cell resolution (away from areas of interest). In locations of volume-driven floodplains, terrain might be defined

MODEL FEATURE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
		represent floodplains as well as cross-sections.	<ul style="list-style-type: none"> 1D models use evenly-spaced, representative cross-sections to define channel terrain. Bad practice for 1D sections to define floodplains unless justified. 	<ul style="list-style-type: none"> by large-cell sizes (>25 m) if sub-cell resolution is high (1-5 m). 1D cross-sections used only in locations where balance of computational power and flowpath representation is considered necessary – for example well-defined, artificial overland channels.
Structures	<ul style="list-style-type: none"> Unlikely to be included. Potential for terrain modifications (e.g., smoothing) to represent flowpaths for large structures. 	<ul style="list-style-type: none"> Key structures included, sometimes with a simplified representation using mix of assumed and known dimensions. Typically, non-operational. Most structures in 2D typically involve basic modification of terrain. Flow dynamics through structures not validated or calibrated. Structure model parameters estimated, for example hydraulic losses and roughness. 	<ul style="list-style-type: none"> Most key structures included with surveyed or known dimensions. Basic operations included where necessary, for example sluice gate open or closed, pump on or off. Flow dynamics through structures validated to basic understanding of structure behaviour including hydraulic losses and roughness. No expectation to calibrate. Basic assessment and modelling of risks to structure undertaken, for example debris blockage. 	<ul style="list-style-type: none"> All key structures included with surveyed or known dimensions. Complex operations included where necessary, for example time- or level-dependant gate operations, pump curves. Flow dynamics through structures are calibrated, including hydraulic losses and roughness. Methodology explaining parameter choices included. Detailed assessment and modelling of risks to structure undertaken, for example debris blockage.
Stormwater Network	<ul style="list-style-type: none"> Not included. 	<ul style="list-style-type: none"> Not explicitly included. Basic representation through simplifications such as smoothing floodplain culvert connections, applying cell-based losses to approximate stormwater capacity. Stormwater network excluded if not applicable. 	<ul style="list-style-type: none"> Stormwater network represented with best available data, likely to be missing dimensions and assumptions made. Assumptions made on hydraulic parameters like manhole losses and roughness. Stormwater network excluded if not applicable. 	<ul style="list-style-type: none"> Stormwater network represented with high-quality data. Varying roughness with material type. Manhole loss methodology developed. Stormwater network excluded if not applicable.

MODEL FEATURE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
Sensitivity Testing	<ul style="list-style-type: none"> Not undertaken. 	<ul style="list-style-type: none"> Basic sensitivity tests with descriptive reporting on outcomes. Sensitivity tests might include variations to roughness or flows. 	<ul style="list-style-type: none"> Starting to identify key model features with uncertainty, such as roughness and flows. Reporting on outcomes of sensitivity tests, making recommendations on improving modelling to address uncertainties. Including assessment of residual risk, for example blockage or extreme flood event (ULS). 	<ul style="list-style-type: none"> Comprehensive assessment of key uncertainties included in the model based on validation and calibration exercises. Testing included of more complex features like hydraulic losses and turbulence formulations. Uncertainties highlighted and detailed by sensitivity testing by implementing improvements to model.
Validation and Calibration	<ul style="list-style-type: none"> Limited to basic comparison of observed flood extents. Suitability of modelling and/or study not judged based on validation. Calibration not undertaken. 	<ul style="list-style-type: none"> Model validated against observed flood extents or surveyed debris levels, typically one event of interest. Suitability of modelling and/or study loosely judged on validation. Calibration not undertaken. 	<ul style="list-style-type: none"> Model validated against observed flood extents and peak water levels for at least one observed event, across several locations or gauges. Calibration to hydrograph shape and levels is attempted across multiple events but outcomes might be considered inadequate to fulfil 'calibration'. Suitability of modelling and/or study judged on validation outcomes. 	<ul style="list-style-type: none"> Model calibrated against observed flood extents, peak water levels, hydrograph shape, travel time (time of concentration). Calibration judged as successful for at least one observed event, typically 2 or more. Extensive methodology and analysis included in reporting. Suitability of modelling and/or study judged on calibration outcomes.
Outputs	<ul style="list-style-type: none"> Mapping focuses on flood extent. 	<ul style="list-style-type: none"> Mapping of flood extent and levels. One key event or AEP. 	<ul style="list-style-type: none"> Mapping of flood extents, levels, depths, velocities, hazard and time series plots. Multiple locations and/or multiple events / AEPs. 	<ul style="list-style-type: none"> Mapping of flood extents, levels, level differences, depths, velocities, time series plots. High-resolution outputs. Includes animations where appropriate. Multiple locations and multiple events / AEPs

4 RECOMMENDATIONS

4.1 MODEL RECOMMENDATIONS

The majority of the existing model work that has been reviewed has been assessed as a Level C. These models typically consider a range of flood depths, levels, speeds and hazards for multiple AEP's, many consider assets into the modelling, consideration of climate change and varying extents of calibration and validation.

Based on the comparison of the provided modelling reports against the Regional Flood Risk Assessment Framework developed for Horizons, the following recommendations for future flood risk modelling are recommended:

- Model build process documentation for accessibility, traceability and repeatability for future modelling. Greater clarification of the Horizons approach to flood risk assessment, purpose of model and limitations of model provided with model outputs to align with Level of Detail from the Framework.
- Establish and communicate standard of services and reflect this in the model and model report.
- Aggregation of local flood risk assessment to a single regional database so current and future findings shift to a whole of catchment or regional overview.
- Horizons to identify a Shared Socioeconomic Pathway (SSP) scenario for inclusion in all models going forward and for those factors to be applied to flood risk model inputs including hydrological inputs and coastal boundaries. It is advised that where historic models with appropriate method and function can update their empirical input data to represent current day conditions and for future climate change, the model may be repurposed.
- Horizons establishes a consistent approach to freeboard modelling for different levels of service in recognition of uncertainty for climate change hydrological scenarios, particularly surrounding communities and developing areas.
- Enhance confidence in models through establishing a quality framework for data sources used in validation and calibration such as gauges, measured debris and photographic evidence of flood extents. Identify locations of input gauges and model input data across the region for data quality assurance and future updates.

Recommendations for a future modelling programme have been informed by the findings of the current state analysis and flood vulnerability assessment. This analysis involved reviewing existing models developed for Horizons and combining these insights with regional modelling outputs related to residential losses. Following this, a prioritised programme of future modelling work has been proposed and can be found within the Final Report.

5 LIMITATIONS

This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for Horizons Regional Council ('Client') in accordance with the WSP Request for Proposal dated 16 July 2024 and the CCCS 4th Edition Dec 2017 signed 9 September 2024 ('Agreement').

Permitted Purpose

This Report has been prepared expressly for the purpose of supporting Horizons in providing a current state analysis report that supports the development of a comprehensive flood vulnerability study for the region that considers the multiple uses of flood modelling information ('Permitted Purpose'). WSP accepts no liability whatsoever for the use of the Report, in whole or in part, for any purpose other than the Permitted Purpose. Unless expressly stated otherwise, this Report has been prepared without regard to any special interest of any party other than the Client.

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APPENDIX A – REGIONAL FLOOD MODELLING FRAMEWORK

WSP has worked collaboratively with Horizons to develop a regional flood modelling framework. The flood modelling framework developed encompasses four levels of assessment, ranging from regional to site specific. Each has different features and outputs, such as scale and flood characteristics. The different levels of assessment have been mapped to the use case personas developed to demonstrate how the level of assessment will contribute to flood risk management for a user.

Further detail on the flood modelling framework can be found in the Horizons Flood Modelling and Mapping Guideline (WSP, 2024).

Level of Detail	Key Features	Output Features	Uses
Level A – Basic Desktop Assessment	<p>Regional model</p> <p>Validated against extents</p> <p>Structures/assets identified from LiDAR</p> <p>Calibration/sensitivity includes check of selected locations against historic records</p>	<p>Low resolution may include flood depth.</p> <p>Approximate map scale down to 1:5,000 or greater. Could be greater than 1:25,000</p> <p>Unlikely to have velocity</p> <p>Suitable to understand the extent of flooding for further detailed investigation</p> <p>Exposure assessments and prioritising areas for further investigation</p>	<p>Emergency management readiness and recovery planning</p> <p>Regional policy and development plan</p> <p>High level community engagement</p> <p>High level asset management and long-term planning for flood infrastructure</p>
Level B – Basic Validated Desktop Assessment	<p>Regional model</p> <p>Validated against extents</p> <p>Structures/assets identified from lidar</p> <p>Calibration/sensitivity includes check of selected locations against historic records</p>	<p>Low resolution may include flood depth.</p> <p>Approximate map scale down to 1:5,000 or greater</p> <p>Unlikely to have velocity (aspire to have velocity)</p> <p>Suitable to understand the extent of flooding for further detailed investigation</p> <p>Exposure assessments and prioritising areas for further investigation</p>	<p>Asset management for flood infrastructure</p> <p>Local Government (Regional and District) policy setting</p> <p>Readiness, recovery and high-level response planning</p> <p>Contingency and evacuation planning</p> <p>District scale planning or policy adjustments</p> <p>Zoning as a function of spatial planning</p> <p>Long-term infrastructure planning</p>
Level C – Localised Catchment Model	<p>Detailed catchment model</p> <p>Includes some assets and streams</p> <p>Sensitivity testing.</p> <p>Validation of model parameters to extents and some levels. Starting to look at gauge calibration.</p>	<p>Refined model</p> <p>Approximate scale down to 1:1250-1:500</p> <p>May have velocity and depth</p> <p>Shows exposure (spatial extent)</p> <p>Flows at gauges</p> <p>Water levels, depths and velocities at critical infrastructure/areas</p> <p>Flood hazard classification</p>	<p>Strategic catchment and infrastructure planning</p> <p>Regional and district policy setting</p> <p>Urban growth and land use planning</p> <p>Decision support for Integrated Catchment management (ICM)</p> <p>Climate adaptation planning</p> <p>Resource Management Act Consents (including land-use, subdivision and resource)</p> <p>Zoning as a function of spatial planning</p> <p>Readiness and recovery planning</p> <p>Community response planning</p>
Level D – Specific Detailed Assessment	<p>Site specific model</p> <p>Includes all assets/structures</p> <p>Often a property/parcel level</p> <p>Sensitivity testing. Calibration at gauges for multiple events and comparison with historic records.</p>	<p>High resolution</p> <p>Approximate map scale down to 1:500 (or less)</p> <p>Includes depth, velocity along with spatial extent</p> <p>Flood hazard classification</p>	<p>LIMS – public use case for property-specific decision making</p> <p>Detailed design of flood protection assets</p> <p>Emergency management response and recovery during a flood</p> <p>Urban growth and land use planning decisions</p> <p>Detailed site planning and development controls</p> <p>Resource Management Act Consents (including land-use, subdivision and resource)</p> <p>Building Consents and site considerations</p>

APPENDIX B – HRC MODELLING REVIEW SPREADSHEET (REFER TO SEPARATE FILE)

File Name

20240527_Totara_Reserve_Options_Report_AllCombined

Report Name

Memorandum on Totara Reserve Options

Region

Lower Manawatu

Location

Pohangina

Date Report Published

1 March 2024

Publication Status

Final

Purpose + Overview of model / report

The report builds upon an existing hydraulic model of Totara Reserve to evaluate two flood mitigation scenarios proposed after a meeting between Horizons Regional Council (HRC) and Manawātū District Council (MDC) on 6 March 2024:

Scenario A: Raising Churchill Road by 3 m at its lowest point.

Scenario B: Constructing a stopbank along the river edge of the northern campground.

The model uses a 50-year Annual Return Interval (ARI) storm under RCP 8.5 climate change conditions. The report assesses overtopping risks, floodplain storage impacts, and recommends infrastructure upgrades.

Data overview - what data has been used (survey, lidar, date)

Topography: Pohangina 2005 DEM (Horizons Regional Council), converted to NZVD2016 using LINZ raster (accessed 31 Oct 2023)

Survey Data: Cross sections and guidebank heights (surveyed 20 Sept 2023)

Imagery: Google Satellite (accessed 29 Feb 2024)

Rainfall: HRC gauges (Alphabet Hut, Delaware Ridge, Range View Farm – data from Jan 2024)

Flow Data: Mais Reach gauge (requested Aug 2023)

Land Cover: LCDB v5.0 (Feb 2024)

Vertical Datum: NZVD2016

Projection: NZTM2000

Watercourses / Stream

Pohangina River: Main river modelled in 1D

Coal Creek: Tributary modelled in 1D upstream of confluence with Pohangina

Catchment Area: ~560 km², divided into Upper Pohangina, Coal Creek, and Lower Pohangina sub-catchments

Hydrological method used

Hydrological model built in HEC-HMS

Used SCS Curve Number method for infiltration

SCS Unit Hydrograph for runoff transformation

Lag routing for river routing

No baseflow, canopy, or depression storage used

Rainfall input via specified hyetographs

Model calibrated using Cyclone Gabrielle (14 Feb 2023) event data

When was hydrology calculated for

Hydrological modelling based on 2023 event (Cyclone Gabrielle)

Rainfall and survey data from 2023–2024

Range of events/scenarios modelled?

Cyclone Gabrielle (2023)

50-year ARI storm under RCP 8.5

Design storms for ARIs: 5, 10, 20, 50, 100 years

Climate change scenarios: RCP 6.0 and RCP 8.5

Sensitivity tests: increased flow, roughness, tailwater, and Coal Creek exclusion

Climate Change Considered?

Yes – RCP 8.5 and RCP 6.0 scenarios modelled using NIWA HIRDS V4 data

Calibration / Validation

Calibrated using:

Surveyed debris levels

Flood photographs

Known breach locations

Validation supported by long-term data at Mais Reach (since 1970)

Sensitivity analysis conducted on key parameters

Downstream boundary

Normal depth boundary condition of 0.0042, derived from terrain data

Model Description

1D/2D HEC-RAS model (v6.4.1)

1D for river channels (Pohangina and Coal Creek)
2D for floodplain (Totara Reserve campsites)
5x5 m mesh for 2D domain
Lateral structures link 1D and 2D domains
Guidebank and terrain modifications applied to reflect 2023 conditions

Model Resolution

2D mesh: 5 m x 5 m
Cross-section spacing: ~100 m

Model Software/Version

HEC-RAS v6.4.1
1D domain: Pohangina River and Coal Creek
2D domain: Totara Reserve floodplain

Modelled assets?

Churchill Road Bridge: Modelled in two scenarios (with and without bridge)

Guidebanks:

Northern: ~430 m

Southern: ~950 m

Lateral Structures: 7 used to connect 1D and 2D domains

Culverts: Flap gate culverts recommended but not explicitly modelled

Cross Sections:

Pohangina: 28 surveyed

Coal Creek: 3 surveyed + 3 added

Excluded:

Bridge piers (unknown dimensions)

3 m culvert behind eastern abutment (too small to affect flood levels)

Stormwater / Surface Water network inclusion

Natural river and stream channels (Pohangina River and Coal Creek)

No piped stormwater network modelled

Overland flow paths and floodplain interactions included

Level of Service for Assets Mentioned? - Standard of protection

Freeboard requirement: 0.5 m

Some guidebank sections do not meet this standard and require upgrades

Overview of Model Outputs and Mapping Available

Flood hazard maps

Water surface elevation profiles

Velocity and overtopping tables

Sensitivity analysis outputs

Longitudinal sections and breach location maps

Assumptions

Bridge failure timing unknown – modelled with and without bridge

Guidebank heights updated based on 2023 survey

2005 LIDAR acceptable with modifications

No baseflow or evapotranspiration considered

Soil type C used for hydrological modelling

No canopy or depression storage used

Limitations

2005 LIDAR data – outdated, though verified with 2023 survey

Fixed bed model – river has a mobile bed

Bridge failure not directly simulated

Mais Reach gauge outflanked during Cyclone Gabrielle – peak flow unknown

Coal Creek flow not directly measured

Some terrain modifications based on assumptions and visual confirmation

Recommendations

Upgrade guidebanks to meet 0.5 m freeboard

Tie guidebanks into higher ground

Use flap gate culverts to prevent backflow into campsites

Conduct geotechnical investigations for guidebank stability

Confirm bridge design details for future modelling

Use peer-reviewed Totara Reserve Modelling Report for final stopbank heights

Potential Updates

Update model with recent LiDAR and cross-section data

Explicit modelling of structures for different scenarios

Recommended Level

Level C

File Name

Rangitawa Stream Modelling Report - HRC v5 Final_2024

Report Name

Rangitawa Stream Modelling

Region

Rangitikei

Location

Rangitawa Stream Catchment, Manawatu District, New Zealand

Date Report Published

30 April 2024

Publication Status

Final Report

Purpose + Overview of model / report

The report documents the process of building an integrated 1D/2D stormwater model of the Rangitawa Stream catchment using Mike by DHI software. The purpose is to map the extent of flooding within the catchment for the 1:200yr Annual Exceedance Probability (AEP) event.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: 1m resolution digital elevation model (DEM) provided by Horizons Regional Council.

Rainfall Data: Intensities from NIWA's High Intensity Rainfall Design System (HIRDS) version 4 for 1% AEP (RCP 6.0) and 0.5% AEP (no climate change).

Survey Data: Asset survey of major bridges and culverts.

Watercourses / Stream

Rangitawa Stream: Main drainage channel.

Other Streams: Various river branches within the catchment.

Hydrological method used

The Soil Conservation Service Curve Number (SCS-CN) methodology was used to calculate effective rainfall.

Inflows: Constant inflow of 0.01 m³/s at the upstream chainage of the three Mike 11 branches.

Hydrographs: Developed using TP108 guidelines.

Boundaries: Rainfall applied to the 2D surface using the rain on grid module within Mike 21.

When was hydrology calculated for**Range of events/scenarios modelled?**

Design Events: 1% AEP (RCP 6.0) and 0.5% AEP).

Climate Change Considered?

Yes, the 1% AEP event includes climate change considerations based on RCP 6.0.

Calibration / Validation

The model was validated using a comparison of flood extent and flow profiles with an Infoworks ICM model for Halcombe Village. The modelled peak flow rates were compared with peak flow rates calculated using TP108 guidelines.

Downstream boundary

A downstream water level boundary where the Rangitawa discharges to the Rangitikei River was set equal to the invert of the downstream chainage (i.e., no initial downstream water depth).

Model Description

The model used Mike by DHI software, including Mike 11 for 1D river extent, Mike 21 for 2D overland flow, and Mike Flood for coupling. The 1D pipe network was modelled in Mike Urban. The ground surface within the 2D zone was represented using a triangular mesh.

The model build process included creating a 2D surface based on LiDAR data, setting up model hydrology, defining 1D river reaches, creating 1D cross sections, incorporating structures, and setting up linkages between 1D and 2D model components.

Model Resolution

1m grid size for the DEM, with mesh sizes of 2 to 8 m² for the 2D zone.

Model Software/Version

Model Software and Software Version

Mike 11: 1D river extent.

Mike 21: 2D overland flow.

Mike Flood: Coupling software.

Mike Urban: 1D pipe network.

Modelled assets?

Bridges and Culverts: Survey data incorporated into the model. All bridges modelled using the FHWA WSPRO method.

Piped Stormwater Network: Culverts and stormwater pipes included, excluding private assets and assets with a diameter <450mm.

Stormwater / Surface Water network inclusion

The model includes the piped stormwater network within Halcombe township and surrounding areas.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify levels or standards of service for assets.

Overview of Model Outputs and Mapping Available

The outputs include flood extent, depth, velocity, direction, flood level contours, and flood hazard maps for the 1% AEP (RCP 6.0) and 0.5% AEP (current climate) scenarios.

Assumptions

Downstream Boundary Condition: No influence from the Rangitikei River on the watercourses within the study area.

Sedimentation or Blockage: Not allowed for in the base model scenarios.

LiDAR DEM: Supplied in draft format and may be altered following QA/QC process.

Limitations

Data Limitations: The supplied DEM is in draft format.

Model Limitations: No sedimentation or blockage allowed for in existing watercourses or culverts.

Recommendations

Produce system performance maps showing depth, velocity, direction, flood extent, flood level contours, and flood hazard for the 1% AEP (RCP 6.0) and 0.5% AEP (current climate) scenarios.

Potential Updates

Include stormwater pipes with diameter <450mm,

Discuss justification for using TP108 storm profile,

Recommended Level

Level C

File Name

310104014 Reid Line Spillway Preliminary Design - FINAL

Report Name

Reid Line Spillway Preliminary Design Report

Region

Lower Manawatu

Location

Reid Line Spillway between the Makino Stream and Kiwitea Stream

Date Report Published

11 April 2024

Publication Status

Final – Revision 4

Purpose + Overview of model / report

The report presents a preliminary design for upgrading the Reid Line Spillway to support flood protection for Feilding up to the 0.2% AEP (1-in-500 year) event, including climate change (RCP8.5 to 2100). It includes hydrological and hydraulic modelling, stopbank upgrades, culvert removals, drainage improvements, and options for the Pharazyn Road crossing and Kiwitea Terrace Drop Structure.

Data overview - what data has been used (survey, lidar, date)

LiDAR DEM (2016, NZVD2016)

Hydrological data (Makino: 1988–2023, Kiwitea: 1976–2022)

Rainfall: NIWA HIRDS v4

Land use: LCDB v5.0 and LUCAS NZ Land Use Map

Soil: Fundamental Soils Layer (LRIS)

Geotechnical data: Desktop study and CPTs

Vertical datum: NZVD2016

Watercourses / Stream

Makino Stream (primary inflow)

Kiwitea Stream (receiving watercourse)

Local ephemeral drains and sub-catchments contributing to the spillway

Hydrological method used

Flood frequency analysis using Generalised Logistic distribution

Upscaling of 2004 flood hydrographs

HEC-HMS model used to confirm critical storm duration (24 hours)

Rainfall hyetographs derived from HIRDS v4

Climate change applied using RCP8.5 to 2100

When was hydrology calculated for

Hydrology assessment completed in March 2024

Data spans 1976–2023

Range of events/scenarios modelled?

1%, 0.5%, and 0.2% AEP events

Each scenario includes climate change (RCP8.5 to 2100)

Climate Change Considered?

Yes – RCP8.5 to 2100 applied to rainfall and inflows

Calibration / Validation

Validated using May 2015 flood event

Compared modelled water levels to surveyed flood debris

Adjusted roughness to improve match

Downstream boundary

Kiwitea Stream: stage-flow boundary with nominal slope (0.01)

Makino Stream: no downstream boundary (assumed diversion gates closed)

Model Description

TUFLOW hydraulic model with 1D/2D domains

Sub-grid sampling (SGS) and quadtree mesh refinement

HEC-HMS for hydrology

Structures represented via raised DEM or 1D elements

Model Resolution

2D mesh: 4m base grid, refined to 1m near stopbanks

LiDAR resolution: 1m

Model Software/Version

TUFLOW (hydraulic)

HEC-HMS v4.10 (hydrology)

GIS: ArcGIS 10.8.2

Modelled assets?

Approximately:

- 7 culverts through the stopbank (to be removed)
- 1 box culvert under Pharazyn Road (2.5m x 0.9m)
- 1 concrete diversion structure at Makino Stream
- 1 gabion drop structure at Kiwitea Terrace (to be replaced)
- 1 proposed low flow cutoff drain (~2.3 km)
- 1 proposed guidebank (100m)
- 1 proposed passive floodgate system (e.g., FloodBreak)
- 1 proposed road raising option (Pharazyn Road)

Stormwater / Surface Water network inclusion

- Ephemeral rural drains
- Proposed low flow cutoff drain to Kiwitea Stream
- Sub-soil tile drains (to be plugged)

Level of Service for Assets Mentioned? - Standard of protection

- Design standard: 0.2% AEP (1-in-500 year) + climate change
- Also assessed: 0.5% and 1% AEP + climate change
- Freeboard: 600 mm recommended

Overview of Model Outputs and Mapping Available

- Flood maps for each AEP scenario (depth, velocity, water level)
- Longitudinal profiles of stopbanks
- Tabulated freeboard results
- Design hydrographs and rainfall hyetographs

Assumptions

- Culverts and floodgates closed during flood events
- LiDAR accurately represents topography
- No infiltration in rainfall modelling
- No explicit representation of Makino/Kiwitea channel bathymetry
- Climate change multiplier applied uniformly

Limitations

- No calibration with flow gauges within model domain
- LiDAR may not capture submerged or vegetated features
- Uncertainty in cross-flows between Kiwitea and Makino
- Sub-soil drains not fully mapped
- Sedimentation rates not quantified

Recommendations

- Raise stopbanks to meet 0.2% AEP + CC with 600 mm freeboard
- Remove 7 culverts and plug tile drains
- Construct low flow cutoff drain
- Replace Pharazyn Road floodgates with passive system or raise road
- Replace Kiwitea Drop Structure with concrete mat
- Remove trees and manage fences in spillway
- Conduct detailed geotechnical investigations
- Monitor sedimentation and grass cover over time

Potential Updates

- Prioritise recommended report updates.
- Investigate uncertainty in cross-flows between Kiwitea and Makino
- Improve channel terrain representation

Recommended Level

Level C

File Name

Woodville_Flood_Modelling_v2_Final

Report Name

Woodville Hydraulic Model build update report

Region

Upper Manawatu

Location

Woodville, New Zealand

Date Report Published

5 April 2024

Publication Status

Final Report

Purpose + Overview of model / report

The report documents the update of the existing Woodville hydraulic model to include the 0.5% Annual Exceedance Probability (AEP) event based on the RCP 8.5 climate change scenario. The updated model uses the most recent LiDAR terrain data and aims to assist Tararua District Council (TDC) in District Plan decision-making.

Data overview - what data has been used (survey, lidar, date)

Flow Records: No empirical flow data available for upstream catchments.

Rainfall Data: High Intensity Rainfall Design Systems v4 (HIRDSv4) design rainfalls, extrapolated for RCP 8.5 scenario.

LiDAR Data: New 2022-2023 LiDAR data from Land Information New Zealand (LINZ).

Survey Data: Cross-sections of the Manga-atua Stream.

Watercourses / Stream

Mangapapa Stream: Included in the model.

Manga-atua Stream: Included in the model.

Hydrological method used

The rainfall data was updated to reflect the RCP 8.5 climate change scenario for the 0.5% AEP event. The rational method was used to estimate peak discharges for upstream catchments. Design flows were derived using HIRDSv4 rainfall intensities and extrapolated for the RCP 8.5 scenario.

Inflows: Derived from upstream subcatchments using the rational method.

Hydrographs: Created using the Manawātū at Upper Gorge normalized unit hydrograph.

Boundaries: Rainfall applied to the entire catchment, boundary inflows from upstream subcatchments, no downstream water level boundary.

When was hydrology calculated for**Range of events/scenarios modelled?**

Design Events: 0.5% AEP event with climate change to 2120 using the RCP 8.5 scenario.

Climate Change Considered?

Yes, the model includes climate change scenarios using RCP 8.5 for the time period 2100-2120.

Calibration / Validation

No additional historical flood information was provided since the original model, and no additional validation or calibration was carried out as part of this model update.

Downstream boundary

No downstream water level boundary has been applied, allowing flow to leave the study area overland without restrictions.

Model Description

The model used 2D Tuflow to represent overland flow routes. The DEM was created using data from HRC and Waka Kotahi, with the new 2022-2023 LiDAR DEM introduced for the updated model.

Model Resolution

The Tuflow model has a 5m cell size.

Model Software/Version

Tuflow

Modelled assets?

Bridge Structures: Not specifically mentioned.

Culvert Structures: Approximately 30 culverts included in the model.

Stormwater Drainage: Includes roads, open channels, and culverts.

Stormwater / Surface Water network inclusion

The stormwater drainage network was modelled using Tuflow based on survey data, Google Street View, and desktop assessment. The network includes roads, open channels, and culverts.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include overland flow direction, flood extent, and depth for the 0.5% AEP flood event with climate change to 2120 using the RCP 8.5 scenario. Flooding with depths less than 50 mm is not shown.

Assumptions

Critical Duration: Assumed to be 6 hours.

Rainfall Profile: May not be representative of future rainfall.

Rainfall Distribution: Assumed to fall simultaneously on every part of the catchment.

Infiltration Losses: Assumed to be 40% of the rainfall.

Downstream Boundary: Assumed water can freely runoff into the Manawatū River.

Flow Gauging: No flow gauging or validation data available.

Rational Method: Provides peak discharge value but not hydrograph or flow volume.

DEM: Combined from different projections, may have small errors.

Limitations

Model Validation: Limited to photos confirming flood-prone areas.

DEM: Combined from different projections, may have small errors.

Culvert Data: Some culverts were added based on desktop assessment, survey data recommended for accuracy.

Buildings: Removed from LiDAR, potential depth of flooding inferred from ground elevation.

Recommendations

Conduct a survey of all critical culverts within the model extent.

Collect data or photos of flooding during major storm events to validate the model.

Update and extend the model with new DEM data as it becomes available.

Undertake a sensitivity test on Manning's n values.

Potential Updates

Explain in detail approach taken in TAaT model

Undertake survey of critical culverts in model area

Undertake sensitivity testing

Recommended Level

Level C

File Name

Tech memo #1_20230526 Cyclone Gabrielle Investigation at Saddle Road - Pohangina River

Tech Memo #2_20230630 Cyclone Gabrielle Design Options at Saddle Road - Pohangina River

Tech Memo #3_20230807 Cyclone Gabrielle Design Options at Saddle Road - Pohangina River & Email Combined

Memo #4_20231026 Cyclone Gabrielle Design Options at Saddle Rd - Pohangina River

Report Name

Cyclone Gabrielle Design Options at Saddle Rd - Pohangina River

Region

Lower Manawatu

Location

Saddle Road and River Road, Pohangina Catchment

Date Report Published

Memo 1: 26 May 2023

Memo 2: 30 June 2023

Memo 3: 07 August 2023

Memo 4: 26 October 2023

Publication Status

All are internal technical memoranda

Memo 2 includes a Revision A

Memo 4 includes a summary of an external consultant's (T+T) report

Purpose + Overview of model / report

Memo 1: Investigates the impacts of Cyclone Gabrielle on five dwellings and the Saddle Road area.

Memo 2: Presents flood mitigation options (conceptual) for 100yr and 200yr ARI events.

Memo 3: Refines modelling for Options 2A, 2B, 2C, and 3; includes sensitivity analysis and IVR warning levels.

Memo 4: Summarizes Tonkin & Taylor's options assessment and outlines next steps for Option 3 implementation.

Data overview - what data has been used (survey, lidar, date)

LiDAR DEM: 2005 and 29 Dec 2022 (NZVD2016)

Hydrological Data: Hilltop flow and level data (1988–2023)

Survey Data: 2018 cross-sections

Aerial Imagery: 2005 and 2021

Flood Maps: Cyclone Gabrielle (Feb 2023)

Rating Curves: Pre- and post-Gabrielle from Environmental Data Team

Watercourses / Stream

Pohangina River: Main river modelled

Unnamed Western Stream: Mentioned in Memo 4 as intersecting stopbank alignments

Hydrological method used

Hydrographs derived from Hilltop data

Peak flows adjusted for breakout flows

Statistical methods used: GEV, EV1, Charles Pearson

Travel time from Mais Reach to Saddle Road estimated (~43 mins)

When was hydrology calculated for

Hydrological analysis and modelling: 2023

Historical data: 1988, 1992, 2004, 2018, 2023

Range of events/scenarios modelled?

Cyclone Gabrielle (Feb 2023)

Mean Annual Flood (467 m³/s)

Design Events: 10yr, 20yr, 55yr, 100yr, 200yr ARI

Sensitivity analysis for downstream boundary

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Calibrated using:

Photos and videos from Cyclone Gabrielle

Observations from May 2023 rainfall event

Modelled depths compared to observed inundation (± 100 mm)

Downstream boundary

Friction slope of 0.003 used

Sensitivity analysis tested constant tailwater depth (55m RL)

Location: Near Railway Bridge, close to Manawatū River confluence

Model Description

HEC-RAS 2D model

Terrain modified to reflect post-Gabrielle conditions

Stopbanks and bridge piers included via terrain editing

Hydrographs scaled to reflect estimated peak flows

Model Resolution

2D Cell Size: 10m x 10m

Breaklines: 5m–8m resolution

Model Software/Version

HEC-RAS 2D (version not specified)

Fully 2D modelling; no 1D domain mentioned

Modelled assets?

Stopbanks: Multiple alignments tested (Options 1, 2A–2C, 3)

Bridges: Saddle Road Bridge and Railway Bridge included

Ring Bund: Proposed for 1090 Saddle Road (not modelled)

Culverts/Stormwater: Not explicitly detailed

Structures Not Included: Ring bund not included in model

Count: Approximately 3–5 stopbank alignments tested; 2 bridges explicitly modelled

Stormwater / Surface Water network inclusion

No detailed stormwater pipe network modelled

Focus is on riverine flooding and overland flow paths

Level of Service for Assets Mentioned? - Standard of protection

Stopbanks designed for:

10yr, 20yr, 55yr, 100yr, and 200yr ARI protection

Option 3 provides 200yr ARI protection

Overview of Model Outputs and Mapping Available

Flood extent and depth maps for each scenario

Model results include water surface elevations and inundation areas

Mapping for IVR warning levels and overtopping thresholds

Assumptions

Travel time from Mais Reach to Saddle Road = 43 mins (based on 2.5 m/s velocity)

MAF = 467 m³/s used as proxy for flood warning

Terrain modifications reflect post-event conditions

Ring bund not included in model but assumed in design

Limitations

Uncertainty in exact breach location and timing during Gabrielle

Rating curve at Mais Reach outdated post-Gabrielle

Lack of bathymetric data

Model calibration limited by anecdotal data

Flow estimates have ±15% uncertainty

Ring bund not modelled

Downstream boundary water levels not well defined

Recommendations

Re-rate Mais Reach gauging station

Install radar at Saddle Road Bridge

Use 467 m³/s as interim flood warning level

Undertake LiDAR and river survey

Develop detailed flood model

Proceed with Option 3 (200yr ARI protection) as preferred mitigation

Secure funding and begin detailed design and consenting

Potential Updates

Update model with recent LiDAR and cross-section data

Validate / Calibrate where data allows, more events

Recommended Level

Level C

File Name

Pahiatua_Flood_Modelling_FINAL_Rev1_20231221

Report Name

Flood Modelling and Mapping of Pahiatua Township

Region

Upper Manawatu

Location

Pahiatua Township, New Zealand

Date Report Published

20 December 2023

Publication Status

Final Report (Rev 1)

Purpose + Overview of model / report

The report documents a flood modelling and mapping study for Pahiatua Township and the surrounding rural and semi-rural areas. The study aimed to develop a comprehensive hydrologic-hydraulic flood model to assess flood hazards for various design flood events and inform decisions regarding flood management and land development.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Annual maximum (AM) flow data from the Mangatainoka River gauge.

Rainfall Data: Design rainfall derived from HIRDSv4 national data sets.

LiDAR Data: Used to create digital terrain models (DTM) for the floodplain surface.

Survey Data: Cross-sections of the Mangatainoka River and other channels.

Watercourses / Stream

Mangatainoka River: Main river adjacent to Pahiatua.

Makakahi River: Contributing to the upstream boundary of the 2D modelling domain.

Mangamarama River: Modelled within the 2D domain.

Hydrological method used

Design flood hydrographs and rainfall inputs were produced for the MIKE+ flood model. A flood frequency analysis (FFA) was carried out using AM flow data from the Mangatainoka River gauge. The Kinematic Wave model was used for hydrological modelling, calibrated to the FFA results.

Inflows: Derived from measured flow records and scaled to match design flood events.

Hydrographs: Based on the calibrated Kinematic Wave model and scaled for design flood events.

Boundaries: Downstream boundary at the Manawatu River confluence using constant water level and inflow.

When was hydrology calculated for

The flow records used were from the period 1955-2016.

Range of events/scenarios modelled?

Calibration Events: October 2000 flood event.

Design Events: 4% (1 in 25), 2% (1 in 50), 1% (1 in 100), and 0.5% (1 in 200) AEP events.

Climate Change Considered?

Yes, the model includes climate change scenarios using RCP 6.0 for the time period 2081-2100.

Calibration / Validation

The flood model was validated against the October 2000 flood event using photographs and consultation with witnesses.

The validation compared simulated flood extents and depths with observed flooding.

Downstream boundary

The downstream boundary was set at the Manawatu River confluence using a constant water level of 83m and an inflow of 800 m³/s from the Tiraumea River.

Model Description

The model used MIKE+ software, combining a 1D network model of the stormwater system, a 2D overland model, and a 1D model of key river sections. The computational mesh was built based on LiDAR DTM and bathymetry data.

Model Resolution

The computational mesh comprised elements ranging in size from 8 m² to 150 m², averaging around 26 m².

Model Software/Version

MIKE+: Integrated water modelling platform.

Kinematic Wave model: Used for hydrological modelling.

Modelled assets?

Bridge Structures: 2 bridges included in the model.

Culvert Structures: 30 culverts included in the model.

Stormwater Drainage: Includes catch pits, manholes, pipes, and open channels.

Stormwater / Surface Water network inclusion

The stormwater drainage network was modelled using MIKE+ based on GIS asset data, survey data, and LiDAR DTM. The network includes catch pits, manholes, pipes, and open channels.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include flood extent, water depth, current speed, flood hazard, and water level points. These were saved as raster and feature datasets in ESRI geodatabases.

Assumptions

Hydrologic Model: Catchment characteristics under climate change conditions were approximated based on estimated increases in flood peaks.

Validation: Compared simulated flood extents with photographs, but timing relative to flood peak was uncertain.

Channel Cross Sections: Derived from LiDAR, may be over or underestimated.

Bridge Structures: Simplified representation due to incomplete information.

Culvert Dimensions: Assumed for structures with incomplete data.

Flooding Timing: Local flooding occurs prior to the main flood peak along the Mangatainoka River.

Limitations

Model Calibration: Limited to one flood event with photographic data.

Channel Cross Sections: Derived from LiDAR, may impact model predictions.

Bridge Structures: Simplified representation, potential impact on flood predictions.

Culvert Dimensions: Assumed, sensitivity testing recommended.

Flooding Interaction: Timing differences for different flood events.

Recommendations

Further calibration to future rainfall events as data becomes available.

Sensitivity testing for culvert blockage, channel roughness, and infiltration parameters.

Monitoring changes within the Mangatainoka River system and updating the model as required.

Potential Updates

Obtain detailed survey of culverts

Sensitivity test parameters in model

Recommended Level

Level C

File Name

Ohakune_Flood_Modelling_Report_Final_20230919

Report Name

Ohakune Flood Modelling

Region

Whangaehu

Location

Ohakune Township, New Zealand

Date Report Published

19 September 2023

Publication Status

Final, Revision No: 1.0

Purpose + Overview of model / report

The report was commissioned by Ruapehu District Council (RDC) and prepared by DHI Water and Environment Ltd in collaboration with Macky Fluvial Consulting. The main aim is to assess the impact of proposed urban development to the north-east of Ohakune township and provide flood level data for setting minimum floor levels. The model has been validated against a previous model by Hydro Tasmania (2010) and includes simulations to predict flooding under current and proposed land use scenarios.

Data overview - what data has been used (survey, lidar, date)

Rainfall Data: Continuous rain gauge records from Makotuku at F Trig (1968-2021) and Waiharuru at SH 49 (2006-2021).

Stream Flow Records: Mangawhero at Hagleys (1999-2006), Mangawhero at Burns St (1975-1982), Mangawhero at Pakihi Rd (2006-2021), Makotuku at SH 49A (1968-2021).

LiDAR Data: Corrected dataset "Oha_VD16ish_b" at 1x1m resolution.

Vertical Datum: Moturiki Vertical Datum using NZMG projection.

Watercourses / Stream

Mangawhero River: Main river passing through the study area.

Tributaries: Mangateitei Stream and an unnamed stream.

Catchment Areas: Upper, middle, and lower sub-catchments of the Mangawhero River.

Hydrological method used

Rainfall and Stream Inflows: HIRDS v4 rainfall data applied as "rain-on-grid" for both 1-hour and 6-hour events.

HEC-HMS Model: Used to determine stream flow hydrographs from HIRDS design hyetographs.

Calibration: Adjusted parameters to replicate calculated peak flows.

4 nearby flow gauges - 3 on the Mangawhero (short records) and 1 on the Makotuku

When was hydrology calculated for

Flow Record Extension: 1968-2021.

Range of events/scenarios modelled?

Design Flood Events: 1-hour and 6-hour events for ARIs of 5, 10, 50, 100, and 200 years.

Climate Change Considered?

No allowance for climate change has been included, aligning with Horizons Regional Plan requirements.

Calibration / Validation

Model Validation: Compared with Hydro Tasmania's (2010) flooding map.

Calibration: Adjusted lag time, initial infiltration loss, and continuing infiltration loss rate.

Downstream boundary

Boundary Condition: Uniform water level of RL 553m used as initial condition; downstream boundary set to RL 553m.

Model Description

MIKE+ Software: Includes both 2D overland flow and stormwater pipe network.

2D Model: Covers low-lying area from Dreadnought Road to State Highway 49.

Culverts: Approximately 38 culverts added to the model.

Model Resolution

2D Mesh: Resolution ranges from 48m² in rural areas to 13m² in urban areas, with a minimum mesh size of 3m² and a maximum of 150m².

Model Software/Version

MIKE+: Used for hydraulic modelling, including MIKE 21 module for 2D culverts.

Modelled assets?

Culverts: Approximately 38 culverts.

Stormwater Network: Includes pipes and manholes, with some assumptions made due to data discrepancies.

Stormwater / Surface Water network inclusion

Stormwater Pipes: Combined existing asset data with recent survey data.

Manholes: Assumed maximum inlet capacity of 20l/s, with adjustments for double sumps.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood Extents: Provided for 1-hour and 6-hour events for various ARIs.

Output Files: Time series of maps of flood level and current speed, and time series of head levels and flow rates within the pipe network.

Assumptions

Rainfall Events: Assumed to fall simultaneously over the entire Mangawhero catchment.

Pipe Network: Some assumptions made due to data discrepancies.

Limitations

Model Validation: Limited by the availability of historical flooding data.

Pipe Network Data: Conflicts between asset data and survey data.

Recommendations

Flood Level Recording: Record flood levels and extents in future events for more robust model validation.

Pipe Network Review: RDC to investigate discrepancies between modelled and actual pipe network.

Potential Updates

Further model validation and calibration

Survey data for pipe network

Consider climate change if requirement of HRC change

Recommended Level

Level C

File Name

Oroua_Report_FINAL

Report Name

Oroua River - Almadale to Downstream of Aorangi Bridge and Adjacent Eastern Rural Area

Region

Lower Manawatu

Location

Oroua River - Almadale to Downstream of Aorangi Bridge and Adjacent Eastern Rural Area

Date Report Published

27 November 2023

Publication Status

Final

Purpose + Overview of model / report

The purpose of this study is to develop a hydrological-hydraulic flood model for the Oroua River and its eastern floodplain to assess flood hazards under current and future climate scenarios. The model supports Horizons Regional Council and Manawātū District Council in making informed land use and flood management decisions.

Data overview - what data has been used (survey, lidar, date)

Flow gauge data: Oroua A/AS (63 years), Kiwitea (46 years)

Rainfall: NIWA HIRDSv4 (historic and RCP 6.0 projections)

DEM: LiDAR and cross-section-derived DEM (year not specified)

Land cover: 2018 LCDB

Soil data: Fundamental Soil Layer (FSL)

Bridge and culvert surveys: Provided by HRC

Vertical datum: Not explicitly stated

Watercourses / Stream

Oroua River (main channel)

Kiwitea Stream (tributary)

Makino Stream (diverted into Kiwitea via floodgates)

Hydrological method used

Flood Frequency Analysis (FFA) using Bayesian Extreme Value Analysis

Kinematic Wave rainfall-runoff model calibrated to match FFA peak flows

Rainfall hyetographs derived using HIRDSv4 and hyperbolic tangent distribution

Climate change scenarios based on RCP 6.0 (2081–2100)

When was hydrology calculated for

Gauge data: 1940s–2022

Rainfall data: HIRDSv4 (up to 2016)

Modelling conducted in 2023

Range of events/scenarios modelled?

25, 50, 100, and 200-year ARI events

Each event modelled under historic and climate change (RCP 6.0) conditions

Climate Change Considered?

Yes – RCP 6.0 projections for 2081–2100 applied to rainfall depths

Calibration / Validation

Hydrological model calibrated to match FFA peak flows

Hydraulic model validated using aerial and satellite imagery from the February 2004 flood (0.5% AEP)

No formal hydraulic calibration due to lack of observed data

Downstream boundary

Free outflow boundary ~350 m downstream of Roberts Line

Elevations lowered to allow smooth water egress

Model Description

MIKE+ 2D hydraulic model with embedded 1D components for bridges

Hybrid DEM combining LiDAR and cross-section data

Flexible mesh with 1.8 million elements (triangular and quadrilateral)

Rainfall and inflow hydrographs applied at domain boundaries

Model Resolution

Mesh element size: 9–66 m² (average 36 m²)

Model Software/Version

MIKE+ (DHI software suite)

RMC-BestFit (USACE, 2020) for FFA

Modelled assets?

Bridges: 2 modelled (Waughs Road and Colyton Road), 1 excluded (Aorangi Rail Bridge)

Culverts: Multiple, including Kiwirail and HRC data (merged where in series)

Stopbanks: 3 (DS-RB, US-RB, DS-LB)

Approximately:

47 surveyed cross-sections

2 short 1D bridge channels

Stormwater / Surface Water network inclusion

Natural streams and overland flow paths only

No piped stormwater network included

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Raster and vector datasets for:

Water depth

Water level

Current speed and direction

Hazard classification (NSW method)

Difference maps between scenarios

Contour datasets (100 mm intervals)

Assumptions

Uniform rainfall timing across catchments

No blockage at bridges or culverts

Roughness and infiltration values based on land use and soil type

100% diversion of Makino Stream into Kiwitea

No formal calibration of hydraulic model

Limitations

Validation limited to one flood event (2004) using imagery

Aorangi Rail Bridge excluded due to proximity to SH54 bridge

No blockage scenarios modelled

Streamline vector data may not align perfectly with LiDAR

Culverts merged conservatively (minimum diameter used)

Recommendations

Calibrate model when better data becomes available

Explore blockage scenarios at bridges and culverts

Monitor riverbed changes due to gravel movement

Conduct sensitivity testing on:

Downstream boundary

Roughness and infiltration

Blockage effects

Consider installing additional gauges in upper Oroua catchment

Potential Updates

Validate / Calibrate model to new events when data becomes available

Sensitivity Testing

Recommended Level

Level C

File Name

1019994_MakirikiriModelReport_FINAL

Report Name

Flood modelling of the Maririkiri Stream - Model build and results report

Region

Makirikiri Stream Catchment

Location

Makirikiri Stream Catchment, including the Kahuraponga Stream and part of the Turakina River

Date Report Published

1 December 2022

Publication Status

Final (Version 2)

Purpose + Overview of model / report

The report was prepared for Horizons Regional Council to assess flood hazards in the Makirikiri catchment. It involved the development of hydrological and hydraulic models to simulate flood events under both current and future climate scenarios. The model outputs are intended to inform regional-scale flood hazard advice.

Data overview - what data has been used (survey, lidar, date)

LiDAR DEM: 1 m resolution, flown in 2015–2016 (NZVD2016 vertical datum)

20 m DEM: From 2010 Turakina model

2015 Survey Cross Sections: 15 cross sections

Land Use: LCDB v5.0

Soil Types: LRIS Portal

Aerial Imagery: 2015/2016 LINZ

Streamflow and Rainfall Data: NIWA SIMS, 1969–1980

HIRDS v4 Rainfall Data: For design rainfall depths

Hydrological Model Calibration: Based on Rangitawa at Halcombe gauge

Watercourses / Stream

Makirikiri Stream: Entire catchment

Kahuraponga Stream: Entire catchment

Turakina River: Approx. 5.5 km reach included to assess hydraulic interaction

Hydrological method used

Rain-on-grid approach using HEC-HMS Clark unit hydrograph

Calibration using both event-based and frequency-based methods

Transposition of parameters from Rangitawa catchment

Design rainfall from HIRDS v4

Hydrographs developed for various AEPs and durations

When was hydrology calculated for

Streamflow and rainfall data: 1969–1980

LiDAR and survey data: 2015–2016

Hydrological modelling and calibration: 2022

Range of events/scenarios modelled?

20-year, 50-year, 100-year, and 200-year ARI events

Present-day and future climate (RCP6.0, 2120)

12-hour storm duration identified as critical

Climate Change Considered?

Yes – RCP6.0 scenario for the year 2120

Calibration / Validation

Calibration using Rangitawa at Halcombe gauge

Validation through comparison of hydrographs from hydraulic and hydrological models at the Makirikiri-Turakina confluence

Good convergence observed

Downstream boundary

Based on Turakina River Mike 11 model (2010)

Stage hydrograph applied at a location with level cross-section

Maximum water levels: ~8.1–8.2 mRL for 100–200 year events

Model Description

TUFLOW HPC Quadtree solver (2020-10-AB)

Rain-on-grid hydrology

Sub-grid sampling and quadtree nesting

DEM from LiDAR and 20 m DEM

Roughness based on LCDB and refined manually

Infiltration: Initial loss 5 mm, constant loss 1 mm/h

Model Resolution

Base grid: 8 m x 8 m

Quadtree resolution: 2 m x 2 m in key areas

Model Software/Version

TUFLOW HPC Solver (2020-10-AB)

2D model with some discrete 1D elements

Modelled assets?

Bridges: 4 (SH3, Turakina Beach Rd @ Kahuraponga, Turakina Beach Rd @ Makirikiri, Scotts Rd)

Culverts: Approximately 20+ (based on red channel modifiers in Figure 4.15)

Floodgates: 1 flap gate (Redmayne Drop Gate, surveyed 2015)

Stopbanks: Represented via LiDAR, not separately surveyed

Dams: 31 identified and pre-filled in sensitivity testing

Structures Not Included: Most culverts and flood scheme structures due to lack of data

Stormwater / Surface Water network inclusion

No formal stormwater network modelled

Natural streams and overland flow paths represented

Some stormwater pipes included in 2D+ model

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood depth and extent maps for all scenarios

Sensitivity “fuzzy” map showing confidence in flood extents

Hydrographs for key locations

Outputs include depth, velocity, and extent

Assumptions

Bridge dimensions estimated from photos and Google Street View

Culvert inverts interpolated from DEM

Roughness values from literature and adjusted

Rainfall applied uniformly

DEM assumed to represent stopbanks adequately

Turakina inflow timing adjusted to align with Makirikiri peak

Limitations

LiDAR limitations in vegetated or incised areas

DEM may not reflect recent ground changes

Lack of surveyed data for many structures

Uniform rainfall application may not capture localised effects

Roughness not calibrated to site-specific data

Direct rainfall approach may produce artefacts (e.g., puddles)

Vertical land movement not considered

Overlap with other models may occur in future

Recommendations

Use fuzzy map to assess confidence in flood extents

Field verification recommended for design or consent purposes

Site-specific assessments advised for high-consequence areas

Consider vertical land movement in future modelling

Prefer finer-scale models where available

Potential Updates

Update model with recent LiDAR and cross-section data

Recommended Level

Level C

File Name

20211206 ADS Flood Hazard Assessment.v3

Report Name

Ashurst Drainage Scheme - Flood Hazard Assessment

Region

Lower Manawatu

Location

Ashurst

Date Report Published

6 December 2021

Publication Status

Final Reissue (Version 3)

Purpose + Overview of model / report

The report assesses the performance of the Ashhurst Drainage Scheme (ADS) using an updated TUFLOW model. It evaluates whether the scheme meets the 100-year Average Recurrence Interval (ARI) level of service under present-day and future climate conditions. The model identifies areas of underperformance and evaluates the benefits of potential upgrades, including stopbank improvements and culvert upsizing.

Data overview - what data has been used (survey, lidar, date)

LiDAR DEM: 2018 (NZVD2016)

Survey Data: March 2021 (stopbanks, culverts, bridges)

Land Use: LCDB v5 (2018)

Hydrology: HIRDS v4 rainfall data

Building Outlines: LINZ

Vertical Datum: NZVD2016

Watercourses / Stream

Ashhurst Stream: Main focus of the model

Barnes Drain: Included in channel DEM

Model includes open channel cross-sections and floodplain interactions

Hydrological method used

Direct Rainfall: Applied across the model domain

Lumped Catchment Inflow: HEC-HMS model used for Ashhurst Stream

Loss Model: Initial and constant loss (4–8 mm/hr)

Hydrographs: Developed for 1, 6, 12, and 24-hour durations

When was hydrology calculated for

Hydrology updated in 2021

Rainfall data from HIRDS v4 (latest available)

Range of events/scenarios modelled?

100-year and 200-year ARI events

Present-day and RCP6.0 (2081–2100) climate scenarios

Three scenarios:

Base Case

Glass-walled stopbanks

Glass-walled stopbanks + culvert upgrades

Climate Change Considered?

Yes – RCP6.0 scenario for the year 2100

Calibration / Validation

No calibration due to lack of observed flood data

Sensitivity testing conducted for hydrology, roughness, and culvert blockage

Downstream boundary

Free-outfall boundary condition (no backwater effect)

Model Description

Software: TUFLOW HPC (2020-10-AA)

DEM: LiDAR + 2021 survey-derived channel DEM

Hydraulic Structures: 1D culverts and 2D bridges

Glass-walling: Used to simulate stopbank performance

Model Resolution

2 m x 2 m grid with 1 m sub-grid sampling

1 m x 1 m grid used for sensitivity testing

Model Software/Version

TUFLOW HPC (2020-10-AA)

2D domain with 1D culvert links

Modelled assets?

Culverts: Approximately 7 modelled (1D), including:

North St, Oxford St, Wyndham St, Mulgrave St

900 mm and 300 mm pipes (Mulgrave St)

Bridges: 6 modelled using 2D layered flow constriction

Stopbanks: Surveyed at ~20 m intervals; glass-walled in scenarios

Flap-gates: Added to 2 pipes in Scenario 3

Vegetation: Represented via Manning's n (low, medium, high)

Stormwater / Surface Water network inclusion

Includes Ashhurst Stream and Barnes Drain

No piped stormwater network explicitly modelled

Level of Service for Assets Mentioned? - Standard of protection

Target LoS: 100-year ARI under present-day climate

Performance assessed against this standard

Overview of Model Outputs and Mapping Available

Peak flood depth and extent maps

Stopbank exceedance maps

Longitudinal flood level profiles

Sensitivity "fuzzy" maps

Consequence assessment (flooded buildings)

Assumptions

All culverts and bridges are unobstructed

Vegetation conditions reflect 2021 survey

Buildings <20 m² excluded from flood count

Floor levels inferred from DEM + offset (300 mm for residential, 100 mm for commercial)

Entire scheme assumed to be upgraded simultaneously in scenarios

Limitations

No calibration data available

Vegetation and blockage conditions may change over time

DEM may not represent buildings or above-ground features

Assumes full scheme upgrades, not staged implementation

Culvert upgrades are conceptual only

Floor levels are estimated, not surveyed

Recommendations

Maintain culverts and remove obstructions

Install flap-gates at key outfalls

Manage vegetation in Ashhurst Stream

Consider staged upgrades and their impacts

Conduct further modelling to optimise upgrade strategies

Integrate hydraulic structure upgrades with scheme improvements

Potential Updates

Validate / Calibrate model to new events when data becomes available

Survey building floor levels

Recommended Level

Level

File Name

rpt_19003_FoxtonEastDrainage_V04

Report Name

Foxton Eas Drainage System Issues and Options

Region

Lower Manawatu

Location

Foxton township and surrounding rural catchments

Date Report Published

25 August 2021

Publication Status

Final – Revision 4

Purpose + Overview of model / report

The report investigates flooding issues in Foxton and evaluates options to improve the level of service provided by the Foxton East Drainage System (FEDS). It presents a proof-of-concept for a preferred solution involving diversion, storage, conveyance improvements, and pumping to mitigate flood risk, particularly for a 2% AEP (1-in-50 year) flood event including climate change effects to 2090.

Data overview - what data has been used (survey, lidar, date)

LiDAR DEM (2013)

HIRDS v4 rainfall data

Survey data: Kings Canal, Hokorawa/Duck Creek, culverts, stopbanks

HDC GIS data for stormwater network

Wellington 1953 Vertical Datum

Watercourses / Stream

Kings Canal

Hokorawa / Duck Creek

Foxton Loop (tidal boundary)

Rural drains and overland flow paths

Hydrological method used

Rain-on-mesh approach using MIKE21

No infiltration assumed (conservative)

Rainfall applied uniformly across the catchment

Tidal boundary conditions based on Manawatū at Foxton gauge

Climate change scenario: RCP6.0 (2081–2100)

When was hydrology calculated for

Rainfall data: HIRDS v4 (current and future climate)

Flood event validation: June 2015

Range of events/scenarios modelled?

June 2015 flood event (validation)

Design events: 50%, 10%, 2%, and 0.5% AEP with climate change

Sensitivity tests: ±15% hydraulic roughness, eddy viscosity

Proposed and alternative options

Climate Change Considered?

Yes – RCP6.0 scenario to 2081–2100 applied to rainfall and sea level rise (+0.5 m)

Calibration / Validation

Validated against June 2015 flood event using photographs

Sensitivity analysis for roughness and eddy viscosity

Model deemed suitable for design assessment

Downstream boundary

Foxton Loop tidal boundary

Includes sea level rise and Manawatū River flood influence

High tide: 3.44 m RL; Low tide: 1.96 m RL

Model Description

MIKE FLOOD (2016 SP3): MIKE21 (2D), MIKE11 (open channels), MIKE Urban (pipes)

Rain-on-mesh hydrology

Coupled 1D/2D model

48-hour simulation period

Model Resolution

Mesh sizes:

Urban areas: 4–100 m²

Rural catchment: up to 10,000 m²

Roads and key features meshed with high resolution

Model Software/Version

DHI MIKE FLOOD (2016 SP3)

Modelled assets?

Approximately:

- 1 DN1050 pipe under Avenue Rd
- 1 DN900 pipe under Avenue Rd (to be upgraded)
- Twin DN1800 diversion pipes (proposed)
- 3x DN900 culverts at private driveways
- 1 DN1700 culvert under Newth Rd
- 1 proposed 4x2 m box culvert under SH1
- Multiple culverts (Coley, Cook, Union Streets) to be upgraded to 2.5x1.5 m box culverts
- 2 pump stations (2.5 m³/s and 1.5 m³/s)
- 1 proposed rural attenuation dam (referable dam)

Stormwater / Surface Water network inclusion

Urban stormwater network from HDC GIS
Includes pipes, culverts, and overland flow paths
Kings Canal and rural drains

Level of Service for Assets Mentioned? - Standard of protection

Design standard: 2% AEP (1-in-50 year) flood event + climate change
Some infrastructure underdesigned (e.g., stormwater network)

Overview of Model Outputs and Mapping Available

Flood depth maps (Appendix D)
Water level difference maps (Appendix E)
Discharge and water level charts (Appendix F)
Floor level assessments
Safety in Design register (Appendix G)

Assumptions

No infiltration due to high groundwater
Uniform rainfall distribution
Tidal boundary includes sea level rise and Manawatū River flood
No discharge from Manawatū River into Moutoa Floodway
Buildings represented by 2.5 m height in DEM

Limitations

Model not calibrated with flow data
DEM from 2013 may not reflect current topography
Rural mesh resolution too coarse for detailed rural flooding
Some assumptions on tidal influence and storm timing
No detailed design included

Recommendations

Proceed with consultation and detailed design
Engage ecology experts
Develop staged construction programme
Consider future wetland treatment options
Address urban stormwater network issues separately

Potential Updates

Update DEM data
Calibrate to improve confidence of validation
Improve building representation as per ARR (2018) if this is important

Recommended Level

Level C

File Name

20211101 Manawatu Drainage Scheme Flood Hazard Final

Report Name

Manawatu Drainage Scheme

Region

Lower Manawatu

Location

Manawatu Drainage Scheme, located between the western edge of Palmerston North City and the Oroua River, New Zealand

Date Report Published

1 November 2021

Publication Status

Final Report (Version 2)

Purpose + Overview of model / report

The report assesses the flood hazard within the Manawatu Drainage Scheme (MDS) to provide a better understanding of spatially varied flood hazards, particularly in areas subject to development and rezoning pressure. The model aims to inform flood management for future development in flood-prone areas. The model uses TUFLOW software to simulate flood conditions and includes various hydraulic structures, rainfall events, and boundary conditions.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: Composite DEM from surveys flown in 2005, 2016, and 2018

Rainfall Data: NIWA's High Intensity Rainfall Design System (HIRDS) V4 values

Hydraulic Structures Data: Survey data from October 2020, existing Oroua MIKE11 flood model, and Manawatu Drainage Scheme data

Land Use Data: Landcare Research's Land Cover Database version 5 (LCDBv5) and LINZ Data Service

Watercourses / Stream

Main Drain: Major drainage channel

Burkes Drain: Major drainage channel

Various Channels: Network of drainage channels within the MDS

Hydrological method used

The hydrological assessment uses a direct rainfall approach with rainfall depths generated using HIRDSV4. Rainfall hyetographs for different ARI events (2, 10, 100, and 200 years) and durations (1-hour, 6-hour, 12-hour, 24-hour, 48-hour, and 72-hour) are simulated to determine critical storm duration relationships.

When was hydrology calculated for

Rainfall Data: Various years (2005-2018)

Flow Data: Various years (2005-2020)

Range of events/scenarios modelled?

Design flood events: 2-year, 10-year, 100-year, and 200-year ARI for present-day climate

Validation event: June 2015 rainfall event

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model is validated using observations from the June 2015 rainfall event, including recorded rainfall data, spillway hydrographs, and estimated flood extents. Sensitivity testing of key model parameters is also undertaken.

Downstream boundary

The model operates like a "glass-wall" with no downstream boundary applied. The only outflow location is the Burkes Drain pump station, with flood gates assumed to be closed.

Model Description

The model comprises a 2D rain on grid model with 1D elements using TUFLOW software. The model includes hydraulic structures such as culverts, flap-gates, bridges, and pumps, represented as 1D elements linked to the 2D model domain. The model uses direct rainfall hydrology and considers hydrological losses using soil infiltration parameters and land use roughness coefficients.

Model Resolution

Quadtree nesting grid sizes: 32m for floodplain, 4m for drainage channels and roads, 2m for hydraulic structure inlet and outlet

Model Software/Version

TUFLOW HPC Quadtree solver: Latest 2020-10-AA version

Modelled assets?

Culverts and Flap-Gates: Various culverts and flap-gates included from three data sources

Bridges: One bridge at Milson Line included as a 1D element, ten other bridges represented using 2D layered flow constriction

Stopbanks: Two main stopbanks along Main Drain and Burkes Drain

Burkes Pump Station: Four pumps with a combined maximum capacity of 7 m³/s

Stormwater / Surface Water network inclusion

The stormwater network includes various drainage channels, culverts, flap-gates, bridges, and pumps. The network is modeled using TUFLOW software based on survey data, GIS data, and existing hydraulic models.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include peak flood depths, velocities, and critical duration maps for different ARI events. Sensitivity testing results and validation against the June 2015 flood event are also provided.

Assumptions

The model has assumed no soil infiltration losses, which was required to achieve appropriate validation against the June 2015 rainfall event

Applying such assumptions to the design rainfall events request by Horizons is considered by T+T to be appropriately conservative, however under less severe rainfall events (which have not been modelled as part of this study), different assumptions of soil infiltration characteristics may be warranted.

Given the inherent differences between levels from a LiDAR derived DEM and surveyed data, and the need to link surveyed 1D structures to the DEM, it was considered within comparable tolerances to assume a single correction of -0.41 m over the entire Scheme to bring WVD-53 levels into terms of NZVD2016.

Inlet and outlet positions and their respective levels were assumed based on the LiDAR DEM if dimensions unknown (generally based on matching invert levels). Where known flap-gates were not captured by data sources, a nominal size of 600 mm diameter was assumed.

The model has assumed that the Burkes Flood Gates will be closed during the simulation due to high water levels in the Manawatū River. This is the most conservative assumption with respect to flood levels and was agreed with Horizons.

To simplify the representation of the Burkes pump station in the model, each of the four pumps was assumed to have a maximum pumping capacity of 1.75 m³/s.

The Burkes Drain flood gates, located adjacent to the pump station, are assumed to be closed. This approach is considered by T+T to be appropriate given the uncertainty around tailwater conditions in the Manawatū River during a flood event

Limitations

DEM Accuracy: LiDAR data may have lower accuracy in certain areas and may not capture landform changes since the survey

Direct Rainfall Methodology: May highlight accuracy deficiencies in input data

Hydrological Losses and Hydraulic Roughness: Assumed values may not capture finer localised details

Model Performance: Lack of calibration data reduces confidence in model outputs

Recommendations

Model Calibration: Install water level and rainfall monitoring devices for future calibration

Terrain Survey: Update LiDAR data to improve accuracy

Land Use Characteristics: Update land use characteristics for specific areas

Hydrology: Consider inclusion of design flood inflow hydrographs at spillway locations

Potential Updates

Hydrology assessment updates

Use recent LiDAR data

Refinement of channels with cross-sections and surveys

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

hrc_omfm_rpt_fin

Report Name

Ohau-Manakau: Flood Modelling & Level of Service Assessment

Region

Manakau

Location

Ōhau-Manakau

Date Report Published

1 August 2021

Publication Status

Final – Revision 02

Purpose + Overview of model / report

The report was commissioned by Horizons Regional Council (HRC) to:

Assess the current level of service (LOS) provided by flood defences in the Ōhau-Manakau drainage scheme.

Identify assets requiring upgrades to meet or improve LOS.

Develop a new 2D hydraulic model to simulate flood levels, depths, velocities, and overtopping rates for 1:10, 1:25, 1:100, and 1:200 AEP events (current climate only).

Data overview - what data has been used (survey, lidar, date)

LIDAR DEM: 2013–2018 (Wellington 1953 vertical datum)

Flow Data: Ōhau (1978–2020), Koputaroa, Manakau, Waikawa

Rainfall Data: HIRDS v4, NIWA gauges (1986–2020)

Land Cover: LCDB v5 (2020)

Soil Data: LENZ soil drainage layer

Survey Data: Cross-sections (2016–2021)

Asset Data: Culverts, bridges, gates from HRC, HDC, NZTA, KiwiRail

Imagery: 2016–17 aerial imagery (LINZ)

Watercourses / Stream

Ōhau River: From Rongomatane gauge to sea

Waikawa Stream: From Tararua Ranges to Waikawa Beach

Manakau Stream: From upstream of SH1 to confluence

Kuku Stream: From foothills to confluence

Additional: Catchments 33d & 33e (Ōhau tributaries), Koputaroa (val

Hydrological method used

Software: HEC-HMS v4.6.1

Loss Method: Initial (7 mm) and constant (5 mm/hr)

Transform: Clark Unit Hydrograph

Routing: Muskingum-Cunge (main), Lag (validation)

Rainfall: HIRDS v4, 4h and 6h durations

Validation: Against observed hydrographs at 3 gauges

When was hydrology calculated for

Hydrology modelling conducted in 2021

Rainfall and flow data from 1974–2020

Range of events/scenarios modelled?

1:10, 1:25, 1:100, and 1:200 AEP events

Storm durations: 3h, 4h, and 6h

Current climate only

Climate Change Considered?

No – climate change not included in this assessment but recommended for future updates

Calibration / Validation

Validation against January 2008 flood extents and multiple historical events

Gauges used: Koputaroa, Manakau (SH1), Waikawa (N. Manakau Rd)

Thiessen polygons used for rainfall distribution

Good match between modelled and observed hydrographs

Downstream boundary

Tidal Boundary: Constant Mean Sea Level (1.1 m, Wellington 1953 datum)

Extent: From river mouths inland ~3 km

No dynamic tide/flood interaction modelled

Model Description

Software: TUFLOW Classic/HPC (2020-10-AA)

Approach: 2D “rain-on-grid” with inflow hydrographs

Quadtree + Sub-Grid Sampling (SGS) for variable resolution

Hydraulic structures: Modelled in 1D (ESTRY), linked to 2D

Model Resolution

Grid Cell Sizes:

Floodplain: 24–48 m

Rivers: 12 m

Roads/Rail: 12 m

Channels: 6–12 m

Narrow streams: 3–6 m

Stopbanks: 3 m

Model Software/Version

Hydrology: HEC-HMS v4.6.1

Hydraulics: TUFLOW Classic/HPC 2020-10-AA

1D Domain: ESTRY (for structures)

2D Domain: TUFLOW with Quadtree and SGS

Modelled assets?

Approximately 30+ structures modelled in 1D:

Culverts: ~25 (various diameters, mostly circular)

Bridges: Several (State Highway, KiwiRail, local roads)

Gates/Drop Structures: ~5 (some modelled as closed)

HRC Scheme Assets: ~20 culverts and outlets (assumed invert levels from LiDAR)

Assumptions: Uni-directional flow for culverts, flap gates assumed where unknown

Stormwater / Surface Water network inclusion

Natural streams and rivers

Drainage channels

Culverts and outlets (HRC, HDC, NZTA, KiwiRail)

Stopbanks and flood defences

Level of Service for Assets Mentioned? - Standard of protection

Not explicitly defined

Overtopping assessed for 1:10 to 1:200 AEP events

Results used to infer LOS performance

Overview of Model Outputs and Mapping Available

Flood depth, velocity, and extent maps for all events

Overtopping volumes, durations, and peak flows per stopbank

Validation against 2008 flood and June 2021 debris lines

Appendices with schematics, validation graphs, and overtopping tables

Assumptions

No climate change included

Invert levels estimated from LiDAR where not surveyed

Culverts assumed uni-directional

Gates assumed closed

No dynamic tide-flood interaction

Rainfall applied without areal reduction factor (slightly conservative)

Limitations

No calibration downstream of Ō2NL extent

Some culvert/gate data missing or assumed

LiDAR may not reflect current riverbed or intertidal bathymetry

SGS may allow leakage without enforced breaklines

Tidal boundary simplified as constant MSL

No consideration of consequences of overtopping (e.g. damage, risk)

Recommendations

Include climate change in future assessments

Survey key structures (culverts, gates) for accurate modelling

Consider dynamic tide-flood interactions

Use results to prioritise asset upgrades and resilience planning

Validate with more recent flood events and debris surveys

Potential Updates

Check vertical datum

Consider climate change

Validate / Calibrate more recent flood events

Improve SGS representation

Recommended Level

Level C

File Name

Ohura 2D HEC-RAS_May 2021

Report Name

Ohura Flood Modelling

Region

Ruapehu District

Location

Ohura Township and surrounding catchment

Date Report Published

14 May 2021

Publication Status

Final (Memo format)

Purpose + Overview of model / report

The purpose of this modelling was to:

Assess flood hazards in the Ohura catchment.

Support Ruapehu District Council in understanding flood risks and future development opportunities.

Inform potential establishment of a new flood control scheme.

A 2D HEC-RAS model was developed to simulate flood extents for various design storm events, focusing on the township of Ohura.

Data overview - what data has been used (survey, lidar, date)

LIDAR-derived DEM: Used for terrain; some anomalies noted (e.g. vegetation not removed).

Hydrograph: Based on the 6–9 December 1968 flood event (peak flow 154.378 m³/s).

Design Flows: Provided by Horizons Regional Council (Jeff Watson), based on Tokirima gauge and NIWA flood estimation tools.

Cross-sections: Surveyed in April 2017 (Mangaroa River).

Rainfall: Design rainfall depths for each ARI scenario; 4 mm/hr infiltration loss applied.

Vertical Datum: Not explicitly stated

Watercourses / Stream

Main River: Mangaroa River (flows NE to SW through Ohura)

Tributaries:

Huhatahi Stream (upstream)

Mangawhena Stream (upstream)

Mangaparare Stream (south)

Mangatawa Stream (south)

Hydrological method used

Hydrographs scaled from the 1968 historical event.

Peak flows adjusted for each design event (MAF to 200-year ARI).

Time of concentration: 16 hours (based on Mangawhena Stream).

Rainfall applied as direct rain-on-grid with infiltration loss.

Tailwater levels set as constant for each scenario to simulate backwater effects.

When was hydrology calculated for

Historical hydrograph from 1968

Design flows based on 1998 event and NIWA tools

Cross-section survey from 2017

Range of events/scenarios modelled?

MAF (Mean Annual Flood)

5-year, 10-year, 20-year, 50-year, 100-year, and 200-year ARI events

Climate Change Considered?

No – climate change is not explicitly considered in this model.

Calibration / Validation

No formal calibration or validation undertaken.

Hydrograph shape from 1968 used as a proxy.

Recommendations include comparing modelled peak flows with historical events.

Downstream boundary

Tailwater depth set as a constant level for each scenario.

Derived from a previous 2D model using NIWA design flows.

Model Description

HEC-RAS 2D model with 10m x 10m grid cells.

Sub-grid sampling used for terrain representation.

Rain-on-grid approach with four upstream inflows and one downstream boundary.

Uniform Manning's n = 0.08 applied across the model.

Model Resolution

10 m x 10 m grid cells

Model Software/Version

HEC-RAS 2D (version not specified)

Modelled assets?

No 1D structures (e.g. culverts, bridges) explicitly modelled.

Approximately 0 structures included; recommendation to add culverts and other hydraulically significant features in future versions.

Stormwater / Surface Water network inclusion

Not included in the current model.

Recommendation to include culverts and drainage features in future updates.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood depth and extent layers for each of the 7 design scenarios.

Outputs are indicative and require refinement.

Assumptions

Uniform Manning's $n = 0.08$ across all land types.

Constant tailwater level for each event.

4 mm/hr infiltration loss applied uniformly.

Hydrograph shape from 1968 used for all scenarios.

Base flows assumed for each tributary.

Limitations

DEM contains anomalies (e.g. vegetation not removed).

No calibration or validation against observed events.

Uniform roughness may not reflect actual land cover.

No 1D structures included (e.g. culverts).

Hydrograph duration and shape may not reflect actual storm dynamics.

Rainfall loss and storm duration not varied by event.

Recommendations

Vary grid cell size for better resolution.

Use event-specific storm durations and hydrographs.

Improve base flow estimates with ongoing monitoring.

Include land cover data for variable Manning's n .

Add 1D structures (e.g. culverts) to improve hydraulic realism.

Consider a coupled 1D/2D model using surveyed cross-sections.

Investigate and correct DEM anomalies.

Potential Updates

Spatially-varying roughness

Climate Change

Hydrology Assessment

Add key 1d structures

Calibration / Validation

Improve DEM

Recommended Level

Level B

File Name

20211221 Technical Memo - Raparapawai 1D modelling
Addendum - Design Height for Raparapawai stopbank
Addendum No 2. Design Levels for New SB alignment

Report Name

Raparapawai 1D Modelling

Region

Raparapawai

Location

Raparapawai Stream

Date Report Published

21 December 2021

Publication Status

Final

Purpose + Overview of model / report

The purpose of the report is to assess the current level of service (LoS) of the Raparapawai Stream stopbanks and identify areas requiring upgrades to meet the 5-year Average Recurrence Interval (ARI) flood protection. The report includes 1D hydraulic modelling to evaluate the stopbank crest levels and potential overtopping areas. The addendums provide design heights and levels for the stopbank upgrades.

Data overview - what data has been used (survey, lidar, date)

Survey Data: Previously surveyed cross sections (12 surveyed on 12 October 2020 and 2 on 2 July 2019) and crest levels (surveyed on 1 July 2019).

Hydrological Data: 20 years of rainfall records at the gauging site (Jackson Rd, Raparapawai).

Digital Surface Elevation Model (DSM): Used for background image and conceptualisation.

Vertical Datum: New Zealand Vertical Datum (NZVD 2016).

Watercourses / Stream

Raparapawai Stream

Hydrological method used

Hydrological analysis was based on flood statistical analysis using 20 years of maximum annual flow records from the gauging site at Jackson Rd. Steady and unsteady flow files were created for model runs.

When was hydrology calculated for

Hydrological data from 2002 to 2021.

Range of events/scenarios modelled?

Steady Flow: 5-year ARI event with peak flow of 53.04 m³/s.

Unsteady Flow: Various scenarios including historical events and modified rational methods.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Model validation was based on comparing water elevation results with surveyed crest levels. Steady state flow was deemed most representative.

Downstream boundary

Normal depth boundary condition with an energy gradient of 0.0075.

Model Description

1D hydraulic modelling using HEC-RAS software. The model included surveyed cross sections and DSM for terrain representation. Steady and unsteady flow scenarios were tested.

Model Resolution

14 Cross-sections over 14km.

Model Software/Version

HEC-RAS 1D

Modelled assets?

Stopbanks: Approximately 2.4km of the right stopbank and 1.9km of the left stopbank require upgrades.

New Stopbank Alignment: Approximately 400m of new true right stopbank alignment.

Stormwater / Surface Water network inclusion

The report does not provide specific details on stormwater pipes or surface water network.

Level of Service for Assets Mentioned? - Standard of protection

5-year ARI flood protection with 300mm freeboard.

Overview of Model Outputs and Mapping Available

Model outputs include water surface elevation and potential overtopping areas. Mapping of surveyed crest levels and model results are provided.

Assumptions

Steady state flow is more conservative than unsteady flow.

DSM used for terrain representation.

5-year ARI design flow of 53.04 m³/s.

Limitations

Limited cross section data (only 14 cross sections for a 7.4km reach).

DSM not suitable for hydraulic modelling.

Poor representation of the channel due to limited cross section data.

Recommendations

Upgrade approximately 1km of the right bank and 0.5km of the left bank to meet 5-year ARI.

Further detailed cross section survey within the reach to improve model accuracy.

Potential Updates

Refine model representation of channel and structures with new surveys

Convert to NZVD2016

Consider climate change

Recommended Level

Level B

File Name

20211119 Technical Memo - Te Kawau Main Drain Modelling v1

Report Name

Sluggish Creek Technical Memo

Region

Lower Manawatu

Location

Sluggish Creek, part of the Te Kawau Main Drain system

Date Report Published

19 November 2021

Publication Status

Version 1 (Initial Technical Memo)

Purpose + Overview of model / report

The purpose of the modelling was to:

Assess the current Level of Service (LoS) for Te Kawau Main Drain, expected to be between 2–5 year ARI.

Identify areas of potential overtopping.

Support prioritisation of future works for the drainage scheme.

A 1D HEC-RAS model was developed to simulate hydraulic behaviour and assess overtopping risks under various design storm events.

Data overview - what data has been used (survey, lidar, date)

Cross Section Survey: 116 cross sections surveyed on 17 May 2021 at 50 m intervals.

Catchment Areas: Derived using ArcGIS watershed functions (Andrew Steffert, HRC).

Peak Flows: Scaled from Mangaone Stream (Milson Line gauge) using NIWA flood statistics and extrapolation formula.

DEM: Used for terrain comparison and cross-section extension; vertical datum not specified.

Vertical Datum: Survey data in NZVD2016; DEM assumed to be ~0.4 m lower.

Watercourses / Stream

Sluggish Creek: Modelled from northeast to southwest.

Upstream Boundary Conditions (USBC): 7 inflow points (A–G).

Downstream Boundary Condition (DSBC): Located at the southwest end of the reach.

Hydrological method used

Design flows derived from Mangaone Stream gauge using area-based extrapolation.

Rational method considered but discarded due to unrealistic results.

Hydrographs created as triangular shapes with durations of 6, 12, 18, and 24 hours.

18-hour duration selected as most representative for design events.

When was hydrology calculated for

Hydrological analysis and modelling conducted in 2021.

Mangaone Stream gauge data used for scaling (historic NIWA data).

Range of events/scenarios modelled?

Mean Annual Flood (MAF, ~2.33-year ARI)

5-year ARI

10-year ARI

Each event modelled with durations of 12, 18, and 24 hours

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

No formal calibration or validation against observed flood events.

Model reviewed and discussed with internal experts (Jeff Watson, John Foxall).

Geometry adjusted based on DEM to better represent overtopping conditions.

Downstream boundary

Energy gradient of 0.00217 used as downstream boundary condition.

Represents channel slope at the discharge point.

Model Description

Software: HEC-RAS 1D

Geometry: Based on 116 surveyed cross sections; extended using DEM where necessary.

Roughness: Manning's $n = 0.035$

Flow Inputs: 7 hydrographs at upstream boundaries

Plans: Multiple scenarios run with different durations and geometries

Model Resolution

Cross sections spaced at 50 m intervals

Geometry extended where DEM indicated insufficient coverage

Model Software/Version

HEC-RAS 1D (version not specified)

Two geometry files used:

Te Kawau Main Drain 1D

Te Kawau 1D – XS Extended

Modelled assets?

Cross Sections: 116 surveyed

Bridges: Kaimatarau Road Bridge mentioned (XS 116), but not explicitly modelled

Drainage Channels: Natural flow paths noted at some overtopping locations

Structures Not Included: Upstream drainage system and bridge constrictions not modelled

Assets with Caveats: Cross sections extended using DEM due to limited survey extent

Stormwater / Surface Water network inclusion

Natural drainage paths and Sluggish Creek channel modelled

No formal stormwater pipe network included

Level of Service for Assets Mentioned? - Standard of protection

Target LoS: 2–5 year ARI

Model shows Sluggish Creek can convey up to 5-year ARI with minor overtopping

Overview of Model Outputs and Mapping Available

Water Surface Elevation (WSE) profiles

Longitudinal plots of terrain and WSE

Identification of overtopping locations and lengths

RasMapper output files for each scenario

Assumptions

Peak flows from all catchments occur simultaneously (not realistic)

DEM vertical datum assumed to be 0.4 m lower than NZVD2016

Cross section extensions based on DEM assumed to represent true ground elevation

Natural flow paths assumed to be part of the drainage system

Limitations

DEM vertical datum unknown; estimated offset introduces uncertainty

Simultaneous peak inflows unlikely in reality

1D model limitations: cannot capture lateral storage or flow spreading

Some overtopping areas may be natural flow paths, not true overtopping

Further survey needed to confirm overtopping lengths and elevations

Recommendations

Conduct further survey to confirm overtopping areas

Investigate natural flow paths and their role in drainage

Consider including upstream drainage system and bridge constrictions in future models

Use 5-year ARI as design event for planning and asset management

Potential Updates

Consider climate change

Recommended Level

Level B

File Name

Woodville_Model_Build_Report_Draft

Report Name

Woodville Hydraulic Model build report

Region

Upper Manawatu

Location

Woodville, New Zealand

Date Report Published

19 November 2021

Publication Status

Draft Report

Purpose + Overview of model / report

The report documents the extension of the current hydraulic model covering Woodville to include areas of future development. The model was built using 2D Tuflow to represent overland flow resulting from excess rainfall and contributing flow from upstream catchments.

Data overview - what data has been used (survey, lidar, date)

Flow Records: No empirical flow data available for upstream catchments.

Rainfall Data: High Intensity Rainfall Design Systems v4 (HIRDSv4) design rainfalls.

LiDAR Data: Used to create digital elevation models (DEM) for the catchment.

Survey Data: Cross-sections of the Manga-atua Stream.

Watercourses / Stream

Mangamanaia Catchment: Included in the original model.

Mangapapa Catchment: Included in the original model.

Manga-atua Stream: Included in the extended model.

Hydrological method used

The rational method was used to estimate peak discharges for upstream catchments. The Curve Number method was also used for Catchment 1. Design flows were derived using HIRDSv4 rainfall intensities and the rational method. A flood hydrograph was created using the Manawatū at Upper Gorge normalised unit hydrograph.

Inflows: Derived from upstream subcatchments using the rational method.

Hydrographs: Created using the Manawatū at Upper Gorge normalised unit hydrograph.

Boundaries: Rainfall applied to the entire catchment, boundary inflows from upstream subcatchments, no downstream water level boundary.

When was hydrology calculated for**Range of events/scenarios modelled?**

Design Events: 0.5% AEP current climate event (equivalent to 1% AEP with climate change to 2120).

Climate Change Considered?

Yes, the model includes climate change scenarios with allowances for warming to 2120.

Calibration / Validation

The model has not been validated due to lack of data. Photos provided by HRC confirmed areas susceptible to flooding, but no information is available for the rainfall event that caused the flooding.

Downstream boundary

No downstream water level boundary has been applied, allowing flow to leave the study area overland without restrictions.

Model Description

The model used 2D Tuflow to represent overland flow routes. The DEM was created using data from HRC and Waka Kotahi.

Culverts were added based on survey data and desktop assessment.

Model Resolution

The Tuflow model has a 5m cell size.

Model Software/Version

TUFLOW

Modelled assets?

Bridge Structures: Not specifically mentioned.

Culvert Structures: Approximately 30 culverts included in the model.

Stormwater Drainage: Includes roads, open channels, and culverts.

Stormwater / Surface Water network inclusion

The stormwater drainage network was modeled using Tuflow based on survey data, Google Street View, and desktop assessment. The network includes roads, open channels, and culverts.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include overland flow direction, flood extent, and depth for the 0.5% AEP current climate event. Flooding with depths less than 100 mm is not shown.

Assumptions

Critical Duration: Assumed to be 6 hours.

Rainfall Profile: May not be representative of future rainfall.

Rainfall Distribution: Assumed to fall simultaneously on every part of the catchment.

Infiltration Losses: Assumed to be 40% of the rainfall.

Downstream Boundary: Assumed water can freely runoff into the Manawatū River.

Flow Gauging: No flow gauging or validation data available.

Rational Method: Provides peak discharge value but not hydrograph or flow volume.

DEM: Combined from different projections, may have small errors.

Limitations

Model Validation: Limited to photos confirming flood-prone areas.

DEM: Combined from different projections, may have small errors.

Culvert Data: Some culverts were added based on desktop assessment, survey data recommended for accuracy.

Buildings: Removed from LiDAR, potential depth of flooding inferred from ground elevation.

Recommendations

Conduct a survey of all critical culverts within the model extent.

Collect data or photos of flooding during major storm events to validate the model.

Update and extend the model with new DEM data as it becomes available.

Undertake a sensitivity test on Manning's n values.

Potential Updates

Explain in detail approach taken in TAaT model

Undertake survey of critical culverts in model area

Undertake sensitivity testing

Recommended Level

Level C

File Name

Tech Memo - Koputaroa 1D and 2D HEC RAS v1

Report Name

Koputaroa 1D and 2D HEC RAS v1

Region

Lower Manawatu

Location

Koputaroa Stream, including tributaries Waoku and Reach 3

Date Report Published

11 November 2020

Publication Status

Final – Version 1

Purpose + Overview of model / report

The purpose of this modelling study is to support a scheme review by assessing stopbank crest levels along the Koputaroa Stream. The study identifies sections of stopbank that may overtop during a 10-year ARI (10% AEP) flood event and recommends upgrades. Both 1D and 2D HEC-RAS models were developed to simulate flood behaviour under various downstream boundary conditions.

Data overview - what data has been used (survey, lidar, date)

LiDAR-derived DEM (modified with bathymetry)

Surveyed cross-sections (28 imported from Hilltop)

Catchment areas measured in ArcGIS

Historical hydrograph from 3 January 1977

Flood frequency analysis from Tavistock Rd gauging site

Vertical datum not explicitly stated

Watercourses / Stream

Koputaroa Stream (main reach)

Waoku Stream (tributary)

Reach 3 (tributary)

Lateral inflows A and B included in 1D and 2D models

Hydrological method used

Flood frequency analysis at Tavistock Rd gauge

Extrapolation using $Q1/Q2 = (A1/A2)^{0.8}$

Hydrographs scaled from 1977 event

Peak flows estimated for five sub-catchments

When was hydrology calculated for

Historical event: 3 January 1977

Modelling and analysis: 2020

Range of events/scenarios modelled?

10-year ARI (10% AEP) flood event

Four 1D model scenarios:

Free outfall

7 m tailwater (high tide + 100-year Manawatū flood)

5.2 m tailwater (normal depth)

Floodgates with 4.68 m tailwater

2D model scenario with floodgates and bathymetry

Climate Change Considered?

Yes – indirectly in Model 2, which simulates a 100-year ARI Manawatū River flood coinciding with high tide (sea level rise scenario)

Calibration / Validation

No formal calibration; hydrographs based on historical event

Surveyed cross-sections used to override DEM

DEM bathymetry adjusted based on field measurements

Downstream boundary

Model 1: Free outfall (friction slope 0.00032)

Model 2: 7 m tailwater (climate change scenario)

Model 3: 5.2 m tailwater (normal depth)

Model 4: 4.68 m tailwater with floodgates

Model Description

HEC-RAS 1D and 2D models developed

1D model includes 81 cross-sections, 28 from survey

2D model uses 10 m grid with 1 m breaklines

Floodgates modelled as inline structures with flap gates

Model Resolution

2D grid: 10 m cells with 1 m breaklines

DEM resolution not explicitly stated but includes bathymetry

Model Software/Version

HEC-RAS (version not specified)

1D and 2D domains coupled

Modelled assets?

Approximately 81 cross-sections in 1D model

2 junctions (Waoku and Reach 3)

1 floodgate structure (Asset ID: 776502) with 3 box culverts (3 m x 3.6 m), 2 modelled

Inline structure for floodgates

No explicit count of culverts or bridges beyond floodgate

Stormwater / Surface Water network inclusion

Not included in the model.

Level of Service for Assets Mentioned? - Standard of protection

10-year ARI (10% AEP) is the scheme design standard

Overview of Model Outputs and Mapping Available

Long sections for each model scenario

Hydrographs and flow profiles

2D flood depth and velocity profiles

Identification of overtopping locations

Assumptions

Extrapolation assumes similar catchment characteristics

DEM bathymetry assumed based on field estimates

Uniform Manning's n = 0.035 for all reaches

Hydrographs peak simultaneously for conservative results

Floodgates assumed to close at 4.68 m Manawatū River level

Limitations

DEM may not fully reflect surveyed bed levels

No formal calibration or validation

Uniform roughness may not reflect actual channel conditions

Geomorphologic processes and seepage not modelled

2D model uses DEM only; 1D uses surveyed cross-sections

Recommendations

Use Model 4 (floodgates + 4.68 m tailwater) for scheme review

Upgrade stopbank crest levels where overtopping is predicted

Refine Manning's n values based on field observations

Consider additional input locations for improved accuracy

Re-run Models 2 and 3 with floodgates if high tailwater scenarios are needed

Potential Updates

Validation / Calibration

Refine Manning's value

Improve DEM / Levels used

Recommended Level

Level C

File Name

Tech Memo - Koputaroa Pumpstations 1D v3

Report Name

Koputaroa Pumpstations 1D v3

Region

Lower Manawatu

Location

Koputaroa Drainage System

Date Report Published

21 October 2020

Publication Status

Final – Version 3

Purpose + Overview of model / report

The purpose of this study is to assess the performance of the existing Koputaroa pump stations (No.2 and No.3) during a 5-year ARI event and to evaluate the feasibility of consolidating the two drainage systems into one (i.e., decommissioning Pump Station No.2). The study uses HEC-RAS 1D modelling to simulate current and proposed drainage configurations and inform the Koputaroa Scheme Review

Data overview - what data has been used (survey, lidar, date)

LiDAR-derived DEM (modified with 0.4 m bathymetry)

Historical hydrograph from 3 January 1977

Flood frequency data from Tavistock Rd gauging site (1974–1996)

Pump specifications from Horizons' Asset Management System (AMS)

Manufacturer pump performance curves (MacEwans and Flygt)

Watercourses / Stream

Koputaroa Drains (main channel)

Tributary reaches: No3 West, No3 South, No3 East, No2 West

Combined drainage system in Model 2

Hydrological method used

Four methods used: NIWA, Rational, Modified Rational, Extrapolation

Extrapolation method selected for modelling based on best fit

Hydrographs scaled from 1977 event to match design flows

When was hydrology calculated for

Historical event: 3 January 1977

Modelling and analysis: 2020

Range of events/scenarios modelled?

5-year ARI (20% AEP) flood event

Model 1: Two pump stations (current configuration)

Model 2: One pump station (Kop No.3 only, combined system)

Climate Change Considered?

No – climate change is not explicitly considered in this study

Calibration / Validation

No formal calibration; DEM adjusted by 0.4 m to reflect bathymetry

Bank lines adjusted to highest points in DEM

Minimum base flows added to stabilize unsteady flow simulation

Downstream boundary

Manawatū River used as downstream boundary

Tailwater levels not explicitly defined in this memo

Model Description

HEC-RAS 1D model developed in RasMapper

Model 1: 6 rivers, 9 reaches, 3 junctions

Model 2: Combined geometry with regraded channel slope

Manning's $n = 0.035$ for all channels and banks

Model Resolution

1D model; no grid resolution applicable

Cross-sections drawn on LiDAR terrain

Model Software/Version

HEC-RAS 1D (version not specified)

Modelled assets?

2 pump stations:

Kop No.2 (ID: 778014): 290–450 L/s capacity

Kop No.3 (IDs: 778024, 778025): 230–900 L/s capacity

Model 2 includes:

2 MacEwans pumps (1.083 m³/s each)

5 Flygt pumps (0.558 m³/s each)

Approximately 21–22 boundary conditions per model

6 rivers, 9 reaches, 3 junctions

Stormwater / Surface Water network inclusion

Natural drainage channels (Koputaroa Drains)

No piped stormwater network included

Level of Service for Assets Mentioned? - Standard of protection

5-year ARI (20% AEP) is the scheme design standard

Overview of Model Outputs and Mapping Available

Hydrographs and long sections

Cross-sections showing overtopping

Pump performance curves

Geometry comparisons (LiDAR vs modified)

Summary tables of overtopping cross-sections

Assumptions

Extrapolation method provides best-fit design flows

DEM bathymetry lowered by 0.4 m

Uniform Manning's n = 0.035

Pumps operate at manufacturer-rated capacity

Bank lines adjusted to highest DEM points

Limitations

1D model may not capture full crest levels

No formal calibration or validation

LiDAR may not reflect actual bed levels

Pump performance based on manufacturer data, not field-tested

Channel cross-sections may not fully represent stopbank geometry

Recommendations

Consider consolidating to one pump station (Kop No.3)

Add pumps and modify channel geometry (e.g., regrade slope, widen)

Conduct financial feasibility assessment

Survey key sections for improved model accuracy

Develop Model 3 to refine pump/channel requirements

Potential Updates

Consider Climate Change

Survey Cross-sections

Incorporate 2D domain to capture crest levels

Recommended Level

Level C

File Name

Technical Memo - Mangaone Stream HEC RAS 1D

Report Name

Mangaone Stream HEC RAS 1D

Region

Lower Manawatu

Location

Mangaone Stream, from its confluence with the Manawatū River to Milson Line

Date Report Published

22 June 2020

Publication Status

Final

Purpose + Overview of model / report

The purpose of this study is to assess the flood protection level of the stopbanks along the Mangaone Stream using a 1D HEC-RAS model. The model simulates a 1% AEP (100-year ARI) flood event to identify potential overtopping locations and evaluate stopbank performance.

Data overview - what data has been used (survey, lidar, date)

Cross-sections:

Ch -140 to 1860: Derived from PNCC 2018 LiDAR DEM

Ch 2060 to 10930: Surveyed in 2019 (Hilltop)

DEM: PNCC 2018 LiDAR (recommended by HRC GIS team)

Vertical datum adjustments: LiDAR raised by 0.2 m and channel bed lowered by 0.96 m to match surveyed data

Watercourses / Stream

Mangaone Stream (approx. 11 km)

Two tributaries:

Waikau Tributary (Ch 2840)

Little Waikau Tributary (Ch 8510)

Hydrological method used

Inflows:

Milson Line inflow: 193.5 m³/s (1% AEP)

Tributary inflows scaled from Milson Line hydrograph

Outflow:

Flygers Line Spillway: 69.5 m³/s

Tailwater level at Manawatū River: 22.454 m (based on 1 in 500-year ARI from MIKE 11)

When was hydrology calculated for

Hydrological data from LMS report (Graham Duall, 2015)

Surveyed cross-sections from 2019

DEM from 2018

Range of events/scenarios modelled?

1% AEP (100-year ARI) flood event

Two scenarios:

Manawatū River at 22.454 m (realistic)

Free outfall (not included in results)

Climate Change Considered?

No – climate change is not explicitly considered in this study

Calibration / Validation

No formal calibration

DEM adjusted to match surveyed cross-sections

Comparison of LiDAR and surveyed data at Ch 2060

Downstream boundary

Manawatū River tailwater level set at 22.454 m (1 in 500-year ARI)

Model Description

HEC-RAS 1D model with unsteady flow regime

80 cross-sections used

Manning's n values tested: 0.035 and 0.04

Spillway and tributary inflows included

Model Resolution

1D model; no grid resolution applicable

Cross-sections spaced along 11 km reach

Model Software/Version

HEC-RAS 1D (version not specified)

Modelled assets?

Approximately 80 cross-sections

2 tributary inflows

1 lateral outflow (Flygers Line Spillway)

No explicit modelling of culverts, bridges, or floodgates

Stormwater / Surface Water network inclusion

Not included in the model.

Level of Service for Assets Mentioned? - Standard of protection

Some stopbanks not designed for 1% AEP (e.g., Ch 10630)

Overview of Model Outputs and Mapping Available

Hydraulic grade lines for $n = 0.035$ and 0.04

Overtopping assessment tables

Maps showing overtopping locations (Figures 6 and 7)

Summary of overtopping sections (Table 4)

Assumptions

LiDAR raised by 0.2 m to match surveyed data

Channel bed lowered by 0.96 m in LiDAR-derived sections

Spillway and tributary inflows scaled from Milson Line hydrograph

Manawatū River level held constant at 22.454 m

Limitations

Some cross-sections not extended fully (e.g., Ch -140 to 1860)

Stopbanks not surveyed in some areas

Manawatū River level based on 1 in 500-year ARI applied for entire 1% AEP event duration (conservative)

No freeboard included in overtopping assessment

Recommendations

Investigate overtopping sections:

Ch -140 to 1860 (2.1 km)

Ch 2360–2530 (400 m)

Ch 2840 (only overtops with $n = 0.04$)

Ch 10630 (not designed for 1% AEP)

Consider surveying stopbanks for improved accuracy

Include freeboard in future assessments

Monitor Pioneer City West development area (Ch 1460–3850)

Potential Updates

Consider Climate change

Validation / Calibration

Survey stopbanks

More scenarios / events that are less conservative

Recommended Level

Level C

File Name

Tech Memo - Sinclair's Creek Diversion Channel HEC RAS 1D v2

Report Name

Sinclair's Creek Diversion Channel HEC RAS 1D v2

Region

Upper Manawatu

Location

Sinclair's Creek, between Range Road and Bluff Road, discharging to the Manga-Atua River and Manawatū River, near Woodville

Date Report Published

23 December 2020

Publication Status

Final – Version 2

Purpose + Overview of model / report

The purpose of this study is to assess the feasibility of increasing flow capacity in the Sinclair's Creek diversion channel to divert more flow to the Manawatū River instead of the Manga-Atua River. The study aims to reduce flooding in the lower catchment, especially under climate change scenarios. Ten HEC-RAS 1D models were developed to simulate various flow conditions, weir configurations, and channel geometries.

Data overview - what data has been used (survey, lidar, date)

LiDAR-derived terrain (year not specified)

Surveyed cross-sections (17 for one-reach models, 28 for two-reach models)

Rainfall data: NIWA HIRDS v4

Design flows: Modified Rational Method

Vertical datum not explicitly stated

Watercourses / Stream

Sinclair's Creek (main channel)

Diversion Channel (flows to Manawatū River)

Manga-Atua River (original downstream discharge point)

Hydrological method used

Modified Rational Method used to estimate peak flows

Time of concentration calculated using Ramser-Kirpich, Bransby-Williams, and US SCS methods

Hydrographs created with simple triangular shapes (12-hour duration)

When was hydrology calculated for

Rainfall data from HIRDS v4 (historic and RCP 8.5)

Hydrology and modelling completed in 2020

Range of events/scenarios modelled?

10-year ARI (historic and RCP 8.5)

2-year ARI (approximate, for capacity testing)

Models with:

Existing weir

Lowered weir

Regraded channel

Box culverts (1 or 2)

Full diversion of flow to Manawatū River

Climate Change Considered?

Yes – RCP 8.5 scenario used for 10-year ARI rainfall

Calibration / Validation

No formal calibration

Simplified hydrographs and uniform Manning's n used

Model simplifications acknowledged

Downstream boundary

Manawatū River (via diversion channel)

Manga-Atua River (original downstream path, excluded in some models)

Model Description

HEC-RAS 1D models with unsteady flow

10 models developed with varying configurations:

1 or 2 reaches

Weir presence and height

Channel regrading

Box culverts

Manning's n = 0.035 used throughout

Model Resolution

1D model; no grid resolution applicable

Cross-sections spaced along surveyed and interpolated locations

Model Software/Version

HEC-RAS 1D (version not specified)

Modelled assets?

Approximately 28 cross-sections (two-reach models), 17 (one-reach models)

1 existing concrete weir (surveyed)

1 box culvert (1.5 m x 1.2 m) under Bluff Road

2 box culverts tested in Model 9

No other structures (e.g., bridges, floodgates) explicitly modelled

Stormwater / Surface Water network inclusion

Not included in the model.

Level of Service for Assets Mentioned? - Standard of protection

10-year ARI (10% AEP) used as design standard

2-year ARI used for capacity testing in Model 10

Overview of Model Outputs and Mapping Available

Long sections and profile plots for each model

Hydraulic grade lines

Overtopping locations highlighted

Summary table of model configurations

Assumptions

Uniform Manning's $n = 0.035$

Simplified hydrographs (triangular, 12-hour duration)

No lateral inflows or seepage

1D model limitations acknowledged (e.g., meanders, bends not fully represented)

Limitations

1D model does not capture complex flow patterns (e.g., 90° bends)

Limited cross-section data

No calibration or validation

Simplified inflow hydrographs

Uniform roughness may not reflect actual conditions

Recommendations

If full diversion is pursued, limit flow to $\sim 6.83 \text{ m}^3/\text{s}$ to avoid overtopping

Consider upgrading the diversion channel

Develop Model 11 with new channel geometry

Survey additional cross-sections for improved accuracy

Consider model calibration for future refinement

Potential Updates

Improve roughness coverage

Consider limitations of 1D model

Validation / Calibration

Recommended Level

Level B

File Name

IZ124200-CH-MEM-001 Reids Line_FINAL_REVA_20191125 (002) Reid Line Floodway 20191125

Report Name

Flood modelling of Reid Line Spillway

Region

Lower Manawatu

Location

Reid Line Floodway between the Makino Stream and the Kiwitea Stream, Feilding, New Zealand

Date Report Published

25 November 2019

Publication Status

Final Report (Revision A)

Purpose + Overview of model / report

The report assesses the hydraulic modelling of Reid Line Floodway to evaluate the extent and depth of flow for flood events of 100 and 200 Year Average Recurrence Interval (ARI). The modelling aims to provide protection to flood-prone areas of Feilding by diverting high flows from the Makino Stream towards the Kiwitea Stream.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: 2016 derived Digital Elevation Model (DEM) with a grid size of 1×1m supplied by Horizons Regional Council (HRC)

Flood Hydrographs: Provided by HRC for 100 and 200 Year ARI events

Watercourses / Stream

Makino Stream: Upstream boundary

Kiwitea Stream: Downstream boundary

Hydrological method used

The hydrological assessment uses flood hydrographs for different flow conditions in the Makino Stream. The upstream boundary is defined by these hydrographs, and the floodplain is modelled in 2D using MIKE 21 FM software, while the culvert of Pharazyn Road is modelled in 1D using MIKE 11 software.

When was hydrology calculated for**Range of events/scenarios modelled?**

Existing Design Flow (EDF) for 100 and 200 Year ARI events

Updated Design Flow (UDF) for 200 Year ARI event

Updated Design Flow with 20 m³/s release in the Makino Stream (UDFR) for 200 Year ARI event

Climate Change Considered?

The report mentions that none of the flood hydrographs include an allowance for the effects of climate change on the flows in the Makino Stream.

Calibration / Validation

The report does not mention specific calibration or validation details.

Downstream boundary

The downstream boundary is set up below the confluence of Reid Line Floodway and the Kiwitea Stream. A normal depth tail water level condition is applied to the Kiwitea Stream.

Model Description

The model uses MIKE Flood software version 2017, combining MIKE 21 FM for the floodplain and MIKE 11 for the culvert. The floodplain is represented by a flexible mesh with fine resolution along the stopbank and coarse resolution for the rest of the area. Existing structures such as the Pharazyn Road culvert, gabion drop structure, and discharge channel are modelled using survey information and LiDAR DEM.

Model Resolution

Mesh Size: Fine mesh under 5 m² along the stopbank, coarse mesh under 10 m² for the rest of the area, average mesh size 4.7 m². 2016 LiDAR

Model Software/Version

MIKE Flood: Version 2017

MIKE 21 FM: For floodplain modelling

MIKE 11: For culvert modelling

Modelled assets?

Pharazyn Road Culvert: Single barrel rectangular culvert, 2.5m wide and 0.9m deep

Gabion Drop Structure: Drains floodwater from floodplain into a channel

Discharge Channel: 1.0m deep and 35.0m wide, 300.0m long

Gate Structure: Across the Makino Stream to regulate flows

Stormwater / Surface Water network inclusion

The stormwater network includes minor streams between the Makino Stream and the Kiwitea Stream, culverts under the stopbank, and the gate structure across the Makino Stream.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood extents and water levels for different flow conditions in the floodway. Flood extents are projected for EDF100, EDF200, UDF, and UDFR scenarios. The report also includes a comparison of water levels with and without a modif

Assumptions

Minor Streams: The flows generated by minor streams between the Makino Stream and the Kiwitea Stream were not considered, as their contribution to the flood extents projected for 100 and 200 Year ARI events is likely to be small.

Culverts: Culverts provided under the stopbank at the location of these minor streams were not modelled, as they are closed during a flood event.

Pass-Forward Flow: The pass-forward flow at the gate structure across Makino Stream towards the town of Feilding is not explicitly modelled.

Tail Water Level: A normal depth tail water level condition was applied to the Kiwitea Stream.

True Right Bank: A “glass wall” approach was adopted to define the true right bank of Reid Line Floodway.

Limitations

Minor Streams: Flows generated by minor streams between the Makino Stream and the Kiwitea Stream were not considered

Pass-Forward Flow: Not explicitly modelled at the gate structure across Makino Stream

LiDAR Data: Uncertainty in LiDAR data (+ 200 mm is typical)

Recommendations

Model Improvements: Consider changes to the design of the drop structure, check the impact of high tailwater levels in the Kiwitea Stream, use sensitivity analysis for Manning’s roughness coefficient, investigate changes to the configuration of the floodway, review crest levels for freeboard allowance, and include an allowance for climate change effects.

Potential Updates

Consider climate change

Assess model sensitivity to roughness

Potential to use survey data of right-bank instead of glass-wall approach

Recommended Level

Level C

File Name

FeildingWFloodingReport171018

Report Name

Flood Modelling of the Feilding West Area

Region

Lower Manawatu

Location

Feilding West area, including Mangaone West Stream catchment, Feilding town, and minor streams running into Feilding, New Zealand

Date Report Published

1 November 2017

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses flood hazards for the Feilding West area by developing a hydraulic model to produce flood maps for 2%, 1%, and 0.5% Annual Exceedance Probability (AEP) flood events.

Data overview - what data has been used (survey, lidar, date)

Rainfall Data: Supplied by Horizons Regional Council for three adjacent rainfall gauge locations: Forest Rd @ Drop Structure, Mangaone @ Milson Lane, and Makino @ Halcombe Rd

LiDAR Data: Used to create a Digital Elevation Model (DEM)

Site Visit Observations: Brief observations from a site visit to Feilding town and the rural catchment

Watercourses / Stream

Mangaone West Stream: Main stream draining the catchment

Makino Stream: Included in the model where it flows through Feilding

Hydrological method used

The hydrological assessment uses rainfall hyetographs for design events and the June 2015 event. Infiltration losses are treated as an initial loss depth and a continuing loss rate. Flow resistance for overland flows is represented by Manning's n values.

When was hydrology calculated for

Rainfall Data: June 2015 event and design hyetographs for 2%, 1%, and 0.5% AEP events provided by HRC from HIRDSv3

Range of events/scenarios modelled?

Design flood events: 50-year, 100-year, and 200-year ARI

Significant rainfall event: June 2015

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

No calibration data were available for the June 2015 event. Infiltration losses were assumed based on soil characteristics and previous studies.

Downstream boundary

Makino Stream outflow from the modelled area is represented as several sinks with a combined outflow rate set high enough to accommodate peak flood flow.

Model Description

The model uses MIKE 21 "Classic" for overland flow with a 5m square grid. The model domain is a rectangle enclosing the Feilding West area. Culverts and bridges are represented by altering the bathymetry to allow runoff to pass without heading up. The urban network in Feilding is credited with carrying up to the 5-year ARI event.

Model Resolution

Grid Size: 5m square grid

Model Software/Version

MIKE 21 "Classic"

Modelled assets?

Culverts and Bridges: Represented by altering the bathymetry

Urban Network: Credited with carrying up to the 5-year ARI event

Stormwater / Surface Water network inclusion

The stormwater network includes minor streams running into Feilding and the urban network capturing low-flow runoff from hill gullies.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include maps of peak water level and peak velocity for the design events and the June 2015 event.

These maps are presented using colour coding for maximum depth and maximum velocity.

Assumptions

Without any calibration data, the initial and continuing losses had to be simply assumed

Limitations

Calibration Data: No calibration data were available for the June 2015 event

Culverts and Bridges: Represented by altering the bathymetry, which may not fully capture their effectiveness

Urban Network: Not fully picked up by the 5m DEM

The present model does not include Makino Stream flows and so modelled flooding in Feilding town does not account for major rainfall events occurring together in the Feilding West area and the Makino Stream catchment.

Recommendations

Not explicitly stated

Potential Updates

Use recent LiDAR and survey, represent channels explicitly using survey data

Refine roughness values

Update to NZVD2016

Consider climate change

Recommended Level

Level B

File Name

MakowhaiFloodingReport171012

Report Name

Flood Modelling of the Makowhai/ Piakatutu Catchment

Region

Rangitikei

Location

Makowhai / Piakatutu catchment, south of the Rangitikei River, New Zealand

Date Report Published

1 October 2017

Publication Status

Draft Report

Purpose + Overview of model / report

The report aims to produce flood maps for the Makowhai / Piakatutu catchment for the 2%, 1%, and 0.5% Annual Exceedance Probability (AEP) flood events . It also includes modelling of a rainfall event from June 2015 for calibration purposes.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: Used to create the Digital Elevation Model (DEM) with a 5m grid.

Rainfall Data: Hyetographs for three adjacent rainfall gauge locations (Forest Rd @ Drop Structure, Mangaone @ Milson Lane, and Makino @ Halcombe Rd) for the June 2015 event and design hyetographs for 2% and 1% AEP events.

Survey Data: Culverts and bridges survey data.

Watercourses / Stream

Makowhai Stream: Main drainage channel.

Other Streams: Various gullies and swales within the catchment.

Hydrological method used

The model was built using MIKE 21 "Classic" with a 5m square grid for overland flow. The catchment was treated as a closed area with outflowing streams represented as sinks. Rainfall hyetographs were weighted and applied to the entire modelled area. Infiltration losses were treated as initial loss depth and continuing loss rate.

Inflows: Rainfall hyetographs.

Hydrographs: Design hyetographs for 50-year, 100-year, and 200-year ARI events.

Boundaries: Closed area with outflowing streams as sinks.

When was hydrology calculated for**Range of events/scenarios modelled?**

Calibration Event: June 2015 rainfall event.

Design Events: 50-year, 100-year, and 200-year ARI flood events.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model was calibrated using debris levels from the June 2015 event. Adjustments were made to infiltration rates and culvert parameters to achieve reasonable agreement between measured and modelled water levels.

Downstream boundary

Outflowing streams were represented as sinks with high outflow rates to accommodate peak flood flow.

Model Description

The model used MIKE 21 "Classic" with a 5m grid for overland flow. Culverts and bridges were modelled using the culvert function within MIKE 21. Rainfall hyetographs were weighted and applied to the entire modelled area.

Model Resolution

5m grid size.

Model Software/Version

MIKE 21 "Classic": Overland flow model.

Modelled assets?

Culverts and Bridges: 187 culverts and bridges, including roadside table drains and stream crossings.

Stormwater / Surface Water network inclusion

The model includes culverts and bridges but does not include the drainage network in the towns of Sanson and Ohakea or any culverts on farm land.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include maps of peak water level and peak velocity for the 50-year, 100-year, and 200-year ARI events. These maps show generally flooded widths and discontinuous flooding in the catchment.

Assumptions

Model Boundaries: The catchment was treated as a closed area.

Infiltration Losses: Initial loss of 20mm and continuing loss rate of 3.2 mm/hour.

Flow Resistance: Single Manning M value of 23 for rural areas, different values for urban areas.

Limitations

Data Limitations: Debris levels are approximate indicators of peak flood level.

Model Limitations: The model's 5m grid and approach to flow resistance are not suitable for detailed analysis of local drainage. The model does not include the drainage network in the towns or any culverts on farm land.

Recommendations

Consider additional culverts or larger ones where culvert drainage is inadequate.

Use the model for broad-brush representation of flooding in response to design events.

Potential Updates

Use recent LiDAR and survey, represent channels and structures explicitly using survey data

Refine roughness values

Update to NZVD2016

Consider climate change

Recommended Level

Level B

File Name

OhakeaFloodingReport171207Draft

Report Name

Flood Modelling of the Ohakea Air Base and environs

Region

Rangitikei

Location

Ohakea Air Base and surrounding land, New Zealand

Date Report Published

1 December 2017

Publication Status

Draft Report

Purpose + Overview of model / report

The report describes a numerical flooding study for Ohakea Air Force Base and the surrounding land. The study aims to produce flood maps for the 5-year and 100-year Average Recurrence Interval (ARI) flood events. The study leverages information from an earlier flood model study of the Makowhai / Piakatutu catchment.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: Resampled on a 1m grid by Horizons Regional Council.

Rainfall Data: Hyetographs for three adjacent rainfall gauge locations (Forest Rd @ Drop Structure, Mangaone @ Milson Lane, and Makino @ Halcombe Rd) for the June 2015 event and design hyetographs for 50-year and 100-year ARI events.

Survey Data: Culverts and bridges survey data.

Watercourses / Stream

Makowhai Stream: Main drainage channel within the model domain.

Hydrological method used

The model was built using MIKE 21 "Classic" with a 1m square grid for overland flow. The catchment was treated as a closed area with outflowing streams represented as sinks. Rainfall hyetographs were weighted and applied to the entire modelled area. Infiltration losses were treated as initial loss depth and continuing loss rate.

Inflows: Taken from output of the Makowhai / Piakatutu model.

Hydrographs: Design hyetographs for 5-year and 100-year ARI events.

Boundaries: Closed area with outflowing streams as sinks.

When was hydrology calculated for**Range of events/scenarios modelled?**

Design Events: 5-year and 100-year ARI flood events.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model adopted parameters from the Makowhai model, which was calibrated against a 2015 event. Adjustments were made to infiltration rates and culvert parameters.

Downstream boundary

Outflowing streams were represented as sinks with high outflow rates to accommodate peak flood flow.

Model Description

The model used MIKE 21 "Classic" with a 1m grid for overland flow. Culverts and bridges were modelled using the culvert function within MIKE 21. Rainfall hyetographs were weighted and applied to the entire modelled area.

Model Resolution

1m grid size.

Model Software/Version

MIKE 21 "Classic": Overland flow model.

Modelled assets?

Culverts and Bridges: All significant culverts and bridges for which sufficient data were available, including several culverts within the base.

Stormwater / Surface Water network inclusion

The model does not include the stormwater pipe network that drains the base or field drains on the runways.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify levels or standards of service for assets.

Overview of Model Outputs and Mapping Available

The outputs include maps of peak water level and peak velocity for the 5-year and 100-year ARI events. These maps show significant ponding on farmland and some overland flow across the runways for the 100-year event.

Assumptions

Model Boundaries: The catchment was treated as a closed area.

Infiltration Losses: Initial loss of 20mm and continuing loss rate of 3.2 mm/hour.

Flow Resistance: Single Manning M value of 23 for rural areas, different values for urban areas.

Limitations

Data Limitations: The stormwater reticulation network at Ohakea base was not included, nor were field drains on the runways.

Model Limitations: The model's 1m grid and approach to flow resistance are not suitable for detailed analysis of local drainage. The design hyetographs are unlike real events.

Recommendations

Consider additional culverts or larger ones where culvert drainage is inadequate.

Use the model for broad-brush representation of flooding in response to design events.

Potential Updates

Use recent LiDAR and survey, represent channels and structures explicitly using survey data

Update to NZVD2016

Consider climate change

Recommended Level

Level B

File Name

Ohakune_addendum_report

Report Name

Ohakune Township Flood Modelling Addendum Report

Region

Whangaehu

Location

Ohakune Township, New Zealand

Date Report Published

31 July 2017

Publication Status

Draft, Revision No: 1.0

Purpose + Overview of model / report

The report was commissioned by Horizons Regional Council (HRC) and prepared by Entura (formerly Hydro Tasmania Consulting). It aims to update the flood modelling for Ohakune Township with new LiDAR data and revised hydrologic and hydraulic models. The study involves re-calibrating the hydrologic model, updating design flood discharges, and combining previous models into a single model with a 2.5m grid.

Data overview - what data has been used (survey, lidar, date)

Flood Frequency Curves: Supplied by HRC for Mangawhero at Hagleys and Makotuku at SH49.

Streamflow Records: Mangawhero at Hagleys, Burns Street, Pakihi Road.

LiDAR Data: 2009 and 2016 LiDAR surveys.

Vertical Datum: Moturiki Vertical Datum using NZMG projection.

Watercourses / Stream

Mangawhero River: Main river passing through the study area.

Tributaries: Six tributaries of the Mangawhero River.

Other Streams: Additional streams covered by the new LiDAR extent.

Hydrological method used

Flood Frequency Review: Updated based on new data and re-calibration of the hydrologic model.

Design Flood Hydrographs: Updated for the 1 in 200 AEP 6hr storm event.

Catchment Areas: Extended to include new LiDAR data.

When was hydrology calculated for

Flow Record Extension: 1968-2015.

Range of events/scenarios modelled?

Design Flood Events: 1 in 200 AEP 6hr storm event.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Flood Frequency Review: Re-calibration based on updated flood frequency curves.

Hydrologic Model Re-calibration: Adjusted proportional runoff (PR) to achieve higher runoff required.

Downstream boundary

MIKE 11 Model Boundary: Linked directly to the MIKE 21 grid, removing the previous downstream boundary condition.

Model Description

MIKE Flood Model: Combined previous models into a single model with a 2.5m grid.

Hydraulic Structures: Approximately 6 additional culverts added to the MIKE 11 model

Model Resolution

Combined Model: 2.5m grid.

Model Software/Version

MIKE Flood: Version 2014 (Service Pack 3).

MIKE 11, MIKE 21, MIKE Urban: Integrated within MIKE Flood.

Modelled assets?

Culverts: Approximately 6 additional culverts.

Stormwater Network: No changes made to the original MIKE Urban model.

Stormwater / Surface Water network inclusion

Stormwater Sumps: No changes made to the original MIKE Urban model.

Pipes: No changes made to the original MIKE Urban model.

Outfalls: No changes made to the original MIKE Urban model.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood Extents: Provided for 1 in 200 AEP 6-hour storm event.

Peak Discharges and Water Levels: Viewable using MIKE VIEW/ZERO software packages.

Assumptions

Flood Frequency Review: Assumed correlation between flood peaks of Makotuku at SH49 and Mangawhero at Hagleys is weak.

Blockage Factor: Not explicitly mentioned in this report.

Limitations

Model Calibration: Limited by the availability of recorded flood data.

Flood Duration: Only the 6hr duration was modelled, which may not result in worst-case flooding in the extended sections of the model.

Recommendations

No specific recommendations mentioned in this report.

Potential Updates

Convert to NZVD2016

Consider climate change

Further validation and calibration

Recommended Level

Level C

File Name

Lower-Whanganui-River-June-2015-Flood-Report

Report Name

Lower Whanganui River Flood Protection Investigations - Review of the June 2015 Flood and Update of Design Flood Level Estimates

Region

Whanganui

Location

Lower Whanganui River, Whanganui City

Date Report Published

1 June 2016

Publication Status

Final

Purpose + Overview of model / report

The report:

Reviews the June 2015 flood event in Whanganui.

Updates flood frequency estimates and design flood levels.

Assesses sedimentation and morphological changes in the river.

Uses updated hydrological and hydraulic modelling to inform flood protection planning and infrastructure design.

Data overview - what data has been used (survey, lidar, date)

Flow Data: Te Rewa and Paetawa gauges (1957–2015)

Rainfall Data: 48-hour rainfall records from June 2015

Cross-Section Surveys: 1995 and December 2015

Hydraulic Modelling: MIKE11 (Hydro Tasmania, 2007)

Vertical Datum: Wellington Vertical Datum 1953 (WVD53); sea levels in Moturiki Datum

Historical Flood Records: 1858–1940 (12 events)

Tributary Flow Estimations: Slope-area methods and transpositions

Watercourses / Stream

Main River: Whanganui River (Paetawa to Tasman Sea)

Tributaries:

Upokongaro

Makirikiri

Kukuta

Matarawa

Mateongaonga

Kauarapaoa

Mangaiti

Awarua

Hydrological method used

Flood Frequency Analysis: L-moments, EV1 and GEV distributions

Historical Flood Inclusion: 12 events from 1858–1940

Tributary Flows: Estimated using slope-area methods and time of concentration (Kirpich formula)

Design Floods: Based on 10% AEP tributary flows coinciding with mainstem peak

When was hydrology calculated for

Hydrology updated in 2016 using data from 1957–2015

Range of events/scenarios modelled?

June 2015 flood (1.2% AEP at Te Rewa; 0.77% AEP at Town Bridge)

Design floods: 2%, 1%, 0.5%, and 1% AEP + climate change (CC)

Sea level rise scenarios

Climate Change Considered?

Yes – 1% AEP + climate change scenario modelled (20% increase in flow projected by 2090)

Calibration / Validation

Calibrated against June 2015 flood using updated cross-sections, tributary inflows, and mouth scour

Adjusted Manning's n values for improved accuracy

Model accuracy within ± 0.3 m; 0.5 m freeboard applied

Downstream boundary

Sea level at Whanganui River mouth (Moturiki Datum)

Design sea levels range from 2.2 m (5-year) to 2.9 m (200-year)

Model Description

Software: MIKE11 (1D unsteady flow model)

Extent: Paetawa (chainage 49330 m) to river mouth (96260 m)

Calibration Steps:

Original 1995 cross-sections

Updated 2015 cross-sections

Added tributary inflows

Included mouth scour

Adjusted roughness values

Model Resolution

50 cross-sections along ~47 km of river

Cross-section spacing varies; detailed in Appendix A

Model Software/Version

MIKE11 (Hydro Tasmania, 2007)

No 2D domain used; 1D model only

Modelled assets?

Bridges: Railway, Dublin Street, City, Cobham Street (included in model geometry but not explicitly modelled hydraulically)

Stopbanks:

Kowhai Park stopbank (overtopped in 2015)

Balgownie stopbanks (upgraded to 0.5% AEP + 0.5 m freeboard in 2011)

Cross-Sections: 50 surveyed (1995 and 2015)

No explicit modelling of culverts, gates, or pumping stations in MIKE11

Stormwater / Surface Water network inclusion

Urban stormwater not included

Matarawa Stream confluence considered due to flood interaction

Level of Service for Assets Mentioned? - Standard of protection

Kowhai Park stopbank: upgraded to 2% AEP (no freeboard) in 2014

Balgownie stopbanks: 0.5% AEP + 0.5 m freeboard (2011)

Overview of Model Outputs and Mapping Available

Flood levels and discharges for:

June 2015 flood

2%, 1%, 0.5%, and 1% AEP + CC events

Tables and graphs of flood levels at key locations

Cross-section comparisons (1995 vs 2015)

Assumptions

Tributary inflows based on 10% AEP coinciding with mainstem peak

Mouth scour only applied to June 2015 event, not design runs

Freeboard of 0.5 m includes model uncertainty and hydraulic effects

Historical flood estimates adjusted per NIWA review

Limitations

No real-time tributary gauges; flows estimated

Mouth scour not guaranteed in future events

Historical flood data has inherent uncertainty

Urban stormwater and tsunami risks excluded

Model is 1D only; no lateral floodplain dynamics

Recommendations

Use updated model for future flood defence planning

Maintain and monitor tributary inflows and rainfall patterns

Consider climate change in all future design levels

Continue periodic cross-section surveys to monitor sedimentation

Potential Updates

Consider climate change

Add floodplain dynamics through 2D domain, if morphological changes are important

Recommended Level

Level C

File Name

302265-Report-01-Floodplain Mapping-Feilding Township and Adjacent Rural and Semi-Rural Areas

Report Name

Floodplain Mapping - Feilding Township and Adjacent Rural and Semi-Rural Areas

Region

Lower Manawatu

Location

Feilding Township and surrounding rural and semi-rural areas, Manawatu Region, New Zealand

Date Report Published

1 April 2013

Publication Status

Revision No: 1

Purpose + Overview of model / report

The report assesses flood risks in Feilding and the surrounding rural and semi-rural areas due to urban stormwater runoff and coincident flooding from the Makino and Kiwitea Streams and the Oroua River. The study aims to develop a detailed hydraulic model to understand flood behaviour and inform flood management strategies. The model combines MIKE 21 DEM and roughness grid, MIKE FLOOD hydraulic model, and MIKE URBAN model to capture the complete physical flow characteristics in the study area.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: Provided by Horizons Regional Council (HRC)

Rainfall Data: Various gauging sites including Feilding Sewage Plant, Makino at Cheltenham, Makino at Halcombe Road, Mangaone at Bunnythorpe, Mangaone at Milson Line, Mangaone at Valley Road, Ngahere Park Climate Station, Oroua at Feilding, and Oroua at Rangiwahia

Flow Data: Gauging sites including Makino at Boness Rd, Makino at Rata St, Makino at Reids Line, Kiwitea at Cheltenham Gun Club, Kiwitea at Haynes Line, Kiwitea at Spur Rd Extension, Mangaone at Milson Line, Oroua at Almadale, and Oroua at Kawa Wool

GIS Data: Land use information, surveyed cross sections, design drawings, Infoworks model of Feilding stormwater network

Watercourses / Stream

Makino Stream: Main stream passing through Feilding

Kiwitea Stream: Included in the MIKE 21 grid

Oroua River: Included in the MIKE 21 grid

Various Channels: Named Channel A to Channel M, passing through Feilding

Hydrological method used

The hydrological assessment uses a rainfall runoff routing model developed using Hydstra Modelling software. Rainfall losses are accounted for using an initial loss proportional runoff (IL PR) model. The model is calibrated to historical flood events and design rainfall inputs to produce design inflow hydrographs.

When was hydrology calculated for

Rainfall Data: Various years (1960-2011)

Flow Data: Various years (1948-2011)

Range of events/scenarios modelled?

Design flood events: 1 in 100 AEP and 1 in 200 AEP for existing condition of Reids Line Stopbank and with the stopbank lowered by 500 mm

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The hydrological model is calibrated in two stages: channel lag parameters and rainfall loss parameters. Seven historical flood events are used for calibration. The hydraulic model was not calibrated due to the lack of recorded flood data.

Downstream boundary

The downstream boundary of the Makino Stream is at the confluence with the Oroua River, which is modelled in MIKE 21.

Model Description

The model comprises MIKE 11 for river channels, MIKE URBAN for stormwater drainage, and MIKE 21 for overland flow. The models are dynamically linked using MIKE FLOOD to simulate flood behaviour and interactions between channels, stormwater drainage, and floodplain.

Model Resolution

10m grid model: Rural and semi-rural areas (model area A and C)

5m grid model: Urban area of Feilding (model area B)

Model Software/Version

MIKE 11: 1D component

MIKE URBAN: 1D component for stormwater drainage

MIKE 21: 2D component

MIKE FLOOD: Coupling software

Modelled assets?

Bridges: 17 bridges over Makino Stream and various channels

Culverts: 20+ culverts over various channels

Weirs: 40+ weir structures included in the MIKE 11 model

Diversion Structure: At Reids Line Stopbank to divert flow from Makino Stream to Kiwitea Stream

Stormwater / Surface Water network inclusion

The stormwater network includes stormwater sumps, manholes, pipes, and outlets. The network is modelled using MIKE URBAN based on the Infoworks model provided by HRC.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood depths, levels, flow speeds, and hazards for different AEP events. MIKE 21 result files are converted to WaterRide files for viewing flood levels, depth, inundation, and hazard.

Assumptions

For this study the soffit level of the bridges were assumed 0.5 m below the surveyed top of the banks.

It has been assumed that the difference between the flow provided by HRC and the modelled flow for each design flood event is the increase in channel capacity due to bed scour. Thus, the flow equivalent to increase in channel capacity due to bed scouring (ie, 29 m³/s for the 100 AEP design event and 33 m³/s for the 200 AEP design event) is taken out from the model at Reids Line Spillway gate to compensate for bed scouring. This assumption was agreed by HRC.

All sumps were assumed to have the same inlet capacity based on flow entering through the lintel at the rear of the sump (ie zero capacity due to full blockage assumed for flow through sump grill due to flat terrain in the township of Feilding). The inlet capacity of the sumps used for Pahiatua Township Flood Study (Entura, 2010) has been used for this study. The inlet capacity was estimated by assuming weir flow (weir coefficient of 1.6) through the lintel with 100% blockage of the grill. Zero blockage of the lintel was assumed.

All pipes were assumed to be reinforced concrete

Limitations

Lack of recorded flood data for calibration

Assumptions made for bed scouring and inlet capacity of stormwater sumps

Recommendations

Further refinement of the stormwater drainage network, investigation of high observed water levels, review of cross sections, and improved field survey data to confirm LiDAR accuracy.

Potential Updates

Further refinement of the stormwater drainage network,

Use refined roughness values other than 5 categories used

Investigation of high observed water levels

Review of cross sections

Improved field survey data to confirm LiDAR accuracy

Update to NZVD2016

Recommended Level

Level C

File Name

Palmerston_North_rp301015-03179cjd130125-Project Report

Report Name

Palmerston North City Flood Mapping Composite Map Creation

Region

Lower Manawatu

Location

Palmerston North City, New Zealand

Date Report Published

31 January 2013

Publication Status

Final Report

Purpose + Overview of model / report

The report aims to create a seamless, composite layer representing the current 200-year design flood for Palmerston North City from HRC from raw flood modelling outputs or WaterRide outputs, to provide a single source of flooding information for planning purposes.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: 2.0m gridded DEM derived from LiDAR flown in 2005, provided by Horizons Regional Council (HRC)

Flood Modelling Outputs: Raw flood modelling outputs or processed waterRIDE™ surfaces across various catchments for the present-day 200-year design flood (or equivalent)

Watercourses / Stream

N/A

Hydrological method used

N/A

When was hydrology calculated for

N/A

Range of events/scenarios modelled?

N/A

Climate Change Considered?

The report includes a 100-year ARI design flood incorporating climate change, used in lieu of a formal 200-year ARI design flood run.

Calibration / Validation

N/A

Downstream boundary

N/A

Model Description

N/A, composite mapping exercise to pull together previous modelling outputs into singular dataset. Involves converting raw model outputs to waterRIDE™ format, stretching water surfaces, converting gridded models to a TIN framework, managing overlapping areas, and mapping to the finer scale DEM.

Model Resolution

DEM Resolution: 2.0m gridded DEM

Model Software/Version

waterRIDE™ FLOOD Manager: For converting raw model outputs to waterRIDE™ format

TIN Framework: For creating a continuous water surface

Modelled assets?**Stormwater / Surface Water network inclusion****Level of Service for Assets Mentioned? - Standard of protection****Overview of Model Outputs and Mapping Available**

The model outputs include a composite flood surface, water level maps, water depth maps, indicative flooded areas, and relative accuracy zones. These outputs are provided in electronic deliverables such as .wrr, .asc, and .shp files.

Assumptions

Relies on outputs from modelling undertaken for HRC and PNCDD

Limitations

Model Quality: The quality of the composite surface is a function of the quality of the underlying modelling and the DEM.

Indicative Flooded Areas: The indicative flooded areas layer was digitized using 1:50,000 scale topographic mapping and was not reviewed for sensibility.

Recommendations

N/A

Potential Updates

N/A

Recommended Level

Level A

File Name

Herbertville - Risk Assessment Report Sept 2012

Report Name

Herbertville - Flood Risk Assessment

Region

East Coast

Location

Herbertville, New Zealand

Date Report Published

1 September 2012

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses the potential sources and extent of flooding in Herbertville. The objective is to produce flood maps to inform planning decisions and recommend actions to protect people and property from future flood events.

Data overview - what data has been used (survey, lidar, date)

Photographic Evidence: Provided by local residents

Survey Data: Cross-sectional information from a survey conducted in June 2012

LiDAR Data: Used to extend river cross sections

Watercourses / Stream

Wainui River: Main source of flooding

Golf Course Creek: Potential route for surface water flooding

Township Drain: Potential route for surface water flooding

Hydrological method used

The hydrological assessment uses parametric methods (Technical Memorandum 61, Rational Method, Regional Method) based on catchment parameters, rainfall intensities, and flood frequency data from nearby catchments. Rainfall intensities are based on NIWA software HIRDS Version 3.

When was hydrology calculated for

Flood Flow Records: No flood flow records available for the Wainui River catchment

Rainfall Data: Based on NIWA software HIRDS Version 3

Range of events/scenarios modelled?

20-year flood flow in the Wainui River and 20-year surface water flow in creek and drain

50-year flood flow in the Wainui River and 20-year surface water flow in creek and drain

100-year flood flow in the Wainui River and 20-year surface water flow in cre

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model was calibrated using a known flood level in the campsite associated with a 1 in 20 year event. Manning's n values were adjusted to match the flood level.

Downstream boundary

A downstream river level of 1.3m representing a high sea level with a storm surge was used.

Model Description

The model uses HEC-RAS software to perform an unsteady analysis of river flows. Cross-sectional information from the survey and LiDAR data were used to build the model. Structures such as road bridges and culverts were included to accurately represent flows around Herbertville.

Model Resolution

The report does not specify the resolution of the model.

Model Software/Version

HEC-RAS: For unsteady analysis of river flows

Modelled assets?

Road Bridge: Over the Wainui River, modelled as a flat decked bridge with two piers

Culverts: 600mm culverts on the golf course creek and township drain, modeled using HEC-RAS

Stormwater / Surface Water network inclusion

The stormwater network includes the Wainui River, golf course creek, and township drain. Structures such as road bridges and culverts were included to represent flow paths.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood maps for various scenarios, showing areas likely to be inundated during flood events. The maps are based on the best available information and can be used to inform planning decisions.

Assumptions

Flood Flow Records: No flood flow records available for the Wainui River catchment

Debris Loading: An allowance was made for debris loading on the piers of the road bridge

Surface Water Flows: Flows at the upstream end of the golf course creek and township drain were staged to coincide with peak river flows

Limitations

Flood Maps: Two parts of the flood outline should be ignored: deep water at the end of the golf course creek and water flowing along the road (contained within the roadside drain)

Recommendations

Flood Action Plan: Devise a Flood Action Plan for Herbertville to protect people and property from future flood events

Record Flood Levels: Continue to record flood levels in future events to improve the knowledge base around flooding from the Wainui River

Potential Updates

Undertake hydrology assessment with hydrometric data if available

Consider Climate Change

Consider suitability of 1D modelling for catchment mapping

Recommended Level

Level B

File Name

50211-Piriaka-Flood Plain Mapping-01

Report Name

Piriaka Flood Plain Mapping

Region

Whanganui

Location

Piriaka, Taumarunui, New Zealand

Date Report Published

1 April 2011

Publication Status

Final Report

Purpose + Overview of model / report

The report was commissioned by Horizons Regional Council (HRC) and prepared by DHI Water & Environment. It aims to provide flood level mapping for about 2km of the Whanganui River valley at Piriaka, upstream of Taumarunui. The main goal is to assess possible flooding of the power station and the settlement of Piriaka. This study complements an earlier DHI report on flood level mapping of Taumarunui and its environs.

Data overview - what data has been used (survey, lidar, date)

Land Level Data: LiDAR survey obtained by HRC in early 2009, with a vertical accuracy of 0.15m.

Hydrological Data: Flow data from gauging sites Whanganui @ Piriaka (1970 – present) and Whanganui @ Matapuna (1964-1973).

River Data: Surveyed cross-sections, including the weir diverting water into the power station intake channel.

Vertical Datum: Not explicitly mentioned.

Watercourses / Stream

Whanganui River: Modelled from immediately upstream of Piriaka settlement to downstream of Piriaka Power Station.

Hydrological method used

Design Flood Hydrographs: Derived from flow data at Whanganui @ Piriaka and Whanganui @ Matapuna for events of 2%, 1%, and 0.5% AEP.

Downstream Boundary: Water level hydrograph obtained from the Taumarunui model results.

When was hydrology calculated for

Flow Record Extension: Up to 2009.

Hydrologic Model Development: Based on historical data up to 2009.

Range of events/scenarios modelled?

Design Flood Events: Whanganui River floods of 2%, 1%, and 0.5% AEP.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Calibration: No specific calibration data available for this part of the Whanganui River. Manning's n value of 0.05 used, based on calibration of the adjacent reaches in the Taumarunui model.

Downstream boundary

Water Level Hydrograph: Obtained from the Taumarunui model results.

Model Description

MIKE FLOOD Software: Combines MIKE 11 1D and MIKE 21 2D software packages.

River Network: Modelled using MIKE 11.

Overland Flow: Modelled using MIKE 21 Flexible Mesh.

1D – 2D Coupling: Dynamically linked using MIKE FLOOD software.

Model Resolution

MIKE 21 Model: Flexible mesh with triangular elements of varying sizes.

Model Software/Version

MIKE FLOOD: Version 2009.

Modelled assets?

Cross Sections: Approximately 6 cross-sections, including surveyed and interpolated sections.

Rock Bunds: Assumed levels for bunds across minor channels.

Power Station Intake Channel: Included with zero flow at its end.

Stormwater / Surface Water network inclusion

The report does not provide specific details on stormwater pipes or surface water network.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood Extent Maps: Provided for 2%, 1%, and 0.5% AEP events.

Peak Water Levels: Maps from the MIKE 21 overland flow model.

Flow Hydrographs: For water spilling overland adjacent to the intake channel and power station.

Assumptions

Bund Levels: Assumed levels for bunds across minor channels.

Zero Flow: Assumed for the power station intake channel during peak flood.

Limitations

Bund Levels: Definitive modelling of flood levels must await surveying of the bund levels.

Calibration Data: No specific calibration data available for this part of the Whanganui River.

Recommendations

Bund Levels Survey: Reconsider model results once the true crest levels of the rock bunds are known.

Potential Updates

Refine model representation with new survey of bunds

Convert to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

Ohakune_300492-Report-01 Final

Report Name

Ohakune Township Flood modelling Study Report

Region

Whangaehu

Location

Ohakune Township, New Zealand

Date Report Published

22 July 2010

Publication Status

Final Report

Purpose + Overview of model / report

The report documents a flood study for the township of Ohakune and the surrounding rural and semi-rural areas, focusing on stormwater flooding and coincident flooding from the Mangawhero River and its tributaries. The project involved developing hydrologic and hydraulic models to estimate flooding for the 1 in 50 AEP, 1 in 100 AEP, and 1 in 200 AEP design events.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Streamflow records from Mangawhero at Hagleys, Pakihi Rd Bridge, and Makotuku at SH49A.

Rainfall Data: Design rainfalls derived using HIRDS software at various locations.

LiDAR Data: Used to create digital elevation models (DEM) for the floodplain surface.

Survey Data: Cross-sections of the Mangawhero River and its tributaries.

Watercourses / Stream

Mangawhero River: Main river passing through Ohakune.

Tributaries: Six tributaries of the Mangawhero River.

Other Streams: Four additional streams flowing through the township.

Hydrological method used

Flow Flood Frequency Curve: Derived for Mangawhero at Hagleys. Rainfall Runoff Routing Model: Built using Hydstra Modelling software. Design Rainfall Losses: Calibrated using historical flood events. Design Flow Hydrographs: Produced for various rainfall durations.

For the rivers and streams that run alongside and through the Ohakune township – rainfall runoff model with design rainfall inputs.

For the stormwater drain catchments in the urban areas – direct rainfall was prepared for input to the MIKE FLOOD Urban hydrologic model.

When was hydrology calculated for

The flow records used were from the period 1968-2009.

Range of events/scenarios modelled?

Calibration Events: Nine historical flood events.

Design Events: 1 in 50, 1 in 100, and 1 in 200 AEP flood events for various storm durations.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Event Calibration: Nine events selected, including measured rainfall inputs and baseflow separation.

Losses Calibration: Using design rainfall inputs to confirm rainfall loss parameters.

Downstream boundary

MIKE 11 Model Boundary: Approximately 1 km downstream of the confluence of the Mongateite River and the Mangawhero River.

Q/H Rating: Based on average river slope and Manning's n value.

Model Description

MIKE FLOOD Urban Model: Combines MIKE 11 1D, MIKE URBAN 1D, and MIKE 21 2D software packages.

Hydraulic Structures: Bridges, culverts, and weirs included based on site visits and LiDAR survey.

Model Resolution

5m grid for the detailed MIKE URBAN model, 10m grids for the coarser MIKE 21 models.

Model Software/Version

MIKE FLOOD Urban: Version 2009.

MIKE 11: 1D component.

MIKE URBAN: 1D component.

MIKE 21: 2D component.

Modelled assets?

Bridges: Approximately 4 bridges.

Culverts: Approximately 40 culverts.

Weirs: Approximately 2 weirs.

Stormwater Network: Includes sumps, manholes, pipes, and outlets.

Stormwater / Surface Water network inclusion

Stormwater Sumps: Typical sump dimensions and inlet capacity.

Pipes: Assumed to be reinforced concrete with varying diameters.

Outfalls: Coupled with MIKE 11 model at corresponding locations.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

Flood Extents: Provided for 1 in 100 AEP 6-hour storm event.

Peak Discharges and Water Levels: Viewable using MIKE VIEW/ZERO software packages.

Assumptions

Concurrent Flooding: Assumed river is in a low flow state during design rainfall bursts.

Blockage Factor: 50% blockage factor applied to all sumps.

Limitations

Stormwater Network Data: Mismatch between ESRI and spreadsheet data.

Model Calibration: Limited by the availability of recorded flood data.

DEM: Combined from different projections, may have small errors.

Culvert Data: Some culverts were added based on desktop assessment, survey data recommended for accuracy.

Buildings: Removed from LiDAR, potential depth of flooding inferred from ground elevation.

Recommendations

Stormwater Network Review: Recommended detailed survey by local Council to firm up actual stormwater drainage on site.

Potential Updates

Undertake survey of critical structures,

Update to NZVD2016

Consider climate change

Recommended Level

Level B

File Name

Pahiatua_300324-Report-01 Final

Report Name

Pahiatua Township Flood Study Report

Region

Upper Manawatu

Location

Pahiatua Township, New Zealand

Date Report Published

1 October 2010

Publication Status

Final Report

Purpose + Overview of model / report

The report documents a flood study for Pahiatua and the surrounding rural and semi-rural areas, focusing on urban stormwater runoff and coincident flooding from the Mangatainoka River. The project involved developing hydrologic and hydraulic models to estimate flooding for the 1 in 100 AEP and 1 in 200 AEP design events.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Historical flood events at Mangatainoka River at Pahiatua.

Rainfall Data: Design rainfalls derived from HIRDS and rainfall records at Tiraumea at Ohehua Repeater.

LIDAR Data: Used to create digital elevation models (DEM) for the floodplain surface.

Survey Data: Cross-sections of the Mangatainoka River and streams through Pahiatua.

Watercourses / Stream

Mangatainoka River: Main river adjacent to Pahiatua.

Streams and Drainage Channels: Various streams and drainage channels passing through Pahiatua.

Hydrological method used

Design hydrographs and rainfall inputs were produced for the MIKE FLOOD Urban model. The impact of the Mangatainoka River was initially investigated and found to have negligible impact on the drainage network through Pahiatua. A rainfall runoff routing model was developed and calibrated to historical flood events.

Inflows: Derived from measured flow records and scaled to match design flood events.

Hydrographs: Based on the October 2000 historical flood event and scaled for design flood events.

Boundaries: Downstream boundary at the Mangatainoka Suspension Bridge river gauge site using Q/H rating.

When was hydrology calculated for**Range of events/scenarios modelled?**

Calibration Events: February 2004, October 2000, and January 2005 flood events.

Design Events: 1 in 100 AEP and 1 in 200 AEP flood events for various storm durations.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The hydraulic model was not calibrated due to the lack of recorded flood levels or photographs showing flood extents.

However, the hydrological model was calibrated using historical flood events.

Downstream boundary

The downstream boundary was set at the Mangatainoka Suspension Bridge river gauge site using the Q/H rating provided by HRC

Model Description

The model used MIKE FLOOD Urban software, combining MIKE 11 for river channels, MIKE URBAN for stormwater drainage, and MIKE 21 for overland flow. The model was developed by coupling river channels to overland flow and stormwater drainage to both river channels and overland flow.

Model Resolution

2.5m grid size for the MIKE 21 model.

Model Software/Version

MIKE FLOOD Urban: Version 2009.

MIKE 11: 1D component.

MIKE URBAN: 1D component.

MIKE 21: 2D component.

Modelled assets?

Bridge Structures: 12 bridges included in the MIKE 11 model.

Culvert Structures: 28 culverts included in the MIKE 11 model.

Weir Structures: 41 weirs included in the MIKE 11 model.

Stormwater Drainage: Includes stormwater sumps, manholes, pipes, and outlets

Stormwater / Surface Water network inclusion

The stormwater drainage network was modeled using MIKE URBAN based on GIS and spreadsheet data provided by HRC.

The network includes stormwater sumps, manholes, pipes, and outlets.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include flood extent inundation and flood depth maps for the 1 in 100 AEP and 1 in 200 AEP flood events. These maps were provided to HRC electronically in ARC GIS format. The MIKE URBAN files can be viewed using the MIKE VIEW software package.

Assumptions

Roughness Values: Based on land use information provided by HRC and adopted during model calibration.

DEM Resampling: Relevant features such as levees, roads, and creek inverts were prioritized in the resampled DEM.

Limitations

Data Limitations: The hydraulic model was not calibrated due to the lack of recorded flood levels or photographs showing flood extents.

Model Limitations: The total event hydrograph rises and falls within 24 hours, which may not match the duration of actual flood events.

Recommendations

Review the adopted stormwater drainage network with detailed survey to firm up the actual stormwater drainage on site.

Consider the limitations of the model when interpreting flood inundations.

Potential Updates

Test different other rainfall profiles than TP108 in urban area.

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

E204350-Report-01 Final

Report Name

Pohangina River Flood and Hazard Mapping

Region

Lower Manawatu

Location

Pohangina River, from its confluence with the Manawatu River to approximately 40km upstream near Komako, New Zealand

Date Report Published

1 April 2010

Publication Status

Revision No: 1

Purpose + Overview of model / report

The report assesses flood hazards for the Pohangina River by developing a two-dimensional hydraulic model. The scope includes developing a calibrated hydraulic model and using it to create flood inundation extents, flood depths, and flood hazards for the 1 in 100 AEP and 1 in 200 AEP design events.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Supplied by HRC at Pohangina River at Mais Reach

LiDAR Data: High-resolution data provided by HRC

River Channel Cross-Sections: Survey data from 2000, 2002, and 2008

Watercourses / Stream

Pohangina River: Main river channel

Manawatu River: Extended to Manawatu Gorge gauge site for better estimation of travel time

Hydrological method used

Inflow hydrographs are derived by scaling the measured Mais Reach hydrograph based on catchment areas and average catchment rainfall. Timing differences are accounted for by applying direct time offsets to the input data.

When was hydrology calculated for

Flow Records: Various years (2000-2008)

Range of events/scenarios modelled?

Calibration event: February 2004 flood

Design flood events: 1 in 100 AEP and 1 in 200 AEP, intermediate runs between 300m³/s and 1 in 100 AEP

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model is calibrated using the February 2004 flood event by comparing modelled and measured discharges at Mais Reach and modelled flood extents against observed flood extents using flood extent maps and photographs provided by HRC

Downstream boundary

The downstream boundary is located on the Manawatu River just downstream of the confluence of the Pohangina River. A discharge vs depth (Q/H) rating is developed for this site using the existing MIKE 11 model of the Manawatu River

Model Description

The model comprises MIKE FLOOD, combining MIKE 11 for river channels and MIKE 21 for out-of-channel flooding. The model uses high-resolution LiDAR data to create digital elevation models (DEM) and enforce features such as levees, roads, and creek inverts. Roughness values are based on land use information provided by HRC.

Model Resolution

Grid Size: 12.5m for the MIKE 21 model

Model Software/Version

MIKE FLOOD: Version 2008

Modelled assets?

Bridges: Totara Reserve Bridge, Raumai Bridge, Saddle Road Bridge, Railway Bridge

Hydraulic Structures: Bridge openings and weirs representing flow at bridges

Stormwater / Surface Water network inclusion

The stormwater network includes various inflow locations and hydraulic structures affecting flow through the area of interest.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood extent maps, flood hazard maps, and flood hazard animations for the 1 in 100 AEP and 1 in 200 AEP flood events. These maps are provided electronically in ARC GIS format.

Assumptions

HRC provided photographs of flooding that occurred during the February 2004 event. It is assumed that these photos show the peak of the flood.

Limitations

Survey Data: Misalignment between ground survey and LiDAR data due to river channel migration over time

Downstream Boundary: Q/H rating is approximate and not based on gauged data

Recommendations

Not explicitly stated

Potential Updates

Use recent LiDAR data

Refinement of channels with cross-sections and surveys

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

50211-Taumarunui_Flood_Mapping-01

Report Name

Taumarunui Flood Mapping

Region

Whanganui

Location

Taumarunui, New Zealand

Date Report Published

1 August 2010

Publication Status

Final Report

Purpose + Overview of model / report

The report aims to assess flood risks in the Taumarunui township and surrounding areas. It provides detailed floodplain mapping and hydraulic modeling to inform land use planning, infrastructure development, and flood risk management. The study includes both riverine flooding from the Whanganui and Ongarue Rivers and local stormwater flooding.

Data overview - what data has been used (survey, lidar, date)

Land Level Data: LiDAR survey obtained by HRC in early 2009, with a vertical accuracy of 0.15m.

Hydrological Data: Flow data from gauging sites Whanganui @ Piriaka (1970 – present), Whanganui @ Matapuna (1964-1973), and Ongarue @ Taringamotu (since 1963).

River Data: Surveyed cross-sections, including the weir diverting water into the power station intake channel.

Vertical Datum: Moturiki datum.

Watercourses / Stream

Whanganui River: Modeled from Te Maire gauge to downstream of Taumarunui.

Ongarue River: Modeled from Taringamotu gauge to the confluence with the Whanganui River.

Local Streams: Includes Punga Stream and other smaller tributaries.

Hydrological method used

Inflow Data: Derived from NIWA gauging stations.

Hydrographs: Generated for design events using historical data and rainfall-runoff models.

Boundaries: Upstream boundaries at Te Maire and Taringamotu gauges; downstream boundaries at the confluence of the Whanganui and Ongarue Rivers.

When was hydrology calculated for

Flow Record Extension: Up to 2009.

Range of events/scenarios modelled?

Design Events: 2%, 1%, and 0.5% Annual Exceedance Probability (AEP) flood events.

Local Rainfall Events: Modeled using HIRDS data.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Calibration: Based on historical flood events, particularly the 1998 and 2000 floods.

Validation: Comparison of model outputs with observed flood extents and water levels.

Downstream boundary

Location: Confluence of the Whanganui and Ongarue Rivers.

Model Description

Model Software: MIKE FLOOD, including MIKE 11 (1D) and MIKE 21 (2D) components.

Key Features: Dynamic coupling of river and floodplain models, detailed representation of hydraulic structures, and flexible mesh for overland flow.

Model Resolution

Cell Size: Variable, with finer resolution in urban areas and coarser in rural areas.

Model Extent: Covers the Taumarunui township and surrounding floodplains.

Model Software/Version

MIKE FLOOD

Modelled assets?

Detailed Description and Numbered Count of Any Structures and Assets Modelled

Culverts

Bridges: Several, including the SH4 bridge

Flapgates

Stormwater Network: Includes pipes, manholes, and open drains

Other Structures: Stopbanks and floodgates

Stormwater / Surface Water network inclusion

Stormwater Pipes: Detailed in GIS data, includes invert levels and diameters.

Streams: Modeled in MIKE 11 and MIKE 21.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood Maps: Depth, velocity, hazard, and extent maps for 2%, 1%, and 0.5% AEP events.

Animations: Available for visualizing flood progression.

Assumptions

Hydraulic Roughness: Assumed based on land use and vegetation.

Inflow Data: Assumed from historical records and synthetic hydrographs.

Limitations

Model Accuracy: Dependent on the quality of input data and assumptions.

Climate Change: Not explicitly considered.

Recommendations

Flood Mitigation: Improve stormwater infrastructure and maintain existing flood defenses.

Land Use Planning: Use flood maps to guide development and zoning decisions.

Further Studies: Conduct detailed studies for specific areas with high flood risk.

Potential Updates

Refine model representation with new surveys

Convert to NZVD2016

Consider climate change

Recommended Level

Level D

File Name

Whanagehu_Turakina-Report-01 FINAL_rev 1

Report Name

Whangaehu and Turakina Rivers Flood and Hazard Mapping

Region

Whangaehu

Location

Whangaehu and Turakina Rivers, New Zealand

Date Report Published

11 May 2010

Publication Status

Final, Revision No: 1.1

Purpose + Overview of model / report

The report was commissioned by Horizons Regional Council (HRC) and prepared by Hydro Tasmania Consulting (HTC). The main aim is to develop a two-dimensional hydraulic model incorporating both the Whangaehu River and Turakina River to estimate flood inundation extents, flood depths, and flood hazards for the 1 in 100 AEP and 1 in 200 AEP design events. The model was later separated into individual models for each river to run intermediate floods and provide result files for real-time flood extent estimates.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Whangaehu River at Kuangaroo, Whangaehu River at Aranui, Mangawhero River at Ore Ore, Turakina River at Oneills Bridge.

LiDAR Data: Provided by HRC for cross-sectional information and floodplain DEM.

Survey Data: Detailed survey carried out in January 2009.

Vertical Datum: Wellington Vertical Datum.

Watercourses / Stream

Whangaehu River: Extends approximately 65 km upstream from the ocean.

Turakina River: Extends approximately 30 km upstream from the ocean.

Hydrological method used

Inflow Hydrographs: Derived from measured flow records and adjusted for timing differences using hydrological routing equations and direct time offsets.

Calibration Event: July 2006 flood event used for model calibration.

When was hydrology calculated for

Flow Record Extension: Up to July 2006.

Range of events/scenarios modelled?

Design Flood Events: 1 in 100 AEP and 1 in 200 AEP.

Intermediate Flood Runs: Series of floods between breakout flow and 1 in 100 AEP peak discharge.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Model Calibration: Compared modelled and measured discharges at Kauangaroo and O'Neils Bridge, and modelled flood extents against observed flood extents using surveyed flood levels and photographs.

Downstream boundary

Ocean Boundary: Dynamic tidal boundary for calibration event; constant tide levels for design and intermediate events.

Model Description

MIKE FLOOD Software: Combines MIKE 11 1D and MIKE 21 2D software packages.

River Cross Sections: Provided by HRC and extended using LiDAR data.

Floodplain DEM: 20m grid size using LiDAR data.

Hydraulic Structures: Approximately 5 bridges in Whangaehu River and 1 bridge in Turakina River.

Model Resolution

MIKE 21 Model: 20m grid size.

Model Software/Version

MIKE FLOOD: Version 2008.

Modelled assets?

Bridges: Approximately 5 bridges in Whangaehu River and 1 bridge in Turakina River.

Link Structures: Approximately 357 lateral links (106 in Turakina River and 251 in Whangaehu River).

Stormwater / Surface Water network inclusion

The report does not provide specific details on stormwater pipes or surface water network.

Level of Service for Assets Mentioned? - Standard of protection

The report does not specify the standard of service for assets.

Overview of Model Outputs and Mapping Available

Flood Extent Maps: Provided for 1 in 100 AEP and 1 in 200 AEP design flood events.

Flood Hazard Maps: Generated based on CSIRO Flood Hazard Guideline.

Flood Hazard Animation: Developed for 1 in 100 and 1 in 200 AEP flood events.

Assumptions

Synthetic Tide Data: Used for calibration event, adjusted for storm surge.

Hydrological Routing: Used for timing differences and flow attenuation.

Limitations

Model Calibration: Limited by the availability of recorded tide data for the July 2006 event.

Cross Section Data: Some invert levels estimated due to presence of water during LiDAR survey.

Recommendations

No specific recommendations mentioned in this report.

Potential Updates

Further model calibration

Convert to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

204059-Report-01 Final Rev 0 Combined

Report Name

Manawatu Gorge Flood Plain Mapping and website development

Region

Upper Manawatu

Location

Manawatu Gorge, New Zealand

Date Report Published

6 March 2009

Publication Status

Final Report (Rev 0)

Purpose + Overview of model / report

The report documents the development of a two-dimensional hydraulic model of the Manawatu and Mangahao Rivers upstream of the Manawatu Gorge. The project involved creating high-resolution flood inundation maps based on 2D hydraulic modelling, integrated with a flood forecasting system and displayed in real-time during flood events.'

Data overview - what data has been used (survey, lidar, date)

Flow Records: Measured flow records from HRC at various sites (Manawatu River at Hopelands, Tiraumea River at Alfredton, Mangatainoka River at Pahiatua, Mangahao River at Ballance).

LiDAR Data: Used to create a digital elevation model (DEM) with a 20m grid size.

Survey Data: MIKE 11 cross-sections provided by HRC.

Watercourses / Stream

Manawatu River: From the Gorge gauge site upstream to the Ngawapurua Bridge.

Mangahao River: From its confluence with the Upper Manawatu River upstream to the Mangahao at Balance gauge site.

Hydrological method used

Inflow hydrographs were derived based on measured flow records and factored to account for unaccounted catchment areas. The hydraulic modelling was carried out using MIKE FLOOD software, combining MIKE 11 (1D) and MIKE 21 (2D) components.

Inflows: Derived from measured flow records and factored for unaccounted catchment areas.

Hydrographs: Produced for three input locations in the hydraulic model.

Boundaries: Downstream boundary at the Manawatu at Upper Gorge gauge site using Q/H rating.

When was hydrology calculated for**Range of events/scenarios modelled?**

Calibration Events: July 1992, October 2000, and February 2004 flood events.

Design Events: 1 in 100 AEP and 1 in 200 AEP flood discharges.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The hydraulic model was calibrated by comparing modelled and measured discharges at the Manawatu at Upper Gorge gauge and modelled flood extents against observed flood extents using surveyed flood levels and flood photographs.

Downstream boundary

The downstream boundary was set at the Manawatu at Upper Gorge gauge site using the Q/H rating provided by HRC.

Model Description

The model used MIKE FLOOD software, combining MIKE 11 for significant river channels and MIKE 21 for out-of-channel flooding. A 20m grid size was used for the MIKE 21 model, and relevant features were prioritized in the DEM.

Model Resolution

20m grid size for the MIKE 21 model.

Model Software/Version

MIKE FLOOD: Version 2008.

MIKE 11: 1D component.

MIKE 21: 2D component.

Modelled assets?

Link Structures: 41 lateral links for flow transfer between MIKE 11 cross-sections and MIKE 21 grid.

Hydraulic Structures: Cross-sections provided by HRC and LiDAR survey.

Stormwater / Surface Water network inclusion

The report does not provide specific details on the stormwater network but includes significant river channels and out-of-channel flooding.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include flood extent inundation and flood depth maps for the 1 in 100 AEP and 1 in 200 AEP flood discharges. These maps were provided to HRC electronically in ARC GIS format.

Assumptions

Roughness Values: Based on land use information provided by HRC and adopted during model calibration.

DEM Resampling: Relevant features such as levees, roads, and creek invert were prioritized in the resampled DEM.

Limitations

Data Limitations: The flood extents shown for the Mangahao River upstream of Balance do not represent the 1 in 100 AEP and 1 in 200 AEP extents for this section of the river.

Model Limitations: Further modelling is recommended for the Mangahao River upstream of Balance.

Recommendations

Further modelling is recommended if 1 in 100 and 1 in 200 AEP flood extents are required for the Mangahao River upstream of Balance.

Potential Updates

Use recent LiDAR and survey,

Use more Manning's roughness categories

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

Breach Models including Whakorongo-Aokautere

Report Name

MANAWATU AND RANGITIKEI RIVERS
FLOOD HAZARD ASSESSMENT - HYDRAULIC MODELLING AND MAPPING
REPORT

Region

Lower Manawatu

Location

Manawatu and Rangitikei Rivers, New Zealand

Date Report Published

1 January 2008

Publication Status

Revision 0

Purpose + Overview of model / report

The report assesses flood hazards due to stop bank breaches on the Manawatu and Rangitikei Rivers. The scope includes hydraulic modelling of seven stop bank breach scenarios and production of electronic flood map data for Horizons Regional Council (HRC). The parameters provided include peak water levels, peak water depths, peak velocities, and flood hazard.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: High-resolution data provided by HRC

Hydrographs: Provided by HRC for breach locations

Land Use Data: Provided by HRC

Watercourses / Stream

Manawatu River: Main river channel

Rangitikei River: Main river channel

Stoney Creek and Aokautere Stream: Added to the MIKE 11 model for floodplain flows

Hydrological method used

The hydrological assessment uses breach hydrographs provided by HRC for flood events. The model includes upstream boundaries at breach locations and downstream boundary conditions with constant water levels or flow-depth relationships

When was hydrology calculated for

Breach Hydrographs in Appendix B

Range of events/scenarios modelled?

Seven stop bank breach scenarios: Four on the Manawatu River and three on the Rangitikei River

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The report does not mention specific calibration or validation details.

Downstream boundary

Downstream boundary conditions for the MIKE 21 models are constant water levels at the lowest point of the model. For Model 1 and 2, a flow-depth relationship is provided by HRC.

Model Description

The model comprises MIKE 21 for floodplains and MIKEFLOOD for areas with significant hydraulic structures. The model uses high-resolution LiDAR data to create digital elevation models (DEM) and enforce features such as stop banks, creeks, and roads. Roughness values are based on land use information provided by HRC.

Model Resolution

Grid Size: 10m for rural areas, 7.5m for urban areas (Model 1 & 2)

Model Software/Version

MIKE 21: Version 2005b

MIKEFLOOD: Version 2005b

Modelled assets?

Stop Banks: Breach locations provided by HRC

Hydraulic Structures: Bridges, culverts, and flap gates included in the model

Stormwater / Surface Water network inclusion

The stormwater network includes various drainage paths and hydraulic structures affecting flow through the area of interest.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include peak flood depth, peak water surface, peak flow velocity, and hazard maps for the stop bank breach scenarios. These maps are provided electronically in ARC GIS format.

Assumptions

Not explicitly stated

Limitations

Hypothetical Scenarios: The flood extents, depths, velocities, and hazards are based on hypothetical scenarios and not actual or historical flood events.

Catchment Conditions: Results are specific to the provided levee breach data, current land use data, and catchment conditions at the time the LiDAR was acquired (2006).

Recommendations

Electronic Maps: Disclaimer notes for electronic maps provided to HRC, indicating the hypothetical nature of the scenarios and the need for detailed interpretation and hydraulic analysis for specific sites.

Potential Updates

Confirm future breach locations with HRC if more are needed, review of hydrology if further breach modelling is required.

Use recent LiDAR data

Refinement of channels with cross-sections and surveys

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

Mangatainoka_Makakahi_Final_report

Report Name

Mangatainoka and Makakahi Flood Plain Mapping and website development

Region

Upper Manawatu

Location

Mangatainoka and Makakahi Rivers, New Zealand

Date Report Published

19 November 2008

Publication Status

Final Report

Purpose + Overview of model / report

The report documents the development of a two-dimensional hydraulic model of the Mangatainoka and Makakahi Rivers between Hamua and Mangatainoka. The project involved creating high-resolution flood inundation maps based on 2D hydraulic modelling, integrated with a flood forecasting system and displayed in real-time during flood events.

Data overview - what data has been used (survey, lidar, date)

Flow Records: Measured flow records at Mangatainoka River at Larsons and Makakahi River at Hamua.

LiDAR Data: Used to create a digital elevation model (DEM) with a 10m grid size.

Survey Data: MIKE 11 cross-sections provided by HRC and additional cross-sections obtained from LiDAR survey.

Watercourses / Stream

Mangatainoka River: From Hamua Rd to the Suspension Bridge gauging site near Mangatainoka.

Makakahi River: Included in the hydraulic model.

Hydrological method used

Inflow hydrographs were produced using measured flow records and scaled to match the required peak discharge for mapping and design flood events. A hydrological routing model was developed to accumulate all inflows and compare with the total flow at the Mangatainoka at Pahiatua site.

Inflows: Derived from measured flow records and scaled up to achieve comparable event peak and volume.

Hydrographs: Based on the October 2000 event and scaled for design flood events.

Boundaries: Downstream boundary at the suspension bridge gauging site on the Mangatainoka River using Q/H rating.

When was hydrology calculated for**Range of events/scenarios modelled?**

Calibration Events: October 2000 flood event.

Design Events: 1 in 100 AEP and 1 in 200 AEP flood hydrographs.

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The hydraulic model was calibrated by comparing modelled and measured discharges at Pahiatua Town Bridge and modelled flood extents against observed flood extents provided by HRC.

Downstream boundary

The downstream boundary was set at the suspension bridge gauging site on the Mangatainoka River using the Q/H rating provided by HRC.

Model Description

The model used MIKEFLOOD software, combining MIKE 11 for significant river channels and MIKE 21 for out-of-channel flooding. A 10m grid size was used for the MIKE 21 model, and relevant features were prioritized in the DEM.

Model Resolution

10m grid size for the MIKE 21 model.

Model Software/Version

MIKEFLOOD: Version 2008.

MIKE 11: 1D component.

MIKE 21: 2D component.

Modelled assets?

Bridge Structures: Eight bridges modelled using culvert and weir arrangement.

Groynes: Fifteen groynes modelled as 1m high weirs.

Link Structures: 89 links for flow transfer between MIKE 11 cross-sections and MIKE 21 grid.

Stormwater / Surface Water network inclusion

The report does not provide specific details on the stormwater network but includes significant river channels and out-of-channel flooding.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The outputs include flood extent inundation and flood depth maps for the 1 in 100 AEP and 1 in 200 AEP flood hydrographs. These maps were provided to HRC electronically in ARC GIS format.

Assumptions

Roughness Values: Based on land use information provided by HRC and adopted during model calibration.

DEM Resampling: Relevant features such as levees, roads, and creek inverts were prioritized in the resampled DEM.

Limitations

Data Limitations: The real-time flood forecasting model does not pick a set of model run results for each peak flow in the 48-hour forecast period.

Model Limitations: The total event hydrograph rises and falls within 24 hours, which may not match the duration of actual flood events.

Recommendations

Consider the limitations of the website when interpreting flood inundations.

Use the flood forecasting model to select the most appropriate set of model run results for display.

Potential Updates

Use recent LiDAR and survey,

Use more Manning's roughness categories

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

50084-Oroua River Flood Hazard Assessment Final Report-v01

Report Name

Oroua River Flood Hazard Assessment

Region

Lower Manawatu

Location

Oroua River between Fielding and confluence with Manawatu River

Date Report Published

1 April 2008

Publication Status

Final Report (Revision 00)

Purpose + Overview of model / report

The report assesses the flood risk due to high water levels in the Oroua River, between Fielding and the confluence with the Manawatu River, with concurrent flood events in the Mangaone Stream and Manawatu River. The study aims to provide a detailed hydraulic model to understand flood behaviour and inform flood management strategies. The model combines a two-dimensional floodplain model and a one-dimensional channel model to capture the complete physical flow characteristics in the study area.

Data overview - what data has been used (survey, lidar, date)

LIDAR Data: High accuracy land level data from airborne laser survey (ALS)

Rainfall Data: Hydrological modelling results from previous studies

Flow Data: Gauged flow data for Oroua River, Makino Stream, Manawatu River, and derived flows for Kiwitea Stream

GIS Data: Roads, railways, stopbanks, watercourses, soil types, land use, topographic maps, aerial photography

Vertical Datum: Wellington datum, with conversions from Moturiki datum (+76mm correction)

Watercourses / Stream

Oroua River: From Fielding to the Manawatu confluence

Manawatu River: From Teachers' College to Moutoa floodgates

Mangaone Stream: Largest watercourse in the Mangaone-Taonui catchment, draining an area of approximately 157 km²

Taonui Stream: Drains the re

Hydrological method used

The hydrological assessment uses results from previous studies, incorporating initial and continuing loss models with kinematic routing. Calibration parameters are derived from the Mangaone flow record, and historical flood events (1976, 1988, 2004) are used for calibration.

When was hydrology calculated for

Rainfall Data: Various years (1976, 1988, 2004)

Flow Data: April 1978 onwards

Range of events/scenarios modelled?

Historical flood events: February 2004

Design events: 100-year and 200-year annual recurrence intervals (ARIs)

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

Calibration is based on reproducing flood volumes for historical events using initial and continuing loss parameters.

Validation includes comparing model results with observed flood extents and spot levels from the 2004 event.

Downstream boundary

The main downstream boundary is the Manawatu River water level downstream of the Moutoa floodgates, provided by Horizons Regional Council for historical and design flood events.

Model Description

The model comprises separate 1D and 2D components dynamically linked via MIKE FLOOD. The 1D model includes major drainage channels, while the 2D model uses LIDAR data for topography. The models simulate flood behaviour and exchange flows between channels and floodplain.

Model Resolution

25m grid model: Covers the entire study area

Model Software/Version

MIKE 11, MIKE 21, MIKE FLOOD.

Modelled assets?

Culverts: 17 circular culverts connecting Sluggish Main Drain and its side drains, and two rectangular culverts representing the Sluggish Main Drain flood gates

Bridges: Various bridges included in the model

Floodgates: Sluggish Main Drain flood gates

Other Structures: Various spillways, flapgates, and drainage channels

Stormwater / Surface Water network inclusion

The stormwater network includes various drainage channels such as the Taonui Stream, Main Drain, Burkes Drain, Whiskey Creek, Makino Stream, and Sluggish Main Drain. These channels are modeled to capture the flow characteristics and interactions with the

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood depths, levels, speeds, and hazards for different ARI events. Sensitivity analyses are conducted to assess the impact of changes in Manning number, structure blockages, and land use changes.

Assumptions

The post-February-2004-event cross sections have been used to calibrate the model to the February 2004 event, as discussed with HRC . This is based on the assumption that

significant transport of river sediment occurs on the rising limb of the river flood wave

The top of the outer stopbanks and the internal summer stopbanks are assumed to not have changed in height since the previous field survey

Limitations

Uncertainties in spillway inflows, rainfall distribution, Oroua River levels, structure blockages, and hydraulic roughness.

Significant changes in flood extent and depth due to these uncertainties.

Recommendations

Uncertainties and Freeboard: The model predictions need to be treated with caution due to uncertainties in the flow conveyance capacity of the Oroua River.

Model Improvement: Further refinement of the Sluggish Main Drain, investigation of high observed water levels, review of Oroua cross sections, and improved field survey data to confirm LiDAR accuracy.

Potential Updates

Hydrology assessment updates

Refinement of channels with cross-sections and surveys

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

50130 Tutaenui_FHA-02

Report Name

Tutaenui Stream Floodplain Hazard Assessment

Region

Rangitikei

Location

Tutaenui Stream, Marton, and Bulls, New Zealand

Date Report Published

6 October 2008

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses the flood hazard in the Tutaenui Stream catchment, particularly in the urbanized areas of Marton and Bulls. The objective is to develop hydrological and hydraulic models to identify the extent and depth of flood inundation for 100 and 200 year ARI flood events

Data overview - what data has been used (survey, lidar, date)

Hydrological Data: Provided by Horizons Regional Council (HRC)

Land Level Data: LiDAR data flown in 2006 and 20m LINZ contour data

GIS Data: Road, railway, stream data, land use mapping, flood detention dam locations, and aerial photography

Cross Sections: Extracted from LiDAR data and surveyed cross sections

Watercourses / Stream

Tutaenui Stream: Main stream in the model

Folly Stream: Included in the model

Painui Stream: Included in the model

Marton West Stream: Included in the model

Various Tributary Streams: Feeding into the Tutaenui Stream

Hydrological method used

The hydrological assessment uses DHI's rainfall runoff Model B, incorporating a simple initial and continuing loss model with a kinematic routing component. The hydrological model was calibrated against recorded historical flood events and used to generate inflows to the hydraulic model.

When was hydrology calculated for

Rainfall Data: Various years (1962-2007)

Streamflow Data: Various years (1968-2007)

Range of events/scenarios modelled?

Historic flood events: October 1974, August 1975, June 1976, February 2004

Design flood events: 100-year and 200-year ARI

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The hydrological model was calibrated using historical flood events recorded at the Hammond Street gauge in Marton. The hydraulic model was validated against the February 2004 flood event, which was mapped by HRC staff.

Downstream boundary

The downstream boundary of the MIKE 11 model is the Rangitikei River water level, set to a constant water level of 30.7m.

Model Description

The hydraulic model combines a one-dimensional (1D) channel model with a two-dimensional (2D) overland model using MIKE 11 for the 1D component and MIKE 21 for the 2D component. The models are dynamically linked via MIKE FLOOD.

The MIKE 21 model uses a 10m and 5m grid with the Multi-cell Overland Solver feature.

Model Resolution

Grid Size: 10m and 5m for the MIKE 21 model

Model Software/Version

MIKE 11: For 1D channel modelling

MIKE 21: For 2D overland modelling

MIKE FLOOD: For dynamic linking between 1D and 2D models

Modelled assets?

Bridges: 17 surveyed bridges (e.g., Arahina, Beaven, Calico Line, Hammond Foot Bridge).

Culverts: 27 surveyed culverts (e.g., Tutaenui Road/Galpins Rad, Jeffersons Line, Folly Stream at Marumaru St).

Detention Dams: 18 detention dams.

Water Supply Dams: 2 dams (Dam B and Dam C).

Stormwater / Surface Water network inclusion

The stormwater network includes the Tutaenui Stream, Folly Stream, Painui Stream, Marton West Stream, and various tributary streams. The model also includes 18 flood detention dams and two water supply dams.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood extents, depths, levels, flow speeds, and flood hazard maps for 100-year and 200-year ARI events. The results are presented in drawings showing water level depth, velocity, and flood hazard.

Assumptions

Initial Conditions: All detention dams are assumed empty at the beginning of events.

Rainfall Distribution: Homogeneous rainfall distribution across the catchment.

Water Supply Dams: Assumed full or 2 meters below full for sensitivity analysis.

Detention Dams: Assumed to be empty at the beginning of all events simulated.

Limitations

Rainfall Data: Limited availability of recorded rainfall data within the catchment.

Model Calibration: Significant phase error in the hydrological model calibration due to synthesised rainfall record and lack of information on rainfall variability across the catchment.

Recommendations

Freeboard Allowance: Apply a 0.5m freeboard to the hydraulic levels to account for uncertainties.

Model Recalibration: Recalibrate the model when a suitable rainfall event is captured on both the Hammond Street flow gauge and the new hourly SCADA rainfall gauges.

Water Level Recorder: Install a water level recorder in Water Supply Dam C to provide data for future historical storm events and possible flood storage optimization.

Additional Land Level Survey: Required upstream of Marton outside of the LiDAR extent to cater for the full floodplain width for the 200-year ARI event.

Potential Updates

Hydrology assessment updates

Refinement of channels with cross-sections and surveys

Update to NZVD2016

Recommended Level

Level C

File Name

Upper Mangaone Stream_rev01

Report Name

Upper Mangaone Stream

Region

Lower Manawatu

Location

Upper Mangaone Stream between Palmerston North and Bunnythorpe, New Zealand

Date Report Published

1 April 2008

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses the flood hazard in the Upper Mangaone Stream area, focusing on the region between Palmerston North and Bunnythorpe. The study aims to develop a detailed model to accurately assess flow capacities and the effects of undersized channels on flood behaviour.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: 1m raster grid supplied by Horizons Regional Council (HRC)

Rainfall Data: Gauges at Valley Road, Palmerston North, and near Feilding

Cross Section Data: Provided by HRC for the Mangaone Stream and Jacks Creek

Watercourses / Stream

Mangaone Stream: Main stream in the model

Whiskey Creek: Included in the model

Various Tributary Streams: Feeding into the Mangaone Stream

Hydrological method used

The hydrological model uses sub-catchments delineated for areas draining into the Mangaone Stream. Rainfall data from gauges at Valley Road and Palmerston North are weighted to derive catchment rainfall. Initial and continuing losses for the catchments are taken as 20mm and 2mm/hr, respectively.

When was hydrology calculated for

Rainfall Data: 1976, 1988, and 2004 events

Range of events/scenarios modelled?

Historic flood events: 1976, 1988, and 2004

Design flood events: 50-year, 100-year, and 200-year ARI

Climate Change Considered?

The report does not explicitly mention climate change considerations.

Calibration / Validation

The model is verified against observed flood events in 1976, 1988, and 2004. The model satisfactorily reproduces the main patterns of observed flooding in 1976 and 2004. Water levels for the 2004 event are compared to actual values measured during the flood.

Downstream boundary

The downstream boundary is below the Milson Line Flow Gauge on the Mangaone Spillway.

Model Description

The model combines a one-dimensional (1D) channel model with a two-dimensional (2D) overland model using MIKE 11 for the 1D component and MIKE 21 for the 2D component. The models are dynamically linked via MIKE FLOOD. The model uses a fine grid (10m) for the area north of the Mangaone spillway.

Model Resolution

Grid Size: 10m for the MIKE 21 model

Model Software/Version

MIKE 11: For 1D channel modelling

MIKE 21: For 2D overland modelling

MIKE FLOOD: For dynamic linking between 1D and 2D models

Modelled assets?

Bridges: 11 bridges included in the MIKE 11 model

Culverts: 16 culverts included in the MIKE 11 model

Stopbanks: Included in the MIKE 11 model

Stormwater / Surface Water network inclusion

The stormwater network includes significant channels and streams modelled with MIKE 11, and smaller streams and overland flow modelled with MIKE 21. The model also includes structures such as bridges and culverts

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets

Overview of Model Outputs and Mapping Available

The model outputs include maximum flood depth, flood level, and flood hazard maps for the 50-year, 100-year, and 200-year ARI events. The report also includes drawings showing catchment delineation, model extent, structures, catchment connections, and his

Assumptions

Catchment Losses: Initial and continuing losses for the catchments are assumed to be 20mm and 2mm/hr, respectively.

Cross Sections: Some cross sections extracted from LiDAR data were modified or removed to ensure numerical stability.

Boundary Conditions: The downstream boundary is set below the Milson Line Flow Gauge on the Mangaone Spillway.

Limitations

LiDAR Data: Inconsistent cross sections due to trees, road crossings, or LiDAR reflection off the water surface were modified or removed.

Model Accuracy: The model predictions for the 1988 flood extent are less accurate compared to the 1976 and 2004 events.

Recommendations

Spill Prevention: Build an additional embankment to prevent spilling from the Airport Stream.

Development Restrictions: Avoid additional development on the northwest side of Bunnythorpe and close to the Mangaone Stream due to high flood risk.

Potential Updates

More detailed hydrology assessment

Consider climate change

Consider any key updates to catchment behaviour since 2008 including hydrology, land/terrain and structures.

Recommended Level

Level C

File Name

50103 Waikawa and Manukau Rivers-02

Report Name

Waikawa and Manukau Streams Floodplain Assessment

Region

Horowhenua

Location

Waikawa and Manukau Streams, Horowhenua District, New Zealand

Date Report Published

1 November 2008

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses the flood hazard in the Waikawa and Manukau Streams catchments. The objective is to develop hydrological and hydraulic models to identify the extent and depth of flood inundation for 100 and 200 year ARI flood events in the lower floodplain.

Data overview - what data has been used (survey, lidar, date)

LiDAR Data: Detailed land level data in the form of airborne laser survey (ALS) data

Rainfall Data: Recording rainfall data from Upper Mangahao and Levin gauges

Streamflow Data: Gauging records from Waikawa at North Manukau Road and Manukau at SH1

Survey Data: Bathymetric and topographic surveys of the lower reaches of the Waikawa Stream and river mouth

Watercourses / Stream

Waikawa Stream: Main stream in the model

Manukau Stream: Main stream in the model

Various Tributary Streams: Feeding into the Waikawa and Manukau Streams

Hydrological method used

The hydrological assessment uses a combination of model development and calibration, regional flood frequency estimates, and analysis of the January 2008 flood event. Design rainfall hyetographs are generated using the Chicago storm approach, with storms of higher intensity and shorter duration nested inside longer duration events.

When was hydrology calculated for

Rainfall Data: Various years (1977-2008)

Streamflow Data: Various years (1978-2008)

Range of events/scenarios modelled?

Historic flood events: January 2008, June 2006, November 2007

Design flood events: 100-year and 200-year ARI

Additional scenarios: 100-year and 200-year ARI with storm surge and climate change

Climate Change Considered?

The report includes simulations for 100-year and 200-year ARI events with climate change, considering a 20% increase in inflows and a sea level rise.

Calibration / Validation

The hydrological model was calibrated using three flood events: January 2008, June 2006, and November 2007. The hydraulic model was validated against the January 2008 flood event by comparing simulated flood extents to observed extents from an aerial survey.

Downstream boundary

The downstream water level boundary is set to mean sea level (0.165m) for design simulations and 0.8m for the January 2008 simulation.

Model Description

The model combines a one-dimensional (1D) channel model with a two-dimensional (2D) overland model using MIKE 11 for the 1D component and MIKE 21 for the 2D component. The models are dynamically linked via MIKE FLOOD. The 1D model includes cross sections and structures, while the 2D model uses a 10m grid DEM based on LiDAR data.

Model Resolution

Grid Size: 10m for the MIKE 21 model

Model Software/Version

MIKE 11: For 1D channel modelling

MIKE 21: For 2D overland modelling

MIKE FLOOD: For dynamic linking between 1D and 2D models

Modelled assets?

Bridges: SH1 and railway bridges on the Waikawa and Manukau Streams, and smaller bridges on Waikawa Beach Road, Takapu Road, and Gleasons Road

Culverts: Various culverts included in the MIKE 11 model

Stormwater / Surface Water network inclusion

The stormwater network includes the Waikawa and Manukau Streams, tributary streams, and various structures such as bridges and culverts. The model also includes a 2D hydraulic resistance map based on land use types.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood extents, depths, levels, flow speeds, and flood hazard maps for 100-year and 200-year ARI events, as well as scenarios with storm surge and climate change. The results are presented in a separate A3 map book.

Assumptions

Rainfall Data: HIRDS data for Upper Mangahao and Levin gauges used for design rainfall hyetographs

Hydrological Model Parameters: Initial and continuous infiltration loss parameters calibrated for each contributing sub-catchment

Boundary Conditions: Mean sea level (0.165m) for design simulations and 0.8m for the January 2008 simulation

Limitations

Hydrological Uncertainty: Limited period of flow record and lack of rainfall stations in the upper catchment

Model Accuracy: Flood levels and flows in the lower part of the model area downstream of the confluence may be underestimated due to limited LiDAR coverage

Recommendations

Uncertainties and Freeboard: Set freeboard allowances to a minimum of 0.5m until additional investigation can refine model accuracy

Model Improvements: Extend LiDAR surveys to cover the model domain northwards, assess interactions with the Ohau catchment, undertake further hydrological investigations, and reinstate the Jarvis raingauge

Potential Updates

Improve LiDAR Coverage

Check hydrological calibration with updated gauge information

Validated / Calibrate flood model to more recent events

Recommended Level

Level C

File Name

50049-Mangaone-Taonui-v1.2

Report Name

Mangaone Stream and Taonui Basin - Floodplain Hazard Assessment - Hydraulic Modelling and Mapping

Region

Lower Manawatu

Location

Mangaone Stream and Taonui Basin, Manawatu region, New Zealand

Date Report Published

1 March 2007

Publication Status

Final Report (Revision 01)

Purpose + Overview of model / report

The report assesses the flood risk in the Mangaone Stream and Taonui Basin area, which was severely affected by flooding in February 2004. The study aims to provide a detailed hydraulic model to understand flood behaviour and inform flood management strategies. The model combines a two-dimensional floodplain model and a one-dimensional channel model to capture the complete physical flow characteristics in the study area.

Data overview - what data has been used (survey, lidar, date)

LIDAR Data: High accuracy land level data from airborne laser survey (ALS)

Rainfall Data: Gauges at Milsons Line, Valley Road, Palmerston North, and Fielding

Flow Data: Mangaone Stream flow gauge at Milsons Line

GIS Data: Roads, railways, stopbanks, watercourses, soil types, land use, topographic maps, aerial photography

Vertical Datum: Wellington datum, with conversions from Moturiki datum (+76mm correction)

Watercourses / Stream

Mangaone Stream: Largest watercourse, draining an area of approximately 157 km², discharging to the Manawatu River.

Taonui Stream: Drains the remaining catchment to the Taonui Basin.

Main Drain and Burkes Drain: Large drainage channels in the Taonui Basin

Hydrological method used

The hydrological assessment uses DHI's Urban Model B ((rainfall-runoff model), incorporating initial and continuing loss models with kinematic routing. Calibration parameters are derived from the Mangaone flow record, and historical flood events (1976, 1988, 2004) are used for calibration.

When was hydrology calculated for

Rainfall Data: Various years (1976, 1988, 2004)

Flow Data: April 1978 onwards

Range of events/scenarios modelled?

Historical flood events: June 1976, July 1988, February 2004

Design events: 50-year, 100-year, and 200-year annual recurrence intervals (ARIs)

Climate Change Considered?

Not explicitly mentioned.

Calibration / Validation

Calibration is based on reproducing flood volumes for historical events using initial and continuing loss parameters.

Validation includes comparing model results with observed flood extents and spot levels from the 2004 event.

Downstream boundary

The main downstream boundary is the Manawatu River water level downstream of the Rangiotu flood gates, provided by Horizons Regional Council for historical and design flood events.

Model Description

The model comprises separate 1D and 2D components dynamically linked via MIKE FLOOD. The 1D model includes major drainage channels, while the 2D model uses LiDAR data for topography. The models simulate flood behaviour and exchange flows between channels and floodplain.

220km² modelled

Model Resolution

25m grid model: Covers the entire study area

10m grid model: Covers the area around the Mangaone Spillway

Coarse and fine grid used for same simulations to compare results

Burned in embankments, road crest alignments etc using 1m LiDAR

Model Software/Version

MIKE 11, MIKE 21, MIKE FLOOD.

Modelled assets?

Culverts: 16

Bridges: 7

Floodgates: Rangiotu floodgates (two sets of one-way culverts)

Other Structures: Various spillways, flapgates, and drainage channels

Stormwater / Surface Water network inclusion

The stormwater network includes various drainage channels such as the Taonui Stream, Main Drain, Burkes Drain, Whiskey Creek, and Kairanga Drain. These channels are modelled to capture the flow characteristics and interactions with the floodplain.

Level of Service for Assets Mentioned? - Standard of protection

Overview of Model Outputs and Mapping Available

The model outputs include flood depths, levels, speeds, and hazards for different ARI events. Sensitivity analyses are conducted to assess the impact of changes in Manning number, structure blockages, and land use changes.

Assumptions

For all events initial and continuing losses of 20mm and 2mm/hr respectively have been assumed

Flood levels in the Airport Stream have been determined assuming no spills take place; the model therefore provides the water levels assuming stopbanks are in place

The aim of this exercise was to delineate the probable maximum and minimum flood extents taking into account “best case” and “worst case” assumptions of catchment runoff and inflows, flow resistance and bridge blockages. Low Margin Manning's reduced by 20%, inflow reduced by 20%, Bridges not blocked. High margin Manning's n increased by 20%, inflow increased by 20%, 95% bridge blockages.

Limitations

Uncertainties in spillway inflows, rainfall distribution, Mangaone Stream levels, structure blockages, and hydraulic roughness.

Significant changes in flood extent and depth due to these uncertainties.

Recommendations

Uncertainties and Freeboard: A freeboard requirement of at least 50cm is recommended due to variations in flood levels.

Model Improvement: Further refinement of the model, especially in the Mangaone Stream and its tributaries upstream of the Flyers Line spillway, is suggested.

Potential Updates

Hydrology assessment updates

Refinement of Mangaone Stream and tributaries upstream of Flyers

Model resolution could be refined

Update to NZVD2016

Consider climate change

Recommended Level

Level C

File Name

RangitikeiModellingSummary-May2005

Report Name

Hydraulic Modelling of Rangitikei River: Kakariki Bridge to Mouth

Region

Rangitikei

Location

Rangitikei River, from Kakariki Bridge to the river mouth at Tangimoana

Date Report Published

1 May 2005

Publication Status

Final

Purpose + Overview of model / report

The purpose of the modelling was to:

Determine design stopbank levels along the Rangitikei River.

Simulate flood behaviour for 2% and 1% AEP events.

Assess future flood levels considering forecasted aggradation and degradation over 25 years.

The model was developed using MIKE 11 software and included multiple berm flow branches in addition to the main river channel.

Data overview - what data has been used (survey, lidar, date)

Cross-Section Data: Surveyed by Horizons Regional Council (HRC) in late 2004.

Hydrological Data:

February 2004 flood event used for calibration (peak flow 2022 m³/s at Kakariki Bridge).

Tributary inflows (Tutaenui, Makowhai, Rangitawa) estimated at 39 m³/s each.

1% AEP peak flow estimated at 2397 m³/s.

Sea Level Data: NIWA tide predictions and storm surge data (Kapiti Island); design sea level set at 2.4 m.

Aerial Photography: Post-flood colour and oblique images used for model setup and calibration.

Flood Level Observations: Provided by HRC and ACCG.

Watercourses / Stream

Main River: Rangitikei River (Kakariki Bridge to Tangimoana)

Tributaries: Tutaenui, Makowhai, Rangitawa Streams (inflows estimated)

Model Branches: Multiple berm flow branches (e.g., RB1, RB2, LB3, Scotts Ferry, Tangimoana)

Hydrological method used

Peak flows estimated from historical events and NIWA data.

Sea level hydrograph derived from tide and storm surge data.

Design simulations used constant sea level to align peak river flow with peak sea level.

Outflow hydrographs applied in calibration to simulate overbank flows.

When was hydrology calculated for

Hydrological data from 2004 event; model developed and calibrated in 2005.

Range of events/scenarios modelled?

February 2004 flood (used for calibration; ~2% AEP)

1% AEP design flood

Forecasted 2% and 1% AEP floods with 25-year aggradation/degradation

Climate Change Considered?

No – climate change is not explicitly considered in this model.

Calibration / Validation

Calibration based on February 2004 flood.

Flood levels compared with observed data; some discrepancies noted.

Higher Manning's n values (0.050–0.100) required in some reaches.

Calibration limited by lack of observed data in some areas.

Downstream boundary

Sea level set at a constant 2.4 m for design simulations (spring tide + wind setup + storm surge).

Model Description

Software: MIKE 11 (1D hydraulic model)

Multiple branches for berm flows and floodplain representation.

Cross-sections adjusted for skew and extended where necessary.

Outflows applied in calibration but excluded from design runs.

Model Resolution

1D model with detailed cross-sections; no specific grid size (not a 2D model).

Model Software/Version

MIKE 11 (DHI software suite)

Modelled assets?

No explicit modelling of culverts, bridges, or gates.

Approximately 100+ cross-sections used, including berm and floodplain branches.

Outflows applied at specific cross-sections to simulate overbank flow.

Stormwater / Surface Water network inclusion

Not included in the model.

Level of Service for Assets Mentioned? - Standard of protection

Design levels provided for 2% and 1% AEP events.

600 mm freeboard recommended to be added to modelled levels.

Overview of Model Outputs and Mapping Available

Flood levels for each cross-section under different scenarios.

Calibration plots comparing modelled and observed levels.

Resistance (Manning's n) values for each model branch.

Model files listed for each scenario.

Assumptions

Constant sea level during flood peak.

Forecasted aggradation/degradation based on current trends.

Outflows excluded from design simulations.

Some cross-sections extended or adjusted for skew.

Limitations

Limited calibration data in some reaches.

Some flood levels inferred rather than directly observed.

High Manning's n values required in some areas.

Potential channel changes during flood not accounted for.

Future flood events should be used to improve calibration.

Recommendations

Collect more flood level data in future events, especially in middle and upper reaches.

Apply smoothing to design levels when designing stopbanks.

Consider updating model with new cross-section data over time.

Potential Updates

Update hydrology - last done in 2005

Consider climate change

Validation / Calibration

Updated survey / LIDAR

Consider 2D modelling where needed

Recommended Level

Level B

File Name

HDC Flood Maps circa 1997

Report Name

Horowhenua District Flood maps: Information Sources and Methodology

Region

Horowhenua

Location

Horowhenua

Date Report Published

1997

Publication Status

Final Report

Purpose + Overview of model / report

The report aims to prepare flood maps for the Horowhenua District to provide district planners with information necessary to identify areas where development is either inappropriate or requires restrictions due to flooding. The maps identify areas likely to be inundated during a 100-year return period event and areas affected by poor drainage.

Data overview - what data has been used (survey, lidar, date)

Flood Photographs: Coverage of flood events between 1968 and 1992

Flood Reports: Prepared by the Regional Council or its predecessors

Non Flood-specific Reports: References to flooding in subdivision enquiry files and other Council files

Staff Recollections: Recollections of long-serving Council staff

Topographic Inference: Detailed contour information and features such as terraces, cliffs, and swampy areas

Watercourses / Stream

Manawatu River: Including the Lower Manawatu River and Moutoa Spillway

Ohau River: Extensive flooding of the lower reaches

Waikawa Stream: Extensive flooding of the lower reaches

Koputaroa Stream: Included in the flood mapping

Various Streams and Drains:

Hydrological method used

The flood maps were prepared using a combination of recorded flood information, staff recollections, and topographic inference. The 100-year return period flood was adopted for mapping, which is more stringent than the 50-year event specified in the Building Act. Areas of poor drainage were also mapped based on wet ground conditions and surface ponding.

When was hydrology calculated for

Flood Photographs: Coverage from 1968 to 1992

Flood Reports: Various years

Range of events/scenarios modelled?

N/A

Climate Change Considered?

N/A

Calibration / Validation

The flood maps were peer-reviewed by long-serving Regional Council officers with considerable experience of flooding and drainage problems within the district.

Downstream boundary

N/A

Model Description

No Model. Methodology: The methodology involved dividing the district into four areas based on information availability and type. Flood limits were defined using stopbanks, flood photographs, Council reports, staff recollections, and topographic inference. The flood limits were extended to the next topographic feature likely to restrict flooding for events smaller than a 100-year event.

Model Resolution

N/A

Model Software/Version

N/A

Modelled assets?

N/A

Stormwater / Surface Water network inclusion

N/A

Level of Service for Assets Mentioned? - Standard of protection

N/A

Overview of Model Outputs and Mapping Available

The outputs include flood maps identifying areas likely to be inundated during a 100-year return period event and areas affected by poor drainage. The maps were prepared using a combination of recorded flood information, staff recollections, and topograph

Assumptions

Flood Limits: Extended to the next topographic feature likely to restrict flooding for events smaller than a 100-year event.

Topographic Inference: Used to define areas of flooding and poor drainage where recorded flood information was unavailable.

Limitations

Information Availability: The information available to identify areas of flooding and poor drainage was not consistent over the entire district.

Return Periods: The return periods for flood information contained in non flood-specific reports and staff recollections are unavailable.

Recommendations

Not explicitly stated

Potential Updates

Undertake hydraulic modelling for this area

Recommended Level

Level A

File Name

Flood Modelling of the Mangaone Stream and East of Levin_RevB_03122021

Report Name

Flood Modelling of the Mangaone Stream and East of Levin

Region

Horowhenua

Location

Upper Mangaone Stream Catchment and East of Levin, New Zealand

Date Report Published

3 December 2021

Publication Status

Final Report

Purpose + Overview of model / report

The report assesses flood hazards in the Upper Mangaone Stream Catchment and the area East of Levin, including the Koputaroa Stream. The objective is to develop hydraulic models to map areas likely to be inundated in a range of flood events.

Data overview - what data has been used (survey, lidar, date)

Digital Elevation Models (DEM): Based on 2016 LiDAR data provided by Horizons Regional Council (HRC)

Flow Data: Mangaone at Milson Line flow gauge from HRC (1980-present)

Land Cover Database: Version 5.0, January 2020

Watercourses / Stream

Mangaone Stream: Main stream in the model

Koputaroa Stream: Included in the East of Levin model

Various Tributary Streams: Feeding into the Mangaone and Koputaroa Streams

Hydrological method used

The hydrological model in HEC-HMS. The loss method adopted uses an initial abstraction and constant continuing loss per hour. The kinematic wave method is used for runoff transformation and reach routing. The model parameters were confirmed for the Mangaone Stream catchment and then applied to the East of Levin catchment.

When was hydrology calculated for

Flow Data: Various years (1980-present)

Range of events/scenarios modelled?

Design flood events: 10-year, 100-year, and 200-year ARI

Additional scenarios: 10-year, 100-year, and 200-year ARI with climate change (RCP 6.0 for the period 2081-2100)

Climate Change Considered?

The report includes simulations for 10-year, 100-year, and 200-year ARI events with climate change, considering the RCP 6.0 scenario for the period 2081-2100.

Calibration / Validation

The model was sense-checked against flood frequency analysis and selected storm flows for the Mangaone Stream catchment. The flood extent maps were reviewed by Horizons Regional Council staff based on their experience of flood mechanisms in the catchments

Downstream boundary

Outflow boundaries were defined as normal depth boundaries with a representative slope based on the terrain data.

Model Description

The overall approach adopted for both models is a fully 2D HEC-RAS model. A 5m 2D grid was used to balance terrain resolution and model run time. Key structures such as bridges and culverts were modelled as HEC-RAS 2D connections. Structures not surveyed but identified as causing backwater were modelled using the HEC-RAS terrain modification channel.

Model Resolution

Grid Size: 5m for the 2D HEC-RAS model

Model Software/Version

HEC-HMS: For hydrological modelling

HEC-RAS: For hydraulic modelling

Modelled assets?

Bridges and Culverts: Key structures (20+) were identified and modelled as 2D connections. Structures not surveyed but identified as causing backwater effects were modelled using terrain modification channels.

Stormwater / Surface Water network inclusion

The stormwater network includes the Mangaone and Koputaroa Streams, tributary streams, and various structures such as bridges and culverts. The model also includes roughness values based on land cover types.

Level of Service for Assets Mentioned? - Standard of protection

The report does not explicitly mention the levels or standard of service for the assets.

Overview of Model Outputs and Mapping Available

The model outputs include flood extents, depths, and levels for the 10-year, 100-year, and 200-year ARI events, as well as scenarios with climate change. The results are presented in figures showing maximum flood depths and long sections of flood levels.

Assumptions

Rainfall Losses: Initial abstraction and constant loss per hour were assumed to be similar for the Mangaone and Koputaroa Stream catchments.

Model Resolution: Limited by the resolution and accuracy of the LiDAR data.

Structures: Unsurveyed structures were represented in a simplified manner by a 0.5m wide open channel.

Limitations

Model Calibration: The model was not calibrated to recorded events, although it was sense-checked against observed discharge for the Mangaone catchment and observed flooding for the Koputaroa Stream.

Model Suitability: The model is not suitable for use in more frequent events due to the 2D representation of the main channel.

Recommendations

Flow Monitoring: Confirm the assumption that the Mangaone and Koputaroa Stream catchments have similar initial and constant loss profiles through flow monitoring on the Koputaroa Stream.

Model Improvements: Add actual details of unsurveyed structures to the model if more detailed results are required at these locations.

Potential Updates

Survey key structures

Survey main channel to improve channel representation to make model suitable for use for wider range of events

Calibrate to larger events

Recommended Level

Level C



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