EFFICIENT MODELLING OF COMPLEX CATCHMENTS IN EAST CHRISTCHURCH

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ABSTRACT

The eastern Christchurch catchments of New Brighton, Bridge Street and Southshore total approximately 600ha. Understanding and managing these stormwater catchments is complex with low lying areas, tidal boundaries, and relatively flat grades. This complexity has increased following the Canterbury earthquakes.

To assess levels of service and compare options for managing stormwater in these catchments, SCIRT engaged Beca to carry out coupled 1D and 2D modelling using MIKE FLOOD software.

The models evolved through the design stages, from concept to detailed design of pipework, roads, storage and pump stations, including assessment of pre- and post-earthquake change and performance against various level of service options. To meet project timeframes a number of measures were adopted.

The model build was streamlined, with pipe and surface data exported from SCIRT's 12d design software and imported into the models. The number of model runs, particularly 2D model runs, was restricted. Manual calculations were used initially, then storm and tide combinations were tested using a modified 1D model, before a final 2D model was run. The size of the 2D grid was also optimized to achieve sufficient resolution without excessive run-times.

This approach meant that the modelling provided the required design inputs within tight timeframes.

KEYWORDS

Flood, model, stormwater, earthquake, Canterbury earthquakes

PRESENTER PROFILE

Elliot Tuck is a senior hydrologist at Beca Ltd in Christchurch, New Zealand. His background is in field hydrology, hydrological data analysis. Since joining Beca he has become an integral part of the modelling team and has spent the last 4 years stormwater modelling on projects throughout New Zealand and Australia.

1 INTRODUCTION

The Canterbury earthquakes of 2010 and 2011 caused unprecedented damage to horizontal infrastructure across most of Christchurch city. One area of Christchurch severely damaged was the eastern suburbs. Large areas of land settlement and damage to the stormwater network have resulted in localised flooding during storms.

This paper describes the modelling of three major catchments: New Brighton Road, Bridge Street and Southshore. These catchments make up the spit of land between the Avon River and the Estuary to the west and the Pacific Ocean to the east.

The work has been undertaken for the Stronger Christchurch Rebuild Team (SCIRT). SCIRT is the alliance responsible for repairing earthquake damage to Christchurch's horizontal infrastructure (roads, water, wastewater and stormwater). The SCIRT alliance includes the Canterbury Earthquake Recovery Authority (CERA), Christchurch City Council (CCC), NZ Transport Agency (NZTA) and five contractors. Engineering consultancies and CCC provide design resources to SCIRT, through staff seconded into the SCIRT design teams and work packages carried out in consultants' home organisations.

SCIRT has commissioned Beca to undertake hydraulic modelling of the New Brighton, Bridge Street and Southshore catchments, to inform the design process. SCIRT is carrying out full design for the rebuild of these three catchments. This includes assessing damage, and concept and detailed design of the stormwater system rebuild works. Hydraulic modelling is required to understand the response of the catchments to storm and tide events, identify areas where flooding may be of particular concern and confirm that the rebuild design meets the required levels of service.

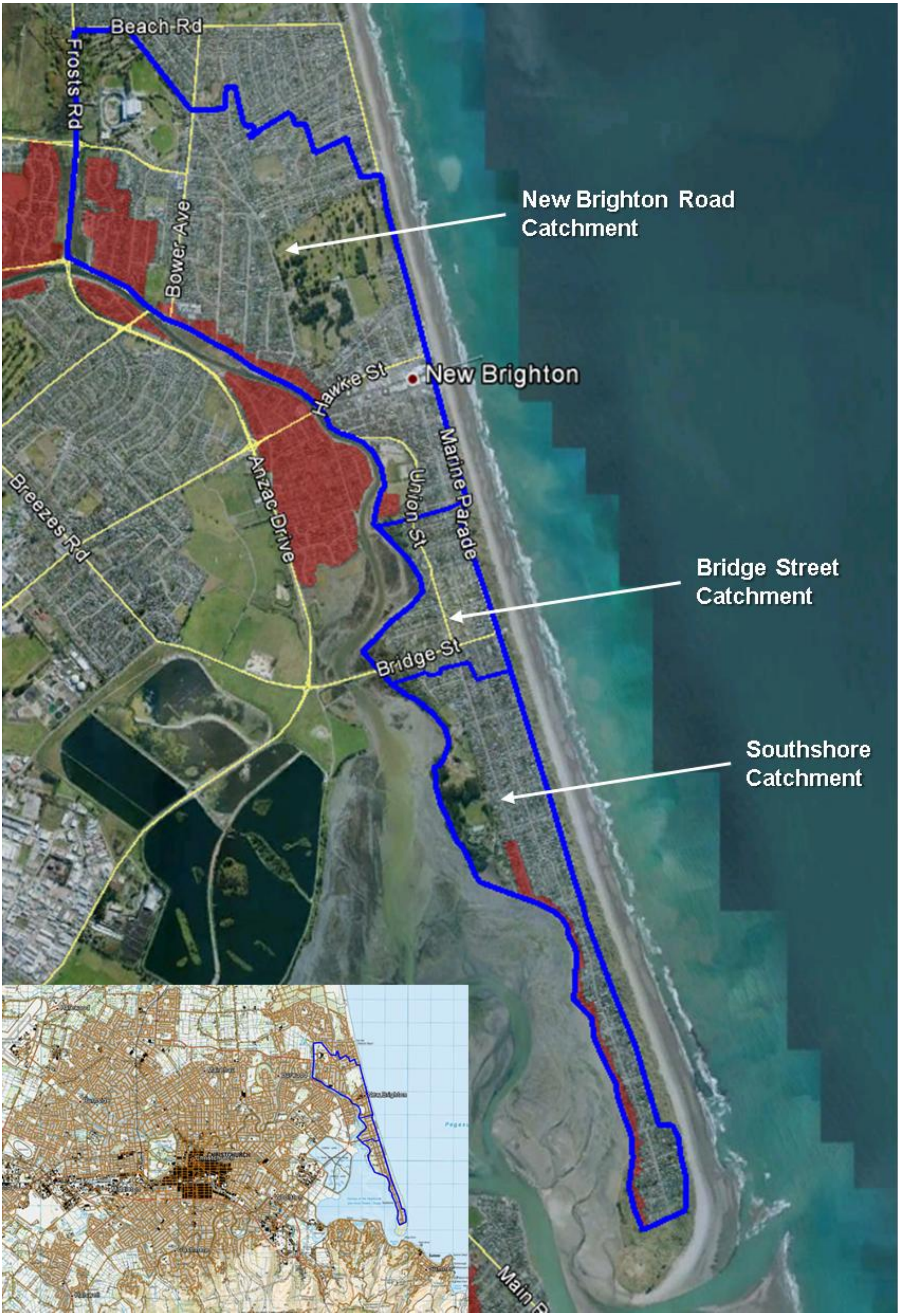
2 PROJECT AREA

2.1 PROJECT LOCATION

Figure 1 shows the location of the three catchments outlined in blue. The red shaded area is the Canterbury Earthquake Recovery Authority (CERA) residential red zone. The red zone is the area where land damage is significant and CERA has deemed the land uneconomic to repair.

The red zone properties in these catchments are mainly along the Avon River or Estuary edge of the New Brighton Road and Southshore catchments. The Bridge Street catchment has no red zoned properties.

Figure 1: Location of the study area



2.2 CATCHMENT CHARACTERISTICS

The three stormwater catchments make up a total area of 595 ha.

The study area slopes very gently from east to west, with the highest ground along the coastal dune system and the lowest areas near the Avon River or Avon-Heathcote Estuary. This means that most of the stormwater networks drains (under gravity) to the River which is tidally influenced in this reach, or the Estuary. The lower reaches of the Avon River and parts of the Estuary are bordered by a stopbank to prevent flood and tidal inundation of properties. The gravity outfalls have flap gates to prevent tidal inflow from the River or Estuary into the stormwater systems.

The land use of the catchments is mainly residential (Christchurch City Living 1 zoning) with a small amount of light business (Business 1 zoning) and some large areas of parks.

Environment Canterbury's online GIS database identifies the soils in the study area as predominantly sandy loams of the Kairaki complex. The Landcare Research online soils database (S-map online) gives the following soil properties (Table 1).

Table 1: Details of soil type in the study area

Soil name	% of the study area	Depth class	Texture profile	Topsoil clay range	Drainage class	Permeability of slowest horizon
Kairaki f (Sib 1)	95%	Deep (>1m)	Sandy loam	0 - 2%	Well drained	Rapid (>72 mm/h)
Taitapu	5%	Deep (>1 m)	Silty loam over sandy loam	18-30%	Poorly drained	Slow (<4 mm/hr)

The soils are mostly sandy with good infiltration capacity especially on the eastern side of the catchments. The Taitapu soils occur close to the Estuary (on the western side of the catchments) and are more poorly drained. Groundwater is tidally influenced and is close to the surface in the lower areas (western side) of the catchments.

2.3 OTAKARO/AVON RIVER AND IHUTAI/AVON-HEATHCOTE ESTUARY

As stated in section 2 and shown in Figure 1, the western side of the study area boarders the Avon River and Avon-Heathcote Estuary. All three catchments discharge to the Avon River or Estuary.

The Avon-Heathcote Estuary and lower reaches of the Avon River are tidally affected. Because of the low lying nature of the catchments stormwater discharges are affected by the state of the tide. Tidal levels for different return periods (from Goring, 2011, as published in CCC Waterways, Wetlands and Drainage Guideline (CCC, 2011)) are included in Table 2. These levels do not include an allowance for sea level rise.

Table 2: High tide levels at Bridge Street

Return Period	**Median**	**2 year**	**5 year**	**10 year**	**50 year**	**100 year**	**200 year**
Level (RL m)	10.1	10.69	10.78	10.82	10.91	10.94	10.96

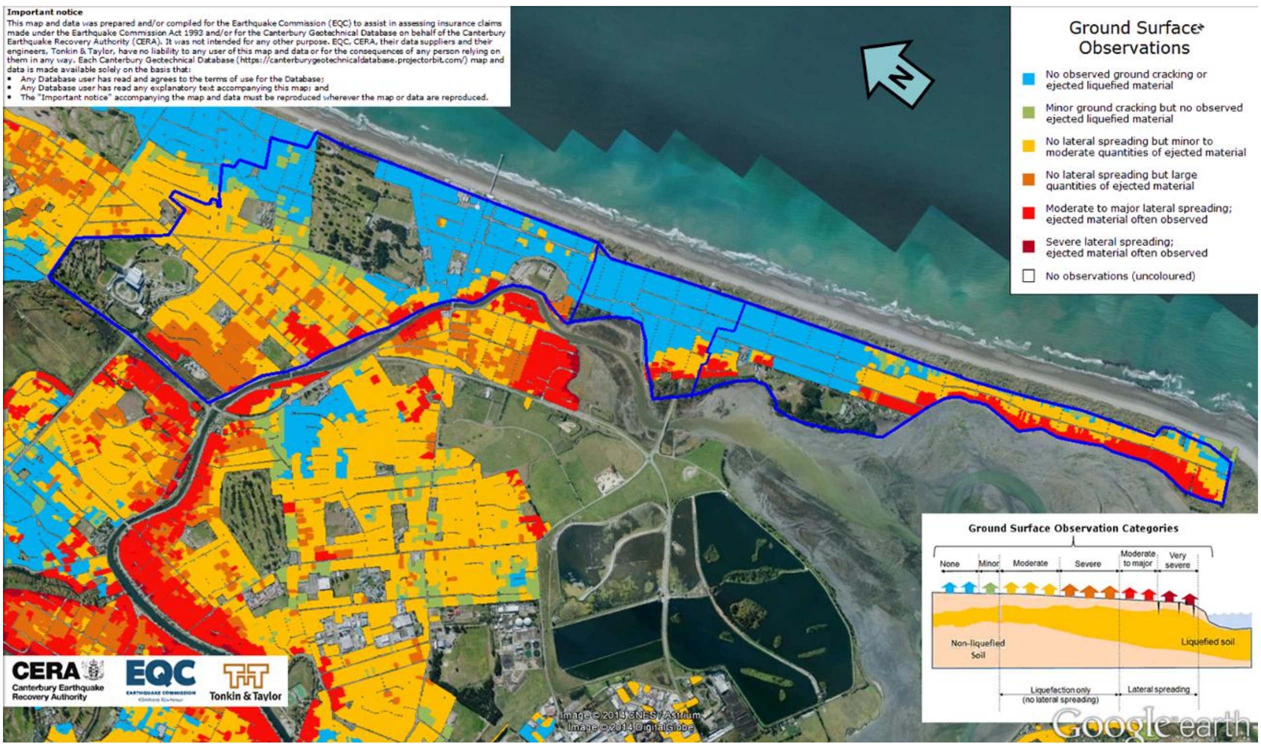
2.4 EARTHQUAKE DAMAGE

The Canterbury earthquakes of 2010 and 2011 had a significant impact on ground levels and buried infrastructure, particularly in the eastern suburbs of Christchurch. In some areas, significant ground settlement and damage to infrastructure has resulted in an increased risk of flooding.

The New Brighton, Bridge Street and Southshore catchments all suffered to some degree from vertical and horizontal movement, including uplift, settlement and liquefaction. Lateral spreading also occurred close to the River and Estuary.

Figure 2 shows liquefaction and lateral spreading observations from the February 2011 earthquake, from the Canterbury Geotechnical Database. The three catchments are outlined in blue. It can be seen from Figure 2 that there was moderate to major liquefaction (yellow and orange colour) in much of the New Brighton catchment, the western part of the Bridge Street catchment, and the southern part of the Southshore catchment. It can also be seen from Figure 2 that there was moderate to major lateral spreading (red colour) in all three catchments, along parts of the River and Estuary edge.

Figure 2: Observed liquefaction and lateral spreading February 2011 earthquake, from Canterbury Geotechnical Database



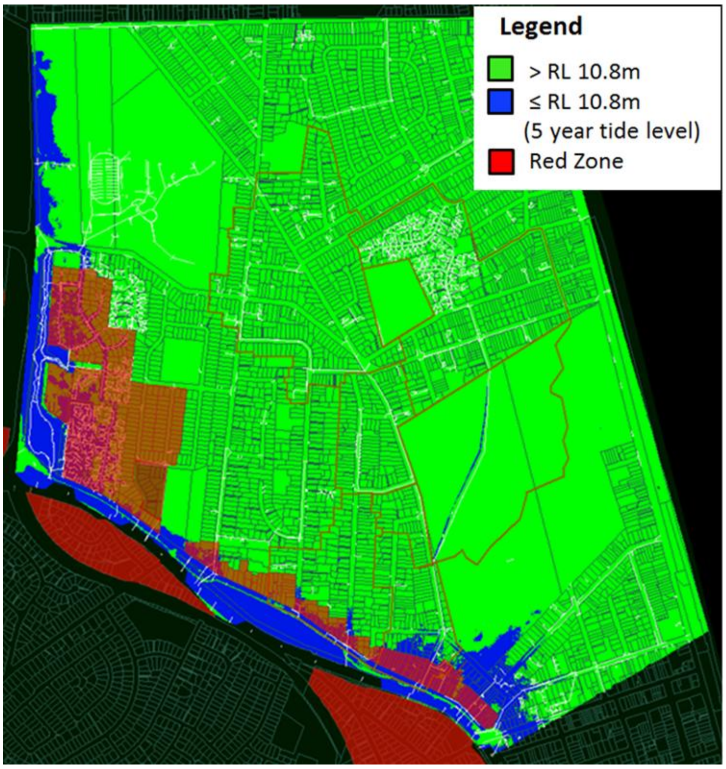
The shaking and differential settlement (varying amounts of settlement in adjacent areas of land) have caused pipes to move out of level, crack or break, and overland flow paths to change grade. The land has settled relative to the tidal levels in the River and Estuary. This has led to a reduction in the available hydraulic grade in the catchment and a number of properties are now very low relative to tidal levels in the River and Estuary.

Settlement and earthquake damage to the existing stop banks led to temporary stopbanks being constructed to help reduce the risk of flooding. These temporary stopbanks, shown in Photograph 1, may be in place for some time but it is assumed that these will be rebuilt at some stage.

Photograph 1: Temporary stopbank on New Brighton Road, looking downstream toward Pages Road Bridge

Figure 3 is a map of the upper region of the New Brighton Road catchment. The blue shows areas that are below the 5 year high tide of RL10.78m. This is based on the post-earthquake LiDAR. A temporary stopbank has been constructed in this area between New Brighton Road and the Avon River, as shown in Photograph 1.

Figure 3: New Brighton Road catchment showing areas below the 5 year high tide level from post-June 2011 LiDAR



In the New Brighton Road and Bridge Street catchments the land settlement means that some areas can no longer drain to the Avon River during extreme high tide events, and therefore detention basins or pumping are likely to be required as part of the rebuild design. Differential settlement has also meant that some properties are no longer able to drain to the primary stormwater network.

3 MODELLING AND REBUILD DESIGN PROCESS

3.1 NEED FOR MODELLING

The need for hydraulic modelling was identified early in the design process for the three catchments due to the catchment complexities, including:

- Tidal boundary conditions in Avon River and Estuary.
- Low private properties and roads, which need to have stormwater drainage and protection from flooding.
- A primary system which consists of kerb and channel and a pipe system with flap gated outlets.
- Secondary flow paths which, although generally along roads, have been modified by settlement and the construction of temporary stopbanks (at the downstream end).
- Areas of relatively flat and low land, creating ponding and storage within the road.
- Proposed stormwater detention basins and pump stations.

- Proposed changes in the primary and secondary stormwater system with the rebuild of the pipe system and roads.

3.2 REBUILD OPTIONS

Options for rebuilding the earthquake damaged catchments included repairs and replacement of pipework, modifying secondary flow paths (along roads and through reserves), and constructing storage/basins and pump stations. Many of these options were combined and tested in the modelling. Each of the catchments had different issues which were identified early in the 1D modelling.

3.3 MODELLING INPUT INTO DESIGN PROCESS

Modelling was initiated early and informed the concept design phase. This phase consisted of testing the options established by the SCIRT design team, and refining these to a preferred option for that catchment.

During detailed design the models were further refined, with more information and detail added, to provide information to the SCIRT design team and test the final detailed design.

3.4 DESIGN PERFORMANCE STANDARDS

The goal of the modelling was to limit the amount of flooding in and around the residential areas of the catchments, by upgrading pipe capacity and adding detention basins and pumping as appropriate. The performance of the basins and pump stations needed to prevent flooding of houses in a 50 year storm, while avoiding excessive capacity and capital costs. To check compliance with this performance standard, floor levels of at risk properties were surveyed and compared to maximum flood water elevations.

Due to the flat nature of the catchment the velocity of flood waters is not an issue, and therefore no velocity-depth mapping was undertaken.

The modelling was also used to check the performance of the primary system (kerb and channel and pipe system) in a 5 year storm.

4 MODELLING APPROACH

4.1 SOFTWARE

CCC is the network asset owner and currently uses the DHI MIKE suite of software. This software was therefore used for modelling these catchments, to allow the models to be handed over to and used by CCC in the future.

MIKE URBAN was used to represent the hydrology and 1D pipes, catchpits and manholes. MIKE FLOOD was then used to couple this to a surface or digital elevation model (DEM). No modelling of the Avon River was necessary other than as a tidal boundary.

4.2 SCENARIOS AND BOUNDARY CONDITIONS

The two rainfall return periods tested were the 5 year and the 50 year. These events were based on the CCC Waterways, Wetlands and Drainage Guideline (CCC, 2011).

A range of storm durations from 30 minutes to 72 hours was tested in the 1D model to establish the critical duration for peak flows in the 5 year storm and maximum ponding in the 50 year storm. This determined that the 6 hour duration was critical for both the 5 year storm and the 50 year storm.

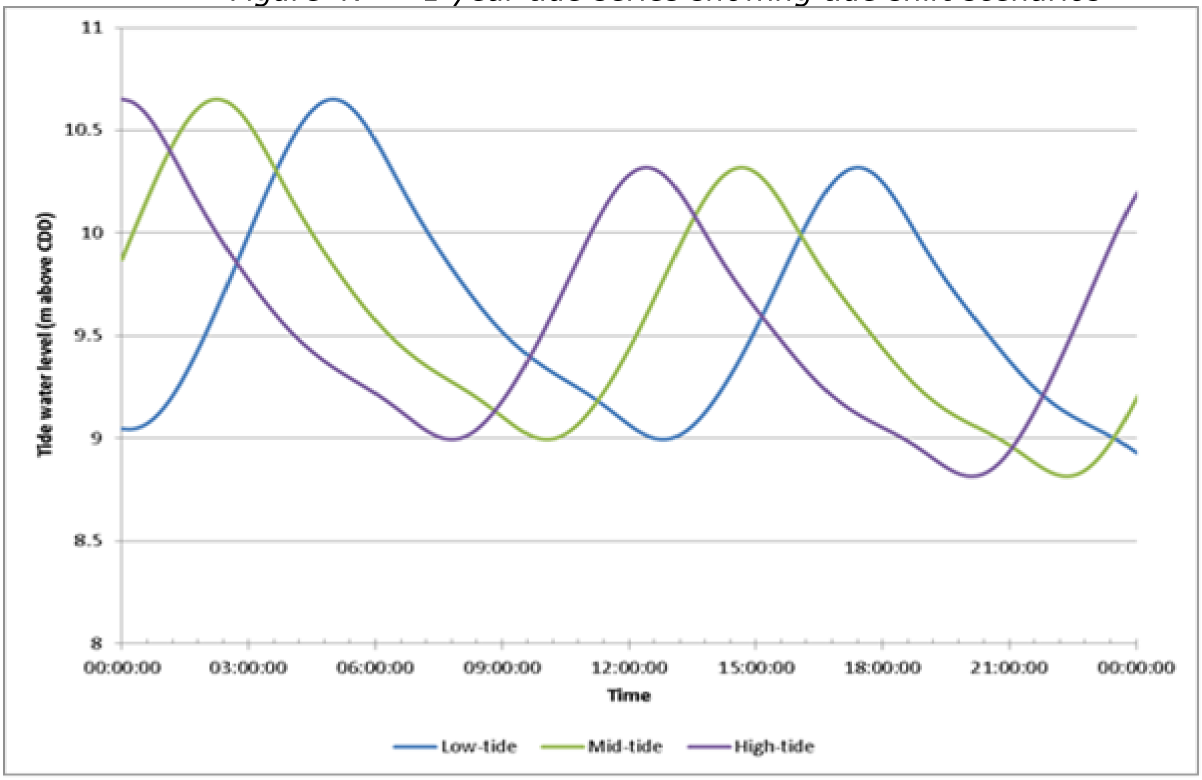
Three tidal events have been tested in the models: a median tide, a 1 year tide and a 5 year tide. A median tide and a 5 year tide have been tested with a 50 year storm. A 1 year tide has been tested with a 5 year storm. In accordance with SCIRT's design guidelines, no allowance for sea level rise was included.

Tidal time series for a range of return periods were obtained from CCC. Tidal levels were provided at 15 minute intervals and are based on tide levels at Bridge Street. The tidal series provided extended 3 days either side of the peak. For modelling purposes the time series was trimmed to begin at the peak high tide in the series. The same time series was applied to all three catchments.

To determine the worst case tide and storm coincidence, all the tidal series were shifted by 3 hours and 6 hours so that the model began a run with the tide starting at low tide, mid-tide and high tide. Tide shift scenarios for a 1 year tide are shown in Figure 5.

The tide series was applied as a downstream boundary condition on the 1D model. The tide shift testing was undertaken in 1D. This allowed us to test a variety of storm durations and tides to align tidal peaks and runoff peaks. A design envelope could be established by using the best and worst case scenarios of tide and storm coincidence.

Figure 4: 1 year tide series showing tide shift scenarios



An examination of the Southshore elevations showed that the area may be susceptible to tidal flooding due to relatively low levels along the Estuary edge. This area of Southshore has no stopbank. For this reason the tidal boundary in the Southshore model was applied in the 2D domain rather than the 1D outlets.

4.3 PRE- AND POST-EARTHQUAKE MODELLING

Where the effects of earthquake damage on the stormwater system are not clear, pre- and post-earthquake modelling is required by SCIRT to compare the catchment performance before and after the Canterbury earthquakes and understand the change in level of service. Where the effects of earthquake damage are clear, for example significant settlement of low-lying areas draining to tidally affected water bodies, this damage may be able to be demonstrated by other means (e.g. analysis of LiDAR data) and modelling may not be required.

Of the three catchments described in this paper, Southshore was the only catchment to be modelled both pre-earthquake and post-earthquake. For the New Brighton Road and Bridge Street catchments, the effects of the earthquakes on the catchments was determined by the design team through analysis of LiDAR data, and pre-earthquake modelling was not required. The New Brighton Road and Bridge Street catchments were therefore modelled with two post-earthquake scenarios: with the existing infrastructure and with the proposed rebuild design.

4.4 KEY PARAMETERS

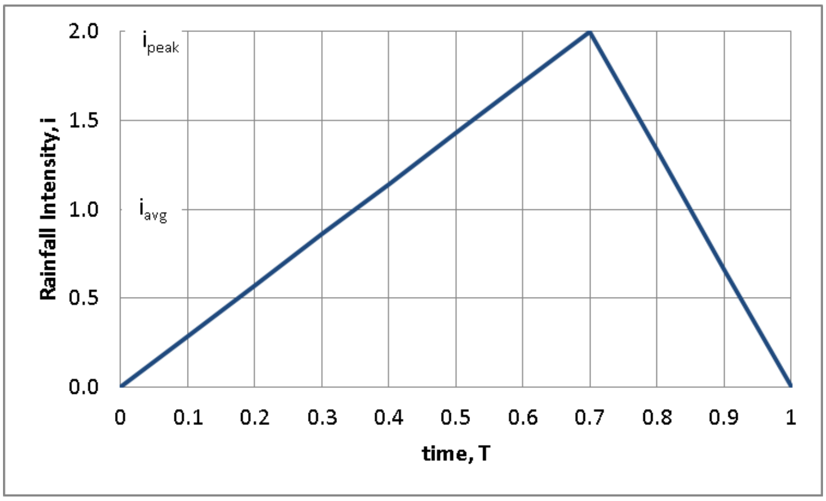
Runoff from the catchments was calculated using the kinematic wave method or Model B in MIKE URBAN. Model B requires manually input variables to calculate runoff, with Horton's infiltration used for losses. A summary of the variables used are listed below, these have either been supplied by CCC or taken from the CCC Waterways, Wetlands and Drainage Guide (CCC, 2011), Section 21, 2011 update.

- Initial loss of 5 mm in Living 1 zone and 10 mm in parks and reserves
- Hortons infiltration:
  - 5 mm/hr reducing to 2mm/hr in the pervious percentage of the Living 1 zone
  - 10 mm/hr reducing to 5 mm/hr in the parks and reserves which are 100% pervious
- Hortons decay factor of
  - 1.5×10^{-3}/s for the Living 1 zone
  - 3×10^{-5}/s for the parks and reserves
- Catchment hydraulic length, measured for each catchment
- Slope, average slope calculated for each catchment
- Catchment Mannings M=30 for the 1D model
- Mannings map created for the 2D model consisting of:
  - Roads M=50
  - Properties / reserves M=28.6

Note that a Mannings M is the inverse of Mannings n. A Mannings M of 30 is equivalent to a Mannings n of 1/30 or 0.033.

Rainfall time series were developed using the CCC Waterways, Wetlands and Drainage Guide (CCC, 2011). The storm profiles were also taken from CCC (2011) with a peak intensity of twice the average intensity occurring at 0.7 of the total storm duration, this is shown in Figure 5.

Figure 5: CCC design hyetograph



Rainfall intensities were taken from Appendix 10 of CCC (2011). These figures include a climate change adjustment of 16% and are shown in Table 3.

Table 3: Rainfall intensities for Christchurch City

AEP	Storm duration (hours)								
	2	**6**	**12**	**24**	**30**	**36**	**42**	**48**	**60**
50%	8.43	4.85	3.43	2.42	2.07	1.82	1.64	1.49	1.27
20%	11.80	6.76	4.77	3.37	2.88	2.54	2.28	2.08	1.78
10%	14.20	8.15	5.75	4.06	3.47	3.06	2.75	2.50	2.14
5%	16.60	9.58	6.76	4.77	4.08	3.59	3.23	2.94	2.52
2%	20.20	11.60	8.19	5.78	4.95	4.35	3.91	3.56	3.05

4.5 PRIMARY SYSTEM

Following the February 2011 earthquake, parts of the pipe network and roads in the modelled area were damaged or shifted by ground movements. These areas require re-design and repairs or replacement. The infrastructure which was modelled included existing sumps, pipes, manholes and roads, which were surveyed after the earthquake. The conceptual and then detailed rebuild design, including sumps, pipes, manholes and roads realignments, was added to the models, and refined through the modelling. Additional sumps, pipes, and manholes were added into the models and pump locations and pipe sizes refined as needed to convey water to the Avon River or Estuary either directly or via new pump stations.

The modelling process is described in more detail in sections 5 and 6.

The kerb and channel forms a very important part of the stormwater network in Christchurch. The primary system of kerb and channel and pipes is generally designed to convey the 5 year event, with secondary flows along roads in larger events. These catchments also include some areas of older style deep dish channel, which has greater conveyance and storage capacity than modern kerb and channel.

The earthquakes have changed overland flow paths along kerb and channel due to differential settlement, meaning in some cases that stormwater is no longer able to reach the existing pipe network.

4.6 SECONDARY FLOW PATHS

Secondary flow paths in these catchments are generally along roads, with some secondary flow paths through reserves.

One example of a secondary path through a reserve is the channel through the Rawhiti Domain in the New Brighton Road catchment (Photograph 2). This runs north-south through Rawhiti Domain from Shaw Avenue to Keyes Road. The channel is grassed and maintained by the golf course as it intersects many of the fairways. It has subsoil drainage and remains dry except during events.

Photograph 2: Overland flow path through Rawhiti Domain

It is important to note that in the New Brighton Road and Bridge Street catchments the catchment is generally separated from the River or Estuary by stopbanks. This means that secondary flow can only serve to convey water to another part of the catchment or to the next sump with spare inlet capacity, due to the stopbank restricting any overland discharge to the River or Estuary.

4.7 CATCHMENT LEVELS RELATIVE TO EXTREME HIGH TIDES

Areas of New Brighton, Bridge Street and Southshore have always been susceptible to extreme high tides. This issue has become worse as a result of earthquake-related settlement. There are areas in all three catchments which are below the 5 year high tide of RL10.78m.

Following the earthquakes, temporary stopbanks were constructed along the Avon River edge in these three catchments. It is understood that these stopbanks will be replaced long-term, at the current level or higher.

To prevent the ingress of water from the River or Estuary into the catchment, flap gates are generally included on the outlets in these catchments. Flap gates on pipes can silt up over time, as shown in Photograph 3 and 4. This can lead to flap gates blocking (preventing stormwater from draining) or leaking and allowing flow into the stormwater network from the River or Estuary.

Photograph 3 and 4: Stormwater outlets draining to the Avon-Heathcote Estuary

The use of in-line rubber flap gates on the rebuilt outfalls and the rationalisation of outfalls (tested in the modelling) is intended improve this.

5 1D MODELLING

5.1 IMPORTING PIPEWORK

The stormwater network, comprising network GIS data supplied by CCC, survey data and newly designed pipe systems, was exported from 12d Design and imported into MIKE URBAN. This process became an iterative task through the design process, as designs were updated and surveys extended to include more of the network. This was also the case for the 2D surface. Since roading is the main overland flow route for stormwater any new roading designs had to be updated and merged with the LiDAR to give the best indication of the future developed case.

The three catchments modelled originally had 56 stormwater outlets draining to the Avon River and Estuary. For modelling purposes it was assumed that all of the outlets and tidal gates were present and operating correctly.

5.2 OVERLAND FLOW PATHS

As is standard with many 1D stormwater models well-defined overland flow paths were added to the 1D model. These included roads (kerb and channel) and swales. The purpose of having these included in the 1D model was to speed up the process of finding the critical duration and tidal time shift testing. The critical durations were then tested in the 2D model.

5.3 TESTING SCENARIOS IN 1D

Due to time constraints models were initially built as 1D only. These models included major overland flow paths such as roads. This meant run times were very quick and could be used to test critical durations and different tide/rainfall event timing. Only the critical durations were then run in the 2D models.

As noted in section 4.2, rainfall durations ranging from 30 minutes to 72 hours were tested in the 1D model. These durations were also tested with the three tide shift scenarios (runs beginning at low, mid- and high tide). These runs were completed for the 50 year ARI rainfall event and 5 year tidal cycle. They were then repeated for the 5 year ARI rainfall event and 1 year tidal cycle. The critical duration was assessed as the event combination which gave the greatest flood depth. This was checked at a range of locations across the catchment.

Pipe sizing for new and replacement pipes were supplied by the SCIRT design team and incorporated into the model. These pipe sizes were tested in the 1D model, and in some cases resized using the 1D model, before being tested in 2D.

Initial pump station locations were selected, in conjunction with the SCIRT design team, based on catchment levels and the existing pipe network. Manual calculations were used as a starting point for pump flow rates. The pump flow rates were refined in the 1D model to a level that reduced the peak water levels in the overland flow paths to an acceptable level. These were then run and refined further in the 2D model.

6 2D MODELLING

6.1 COMBINED 2D SURFACE

The surface tested in the 2D MIKE URBAN model was a digital elevation model (DEM) constructed by the SCIRT design team in the civil design software 12d Design using a series of layers built up to give the most up to date and accurate surface possible. These layers included:

- Post-earthquake LiDAR, flown post-June 2011 event or post-December 2011 event.
- Topographical survey of roads
- Topographical survey of critical areas.
- Future roading designs by SCIRT
- Future design of stopbanks

In the New Brighton catchment, low lying areas of the red zone were surveyed to accurately reflect any informal storage which may occur in low lying areas. In the surveyed red zone areas, where houses will be demolished, the houses were removed from the DEM, meaning that in the model water can pond over the entire property. This creates extra storage capacity but it is limited to small areas around the edge of the River.

In all three models, elevations for existing house footprints (outside of the red zone) were edited in the 2D surface from LiDAR by being extended vertically by 30m, so that stormwater in the models was not able to flow through or be stored in the house footprint. This is a conservative approach as it will limit the amount of flood storage available.

6.2 OPTIMIZING GRID SIZE & TIME STEP

With a heavy reliance on kerb and channel flow to convey water it was decided that grid size would be crucial to represent this overland flow correctly.

Grid size can have a dramatic effect on the run times of 2D models. A range of grid sizes were tested to find the optimum balance between model run time and appropriate representation of flow along the kerb and channel and road. A 5m gird was too coarse to define the kerb and channel flow and 0.5m grid was too fine resulting in long run times. Results showed that in most places a 2m x 2m grid was adequate for representing overland flow along kerb and channel. Some streets have deep dish channels; this means that driveways crossing the dish are picked up by the LiDAR and transferred to the grid, which can cause an obstruction to the flow. These areas were identified and the grid edited where this was inappropriately impeding or redirecting overland flows.

Model time steps were also tested to find the best balance between run-time and stability. This resulted in a 0.5 second time step being adopted for the coupling of the models and reporting results at a 1 minute interval.

The largest catchment modelled was the New Brighton Road catchment at 391 ha. With a 2m x 2m grid and 0.5 second time step, this resulted in a 10 hour model run time. This meant any design changes were incorporated before the model was run overnight, giving a two day turnaround on results.

6.3 VERIFICATION/CALIBRATION

As with many stormwater models, full calibration of these models was not possible, but field checks were made to verify results. One method used to verify results was to speak with residents about the flooding issues both pre- and post- the earthquakes. Flooding in these areas has also had media attention. Photos of historic flooding were available from both the media and residents. Another useful verification method used was the comparison of ponding areas predicted in the model to CCC’s rain on grid results maps for the Avon River catchment.

Since the earthquakes there has been a series of small rainfall events that have shown flooding in the three catchments. A storm event on the 4 and 5 of March 2014 showed significant flooding across large areas of Christchurch. Site visits were made to areas of flooding predicted by the 2D modelling. It was found that the 2D modelling and observed flood areas and extents were generally consistent.

Photograph 5 shows the extent of flooding in the Keyes Road/Lonsdale Road intersection area on the morning of 5 March 2014. The modelling showed this area to be at risk of flooding and acting as an overland flow path toward the river.

Photograph 5: Flooding on Keyes Road near intersection with Lonsdale Street

6.4 COMMUNICATING MODELLING RESULTS

The results from 2D modelling can be bulky and difficult to display in detail over a large area. As a key input into the design process, the modelling results needed to be communicated with the SCIRT design team, located in a separate office remote from the Beca modelling team.

We found that although reports on the modelling inputs and results were the key deliverable, the SCIRT design team preferred spatial results where they could navigate themselves. The SCIRT design team did not have access to GIS software so all flood depth and flood level results were exported to Google Earth format (.kml). This meant results were displayed in a format that was easy to display, navigate and interrogate quickly. This lead to a good understanding of the modelling results by the SCIRT design team and quick turnarounds in design changes.

7 OUTCOMES

The three modelled catchments are all similar but have resulted in three different solutions.

7.1 SOUTHSHORE

The 2D modelling of pre-earthquake and post-earthquake showed that there was not a significant overall increase in flooding as a result of the earthquakes, and in some areas the flooding extent had been reduced. A decision was made to repair and/or replace damaged pipes in the Southshore catchment, with no wider network improvement.

7.2 BRIDGE STREET

The Bridge Street catchment solution involves construction of a storage pond of around 2,100m^3 volume and a 1,000L/s pump station discharging to the Avon River. The modelling showed this option was required to protect houses from flooding in the 50 year event. The construction of this solution is currently underway and is due to be completed mid-2015.

7.3 NEW BRIGHTON ROAD

In the New Brighton Road catchment there is very limited land available at the downstream end of the catchment and therefore a stormwater basin is not a workable solution. Instead, solutions for the New Brighton Road catchment involve pipework replacement and a number of new pump stations discharging to the Avon River, with a combined capacity of approximately 4,600L/s.

Concept design for the New Brighton Road catchment has been completed, and detailed design has been split into two projects. For the area south of Pages Road detailed design is complete and construction of the stormwater rebuild works, including two new pump stations, is planned to commence in mid-2014. For the area from Pages Road north detailed design is currently on hold, pending red zone decisions.

8 CONCLUSIONS

The New Brighton, Bridge Street and Southshore catchments in east Christchurch are complex catchments, with a range of issues following the earthquakes. Modelling of these catchments provided useful input throughout the rebuild design process, from understanding the catchments, to options assessment and detailed design.

A number of techniques were used to efficiently develop models that were fit for purpose for each part of the design process. These techniques included: limiting the modelling to an appropriate level of detail for that design stage, importing data from the civil design software 12d Design, limiting the number of 2D runs, and optimizing the 2D grid size and time step. This approach meant that tight design deadlines could be met whilst still providing the level of accuracy required for that step in the design process. As each of the models was developed by the modelling team, the SCIRT design team had a greater awareness of the issues associated with each catchment, and could make informed decisions on design changes.

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