ASHBURTON STORMWATER MODELLING – THE GUMBOOT TEST

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ABSTRACT

This paper discusses the success of the Ashburton stormwater model development, how the process has led to many benefits not immediately obvious and how it has been used to inform council decision making and long term asset management. Key to this was the 'hands on' approach taken by the team and the utilization of easy to interpret visual outputs. This enabled immediate buy in from the councilors allowing staff to move quickly to using the model for long term stormwater management planning.

KEYWORDS

Stormwater, Asset Management, Hydraulic Modelling

PRESENTER PROFILES

Mark Groves is an engineer with over 15 years of experience spanning both New Zealand and the United Kingdom covering infrastructure design, hydrology, hydraulic modelling, low impact stormwater design and flood risk management.

Sarah Dudson is an Environmental Engineer with Opus International Consultants. During her eight years' experience Sarah has developed broad infrastructure design skills across the three waters and has specialised in stormwater management, including design of stormwater conveyance and treatment systems, low impact design and strategy development. Sarah is currently project lead for the Ashburton Urban Stormwater Strategy.

1 INTRODUCTION

This paper discusses the value of the detailed modelling work that was undertaken as part of the Ashburton Urban Stormwater Strategy (AUSS). The AUSS started with a policy statement in 2007 and has since progressed to a Stormwater Management Plan for Ashburton, Tinwald and Fairton, as well as stormwater design guidelines for the local area.

The focus of this paper is on how the modelling undertaken has been used to aid Council and improve asset management and planning procedures, as well as the value it added to the overall project.

2 BACKGROUND TO THE MODELLING

The model that was developed was a linked 1D-2D hydraulic model which also incorporated catchment hydrology. The model combined open channels and the entire stormwater network, including sumps, in a single model incorporating LiDAR data for assessment of flood extent and overland flow paths. The model was calibrated to 12 flow

monitoring locations and 5 rainfall gauges, and validated with historic flooding information, site walkovers during flood events and customer complaints.

Prior to the development of the model, studies had carried out done in Ashburton, but they often focused on isolated locations or did not consider the open channel network and the piped network together. There was also limited GIS asset data for the stormwater network.

3 VALUE OF MODEL DEVELOPMENT

Development of the model, whilst of great benefit to the project in itself, also provided a number of other immediate benefits through the data collection and review process. These included:

- Survey of all pipe assets and open channels to a consistent datum. This was then developed into a GIS of asset data for return to council. The model review process also identified and resolved any anomalies in the GIS dataset for Council.

- Inspection of manholes identified a number of locations that required maintenance. These were prioritized and passed back to council for maintenance. Some of the worst locations included pipe outlets that were completely buried under silt and was therefore of immediate benefit.

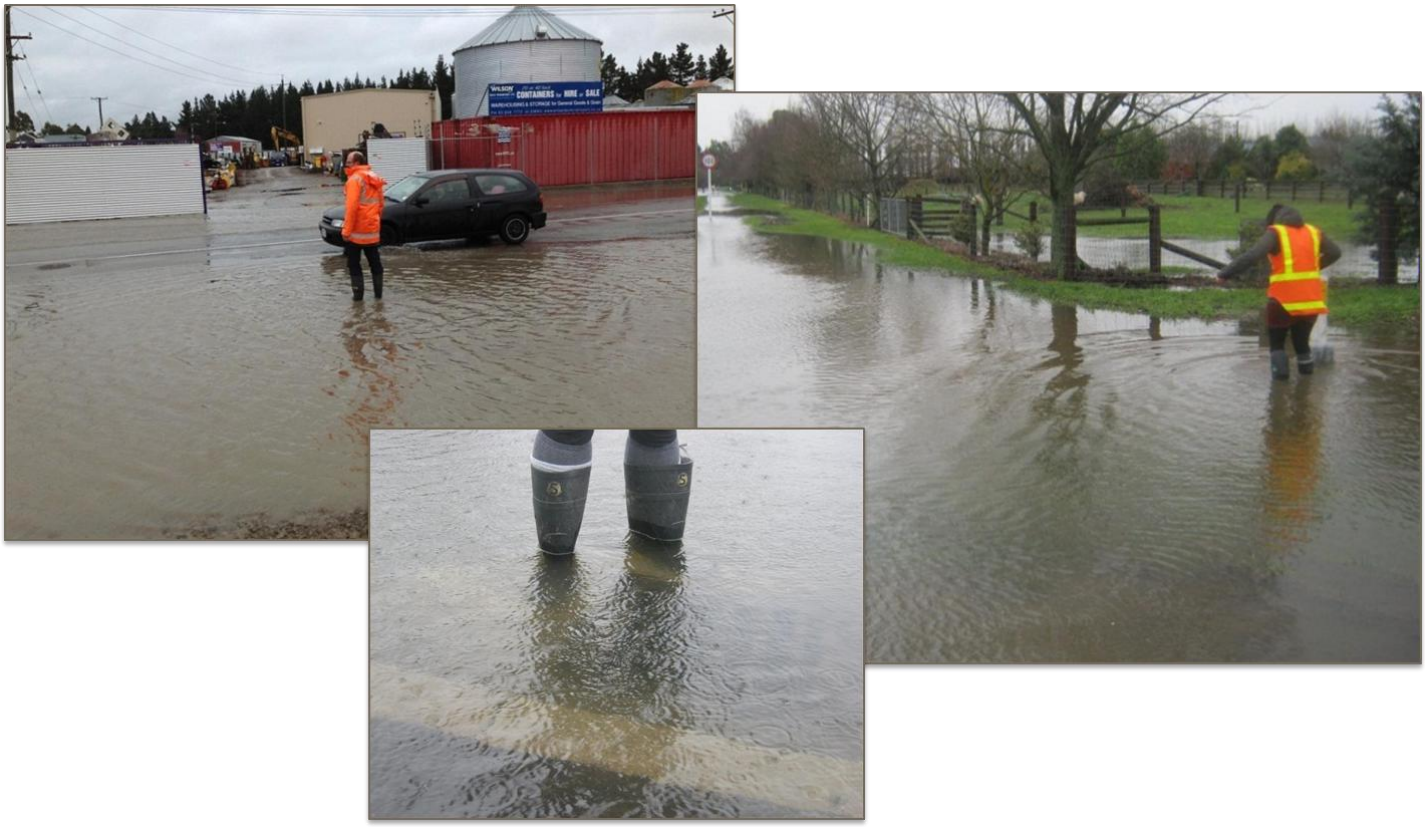
- Customer complaint data was plotted geo-spatially based on street or house address to provide a spatial data set. This enabled visual identification of repeat issues or areas with multiple complaints.

- The LiDAR dataset was processed into a more easily useable gridded product and 0.5m contours were generated in both AutoCAD and GIS format so council could have quick access to level data for the entire township and surrounding area.

- Flow monitoring immediately provided council with a better understanding of flows in their network. For example, the Mill Creek is fed by an irrigation race and the flow entering it could now be estimated. The flow monitoring also confirmed that there was considerable spring flow entering the Mill Creek through one reach, which previously was anecdotally said to be or not be occurring.

- In order to assess system performance, rainfall analysis was undertaken and Ashburton specific design rainfall developed and storm hyetographs developed. This has been incorporated into a design guideline document for Ashburton.

On the ground validation of the model was also carried out during significant rainfall events. We term this the "gumboot test' as the team compared their real world experience of flooding with model outputs to validate results. This often involved comparing depth up their gumboot with predicted depth on screen. This approach demonstrated to council that we understood existing issues, given we had been there at the time, but also provided good flood information for model validation and presentation.



Photographs 1-3: The "Gumboot Test"

4 VALUE OF MODELLING THE WHOLE SYSTEM

The Ashburton stormwater network consists of both pipework and several watercourses. Through the modelling work undertaken, it could be demonstrated that prior estimates of flood flows in these watercourse were overestimated, as these estimates did not account for the effect of the piped system. In the case of Ashburton, it was found that during large events (10% AEP and larger) the pipe network surcharged triggering catchment wide attenuation of flows through surface ponding or diversion of flows away from the watercourse via overland flow paths. The result was a 67% reduction in the predicted peak flow for the Mill Creek compared to a traditional estimate that does not account for operation of the pipe networks.

This result firstly showed the value of looking at how the system operates as a whole, but secondly provided council with an understanding of the impacts of upsizing their pipe network and what the follow on impacts on flood risk or required mitigation would be.

Having level data for the Mill Creek, the stormwater network, the Mill Creek flood attenuation basin and the surrounding road and land levels also immediately identified the causes of a long standing historical issue. Having data for all of these together to a consistent survey datum showed that the entry weir into the flood attenuation basin was higher than the level of upstream sumps. The sumps in turn were connected to the adjacent watercourse which had to head up and flow over the weir into the basin during times of high flow. Long sections could be easily produced to visually demonstrate the issue. Running the model re-created the historic issue very well and enabled generation of 3-dimensional animated visualizations (generated within the software) which non-technical persons could easily understand and relate to.

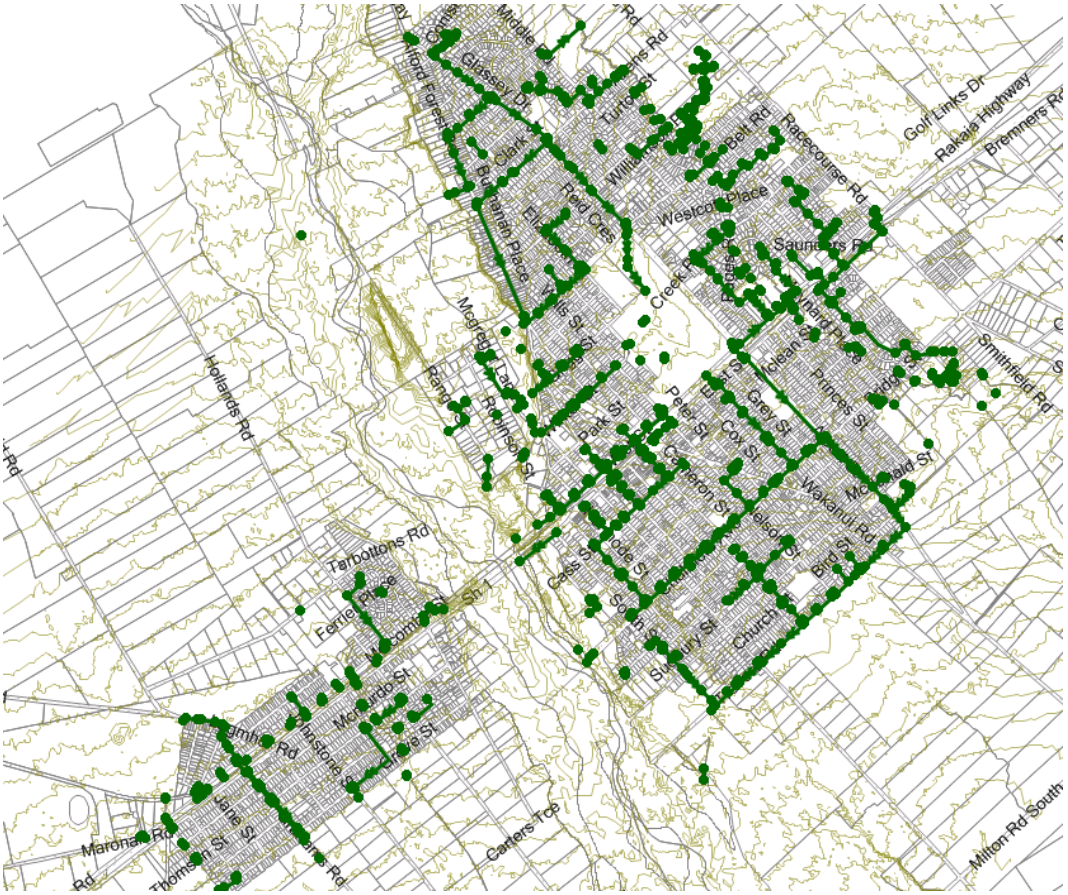


Figure 1: Ashburton stormwater asset and LiDAR information in the model

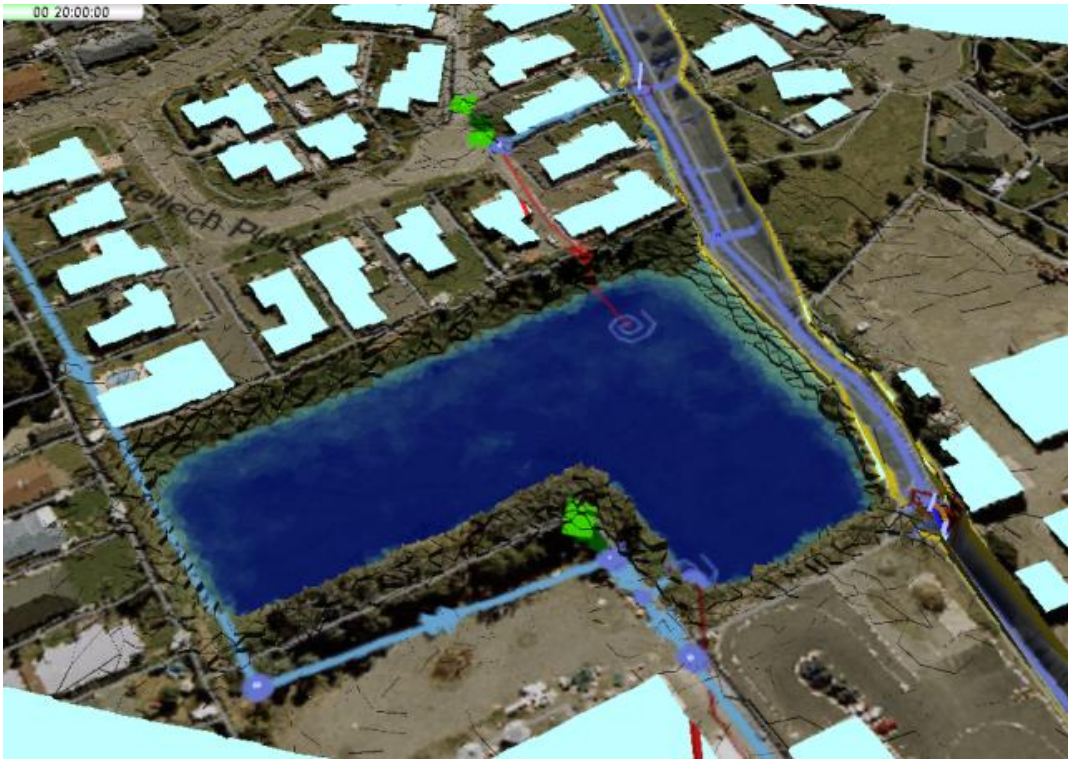


Figure 2: Snapshot from the 3-dimensional animated visualizations of the Mill Creek flood attenuation basin

5 VALUE OF MODEL OUTPUTS

Outputs from the model were presented to council showing animated themed flooding overlaid on aerial photography or 3-dimensional models based on LiDAR and aerial mapping. These visual outputs were paired with photographs of actual flooding to demonstrate the models value.

Figure 3: Example of information presented to Council showing good correlation between model outputs and actual flooding observed.

The outputs from the model will aid Council with planning decisions around flood risk and can be used to produce flood mapping, or understanding the causes of historic issues.

However, for the AUSS, the model was taken further, being used to inform the council's long term asset management and financial planning. This was achieved using a number of upgrade scenarios. Various scenarios were developed that saw the network upgraded to achieve a number of target levels of service (no flooding at 10% AEP, 5% AEP, no flooding greater than 200mm deep at 10%AEP etc…). A financial model was then developed that compared the cost of the various LOS scenarios with a baseline renewal cost. The resulting costs for each scenario were then presented to Council at a workshop.

This was a key output for the project as it provided the councilors with budget costs for various levels of service, allowing them to have informed discussion with rate payers around acceptable levels of service, versus potential costs to the rate payer. This process allowed council to set meaningful objectives and understand the implications of various funding scenarios.

Financial impact of providing for growth through network upgrades could then also be assessed, and climate change mitigation costs assessed in relation to potential damage costs.

Network-wide design values can then be provided to council so when renewals are undertaken, they have the option to future proof the pipe being replaced to consider the longer term network level of service aspirational target.

Given the imminent changes to the Local Government Act, the stormwater model will be a powerful asset management tool, enabling the Council to make informed decisions, demonstrate effectiveness and efficiency in design and help in preparation of 30 year asset management plans.

6 2D RAIN ON GRID HYDROLOGY

One long running issue for council was flooding of rural land bounding Ashburton and Tinwald, which following prolonged rainfall, is prone to widespread but shallow surface ponding and overland flow. In order to identify the flow paths and ponding areas that activate, Rain on Grid modelling was employed with a 2D hydrological model and run for a historic long duration event. Despite the flat and poorly defined topography, this approach yielded excellent results, capturing subtle remnants of old river channels that are visually hard to identify when on the ground, as well as those low points in the topography that pond. The process was quick and very cost effective but yet provided excellent visual outputs which non-technical persons could immediately relate to.

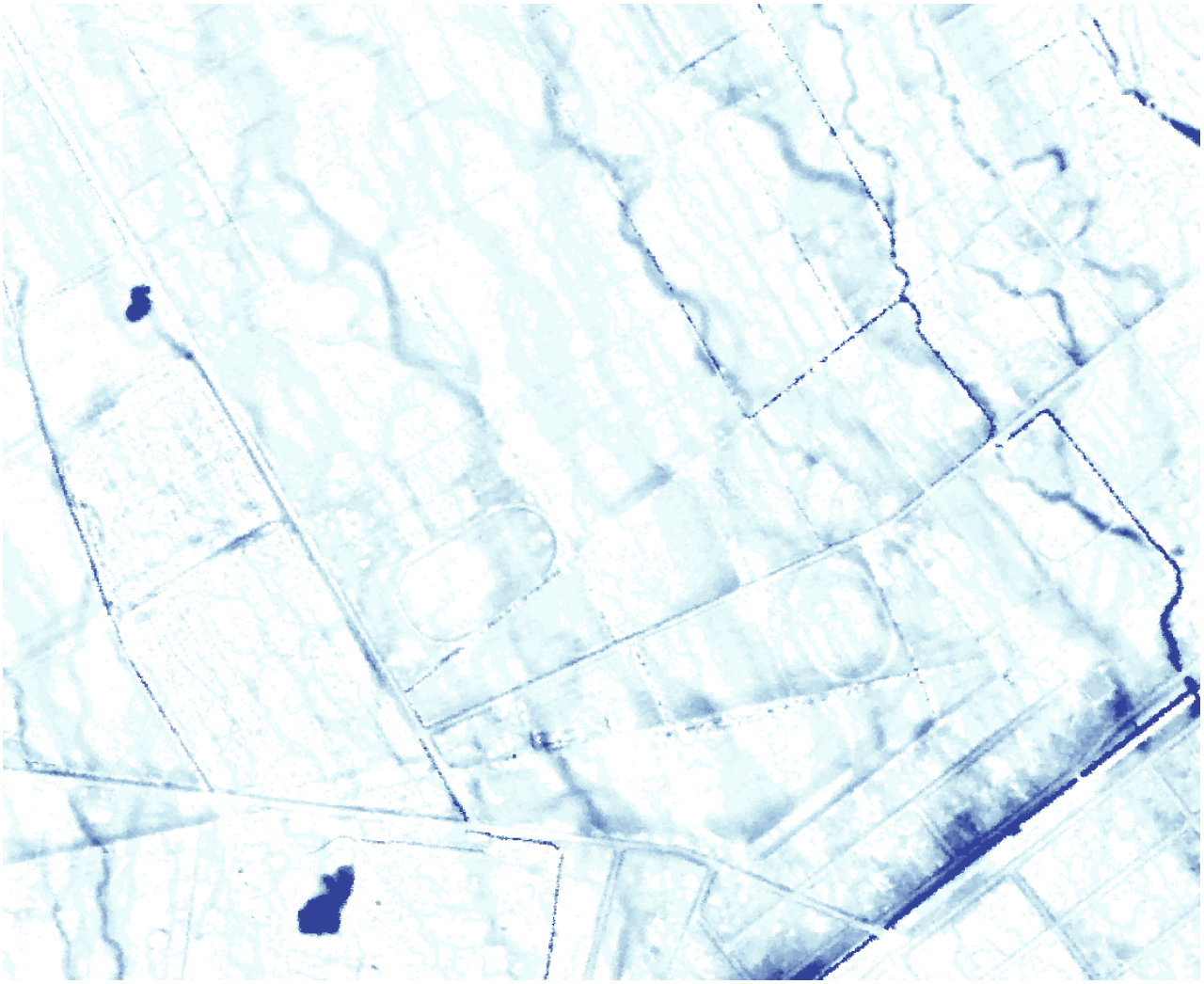


Figure 4: Output from the Rain on Grid modelling

7 CONCLUSIONS

Development of the Ashburton stormwater model has been of huge benefit to council:

- Increasing knowledge of their assets;
- Planning for future changes in Level of service;
- Understanding the network implications of development;
- Being able to provide good quality data to developers;
- Knowing what their long term network needs to look like;
- Enabling them to make informed decisions around target levels of service and cost to the ratepayer; and
- Aiding preparation of 30 year asset management plans.

Use of the latest 2D modelling techniques combined with graphical outputs that were easy to interpret and relate in conjunction with a 'hands on approach' to validation immediately bought Council buy-in, allowing them to focus on the way forwards.

ACKNOWLEDGEMENTS

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