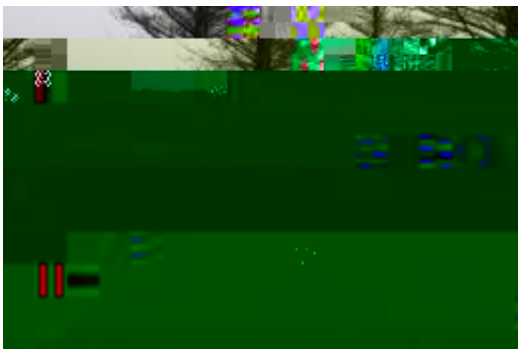
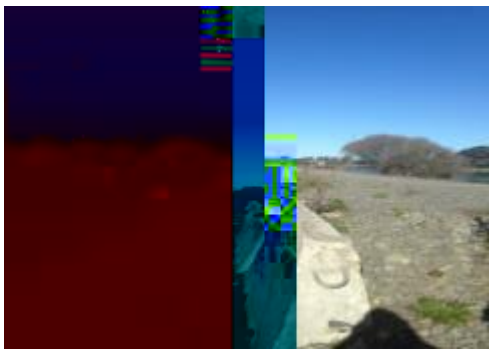
Flood Management in the Avon-Otakaro Corridor: Short-term & Long-term Options


Sarah Long, Emma Fleetwood, Sarah Hayman, Paul Sutherland, James Lentjes & Ellis Evens

Table of Contents:

1. Executive Summary

What is the most suitable and viable mitigation option in the lower Avon Otakaro Corridor?

What are the current mitigation methods in place?

Physical data was collected in the form of GPS and LiDAR data. These were used to show the current mitigation measures, red zoned areas, flood risk areas, as well as to create maps showing pre and post-earthquake land subsidence.

2. Introduction

On September 2010 a 7.1 magnitude earthquake struck the New Zealand city of Christchurch and initiated a series of major earthquakes until June 2011. This increase in seismic activity has had severe impacts on the built and natural environment throughout Christchurch, particularly in the eastern suburbs. A natural impact is the subsidence of land, caused by the sinking of silts and sands; which makes up the majority of Christchurch's underlying sediment. The subsidence has had a direct contribution to the increased flood hazard in the Avon River corridor. This includes areas such as Bexley that have now been deemed as red zones. Our research was set out to discover what conditions currently existed in our selected area, what residents opinions were on current and future options, as well as aiming to gage what direction the Christchurch City Council (CCC) are looking to take towards solving this problem. Following from this our group used a wide array of data collection techniques in order to find the most appropriate mitigation option, the details and results of which are outlined in this report.

3. Literature Review

Literature has shown that there are many mitigation measures that can be implemented to lessen flooding impacts. However, it is about determining the most viable and suitable option for the Avon corridor that would have the most significant effect in reducing the flood risk. Depending on the financial situation of the inflicted area will determine what type of management scheme will be used. The majority of urban flood defences comprise of soft measures or hard engineering structures (van Ree et al., 2011). Where there is no money available, this is when no active intervention is used as engineering options are too expensive (Ledoux et al., 2004). Management retreat is considered a soft measure and is only feasible when all other methods have been exhausted and considered when public or private assets are unsustainable (Ledoux et al., 2004). Therefore flood management techniques used is dependent on the society involved and the economics (Ledoux et al., 2004).

Reducing flooding risk and increasing resilience is a key theme that arises from literature. Since urban areas are more developed they are con

4. Methodology

The yellow box on Figure 1 outlines the case study area in the Avon-Otakaro corridor where we collected our information. This area was chosen as it has the largest flood risk from sea level rise, rainfall and tidal flooding. Although some of this area has been red zoned due to the earthquakes, there are still areas that are inhabitable and are exposed to the flood risk (as shown on Figure 2 and 3).

Figure 1: Case study area of the lower Avon River (Christchurch City Council, 2013).

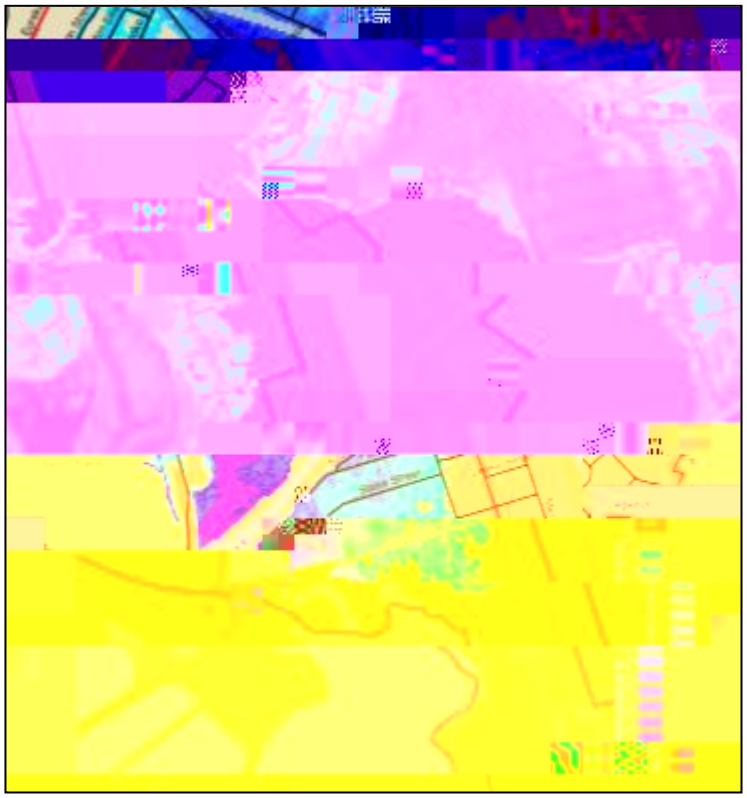


Figure 2: Flood risk of a 0.5 metre rise in sea level (Christchurch City Council, 2013).

Figure 3: Red zone land of the lower Avon (Christchurch Earthquake Recovery Authority, 2012).

The first step was to develop a survey to address our issue of community involvement. When surveying, we chose random sampling so that we got a good assortment of people with different perceptions and backgrounds and targeted people situated within the flood zone. This was to make sure there was no bias result and that the people being directly affected were surveyed. Surveys were done either face-to-face or through email which our community partner distributed to his contacts in the area.

We also set up interviews with key Christchurch decision makers who were involved with the flood issue. Firstly we spoke with Tony Oliver, a principal hazard analyst from Environment Canterbury. We also interviewed Greg Whyte, a principal engineer from DHI Group that runs computer configurations for the CCC using GIS software. Lastly, we interviewed Graham Harrington, a senior surface water planner for the CCC. These

interviews were used to learn more about flood mitigation options and any new plans that were being considered for the Avon corridor.

We collected GPS data which we analyzed and produced maps using ArcGIS. LiDAR data was obtained from the University of Canterbury's Geography Department and programmed into ArcMap where maps were produced. From the LiDAR data particular grids had to be selected that represented our case study area. Using ArcMap we were able to Mosaic those grids together and make a clean image that would show the elevation pre and post-earthquake. These elevation maps were then used to determine subsidence and suitable locations for proposed mitigation measures.

5. Results & Discussion

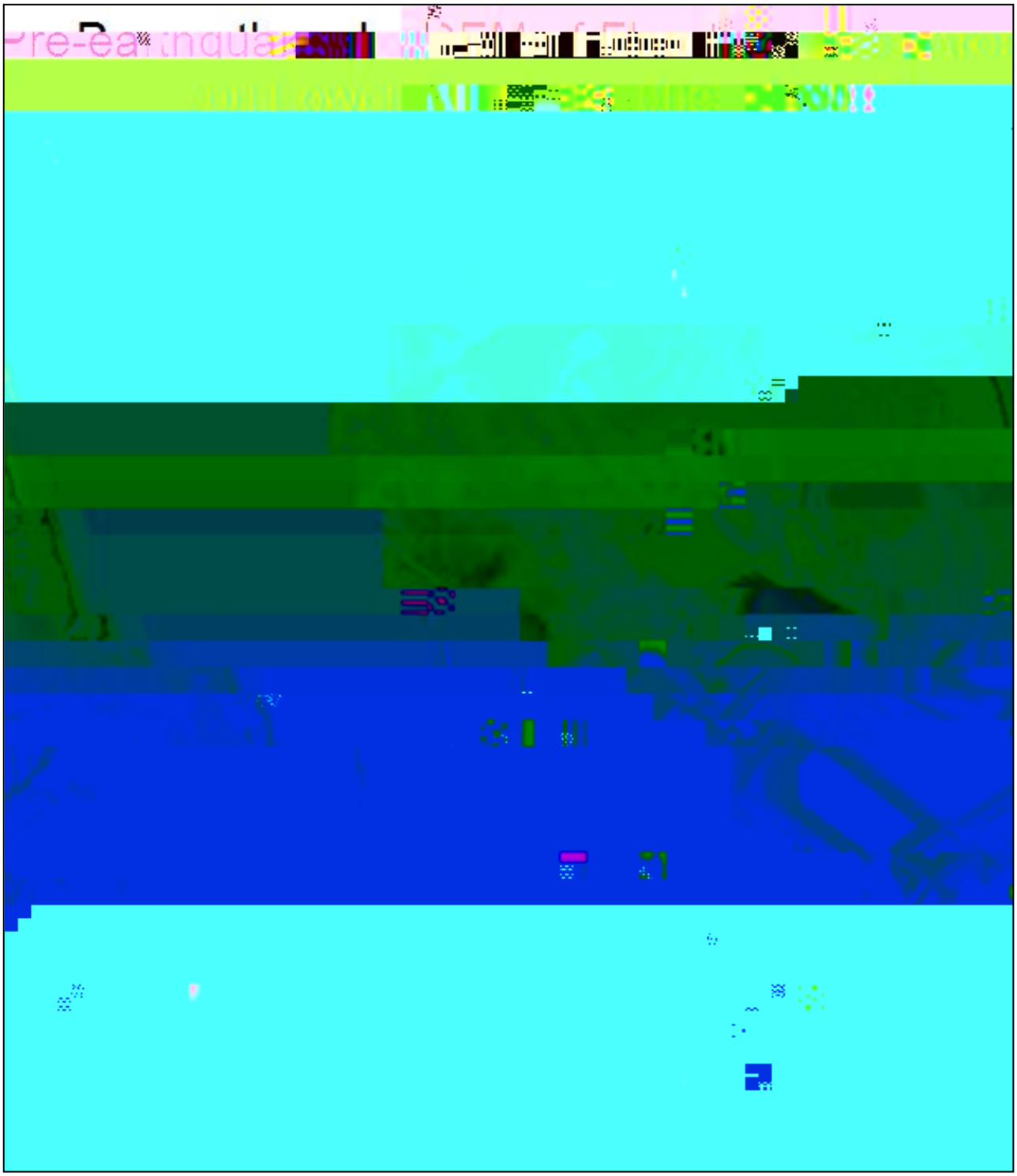


Figure 4: LiDAR data showing land elevation pre-earthquake in the lower Avon corridor.

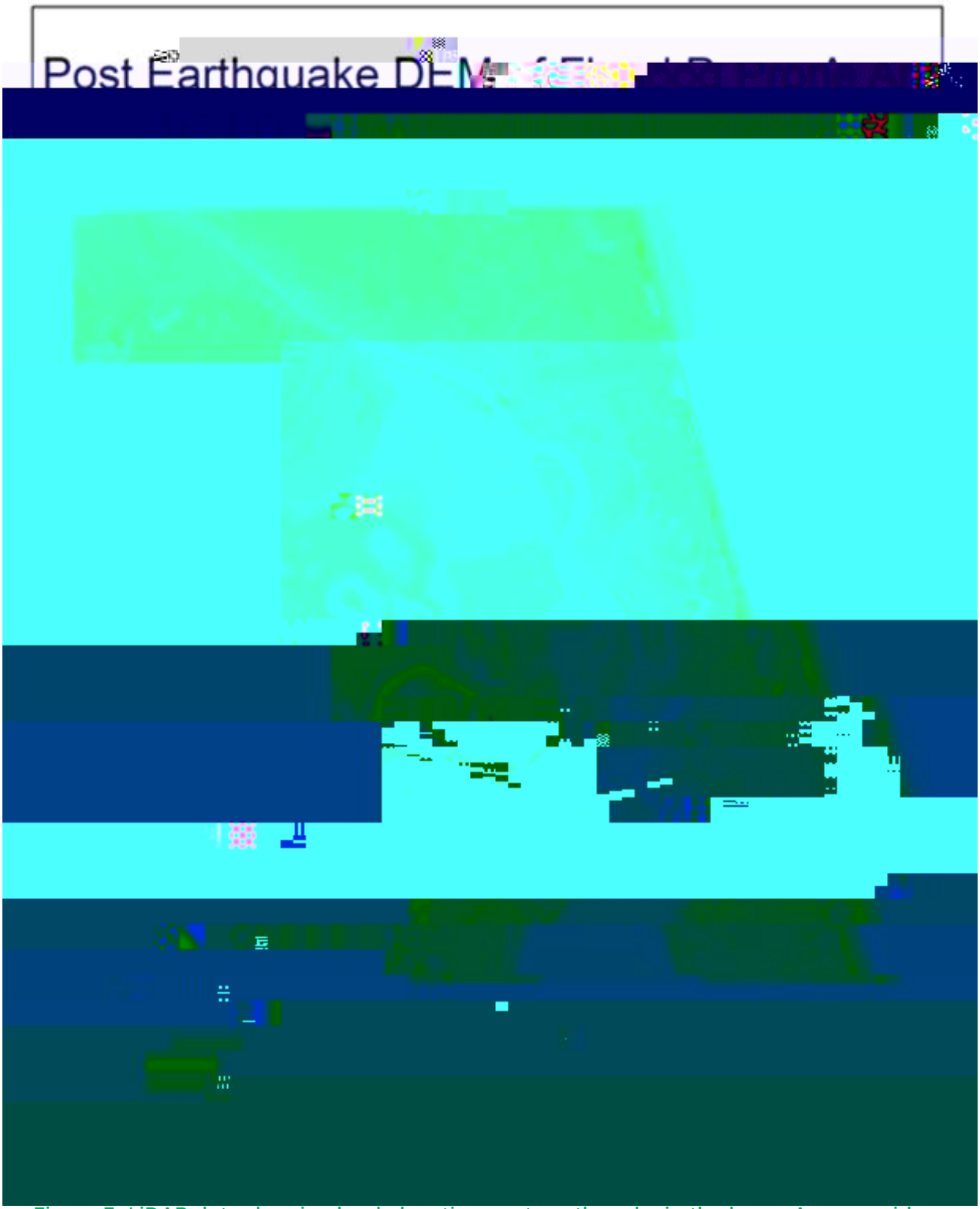


Figure 5: LiDAR data showing land elevation post-earthquake in the lower Avon corridor.

There are various types of stopbanks currently in place, these range in size and suitability

Figure 6: Photograph of sandbags on Owles Terrace.

Figure 7: Sandbag location in relation to Avon River (Google Maps 2013).

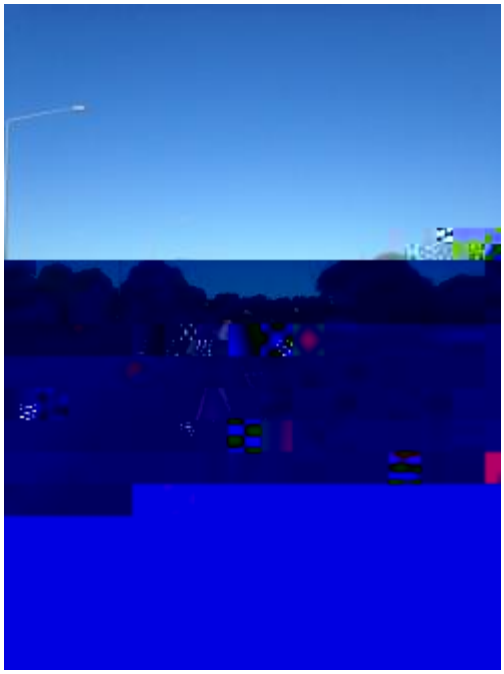


Figure 8: Photograph of temporary stopbank.

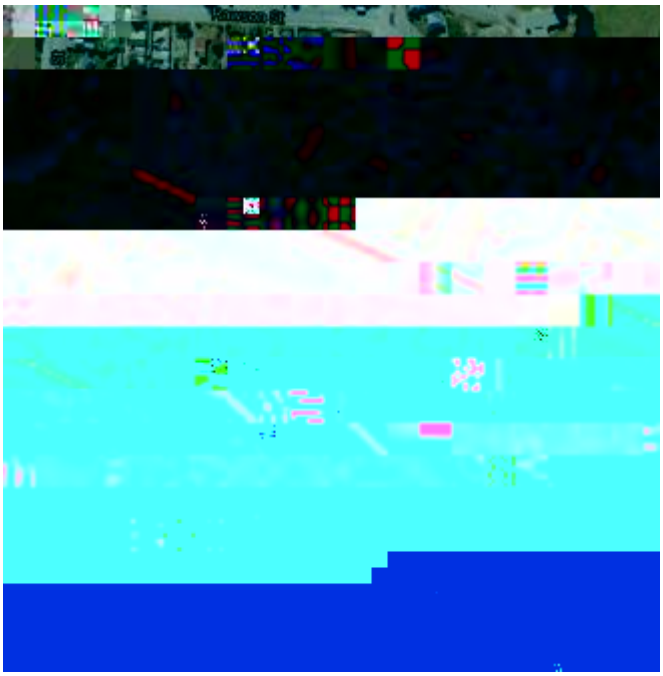


Figure 9: Stopbank location in relation to Avon River Source (Google Maps 2013).

bike paths running on top of them, making them more appealing and functional to the public.

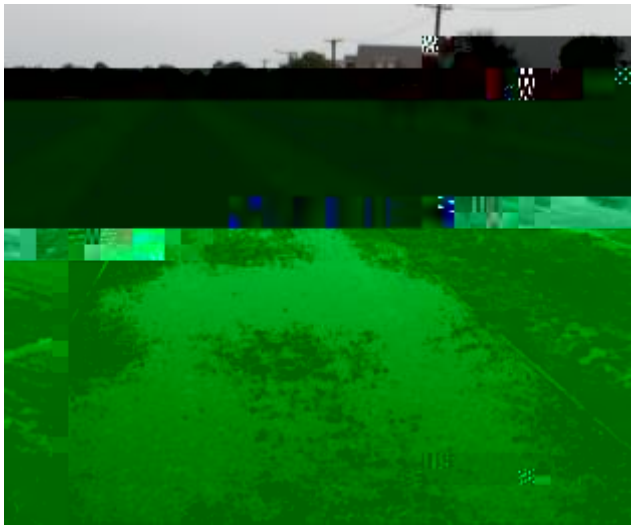


Figure 10: Photograph of permanent stopbank.

Figure 11: Location of stopbanks in relation to Avon River (Google Maps, 2013).

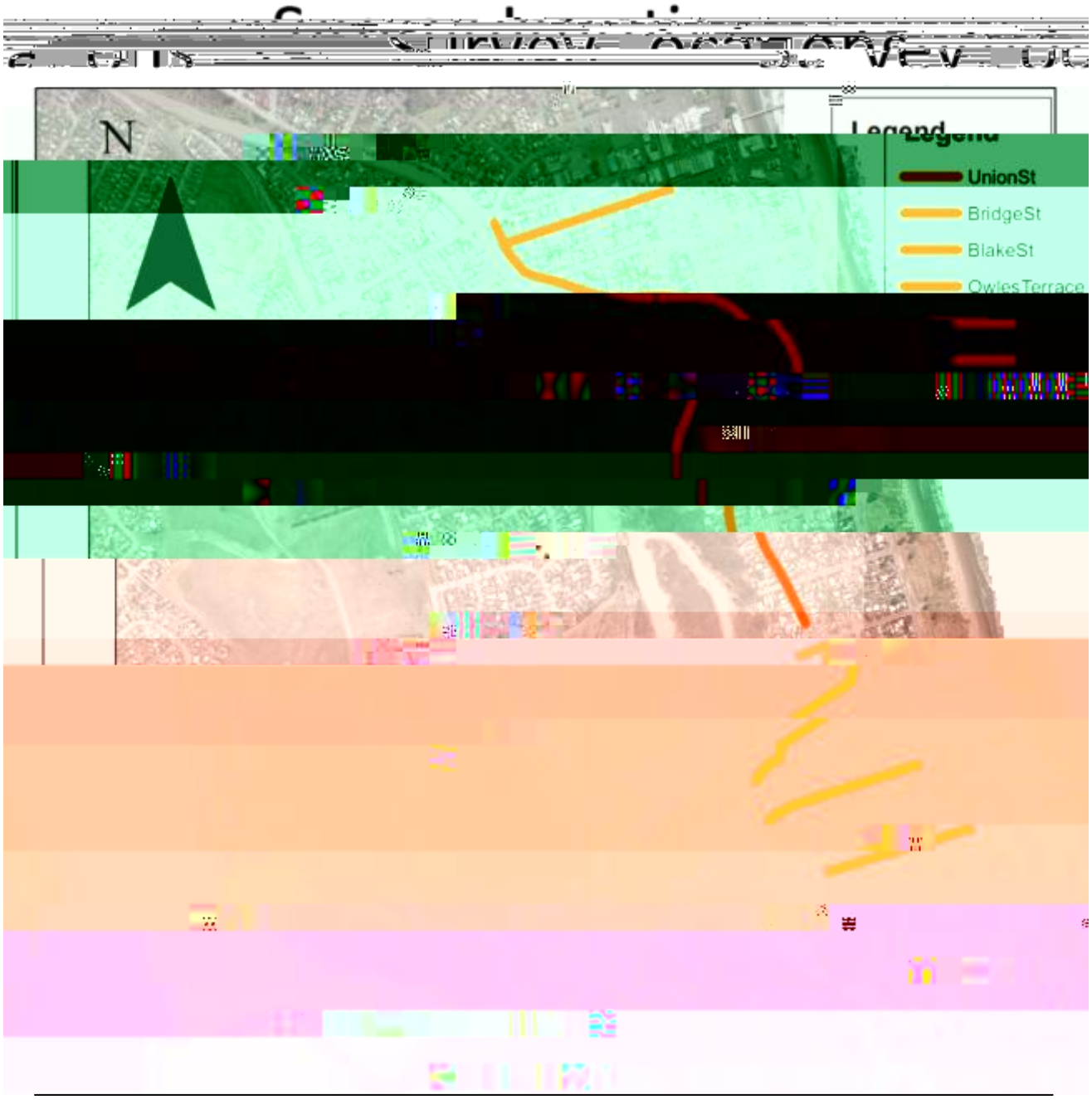


Figure 12: Map of locations where surveys were taken in the lower Avon Otakaro corridor.

Figure 13: Percentage of people who are informed of the flood risk by the city council as answered by surveys.

We collected surveys from 20 different households with their locations shown on Figure 12. The questions that were answered by residents in the case study area are in Appendix 10.1. Our survey results showed that there was only one street (Kibblewhite Street) who had received a pamphlet that obtained information from the CCC about the current flood hazard. This is why 10% of households thought the council was informing them on the current flood hazard, as shown on Figure 13. Whilst 65% of households had not heard anything and 25% of households did not even know there was a flood hazard. This was interesting because areas where people were experiencing flooding were receiving no information from the council. However, people that were not experiencing flooding were receiving pamphlets from the council about the flood risk. This suggests that the council needs to better plan the areas that require flood information based on the areas flooding experiences.

Surprisingly, no one had flooding on their property, but 65 % of households had experienced street/path flooding, as shown on Figure 15.

Figure 16: Percentage of people's thoughts on management retreat as answered by surveys

flood mitigation techniques. Stopbanks was the main option highlighted in the report, which are discussed further in .

While interviewing Greg Whyte we were able to obtain a better visualization of the flood risk in the Avon corridor through the use of GIS. The main point we took from this interview was that not one mitigation measure will be able to mitigate all flood types. This allowed us to understand that a combination of mitigation techniques are needed to constrain the flood extent. Greg also suggested the idea of spillways and noted the issue of the land being high in elevation compared to the river so would therefore require significant excavation. This issue is discussed further in

Obtaining information from the CCC was also crucial as they are key decision makers in Christchurch. Although Graham Harrington could not provide great detail on the work the council is doing due to it not being disclosed information, he assured us the council is looking into stopbanks and potentially management retreat. Questions were asked about whether stopbank height was considered in comparison to sea level rise. This allowed for insight into whether the council was looking into long-term mitigation strategies. We also asked if the council had considered management retreat in the New Brighton area. It had briefly been considered and they have said there is more information in which they need to

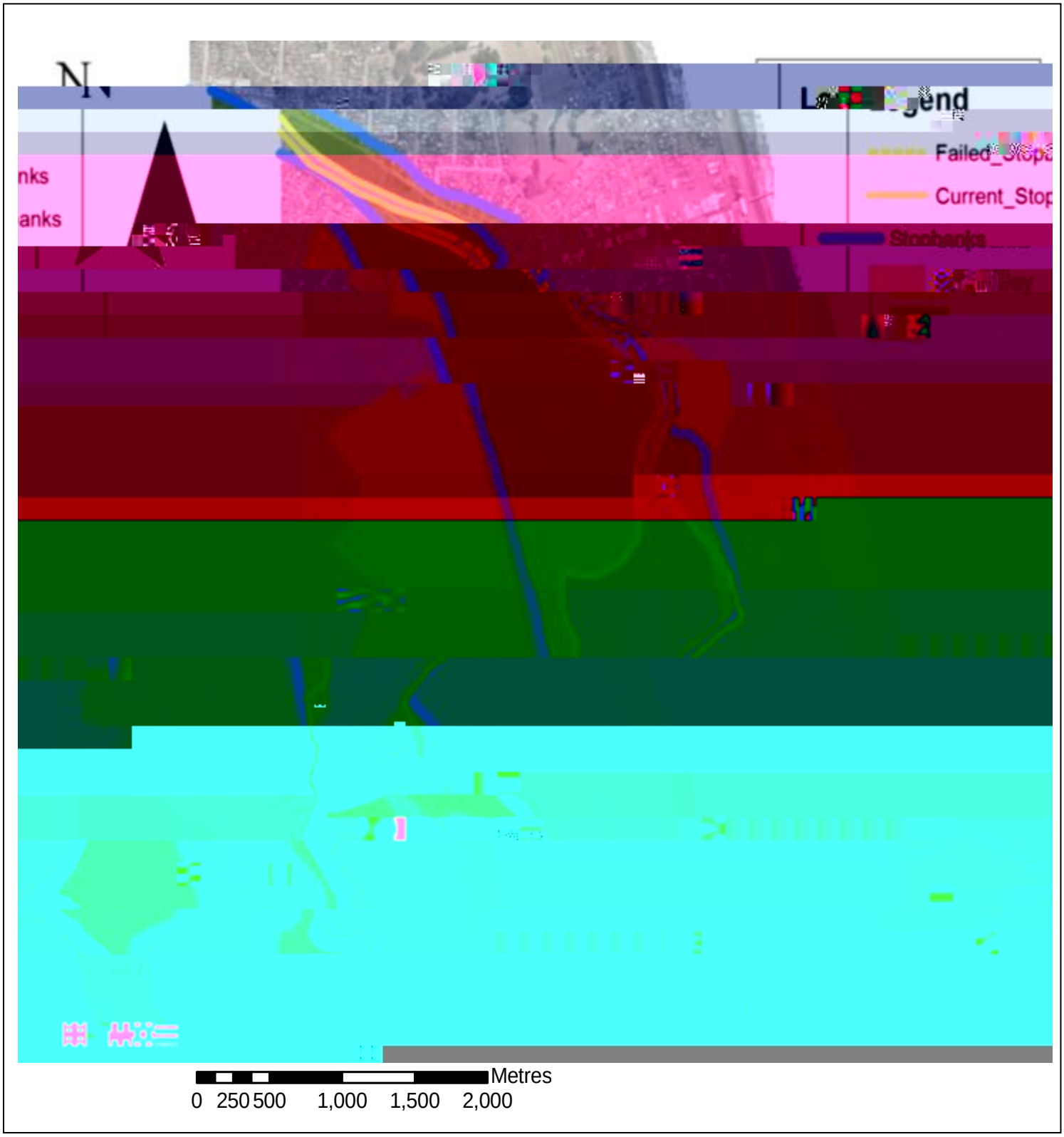


Figure 17: Proposed mitigation measures for the lower Avon Otakaro corridor produced in ArcMap

Figure 17 shows the proposed mitigation measures that were produced using the digitize tool in ArcMap. This map was completed based on the research we had found and the mitigation measures that were believed to be the most appropriate for the area. The blue

lines indicate where new stopbanks would be implemented and are located around the edge of the red zone. These stopbanks are placed here because when the river is in flood, the water is able to flow over the banks and into the wetlands. The wetlands (green areas) will allow water to infiltrate and reduce run-off, which will reduce flood extents. Since Bexley was severely damaged in the earthquakes and this area has now been deemed uninhabitable and uneconomic to build on, this area would be restored back to wetlands. The orange area represents spillways that will be used to store water during flood events.

District Council, 2012). Management retreat is a suitable option as moving people out of the affected area reduces the risk to the community and allows for long-term planning and management.

However there are still limitations to this option. Although whilst carrying out our surveys we were able to further explain the option to some of the community, there was still a definite lack of understanding and awareness. Community awareness needs to be addressed and the public need to be educated for acceptance to be gained on management retreat (Alexander et al., 2012). This could be done through the use of workshops and

accommodate human needs (Zedler, 2000). Adequate timing, frequency, amplitude and duration of high water levels need to be maintained to support biodiversity and functionality of wetlands (Zedler, 2000). Therefore wetlands are a suitable option for the lower Avon but would require a significant scientific knowledge and research on the existing wetland conditions.

The following includes a brief summary of other methods that we researched but did not

that it is an idea that has come up, but no one is willing to do the research needed, making it harder for us to find information.

Short-term and Long-term Definitions

The terms "short term" and "long term" are both hard to define and are dependent on the issue and situation. Due to there being ongoing seismic activity and disruption to Christchurch it is hard to determine when the flood mitigation measures will be implemented. In our current situation "short term" is defined as occurring during the next 5 to 7 years. Whilst in the long term we can expect the measures to take place in up to 10 years or more as these measures require more planning and management. There is also the question of how fast climate change will occur and when Christchurch will encounter sea level rise. This can only be determined by further research and modeling to define the impact of sea level rise on the area.

Time

An important constraint for our study was time as we only had 12-13 weeks to carry out our research. This has caused us to restrict the case study area to only the lower Avon corridor instead of the entire river. Time restraints also lessened the amount of people surveyed which limited the

Agyeman, J., Devine-Wright, P., & Prange, J. (2009). Close to the edge, down by the river? Joining up managed retreat and place attachment in a climate changed world. , (3), 509-513.

Alexander, K.S., Ryan, A., & Measham, T.G. (2012). Managed Retreat of Coastal Communities: Understanding Responses to Projected Sea Level Rise. , (4), 409-433.

Christchurch City Council. (1997). Retrieved from Tony Oliver, Environment Canterbury.

Christchurch City Council. (2013). . Retrieved from http://www.ccc.govt.nz/

Christchurch Earthquake Recovery Authority. (2012). . Retrieved from http://cera.govt.nz/maps/land-status

Cooper, N.J. (2003). The use of 'managed retreat' in coastal engineering. (2), 101-110.

Correia, F.N., Fordham, M., Saraiva, M., & Bernardo, F. (1998). Flood Hazard Assessment and Management: Interface with the Public. , , 209-227. Retrieved from SpringerLink database.

Drainage Services Departments (2012). s. Retrieved from http://www.dsd.gov.hk/EN/HTML/242.html

Google Maps. (2013). [Avon River, Christchurch] [Street Map]. Retrieved from https://maps.google.co.nz/maps?q=avon+river&hl=en&ll=-43.514852,172.725377&spn=0.017646,0.042272&sll=-40.799894,175.310128&sspn=37.550906,86.572266&t=h&hq=avon+river&z=15

Jing, Z. (2010). GIS Based Urban Floo City ET4Z. p5(11)4(0.)] T()3(2)7(01JET:64n)4(M()3(1)7(9se)-2(:51 2355

Ledoux, L., Cornell, S., O'Riordan, T., Harvey, R., & Banyard, L. (2004). Towards sustainable flood and coastal management: identifying drivers of, and obstacles to, managed realignment. (2005), 129-144. Retrieved from ScienceDirect database.

The Press. (2012). . Retrieved from http://firstfourships.co.nz/rzProject/zonelife-ideas.php

van Ree, M.A., Heilemann, K., Morris, M.W., Royet, P., & Zevenbergen, C. (2011) FloodProBE: technologies for improved safety of the built environment in relation to flood events. , , 874-883.

Xing, Y. N., Ruan, X. H., & Zhao, Z. H. (2006). Effects of depth of sediment dredging in urban rivers on release of nitrogen and phosphorus. , 4, 005.

Zedler, J.B. (2000). Progress in wetland restoration ecology. , (10), 402 - 407. Retrieved from ScienceDirect.

Zevenbergen, C., Cashman, A., Evelpidou, Pasche, E., Garvin, S., & Ashley, R. (2011). Flood proofing the urban fabric. (pp. 205-225). London: Taylor & Francis Group.

Zevenbergen,C., Gersonius,B., Puyan,N., Van Herk,S., (2007) Economic Feasibility Study Of Flood Proofing Domestic Dwellings. , 299-319.

10. Appendix

1. What is your current street address?

2. How long have you been living in the address above?

3. Are you a business owner or household owner?

Stock banks

Vegetation

Manage retreat

Raising houses

Dredging

Other

18. How much do you know about Management retreat?

19. Would you be willing to move house?