

# MAYORAL FLOOD TASKFORCE

## Final Report Part A: Key Findings and Recommendations

August 2014



Document Control

Document title: Mayoral Flood Taskforce Temporary Flood Defence Measures  
Final Report – Part A: Key Findings and Recommendations

Revision: Final Rev A

Date: 8 August 2014

TRIM ref: 14/893988

**Document history and status**

Revision	Date	Description	By	Review
Final Draft	4 July 2014	Final draft for internal review only	Peter Christensen	Mike Gillooly Tom Parsons Sylvia Maclaren
Final Rev A	8 August 2014	Final report	Peter Christensen	John Mackie

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## Foreword

Those of us who haven't experienced the devastation of flood waters entering our homes would find it hard to imagine what it is like.

Over the last twelve months I have met many of you in school and church halls. I have sat around the kitchen table in your flooded homes and heard your stories, your frustration and your anger. I have watched, helpless, as you evacuated your homes, carrying your children to the car in the middle of the night.

This report tells us for the first time how big the problem is across the city for our most vulnerable homes. It tells us more of the human dimension – the impacts on children, families, and the elderly, and how we as a Council and as a community can help.

It offers viable solutions for some, and for others there is still more work to do. Some will be surprised that they are not represented in this report and for that I apologise in advance. In the time available it just wasn't possible to include everyone, and I am acutely aware of some of the shortcomings of the data that we are dealing with.

There are solutions and they vary. The focus of the Taskforce was on what we could do to help until more permanent solutions are put in place.

Some things can be done immediately, some will take time, and some will take a lot more dialogue with other agencies and Central Government.

I would like to thank all my colleagues in this Taskforce for their huge effort and commitment over the last two months.



Mike Gillooly

Land Drainage Operations Manager and Task Force Leader

4 July 2014

## Acknowledgements

The team would like to acknowledge the support provided from the wider Council, SCIRT, other stakeholder organisations (ECan, EQC and CERA), organisations of the Taskforce members and most importantly, the members of the public who shared their knowledge.

## Executive Summary

In early 2014 Christchurch had the heaviest sequence of rainfall since the 1970s. Several large rainstorms fell in the city, saturating the ground, raising river and stream levels, and flooding homes, properties and streets. In many locations flooding was worsened by damage from the 2011 Canterbury earthquake sequence.

Many residents trying to recover from the earthquakes are now faced with flooded and unhealthy homes, increasing health problems, stress and financial challenges. They need urgent, practical help until existing programmes to repair infrastructure, waterway and land damage are complete. The majority of these measures will take several years to implement and short-term flood defence measures are needed in the interim.

At a request from Christchurch Mayor Lianne Dalziel, the Council set up the Mayoral Flood Taskforce (the Taskforce) on 29 April 2014 with the aim of finding immediate/short-term solutions for those residents. The Taskforce started work on 1 May with members from Council staff, engineering consultants, the Stronger Christchurch Infrastructure Rebuild Team (SCIRT), Environment Canterbury (ECan), and the Earthquake Commission (EQC).

A preliminary Taskforce report was submitted to an Extraordinary Council meeting on 12 May 2014. The outcome of the meeting was a series of Council Resolutions that extended the Taskforce to allow it to complete the work begun.

The focus of the Taskforce was on addressing the regular flooding made worse by the earthquakes. The extreme rainfall event on 4-5 March 2014 was not regular flooding and requires longer term solutions. Temporary flood defence measures investigated by the Taskforce will not protect against extreme flooding, but will provide mitigation against events such as those that occurred in June 2013 or April 2014.

The Taskforce has concentrated on the most vulnerable people affected by regular flooding. Their vulnerability is both social and physical and the Taskforce examined both aspects. The physical aspect relates to a houses vulnerability to flooding. The Taskforce determined that the most vulnerable houses were those with two or more instances of flooding above floor level since the earthquakes (Vulnerability Level 1 or Level 1). The next most vulnerable were houses that had flooded beneath the house on two or more occasions (Vulnerability Level 2 or Level 2, which may include one instance of above floor flooding). The Taskforce recognised that restricted access to houses was also an important issue (Vulnerability Level 3 or Level 3), but focussed on above- or under-floor flooding as they caused the most vulnerability.

The flooding events over the last three years have impacted on people's health and wellbeing, their ability to cope with uncertainty and change, and their ability to cope financially. In order to address those most impacted by this the Taskforce investigated the social and health impacts in the worst affected areas of Christchurch with the most vulnerable people and houses.

Extensive engagement occurred with the communities most affected by regular post-earthquake flooding. This took the form of community meetings, engineers door knocking in affected areas, and a survey on flooding which included the social effects of flooding. A Social Assessment Report was also prepared to understand the impacts on the people and communities as a result of repeated flooding events.

People reported being concerned about: their health as a result of damp and mouldy houses; financial concerns including increased insurance excess, loss of equity in homes, insurance money running out; potential loss of community and/or fragmented communities and a loss of amenities; uncertainty about timing of repairs; and the time it may take to reduce flooding impacts and what to do in the meantime. There is a reported increase in stress, depression, feelings of hopelessness, frustration, anger and powerlessness amongst people.

Rates relief was offered to property owners whose houses have been affected by flooding. The Council also worked with the Ministry of Social Development (specifically the Earthquake Support

Coordination Service), the Canterbury District Health Board, the Ministry of Education, CERA and other non-government organisations who are members of the Psychosocial Subcommittee.

One outcome of this was that the Honourable Gerry Brownlee, the Minister for Canterbury Earthquake Recovery, and Honourable Paula Bennett, Minister for Social Development announced on 25 June 2014 that Canterbury residents impacted by recent flooding will now be eligible to apply for funding through the Government's Temporary Accommodation Assistance (TAA) programme which is administered by CETAS.

The Taskforce examined a range of short-term flood defence measures. They included house defence (which means defending an individual house against flooding, typically on that house's property), maintenance measures, and local area schemes (which benefit more than one house and are typically on the street or within drainage easements). Where none of these options are possible, temporary or permanent relocation may need to be considered.

The primary house defence measures examined by the Taskforce were either raising the house permanently or tanking the house by waterproofing up to the level of regular flooding.

Maintenance and local area schemes are more complex, but typically involve one-off maintenance work, diversions, bunding and pumping or improving the capacity of the existing drainage network.

Maintenance and local area schemes were considered preferable as they have less impact on residents and because they offer wider benefits such as addressing the issues of the most vulnerable as well as the less vulnerable houses in surrounding areas. This helps maintain occupancy within affected areas, which is an important component of strengthening these communities and improving quality of life.

Taskforce field engineering teams carried out an area-by-area analysis of the causes and scope of flooding problems in each of the priority areas of Dudley Creek (Flockton), Lower Avon, Heathcote Valley, Lower and Upper Heathcote, Southshore, Sumner, and Lyttelton.

The vulnerability analysis of the flat areas of Christchurch was based on observed flooding, with the assumption that flooding would re-occur in the same areas. In Lyttelton the unstable nature of the upstream catchment and geotechnical risks associated with saturated ground render this method inappropriate because previous flood impacts do not provide sufficient insight into the likely consequences of future flood events. Therefore a risk assessment methodology was developed for Lyttelton which includes slope stability issues. The initial assessment of Lyttelton risk using this methodology is complete.

Little River was originally in the scope and the vulnerable houses there are included in the total numbers. However, no recommendations for works have been made as flooding was not significantly worsened by the earthquakes. The issues at Little River were referred to the joint CCC/ECan Surface Water Issues Management (SWiM) Group for action. Other areas in the city were also investigated where surveys identified houses with above- or under-floor flooding two or more times.

The field teams identified the flooding issues, quantified the effects of earthquake damage where possible, assessed frequency of inundation above or below floor level, and designed appropriate house defence or local area schemes. Over 2,500 reports of regular post-earthquake flooding were validated.

The field teams had limited time in which to carry out the work, so engineering judgement and interpolation was necessary. However, the Taskforce considers the process sufficiently robust to give a high level of confidence in the key findings. The area reports are provided in detail in Appendix B, with a summary of the key data in both Part A and Part B of the main report. The information in Appendix B aims to preserve the knowledge gained from experienced engineers who visited a large number of areas shortly after flooding. This is one of the key outcomes of the Taskforce and will be invaluable when assessing longer term schemes.

The exact extent of flooding and impacts of the earthquakes has not been established by the Taskforce though earthquake effects were identified in many areas. Houses known to have flooded above floor level in the 5 March 2014 event were used to trigger field investigations, as was the survey data provided by residents. This observational based methodology is different from that used

by the Earthquake Commission for assessing Increased Flooding Vulnerability (IFV) or by Council for designing long-term measures.

The field investigations form the basis of the Taskforce reporting of vulnerability. The most affected properties are those that have flooded two or more times above floor level since the earthquakes (Level 1). Seventy seven houses have been identified that have experienced this level of flooding. They are spread across the city, but are concentrated in Flockton/Dudley Creek and Lower Heathcote.

In addition to flooded floor levels there are an estimated 427 houses where flooding has occurred beneath the floor on two or more occasions (Level 2, which may include one instance of above floor flooding). A further 948 houses have had restricted access more than once as a result of flooding (Level 3). Given the Taskforce constraints there will be other vulnerable houses which have not yet been identified.

Note too that these numbers do not include vulnerable houses in Lyttelton. Lyttelton has been assessed using a risk assessment methodology to determine the priority for further investigation, maintenance, and mitigation works. Eighty nine properties have been assessed as being high priority and 138 properties have been assessed as being medium priority. These allow identification of critical assets and prioritisation of investigations and mitigation measures, but do not constitute a comprehensive risk assessment.

The field investigation teams identified a range of defence measures which can resolve the impacts of regular flooding. Costs between individual house defence and local area schemes were compared. In most cases it was found that the local area schemes were not only more cost-effective, but also benefited a much wider area. The schemes can all be implemented within 12 months with the majority of the benefits realised within 3 months.

The cost of the Taskforce investigations and community engagement was \$1.45M. The costs for temporary defence measures to reduce flooding impacts on Vulnerability Levels 1 and 2 can be split into four groups. These costs are likely to be borne by a number of parties but the Taskforce has not attempted to determine who has responsibility for costs.

There are a group of maintenance and minor capital items outside of Dudley/Flockton which can be, and have largely already been, acted upon immediately. The total costs for this work is \$2.1M +/-30%. These works benefit 3 Level 1 properties and 49 Level 2 properties.

The works in Dudley/Flockton have largely already been approved and are in progress and total \$8.6M +/- 30%. These works benefit 45 Level 1 properties and 51 Level 2 properties.

Temporary stopbanks in some locations along the Lower Heathcote are one option for temporary flood defence. However, temporary stopbanks need to be considered in the context of the integrated management of the Heathcote catchment, and it is recommended that Asset and Network Planning review this scheme against the long-term options to ensure that the best outcome is achieved for the Lower Heathcote catchment. This scheme has been separated from the other works for clarity. The total cost for this work is \$4.6M +/- 30%. These works benefit 13 Level 1 properties and 127 Level 2 properties.

Even with the above works, there remain 12 Level 1 and 186 Level 2 houses. Some of the Level 2 properties (40) were Level 1 without the Tay Street Drain pump station. House tanking, raising and in some instances relocation are the only options for providing temporary flood defence to these houses. However, these costs are unlikely to be borne by Council but are reported here to inform the community of the costs of providing temporary flood defence to these vulnerable households. The total cost for this work is \$6.1M +/- 30%.

No costs have been estimated for Lyttelton mitigation works as there is insufficient information to estimate this.

These costs are likely to be borne by a number of parties but the Taskforce has not attempted to determine who has responsibility for costs.

## Table of Contents – Part A: Key Findings and Recommendations

Executive Summary .....	5
1 The Mayoral Flood Taskforce .....	9
2 Methodology .....	11
3 Earthquake effects on flooding .....	19
4 Vulnerability to post-earthquake regular flooding .....	21
5 Lyttelton risk assessment .....	23
6 Social and health impacts of flooding .....	24
7 Responding to social needs .....	26
8 Area investigations .....	29
9 City wide proposals .....	31
10 Priority area proposals .....	35
11 Costs and implementation programme .....	46

The Taskforce Final Report also consists of the following companion volumes:

### PART B: ISSUES AND OPTIONS

Part B describes the context of recent flooding in Christchurch, the short-term flood defence measures, and the field investigations and community feedback that has occurred in flood affected areas throughout the city.

### PART C: APPENDICES

Appendix A	Temporary Flood Defence Options
Appendix B	Detailed Area Reports
Appendix C	Wastewater Overflows in Flood Events



## 1 The Mayoral Flood Taskforce

In early 2014 Christchurch had the heaviest sequence of rainfall since the 1970s. Several large rainstorms fell in the city, saturating the ground, raising river and stream levels, and flooding homes, properties and streets. In many locations flooding was worsened by damage from the 2011 Canterbury earthquake sequence.

Many residents trying to recover from the earthquakes are now faced with flooded and unhealthy homes, increasing health problems, stress and financial challenges. They need urgent, practical help until existing programmes to repair infrastructure, waterway and land damage are complete. The majority of these measures will take several years to implement and short-term flood defence measures are needed in the interim.

At a request from Mayor Lianne Dalziel, the Christchurch City Council ('Council') set up the Christchurch Flood Taskforce (Taskforce) on 29 April 2014 with the aim of finding immediate/short-term solutions for those residents most vulnerable to regular flooding.

The Taskforce started work on 1 May 2014 with members from Council staff, engineering consultants, the Stronger Christchurch Infrastructure Rebuild Team (SCIRT), Environment Canterbury (ECan), and the Earthquake Commission (EQC).

The Taskforce has identified a package of measures that can ***assist the most vulnerable households in Christchurch cope in the short-term with the increase in regular flooding due to earthquake land damage.***

This report summarises the findings of the Taskforce.



Figure 1 Barbadoes St, March 2014

A report on the preliminary Taskforce work was submitted to an Extraordinary Council meeting on 12 May 2014. The outcome of the meeting was a series of Council Resolutions that extended the work of the Taskforce. The resolutions assigned to the Taskforce were:

- 5.4** *Requests the Acting Chief Executive establish a second phase Taskforce to:*
- 5.4.1** *Confirm the level 1 properties are appropriately identified, including face-to-face engagement to establish the most appropriate solutions*
  - 5.4.2** *Provide a recommended programme of actions and costs to implement urgent solutions in each catchment:  
(a) noting that this should include a temporary pumping solution in Flockton, the repair of flap gates in the Avon and Heathcote rivers, the dredging of the Heathcote River and the removal of debris and improved maintenance regime.*
  - 5.4.5** *Meets with the CCC/CERA Flood Steering Group to ensure that all workstreams are aligned with no doubling up or gaps.*
  - 5.4.6** *Identify any areas that have been impacted by flooding on the proposed levels 1 to 3 vulnerability and report on those.*
  - 5.4.7** *Urgently review criteria for assessing flood risk and land movement in Lyttelton to improve the analysis of vulnerability and strategic infrastructure.*
- 5.10** *Request that a progress report comes to the Earthquake Recovery Committee of the Whole on the 5 June 2014 which is delegated the power to act on any recommendations.*

As well as the above tasks undertaken by the Taskforce, the following further resolutions were completed by Council staff outside of the Taskforce, and are included in this report:

- 5.4.4** *Ensures that the SCIRT work programme is fully aligned with the Land Drainage Recovery Programme.*
- 5.4.8** *Assess upstream developments for their contribution to flooding and whether mitigations requirements are being fully implemented.*
- 5.4.9** *Talk to the Ministry of Education regarding a comprehensive response to flooding affecting schools.*

At the time of writing all these tasks had been completed.

The scope of the Taskforce excluded the following items:

- permanent solutions
- cost/benefit or economic analysis
- hydraulic modelling (except for Dudley Creek where the post-earthquake model was already well advanced)
- floor level surveys
- solutions for houses within the Residential Red Zone

## 2 Methodology

The Taskforce needed to develop a clear understanding of: the location of the houses with regular flooding worsened by the earthquakes; the needs of the flood vulnerable households; and the available temporary flood defence measures to address those needs. The following sections describe the methodology (Figure 2) the Taskforce used to develop this understanding.

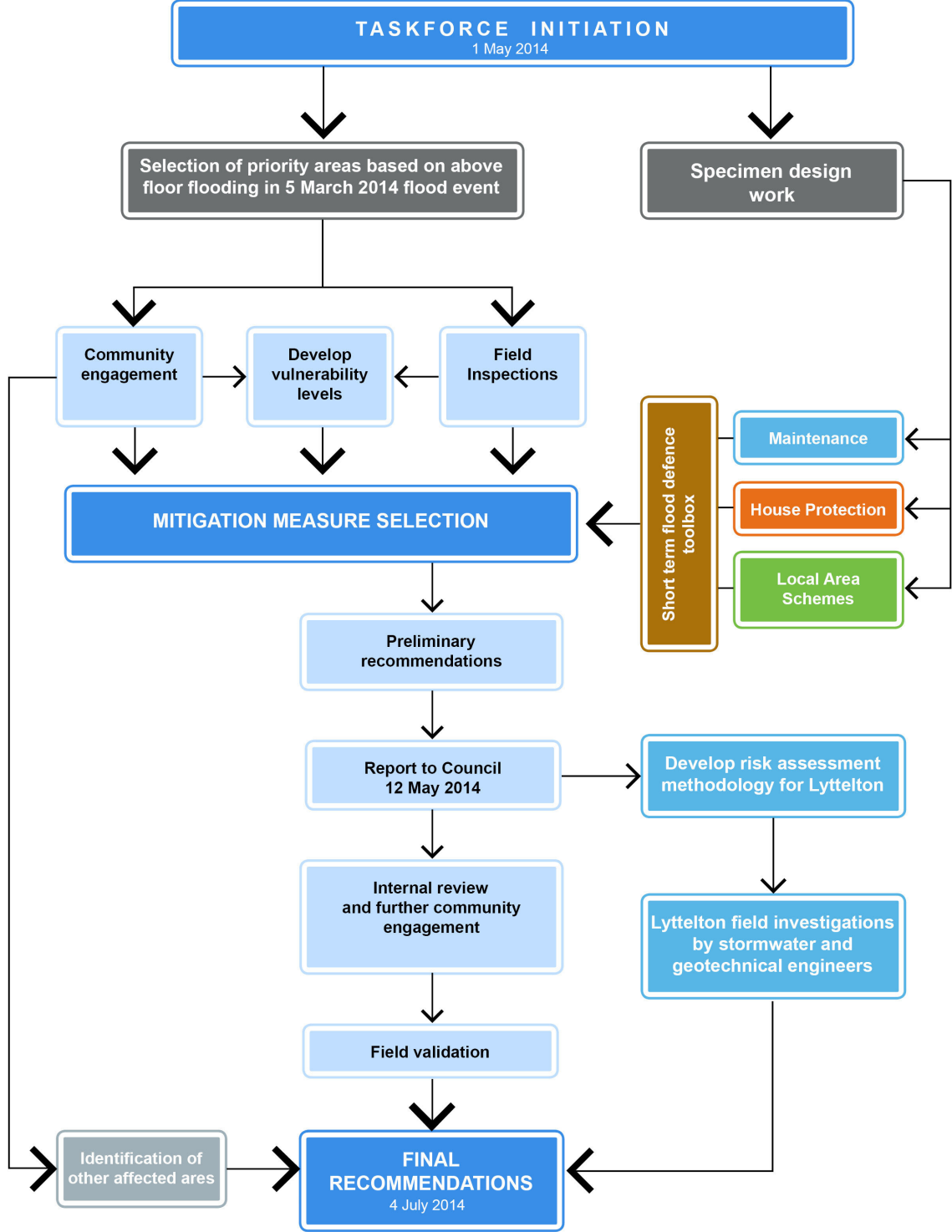


Figure 2 Taskforce methodology

## 2.1 Definition of priority areas

The 5 March 2014 event was an extreme event affecting a large area of the city and was significantly greater in magnitude than any other flooding Christchurch has experienced since the earthquakes. Those affected by suspected and observed above floor flooding in this event represent an upper bound on those who would be impacted by regular flooding. This event was used to identify the flood prone areas of the city and define study areas (Figure 3) for field investigations. The Taskforce scope was initially limited to identifying houses most vulnerable to regular flooding in the priority areas shown, although this was later extended to identifying vulnerable houses outside of the priority areas. Council's understanding of the March flood event is based upon operational experience during the event, flood surveys after the event, customer service request information and ground topography.

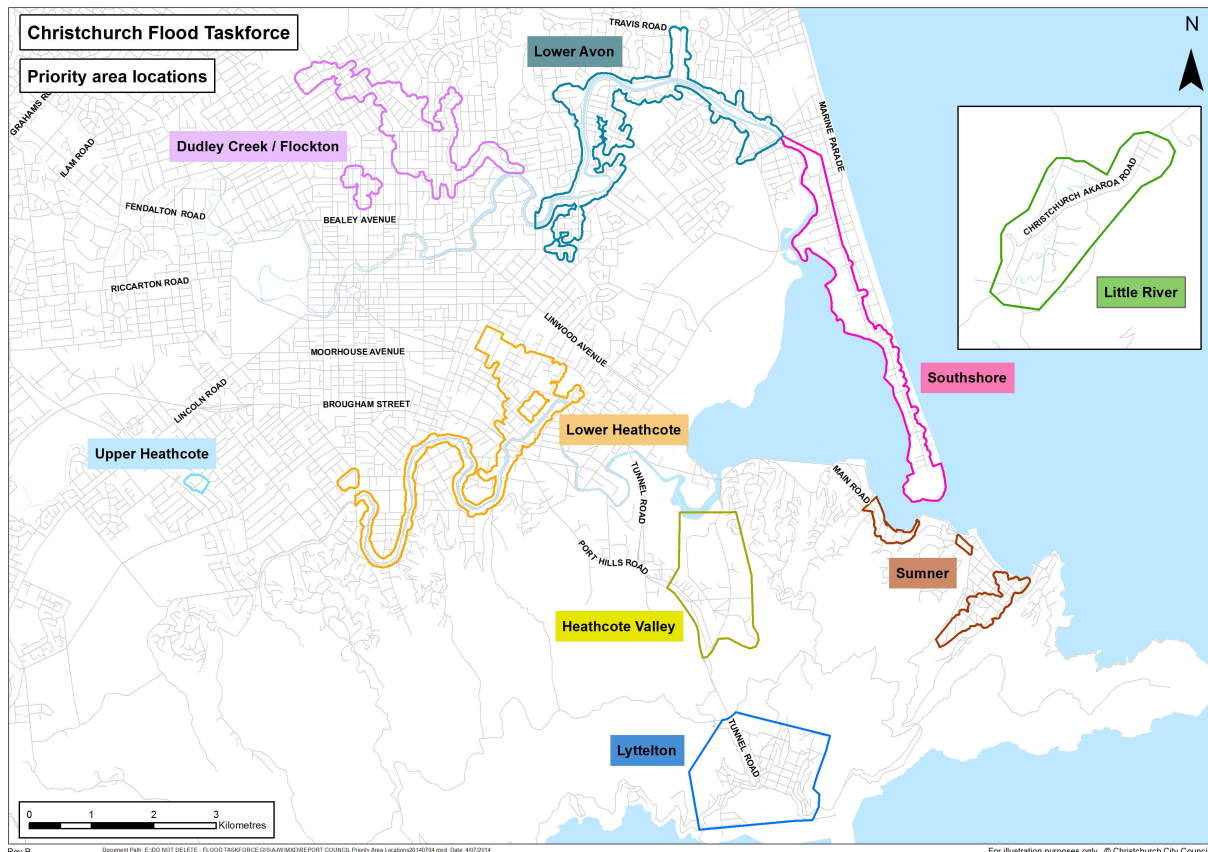


Figure 3 Priority area locations

## 2.2 Community engagement

The Taskforce focussed on the most affected areas of Christchurch and prioritised the most vulnerable people and houses (as defined in Section 2.4). The Taskforce also identified community engagement as a key activity, and one of the most important ways to understand people's issues, concerns and preferences.

Community engagement included discussions with engineers in the field, community meetings, and quantitative and qualitative data collection including a survey about flooding developed specifically for the Taskforce.

## 2.3 Field investigations

Engineers undertook field studies in areas which included floor level flooding during the 5 March 2014 event to collate data on:

- Causes and mechanisms of flooding in that area

- Vulnerability of houses within the area
- Potential measures to help alleviate regular flooding

Initial investigations were triggered in areas where floor level flooding was recorded or estimated to have occurred in the March 2014 event. Following this other areas where regular flooding occurred were investigated.

Akaroa was excluded from the scope as flooding has not been compounded by earthquake damage. Flooding in Little River was later identified as not being worsened by the earthquakes and so while the numbers are included in the totals, no mitigation measures have been developed. Styx was excluded as no houses were identified with flooding on 5 March 2014, nor has post-earthquake above floor flooding been reported. There may be houses which flood beneath the floor which have not been investigated.

## 2.4 Development of vulnerability levels

The Taskforce's objective was to recommend a package of measures that can *assist the most vulnerable households in Christchurch cope in the short-term with the increase in regular flooding due to earthquake land damage*.

This objective, and the vulnerability levels derived from it, are not intended to replace Council's current level of service (as discussed in Part B of the report). Rather, the vulnerability levels are a methodology developed to assess house and household vulnerability following a specific series of events. Whilst compatible with Council's existing levels of service, a planning and policy review should be undertaken if they were to be used outside of this context.

The Taskforce used the following definitions to implement the objective:

### *Households*

The Taskforce is focussed on protecting the main dwelling (house) on a property. It is understood that disruption to commercial premises, garages, sleepouts and sheds is also a significant concern and many of the measures that the Taskforce proposes will help these buildings as a secondary benefit.

Residential Red Zone properties were not included in the assessment.

### *Regular flooding*

The Taskforce was concerned with 'regular' flooding, which means flooding like that which occurred in August 2012, June 2013, Easter 2014 and the evening of 29 April 2014. It is this level of flooding which is considered to have been most significantly worsened by the earthquakes and potentially able to be mitigated through short-term flood defences.

The Taskforce did not look into defence against more extreme flood events, such as that which occurred on 5 March 2014. In many parts of the city the associated flooding may have been worse than the 50 year flood event that the Building Act uses as a minimum design standard for flood protection of houses. This also exceeds Council's recommended level of service. Excluding the 5 March event was why the threshold for vulnerability is at least two flooding events. Instead, the measures aim to reduce the *regular* flooding of households since the earthquakes.

The Taskforce has not attempted to define the level of protection provided against a particular return period for any of the defence measures. This is common for long-term measures, but because the Taskforce was focused on short-term measures using recent events as benchmarks, it was not considered necessary. The events cited above had a range of return periods depending on where the rainfall was measured. However, it is considered that there have been enough post-earthquake flood events to provide sufficient variability in event size, effects and spatial distribution to allow for this approach to designing short-term measures.

## Earthquake effects

The Taskforce has been able to clearly identify in many areas increased regularity of flooding due to the effects of the earthquakes. This is due to land subsidence, reduced capacity of waterways, and damaged infrastructure. More detail on earthquake effects is provided in Part B of the Final Report, and in the detailed area reports in Appendix B.

## Vulnerable

Vulnerability is defined in two complementary ways; the vulnerability of the house to flooding and the vulnerability of the occupants of the house.

The Taskforce developed three levels of vulnerability of a house to flooding:



### **Level One: Two or more instances of flooding of house floors since the earthquakes**

These are considered to be the most vulnerable homes in Christchurch. Multiple flooding bears a high cost in house and contents repair / replacement, high personal disruption and increased health risks. It may lead to the property being uninsurable, uninhabitable and / or dropping in resale value. The Taskforce did not include in Level One houses that insurance or the Earthquake Commission have designated to be rebuilt or raised (based on site observation or information from the owner).



### **Level Two: Two or more instances of flooding under houses since the earthquakes**

The community provided strong feedback that regular flooding under homes was a significant health and property concern. It was reported that they cannot claim on insurance for mould and rising damp, or for the difficulty of cleaning up contaminated water under homes.

This vulnerability level includes buildings that have flooded only once above floor level and on at least one other occasion, flooding under the floor.



### **Level Three: Two or more instances of flooding restricting resident access to their house since the earthquakes**

Flood waters are often contaminated and can be so deep that residents cannot get into or out of their homes. This was particularly a concern for families with young children, elderly or people with disabilities.

This level of vulnerability did not trigger local area schemes or house defence in isolation. It was used to determine the additional benefit provided by any local area or maintenance schemes.

The second dimension of vulnerability relates to the occupants of those houses and their ability to cope with flooding and the ongoing effects of flooding. Where possible when implementing solutions, prioritisation of the most vulnerable should be considered. The most vulnerable are defined as: people with mobility needs, people with mental and physical health needs; families with young children and people homes made uninhabitable by flooding.

Conceiving of vulnerability in terms of the property and the household recognises that there is not a one size fits all approach or solution, especially when it comes to short term solutions.

## 2.5 Temporary flood defence options

In parallel with the field investigations, a team of engineers undertook a desktop design process to establish viable options for flood defence. This process identified and assessed defence options based upon cost, availability of resources, effectiveness and implementation timeframes. The options included:

- Improved maintenance
- House defence
- Local area solutions (such as house raising, bunding, pumping, flap valve replacement and sandbagging)

This formed the 'toolbox' of options for providing flood defence at both the house defence and local area level.

The Taskforce's main objective was to assist the most vulnerable households to *cope in the short term*. This meant that the measures must be able to be carried out cost-effectively to help the community in the short term until a long term solution is implemented. As such these measures are not a solution to flooding and only *reduce* the regular flooding risk as opposed to 'solving flooding'.

## 2.6 Mitigation measure selection

A decision tree was formed to guide the process to select and develop packages of measures in each area (Figure 4). This process has been used in all areas investigated across the city to provide a consistent and transparent approach.

The mitigation measures are focused on the most vulnerable homes in Christchurch. The first step in the process was quantifying (through a combination of field work, council records and interrogation of the available desktop information) the number of homes in each level of vulnerability within each study area. The numbers provided are not exact, with the level of confidence highest in Level 1, and lowest for Level 3, as many residents with restricted access may not report flooding.

Where possible a high level assessment was undertaken to identify the potential influence of the earthquakes on the flood vulnerable houses. Typically this includes an assessment of the surrounding land damage and the known impacts on the waterways. Where earthquake effects were considered unlikely to have increased flood risk to a house (as estimated from field observations) then the house was not assessed for mitigation measures under this investigation (although a local area scheme may benefit these houses).

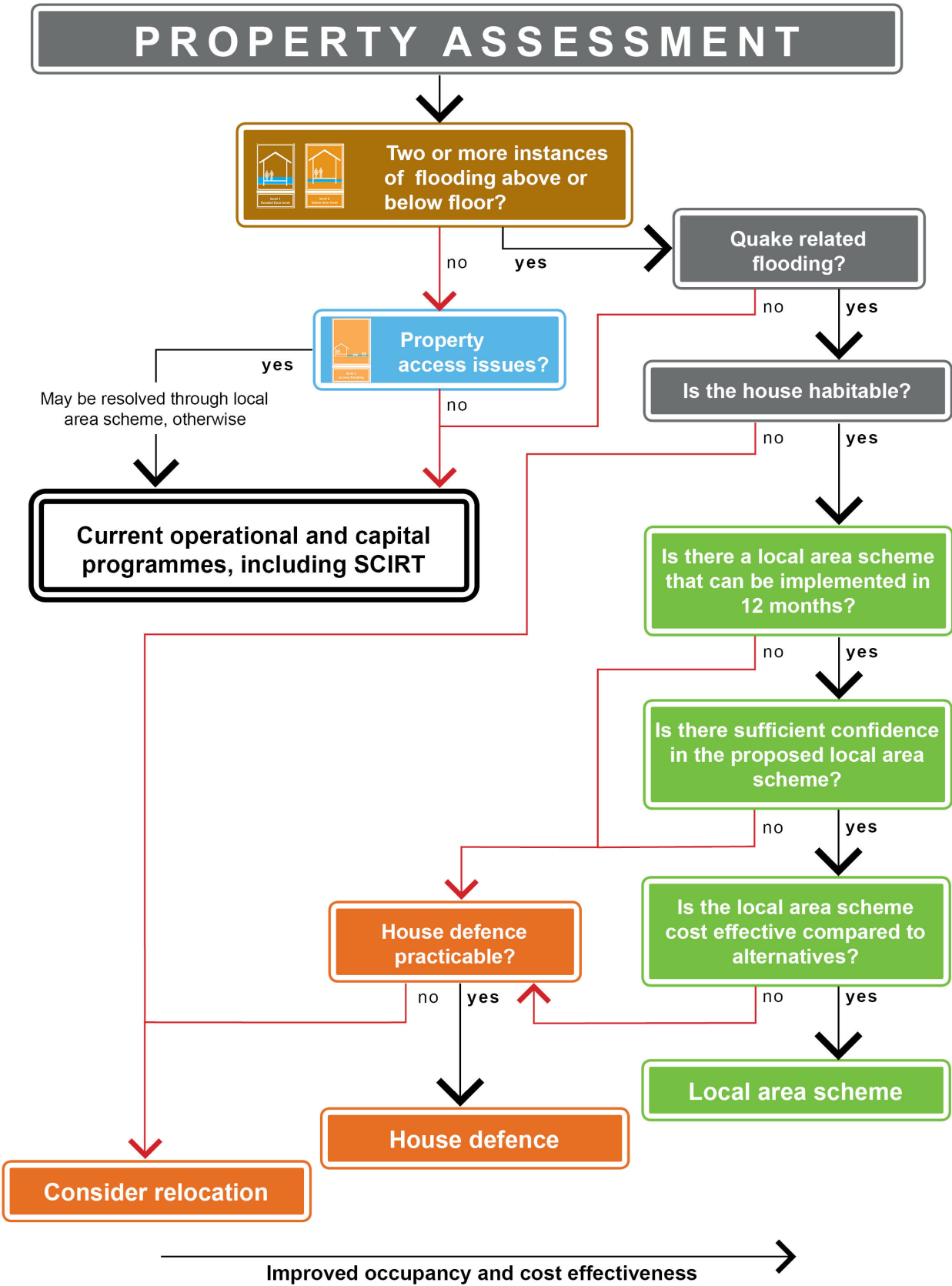


Figure 4 Flood mitigation measure selection process



The criteria for the selection of mitigation measures that target the **most vulnerable** homes have three main drivers: cost effectiveness; confidence in outcome; and improved occupancy. Local area schemes (which provide a benefit to a wider area) are also considered preferable to individual house defence solutions as long as it can be demonstrated that:

- There is a high level of confidence in performance; and
- There are cost savings in comparison to house defence measures.

If local area schemes cannot meet these criteria then house defence solutions will be used if possible.

Some of the most vulnerable houses may not be able to be provided with an acceptable level of defence against regular flooding. This could be due to the absence of an area scheme and the house construction not being suitable for house defence. For these households permanent or temporary relocation may be appropriate. Relocation may also be appropriate for uninhabitable houses.

A house was deemed habitable if, after the post-earthquake flooding events, the living conditions inside the home are similar to the living conditions in other homes in Christchurch that have not been flooded. It must be able to be occupied to a satisfactory level of health for its occupants. For example, compared to other similar homes in Christchurch, the home is warm and dry, it can be heated, it does not contain mould in the dry areas of the home and it does not increase the risk of respiratory illness and other illnesses worsened by mould, damp and cold.

## 2.7 Preliminary recommendations and review

Preliminary recommendations were included in the draft Technical Report and the 12 May 2014 Council report.

In order to test the preliminary recommendations an extensive review and consultation process was undertaken. A number of Council officers in the areas of legal, policy and engineering were asked for review and feedback on the recommendations. Councillors were also presented with an opportunity for feedback.

One of the key parts of the process was the review with Council engineering and operational staff. This included 'challenge sessions' which took place to test the proposed measures for practicality and to examine alternative solutions.

Community meetings took place after the release of the preliminary recommendations to explain what was proposed and to obtain feedback. A key part of this was also identifying any gaps in the recommendations.

CERA was also invited to comment and feedback was received.

The feedback from these sources has contributed to the final report.

## 2.8 Confirmation of vulnerability and schemes

Further field validation was undertaken to check the assessment of the vulnerability levels and to finalise scheme, maintenance or house protection details.

## 2.9 Identification of other vulnerable houses

After the main priority areas were visited, field visits were undertaken to investigate reported flood issues in areas outside of the priority areas. The cause and extent of flooding was investigated and reported on, but potential defence schemes were not identified outside of the priority areas.

## 2.10 Lyttelton

The steep nature of Lyttelton results in fast flowing and concentrated floods that can endanger human life and cause significant localised damage. Floodwaters also have the potential to saturate steep slopes and increase the likelihood of landslips and retaining wall failures.

The vulnerability analysis of the flat areas of Christchurch was based on observed flooding, with the assumption that flooding would re-occur in the same areas.

In Lyttelton the unstable nature of the upstream catchment and geotechnical risks associated with saturated ground render this method inappropriate because previous flood impacts do not provide sufficient insight into the likely consequences of future flood events.

Recognising this, on 12 May 2014 Council resolved that the Taskforce should *“Urgently review criteria for assessing flood risk and land movement in Lyttelton to improve the analysis of vulnerability and strategic infrastructure.”*

The Taskforce chose a risk assessment approach as most appropriate for this catchment to assess priorities for investigation and works. Note, however, that it *does not* correlate with the vulnerability levels for the other areas and should be distinguished from them.

Representatives of the Council's Land Drainage Team, in conjunction with geotechnical and drainage engineers, developed a risk assessment matrix for Lyttelton, identifying houses and critical infrastructure with extreme, high, medium, low or nil priority for investigations and mitigation measures.

## 2.11 Final recommendations

Final recommendations, costs and an implementation programme are contained in Section 10 of this report. More significant or expensive works should be reviewed to address the overall catchment management plans and consideration of the long term impacts of climate change, a “no regrets” check.

### 3 Earthquake effects on flooding

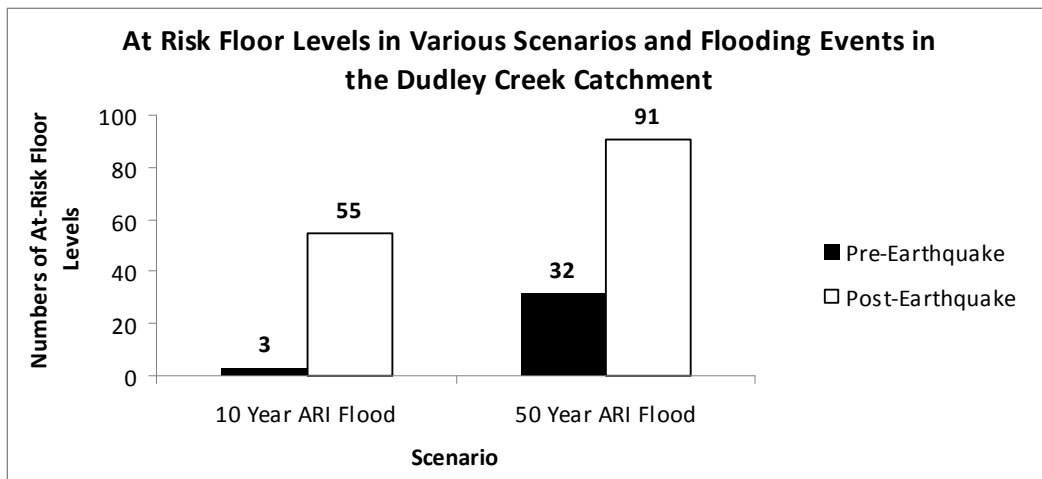
The Canterbury earthquakes have changed the risk of flooding in some parts of the city by:

- Lowering the land in some areas (due to land settlement)
- Reducing the capacity of waterways (due to lateral spread, liquefaction and stream bed heave)
- Changing the drainage patterns within a catchment (due to displacement and land level changes)
- Damaging stormwater infrastructure

The Taskforce identified earthquake effects within each priority area based on field inspections by engineers as well as information provided by residents. These are described in detail in Part B of the report.

The Land Drainage Recovery Programme (LDRP) was initiated in 2012 to investigate the effects of the earthquakes on the land drainage network. Through this programme the Dudley Creek Catchment (which includes the Flockton area) has been extensively investigated. Computer modelling and observations of several flood events have given an understanding of the changes in the depth and extent of flooding extents as a consequence of earthquake effects. Parts of this catchment have settled by up to 0.4m.

The calibrated modelling results were combined with an extensive floor level survey in the catchment to identify the number of floor levels at risk from flooding in both the pre- and post-earthquake catchment. Added to these were the Taskforce Level 1 properties where these were not identified by the modelling (Figure 5). This analysis quantifies the significant increase in the number of at-risk floor levels due to the effects of the earthquakes for *both* the 10 year and 50 year average return interval events.



**Figure 5 Houses at risk from above floor flooding pre- and post-earthquake**

Note that the numbers in Figure 5 are based on both theoretical design storm events *and* the Taskforce numbers. Therefore the Taskforce Vulnerability Level 1 results (54 houses in Dudley Creek Catchment) are less than the numbers above.

The map on the following page shows the combination of earthquake related increased flood risk from both modelling and Taskforce investigations. This clearly shows the extent of earthquake related increased flood risk in this area.

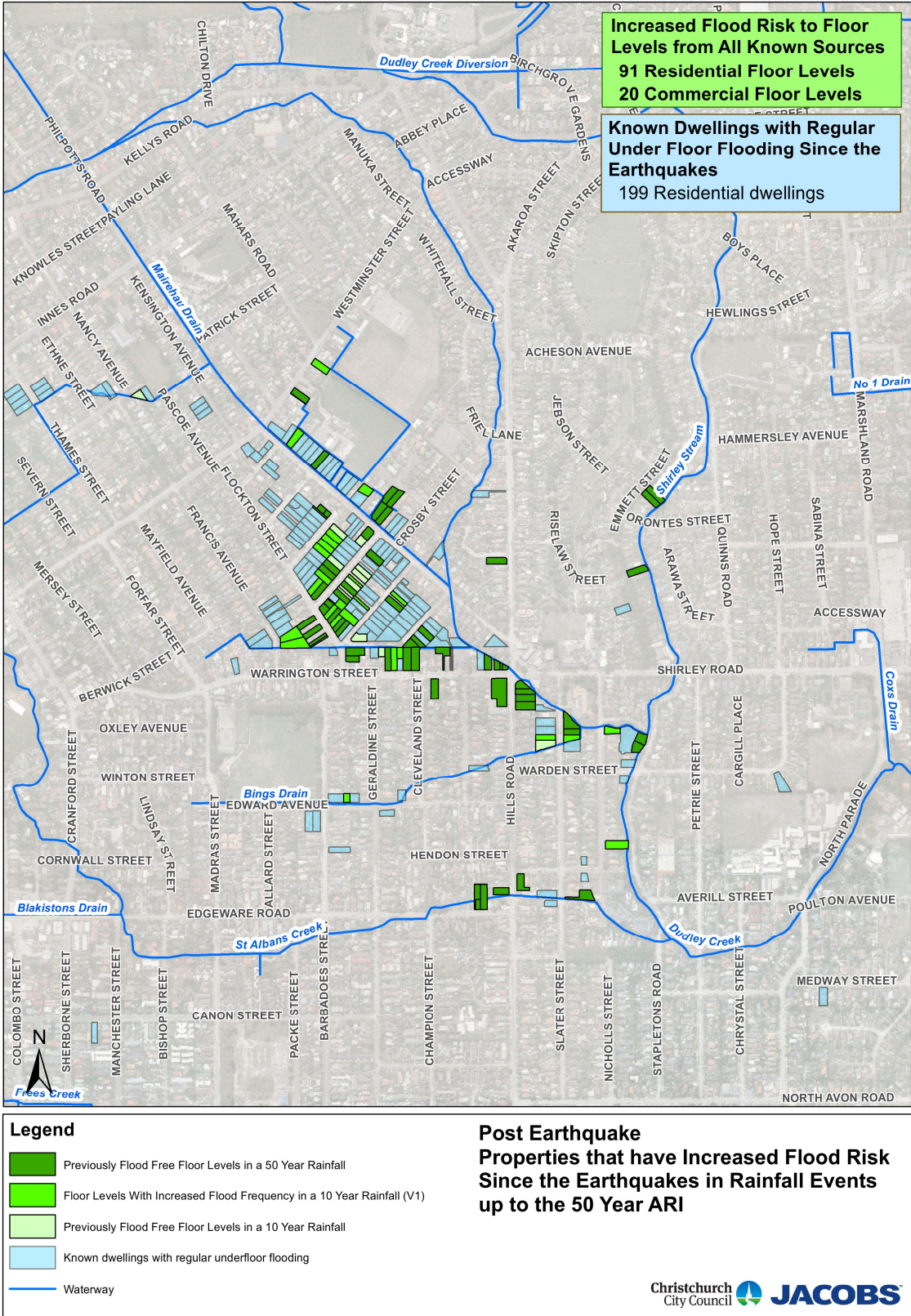


Figure 6 Increased flood risk from all known sources

Other areas examined by the Taskforce do not have this level of detail available from the LDRP, but for each measure proposed by the Taskforce a clear earthquake effect was determined through site inspections and information from local residents. These effects include land subsidence, reduced capacity of waterways, and damaged infrastructure.

## 4 Vulnerability to post-earthquake regular flooding

One of the key tasks of the Taskforce was to identify and validate those houses vulnerable to regular flooding as a result of earthquake effects. The focus was on the priority areas, but 70 houses outside of the study area were also assessed. Initially potential vulnerability was based on the 5 March 2014 event, but after the publication of the initial Taskforce report Council received a large number of calls from residents. To capture this information a survey was developed to collect consistent and comprehensive information on the number of times an address has flooded above floor level, below floor level and the number of times access issues have been identified. This data allowed the engineers to investigate and assign a vulnerability level to each property.



The final number of houses in each vulnerability level are shown above. Table 1 below and Figure 7 on the following page breaks down the numbers by area.

**Table 1 Vulnerable houses by area**

Area	Level 1	Level 2	Level 3	Not Vulnerable	Total Validated
Dudley Creek	54	201	421	119	795
Lower Avon	0	6	53	312	371
Heathcote Valley	1	37	13	22	73
Upper Heathcote	0	4	12	0	16
Lower Heathcote	13	137	257	548	955
Southshore	2	7	68	22	99
Sumner	1	9	15	83	108
Little River	2	10	12	3	27
Outside priority areas	4	16	97	45	162
<b>Total</b>	<b>77</b>	<b>427</b>	<b>948</b>	<b>1154</b>	<b>2606</b>

These numbers include some houses with private drainage issues included above which do not have flood defence schemes designed for them (3 x Level 1, 7 x Level 2, 9 x Level 3).

**Note too that these numbers do not include vulnerable houses in Lyttelton.** Lyttelton has been assessed using a separate methodology for assessing vulnerability (which includes slope stability effects) and is reported in Section 5.

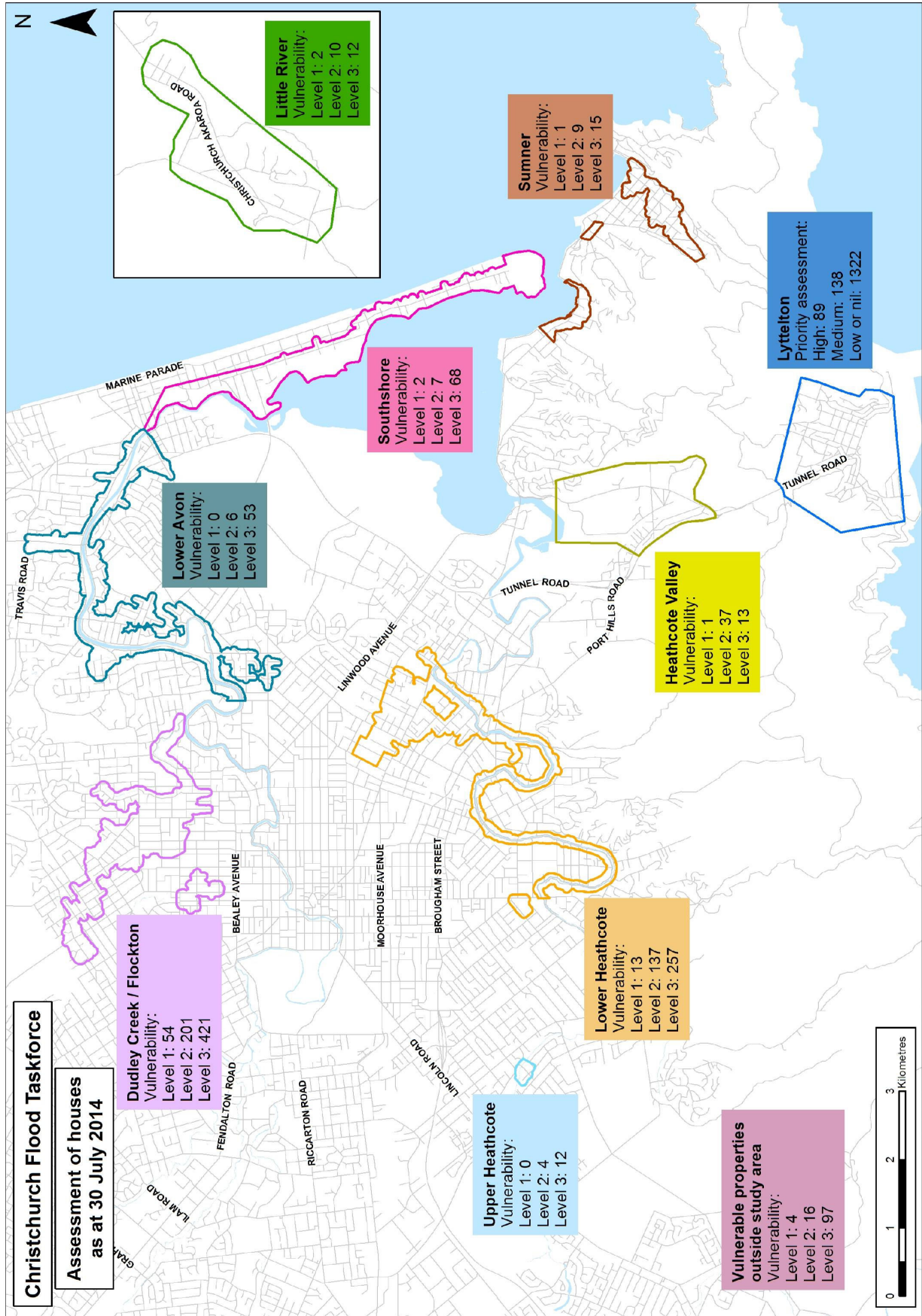


Figure 7 Vulnerable houses identified by the Taskforce

## 5 Lyttelton risk assessment

The steep nature of Lyttelton results in fast flowing and concentrated floods that can endanger human life and cause significant localised damage. Floodwaters also have the potential to saturate steep slopes and increase the likelihood of landslips and retaining wall failures.

The vulnerability analysis of the flat areas of Christchurch was based on observed flooding, with the assumption that flooding would re-occur in the same areas.

In Lyttelton the unstable nature of the upstream catchment and geotechnical risks associated with saturated ground render this method inappropriate because previous flood impacts do not provide sufficient insight into the likely consequences of future flood events.

Recognising this, on 12 May 2014 Council resolved that the Taskforce should *“Urgently review criteria for assessing flood risk and land movement in Lyttelton to improve the analysis of vulnerability and strategic infrastructure.”*

The Taskforce chose a risk assessment approach as most appropriate for this catchment to determine priority categories for investigation and works. Note, however, that it *does not* correlate with the vulnerability levels for the other areas and should be distinguished from them.

Representatives of the Council’s Land Drainage Team, in conjunction with geotechnical and drainage engineers, developed a risk assessment matrix for Lyttelton to enable prioritisation.

The preliminary results of priority assessment indicate that:

- 89 properties in the high priority category
- 138 properties in the medium priority category
- 1322 properties with low or nil risk and therefore are not prioritised for action

The number of properties in the high or medium priority category will increase if the private drainage fault study was extended.

Five strategic assets, including Brittan Terrace, the wastewater treatment plant, a water supply reservoir and two electricity substations were assessed as having high priority. A further two strategic assets were identified as having medium priority.

A pilot study was conducted investigating the condition of private drainage assets at 39 residences. Nearly a third of properties were found to have private drainage faults significant enough to potentially cause damage to both their own and neighbouring properties. One of these faults was considered to be causing extreme risk to a neighbouring property. If this study were extended to all parts of Lyttelton it is likely that the number of properties at risk due to “private drainage faults” would increase.

It is recommended that further investigation commence immediately for those properties with high or medium priority to enable the development of options to reduce the risk to these properties. The private drainage study also needs to be extended to assess the full extent of the risk posed by private drainage faults.

## 6 Social and health impacts of flooding

The flooding events over the last three years have impacted on people's health and wellbeing, their ability to cope with uncertainty and change, and their ability to cope financially. In order to address those most impacted by this the Taskforce investigated the social and health impacts in the worst affected areas of Christchurch with the most vulnerable people and houses.



Figure 8 Slater St, June 2013

### 6.1 Social impacts

Engagement occurred with the communities most affected by regular post-earthquake flooding. The key themes that emerged from this were:

- People are concerned about living in damp, mouldy houses and consider living in warm, dry, healthy homes is a priority for physical health and for personal wellbeing.
- There is a reported increase in stress, depression, feelings of hopelessness, frustration, anger and powerlessness. These feelings are partly because of a perceived lack of coordination between the agencies, and a perceived lack of urgency and communication from the agencies. These feelings are also because of uncertainty about the future, financial worries, and living in cold, damp, unhealthy homes.
- Financial concerns including increased insurance excess, loss of equity in homes, insurance money running out, increased financial obligations such as having to service a mortgage and pay rent, increased electricity and heating costs, impacts on businesses (loss of revenue) and forced annual leave.
- People are concerned about the potential loss of community and/or fragmented communities and a loss of amenities.
- Uncertainty with timing of house repairs.
- The time it may take to remedy or reduce flooding and uncertainty of what to do in the meantime.
- For the most affected residents, a one-on-one meeting to discuss their situation is the preferred method of contact. One-on-one meetings have been and continue to be organized.



In terms of mitigation measures, there was a clear preference for solutions that benefit the whole area rather than those that focus on individual houses. It was also recognised that non-engineering solutions such as temporary relocation may be needed where the engineering solutions will take too long to put in place.

## 6.2 Wastewater contamination

The main wastewater issue in floods is contamination. As a public health risk it can contaminate houses and sections and is an unpleasant experience for those affected. NIWA<sup>1</sup> studied health risks from wastewater overflows, concluding that overflows elevate risk, and noting that the rivers themselves also become health risks. Flooding of watercourses can also prevent wastewater overflows from operating, causing upstream manholes to surcharge into the street.

Flood waters can contain visible waste 'solids' such as tissue or sanitary products, which are then left on the ground or on properties as flood waters recede.

Key issues relating to wastewater and flooding are:

- Surface flooding enters the wastewater network and increases flow rates
- Parts of the wastewater network cannot cope with the increasing flows, resulting in surcharging of the network and overflow operation
- Most flood-affected areas contain or are downstream of wastewater overflows which contaminates waterways and flood waters
- Flood waters are not safe for human contact regardless of wastewater contamination
- Wastewater overflows sometimes cannot operate due to flooded waterways causing upstream wastewater manholes to surcharge, which forces wastewater into the street
- Surcharging private gully traps forces wastewater into private sections and houses
- Visible solids in flood waters are left on the ground as flood water recedes
- There is a health risk to those returning or leaving home or coming into contact with flood waters
- People are distressed by the contamination, particularly if solids are visible
- There is a risk to the untreated potable water supply especially where wells or pump stations are in flood prone areas

Appendix C contains a more detailed summary on wastewater contamination and flooding.

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<sup>1</sup> *Quantitative Microbial Risk Assessment associated with sewer discharges to the Avon and Heathcote River catchments*, NIWA Client Report HAM2009-158, October 2009.

## 7 Responding to social needs

### 7.1 Community engagement

In order to gather information about regular post-earthquake flooding and provide information on potential short-term defence measures, the Taskforce engaged with the community in a variety of ways.

#### 7.1.1 Community meetings

Between March 2014 and June 2014 the Council engaged with flood-affected communities as follows:

- Held four community meetings pre-Taskforce establishment (two in Heathcote Valley, one in Sumner and one in Flockton).
- A trained and experienced group of volunteers carried out a door knocking survey in Flockton.
- Council staff held two focus group meetings and hosted a drop-in session in the Flockton area on Saturday 3 May 2013.
- Prepared and delivered another eight community presentations since 3 May 2014. The purpose of the meetings was to provide attendees with information about the flooding issues in their area, the proposed measures to reduce the effects of flooding and to collect local knowledge of flooding behaviours.
- Key agencies invited to the meetings included: EQC, SCIRT, Insurance Companies, CERA and Red Cross. CCC, ECan and NZTA presented at the Little River meeting.
- Posted area specific presentations and FAQs on the Council website (<http://www.ccc.govt.nz/cityleisure/projectstoimprovechristchurch/landdrainage/Taskforcecommunitymeetings.aspx>)
- Organised more than 3,000 direct mail drops to flood catchment areas to ensure residents without access to computers receive information in a timely fashion.
- Organised a street meeting with residents of Chancellor Street on Wednesday 25 June 2014 to provide information on the removal of the Chancellor Street culvert/bridge.

Overall, the presentations were well received by the 850 residents who attended the community meetings. Residents felt they had an opportunity to hear from Taskforce engineers about the work being planned and undertaken in their area. Attendees particularly appreciated having one-on-one conversations with those Taskforce engineers.

#### 7.1.2 Site visits

- Heathcote Valley – a site walkover in the Heathcote Valley with affected residents towards the end of April 2014.
- Beckenham - held one-on-one meetings with residents regarding specific issues e.g. a house tanking demonstration and meeting residents from the Tennyson Drain area.
- Flockton Area - daily communications with residents along Dudley Creek during maintenance works.
- New Brighton/Southshore - engineers visited 109 Beresford Street New Brighton Community Preschool and Nursery about frequent flood issues.
- Lyttelton - site walkover on Saturday 21 June 2014 with Lyttelton residents from the community meeting.

Site visits incorporating members of the community were a valuable way of collecting local information and providing residents with real time feedback on the flood mitigation work achieved and proposed by the Taskforce.

### 7.1.3 Surveys and other communication

The Taskforce collected information to determine vulnerabilities of house and household. Contact information was collated to ensure all parties affected by the flooding were kept up to date with progress. Communication activity included:

- A contact list with nearly 900 contacts. These include flood-affected residents, support agencies, schools and government departments.
- For inbound calls the Council set up an online survey to capture resident information, contact details, concerns and requests. The survey was also made into a paper copy to capture information from people face-to-face at community meetings. The surveys were also available at service centres. More than 520 surveys have been completed.
- Three temporary staff were employed to contact more than 250 residents identified during the first week of the Taskforce.
- More than 800 emails and telephone calls were sent within 48 hours to residents who attended area-specific community meetings. These thank you emails directed residents to the Taskforce web page where area specific questions have been answered.
- Individual property related questions continue to be answered on a case-by-case basis by Taskforce engineers or Council staff. Residents requiring additional information are able to contact the Taskforce via the flood mitigation email address: [floodmitigation@ccc.govt.nz](mailto:floodmitigation@ccc.govt.nz)
- 675 residents have agreed online or at public meetings to receive more information. Some feedback from a resident about the Council's e-newsletter is below:

*"Thank you very much everyone for your regular flood mitigation newsletters. I live on my own and am feeling a little vulnerable but your newsletters and the support of neighbours are a great comfort to me and the other folks in the street"*

- All information has been made available in Council Service Centres including e-newsletters, presentations from Taskforce community meetings, survey forms, and the rates remission application form with supporting information.
- The Council continues to update FAQs. The FAQs have been compiled from various sources including questions asked at community meetings and interaction with Taskforce engineers on a one-on-one basis. FAQs will be sent to external agencies and organisations including non-government agencies and resident associations.

The Council continues to communicate with residents through updates on its website, e-newsletters and Council Service Centres. Information gathered at community meetings, in the surveys and other inbound communication (phone calls, e-mails, letters) are still being analysed.

## 7.2 Social Assessment report

The Taskforce prepared a Social Assessment Report to understand the impacts on the people and communities as a result of repeated flooding events. The report is being used, in part, to inform Council's work with the agencies involved in providing support for individuals.

## 7.3 Rates relief

The Council has offered a rates relief to property owners whose houses have been affected by flooding using the following criteria:

- The house is unoccupied due to flood damage; and

- The house is on the Taskforce list of vulnerable houses or the resident has applied to have it added to that list, and
- Repairs to make it habitable are reliant on further Council action.

So far over 50 people have applied for the rates rebate and the Council continues to process applications and is notifying flood-affected residents of the status of their application.

#### 7.4 Work with other agencies

The Council is working with the Ministry of Social Development (specifically the Earthquake Support Coordination Service), the Canterbury District Health Board, the Ministry of Education, CERA and other non-government organisations who are members of the Psychosocial Subcommittee. The Psychosocial Subcommittee was set up by CERA and consists of a number of community groups and organisations within Christchurch.

The Council has also contacted the Ministry of Education (MoE) (19 June 2016) to understand their policies in relation to flooding. The purpose was to understand how the Ministry of Education responds to flooding events to ensure the health, wellbeing and safety of school children.

The Council has also been working with the Canterbury Earthquake Temporary Accommodation Service (CETAS) to determine:

- The best practice process required to provide financial support and accommodation to families requiring help.
- Clarifying CETAS policy, criteria and the resource required to provide support to flood-affected residents where flooding is earthquake related.

One outcome of this was that the Honourable Gerry Brownlee, the Minister for Canterbury Earthquake Recovery, and Honourable Paula Bennett, Minister for Social Development announced on 25 June 2014 that Canterbury residents impacted by earthquake related flooding are eligible to apply for Temporary Accommodation Assistance (TAA) programme which is administered by CETAS.



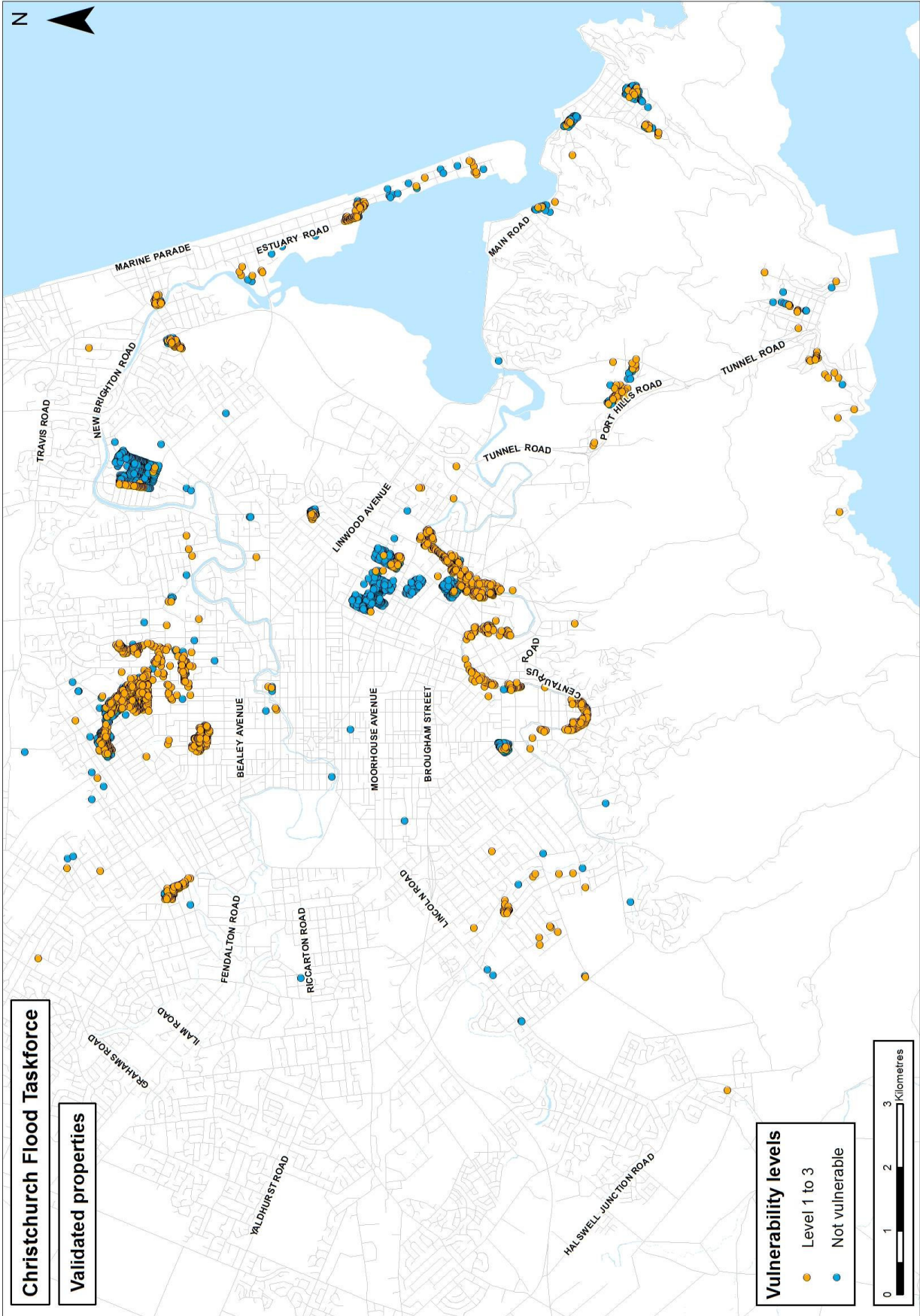
Figure 9 Maintenance works on Dudley Creek to increase channel capacity

## 8 Area investigations

Over 2,500 houses have been evaluated for flooding vulnerability by the Taskforce (Figure 10 on following page). The key findings from the area investigations are summarised below (Table 2).

**Table 2 Key findings from area investigations**

Areas investigated by Taskforce	Key findings
Dudley Creek	<ul style="list-style-type: none"> <li>• This catchment contains the highest number of vulnerable houses</li> <li>• Local area schemes have a wide benefit which can be implemented quickly (50% of benefit within six weeks)</li> </ul>
Heathcote Valley	<ul style="list-style-type: none"> <li>• Solutions are easy to implement</li> <li>• Maintenance is important</li> </ul>
Lower Avon	<ul style="list-style-type: none"> <li>• Most of the vulnerable houses are within the Residential Red Zone</li> <li>• The remaining houses will largely be benefited by increased maintenance</li> </ul>
Lower Heathcote	<ul style="list-style-type: none"> <li>• Adjustments to the maintenance regime may reduce regular flooding impacts</li> <li>• There are a number of local schemes possible but these require further investigation as they have potential impacts on adjacent houses</li> <li>• Dredging is still being investigated for effectiveness</li> </ul>
Little River	<ul style="list-style-type: none"> <li>• The earthquakes have not worsened flooding</li> <li>• Maintenance and improvement are the responsibility of multiple authorities (ECan, NZTA, Council, private landowners)</li> <li>• A number of houses repeatedly flood</li> </ul>
Sumner	<ul style="list-style-type: none"> <li>• Although Sumner experienced significant flooding in March the area has not been identified as susceptible to regular flooding using the Taskforce criteria (repeated floor level flooding)</li> <li>• Flooding will be reduced by increased maintenance</li> </ul>
Southshore	<ul style="list-style-type: none"> <li>• SCIRT works will soon minimise regular flooding impacts</li> <li>• Ebbtide stopbank needs to be repaired</li> </ul>
Upper Heathcote	<ul style="list-style-type: none"> <li>• A pocket of vulnerable houses can be mitigated with a local bund</li> </ul>
Lytelton	<ul style="list-style-type: none"> <li>• Land slip poses a significant natural hazard</li> <li>• The risk is likely to have increased due to the earthquakes</li> <li>• The houses with highest risk are disbursed across the area</li> <li>• Ongoing investigations are required to address land slip</li> <li>• Private drainage faults increase the risk to properties</li> </ul>
Other city areas	<ul style="list-style-type: none"> <li>• Vulnerable houses have been identified outside of the priority areas</li> <li>• Some clusters of vulnerable houses would benefit from schemes such as those designed for the priority areas</li> </ul>



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Figure 10 Flood survey results validated by Taskforce

## 9 City wide proposals

This section contains Taskforce recommendations that are not specific to one area.

### 9.1 Community engagement and social needs

Item	Recommendation	Status	To be progressed by
Communication	Contact the people who have requested a follow up meeting requiring technical assistance.		Strengthening Communities External Relations & Communication Technical experts
Communication	Ongoing communication with all residents who are on the Taskforce's contact list with updates and information about the evolving social and financial supports that are available.		Strengthening Communities External Relations & Communication Land Drainage Operations
Specialist support and cross agency collaboration	Work with the agencies on the Psychosocial Subcommittee to directly contact the flood-affected residents who are considered the most vulnerable. This is generally defined as the Level 1's. Provide information about the current and evolving social and financial supports that are available.		Strengthening Communities Third party departments or agencies that can provide psychosocial support
Information sharing	Share information that is not sensitive with other departments and/or agencies to ensure a more coordinated approach to communicating with and supporting flood-affected residents.		Strengthening Communities Third party departments or agencies that can provide psychosocial support
Reporting to Psychosocial Subcommittee	Provide ongoing updates to the Psychosocial Subcommittee on the findings from the data collected during the Taskforce.		Strengthening communities
Financial assistance	Investigate support services (social and financial) for flood-affected residents.		Strengthening Communities Strategic Initiatives Third party departments or agencies that can provide funding and social supports

## 9.2 Information, awareness and response recommendations

Item	Recommendation	Status	To be progressed by
Data availability	Rainfall and river level and flow data is made available to the public in one location, preferably via a website	Recommendation	Asset and Network Planning
Council flood assistance contact	A single point of contact in Council could be appointed to deal with and provide assistance and advice to residents in flood prone areas	Recommendation	Unit Manager - Transport and Greenspace
Canterbury District Health Board (CDHB) FAQ	A link to the CDHB FAQ be provided on the Council website	Completed	External Relations & Communication
Review and update wet weather response plans based on Taskforce findings	Response plans reviewed and updated based on Taskforce findings as required	Underway	Unit Manager - Transport and Greenspace
Updates on flooding/informing residents	Develop a package of information sharing methods and provide updates on Taskforce recommendations, measures, what to do if it floods	Recommendation	External Relations & Communication

## 9.3 Maintenance systems and processes

Item	Recommendation	Status	To be progressed by
Customer relationship management (CRM)	It is recommended that the project to review the CRM process and replace Council's existing WorkSmart system be given a high priority in order to deliver early benefits across the Council.	Recommendation	Director of Corporate Services
Adjust maintenance contracts	<p>The boundaries between different maintenance contracts of land drainage components should be reviewed. At present there are three different maintenance contracts governed by different sections in Council as follows:</p> <ul style="list-style-type: none"> <li>■ Gutters, sumps and the lead to the main pipe – Roading</li> <li>■ Pipes and surface water channels – Land Drainage</li> <li>■ Basins and wetlands - Parks</li> </ul> <p>It is recommended that a review take place</p>		Unit Manager - Transport and Greenspace



Item	Recommendation	Status	To be progressed by
	to ensure that these boundaries do not cause inefficiencies or issues, particularly during extreme events.		
Improve tracking of maintenance activities	<p>The routine maintenance “rounds” should be revised based on the findings from the Taskforce work, and a planned maintenance scheduling system be investigated to assess the benefits of automating the issue of routine work instructions to contractors. This would potentially provide a means to monitor and optimise routine maintenance activities. It would also provide asset and customer information back from the field that can be recorded in Council’s Asset Management Information system including:</p> <ul style="list-style-type: none"> <li>■ Job completion dates and times</li> <li>■ Details of asset condition</li> <li>■ Proof of presence using GPS</li> <li>■ Job costs</li> </ul> <p>Maintenance contractors currently do this internally and provide access to Council to their system.</p>		Unit Manager - Transport and Greenspace

#### 9.4 Houses outside priority areas

Item	Recommendation	Status	To be progressed by
Inform newly identified Level 1 and 2 households	Pass on the same information provided to those already identified	Recommendation	External Relations & Communication

## 9.5 Wastewater overflows

Item	Description	Status	To be progressed by
Overflow reduction pilot study	<p>The objectives of the project are to:</p> <ol style="list-style-type: none"> <li>1. Provide a robust trial of inflow and solids reduction measures</li> <li>2. Report on the effectiveness of each trialled measure in a consistent manner</li> <li>3. Provide recommendations, supported with evidence, of all or any of the measures that could be rolled out across the city</li> </ol> <p>A draft Charter for this pilot study has been prepared</p>	Underway	City Water and Waste
Wastewater solids cleanup	Review current procedures for post-flooding cleanup of wastewater solids	Existing - review	City Water and Waste
Private property post-flood cleanup	In areas facing large insurance excesses and until longer term solutions are in place, Council may consider providing guidance and advice about access to funding for post-flooding clean-up	Recommendation	External Relations & Communication

## 9.6 Private bridging policy

Item	Recommendation	Status	To be progressed by
Private bridging policy	There are a number of private bridges which impede waterways within the city. It is recommended that a review of this issue be undertaken and a policy developed on this issue if necessary.	Underway	Unit Manager - Transport and Greenspace

## 10 Priority area proposals

This section contains those proposals that are specific to one priority area. It is a high level summary of the information contained in Section C of the Part B report. Detailed breakdowns of each local area or maintenance scheme have been prepared should any proposal proceed to construction. The detail contained in the detailed breakdown is such that most schemes could be implemented with minimal additional effort.

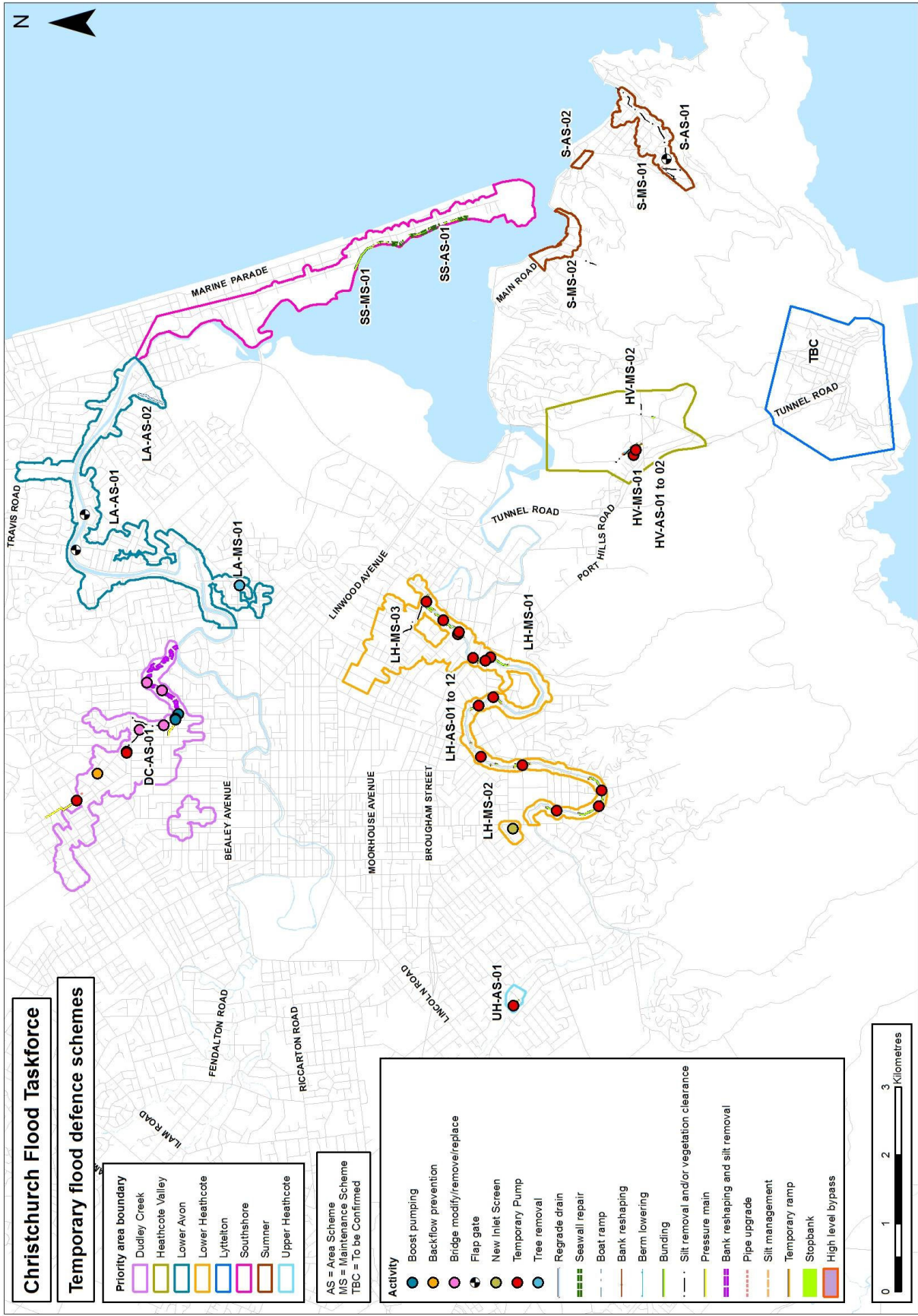
Cost estimates include operational expenditure for two years where relevant and are rounded to the nearest \$5,000 for clarity. **Ongoing operational expenditure (including depreciation) needs to be quantified and the Land Drainage Operations budget will need to be increased accordingly.** Ongoing operational costs beyond two years have not been included.

Note that the delivery mechanism and funder for each of these proposals has not been decided. Council will be involved in some proposals, but others are likely to be led and funded by other agencies.

The locations of each scheme (by scheme reference number) are shown in Figure 12 on the following page.



Figure 11 Clearing vegetation on Dudley Creek, May 2014



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Figure 12 Scheme locations and details

## 10.1 Dudley Creek

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
<b>DC-AS-1</b>		<b>\$8,630,000</b>		
Tay Street Drain (Kensington Avenue) Pump Station 202 (DC-AS-1.1)	Installation of a pump station to divert flood flows from Tay Street Drain and Mairehau Drain to the Lower Dudley Creek Diversion.	\$6,120,000	In progress	Unit Manager - Transport and Greenspace
Dudley Creek Channel Improvements and Constraint Removal (DC-AS-1.2)	Minor channel widening, lowering and vegetation clearance through the lower Dudley Creek between North Parade and Banks Avenue, with additional localised widening upstream. Silt removal between Hills Road and North Parade.	\$700,000	In progress	Land Drainage Operations Team
Warrington Street pump station (DC-AS-1.3)	Installation of a backflow device on the Flockton Invert with a nominal overpumping capacity of 500 L/s	\$630,000	Complete	Land Drainage Operations Team
Boost Pumping (DC-AS-1.4)	Temporary pumping at culverts to improve conveyance - Pumps fitted with reducer nozzles on outlet pipework to form a jet of water that are then directed downstream through the system to increase system energy resulting in higher velocities and greater discharge	\$280,000	Continued operational requirement	Land Drainage Operations Team
Chancellor Street Culvert and Guild Street Footbridge Removal (DC-AS-1.5)	Removal of the Chancellor Street culvert and Guild Street footbridge which are constraints on conveyance	\$315,000	In progress, Guild Street complete	Land Drainage Operations Team
Westminster Drain Backflow Prevention (DC-AS-1.6)	Installation of localised backflow prevention on local drains connecting to Westminster Drain directly upstream of the Mairehau Drain confluence.	\$5,000	Proposed	Land Drainage Operations Team
Bridge removal and replacement for betterment (DC-AS-1.7)	Demolition and temporary replacement of 2 private access bridges to facilitate significant betterment	\$30,000 (betterment component)	Negotiations commenced	Unit Manager - Transport and Greenspace

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
Hydraulic model update (DC-AS-1.8)	Update hydraulic model to establish expected hydraulic performance once channel widening, culvert removal and Tay Street Drain pump station are implemented, enabling review of catchment upgrade options 1 and 2 to take account of benefits achieved.  Also develop operational plan for Cranford Basin with Tay Street Drain pump station operating.	\$60,000	Scope written	Land Drainage Recovery Programme
<b>MAINTENANCE AND OTHER WORKS</b>				
Channel clearance	On-going maintenance of the channel will be required to maintain channel capacity, in particular it has been noted that silt deposition in the channel continues to be a problem and that following extensive silt clearance in 2013 further deposition continues to occur.	\$500,000 (estimated for two years, to be reviewed following)	Ongoing and initial clearance complete	Land Drainage Operations
Warrington Street pump station operation plan	An operation plan is needed to ensure correct operation of the Warrington Street pump station and culvert boost pumps.		Complete	Land Drainage Operations
<b>HOUSE DEFENCE</b>				
House defence pilot study	Conduct pilot study into house defence measures and present results	\$30,000	Completed	Unit Manager - Transport and Greenspace
House defence (DC-HD-1)	Defend residual houses through tanking, raising or relocation  This is to cover the 10 Level 1 and 148 Level 2 houses which <b>do not</b> benefit from the temporary measures above (Although a review may need to be completed following the revised flood risk assessment and measures implemented as required)		Proposed	Various agencies

## 10.2 Lower Avon

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
Flapgates (LA-AS-1)	Flap Gates at PS220 to prevent backflow into the Avondale Catchment.	Already in EQ OPEX budget for 2014/15	Scheduled	Land Drainage Operations
Regrading of Lower Knights Drain (LA-AS-2)	Regrading of Knights Drain required from Pages Road to Anzac Drive.	\$235,000	Proposed	Land Drainage Operations
<b>MAINTENANCE WORKS</b>				
Brittans Drain tree removal (LA-MS-1)	Immediate removal of a large tree blocking Brittans Drain would relieve the foundation level flooding experienced.	In existing contracts	Completed	Land Drainage Operations
RRZ flapgates	Backflow prevention in the Residential Red Zone needs to be investigated in co-ordination with the stop bank maintenance through the Land Drainage Operations Team. Consider whether RRZ traffic routes should be protected	In existing budgets	Proposed	Land Drainage Operations

### 10.3 Heathcote Valley

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
<b>HV-AS-1</b>		<b>\$650,000</b>		
Tunnel Road (HV-AS-1.1)	Placing sand bags along kerb and channel at 15 m intervals to trap sediment before entering pipe network.	\$10,000	Proposed	Land Drainage Operations-
Truscotts Road Timbering (HV-AS-1.2)	Raise height of timbering on carriageway side of existing timbered drain and bund adjacent to contain water within timbered drain to a point downstream of Deavoll Lane.  Inlet improvements to direct flow to drain.	\$340,000	In progress	Land Drainage Operations
Truscotts Road - High Level By-pass (HV-AS-1.3)	Construct two high level by-pass areas on Truscotts Road to allow water to flow across the carriageway and berms from the timbered drain to the branch of the Mutuku Waterway.	\$35,000	In progress	Land Drainage Operations
Pawaho and Stedley Place (HV-AS-1.4)	Raise height of timbering on property side of timbered drain from Martindales Road for 300m downstream to culvert to stop water overtopping the drain and flowing on to adjacent houses.  Inlet improvements to direct flows to drain.	\$265,000	Proposed	Land Drainage Operations
<b>HV-AS-2</b>		<b>\$135,000</b>		
Marsden Road - Bridle Path Road Intersection	Bunding across end of Marsden Road at the Bridle Path Road intersection	\$135,000	Proposed	Land Drainage Operations
<b>MAINTENANCE WORKS</b>				
Truscotts Stream Branch drain (HV-MS-1)	Truscotts Stream Branch drain sediment removal over approximately 350m between Martindales Road to the downstream Truscotts Rd bend.	\$60,000	Complete	Land Drainage Operations
Martindales Road Drain (HV-MS-2)	Martindales Rd Drain - clearance of vegetation and sediment removal over a length of 165m upstream of inlet	\$35,000	Proposed	Land Drainage Operations



Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
	structure at Martindales Rd.			
Review recommendations for minor capital and maintenance work outside of Taskforce scope in Part B	A number of inlet and other drainage improvements have been identified during the Taskforce work. However, these fall outside of the scope of the Taskforce and so are not included in the costs. It is recommended that these works are reviewed outside of the Taskforce.		Proposed	Land Drainage Operations

#### 10.4 Upper Heathcote

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
Weir Place (UH-AS-1)	A localised bund forming a stopbank with a mobile pump (although a permanent pumping option should be considered). This includes constructing a bund and a road hump reshaping at the intersection of Smartlea Street.	\$50,000	Concept	Capital Programme Group

## 10.5 Lower Heathcote

Note that the feasibility of temporary stopbanks, and their height and location will be finalised after modelling is completed. If temporary stopbanks are installed this may commit Council to installing long-term stopbanks which is a planning decision which needs careful consideration.

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
Richardson Terrace (LH-AS-1)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding on Richardson Terrace to Ferry Road.	\$935,000	Concept	Asset and Network Planning
Clarendon Terrace (LH-AS-2)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding from on Clarendon Tce to Radley Street.	\$320,000	Concept	Asset and Network Planning
89 - 101 Clarendon Terrace (LH-AS-3)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding in front of 89-101 Clarendon Tce.	\$235,000	Concept	Asset and Network Planning
Clarendon Tce to Grange Street (LH-AS-4)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding on Richardson Terrace to Ferry Road.	\$535,000	Concept	Asset and Network Planning
Ford Road (LH-AS-7)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding from Ford Road to Opawa School.	\$290,000	Concept	Asset and Network Planning
258 Riverlaw Tce to Derrett Place (LH-AS-9)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding from Riverlaw Tce to Derrett Place.	\$250,000	Concept	Asset and Network Planning

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
Derrett Place to Esher Place (LH-AS-10)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding from Derrett Place to Esher Place.	\$280,000	Concept	Asset and Network Planning
Riverlaw Terrace (LH-AS-11)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding from Riverlaw Terrace to Waltham Road & Eastern Terrace.	\$480,000	Concept	Asset and Network Planning
Beckenham Loop (LH-AS-12)	Installation of temporary stopbanks on the Heathcote River including traffic management and localised bunding around Beckenham Loop/Waimea/Hunter/Eastern Terrace.	\$1,310,000	Concept	Asset and Network Planning
<b>MAINTENANCE WORKS</b>				
Backflow checks (LH-MS-1)	Cleaning and checking of flap gates and backflow devices is required to ensure backflow prevention.	\$15,000	In progress	Land Drainage Operations
Tennysons Drain inletting (LH-MS-2)	Upgrading of the Tennysons Drain Inlet	\$480,000	Proposed	Land Drainage Operations
Bells Creek (LH-MS-3)	Removing silt from Bells Creek. Channel works comprising widening, lowering and vegetation clearance are all recommended. Blocked sumps on Randolph and Bass Streets that need to be cleared are covered under the maintenance contract.  Costs are for two years of silt removal and the Land Drainage Recovery Programme is looking at longer term options for Bells Creek.	\$255,000	Proposed	Land Drainage Operations
<b>HOUSE DEFENCE</b>				
House defence (LH-HD-1)	Defend 8 houses <b>not</b> protected by proposals above		Proposed	Various agencies

## 10.6 Southshore

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
Southshore Red Zone Godwit St to Tern St (SS-AS-1)	Work to provide a minimum level of protection from tidal flooding of the cleared Red Zone houses fronting the estuary including ground shaping or importing of material to form an earth bund to achieve a continuous physical barrier along the estuary frontage, and also repairs or topping up of damaged or inadequate seawalls.	\$295,000	Concept	Land Drainage Operations
<b>MAINTENANCE WORKS</b>				
Ebbtide St Stop Bank (SS-MS-1)	Importing and placement of material to reinstate Ebbtide St stop bank to original design standard	\$140,000	Underway	Land Drainage Operations

## 10.7 Sumner

### 10.7.1 Sumner physical works

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>PHYSICAL WORKS</b>				
Wakefield Ave Drainage (S-AS-1)	Improve inlet capacity in Wakefield Ave and Paisley Street area by installing double sumps each side of Wakefield Ave at low point and one on north side of Paisley Street at intersection with Wakefield Ave	\$60,000	Scheduled	Land Drainage Operations
Cave Rock drain – outfall to beach (S-AS-2)	Design and construct permanent hard outfall from Cave Rock Drain to formalise secondary system protecting Mariner Street	\$75,000	Concept	Asset and Network Planning

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>MAINTENANCE WORKS</b>				
Planned maintenance on Sumner Stream (S-MS-1)	Channel works comprising silt removal and vegetation clearance are planned for Sumner Stream	\$140,000	Underway	Land Drainage Operations
Maintenance on Rifle Range Drain (S-MS-2)	Clear silt from Rifle Range Drain Overflow weir and reform the channel upstream of Bay View Road end to increase the cross sectional area and prevent spilling down Bay View Road	\$10,000	Scheduled	Land Drainage Operations

## 10.8 Lyttelton

Item	Recommendation	Status	To be progressed by
Extend private drainage fault study	A pilot study in a small area of Lyttelton identified a significant number of private drainage faults which increase the risk to surrounding properties. It is recommended that this study is extended to all of Lyttelton to enable a complete understanding of risks and to identify those properties needing to fix their drainage.	Proposed	Unit Manager - Transport and Greenspace
Development of mitigation options	Completion of the technical report on the risk assessment. Further investigation into mitigation options for high or medium risk properties.	Proposed	Unit Manager - Transport and Greenspace

## 10.9 Other areas

Item	Description	Estimated Cost +/- 30%	Status	To be progressed by
<b>HOUSE DEFENCE</b>				
House defence (OA-HD-1)	Estimate to allow for defence of residual Level 1 and 2 houses outside of the priority areas		Proposed	Various agencies

## 11 Costs and implementation programme

The costs of the options presented by Taskforce are split between:

- Maintenance and minor capital works outside of Dudley/Flockton (which can be acted upon immediately)
- The works within Dudley/Flockton (which need to be considered as a package)
- Lower Heathcote temporary stopbanks (which need to be considered within the long-term planning context)
- House defence for those houses outside of the schemes above (and which are likely to be carried out by agencies other than Council)

The split between these options, and the Vulnerability Level 1-3 properties covered by each, are shown below.

### 11.1 Maintenance and minor capital items for immediate action - outside of Dudley/Flockton

Costs are presented for a number of areas and activities. Approximately \$2.1 million worth of immediate and minor capital works have been recommended by the Taskforce. Of these, approximately 65% are either scheduled, in progress or completed. The remaining works need further work before approval.

**Table 3 Costs for maintenance and minor capital items for immediate action (excluding Dudley/Flockton)**

Priority Area	Benefitted Houses			Estimated Cost		
	Level 1	Level 2	Level 3	CAPEX (\$'000)	OPEX (\$'000)	TOTAL (\$'000)
Lower Avon	0	5	53	235	-	235
Lower Heathcote	0	3	20	252	35	287
Heathcote Valley	1	21	8	751	55	806
Upper Heathcote	0	4	12	41	10	51
Sumner	0	10	15	130	176	305
Southshore	2	6	40	292	140	432
<b>TOTAL</b>	<b>3</b>	<b>49</b>	<b>148</b>	<b>1,702</b>	<b>416</b>	<b>2,117</b>

## 11.2 Dudley/Flockton works

Dudley/Flockton total costs of recommended works is \$7.3 million. The majority of this work has been approved and is scheduled, in progress or completed. Note that these works must be considered as a whole when evaluating benefit to houses.

**Table 4 Costs of Dudley/Flockton recommendations**

Priority Area	Benefitted Houses			Estimated Cost		
	Level 1	Level 2	Level 3	+/- 30%		
				CAPEX (\$'000)	OPEX (\$'000)	TOTAL (\$'000)
Tay Street Drain Pump Station				6,100	18	6,118
Dudley Creek Channel Improvements and Constraint Removal				560	140	700
Warrington St pump station				456	171	627
Boost Pumping				66	213	279
Chancellor Street Culvert and Guild Street Footbridge Removal				314	-	314
Westminster Drain Backflow Prevention				4	-	4
Private Bridge Betterment				31	-	31
Hydraulic model update				56	-	56
Channel clearance				-	500	500
<b>TOTAL</b>	<b>44</b>	<b>51</b>	<b>418</b>	<b>7,588</b>	<b>1,042</b>	<b>8,630</b>

### 11.3 Lower Heathcote temporary stopbanks

Temporary stopbanks in some locations along the Lower Heathcote are one option for temporary flood defence. However, temporary stopbanks need to be considered in the context of the integrated management of the Heathcote catchment, and it is recommended that Asset and Network Planning review this scheme against the long-term options to ensure that the best outcome is achieved for the Lower Heathcote catchment. This scheme has been separated from the other works for clarity.

Table 5 Lower Heathcote stopbank costs

Priority Area	Benefitted Houses			Estimated Cost		
	Level 1	Level 2	Level 3	+/- 30%		
				CAPEX (\$'000)	OPEX (\$'000)	TOTAL (\$'000)
Richardson Terrace	0	24	18	792	141	933
Clarendon Terrace	2	10	9	245	74	318
Clarendon Terrace	2	6	4	194	39	233
Clarendon Tce to Grange Street	0	13	21	466	68	534
Ford Road	1	10	13	231	57	288
Riverlaw Tce to Derrett Place.	0	8	6	205	45	250
Derrett Place to Esher Place	0	4	7	232	47	278
Riverlaw Terrace to Waltham Road	0	4	2	413	62	475
Beckenham Loop	8	48	39	1,173	135	1,308
<b>TOTAL</b>	<b>13</b>	<b>127</b>	<b>119</b>	<b>3,951</b>	<b>667</b>	<b>4,617</b>

### 11.4 House defence

There are 12 Vulnerability Level 1 and 186 Vulnerability Level 2 houses which are **not** provided with any flood defence by maintenance or local area schemes. The best flood defence for these properties in the short-term is individual house flood defence. Note that some of these Level 2 houses were Level 1 without the proposed works in Dudley/Flockton.

The costs to provide individual house defence is shown below. These costs are unlikely to be borne by Council, but are reported here to allow other agencies and Council to consider the best approach for dealing with the regular flooding faced by these households. The total cost of house defence for these residual properties is \$5.85 million.

An equal division between house raising and relocation used to establish the cost estimate for house defence measures, i.e. where house raising is not viable the relocation is suggested. This split is based upon advice given by contractors on the general viability of house raising. The feasibility of raising the individual houses has not been considered. As a result there is low certainty with the total costs of house defence measures.



Table 6 House defence costs

Priority Area	House defence type	Benefitted Houses			Estimated Cost +/- 30% TOTAL (\$'000)
		Level 1	Level 2	Level 3	
<b>Lower Avon</b>	House tanking	<b>0</b>	<b>3</b>	<b>0</b>	<b>45</b>
<b>Dudley/Flockton</b>	House tanking	0	164	0	2,460
	House raising	5	0	0	750
	Relocation	5	0	0	2,000
	<b>Dudley total</b>	<b>10</b>	<b>164</b>	<b>0</b>	<b>5,210</b>
<b>Lower Heathcote</b>	House tanking	<b>0</b>	<b>8</b>	<b>0</b>	<b>120</b>
<b>Other areas</b>	House tanking	0	11	0	165
	House raising	1	0	0	150
	Relocation	1	0	0	400
	<b>Other area total</b>	<b>2</b>	<b>11</b>	<b>0</b>	<b>715</b>
<b>TOTAL</b>		<b>12</b>	<b>186</b>	<b>0</b>	<b>6,090</b>

## 11.5 Lyttelton

No costs have been included for mitigation measures in Lyttelton. In the 12 May Taskforce draft report a cost of \$2.7M was included for works. Further investigation is needed to fully quantify the extent of the issues and to develop mitigation options. Once this is completed then costs for works can be estimated.

## 11.6 Taskforce

The total cost of the Taskforce was \$1.45M.

## 11.7 Discussion

The 12 May 2014 report indicated a total cost for the works of \$20.4M +/- 30%. However, that total included Lyttelton and Little River which have not been assigned costs in this report.

Ongoing operational costs associated with an altered maintenance regime and new capital assets have not been quantified beyond the initial two year period. Some of these costs may be significant and need to be calculated so that operational budgets can increased accordingly.

A breakdown of the costs is shown in Figure 13. This is **preliminary only** and needs further analysis to confirm available resources and prioritisation of projects. Some costs are still to be finalised also, such as those for Lower Heathcote where the results of the modelling are still not available to enable stopbank height determination.

More significant or expensive works should be reviewed to address the overall catchment management plans and consideration of the long term impacts of climate change, a “no regrets” check.

Key assumptions in developing the total cost estimate include:

- Dependencies and resourcing have not yet been investigated so the programme forecast assumes that the works are delivered concurrently
- The CAPEX/OPEX split has not been verified, although an indicative split has been included
- No allowance has been made in the cost estimates for vulnerable houses not identified by the Taskforce.

There are additional assumptions relevant to each local area scheme which are detailed in the text.

There are also a number of exclusions in developing the cost estimate. No costs have been included for:

- Little River (identified in the 12 May report as having \$235,000 of works)
- Maintenance already programmed (e.g. included existing maintenance contracts)
- Dredging is not included in the cost estimate. The current cost estimates put the cost of dredging the lower Heathcote River in excess of \$16M.
- Any vulnerable houses and associated flood defence outside of the priority areas
- Modification to the wastewater network from Taskforce recommendations

Priority Area	Scheme Type	Work Description	To Be Progressed By	Status	Benefit			Estimated Cost +/- 30%				
					Level 1	Level 2	Level 3	CAPEX (\$'000)	OPEX (\$'000)	TOTAL (\$'000)		
<b>Maintenance and minor capital items for immediate action - outside of Dudley/Flockton</b>					<b>3</b>	<b>49</b>	<b>148</b>	<b>1,702</b>	<b>416</b>	<b>2,117</b>		
Lower Avon	Capital	LA-AS-1	Avondale Area	Land Drainage Operations Team	Scheduled	0	0	25	-	-	-	
	Capital	LA-AS-2	Knights Drain	Land Drainage Operations Team	Recommendation	0	5	28	235	-	235	
	Maintenance	LA-MS-1	Brittains Area	Land Drainage Operations Team	Completed	0	0	0	-	-	-	
						<b>0</b>	<b>5</b>	<b>53</b>	<b>235</b>	<b>-</b>	<b>235</b>	
Lower Heathcote	Maintenance	LH-MS-1	Lower Heathcote Backflow Checks	Land Drainage Operations Team	In progress	0	0	0	-	-	-	
	Maintenance	LH-MS-2	Tennysons Drain Inletting	Land Drainage Operations Team	Recommendation	0	0	0	-	35	35	
	Maintenance	LH-MS-3	Bells Creek	Land Drainage Operations Team	Recommendation	0	3	20	252	-	252	
						<b>0</b>	<b>3</b>	<b>20</b>	<b>252</b>	<b>35</b>	<b>287</b>	
Heathcote Valley	Capital	HV-AS-1	Tunnel, Truscott, Pawaho, Stedley Rds	Land Drainage Operations Team	In progress	1	15	5	619	20	639	
	Capital	HV-AS-2	Marsden Road	Land Drainage Operations Team	Recommendation	0	6	3	132	-	132	
	Maintenance	HV-MS-1	Maintenance	Land Drainage Operations Team	In progress	0	0	0	-	35	35	
						<b>1</b>	<b>21</b>	<b>8</b>	<b>751</b>	<b>55</b>	<b>806</b>	
Upper Heathcote	Capital	UH-AS-1	Weir Place	Capital Programme	Recommendation	0	4	12	41	10	51	
Sumner	Capital	S-AS-1	Wakefield Ave / Paisley St	Land Drainage Operations Team	Scheduled	0	3	6	57	-	57	
	Capital	S-AS-2	Cave Rock Drain Secondary Flow Path	Asset and Network Planning	Recommendation	0	3	4	73	-	73	
	Maintenance	S-MS-1	Sumner Stream Maintenance	Land Drainage Operations Team	In progress	0	2	4	-	169	169	
	Maintenance	S-MS-2	Rifle Range Drain Maintenance	Land Drainage Operations Team	Scheduled	0	2	1	-	7	7	
						<b>0</b>	<b>10</b>	<b>15</b>	<b>130</b>	<b>176</b>	<b>305</b>	
Southshore	Capital	SS-AS-1	Southshore Red Zone Godwit St to Tern St	Land Drainage Operations Team	In progress	2	3	3	292	-	292	
	Maintenance	SS-MS-1	Ebbtide St Stop Bank	Land Drainage Operations Team	In progress	0	3	37	-	140	140	
						<b>2</b>	<b>6</b>	<b>40</b>	<b>292</b>	<b>140</b>	<b>432</b>	
<b>Taskforce costs</b>												
	TF		Christchurch Mayoral Flooding Taskforce	UM - Transport and Greenspace	Completed				-	1,450	1,450	
									-	1,450	1,450	
<b>Dudley / Flockton</b>					<b>44</b>	<b>51</b>	<b>418</b>	<b>7,588</b>	<b>1,042</b>	<b>8,630</b>		
Dudley / Flockton	Capital	DC-AS-1	Tay Street Drain Pump Station	UM - Transport and Greenspace	In progress				6,100	18	6,118	
	Maintenance	DC-AS-1	Dudley Creek Channel Improvements and Constraint Removal	Land Drainage Operations Team	In progress				560	140	700	
	Capital	DC-AS-1	Warrington St pump station	Land Drainage Operations Team	Completed, ongoing OPEX				456	171	627	
	Maintenance	DC-AS-1	Boost Pumping	Land Drainage Operations Team	Concept				66	213	279	
	Capital	DC-AS-1	Chancellor Street Culvert and Guild Street Footbridge Removal	Land Drainage Operations Team	In progress, Guild St removed				314	-	314	
	Maintenance	DC-AS-1	Westminster Drain Backflow Prevention	Land Drainage Operations Team	Recommendation				4	-	4	
	Capital	DC-AS-1	Private Bridge Betterment	UM - Transport and Greenspace	Discussions underway				31	-	31	
	Modelling	DC-AS-1	Hydraulic model update	Land Drainage Recovery Programme	Recommendation				56	-	56	
	Maintenance	DC-MS-1	Channel clearance	Land Drainage Operations Team	Ongoing				-	500	500	
<b>Lower Heathcote capital works</b>					<b>13</b>	<b>127</b>	<b>119</b>	<b>3,951</b>	<b>667</b>	<b>4,617</b>		
Lower Heathcote	Capital	LH-AS-1	Richardson Terrace	Asset and Network Planning	Concept	0	24	18	792	141	933	
	Capital	LH-AS-2	Clarendon Terrace	Asset and Network Planning	Concept	2	10	9	245	74	318	
	Capital	LH-AS-3	Clarendon Terrace	Asset and Network Planning	Concept	2	6	4	194	39	233	
	Capital	LH-AS-4	Clarendon Tce to Grange Street	Asset and Network Planning	Concept	0	13	21	466	68	534	
	Capital	LH-AS-7	Ford Road	Asset and Network Planning	Concept	1	10	13	231	57	288	
	Capital	LH-AS-9	Riverlaw Tce to Derrett Place.	Asset and Network Planning	Concept	0	8	6	205	45	250	
	Capital	LH-AS-10	Derrett Place to Esher Place	Asset and Network Planning	Concept	0	4	7	232	47	278	
	Capital	LH-AS-11	Riverlaw Terrace to Waltham Road	Asset and Network Planning	Concept	0	4	2	413	62	475	
	Capital	LH-AS-12	Beckenham Loop	Asset and Network Planning	Concept	8	48	39	1,173	135	1,308	
	<b>House defence options for inter-agency discussion</b>					<b>12</b>	<b>186</b>	<b>0</b>	<b>6,090</b>	<b>0</b>	<b>6,090</b>	
	Lower Avon	House Defence	LH-HD-1	House tanking	Other agencies	Concept	0	3	0	45	-	45
Dudley/Flockton	House Defence	DC-HD-1	House tanking	Other agencies	Concept	0	164	0	2,460	-	2,460	
	House Defence	DC-HD-1	House raising	Other agencies	Concept	5	0	0	750	-	750	
						<b>5</b>	<b>0</b>	<b>0</b>	<b>2,000</b>	<b>-</b>	<b>2,000</b>	
						<b>10</b>	<b>164</b>	<b>0</b>	<b>5,210</b>	<b>0</b>	<b>5,210</b>	
Lower Heathcote	House Defence	LH-HD-1	House tanking	Other agencies	Concept	0	8	0	120	-	120	
Other Areas	House Defence	OA-HD-1	House tanking	Other agencies	Concept	0	11	0	165	-	165	
	House Defence	OA-HD-1	House raising	Other agencies	Concept	1	0	0	150	-	150	
						<b>1</b>	<b>0</b>	<b>0</b>	<b>400</b>	<b>-</b>	<b>400</b>	
						<b>2</b>	<b>11</b>	<b>0</b>	<b>715</b>	<b>-</b>	<b>715</b>	

Figure 13 Preliminary implementation programme and cost breakdown