MILTON 2060

Flood Risk Management Strategy for Milton and the Tokomairiro Plain

Ajax Street (foreground), Milton June 1972

Ajax Street, Milton July 2007

Otago Regional Council

Clutha District Council

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1 Introduction

Flooding as a result of heavy rainfall in the Tokomairiro catchment is a natural process which is largely uncontrollable. Milton, which sits at the centre of the Tokomairiro Plain (Figure 1) is prone to flooding, often with adverse effects. The Otago Regional Council (ORC) and the Clutha District Council (CDC) have proposed the Milton 2060 Flood Risk Management Strategy to enable long-term, sustainable occupation and development in Milton.

The strategy's objectives are to:

- identify the characteristics of flood events, and their effect on Milton and the northern Tokomairiro plain;
- equip the community to understand, and live with, the effects of flooding;
- guide the nature and extent of land use development so that that flood risk does not increase and that this risk is progressively reduced, and;
- support the investigation and implementation of flood risk reduction measures.

Sections 2 and 3 respectively describe the scope of the strategy, and the environment within which it sits. Section 4 describes the legislative context within which the strategy has been defined and will operate. Sections 0 and 6 outline the strategy's guiding principles and core components. Defined areas with common flood hazard characteristics are mapped in Section 7. The control mechanisms for managing and reducing flood risk within those areas are outlined in Section 8. Section 9 describes some physical works which could reduce the flood hazard in parts of Milton.

2 Scope

2.1 Geographical

The strategy's geographical scope is the Milton urban area, including Tokoiti and Helensbrook. It also encompasses the full width of the Tokomairiro floodplain between Clarkesville and Milburn (Figure 2). The natural and social setting specific to Milton and the surrounding floodplain is discussed in Section 3.

2.2 Risk

This strategy addresses Milton and the surrounding floodplain's flood hazard, focusing on the risks and impacts associated with high river levels and surface runoff. It is recognised that heavy rainfall events may lead to a range of other risks, including sediment movement and land instability.

There are several other natural hazards in the Tokomairiro catchment. These include seismic activity associated with local fault systems and other major faults in the lower South Island, and extreme sea levels associated with storm surge or tsunami activity. While numerous other natural hazards exist, the strategy is primarily concerned with the flood risk associated with high river levels and the drainage of surface runoff across the Tokomairiro Plain.

2.3 Strategy development

The strategy is intended to be a living document, which will evolve in response to new information on flood hazard and risk,[1] the needs of the community, and the work of the respective councils. It will be reviewed every three years as part of both councils' long-term planning process. The review process will be a joint one between ORC and CDC. It will involve executive staff with responsibilities for land use planning and control, building control, utilities and natural hazards; and CEO's and local councillors from both councils. The review is proposed to monitor the strategy's effectiveness; the workability of the principles, relevance of the identified issues and success of the initiatives actioned.

[1] Including additional understanding of flood hazard and risk gathered during future flood events.

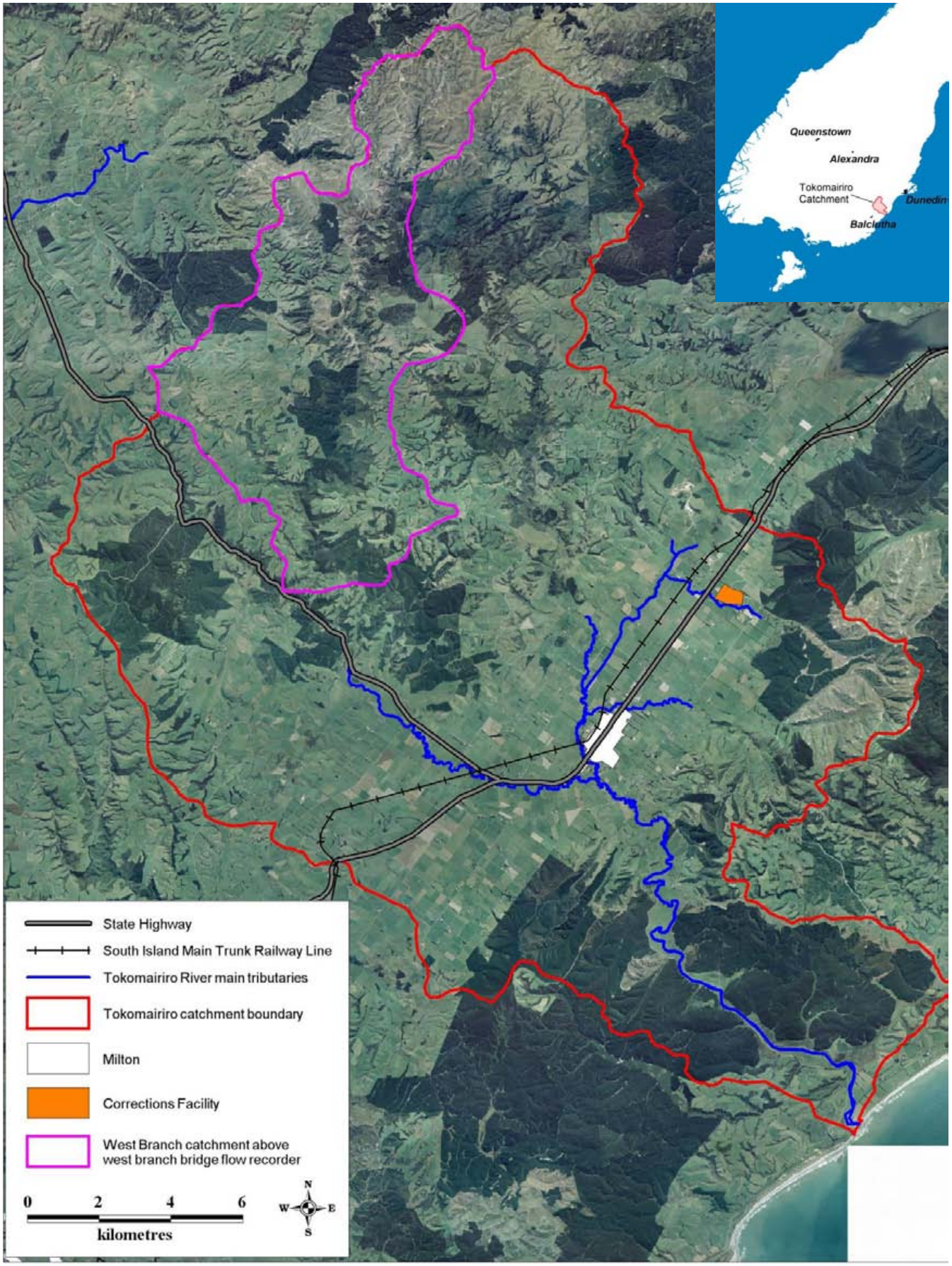

Figure 1. Tokomairiro catchment boundary.

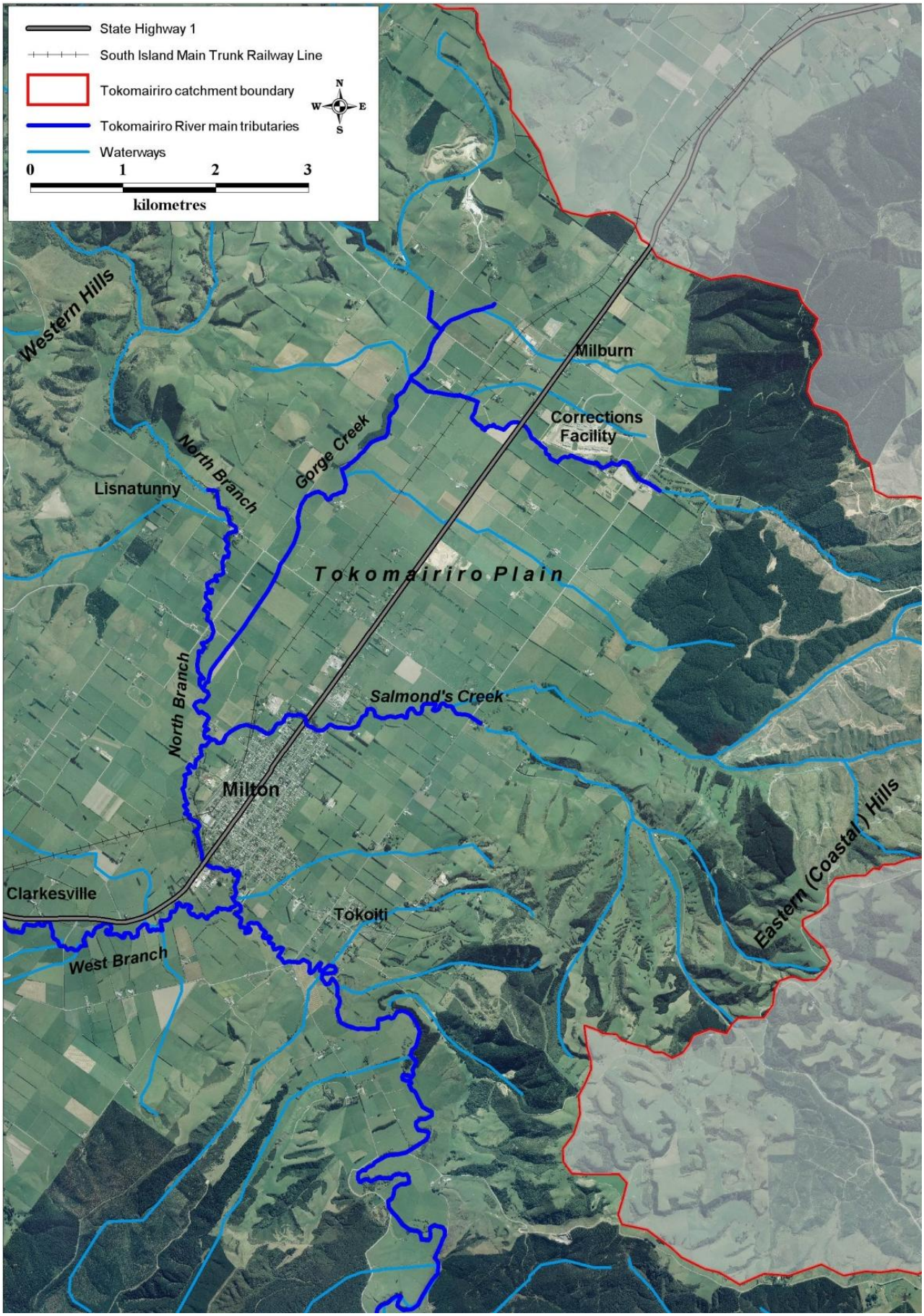

Figure 2. Location of Milton and the northern Tokomairiro Plain.

3 Environment setting

The natural and social settings' special characteristics which shape the flood hazard in the study area are as follows:

3.1 Geographical setting

The town of Milton is located on the Tokomairiro Plain, which lies within the Tokomairiro catchment (Figure 1), between Dunedin and Balclutha. The plain has been formed as gravel. Sediment has been eroded from the surrounding hill country, and subsequently deposited in the depression between the eastern and western hills. This process is thought to be still occurring on a limited scale, in areas actively affected by floodwater, such as Salmond's Creek to the north of Milton. Sediment carried by flood flows in these creeks can be deposited in the catchment's lower reaches, where the slope is shallower and stream velocity reduces. The remainder of the plain has been identified as an inactive floodwater dominant alluvial fan (Opus, 2009).

3.2 Meteorological setting

The Tokomairiro catchment is located on the east coast of the lower South Island, within Clutha District. Flood events in coastal catchments such as the Tokomairiro are generally caused by persistent rain-bearing easterlies, with continual rainfall over several days saturating the soil, leading to rapid runoff. Generally these types of events occur in late summer to late autumn, although they can occur at any time of the year.

Figure 3 shows the distribution of rainfall across the catchment during a severe storm in July 2007. During this event, the heaviest rain fell in a band along the low-lying area between Milton and Waihola, with more moderate totals to the east and west of this band. A similar pattern occurred in April 2006. Anecdotal evidence suggests that rainfall is often more intense through this low-lying part of the catchment.

While Figure 3 shows a number of daily manual rain gauges spread across the catchment, automatic (instantaneous) records did not start until August 2011, when a gauge was installed at Table Hill Road in the upper north branch. The nearest long-term automatic gauges are at Riccarton Road on the Taieri Plain, and at Balclutha.

Although weather conditions generally clear reasonably quickly after heavy rainfall events, enabling river levels to drop away, a sequence of fronts will occasionally move across the east coast, bringing further rain to already saturated catchments. The effect of these frontal bands can sometimes be compounded by the added runoff from snowmelt in the upper catchment.

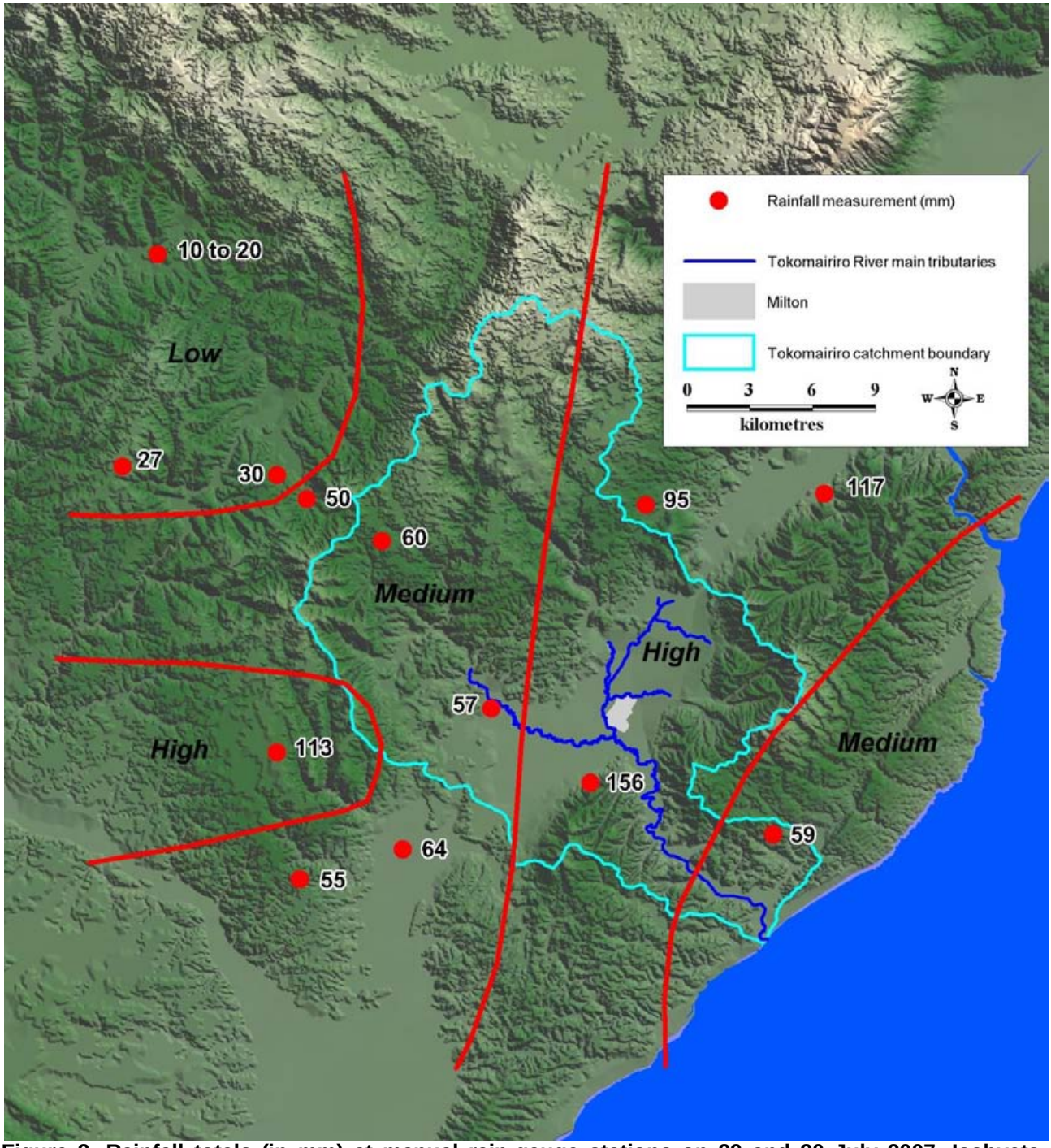

Figure 3. Rainfall totals (in mm) at manual rain-gauge stations on 29 and 30 July 2007. Isohyets are shown as thick red lines, separating areas of low (<40mm), medium and high (>100mm) rainfall intensity during this period.

3.3 Hydrological setting

The entire Tokomairiro River catchment is 393 km^2 in area, and extends from Toko Mouth approximately 30km inland to the north and northwest. The highest point is 584m above sea level in the far north of the catchment. River flow information is limited to one long-term river monitoring site on the west branch of the Tokomairiro River at SH8, commissioned in 1981. The catchment area upstream of this site is 69km^2 and is shown in Figure 1. Figure 4 shows the full flow record for this site - the largest flood events on record occurred in April 2006 (147 cumecs), July 2007 (134 cumecs), February 1991 (102 cumecs) and May 2010 (83 cumecs).[2] Additional evidence (photos, council reports) also exists of flood events in the Tokomairiro catchment during the 1960's and 70's and earlier (Figure 5).

[2] Normal base flow at the site is less than 1 cumec.

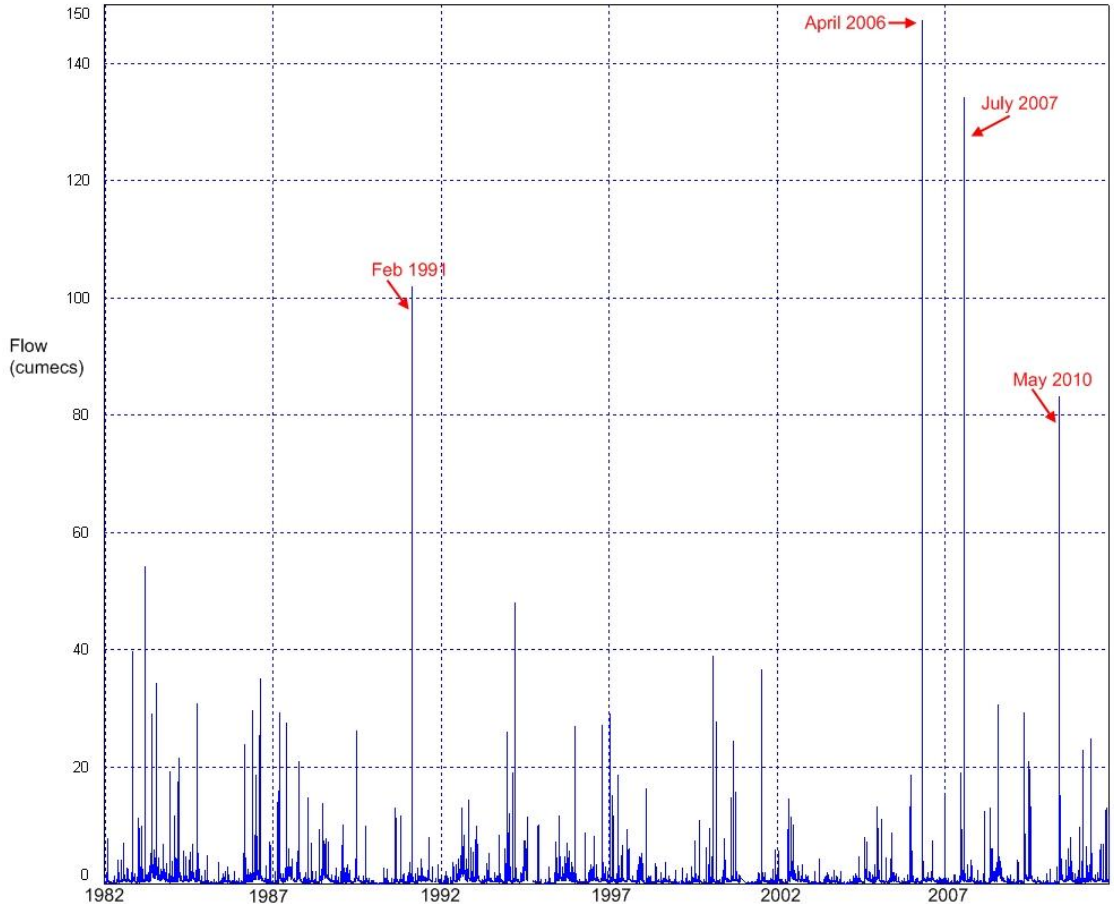

Figure 4. Flow record for the Tokomairiro River at West Branch Bridge, December 1981 to November 2011.

The river can rise reasonably quickly at the west branch site during flood events, with a rate of rise of up to 30 cumecs per hour over a three to four hour period observed.

Although currently un-gauged, the north branch of the Tokomairiro River has similar physical characteristics to the west branch site, including relief, catchment area and topography (Figure 3). Other major tributaries also contribute to flow in the north branch as it crosses the plain, including Salmond's and Gorge Creeks (Figure 2). Figure 5 shows the north branch just upstream of its confluence with the west branch during a flood event in June 1972.

Figure 5. The north branch of the Tokomairiro River just upstream of its confluence with the west branch in June 1972. The view is from Milton towards the southwest along SH1. This photo was not necessarily taken at the peak of the flood event.

In addition to these main tributaries, there are several natural overland flow paths or 'floodway corridors' which drain surface runoff during flood events (Figure 6 and Figure 7). These flow paths can take numerous forms, ranging from reasonably incised channels (1-2m lower than the surrounding land) through to relatively wide and shallow features, which can be difficult to identify during dry 'non-flood' conditions.

Although flood flows in these drainage corridors are generally smaller than those in the main river and the larger tributaries, they are still critical drainage features. They form a network which is necessary to allow flood water to drain quickly and efficiently from the eastern hill catchments and the floodplain into the larger tributaries of the Tokomairiro River. As a result, there is a level of flood hazard associated with these features, although this can easily be overlooked or underestimated as many do not normally carry water, or are not obvious drainage features.

The physical geography of Milton means it is exposed to flooding from a number of sources. The town is located in the lower reaches of the Tokomairiro basin, with the upstream catchment consisting of extensive hill country and a smaller floodplain component (Figure 1). The main tributaries of the Tokomairiro River and a number of overland flow paths converge at this point, before draining to the Pacific Ocean through a narrow gorge. Natural drainage through the gorge is restricted as the river lies close to sea level through this reach, and is tidally influenced for approximately 14km upstream of Toko Mouth.

Although Milton itself is elevated some 10-20m above mean sea-level, much of the town sits at a relatively low level compared to the network of tributaries which converge in this area. The southwestern end of the town is particularly vulnerable to flooding - there are two residential areas which sit in bowl-shaped depressions which are natural collection points for floodwater and surface runoff (Figure 10). Water can pond in these areas for a day or more after a flood, due to limited drainage capacity. Physical works (floodbank and pump station) constructed by the CDC to help mitigate this flood hazard are described in Section 6.2.

Figure 6. Rural floodway corridor near Back Road draining surface runoff during a rainfall event in February 2012.

Figure 7. Aerial view showing a network of overland flow paths to the east of Milton, following a flood event in August 1974. The Tokomairiro River can be seen to the left of the image.

3.4 Community setting

Milton plays an important role in the wider community, at a local, district, and regional level. It is a service centre and focal point for the surrounding rural community. Some key links in the lower South Island transport network also cross the Tokomairiro Plain, including State Highway's 1 and 8 and the main trunk railway line.

The Otago Corrections Facility is also situated near Milton, and accommodates up to 335 prisoners and employs 200 staff. Although the town's population has gradually fallen in recent decades[3], there has been some expansion in the local farming industry, due to a number of dairy conversions. Commercial development is also occurring (and is expected to continue) on the Tokomairiro Plain to the north of Milton.

Residential and commercial development has occurred within areas which are naturally prone to flooding from the Tokomairiro River and from surface runoff draining the hill catchments to the east.

Milton has been affected by flooding on a number of occasions since it was first settled (Soil Conservation and Rivers Control Council, 1957). More recently, extensive flooding of Milton and the surrounding area occurred in April 2006, July 2007 and May 2010. At least 80 residential properties and a number of commercial premises in Milton and Helensbrook were badly affected by flooding in July 2007, with water above the floor level of approximately 20 houses.

As well as the tangible impacts of floods, such as inundation and damage to property, flooding can also have a range of indirect effects on the wider community. These include interruptions to the transport network (including local roads, State Highways, and the South Island Main Trunk Line); closure of community services such as schools, workplaces, and health services; and restricted access to the town centre.

4 Legislative context

The manner and degree to which the flood risk of the Tokomairiro Plain can be managed by the community, CDC and ORC is influenced by the obligations, powers, and restrictions set out in various statutes. The Resource Management Act (RMA) takes an effects-based approach to resource management, including the management of flood risk. Further, minimum standards of flood protection for communities are not prescribed in law.

The building code (Building Regulations 1992) states a minimum standard (50 year return period) for inundation of dwellings, but other factors, such as the consequences of "superdesign", determine the appropriate standard in any particular situation. Therefore, the Building Act alone cannot be relied upon to achieve good flood risk management outcomes[4].

The legislation provides for a high degree of community participation, which helps shape the form the flood risk reduction takes. This is supported by CDC and ORC's obligation to make relevant information available to the community to enable informed decision-making. This allows a high degree of community input to the management of flood risk at planning and implementation stages.

No legislation confers the exclusive power or right for managing flood risk, on ORC or CDC, whether through works or services. Individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for flood protection works, to apply for and hold the necessary resource consents, and to privately fund works and services should they wish to do so.

The legislation relating to the management of flood risk gives ORC and CDC various powers and responsibilities at strategic and operational levels. Both councils can achieve their respective statutory functions through a variety of complementary methods, including regulation, education and awareness, and works and services. The legislation provides for the avoidance of new or additional risks as well as reduction of existing risks. There are however, constraints on what can practically be achieved through consideration of environmental effects and funding mechanisms.

The law provides for a range of methods which both councils and the community can use to manage flood risk. These do not just relate to physical works, but also to planning, information, and emergency

[3] From 2,088 in 1991 to 1,887 to 2006 (NZ Census data).
[4] *Flood Risk Management, A Position Statement from Local Government*, 27 February 2007, Local Government New Zealand, 9p.

preparedness and response. These can only be implemented after taking environmental effects into account (under the RMA) and funding considerations (under the Local Government Act). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals.

This 'legislative context' within which the strategy is defined and operated is outlined as follows:

- The duty of both CDC and ORC to gather information, including information on natural hazards (RMA), make such information publicly available and provide information upon request, including information on natural hazards in Land Information Memoranda (Local Government Official Information and Meetings Act).The ORC flood manager also plays an important role during flood events, disseminating information to the public and the media, Civil Defence staff, and CDC assets managers.

- The obligations of CDC as a territorial authority regarding land use planning and the role it plays in influencing and guiding community development through District Plans (RMA). The Act requires that everyone exercising functions and powers under the Act will have particular regard to *the effects of climate change* amongst other things.

- The matters to be considered by CDC when making decisions on planning for land use and proposals to subdivide land (RMA) and altering and constructing buildings (Building Act) which influence community exposure to natural hazards. The RMA places restrictions on use and subdivision of land.

- Controls on activities, including structural measures that affect flooding risk, and the requirement to consider effects on the environment (RMA). This applies irrespective of whether such measures are undertaken by CDC, ORC, or the community. The RMA places restrictions on certain uses of beds of lakes and rivers.

- The joint responsibilities and obligations of CDC and ORC regarding planning, preparing and responding to natural hazard events individually, together, and with other agencies through the Civil Defence Emergency Management Act (CDEM Act). These matters are set out in detail in the Otago Civil Defence and Emergency Group Plan 2012-2015, which puts some emphasis on risk reduction through lifelines and land use planning.

- The obligations of CDC as a lifeline utility provider (CDEM Act) arising from its ownership and operation of community water supply and sewage collection and treatment systems. This is additional to CDC's other emergency preparedness and response responsibilities listed above.

- The obligations of lifeline utility operators, in addition to CDC, regarding emergency preparedness, response and recovery planning (CDEM Act).

- The powers of the ORC to undertake works and services where appropriate to manage flooding risk (Soil Conservation and Rivers Control Act). This is a policy matter for the ORC to decide in consultation with the community and having regard to environmental and funding considerations.

- The controls under the Otago Flood Protection Management Bylaw 2008 which prevent any person interfering with flood protection and control works that have been constructed by or for ORC.

- The obligations on both councils to consult with their communities over projects, budgets, and funding under the Local Government Act 2002.

5 Principles

The Milton 2060 Strategy is intended to provide a framework through which the CDC, the ORC, and the community will work to actively manage flood risk in Milton and the surrounding floodplain area. The framework draws extensively from *New Zealand Standard 9401:2008 Managing Flood Risk*, and centres on the following principles:

PRINCIPLE 1: ENSURE SAFETY

- ⇨ Flood risk management will ensure the safety of people, and the effective operation of community infrastructure and public and private assets, both now and into the foreseeable future.

- ⇨ Community concerns over flood risk (including the residual risk[5] associated with 'super design' events) will be addressed.

- ⇨ The management or mitigation of flooding will not exacerbate or negatively impact the wider community.

Understanding the underlying natural systems and processes that operate in the Tokomairiro catchment is crucial to managing flood risk and ensuring community safety.

PRINCIPLE 2: PLAN AHEAD

Manage for uncertainty. An adaptive approach to flood risk management will allow for changes in flood hazard due to natural climate variability and improvements in the understanding of flood hazard.

Consider the impacts of climate change. Recognise that the effects of changes in climate and sea level may not be felt until late within the current planning horizon. Ensure that future generations do not have to cope with the results of poor planning decisions made today.

Adopt a responsible approach when considering new development on potentially flood-prone land and when mitigating the flood risk of existing development.

Use resources wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community.

Ease transitions. The risk associated with flooding will reduce over time by taking a broad-scale, adaptive approach over the longer term. The ability to respond to changes in the nature and extent of risk, and provide the level of safety desired by the community is essential.

PRINCIPLE 3: SUSTAINABLE LAND USE

Decisions enabling the sustainable and appropriate use of land will be informed by:

- Community awareness and acknowledgement of both the benefits and the risks (including the residual risk associated with 'super design' events) that exist for development already located in flood hazard areas.
- Consideration of all available options to manage flood risk, including structural and non-structural options.
- Land use planning controls.

Decisions on land use also need to be compatible with the other principles outlined above.

[5] See the Glossary for definitions of these and other key terms.

6 Strategic elements

These are areas where the CDC, the ORC, and the community can achieve positive outcomes for Milton and the surrounding area. They are derived from the principles outlined in Section 5 and aim to:

- ⇨ ensure that flood risk does not increase beyond current levels,
- ⇨ actively reduce flood risk where there is opportunity to do so,
- ⇨ improve resilience through risk reduction, readiness, response, and recovery from flooding.

The strategy's strategic elements are:

1. Understanding natural river and catchment processes and the potential impacts of climate variability / climate change on those processes.
2. Identifying and managing risks posed to and by community infrastructure and services (roading, water supply reticulation, wastewater collection and disposal, stormwater collection and disposal) and other utilities (telecommunications, electricity), with links to Lifelines Planning.
3. Flood-sensitive urban design and the incorporation of flood awareness and risk mitigation into all relevant council activities such as community plans and bylaws, building consents and infrastructure planning, renewal and maintenance.
4. Robust community response systems; informed by reliable flood warning and prediction tools, increased public awareness of flood hazard, and information sharing through 'linked-up' communication networks.
5. Commissioning of appropriate and affordable capital and maintenance works where the residual flood risk is significant.
6. Defining and articulating roles and responsibilities amongst individuals, communities, and the two councils.
7. Assisting the community to develop innovative and appropriate methods of managing flood risk by:
    - outlining strategic objectives,
    - education and awareness,
    - providing clear and practical base data and information, and
    - enhancing personal accountability and capability.

Progressing some of these elements may influence the effectiveness of other elements.[6] A coordinated approach is therefore required to ensure that progress in one area does not inadvertently offset or invalidate improvements that have been achieved elsewhere.

Sections 6.1 to 6.5 describe work which has been undertaken, and existing knowledge about the strategic elements outlined above. This information has then been incorporated into a list of proposed activities for controlling or managing flood risk. These activities have been derived using the principles and elements outlined above. To enable the community to easily identify how and where these activities will be implemented, the activities which are relevant to defined areas with different flood hazard characteristics is provided in Section 6 and 7.

6.1 Understanding natural river and catchment processes

A good understanding of natural river and catchment processes is required to ensure that appropriate and sustainable flood risk management measures can be put in place. To this end, flows associated with a high magnitude flood event (approximately equivalent to a 1:100 year flood) in the north and west branches of the Tokomairiro River and Salmond's Creek have been modelled. These estimates have been verified with observations and measurements wherever possible. The maximum modelled

[6] Note that the effect on other elements may be beneficial, detrimental or neutral.

flow was 427 cumecs, below the confluence of the west and north branches. For comparison, this is similar to flows in the Clutha River at Balclutha during typical low-flow conditions.

This information, combined with topographical data has been used to determine the likely characteristics of flood events in Milton and the surrounding area. These include the depth and extent of inundation, the speed (velocity) of water at the peak of the flood, and the length of time flooding may persist.

For smaller tributaries of the Tokomairiro River and major overland flow paths, the estimated bank full extent (i.e. the point where flood flows begin to overtop the bank and spread across the floodplain) was determined using topographical information. The exception was Gorge Creek, where historical flood information was available to map the flood extent.

Land within the Milton 2060 study area which is susceptible to flooding is mapped in Appendix 1. These maps show in general terms the characteristics of flood hazard within the study area.

6.2 Understanding infrastructural flood risk

To enable timely, focused flood response and recovery, both councils recognise the need to understand the flood risk posed not only by the natural, but by the structural or built environment. Accordingly, CDC and ORC have gathered information and undertaken remedial works in the following areas:

Identifying and remedying restrictions within the stormwater network
CDC has undertaken work to maintain and upgrade the stormwater network in Milton in recent years. This has included CCTV examinations of stormwater pipes, as well as cleaning and enlargement of pipes. This work will continue as and where required as part of the normal asset maintenance programme. Even with ongoing scheduled maintenance and improvements, the stormwater network will still occasionally be overwhelmed by large 'super-design' events. Overland flowpaths complement the stormwater network in those situations and are therefore important to safe and effective stormwater management.

Historic drainage
Milton has a historic network of stone and brick drains which formerly provided stormwater and sewerage drainage for the town. The CDC is aware of these and has some records of them, but they have largely fallen into disrepair and are not maintained. They are not part of the current stormwater network, so any drainage they do provide would be in addition to the newer works that the CDC has designed and maintains. They are unlikely to provide any significant drainage during floods, as the outlets are generally at a low level and so are drowned during flood events. However, any interference with this network (e.g, by blocking or redirecting the flow) may reduce its effectiveness, and exacerbate flooding in some areas.

Mill Street floodbank and pump station
The CDC constructed a 700m long floodbank along the true left (north) bank of the Tokomairiro River below SH1 in 2009-10. The floodbank works in conjunction with the Mill Street Pump Station which was completed in 2010. The Pump Station has a rated capacity of 1200 litres of water per minute at its peak. This is equivalent to the peak flow generated in a 10 year return period, 30 minute long rainstorm.

These assets enable water to be pumped from low-lying areas, whilst preventing the river from flowing back into the drainage area, even when the river is high. The floodbank is not intended to provide direct flood protection to Milton.

Roading and railway infrastructure impacts and vulnerabilities
Road and railway infrastructure can reduce the ability of floodwater to drain rapidly along natural overland flow paths. For example, an ORC investigation found that elevating SH1 by about 25cm above the surrounding land at Helensbrook has been sufficient to impede the natural drainage of flood

water along a swale towards the Tokomairiro River. As a result, residential properties along SH1 can be affected by flood water during heavy rainfall events.

Designations within the District Plan provide for the use and development of this infrastructure. These designations do not have conditions relating to diverting, or restricting the conveyance of floodwater. However, there are provisions within the Regional Plan: Water which do relate to the diversion of floodwater. It is likely that the effect of the infrastructure does not comply with the Regional Plan permitted activity provisions.

It is important that ongoing maintenance, improvements, or changes to roading and railway infrastructure on the Tokomairiro Plain does not unduly restrict or alter the conveyance of floodwater, or result in additional flood risk elsewhere. This issue will be addressed through both councils' resource consent processes and a greater awareness of the potential effects of these assets by those responsible for managing them. Roads also act as corridors for safe access and egress, especially in ponding areas.

The criticality of particular roads will be considered when deciding priorities and timing for road improvements and maintenance within Milton. To help inform these processes, the depth of flooding which could be expected to occur on flood-prone sections of the state highway network and local roads has been mapped, and is included in Appendix 2.

6.3 Flood sensitive urban design

Parts of Milton have been developed on land that is naturally prone to flooding from the Tokomairiro River and from surface runoff draining the hill catchments to the east. As such, flooding is inevitable in some areas, and buildings must have the durability to withstand inundation by contaminated water for extended periods.

Some residential and commercial building owners in Milton have already taken steps to make their buildings able to withstand inundation. The challenge however, is to make such measures widespread. This task can be hindered by the cost of flood-proofing a building relative to its value, and the fact that flooding can occur relatively infrequently, and therefore the exposure to flood risk may be seen to be relatively small.

Where property owners intend to retain ownership of a building for some time, or when inundation occurs several times over a short period,[7] then property owners may be more willing to consider flood sensitive design as a worthwhile investment in their property.

Raising the floor of a building above the design flood level is one method which has been used in Milton to avoid flood damage to the building and its fittings (Figure 8). Although this process may have tangible benefits for property owners and residents, there are a number of potential conflicts and issues which should also be considered. These include building accessibility issues, the ability to gain access to and clean the sub-floor space following a flood (particularly where contamination of floodwater has occurred), and any negative effect of inundation and subsequent drying on the piles, beams, and joists used to suspend the floor.

CDC intends developing a set of guidelines to disseminate local knowledge gained from past floods with regards to durable building design. This will include initiatives such as movable storage for commercial premises and the use of flood resilient construction techniques. Guidance on appropriate methods for raising the floor level of existing or new buildings above the flood level will also be included. The guidelines will be made available for community comment and input to create discussion and raise awareness of flood risk management through good design.

[7] as occurred for many properties during flood events in 2006, 2007 and 2010.

Figure 8. Residential building on raised foundations.

6.4 Robust community response systems

Greater awareness of flood hazard, easily accessible information, and timely and relevant flood warnings are useful tools for improving the community's ability to respond, both during and before to a flood event. A well prepared community response will help to reduce the economic and social impact of flooding. Relevant initiatives which have been recently undertaken, or which are proposed include:

Improved flood warning and modelling processes
ORC operates two permanent hydrological sites in the Tokomairiro catchment. The flow site on the west branch of the Tokomairiro at SH8 and the rainfall site at Table Hill Road provide 'real-time' information during flood events. The Table Hill Road rain gauge was installed in 2011 to provide additional information and warning during flood events, and to provide an independent source of local information. ORC also operates a sea level gauge at Green Island, located offshore from Dunedin, and tidal information from this site can be used during flood events to estimate the timing of flood peaks in the Tokomairiro catchment.[8]

The hydrological information from these and other nearby sites is used by the ORC flood manager to provide flood warnings to CDC Civil Defence staff. It can also be accessed by the public via ORC's Water Info website and phone service.[9]

Even with these sources of information, the timing and magnitude of flood events in the Milton area can be difficult to predict, as several tributaries with different characteristics converge near the town, rainfall totals can vary significantly across the catchment (Figure 3), and runoff can drain rapidly from upper catchment areas.

ORC does not currently have flood models which predict the timing or magnitude of water levels or flows at Milton. Therefore, if community response systems are to be sufficiently robust, they need to be informed not only by the ORC's flood warning network, but also by additional sources of relevant information including the media, the Civil Defence network, and local observations. In addition, ORC will continue to review its monitoring and prediction systems to ensure their robustness.

[8] As much of the river channel in the lower reaches of the Tokomairiro River (between Coal Gully Road Bridge and Toko Mouth) is at or below mean sea level, conditions at the mouth (including tides and storm surge) can limit the ability of flood waters to drain.
[9] This service can be accessed online at www.orc.govt.nz/WaterInfo or by phoning 0800 426 463.

Review of ORC flood procedures manual
The ORC flood procedures manual specifies the warning, communication, and response procedures the council follows during a flood event. It is reviewed and updated annually. As part of the Milton 2060 Strategy, a specific review of improvements which could be implemented in the Tokomairiro catchment is to be undertaken in 2012. The focus of this review will be assuring and improving inter-council communication and flood warning systems where necessary.

Flood communication workshops
To enable more effective dissemination of meaningful information prior to, during and after a flood event, a flood communication workshop made up of the flood management teams from both councils is to be held in 2012 to enable more effective dissemination of information before, during, and after a flood event. The workshops will occur annually in the early summer before the flood season as a key means of achieving the strategy initiatives of improving flood warning and response systems. It will also act as a means of preparing the relevant staff, confirming communication protocols, reaffirming roles and responsibilities, raising flood awareness, and improving overall event response.

Pre-flood readiness actions
Modern technology and forecasting systems mean there should be at least one to two days warning before a large flood event in the catchment. As part of the response to such to an event, there are a number of actions which should be taken by CDC and ORC, individually and together, before flooding occurs to protect public safety and property, and to help communities recover. Those actions include, for example, checking that critical floodways are clear of debris and that stormwater outlets to the Tokomairiro River are functioning correctly. These actions will be set out in an operating protocol to be developed and agreed by utilities staff from both organisations. The actions will be reviewed after major flood events, and during the annual flood communication workshop described above.

6.5 Physical works

A range of mitigation works has been identified which would provide additional flood protection for the Milton urban area. The intention of these works is summarised where appropriate in Section 8, while a more detailed description is presented in Section 9. It should be noted that an element of residual risk would remain, even if these works were to be put in place.

7 Flood risk management maps

Land within the strategy study area which is known to be susceptible to flooding has been identified. The characteristics of large flood events are shown in Appendix 1 (this includes the depth of inundation, the velocity of water at the peak of the flood, and the length of time flooding may persist).

Figure 9 and Figure 10 below show defined areas which have similar flood hazard characteristics.

These include:

Area 1: The Tokomairiro River Floodplain.
- Area 1A is the floodplain area which can be flooded by the north and west branches of the Tokomairiro River.
- Area 1B is the part of the floodplain where flood flows are sufficiently fast and / or deep to cause a significant safety risk (for the purposes of this report, the term ‘floodway corridors’ has been used to describe areas with these characteristics).

Area 2: Low-lying ponding areas. These are urban areas where water ponds during prolonged heavy rainfall events.
- Area 2A is to the north and west of SH1.
- Area 2B is to the south and east of SH1.

Area 3: Milton urban area.

- Area 3A is the Milton urban area, excluding the areas which act as floodway corridors (Area 3B), and low-lying ponding areas (Areas 2A and 2B).
- Area 3B includes the floodway corridors which drain internal runoff and water from the floodplain and eastern hill catchments through the Milton urban area.

Area 4: Rural and semi-rural areas on the Tokomairiro Plain.

- Area 4A refers to the rural / semi-rural floodplain area to the north and east of Milton (excluding the floodway corridors identified as Area 4B). [10]
- Area 4B includes the floodway corridors which drain water from the floodplain and eastern hill catchments.

Mechanisms for controlling or managing flood risk within each of these defined areas are discussed in Section 8.

[10] A geomorphological approach has been taken to mapping the Area 4A floodplain – i.e. as a landform composed primarily of unconsolidated depositional material, derived from sediments which have been transported by fluvial processes (Department of Regional Development and Environment, 1991). As such, parts of Area 4A may not be directly inundated by adjacent waterways during flood events, but may be affected by surface runoff.

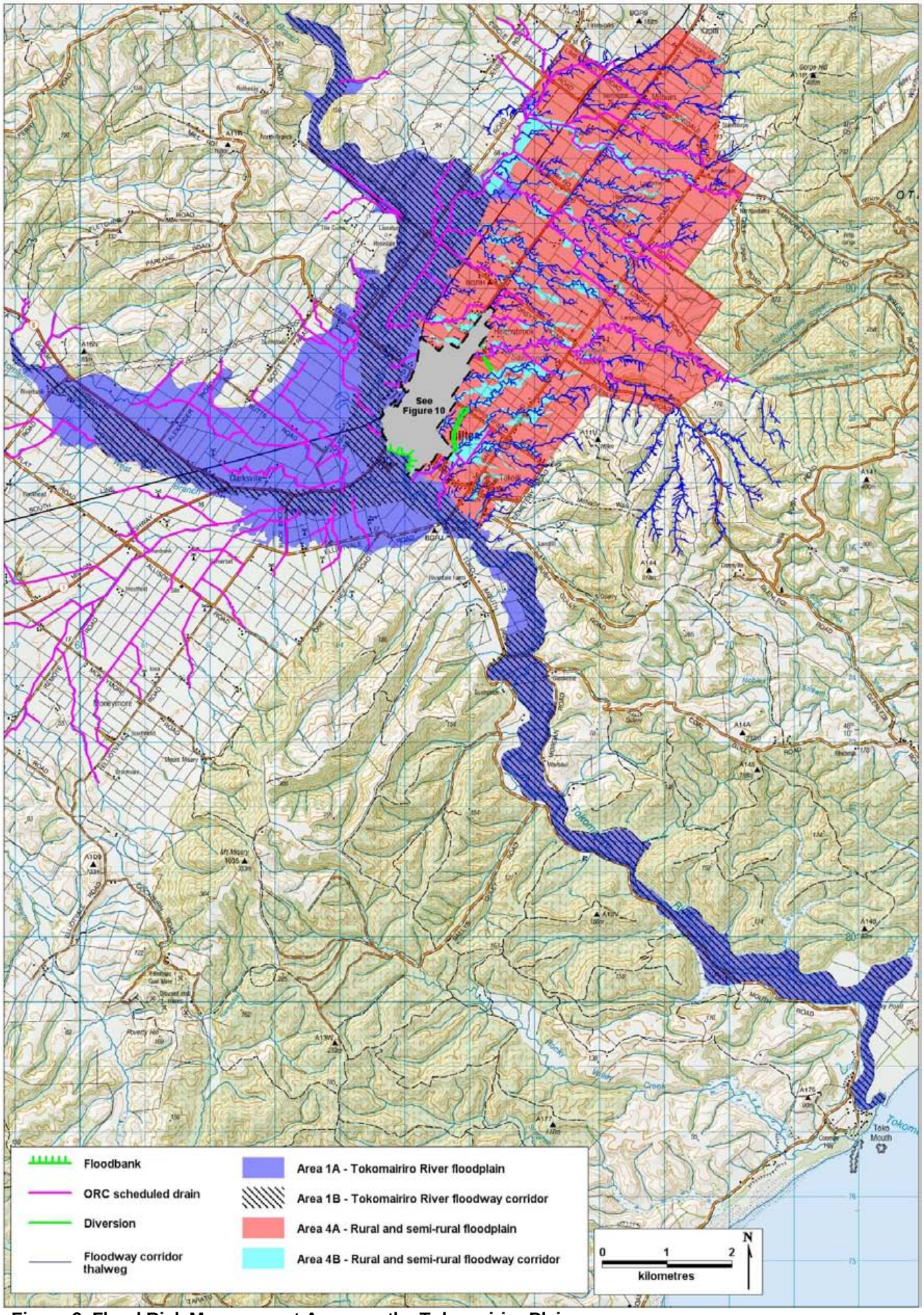

Figure 9. Flood Risk Management Areas on the Tokomairiro Plain.

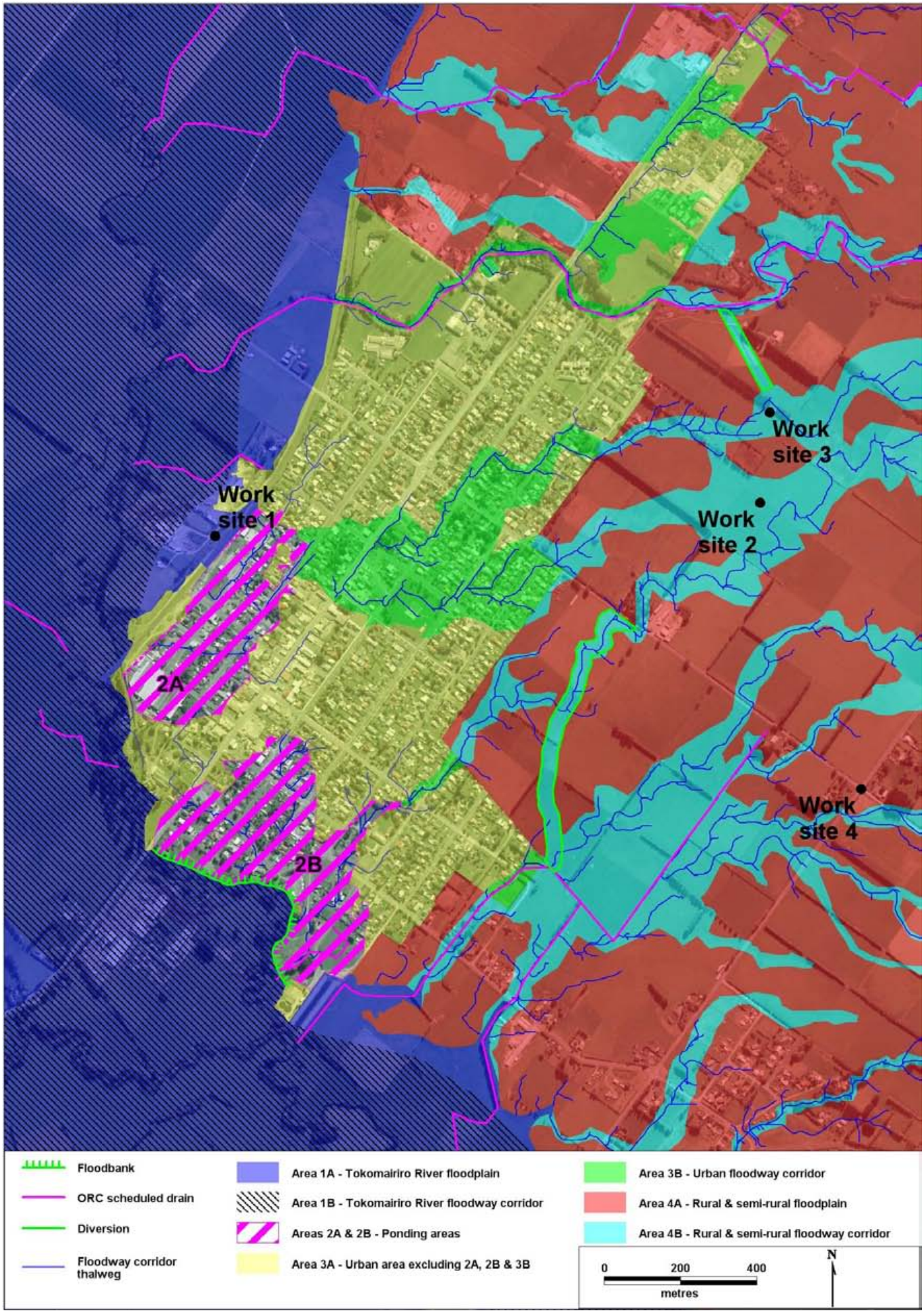

Figure 10. Flood Risk Management Areas in the Milton urban area. The locations of possible mitigation work (as described in Section 9) are also shown.

8 Control Mechanisms

The flood management issues encountered in each of four areas which have common flood hazard characteristics (as shown in Figure 9 and Figure 10) are shown in the tables below. Mechanisms for controlling or managing flood risk and activities which can be used to implement each of these mechanisms are also identified. These have been derived using the principles and strategic elements outlined in Sections 5 and 6.

These controls would apply to new activities. Existing activities have “existing use rights” under the Resource Management Act, so are not affected. In the event that an existing activity stops for a short time, there is a 12 month period during which existing use rights continue to apply (e.g, if a house in a flood prone area burnt down, rebuilding could start within a year without needing resource consent).

Area 1 - Tokomairiro River Floodplain.

- **Area 1A –** Floodplain area which can be flooded by the north and west branches of the Tokomairiro River.
- **Area 1B –** Floodway corridor where water depth is 0.3m or greater, and velocity is 0.25m/s or greater during flood events (i.e. flood flows are sufficiently fast and / or deep to cause a significant safety risk).

Flood Hazard Characteristics	Flood Management Issues	Control Mechanisms	Associated Policy / Rule / Activity
Depth of water: up to 2 m. Duration of flooding: 24-36 hrs. Medium to very high velocity. Tokomairiro River flood peaks:[11] East Branch, 210 to 220 cumecs. Below west branch confluence, 430 cumecs.	Peak flow (depth and velocity - safety). Conveyance (structures, earthworks redirect or impede overland flow and drainage of flood water). Reliance on an outlet (sea level, conditions at river mouth influence duration). Disruption of and damage to regional / local transport links.	Personal accountability (readiness, response). Defined escape pathways. Manage risks posed to and by community infrastructure and services. Enable relocation out of hazardous areas / redevelopment into safe areas. Land use controls.	Individual response plan: • Awareness of flood hazard. • Accessible flood warning information and an understanding of its relevance to individual circumstances. • Known evacuation route, destination (and alternatives). • Prepared for road closures, disruption to services / utilities. District Plan protection of defined escape pathways to control activities which may restrict safe access or egress during floods. Particular roads to be managed by roading authority as identified escape and access routes[13]. Flood proofing of services and utilities. Ensure that modifications to assets and infrastructure (including road and rail transport links, floodbanks and drains) do not exacerbate flood hazard elsewhere, and aim to reduce flood hazard where possible. District Plan zoning of alternative areas with minimal flood risk. Require consent applications to consider all available options to reduce exposure to flooding. Include consideration is given to non-structural methods such as avoiding flood-prone areas, and removing people and assets from risk areas. District Plan gives control over identified activities to avoid any net increase in risk[14] and to ensure areas with unacceptable flood hazard are avoided: (1) District Plan zoning of Area 1A to include: • the classification of dwellings/activities that accommodate people as discretionary,[15] • the classification of other buildings as restricted discretionary or

[11] as modelled for a high magnitude event, approximately equivalent to a 1:100 year flood.
[13] See Appendix 2.
[14] e.g. through more intensive development or significantly increasing the number of residents
[15] See definitions of this and other terms in the Glossary

		Ensure adequate conveyance and efficient drainage. Prevent alteration of overland flow paths.[12] Prevent the creation of new flood hazard, or the aggravation of existing flood hazard.	controlled, • allowing other activities such as fences and earthworks as permitted activities, subject to certain standards and conditions. (2) District Plan zoning of Area 1B to include: • the classification of dwellings/activities that accommodate people as non-complying, • the classification of farm and other buildings, and storage of materials as discretionary, • additional controls over activities such as fences and earthworks, • a review of the appropriateness of industrial zoning. Inclusion of these matters in the controls under District Plan Rules. Protection of ORC drainage system through Regional Council Flood Protection Bylaw. Maintenance of drainage and flood protection works by both Councils.

[12] excluding works associated with any public flood protection scheme.

Area 2: Low-lying ponding areas. Urban areas where water ponds during prolonged heavy rainfall events.[16]

- Area 2A is to the north and west of SH1.

Flood Hazard Characteristics	Flood Management Issues	Control Mechanisms	Associated Policy / Rule / Activity
Depth of water: 0 to 1.5m. Duration of flooding: 24-36 hrs. Minimal velocity. Previously flooded, including July 2007. Current mitigation: Stormwater system, elevated land to northwest (railway embankment) and southwest.	Ponding duration and depth of inundation. Drainage capacity (reliance on an outlet). Contamination of floodwater.	Personal accountability (readiness, response). Defined escape pathways. Manage risks posed to and by community infrastructure and services. Enable relocation out of hazardous areas / redevelopment into safe areas. Land use controls.	Individual response plan: • Awareness of flood hazard. • Accessible flood warning information and an understanding of its relevance to individual circumstances. • Known evacuation route, destination (and alternatives). • Prepared for road closures, disruption to services / utilities. District Plan protection of defined escape pathways to control activities which may restrict safe access or egress during floods. Particular roads to be managed by roading authority as identified escape and access routes. Sealing of wastewater collection system – Reduce inflow and infiltration. Flood proofing of other services and utilities. Improved capacity to drain floodwater from ponding area. Ensure that modifications to assets and infrastructure (including road and rail transport links, floodbanks and drains) do not exacerbate flood hazard elsewhere, and aim to reduce flood hazard where possible. District Plan zoning of alternative areas with minimal flood risk. Require consent applications to consider all available options to reduce exposure to flooding. Ensure that consideration is given to non-structural methods such as avoiding flood-prone areas, and removing people and assets from risk areas. District Plan gives control over identified activities to avoid any net increase in risk[17] and to ensure areas with unacceptable flood hazard are avoided. (1) Building alterations and footprint extensions/ancillary buildings in Area 2A to become ***controlled*** activities under the District Plan to ensure: • A minimum floor height of 13m above mean sea level.[18] • Suitable construction methods and flood proof utility connections. • Safe egress during flood events.

[16] See Section 3.3 for additional explanation of the flood hazard in these areas.
[17] e.g. through more intensive development or significantly increasing the number of residents
[18] Land in this area is generally between 11 and 13m above mean sea level.

		Additional mitigation.	(2) New dwellings, commercial residential and other activities that accommodate people to become ***discretionary*** under the District Plan. Investigate effects of constructing a flood bank along Tower Road (see Section 9).

Area 2: Low-lying ponding areas (continued). Urban areas where water ponds during prolonged heavy rainfall events.

- Area 2B is to the south and east of SH1.

Flood Hazard Characteristics	Flood Management Issues	Control Mechanisms	Associated Policy / Rule / Activity
Scenario 1 (Pump station and floodbank remain operational): Depth: 0 to 0.2m. Duration: up to 24 hours Minimal velocity. Scenario 2 (Pump station failure): Depth: 0 to 0.7m Duration: 24-36 hours Minimal velocity. Scenario 3 (Floodbank failure): Depth: 0 to 1.5m. Duration: 24-36 hours Moderate to high velocity. Previously flooded, including July 2007. Current mitigation: Dryden Street flood diversion	Ponding duration and depth of inundation. Drainage capacity (reliance on an outlet). Contamination of floodwater. Reliance on critical flood protection assets: • Floodbank overtopping (additional ponding). • Floodbank breach / failure (rapid inundation of ponding area - velocity and depth). • Pump failure (additional ponding, extended duration).	Personal accountability (readiness, response). Defined escape pathways. Manage risks posed to and by community infrastructure and services. Enable relocation out of hazardous areas / redevelopment into safe areas. Land use controls.	Individual response plan: • Awareness of flood hazard. • Accessible flood warning information and an understanding of its relevance to individual circumstances. • Known evacuation route, destination (and alternatives). • Prepared for road closures, disruption to services / utilities. District Plan protection of defined escape pathways to control activities which may restrict safe access or egress during floods. Particular roads to be managed by roading authority as identified escape and access routes. Sealing of wastewater collection system – Reduce inflow and Infiltration. Flood proofing of other services and utilities. Ensure that modifications to assets and infrastructure (including road and rail transport links, floodbanks and drains) do not exacerbate flood hazard elsewhere, and aim to reduce flood hazard where possible. District Plan zoning of alternative areas with minimal flood risk. Require consent applications to consider all available options to reduce exposure to flooding. Ensure that consideration is given to non-structural methods such as avoiding flood-prone areas, and removing people and assets from risk areas. District Plan gives control over identified activities to avoid any net increase in risk[19] and to ensure areas with unacceptable flood hazard are avoided. (1) Building alterations and footprint extensions/ancillary buildings in Area 2B to become ***controlled*** activities under the District Plan to ensure: • A minimum floor height of 12m above mean sea level. [20] • Suitable construction methods & flood proof utility connections. • Safe egress during flood events.

[19] e.g. through more intensive development or significantly increasing the number of residents

[20] Land in this area is generally between 9.5 and 12m above mean sea level.

and Tokomairiro River floodbank and pump station.		Ensure the effectiveness of existing flood protection.	(2) New dwellings, commercial residential and other activities that accommodate people to become ***discretionary*** under the District Plan. Ensure continued operation of existing flood protection: • Build redundancy into Mill Street Pump Station (spares, preventative and planned maintenance, backup power supply, site access during flooding). • District Plan designation to allow for operation, upgrade, maintenance and access, and to control activities that may negatively affect the floodbank.

Area 3: Milton urban area

- **Area 3A –** The Milton urban area, excluding land which acts as a floodway corridor (Area 3B), or low-lying ponding areas (Areas 2A and 2B).
- **Area 3B –** Floodway corridors which drain internal runoff and water from the floodplain and eastern hill catchments through the Milton urban area.

Flood Hazard Characteristics	Flood Management Issues	Control Mechanisms	Associated Policy / Rule / Activity
Depth of water: 0 to 0.3m Duration of flooding: 6-18 hrs. Low to medium velocity. Peak flows: 0.6 to 2 cumecs. Current mitigation: Dryden Street and Keinan Ave flood diversion channels.	Peak flow (depth and velocity). Conveyance (structures, earthworks redirect or impede drainage of floodwater). Disruption of regional / local transport links. Linkages to ponding areas / Tokomairiro River.	Personal accountability (readiness, response). Defined escape pathways. Manage risks posed to and by community infrastructure and services. Land use controls (to apply within Area 3B floodway corridors).	Individual response plan: • Awareness of flood hazard. • Accessible flood warning information and an understanding of its relevance to individual circumstances. • Known evacuation route, destination (and alternatives). • Prepared for road closures, disruption to services / utilities. District Plan protection of defined escape pathways to control activities which may restrict safe access or egress during floods. Particular roads to be managed by roading authority as identified escape and access routes. Flood proofing of services and utilities. Improve capacity of stormwater network to cope with floodwater. Ensure that modifications to assets and infrastructure (including road and rail transport links, floodbanks and drains) do not exacerbate flood hazard elsewhere, and aim to reduce flood hazard where possible. District Plan gives control over identified activities to avoid any net increase in flood risk. (1) Minor building alterations/footprint extensions and ancillary buildings are a ***permitted*** activity provided: • floor height is sufficiently elevated to avoid inundation, • suitable construction methods & flood proofed utility connections are used, and • any re-direction of flood flows is avoided. (2) Dwellings and footprint extensions/ancillary buildings over a certain size are a ***controlled*** activity in regard to: • earthworks (avoid re-direction of flood flows), • suitable floor height (to avoid inundation), • suitable construction methods (to withstand inundation to a defined depth and velocity), • flood proofing of utility connections, • location (avoiding areas of excessive depth or velocity, or re-direction

		Ensure adequate conveyance and efficient drainage. Prevent alteration of overland flow paths.[21] Prevent the creation of new flood hazard, or the aggravation of existing flood hazard. Enable diversion of flood water to east of Milton.	of flows), and • safe egress during flood events. Inclusion of these matters in District Plan Rules. Protection of ORC drainage system through Regional Council Flood Protection Bylaw. Maintenance of drainage and flood protection works by both Councils. District Plan designation allows for operation, upgrade, maintenance, access of the Dryden Street flood diversion. Investigate effects of additional diversion of flood water, including the effectiveness of the Keinan Ave. diversion (see Section 9).

[21] excluding works associated with any public flood protection scheme.

Area 4: Rural and semi-rural areas on the Tokomairiro Plain.

- **Area 4A –** The rural / semi-rural floodplain area to the north and east of Milton (excluding the floodway corridors identified as Area 4B).
- **Area 4B –** Floodway corridors which drain water from the floodplain and eastern hill catchments.[22]

Flood Hazard Characteristics	Flood Management Issues	Control Mechanisms	Associated Policy / Rule / Activity
Depth and extent of flood water variable. Duration 6-18 hrs. Low to medium velocity. Peak flows in floodway corridors: 0.6 to 4 cumecs. Rural standard drainage network, overland flow paths.	Avoiding additional flood risk (land-use decisions enable sustainable development to occur). Reducing existing flood risk (allow for mitigation measures to reduce flood risk in Milton and the transitional area to the east).	Personal accountability (readiness, response). Defined escape pathways. Manage risks posed to and by community infrastructure and services. Enable development of safe areas. Land use controls (to apply within Area 4B floodway corridors).	Individual response plan: • Awareness of flood hazard. • Accessible flood warning information and an understanding of its relevance to individual circumstances. • Known evacuation route, destination (and alternatives). • Prepared for road closures, disruption to services / utilities. District Plan protection of defined escape pathways to control activities which may restrict safe access or egress during floods. Particular roads to be managed by roading authority as identified escape and access routes. Flood proofing of services and utilities. Ensure that modifications to assets and infrastructure (including road and rail transport links, floodbanks and drains) do not exacerbate flood hazard elsewhere, and aim to reduce flood hazard where possible. District Plan re-defines Transitional Resource Areas to discourage development in known flood hazard areas, and enable development in safer areas. Use of 'structure plans' to guide infrastructure layout for new development (e.g. roads, 3 waters). District Plan gives control over identified activities to avoid any net increase in risk, and to ensure areas with unacceptable flood hazard are avoided. (1) Buildings and activities within mapped floodway corridors that accommodate people become ***non-complying*** or ***discretionary*** activities. (2) Other buildings and structures[23] within mapped floodway corridors become ***restricted discretionary*** activities. Discretion restricted to: • The avoidance of areas with excessive depth or velocity of flood water.

[22] See Section 3.3 for an explanation of the hazard associated with these features.
[23] excluding fences, or works associated with a public flood protection scheme.

		Ensure adequate conveyance and efficient drainage. Prevent alteration of overland flow paths (excluding works associated with any public flood protection scheme). Prevent the creation of new flood hazard, or the aggravation of existing flood hazard.	• Avoiding the obstruction, impedance or re-direction of flood water. (3) Earthworks within mapped floodway corridors become ***restricted discretionary*** activities.[24] Discretion restricted to: • Avoiding the obstruction, impedance or re-direction of flood water. (4) Shelterbelts, fences, plantings and storage areas within mapped floodway corridors are a ***permitted*** activity, provided they are located and designed to ensure that the existing overland passage of stormwater flows is not obstructed, impeded or redirected. Inclusion of these matters in District Plan Rules. Protection of ORC drainage system through Regional Council Flood Protection Bylaw. Maintenance of drainage and flood protection works by both Councils.

[24] unless the earthworks are part of any public flood protection work designed to mitigate or reduce the effects of flooding on the Milton township.

9 Possible mitigation works

Possible mitigation works have been identified for each of the four diversion sites identified on Figure 10. It should be noted that the proposed works will not mitigate flooding caused by internal runoff and by the stormwater network. Additional work such as detailed investigation (design, and analysis, site visits and surveys), negotiation with landowners, consenting, management and supervision would be required before any of these possible works began. The works at the four sites are outlined as follows (in no particular order).

Site 1 - Tower Rd Railway closure
Works at this site would restrict significant inflow from the east branch of the Tokomairiro River into Milton. The works would comprise a bund no higher than 1m over a length of 250m. This work would not prevent ponding at the southern end of Milton by itself, but would mitigate the effects of potentially large inflows.

Site 2 - Upstream of Dryden St diversion
These works upstream of ORC's T3 scheduled drain would enhance and extend the conveyance capacity of the existing Dryden Street diversion to the north. The works would comprise a bund no higher than 1m over a length of 250m.

Site 3 - Keinan Ave diversion upgrade
The upgrade of the Keinan Avenue diversion would enhance the mitigation this feature currently provides. The diversion provides some mitigation but it is neither an ORC nor a CDC flood mitigation asset and the standard of protection is relatively low. The works would comprise light channel excavation and widening, raising of the existing bund by up to 0.5m over a 160m length and upgrading of two existing culverts.

Site 4 - Back Rd/Springfield Rd intersection drain improvements
Water flows over Springfield Road during heavy rainfall due to a tight bend in the roadside drain next to Back Road. This impacts on users of one of the access and escape routes for Milton (Appendix 2). The works would comprise constructing a culvert beneath Springfield Rd and diverting the flow into the existing swale that crosses Back Rd immediately south of the Springfield Rd intersection.

9.1 Road and rail infrastructure

Following the adoption of this Strategy, further work will be required on road and rail infrastructure to ensure that:

- in the short term, maintenance and upgrade works do not increase flood risk; and
- in the long term, existing impacts on other properties are eliminated or reduced.

Clutha District Council roads within the Tokomairiro Plains
Prior to undertaking any works which could alter the road crest level or the flow of road drainage, an assessment will be made of impacts on flood risk. Works shall be done in such a way that there is no increase in flood risk for other properties. Over time, the intention will be to lower road crest heights in key locations, and/or improve drainage, so that flood risk for other properties is decreased.

State Highways and railway lines
The Clutha District Council and the Otago Regional Council will work with NZTA and KiwiRail to help them minimise flood risk impacts due to state highway and railway infrastructure. This will include developing a strategy for future works, so that impacts on other properties are avoided. Ideally, one strategy will cover Council roads, State Highways and rail, to ensure that work on all infrastructure is coordinated. It will also include implementing the Milton 2060 Strategy itself, so that roading and rail networks are also protected from increased flood risk arising from activities on other properties.

There are currently no direct land use controls within the District Plan over the State Highway and Rail networks. Both NZTA and KiwiRail are 'Designating Authorities' under the RMA and have used that status so that they do not need District Plan resource consents for work on their networks. It would be possible to seek changes to the designations when they are next reviewed, but the preference is to address flood risk through a joint strategy approach.

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Glossary

Average Recurrence Interval (ARI)	An estimate of the average interval of time between events.
Cumec (m^3/s)	A measure of flow rate, referring to a cubic metre of water per second.
Risk	The likelihood and consequence of an event occurring.
Flood Risk Management	The management through a variety of means of the known flood risk. For the purposes of this document the term flood risk management is considered analogous to the term flood risk mitigation.
Hazard	A source of potential harm or an event with potential to cause loss.
LiDAR	Light Detection and Ranging is a mass of spot height information captured over a wide area using an aircraft mounted laser. The Otago Regional Council's LiDAR dataset has a vertical accuracy of ± 0.14m and was collected in 2004/5.
Lifelines	Lifelines are the essential infrastructure and services that support life within a community. They include utility services such as water, wastewater and stormwater, electricity, gas, telecommunications, and transportation networks including road, rail, airports and ports.
Non-structural flood management options	Elements which are designed to either remove people and assets from risk or to manage exposure to flood effects. Examples include land use planning, emergency management, and flood-proofing buildings.
Residual risk	The risk remaining after the implementation or undertaking of risk management measures.
Structural flood management options	Elements which are designed to contain floods and to limit erosion and deposition by controlling river behavior.
Super-design event/s	Event/s exceeding the design capacity of the subject structure.
True left river bank	That which is on the left hand of a person who is facing downstream.
True right river bank	That which is on the right hand of a person who is facing downstream.

Resource consent requirements - Types of activities

Permitted Activities	No resource consent is required, provided that any conditions set in the District Plan are complied with.
Controlled activity	Resource consent is required, but must be granted. Conditions can be imposed on the consent, but can only relate to matters that Council has specified in the District Plan.
Discretionary activities	Resource consent is required, and can be granted or declined on a case by case basis. If the consent is granted, conditions can be imposed on any matters that Council considers necessary to address environmental effects.
Restricted discretionary Activities	Resource consent is required, and can be granted or declined on a case by case basis. If the consent is granted conditions can be imposed, but can only relate to matters that Council has specified in the District Plan.
Non-complying activities	Resource consent is required, and can only be granted if the effects are minor or the activity is consistent with the objectives and policies of the District Plan. If the consent is granted, conditions can be imposed on any matters that Council considers necessary to address environmental effects.
Prohibited activity	No resource consent application can be made for a prohibited activity.

Appendix 1. Characteristics of Flood Hazard on the Tokomairiro Plain

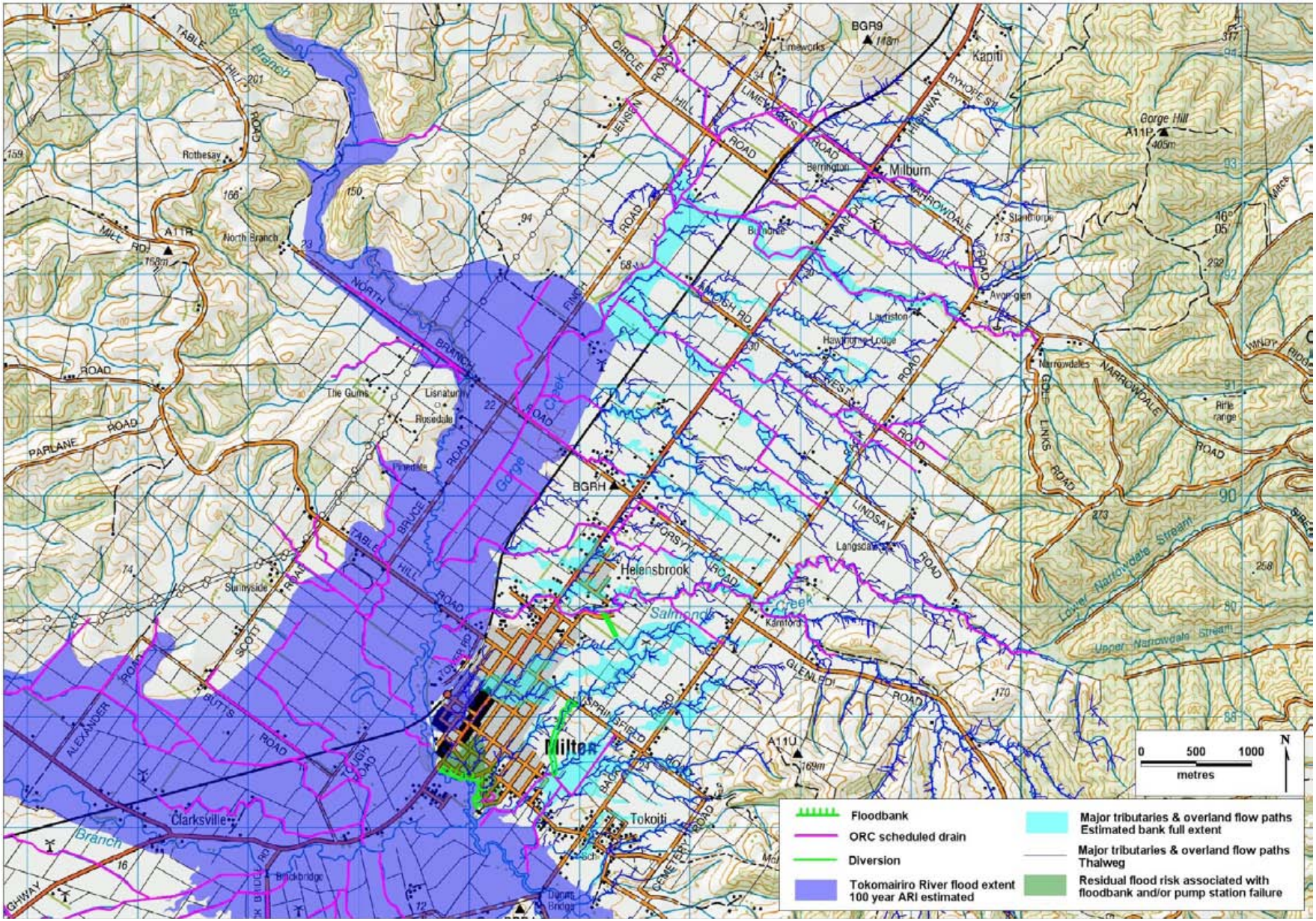


Figure 11. Flood hazard on the Tokomairiro Plain. The blue shaded areas show the estimated extent of flooding for a high magnitude flood. The green shaded area shows the residual flood risk associated with failure of the Mill Street floodbank and/or pump station.

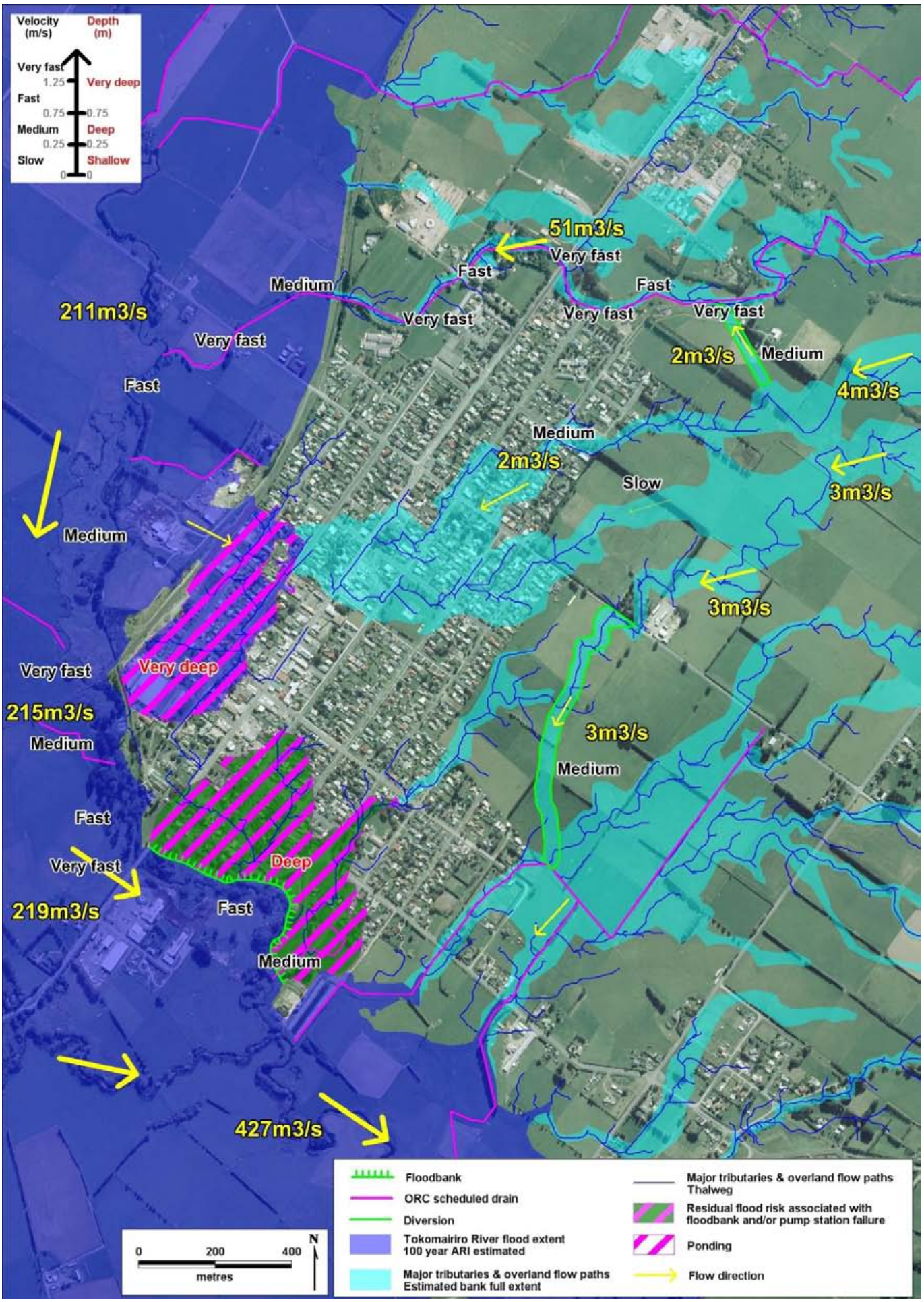
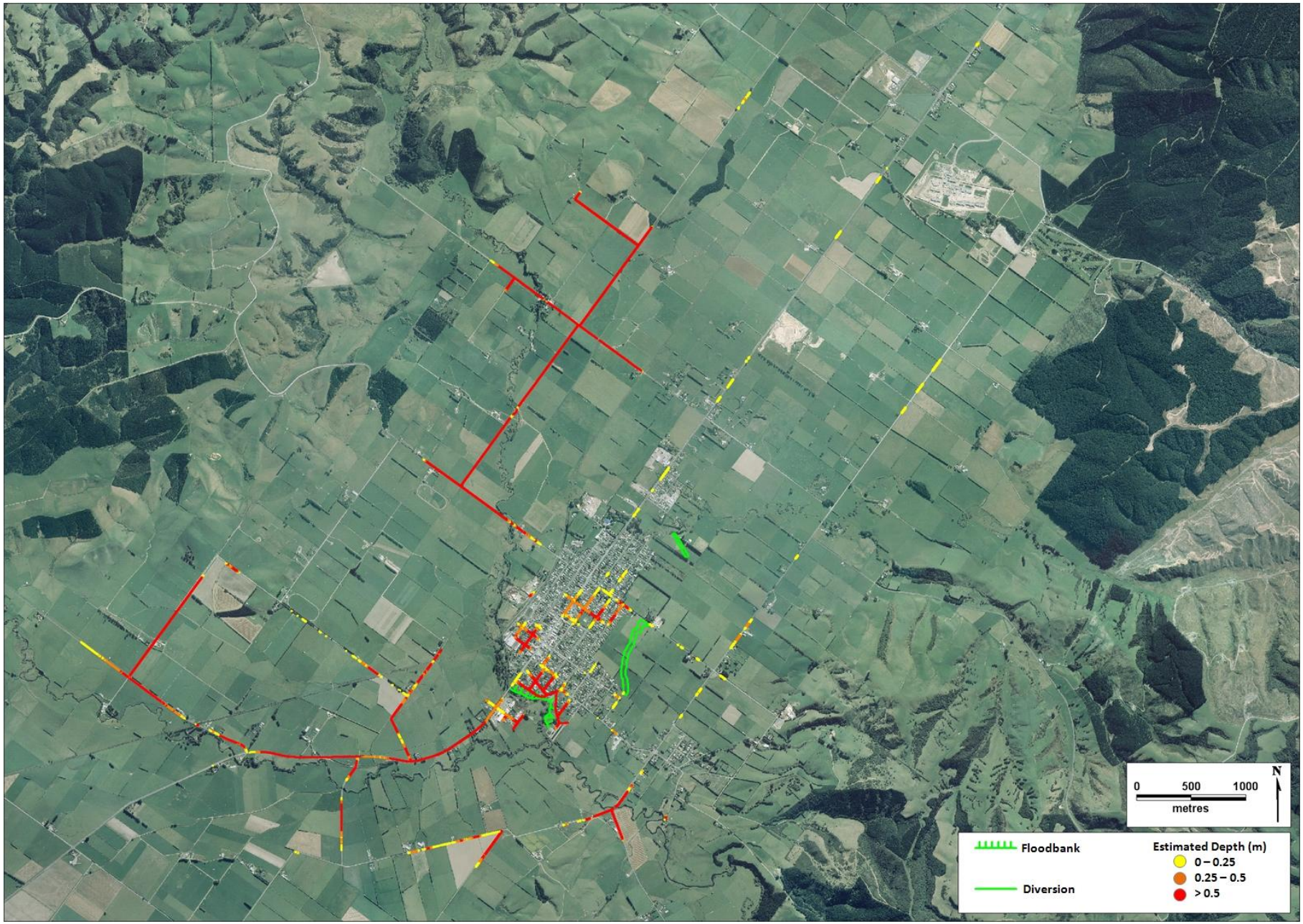


Figure 12. Flood hazard characteristics (extent, depth, velocity and peak flows) for a high magnitude flood in the Tokomairiro catchment at Milton.

Appendix 2. Inundation depths across the roading network in Milton and the Tokomairiro floodplain, which could be expected during a high magnitude flood.



Appendix 3. Milton 2060 Action Plan: Flood Risk Management Initiatives – July 2012

Strategic Element	Action	Responsibility	Commencement date
Understanding natural river and catchment processes			
Understand flood hazard	Capture flood hazard information and incorporate into the Otago Natural Hazards Database, especially in relation to the Area 1B and Area 4B floodway corridors.	ORC	During and after major flood events
Understanding and managing infrastructural flood risk			
Improve resilience of Milton's utility infrastructure	Identify and remedy restrictions within the stormwater network, and its outlets to the Tokomairiro River.	CDC	Current and ongoing
	Seal the wastewater collection system to reduce infiltration and contamination of stormwater.	CDC	"Inflow and Infiltration' process already under way
Reduce the negative effects of infrastructure on the conveyance of floodwater	Identify locations where the roading network can be modified, and measures which can be taken to reduce flood hazard for road users and adjacent land.	CDC	Sep-2012
	Undertake measures to reduce the negative impacts of the local roading network on flood hazard.	CDC	Jan-2013
	Advocate for no increase, and a reduction in flood hazard for road users and privately owned land when works are undertaken by NZTA and KiwiRail to maintain or upgrade the state highway and the South Island Main Trunk Line.	CDC / ORC	Sep-2012
Flood sensitive urban design			
Raise awareness of flood risk management through good design	Develop and publish a set of guidelines to encourage and assist flood-durable building design.	CDC	Dec-2012
Robust community response systems			
Review ORC flood procedures	Review the actions and procedures to be undertaken during flood events, and ensure these are recorded in the ORC flood procedures manual.	ORC	Nov-2012
Improvements to ORC / CDC flood communications	Convene annual flood communication workshops, involving the flood management teams from both councils.	CDC / ORC	Nov-2012 (and then annually)

Pre-flood readiness actions	Develop an operating protocol to be followed by utilities staff from both councils before, during and after flood events.	CDC / ORC	Nov-2012
Physical works			
Reduce flood risk in Milton	Undertake detailed investigation work for the possible mitigation works identified in the strategy.	CDC	Sep-2012
	Determine the effects and cost of the possible mitigation works identified in the strategy, along with any mitigation which may be required.	CDC	Jun-2013
Channel management program	Undertake a program of works to ensure the efficient conveyance of floodwater in: • the north branch of the Tokomairiro River between Table Hill Road and Coal Gully Road, • the west branch of the Tokomairiro River between Crichton Road and the confluence with the north branch.	ORC	Ongoing
Enable long-term, sustainable occupation and development in Milton			
Land use planning	Incorporate the Flood Risk Management Areas identified in the Milton 2060 Strategy into the Clutha District Plan.	CDC	Assess Flood Risk Management Area information when considering new consent applications: immediate Notify District Plan Change: Feb-2013
Reduce exposure to flooding	Integrate the policies identified in the Milton 2060 Strategy into the Objectives, Policies and subsequent provisions of the Clutha District Plan.	CDC	Assess policy information when considering new consent applications: immediate Notify District Plan Change: Feb-2013
Review Milton 2060 Flood Risk Management Strategy			
Review of strategy	Review the strategy's effectiveness, the workability of the principles, relevance of the identified issues and success of the initiatives auctioned.	CDC / ORC	Nov-2014 (then every three years)