Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Memo

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Using earthquake fault information in the Timaru District Plan review

1. Introduction

Timaru District Council are reviewing their District Plan. I recommend that earthquake fault information and provisions are incorporated into the District Plan to reduce the risk of damage from surface fault rupture.

Surface fault rupture is a different, and less common, earthquake hazard from earthquake shaking. It is the permanent ripping and warping of the ground surface along a fault as the ground on one side moves sideways and/or up relative to ground on the other side during an earthquake on that fault. Surface fault rupture will generally only occur when the earthquake on a fault is magnitude 7 or larger; in smaller earthquakes the movement on the fault is usually entirely underground and does not reach the ground surface.

Surface fault rupture caused damage to houses and infrastructure during the 2010 Darfield (Canterbury) earthquake and the 2016 Kaikoura-Hurunui earthquake (see Figures 1 and 2).

Figures 1 and 2: Kekerengu (above) and Papatea (right) fault ruptures during the 2016 Kaikoura-Hurunui earthquake.

The ripping and buckling of the ground from movement on a fault only affects a narrow area of land a few tens to a few hundreds of metres wide along the fault. If we know where faults are, we can avoid or manage development in those areas to reduce the likelihood of houses or infrastructure being damaged in future earthquakes on those faults.

'Active faults' are defined as faults that have moved within the last 125,000 years and could move again in future, causing an earthquake and possible surface fault rupture.

The strong shaking created when a fault moves (the 'earthquake' itself) affects a much wider area than the fault rupture. It is hard to avoid strong shaking at some point in a building's life in New Zealand. Earthquake shaking is therefore dealt with through the Building Act 2004 and the Building Code, which ensures that our buildings are constructed to be strong and flexible to withstand strong shaking.

2. District active fault mapping

Environment Canterbury commissioned GNS Science to map known and suspected active faults in Timaru District in 2014 as part of a regional fault mapping programme. The report *General distribution and characteristics of active faults and folds in the Timaru District, South Canterbury* was officially provided to Timaru District Council in September 2017 and a presentation was given to Timaru District Council staff in October 2017. The report is available on the Environment Canterbury website at https://api.ecan.govt.nz/TrimPublicAPI/documents/download/2370766. The report was peer reviewed by Golder Associates Ltd.

The project compiled and reviewed existing 1:250,000 scale fault information. It did not involve new field mapping. Each fault was assigned a:

- certainty – how certain it is that the mapped feature is actually a fault: definite, likely or possible;
- surface form – how easy it is to see the fault at the ground surface: well-expressed, moderately-expressed or not expressed; and
- recurrence interval – the long-term average time between earthquakes on the fault, usually expressed as a range spanning several thousand years.

All of the faults mapped in Timaru District are in sparsely populated rural or mountainous areas. Many are 'possible' active faults with a recurrence interval of more than 10,000 years. There are three main fault zones with definite and likely faults:

- the Forest Creek Fault Zone in the upper Rangitata, with recurrence intervals in the order of 1200-6000 years
- the Fox Peak Fault Zone in the upper Rangitata, with a recurrence interval of >10,000 years
- the Canterbury Range Front Fault Zone / Geraldine-Mt Hutt Fault System, running from Te Moana to Peel Forest, with individual fault recurrence intervals of 1700-30,000 years.

For context, fault recurrence intervals in New Zealand range from a few hundred years (e.g. Alpine Fault, Hope Fault) to many tens of thousands of years (e.g. the Greendale Fault that caused the 2010 Canterbury earthquake).

It is possible that there are unknown or 'blind' faults under the gravels of the Canterbury Plains, however because they cannot be seen at the ground surface (i.e. have been covered with gravel since their last rupture) they are likely to have very long recurrence intervals if they do exist.

3. Fault awareness areas

The Ministry for the Environment guidelines *Planning for development of land on or close to active faults* ('the MfE guidelines') recommend mapping faults at 1:35,000 or better and delineating fault avoidance zones around these faults within which development should be managed to reduce the risk of damage from surface fault rupture.

Mapping faults at this level of detail is expensive. The cost of mapping all the earthquake faults in Canterbury – many of which are in sparsely populated areas – to this level of detail is difficult to justify in most places. Detailed mapping of faults has, to date, been focussed on the most active faults near developed areas, for example the Hanmer Fault at Hanmer Springs, the Hope Fault Zone at Mt Lyford Village and Kaikoura, the Ashley Fault Zone north of Rangiora and the Ostler Fault Zone at Twizel.

The regional-scale 1:250,000 fault mapping in the Timaru District fault report is not detailed enough to be able to apply the MfE guidelines directly using fault avoidance zones. However, the 1:250,000-scale fault information is still useful because it shows councils, developers, landowners or prospective buyers the general location of faults and it highlights locations where more detailed investigations could or should be undertaken for certain developments.

GNS Science and Environment Canterbury developed guidelines for using the 1:250,000 fault information in 2016. These recommend creating fault awareness areas, rather than fault avoidance zones, around the 1:250,000 fault information. The width of the fault awareness areas – either 125 m or 250 m either side of the fault – depends on the certainty and surface form of the fault. This 125 m or 250 m buffer accounts for the inaccuracies involved in mapping at 1:250,000 scale, and also the possibility that future fault ruptures and associated ground deformation could occur away from the mapped areas of previous fault rupture deformation, as was seen during the 2016 Hurunui-Kaikoura earthquake.

The GNS Science/Environment Canterbury guidelines are available on the Environment Canterbury website at https://api.ecan.govt.nz/TrimPublicAPI/documents/download/2147172. The guidelines can be modified to suit individual districts' requirements.

Fault awareness areas were developed for all faults in Canterbury by Environment Canterbury and this dataset was provided to Timaru District Council in March 2018. The fault awareness areas, which were updated in 2019 with the new information for Waimakariri and Kaikoura districts, can be viewed on Canterbury Maps at https://mapviewer.canterburymaps.govt.nz/?webmap=f716b840dc434c009e8f74f644a271d6 and downloaded at https://opendata.canterburymaps.govt.nz/datasets/canterbury-fault-awareness-areas-2019.

The Timaru fault awareness areas are shown in Figure 3.

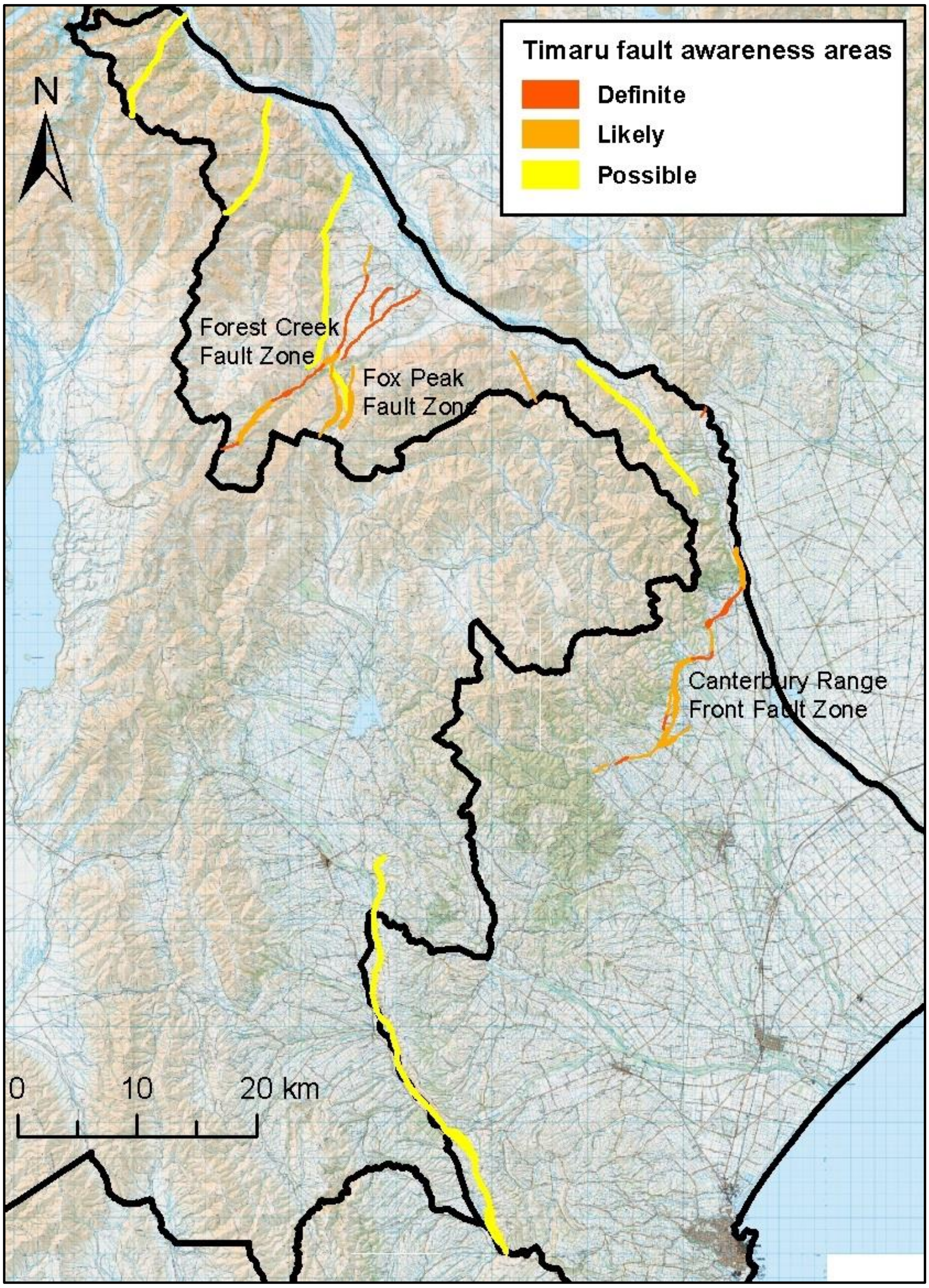

Figure 3: Fault awareness areas in Timaru District based on faults and folds mapped by GNS Science in 2016.

4. Suggested district plan provisions within fault awareness areas

Based on the 2016 GNS Science/Environment Canterbury fault guidelines, I recommend that provisions are included in the proposed Timaru District Plan to require more detailed mapping for future subdivision and the development of important or critical infrastructure and facilities within the fault awareness areas and to manage development if necessary within these areas.

Subdivision

The 2016 GNS Science/Environment Canterbury fault guidelines recommend that if a new subdivision consent application is received proposing development within a fault awareness area of a definite (well-expressed or moderately-expressed) or likely (well-expressed or moderately-expressed) fault, that the applicant is required to map the zone of deformation associated with fault rupture at a scale of 1:35,000 or better (preferably 1:10,000 or better) to create fault avoidance zones as per the Ministry for the Environment fault guidelines, i.e. the zone of fault deformation plus a 20 metre buffer. Any building sites should be set back from the fault avoidance zone. This can be achieved through methods such as the land parcels being set back from the fault avoidance zone or, if the land parcels do include part of the fault avoidance zone, a consent notice that ensures the building setback is enforced when the subdivision is completed.

The GNS Science/Environment Canterbury fault guidelines do not recommend requiring detailed mapping as part of a subdivision consent within 'not expressed' or 'possible' fault awareness areas, as in most cases there is not enough evidence or certainty of the fault rupture hazard at the ground surface to justify doing it.

I suggest that this approach is adopted and that the requirement to map any fault deformation also applies to some small lengths of definite (not expressed) and likely (not expressed) fault awareness area where they link two definite (well-expressed or moderately-expressed) or likely (well-expressed or moderately-expressed) fault awareness areas. I suggest these fault awareness areas are included because while they are classified as 'not-expressed' the fault is definitely present but may, for example, have been eroded by a stream or covered in landslide debris since the last movement, and the fault rupture hazard should still be considered as part of a subdivision consent. I suggest these small lengths of definite (not expressed) and likely (not expressed) fault awareness area have their width reduced to be the same as the definite (well-expressed or moderately-expressed) and likely (well-expressed or moderately-expressed) fault awareness areas on either side (total width 250 metres) as it is unlikely that the actual location of the fault trace deviates from the adjacent definite (well-expressed or moderately-expressed) and likely (well-expressed or moderately-expressed) fault awareness areas.

This overlay could be called the fault hazard (subdivision) overlay, or similar, and is shown in Figure 4. I have supplied a GIS shapefile of this suggested overlay with this memo. The attribute fields of the shapefile have been simplified to only include the fault name, certainty and surface form and recurrence interval information. Other, more technical fault attributes, such as fault dip, can be found in the 2019 Canterbury Fault Awareness Area dataset that this shapefile was extracted from.

The GNS Science/Environment Canterbury guidelines state that there can be some discretion in this provision around the size or nature of the proposed subdivision, i.e. it may only apply to subdivisions over a certain size or involving a certain number of lots. Also, detailed fault mapping should not be required for areas of the proposed subdivision that are not within the fault hazard (subdivision) overlay.

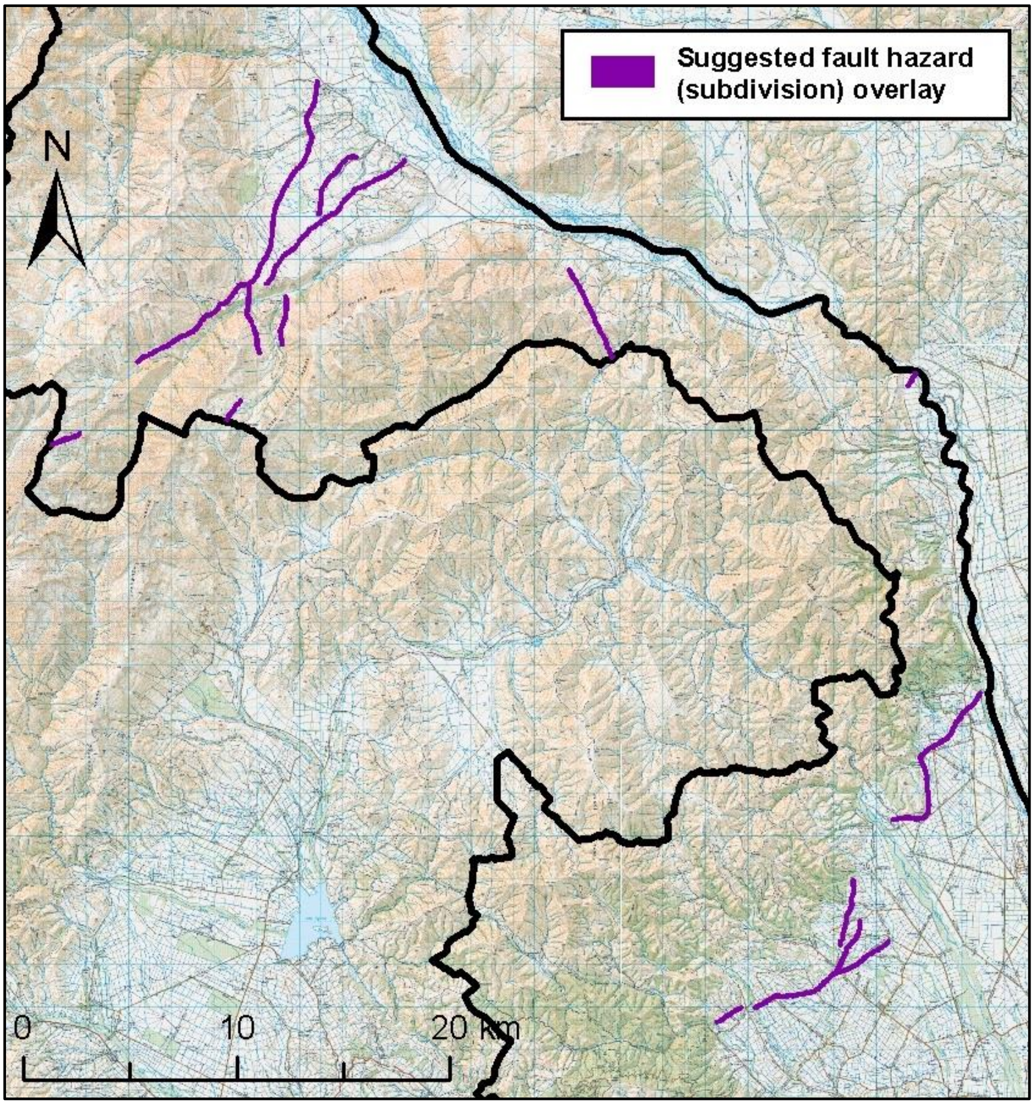

Figure 4: Suggested fault hazard (subdivision) overlay for Timaru District, based mainly on definite and likely, moderately- and well-expressed fault awareness areas.

Important or critical infrastructure or facilities

Important or critical infrastructure or facilities usually require a resource consent for other reasons. I suggest that one of the matters of assessment or discretion, if the proposed activity falls within any fault awareness area (including those where the fault is considered 'possible' and/or is not well expressed at the ground surface), should be whether the surface fault rupture hazard has been adequately assessed and, where required, steps have been taken to mitigate it if practicable.

Depending on the scope of the proposed important or critical infrastructure or facility, there may be a need to do sub-surface investigations to confirm the presence (or not) of the fault. I suggest that, depending on the results of the site-specific investigation, that where practicable the infrastructure or facility is sited at least 20 metres away from the zone of deformation associated with the fault, or the potential effects of surface fault rupture are mitigated through engineering design.

'Important or critical infrastructure or facilities' needs to be defined in the District Plan. Following the MfE fault guidelines, important or critical infrastructure or facilities refers to Building Importance Level 3, 4 and 5 structures, which are:

- Level 3: Structures that may contain crowds, have contents of high value to the community or pose a risk to large numbers of people in close proximity, such as conference centres, stadiums and airport terminals.
- Level 4: Buildings that must be operational immediately after an earthquake or other disastrous event, such as emergency shelters and hospital operating theatres, triage centres and other critical post-disaster infrastructure.
- Level 5 (not included in the MfE guidelines): Structures whose failure poses a catastrophic risk to a large area or a large number of people, such as dams, nuclear facilities or biological containment centres.

More examples of structures within each level are given in Clause A3 of the Building Code at http://www.legislation.govt.nz/regulation/public/1992/0150/latest/DLM162576.html#DLM4417717. (Level 1 structures are low risk structures, such as walkways, outbuildings, fences and walls; Level 2 structures include houses.)

Selwyn District Council is using the definitions given for Building Importance Levels 3, 4 and 5 for the fault provisions in their draft proposed District Plan. Alternatively, Timaru District Council may already have a definition that could be used, or the definition of critical infrastructure in the Canterbury Regional Policy Statement could be used:

> Infrastructure necessary to provide services which, if interrupted, would have a serious effect on the communities within the Region or a wider population, and which would require immediate reinstatement. This includes any structures that support, protect or form part of critical infrastructure. Critical infrastructure includes:
>
> - regionally significant airports
> - regionally significant ports
> - gas storage and distribution facilities
> - electricity substations, networks, and distribution installations, including the electricity distribution network
> - supply and treatment of water for public supply
> - storm water and sewage disposal systems
> - telecommunications installations and networks
> - strategic road and rail networks (as defined in the Regional Land Transport Strategy)
> - petroleum storage and supply facilities
> - public healthcare institutions including hospitals and medical centres
> - fire stations, police stations, ambulance stations, emergency coordination facilities.

However, the Canterbury Regional Policy Statement definition does not cover all the structures within the Building Code Building Importance Levels 3, 4 and 5.

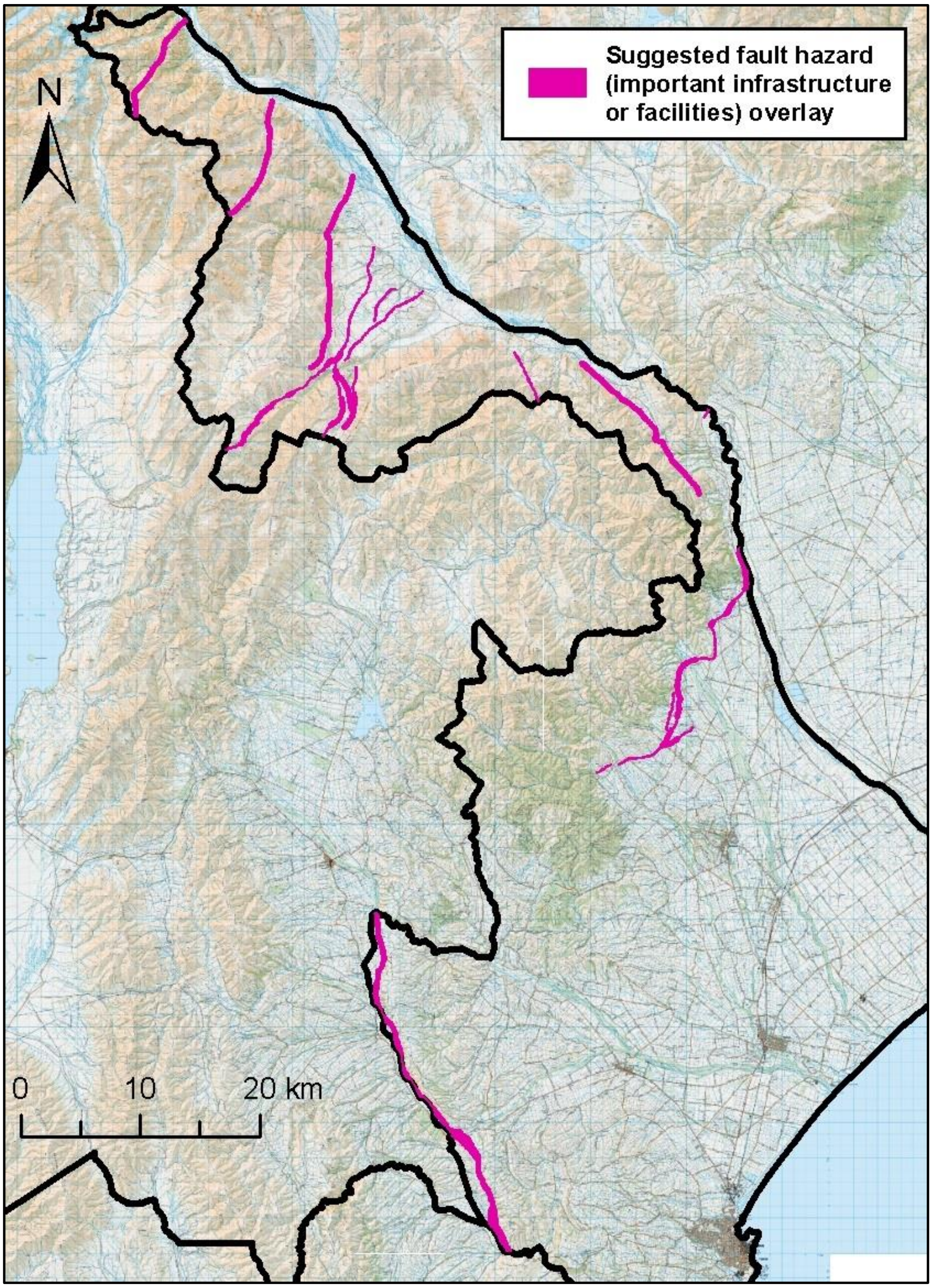

Figure 5: Suggested fault hazard (important infrastructure and facilities) overlay for Timaru District, based on all fault awareness areas.

The District Plan provision for important or critical infrastructure or facilities should be written so there is flexibility around the scale of investigation required depending on the nature and size of the development. The investigations and mitigation that might be needed for telecommunications infrastructure are obviously different to what would be needed for the likes of a major dam, so there should be some discretion in the level of investigation and mitigation required. The important thing is that the known or possible presence of a surface fault rupture hazard is recognised and addressed during the project development and steps are taken to mitigate the risk if necessary and practicable.

This overlay could be called the fault hazard (important infrastructure or facilities) overlay, or similar, and is shown in Figure 5. This includes all known and possible faults within the district. I have supplied a GIS shapefile of this suggested overlay is with this memo. The attribute fields of the shapefile have been simplified to only include the fault name and recurrence interval information. All other faults attributes can be found in the 2019 Canterbury Fault Awareness Area dataset that this shapefile was extracted from.

Plan Changes

For proposed plan changes within a fault awareness area, whether classed as definite, likely or possible, that enable intensification of land use, or where development could be damaged by surface fault rupture, Policy 11.3.3 of the Canterbury Regional Policy Statement applies. This requires a site-specific investigation including detailed mapping of the fault at 1:35,000 or better and assessment of its recurrence interval (if not already well constrained) be undertaken to a level sufficient to apply the MfE guidelines.

Residential and farm buildings (outside new subdivisions)

I do not recommend that there are restrictions on new individual timber-framed residential buildings or farm buildings (Building Importance Level 1 and 2 structures) outside new subdivisions within fault awareness areas. This is because the zones of deformation associated with fault rupture have not been mapped in enough detail and requiring these to be mapped for such activities would be too onerous for the applicant.

Land Information Memoranda (LIMs)

I recommend that fault awareness areas be included in the District Plan *and* on Land Information Memoranda for information so that people are aware of the potential fault rupture hazard and can make their own decisions about where to locate new buildings.