

The Canterbury Earthquakes: The land damage and planning for the recovery process

Shannon Richardson, Senior RM Planner

Tonkin & Taylor Ltd

Environmental and Engineering Consultants



Part 1

4 September 2010 Magnitude 7.1 Earthquake



September 2010 Earthquake

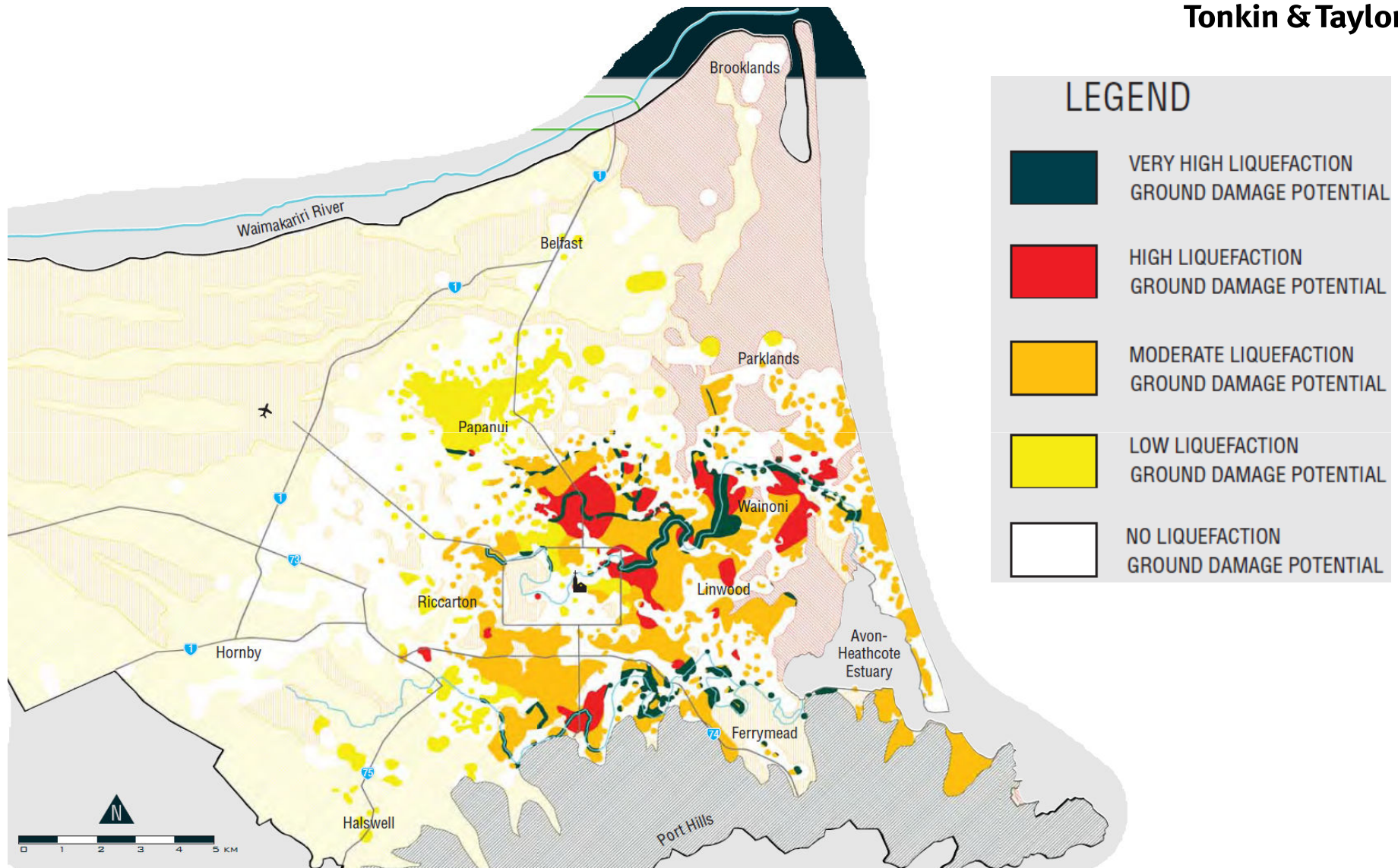


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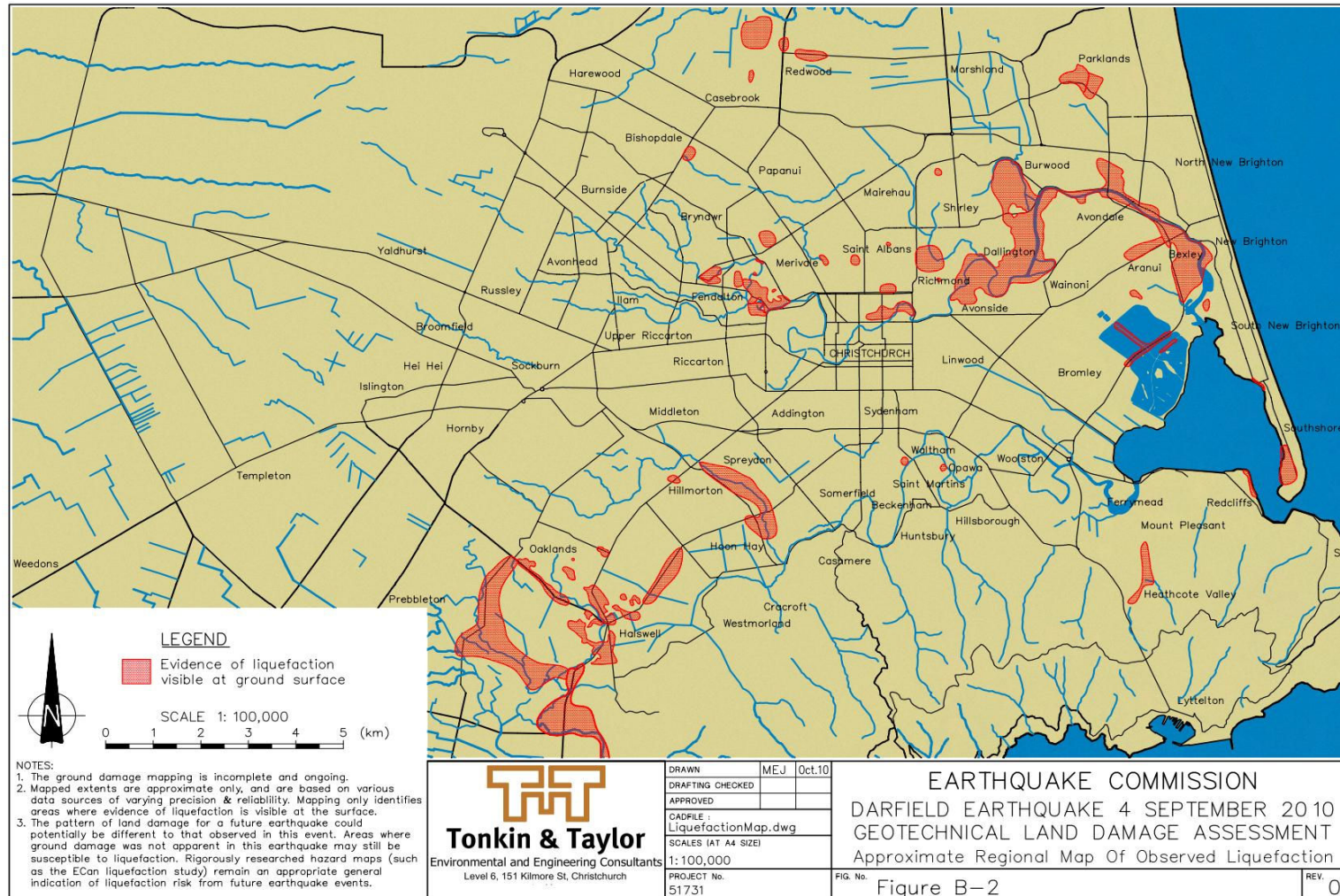
- Magnitude 7.1 earthquake occurred near Darfield, 40 kms west of Christchurch City at 4:36 am on 4 September 2010
- Tonkin & Taylor engaged by the Earthquake Commission (EQC)
- Identify the nature and cause of land damage associated with residential property
- The Sept 2010 earthquake caused extensive ground liquefaction, in localised areas of Canterbury.
- The liquefaction resulted in major and building damage.



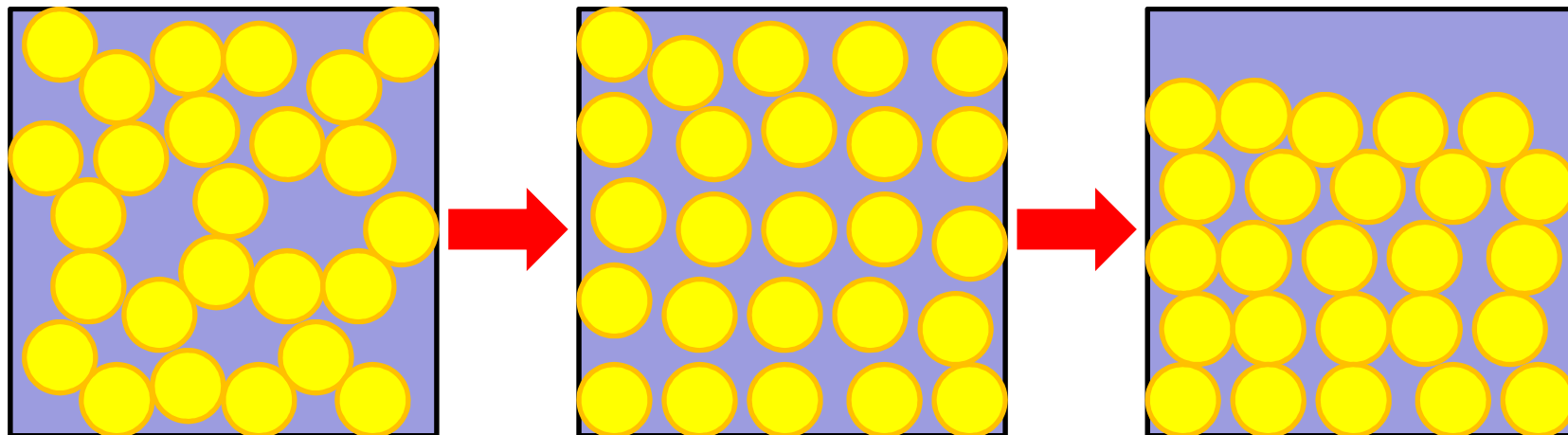
ECan 2004 Liquefaction Study



Ground Damage Observations October 2010



Liquefaction mechanism



Before
liquefaction

During
liquefaction

After
liquefaction



Liquefaction damage

- Ejected sand and ground cracking
- Ground subsidence
- Settlement of large areas due to consolidation
- Flotation of buried services (i.e. water and wastewater)
- Failure of foundation bearing capacity
- Lateral spreading of gentle slopes or land next to a free face (e.g. riverbanks)
- Damage to piles from liquefaction induced horizontal soil movement



Liquefaction

sand and water ejection



Liquefaction



Liquefaction – uplift of manholes

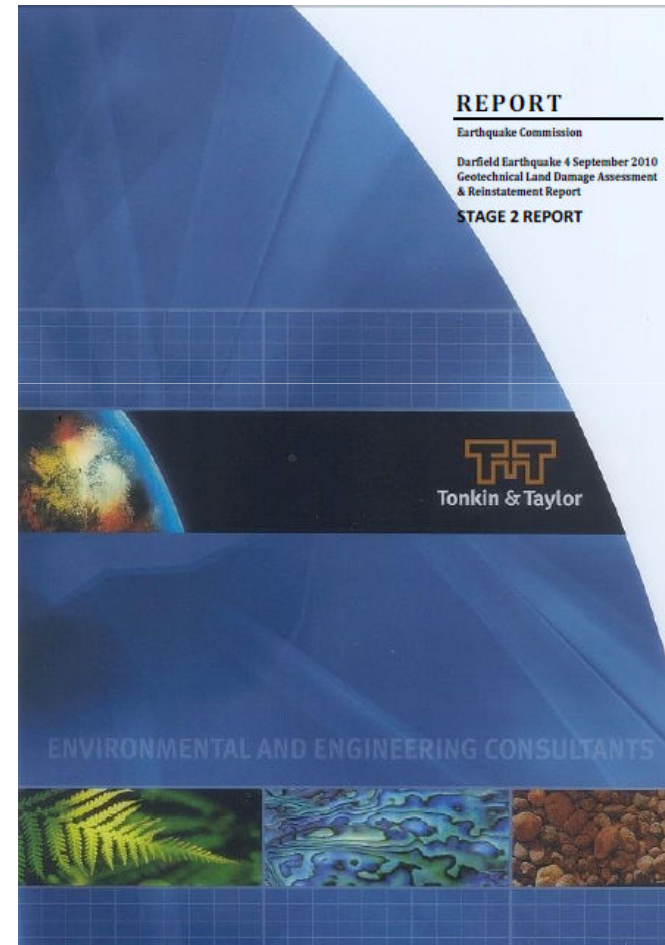
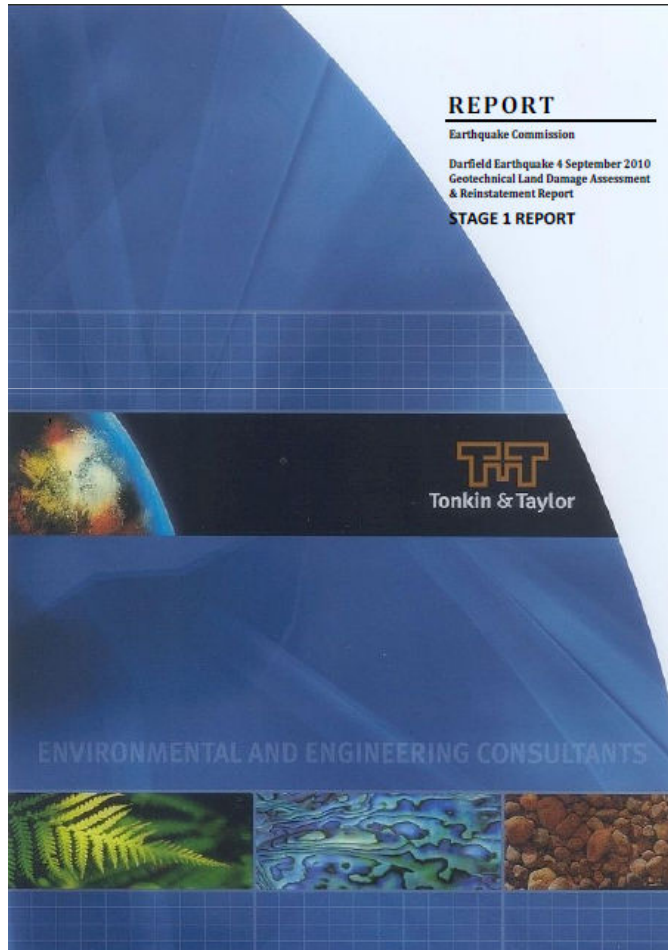




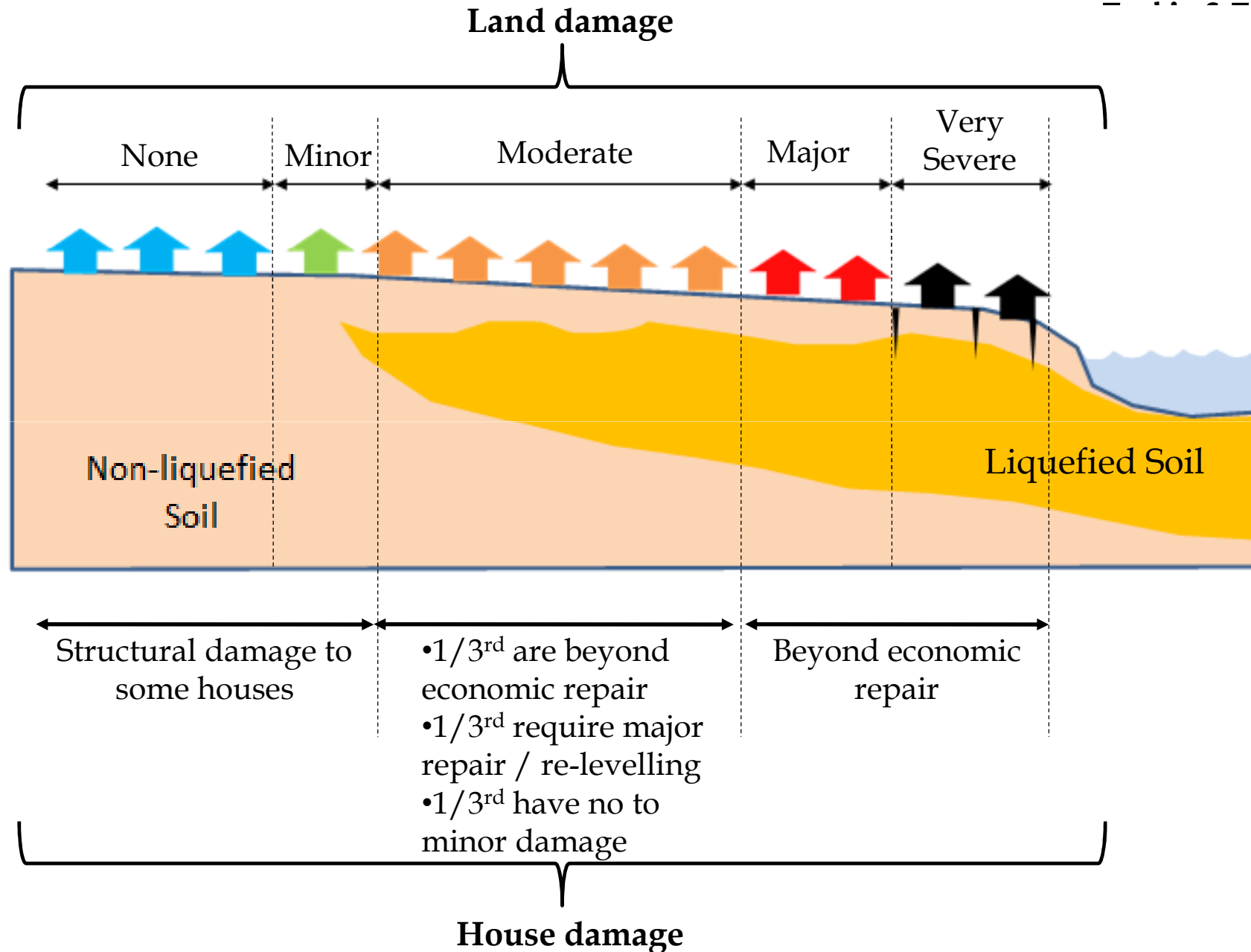
Lateral Spread



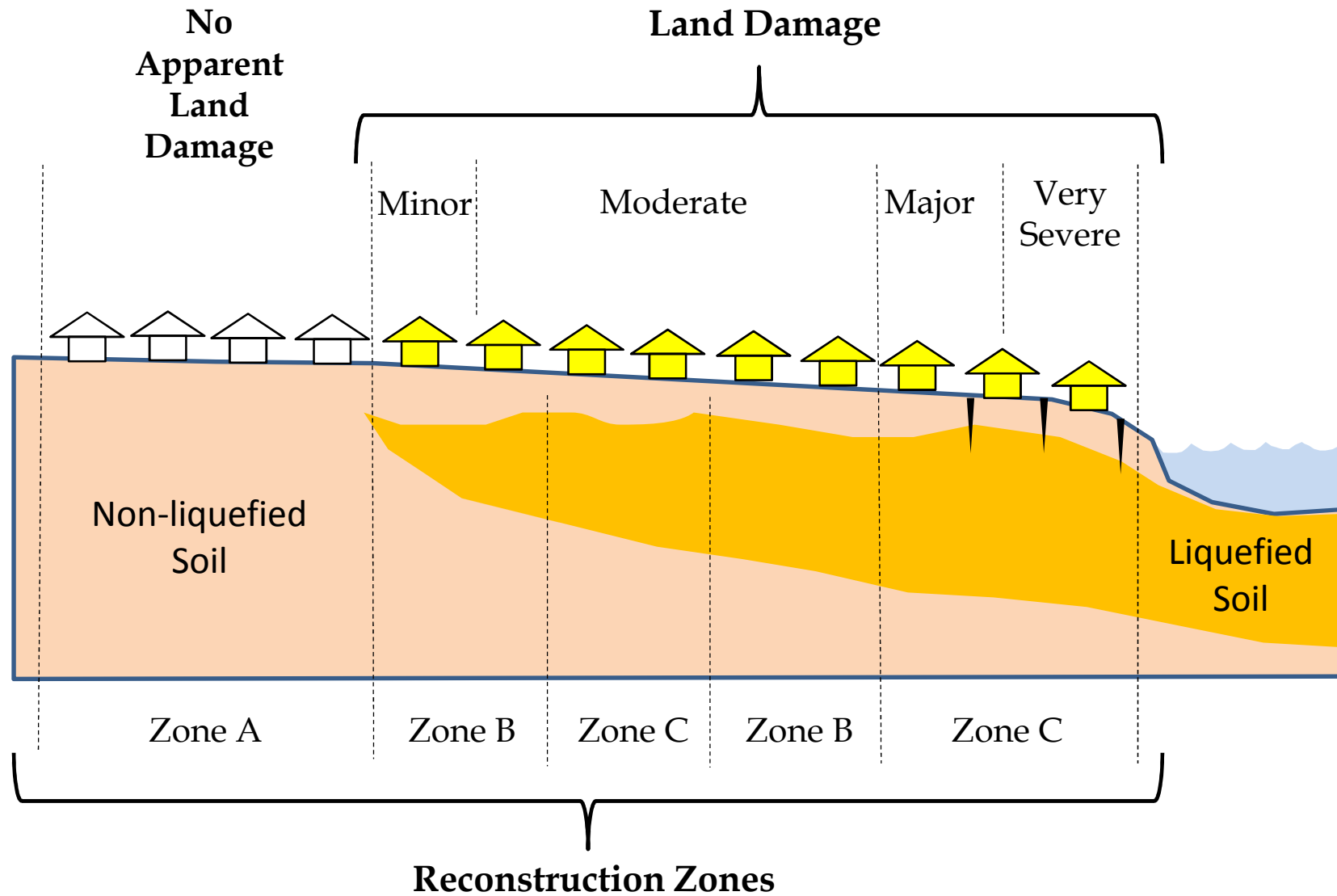
The Response: Stage 1 & Stage 2 Reports



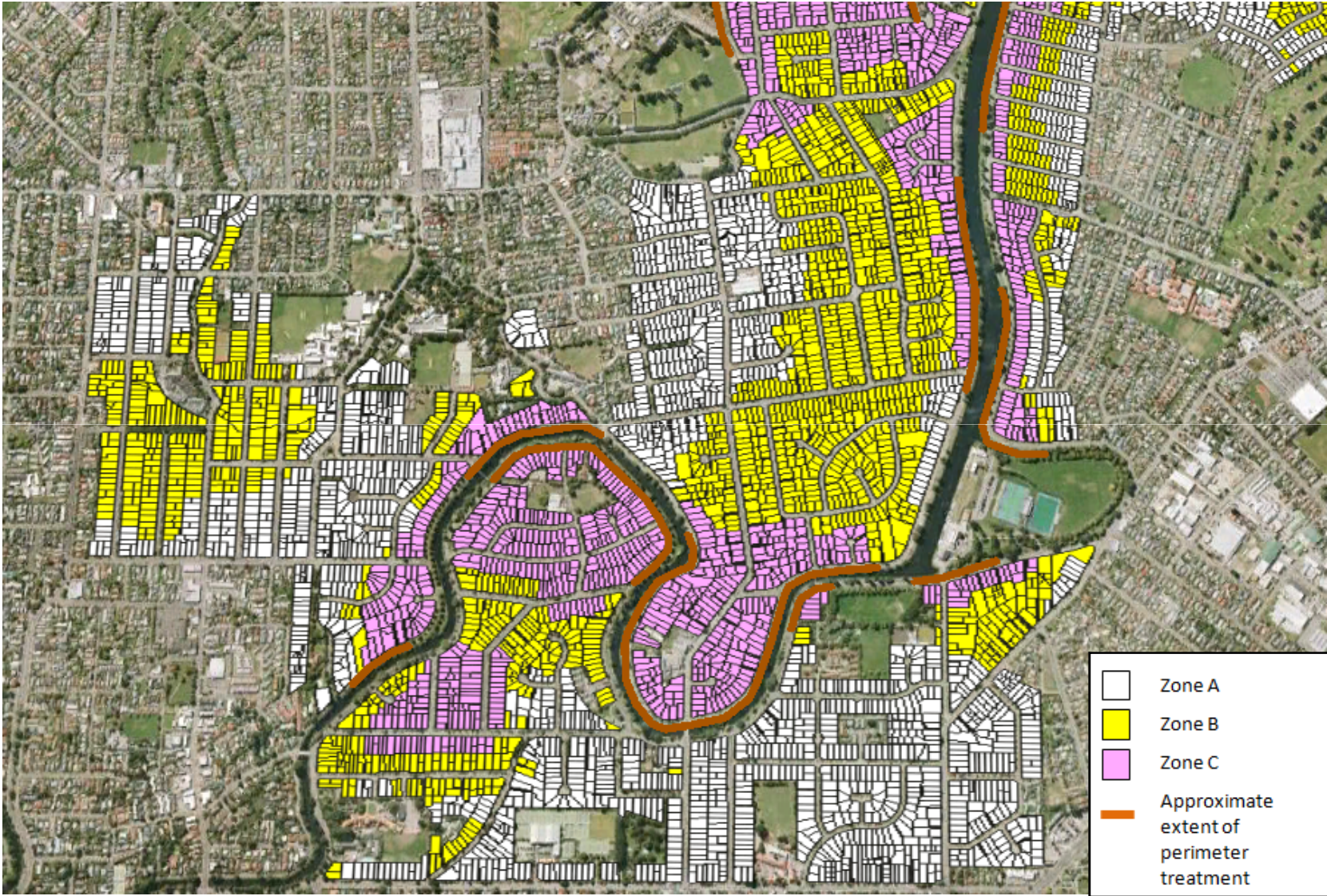
Reconstruction zones - Generic cross-section



Reconstruction zones - Generic cross-section



Christchurch City - Richmond, Dallington & Avondale



How far had we got by 22 February ?

- GIS mapping of land and building damage (using insurance data)
- EQC programme of land remediation works
- EQC Concept Design Report (well advanced)
- Spencerville land remediation pilot project
- Consultation with key stakeholders around programme of works and proposed OiC
- Consent application(s) for 'early works packages' in Waimakariri (well advanced)



Spencerville Pilot Project Tonkin & Taylor





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The Legislative Response

- Earthquake (Response and Recovery) Act 2010
- Canterbury Earthquake Recovery Commission
- Orders in Council (OiC's) to amend legislation
- Relevant OiC's include:
 - Building Act
 - Historic Places Act
 - Reserves Act
 - Resource Management Act (non-notified consents, limited consultation, no written approvals)
 - The list is growing



Engineering Response:

Review of Building Codes/ Standards

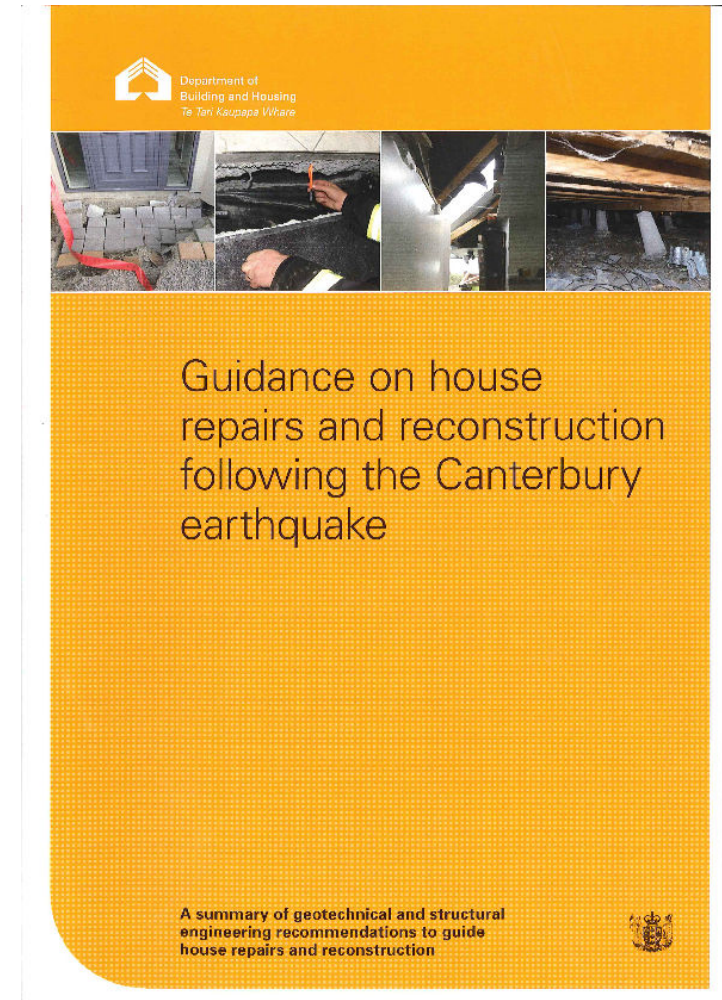
- GNS reviewing seismic risk for Canterbury
- DBH - Review of all design codes & standards with regard to liquefaction – liquefaction prone ground excluded from ‘good ground’ definition (NZS3604)
- Possible future land design code - in liquefaction prone areas stiffer floor requirement / flexible services



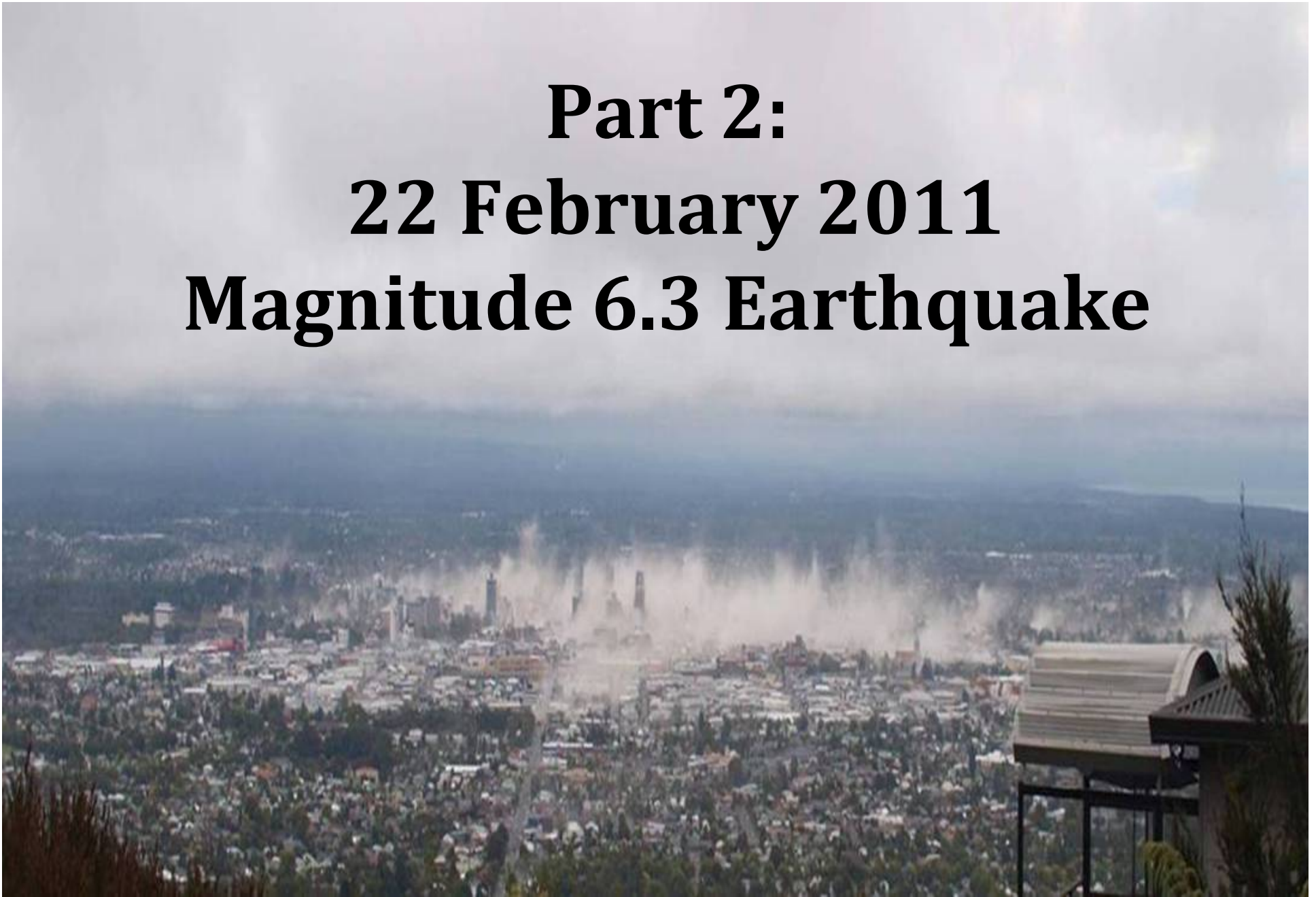
Department of Building & Housing Guidance Document

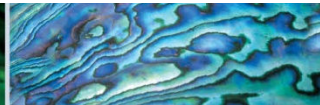
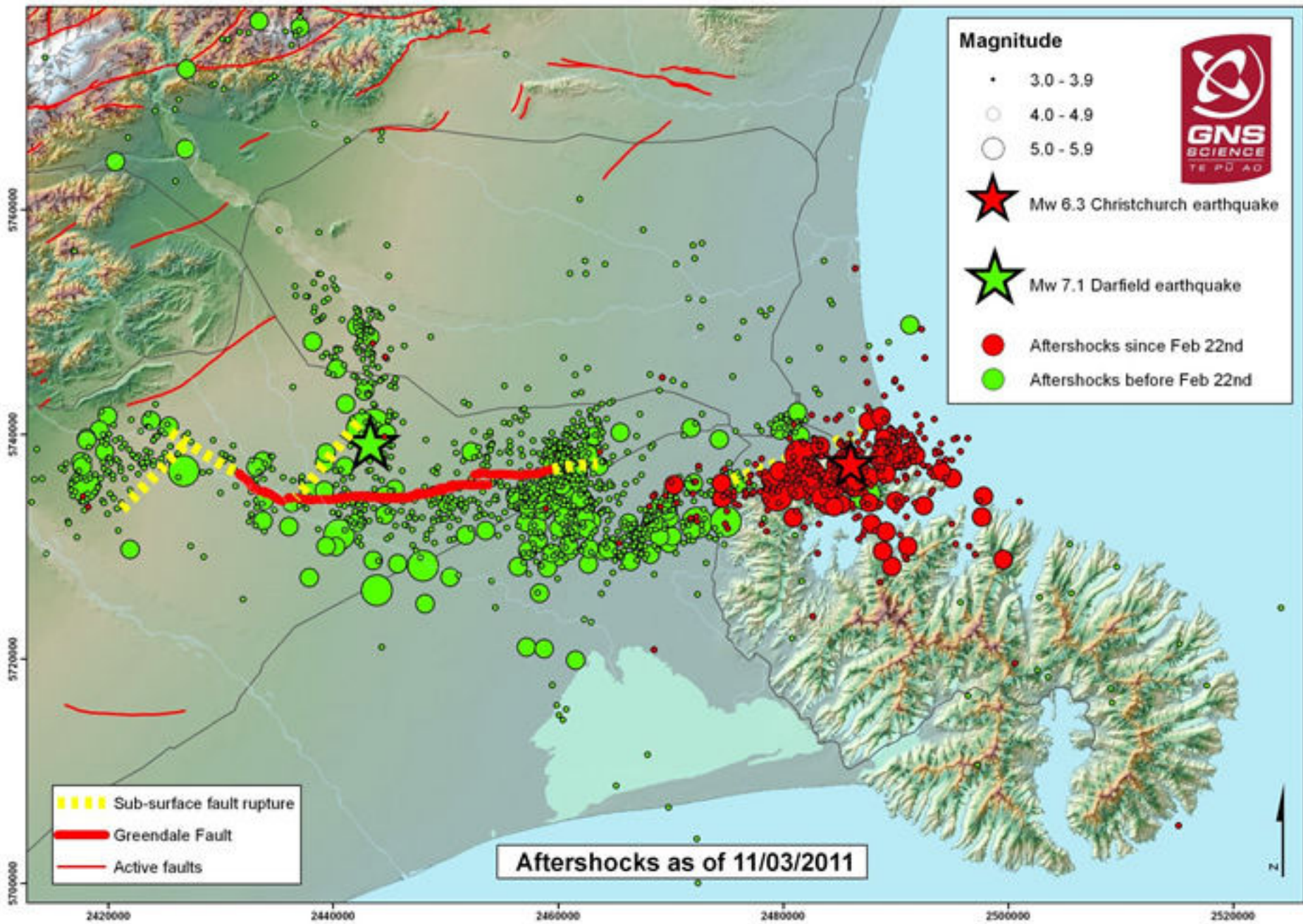


- Engineering Advisory Group established
- Issued guidance document on house repair & reconstruction
- Aim to make remediation unified & efficient



**Part 2:
22 February 2011
Magnitude 6.3 Earthquake**





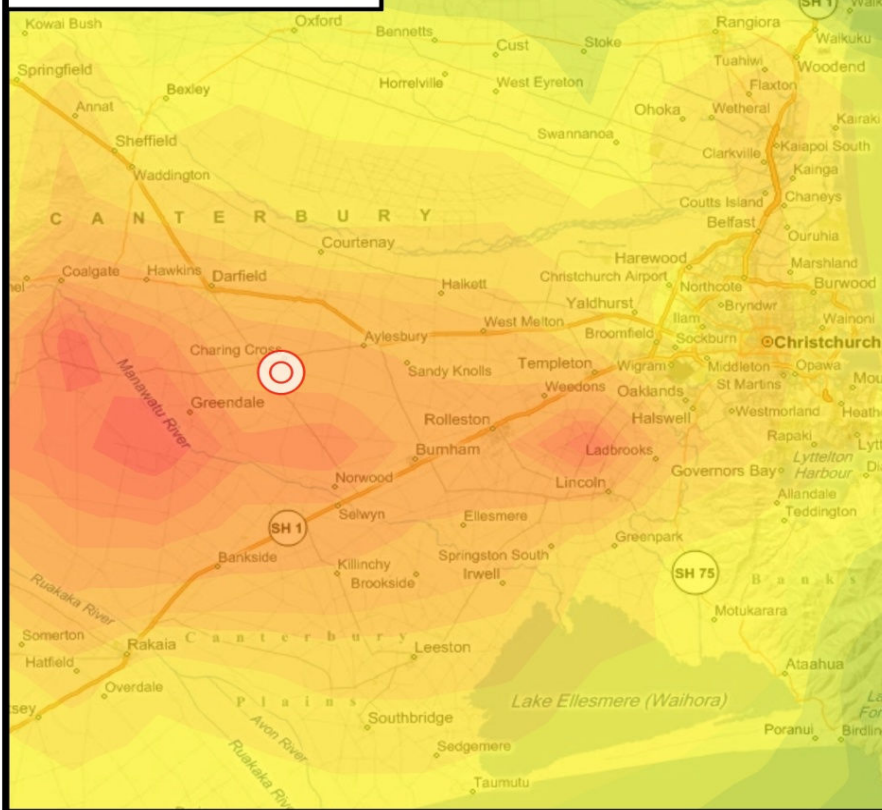
Peak ground acceleration (PGA) Tonkin & Taylor

PGA	Mag	Depth	Earthquake
2.2g	6.3	5km	<u>2011 Christchurch earthquake</u>
1.7g	6.7	19km	<u>1994 California earthquake</u>
1.26g	7.1	10km	<u>2010 Canterbury earthquake</u>
0.8g	6.8	16km	<u>1995 Kobe earthquake</u>
0.5g	7.0	13km	<u>2010 Haiti earthquake</u>

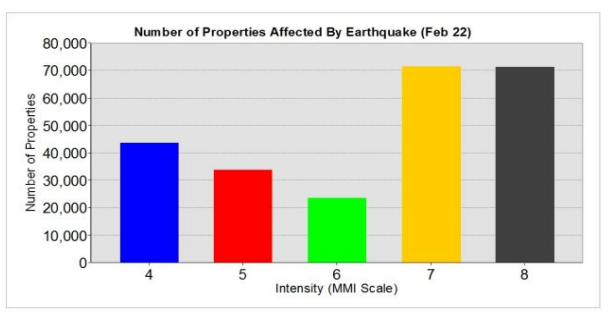
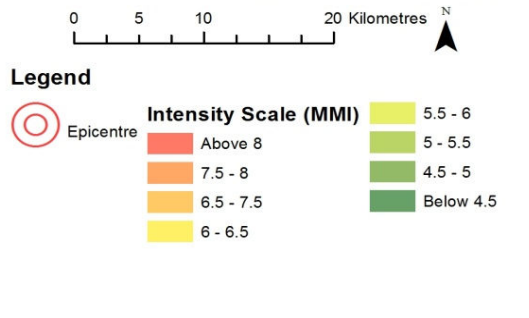
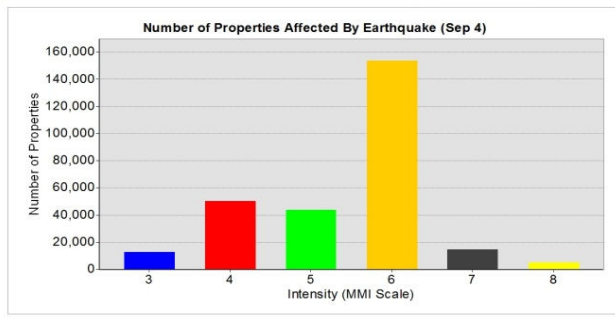
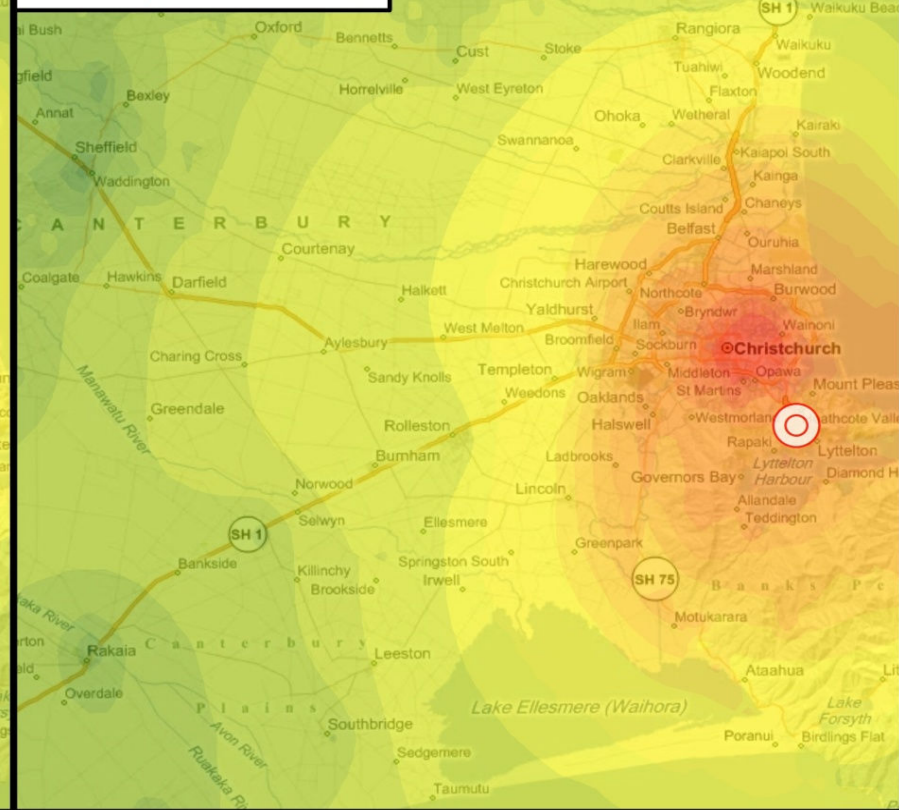


Canterbury Earthquake Damage - 24 Feb 2011

September 4th Intensity



February 22nd Intensity



Liquefaction



Liquefaction

uplift of pump stations



Widespread flooding due to liquefaction



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Lateral spread





Lateral spread






Part 3

The Recovery Process

GREEN

Christchurch City Council 

INSPECTED

NO RESTRICTION ON USE OR OCCUPANCY

This building has received a brief inspection only. While no apparent structural or other safety hazards have been found, a more comprehensive inspection of the exterior and interior may reveal safety hazards.

Exterior Only
 Exterior and Interior

Facility/ Tenancy Name and Address
374 Barbados St

Please ensure the owners are advised of this notification. Owners are encouraged to obtain a detailed structural engineering assessment of the building as soon as possible. Report any unsafe conditions to the Territorial Authority. Subsequent events causing damage may change this assessment. Re-inspection may be required. Secondary damage (partitions, windows, fittings and furnishings) may be hazardous. Electrical and mechanical equipment, gas connections, water supplies and sanitary facilities have not been inspected.

Do Not Remove this Placard. Placed on Behalf of the Civil Defence Emergency Management Controller Under the Authority of the Civil Defence Emergency Management Act 2002

This facility was inspected pursuant to the Civil Defence Emergency Management Act 2002 0274537962

Inspector ID: D. Dzhuic & T. Morrison

Acting under the authority of the Civil Defence Emergency Management Controller:

Date: 26/02/11
Time: 10:10 am

Contact for information: ph. (03) 941 8999
or
TXT: 021 02069179 with following details: Address, Placard colour, contact name, contact phone number

Clear 28/2
1045 NZAT6



Restoration of key infrastructure and transport routes



The Challenges

- Complex, area wide, multi-site, multi-party engineering solutions at significant scale (originally 12km perimeter works)
- Concept of working through RMA / City Plan processes in response to a natural disaster (Spencerville Pilot Project)
- Stakeholder consultation / co-ordination (CCC, ECan, EQC, SDC, WDC, MfE, HPT, DoC, iwi)
- Identifying opportunities for works on public land (i.e. reserves, roads, riparian margins of the Avon etc)
- Balancing public vs private property rights
- The tensions between speed of recovery and public participation (Clause 10 of OiC)



The Challenges

- EQC's programme of land remediation works have not been affected in Waimakariri District.
- Seeking resource consents on the basis of:
 - Preliminary concept design drawings
 - Concept of a maximum construction envelope (alignment and envelope of effects)
 - Agreed performance standards which will be managed via a Construction Environmental Management Plan (CEMP) and associated management plans
- The clock has been reset following 22 February event - damage mapping and land remediation proposals start again
- STILL A LONG WAY TO GO



The Opportunities and Lessons Learnt

- Managing the liquefaction hazard better (i.e. building more resilient communities)
- Royal Commission of Enquiry into why some buildings collapsed which had been passed fit for use (i.e. CTV and Pine Gould buildings)
- Canterbury Earthquake Recovery Authority (CERA)
- Re-development opportunities and a new approach to urban design / sustainability / self sufficiency
- The tool box of solutions for remediation will be much, much broader (i.e. not just general earthworks and perimeter treatment)

