

# Christchurch Earthquakes

Sept 2010, Feb-Jun-Dec 2011, Present

***Maurice Perwick***

RP Surv – NZIS

Accred Hydro Level 1

***Innovation from Disaster***

**Eliot Sinclair**  
surveyors | engineers | planners



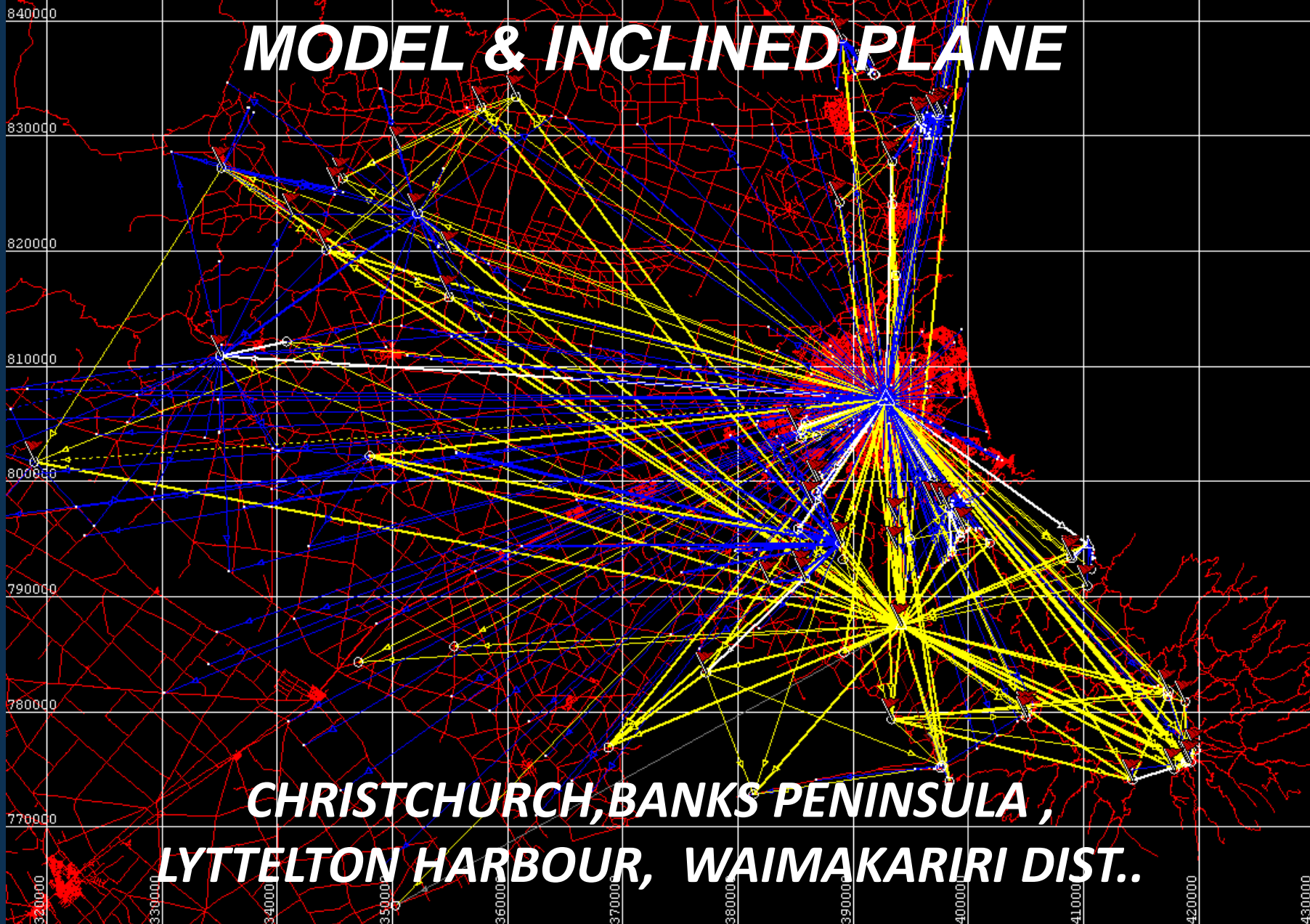
FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND  
2–6 May 2016



Recovery  
from disaster

# ***SITE CALIBRATION – COMBINED GEOID MODEL & INCLINED PLANE***



***CHRISTCHURCH, BANKS PENINSULA,  
LYTTELTON HARBOUR, WAIMAKARIRI DIST..***

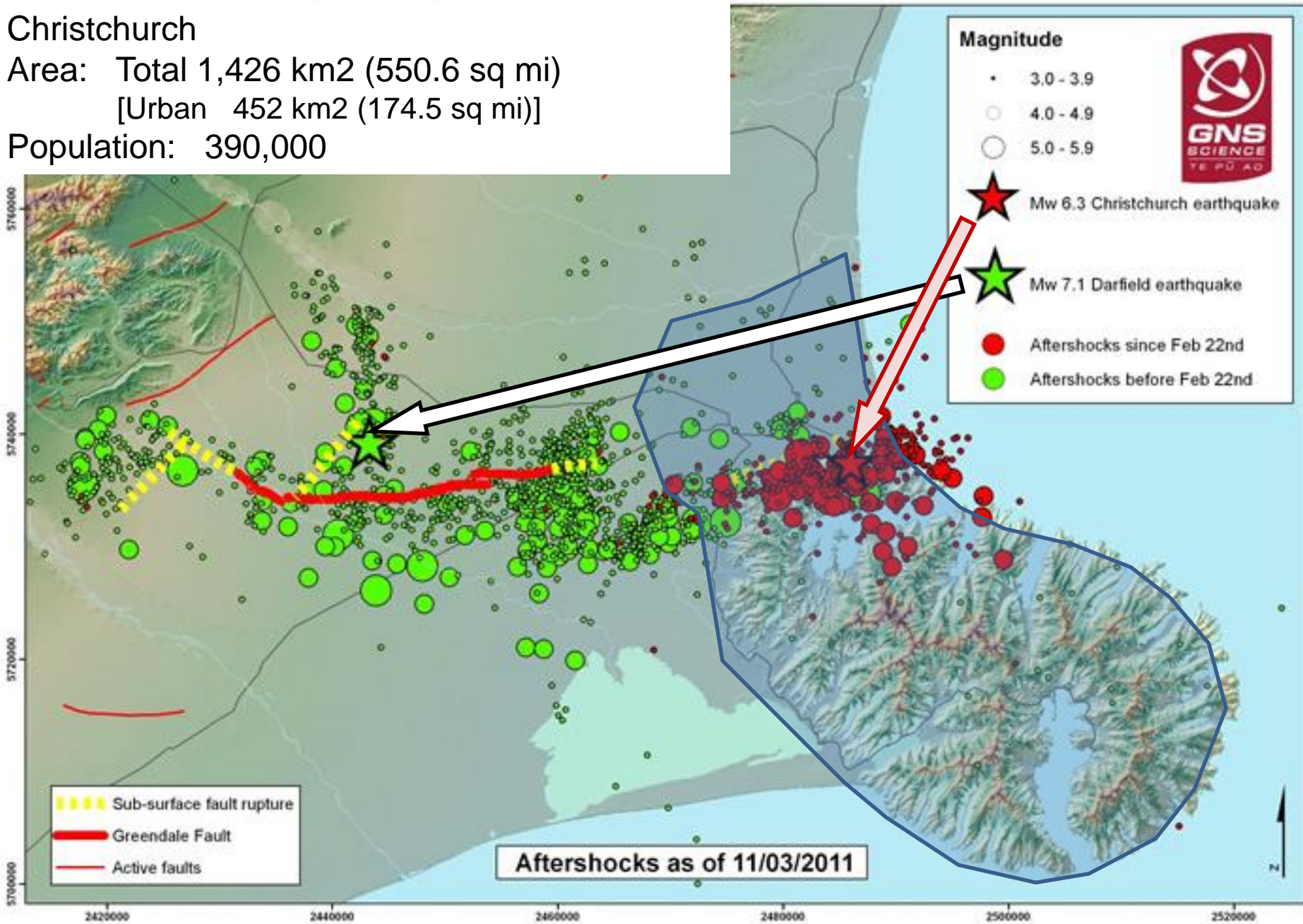
# Best Survey Practise

- Global Approach
- Modern Techniques & Equipment
- Use of Geoid –Spheroid Correction Models
- National Geodetic datum & CORS
- Stable and Reliable Ground Monumentation
- Archiving & Access to Data
- Baseline & As-Built Surveys

# Christchurch

Area: Total 1,426 km<sup>2</sup> (550.6 sq mi)  
[Urban 452 km<sup>2</sup> (174.5 sq mi)]

Population: 390,000



# 4 September 2010 Earthquake

## Greendale Fault

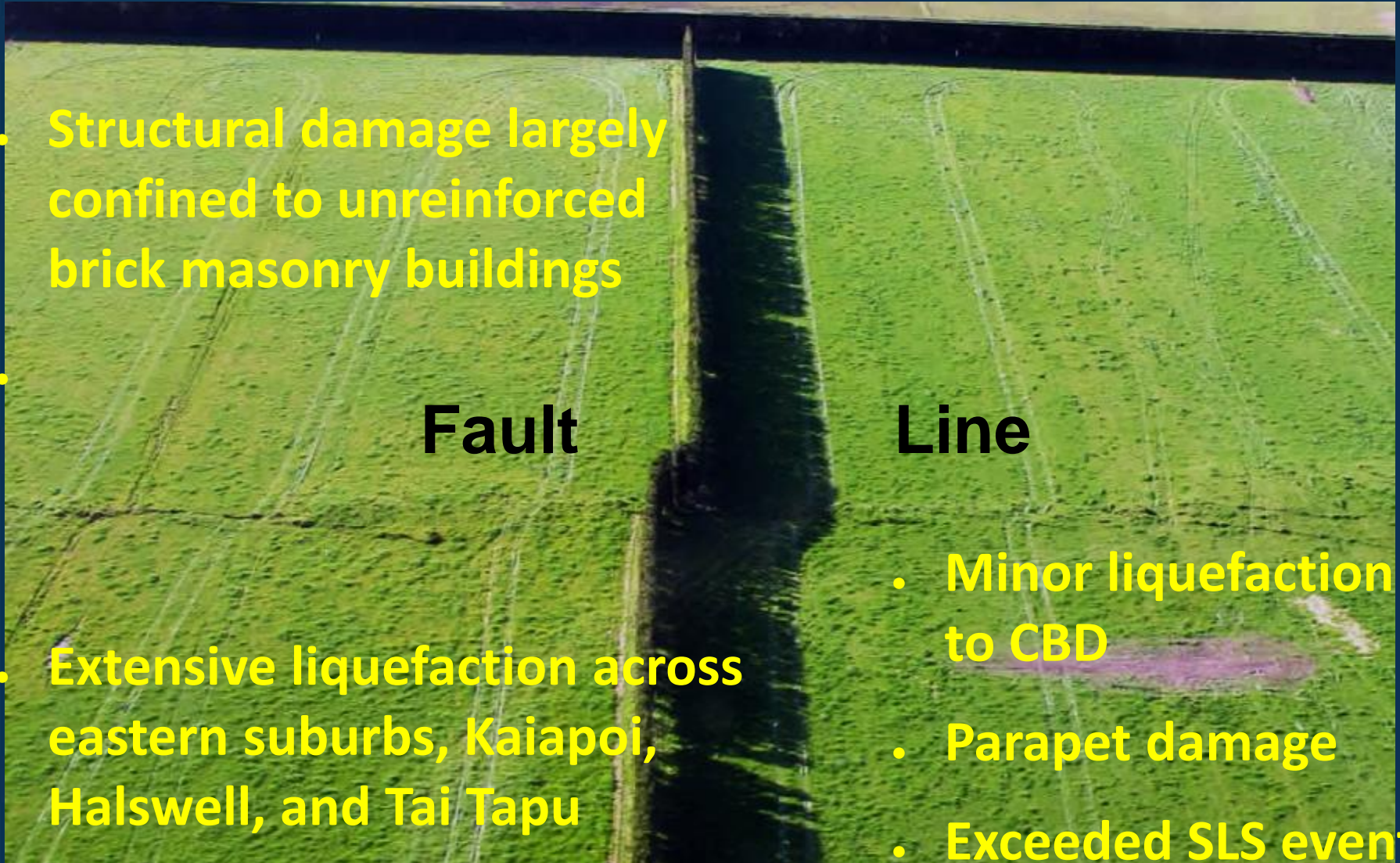
- Structural damage largely confined to unreinforced brick masonry buildings

**Fault**

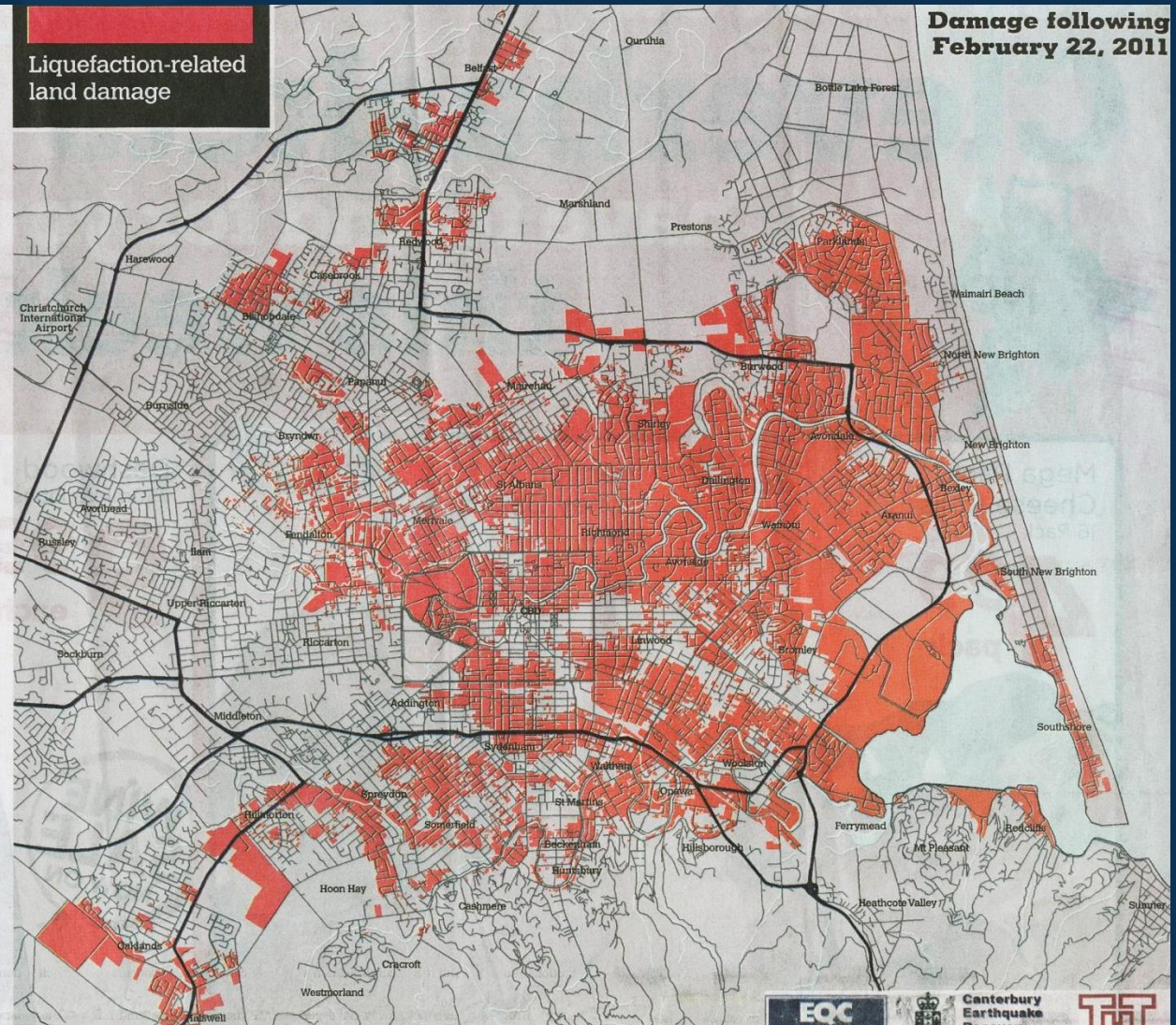
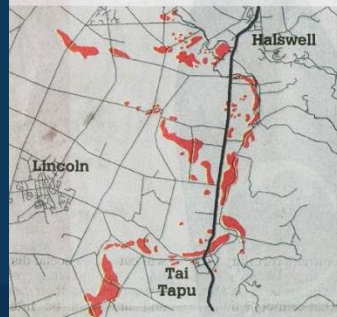
- Extensive liquefaction across eastern suburbs, Kaiapoi, Halswell, and Tai Tapu

**Line**

- Minor liquefaction to CBD
- Parapet damage
- Exceeded SLS event



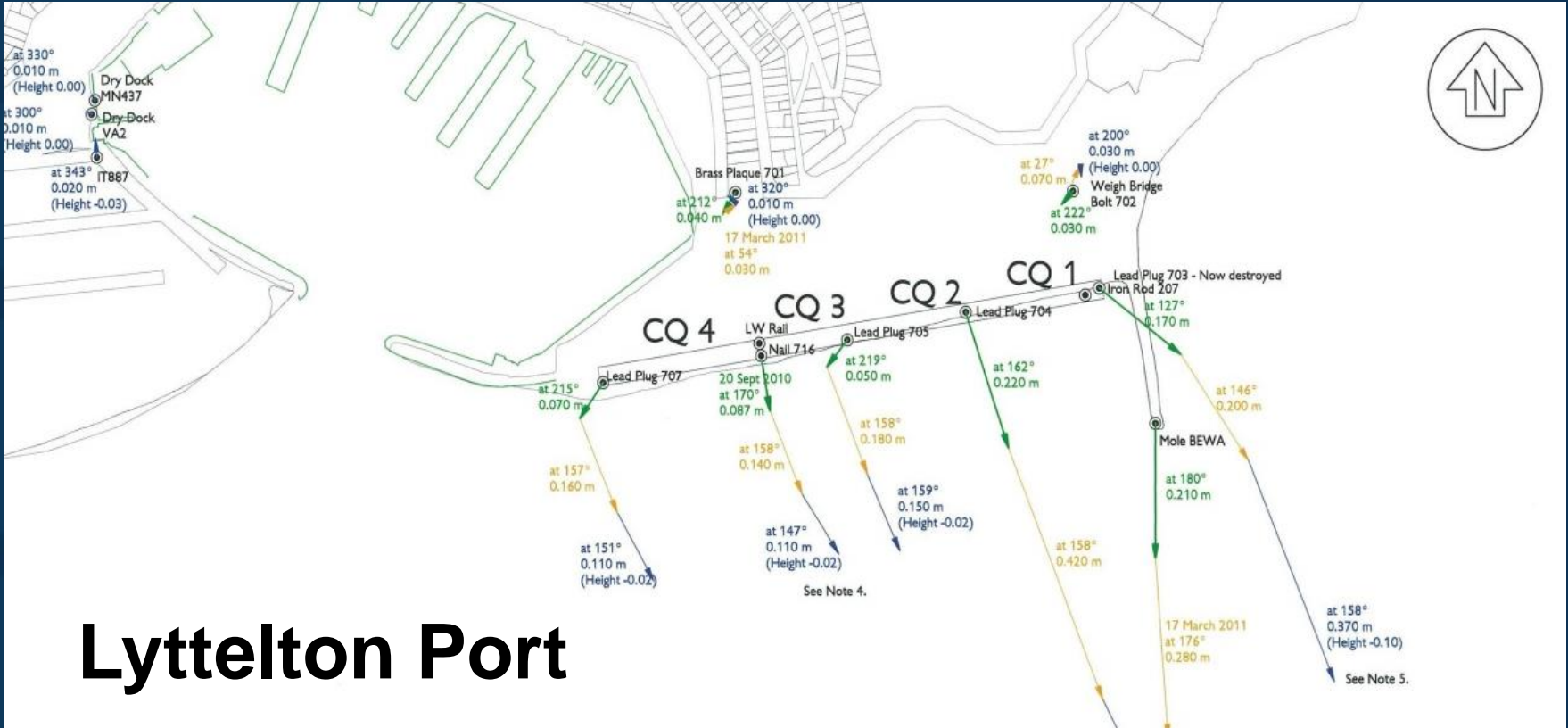
# Christchurch Earthquake - Liquefaction





Flooding & Subsidence from  
liquifaction everytime a big shake

# Vectors - Displacements



## Lyttelton Port

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# Intense monitoring of Tank Farm & Wharf



- Differential settlement
- Tilting
- High manifold pressures
- Rock column failure
- Stress on Pipework / flanges
- Load Bearing Reduced

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2-6 May 2016



Recovery  
from disaster

# Tank Settlements

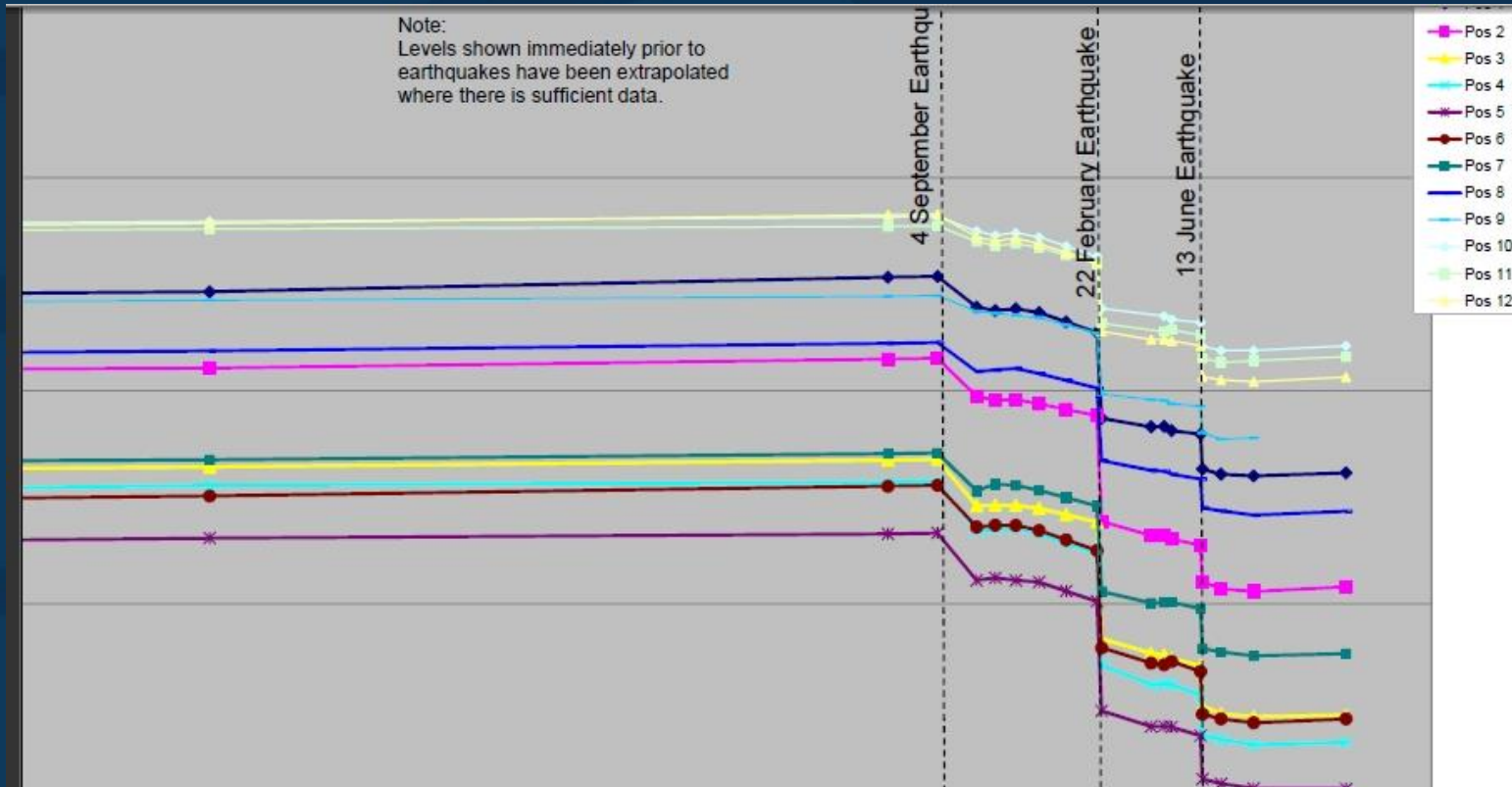


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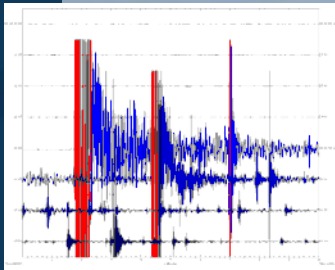


Recovery  
from disaster

# The Second One !

## Christchurch Earthquake

22-Feb-2011 12:51pm



Images and data sourced from:

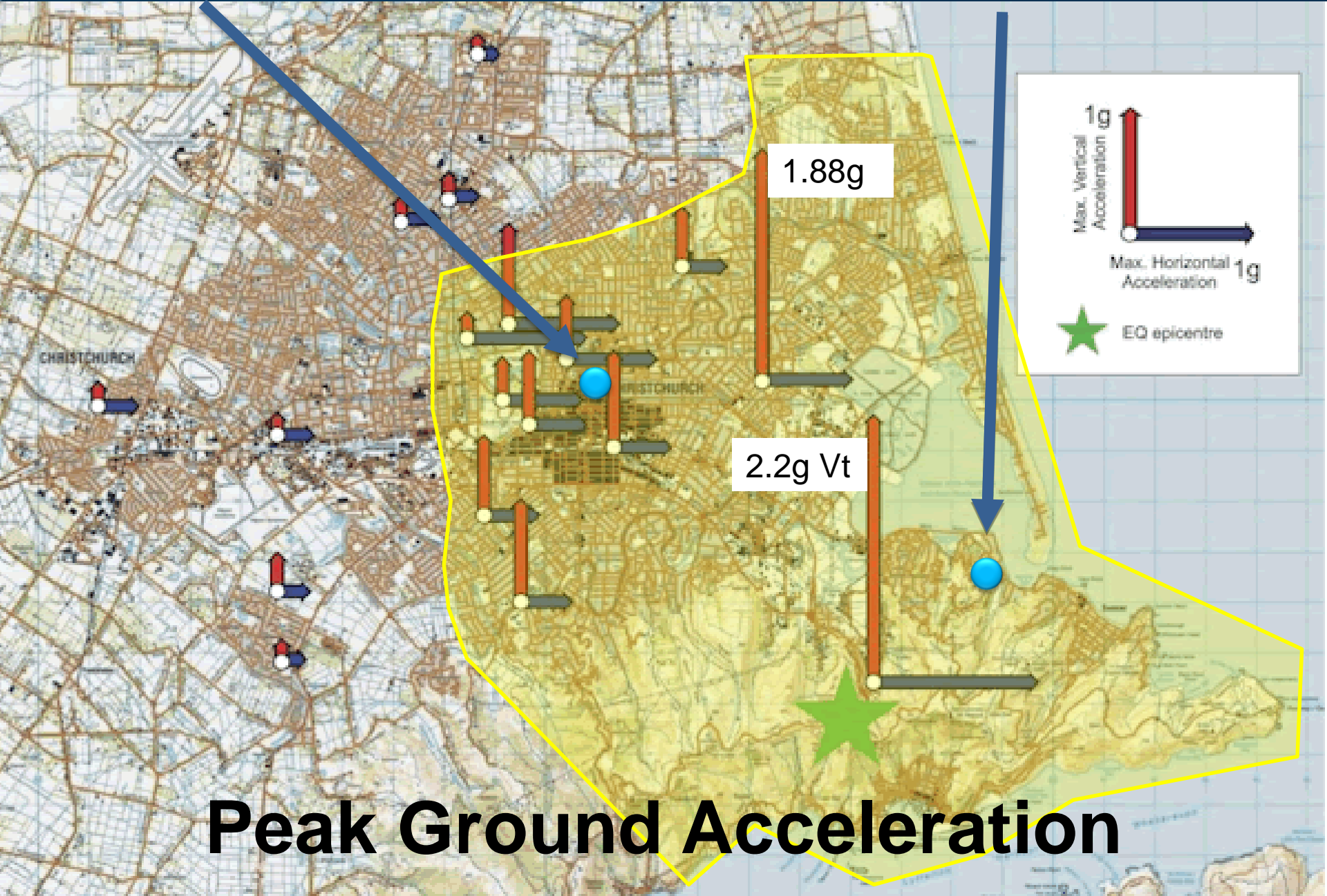
LINZ, GNS, USGS, WIKI, many Private Photo Albums, WWW public forums

[sssi.org.au](http://sssi.org.au)

Work

20 Minute Journey- 3 Hours !

Home



**Peak Ground Acceleration**



My way home – impassible – huge detours !  
Bridges Closed or Dislocated from Carriageway  
0.3m – 1.5m Vertically

# Horizontal Infrastructure

*Surface and  
Underground services  
failed*



# Home Sweet Home

## Everything Trashed !

- No telephone ( 14 days) TXT & Car Charger only
- No Power (10 days )
- No Fridge / Freezer
- No local shops & super Market
- No rubbish Collection
- No Water ( six weeks )
- No Sewer ( one month, spa water to flush)
- No washing (body & clothes)
- Rain Water captured- Boiled
- Spa water – body wash
- Gas BBQ & Hob
- Bottled water



# Cashin Quay Breakwater Lyttelton Port of Christchurch







# FIG Working Week 2016

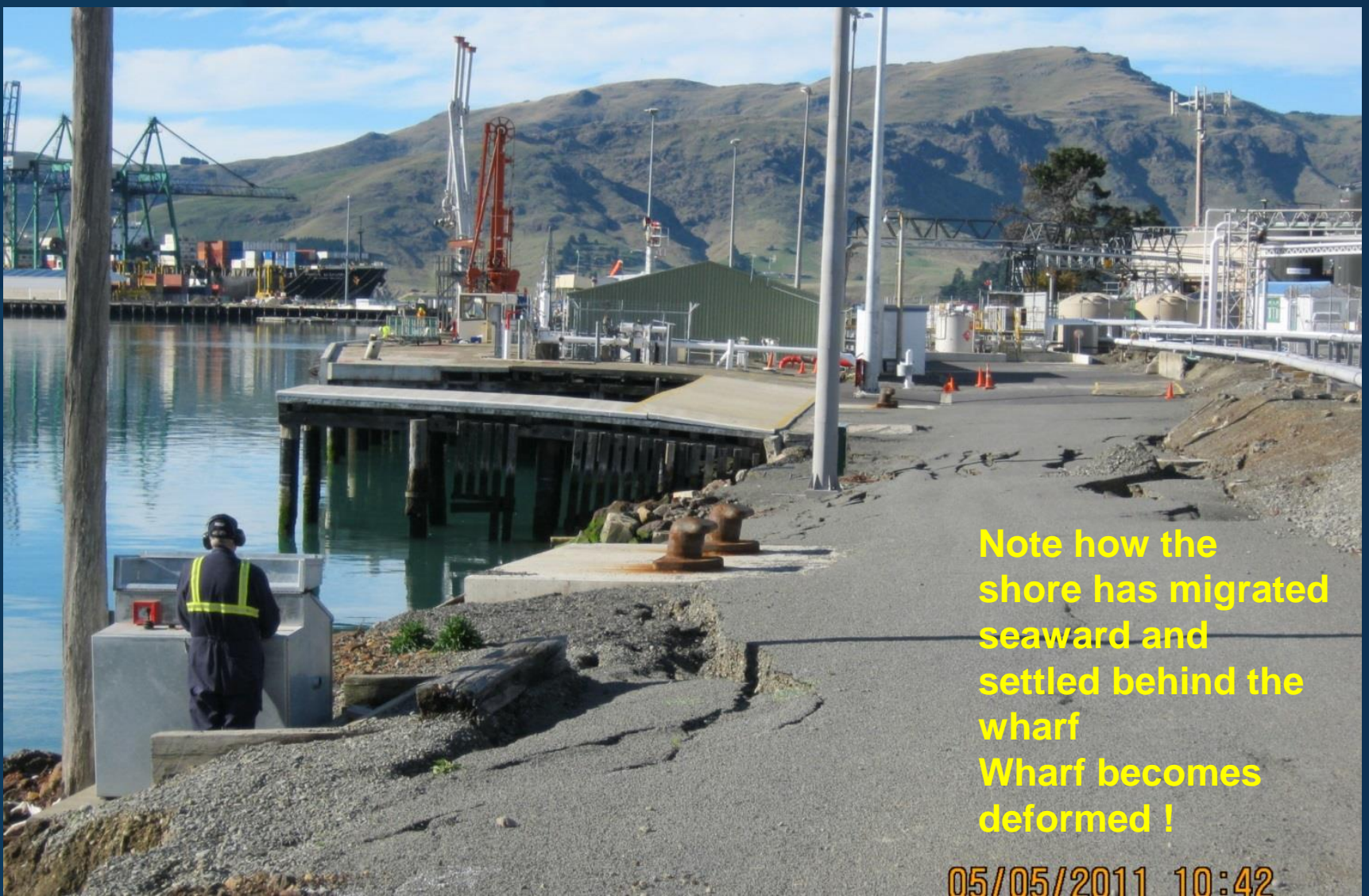
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Recovery  
from disaster



Lateral forces from the hardstand push  
the decking seaward



Note how the shore has migrated seaward and settled behind the wharf  
Wharf becomes deformed !

05/05/2011 10:42

## Oil Wharf - Lyttelton

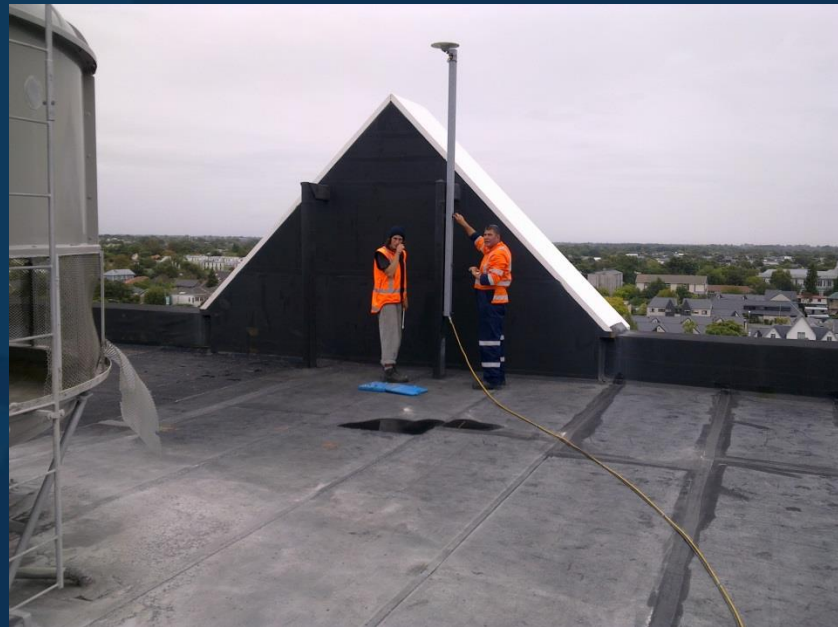
# Gear Recovery – Day 3 (25/2/2011)



Dismantle our CORS

Grab our Server

Pluck our Plotters



## Burglar (level 5)

- Crossed Army Cordon
- Braved darkness & Quakes
- GPS, Levels, Total Stations
- Data recorders, Laptops  
[sssi.org.au](http://sssi.org.au)



## ‘Our Office’

Bob’s garage (North West Christchurch)

Laptops / internet

Governance by  
Remote control  
wearysome

Field gear allocated to vehicles  
to limit travel ( fuel rationed)  
Permits sought to access city /  
port



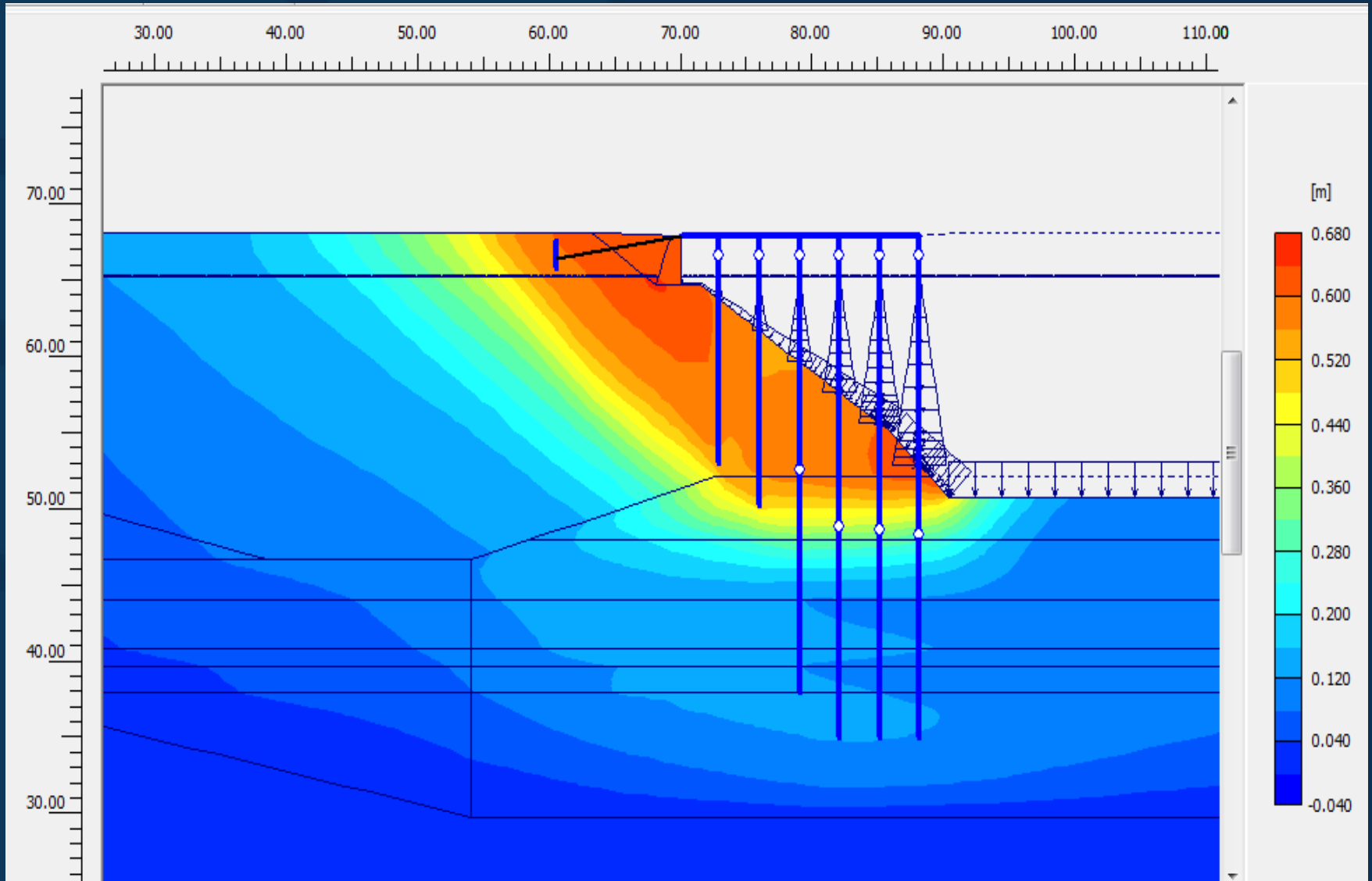
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Recovery  
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# Total Deformation Contours – 22 Feb 2011





## Coal berth reconstruction & loading ships



Bush Carpenrty  
at its Finest



# Windy Point Monitoring station - Lyttelton



# Reconstruction Monitoring Cashin Quay



- Daylight surveys
- 15 Minute Cycle
- Real-time Reporting
- Crucial during Construction
- Remote & stable Reference Marks
- Hierarchy of Offset lines

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No. 7 Wharf- Seismic Isolation Joint  
Provided RORO functionality

# Sewage treatment Plant

- Liquifaction (shallowing)
- Raw Sewage into Ponds (Loss of Volume)
- Clarifiers suffered mechanical failure and uplift
- Profiles & contours showed differences



# Other Tasks

## Golf Resort



## Ocean Outfall

- Inspections
- Side Scan
- Mapping - 3D

# Redcliffs Seawall collapse



500 KHz E/S Bow mounted

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Recovery  
from disaster

# Acknowledgements

## Fellow staff at Eliot Sinclair

**Sam Cech - Surveyor & IT (Tatras Consulting Ltd)**

**Warren Haynes - Senior Surveyor**

**John Aramowicz – Geotech Engineer**

## Others

**Neil Mclennan – Lyttelton Port of Christchurch**

**Local Internet sites reporting earthquake events**

**EQC, EQR, GNS,LINZ,T&T**

# Conclusion

**Preparedness is the Key**

**But Nothing can Prepare you !**

**Share the resources and knowledge !**

**Use Imagination and be Brave !**

## Infrastructure Dies

- **Telephone-internet- communications**
- **Power Reticulation**
- **Water supply**
- **Sewage**
- **Stormwater drainage (flooding)**
- **Traffic Management (traffic Lights)**
- **Roading Network – essential services**
- **Bureaucracy goes crazy !! Permits !!!**



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Recovery  
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# FIG Working Week 2016

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Dangerous goods route to port  
blocked for foreseeable future



Masonry cladding, Tile roof, unsupported  
ground slopes



Rescuers really did risk their lives  
with ongoing shocks at PGG



Pick up sticks !  
Will it fall down?







Walking home thru the rubble !



# CDB Destroyed !





## Suburban perils



**Dust & liquifaction**

**Buildings & facards collapsed**





Transport routes  
severely affected



Eastern suburbs are flooded after Christchurch, New Zealand, was hit by a 6.3 magnitude earthquake.

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Eliot Sinclair and Partners Ltd – Christchurch NZ

**Eliot Sinclair**  
surveyors | engineers | planners