A New Zealand Perspective on Mitigating Surface Fault Displacement Hazard & Integrating Displacement Hazard Information in Community Planning

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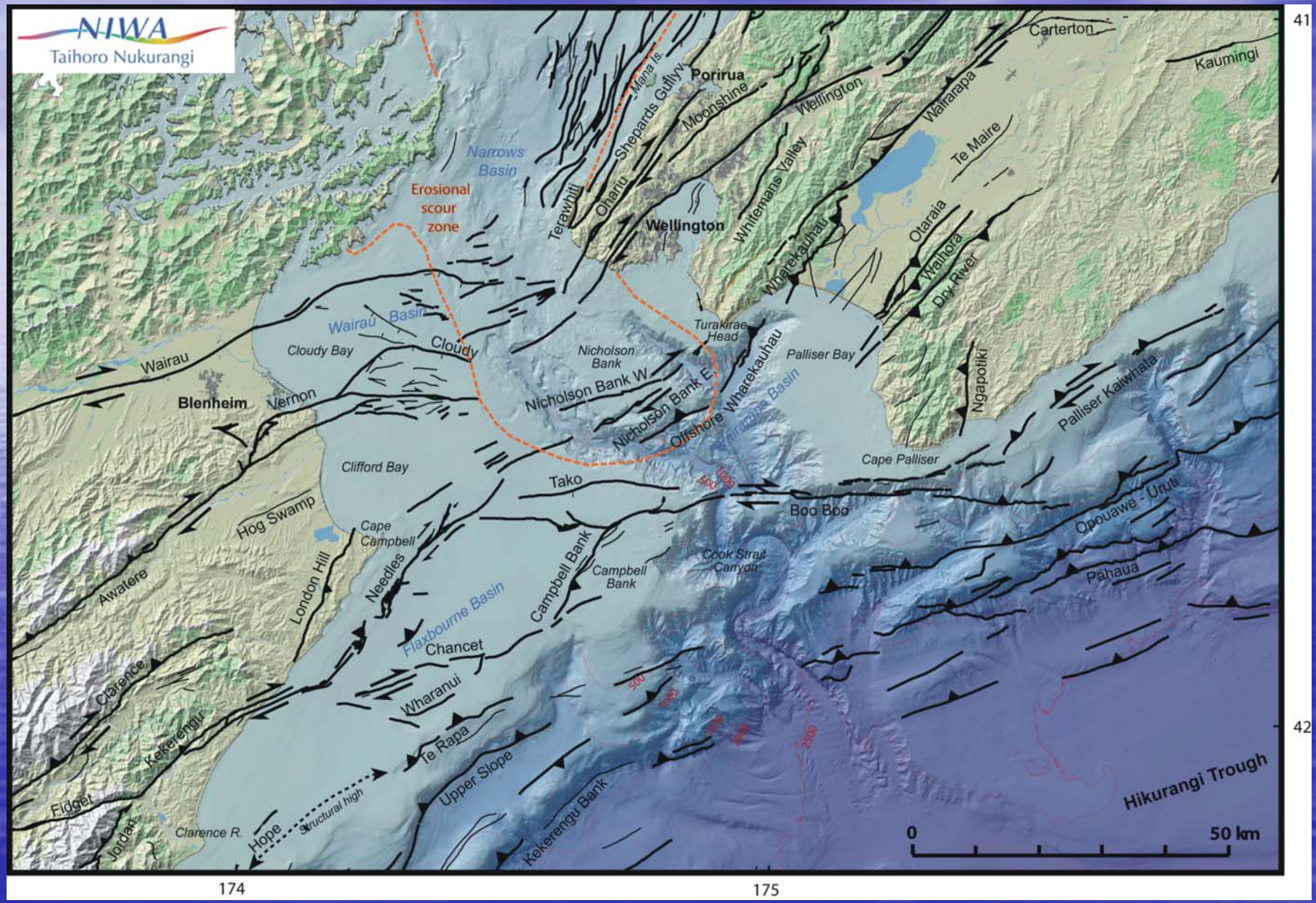
PEER workshop, Berkeley 2009

New Zealand's Active faults

Closer look near Wellington, NZ's capital, including offshore active faults



Some historic and pre-historic NZ ruptures
Hope Fault 1888

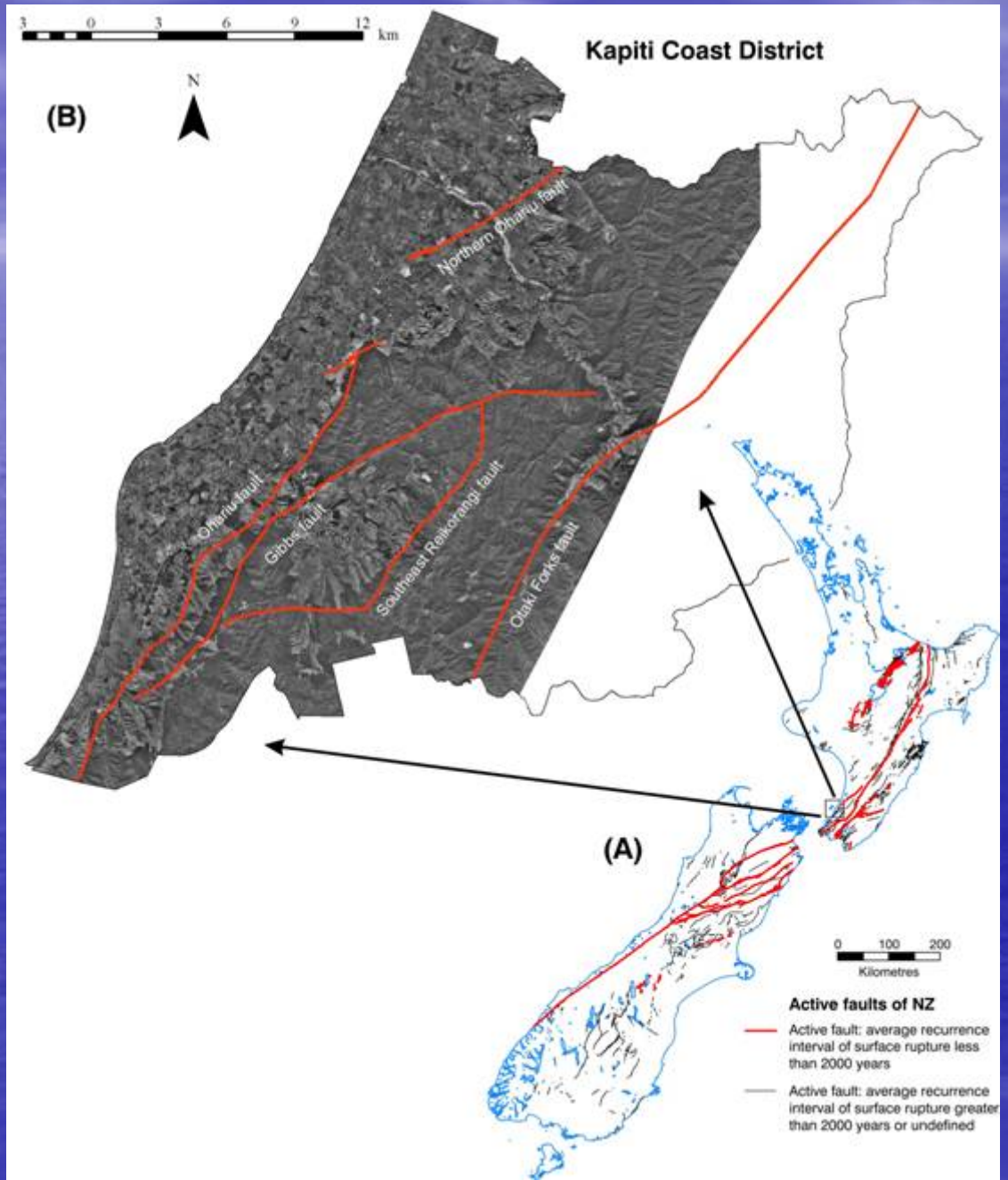
Murchison 1929

Despite examples of historic surface rupture and lots of well-defined fault traces, surface fault displacement hazard in New Zealand is:

- Neither specifically addressed in the Building Code
- Nor specifically addressed in any other legislation (e.g. no Alquist-Priolo in NZ)
- Only covered in non-binding guidelines commissioned by Ministry for the Environment and issued in 2004

Remainder talk presents a case-study example that illustrates key aspects of the MfE Active Fault Guidelines

Kapiti Coast Case Study



Kapiti Coast District

population ~50,000

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Kapiti Coast District

Scope of Study

- Identify all known active fault traces
- Accurately map as many fault traces as possible
- Provide fault data on
  - location certainty
  - activity (recurrence interval of surface rupture)
  - single-event displacement size
- Classify faults in terms of MfE Guidelines
  - Recurrence Interval Class
  - Fault Complexity
  - Fault Avoidance Zones

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Ministry for the Environment Guidelines

- MfE Guidelines formulated by joint study group of
  - Geological Society of New Zealand
  - New Zealand Society for Earthquake Engineering
- Aim to assist planners with development near active faults
- Life-safety is the key driver
- Promote a risk-based approach
  - Type of proposed development (Building Importance Category)
  - Existing site usage (Greenfield vs. Developed site)
  - Fault activity (Recurrence Interval Class)
  - Location & complexity of fault rupture (Fault Avoidance Zones)

MfE Guidelines: Building Importance Categories

Building Importance Category	Description	Examples
1	**Temporary structures** with low hazard to life and other property	• Structures with a floor area of <30 m^2 • Farm buildings, fences • Towers in rural situations
2a	**Timber-framed** residential construction	• Timber framed single-story dwellings
2b	**Normal structures** and structures not in other categories	• Timber framed houses with area >300 m^2 • Multi-occupancy buildings accommodating <5000 people and <10,000 m^2 • Public assembly buildings, theatres and cinemas <1000 m^2
3	**Important structures** that may contain people in crowds or contents of high value to the community or pose risks to people in crowds	• Emergency medical and other emergency facilities not designated as critical post disaster facilities • Airport terminals, principal railway stations, schools • Structures accommodating >5000 people • Public assembly buildings >1000 m^2
4	**Critical structures** with special post disaster functions	• Major infrastructure facilities • Air traffic control installations • Designated civilian emergency centres, medical emergency facilities, emergency vehicle garages, fire and police stations

MfE Guidelines: a risk-based approach

Recurrence Interval Class & Building Importance Categories

Recurrence Interval Class	Average Recurrence Interval of Surface Rupture	Building Importance (BI) Category Limitations (allowable buildings)	
		Previously subdivided or developed sites	**Greenfield sites**
I	≤2000 years	**BI Category 1** Temporary structures only	**BI Category 1** Temporary structures only
II	>2000 years to ≤3500 years	**BI Category 1& 2a** Temporary & Timber-framed residential structures only	
III	>3500 years to ≤5000 years	**BI Category 1, 2a, & 2b** Temporary & Normal structures only	**BI Category 1& 2a** Temporary & Timber-framed residential structures only
IV	>5000 years to ≤10,000 years	**BI Category 1, 2a, 2b & 3** Temporary, Normal & Important structures only	**BI Category 1, 2a, & 2b** Temporary & Normal structures only
V	>10,000 years to ≤20,000 years		**BI Category 1, 2a, 2b & 3** Temporary, Normal & Important structures only
VI	>20,000 years to ≤125,000 years	**BI Category 1, 2a, 2b, 3 & 4** Critical structures with post-disaster requirements cannot be built across an active fault with a recurrence interval ≤20,000 years	
Note: Faults with average recurrence intervals >125,000 years are not considered active			

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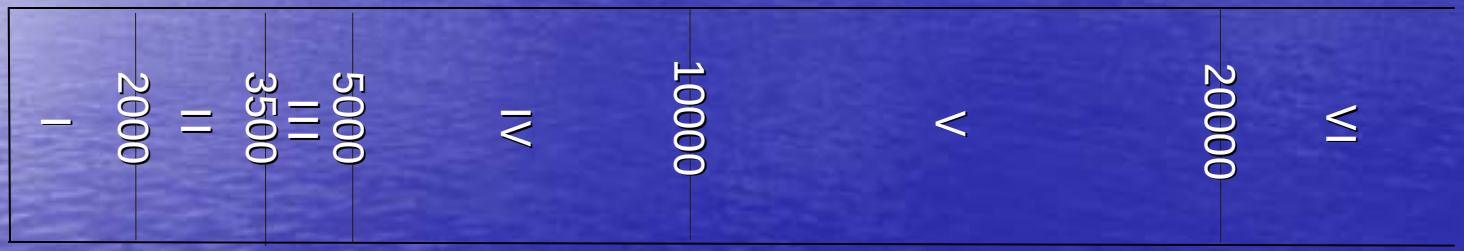
MfE Guidelines

Recurrence Interval Class and Building Importance Categories

Previously developed sites



Greenfield sites

BIC 1 temporary

BIC 2 LTF houses

BIC 2b normal

BIC 3 important

BIC 4 critical

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MfE Guidelines

Recurrence Interval Class and Building Importance Categories

BIC 1 temporary

BIC 2 LTF houses

BIC 2b normal

BIC 3 important

BIC 4 critical

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MfE Guidelines

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MfE Guidelines

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Active Faults & Surface Rupture Hazard Kapiti Coast District

Methodology

- Identify all know active fault traces
  - authors' first-hand knowledge of geology and faults
  - GNS & KCDC airphoto collection
  - published papers
  - unpublished GNS Science and Client reports
  - survey data from GNS clients (developers)
  - drillhole data
  - KCDC District Plan

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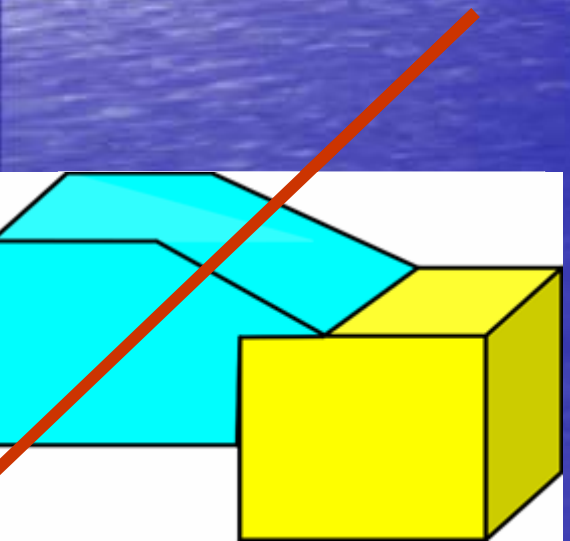
Methodology

- Accurately map fault traces and related structures
  - two sources of error
    - location on ground (age and site)
    - capture error (airphoto, orthophoto, RTK GPS)



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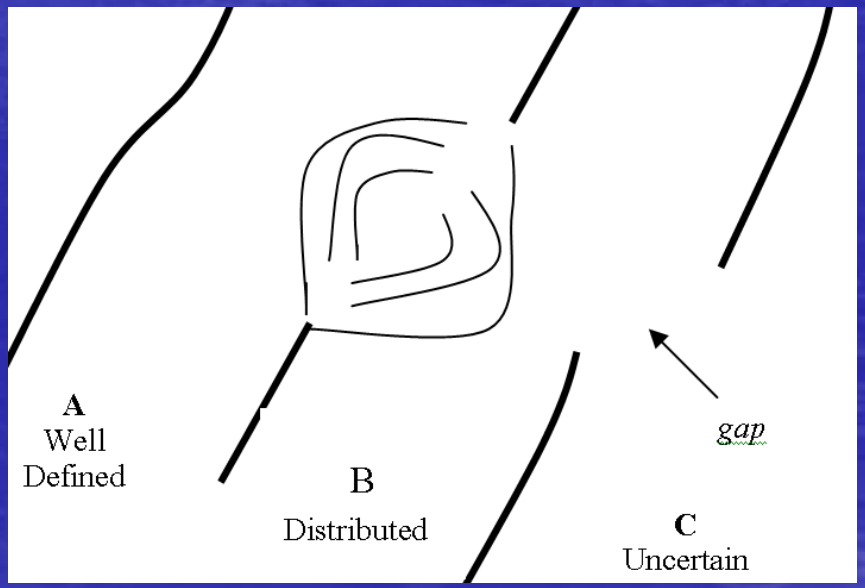
Methodology

- Classifying Fault Complexity (a function of hazard & risk)
  - Well defined
  - Distributed
  - Uncertain
    - Constrained
    - Poorly constrained



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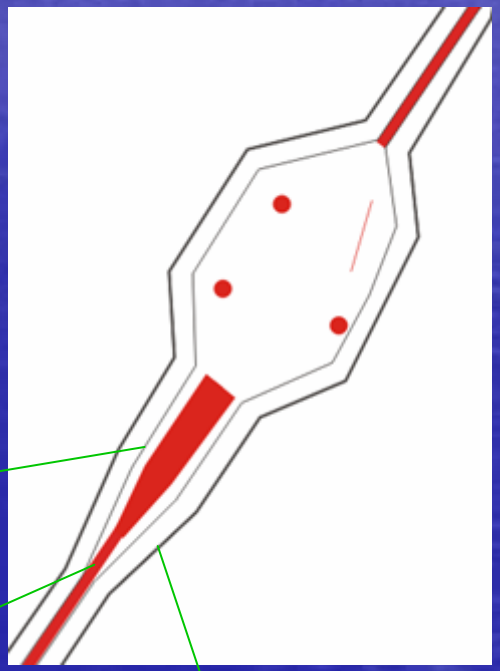
Methodology

- Defining Fault Avoidance Zones
  - faults are often a zone of deformation
  - uncertainty of location included
  - buffered 20 m as suggested in MfE guidelines



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Methodology

- Defining fault activity, and assigning Recurrence Interval Class
  - based on existing data only

Fault Name	Recurrence Interval Class	Recurrence Interval Range of Recurrence Interval Class
Ohariu fault	RI Class II	>2000 years to ≤3500 years
Northern Ohariu fault	RI Class II	>2000 years to ≤3500 years
Otaki Forks fault	RI Class III	>3500 years to ≤5000 years
Gibbs fault	RI Class III	>3500 years to ≤5000 years
SE Reikorangi fault	RI Class IV	>5000 years to ≤10,000 years

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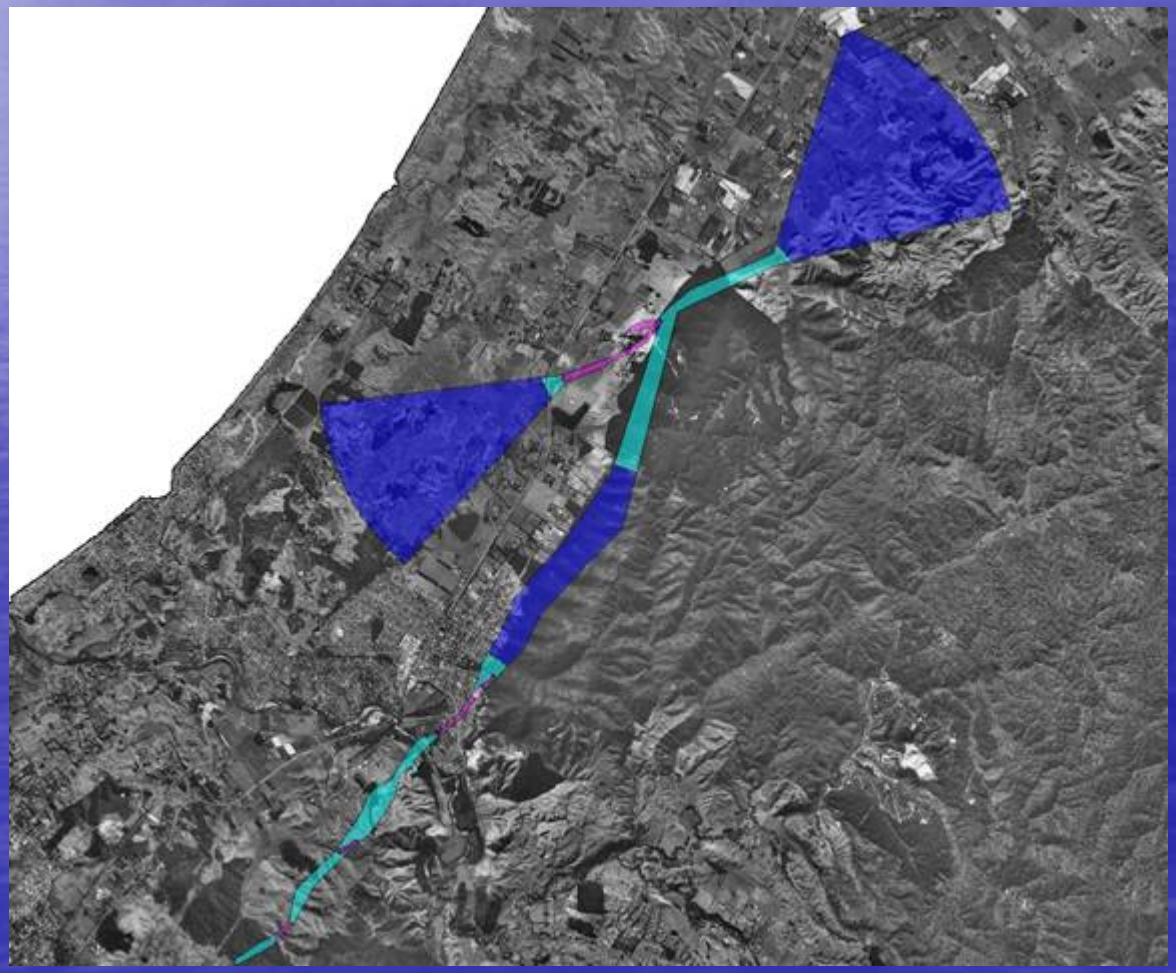
Ohariu fault



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OHARIU FAULT (RIC II: 2000 - 3500 years)					
Developed and/or Already Subdivided Sites					
Building Importance Category	**1**	**2a**	**2b**	**3**	**4**
Fault Complexity	**Resource Consent Category**				
Well Defined	Permitted	Permitted	Non-Complying	Non-Complying	Prohibited
Distributed, & Uncertain - constrained	Permitted	Permitted	Discretionary	Non-Complying	Non-Complying
Uncertain - poorly constrained	Permitted	Permitted	Discretionary	Non-Complying	Non-Complying
Greenfield Sites					
Building Importance Category	**1**	**2a**	**2b**	**3**	**4**
Fault Complexity	**Resource Consent Category**				
Well Defined	Permitted	Non-Complying	Non-Complying	Non-Complying	Prohibited
Distributed, & Uncertain - constrained	Permitted	Discretionary	Non-Complying	Non-Complying	Non-Complying
Uncertain - poorly constrained	Permitted	Discretionary	Non-Complying	Non-Complying	Non-Complying

Mitigation of Surface Rupture Hazard in New Zealand

Conclusions

- Classify active faults in terms of MfE Guidelines
  - Recurrence Interval Class
  - Fault Complexity
  - Fault Avoidance Zones
- Define Resource Consent Categories for Fault Avoidance Zones
  - Type of proposed development (Building Importance Category)
  - Existing site usage (Greenfield vs. Developed site)
  - Fault activity (Recurrence Interval Class)
  - Location and complexity of fault rupture (Fault Avoidance Zones)

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Conclusions