Health consequences of an Auckland eruption

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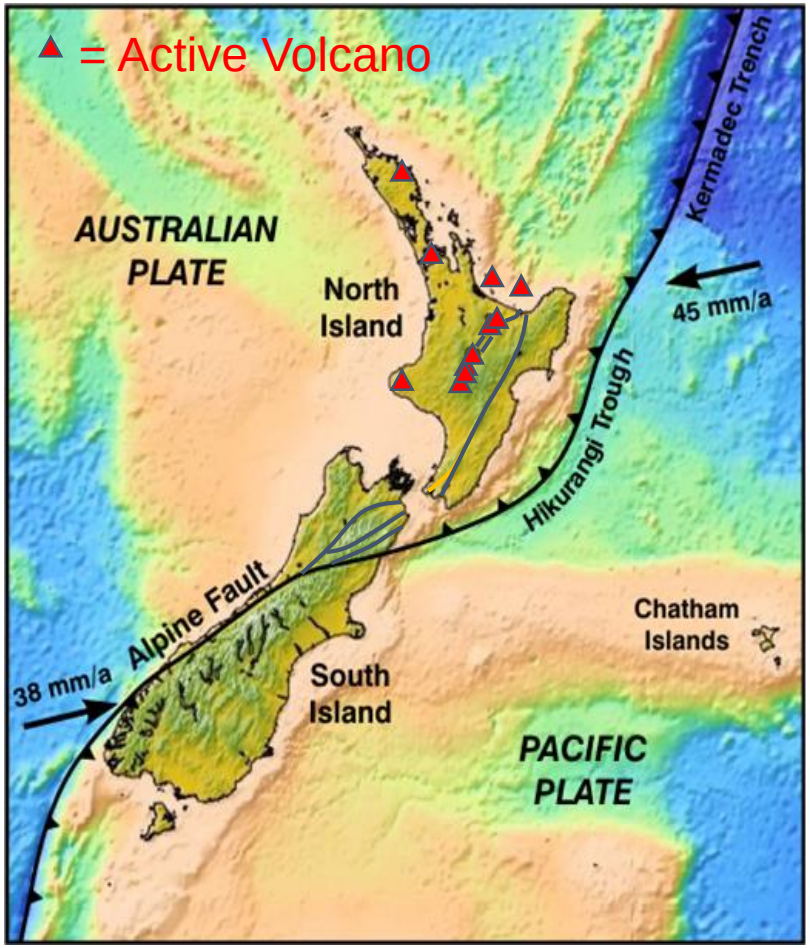
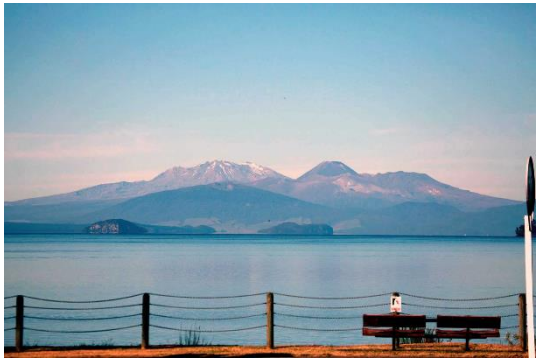
GNS SCIENCE TE PŪ AO

NZ's active volcanoes



Volcanic fields

Calderas

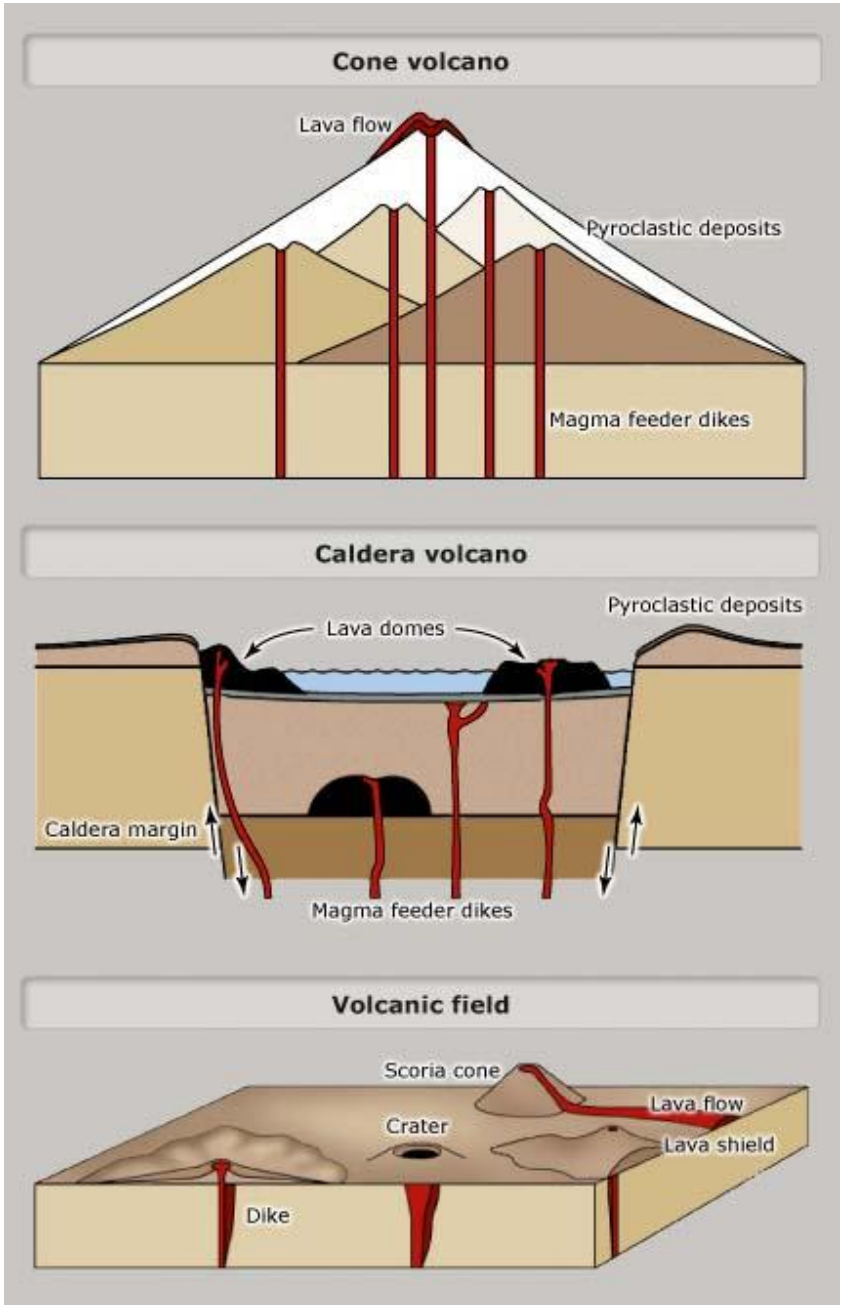


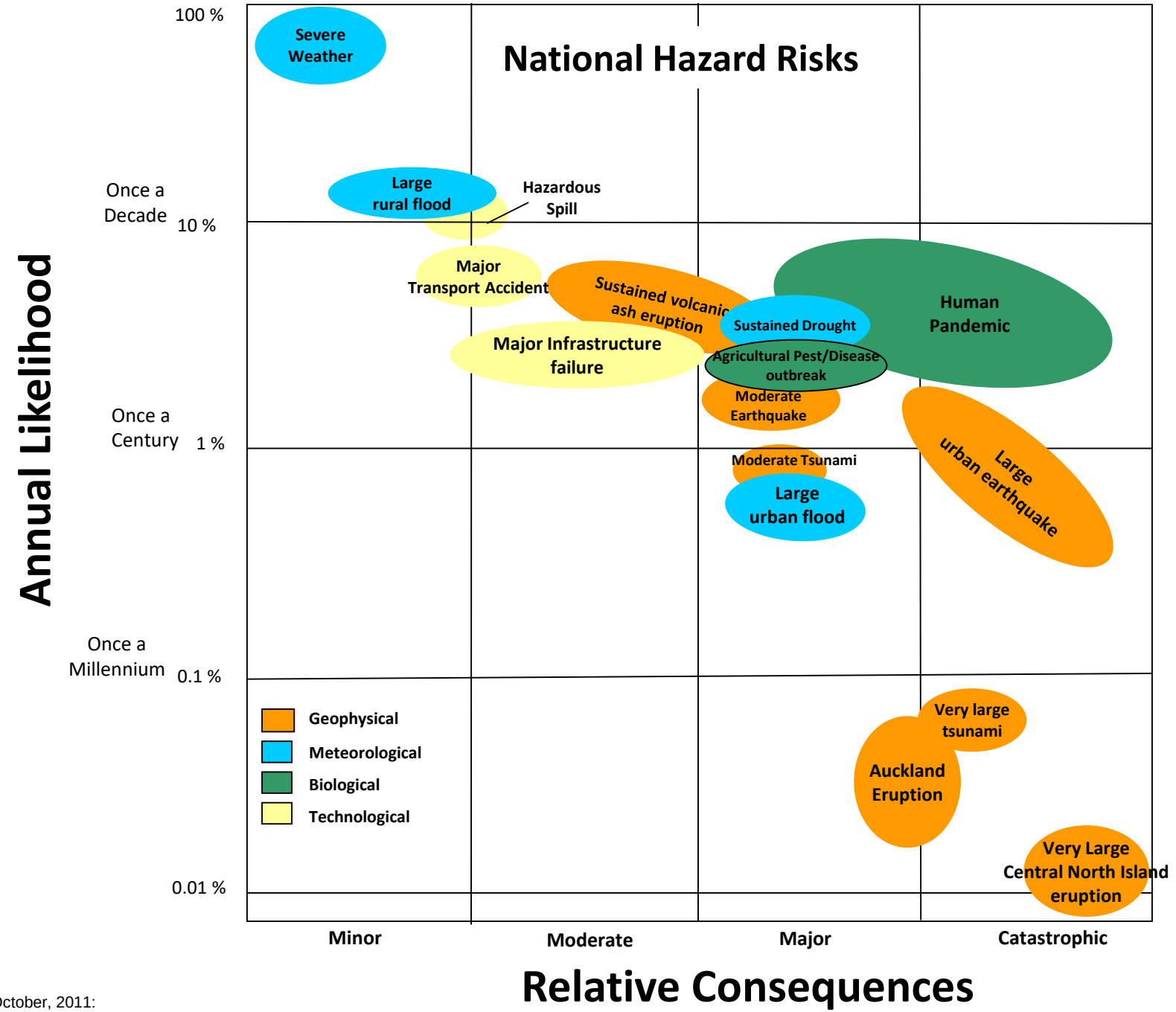
Cones

Andesite cones:
Taranaki, Ruapehu, Tongariro

Rhyolite calderas and domes: Taupo, Okataina, Mayor Island

Basalt fields:
Auckland Volcanic Field (AVF)
Bay of Islands

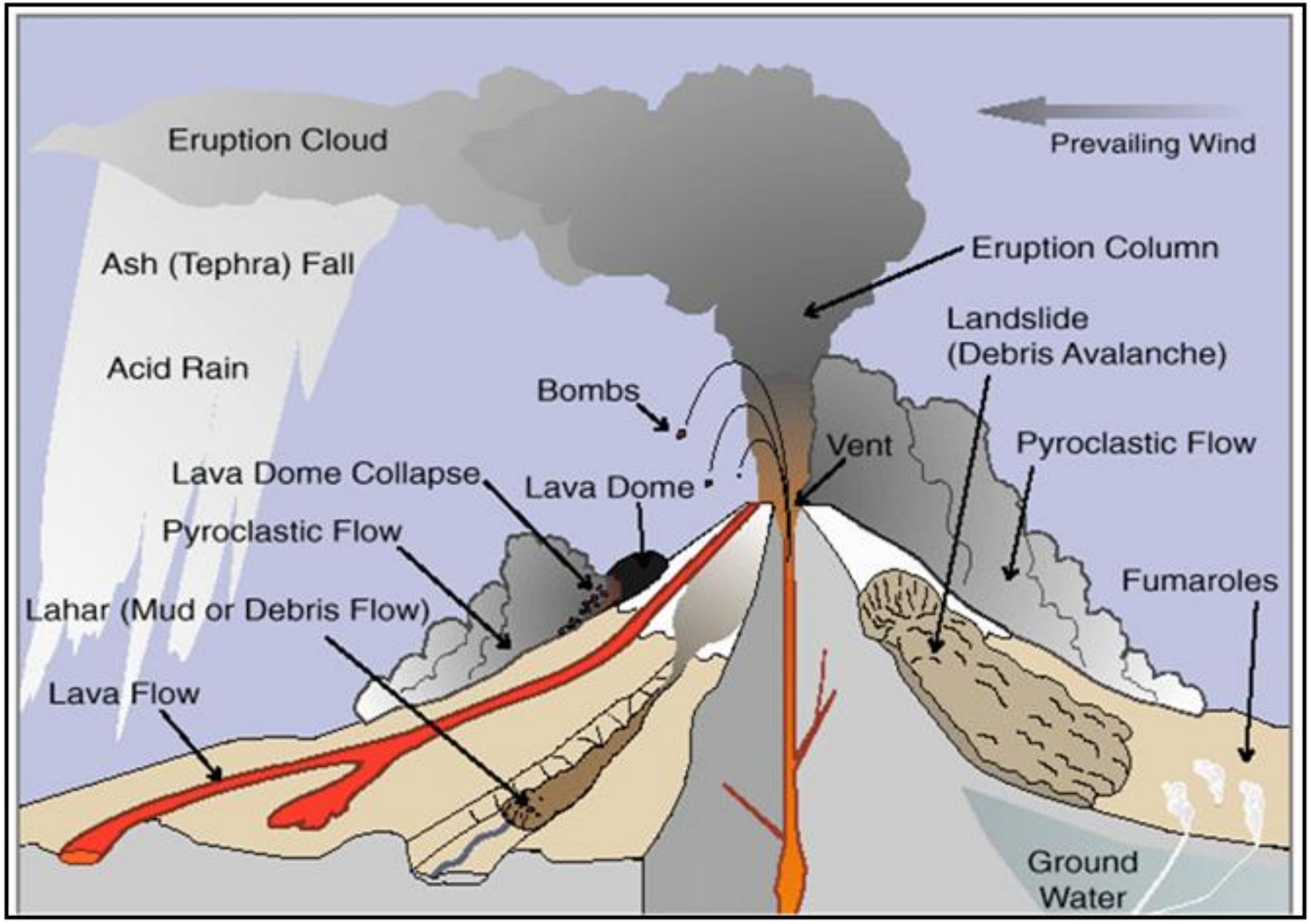



National Hazard Risks
Annual Likelihood
100 %
Once a Decade
10 %
Once a Century
1 %
Once a Millennium
0.1 %
0.01 %
Severe Weather
Large rural flood
Hazardous Spill
Major Transport Accident
Sustained volcanic ash eruption
Major Infrastructure failure
Sustained Drought
Agricultural Pest/Disease outbreak
Human Pandemic
Moderate Earthquake
Moderate Tsunami
Large urban flood
Large urban earthquake
Very large tsunami
Auckland Eruption
Very Large Central North Island eruption
Geophysical
Meteorological
Biological
Technological
Minor
Moderate
Major
Catastrophic
Relative Consequences

Comparison of large hazard events

EVENT	Duration (max)	Extent (max)	Hazards	Warning
Volcanic eruption	Decades	International	Multiple	Days to months
Earthquake	Minutes	Regional	Single	None
Flood	Hours to days	Regional	Single	Days
Tsunami	Hours	International	Single	Hours

Volcanic activity can produce multiple hazards



Near-volcano hazards

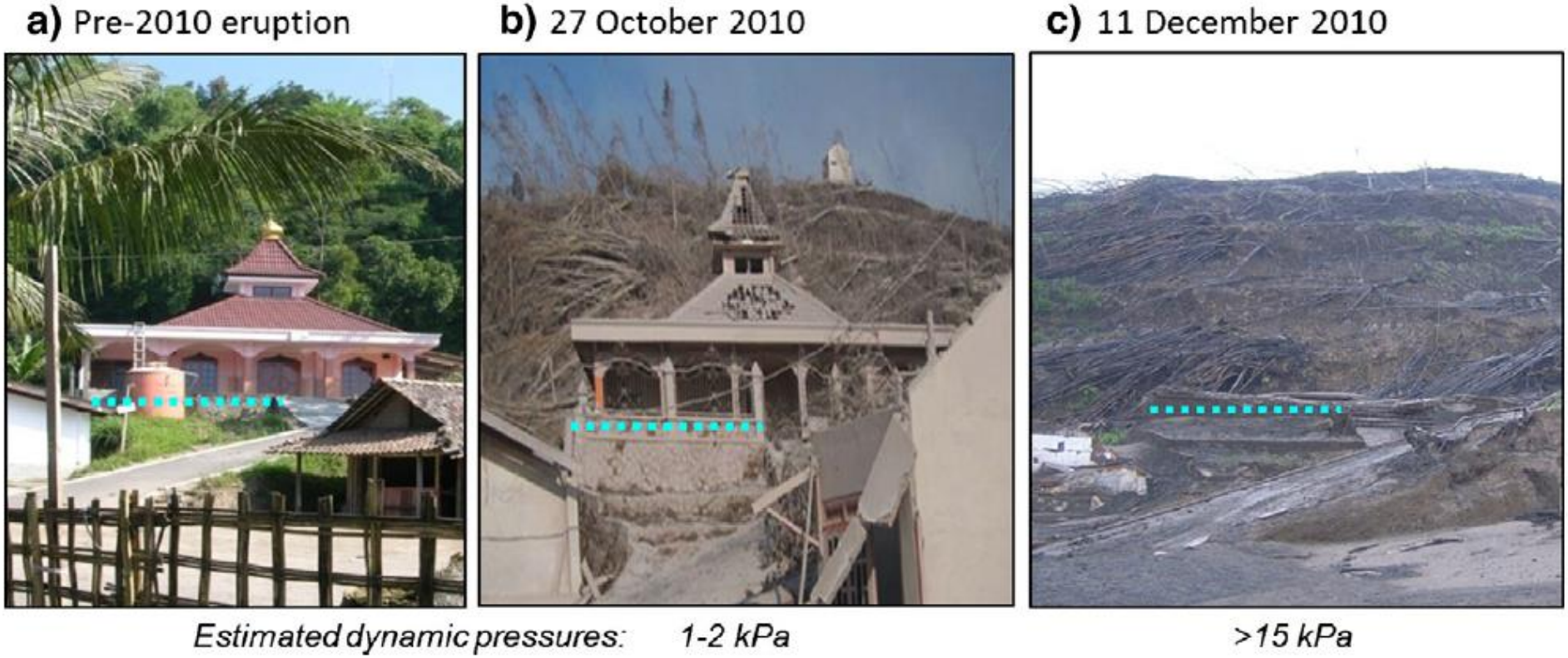
- Pyroclastic density currents (PDCs or PFs)
- Ballistics
- Lahars (can also travel far)
- Lava flows

PDCs

PDC video: 1991 Mt Unzen eruption

43 fatalities

2010 Merapi eruption



Jenkins et al (2013) Journal of Volcanology and Geothermal Research

Ngauruhoe, 1975

Lahars

Geoff Mackley

Lava flows

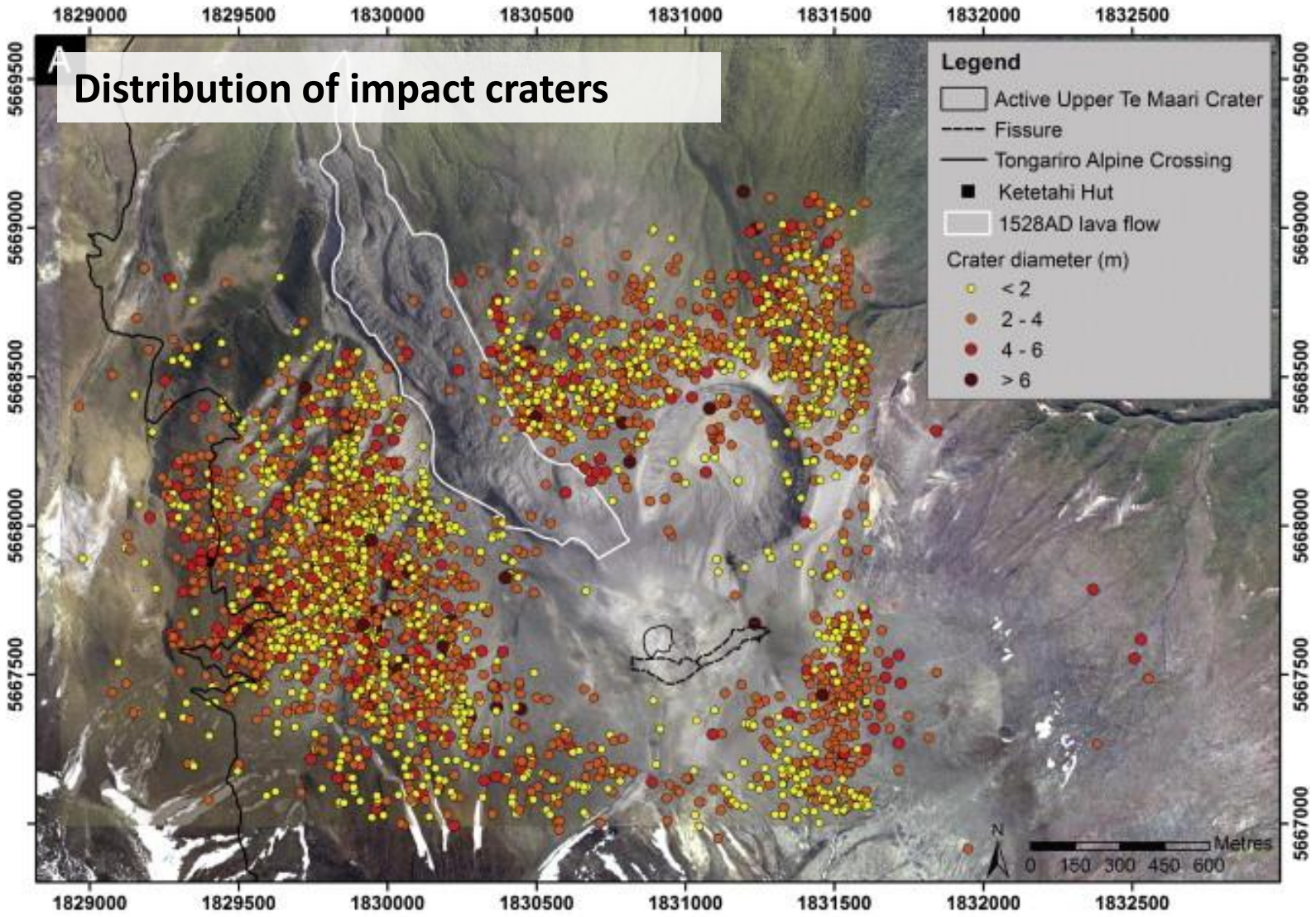
Lava (aʻā) video: Puʻu ʻŌʻō, October 2007

Lava (pāhoehoe) video: Puʻu ʻŌʻō, November 2014 (Transfer station)

Ballistics

Ballistic damage from 2012 Tongariro eruption

Ballistics craters, 2012 Tongariro eruption

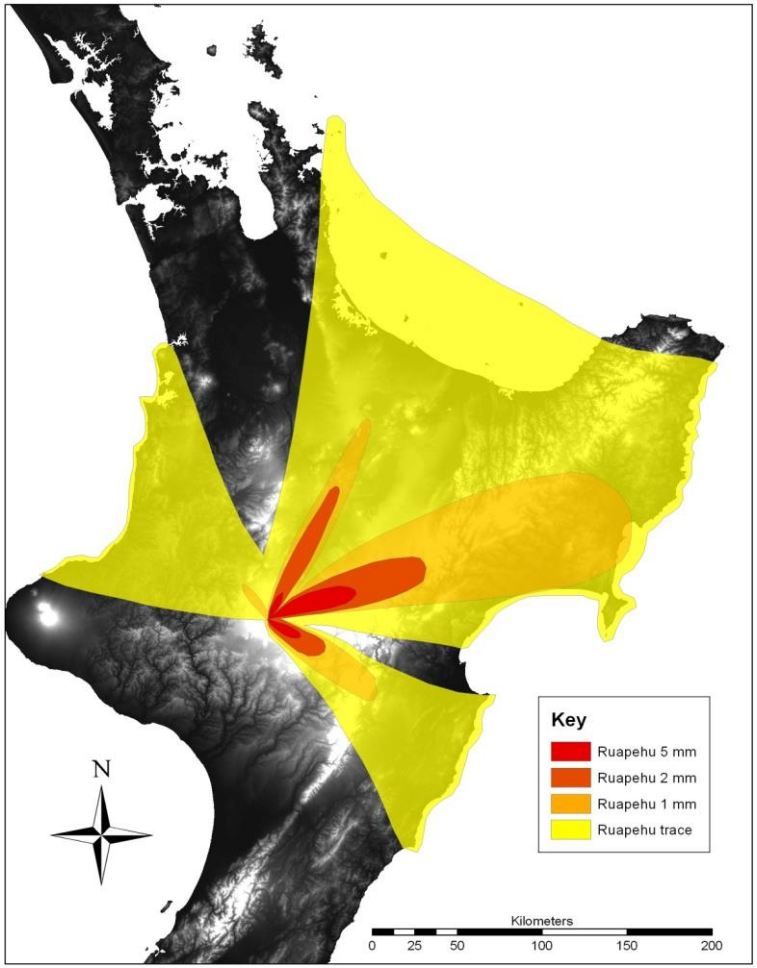


Fitzgerald et al (2014) Journal of Volcanology and Geothermal Research

Far-reaching volcanic hazards

- Volcanic ash (tephra)
- Gas and acid rain

Clearing basaltic tephra from roof, Iceland



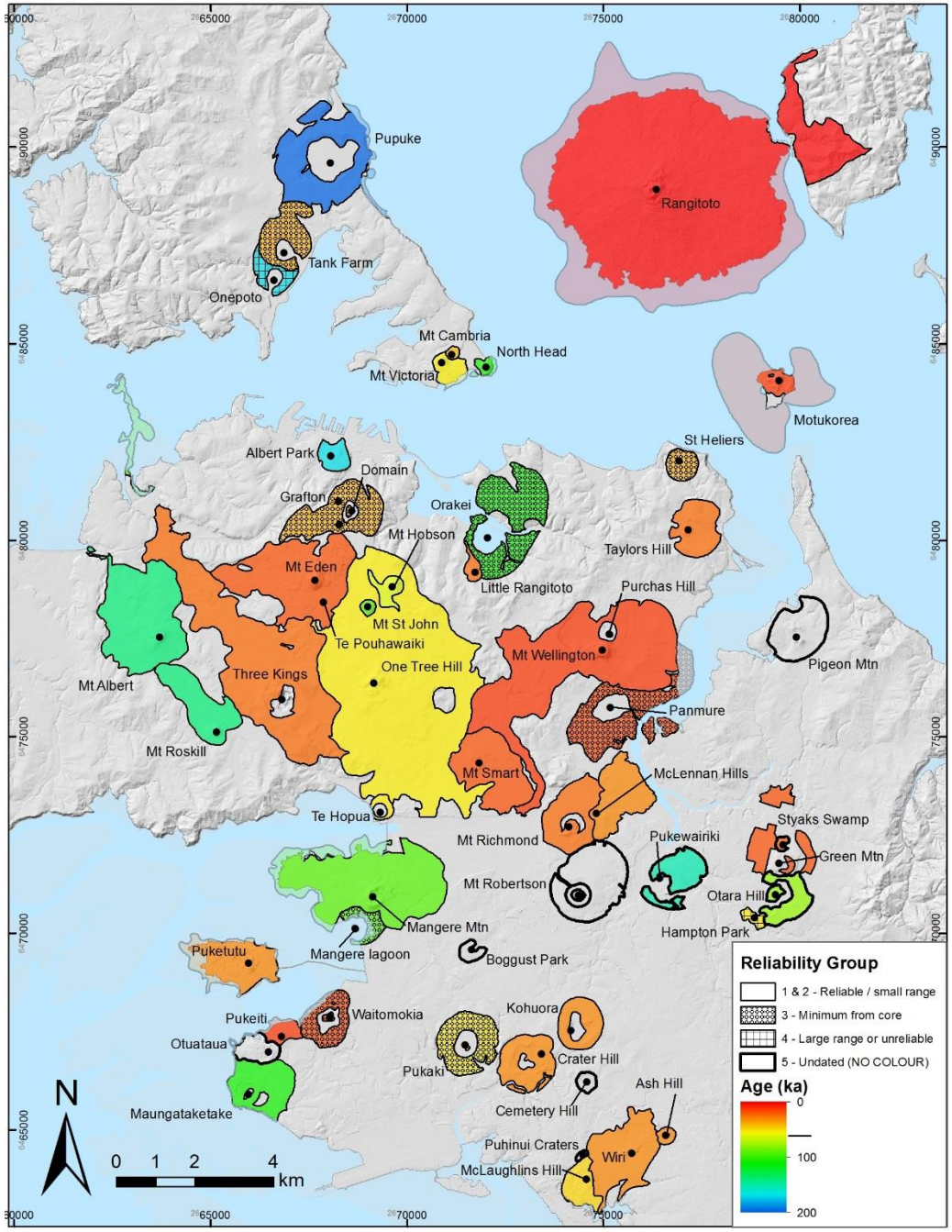
Areas that received ashfall from 1995-1996 eruptions of Ruapehu volcano

Impacts of basaltic tephra on urban area

- Probably too coarse (> 100 µm) to be a respiratory hazard
- Will enter drainage networks and be difficult to remove
- Will cause abrasion damage to machinery
- Small amounts on parks and gardens can be left in place, but paved surfaces need to be cleared and ash dump sites created

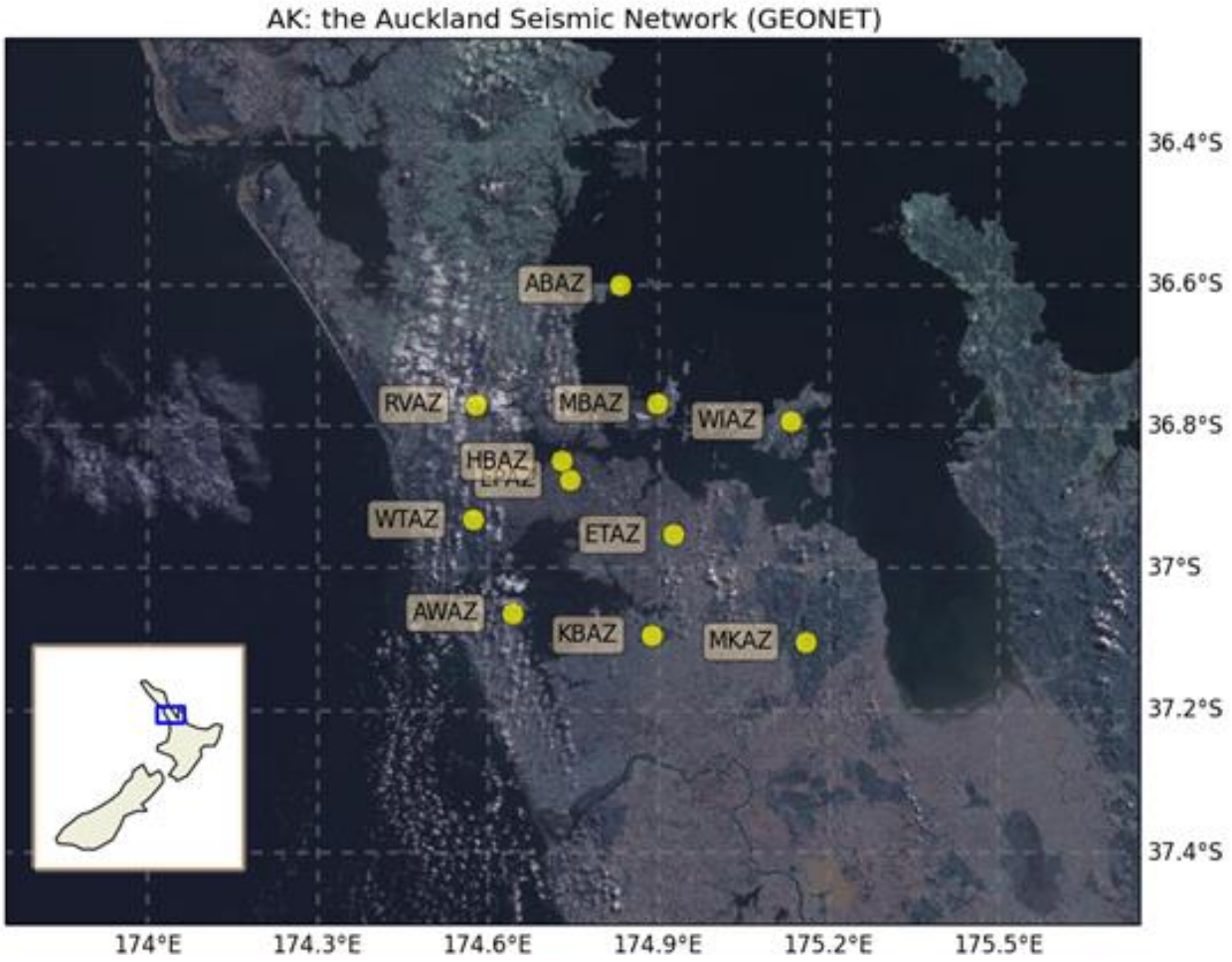
Basaltic ash advice recently developed for Ambae, Vanuatu (possibly not applicable to Auckland)

- Move livestock under kitchen roof
- Feed livestock banana stumps
- Add crushed shells or coral sand to your water supply to neutralise acid rain



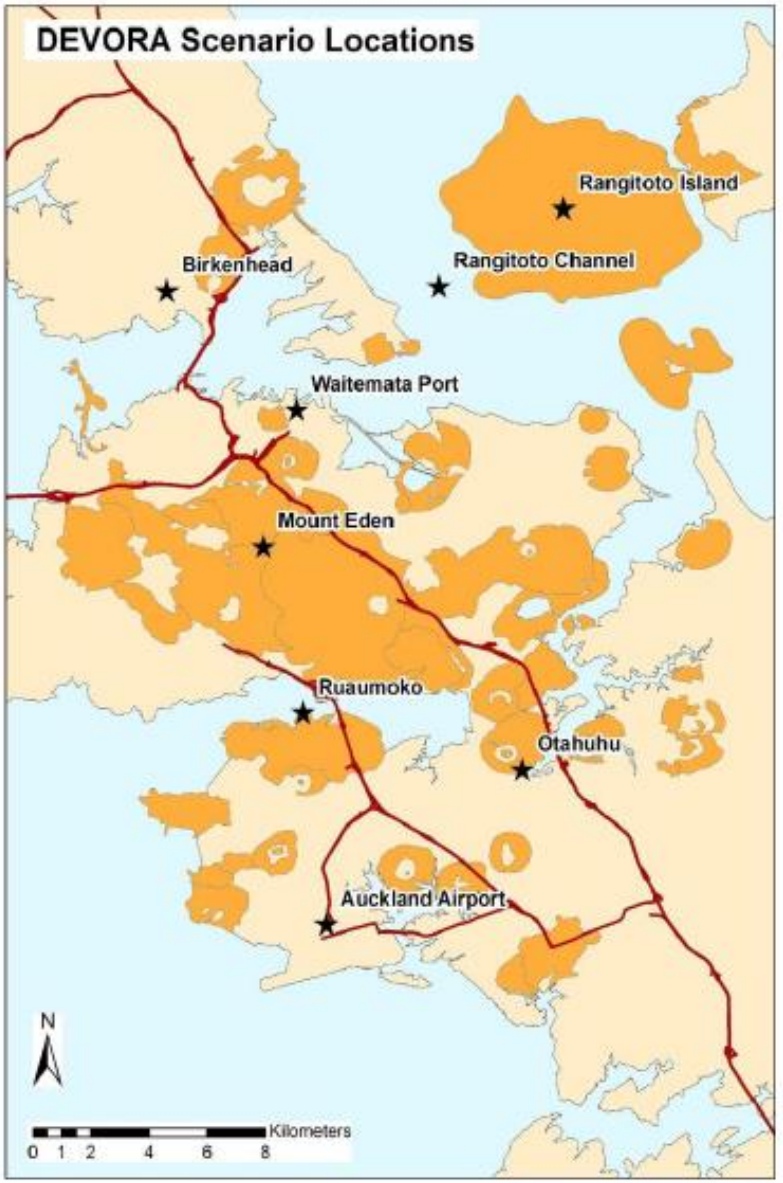
G. Leonard, GNS Science

GeoNet Auckland seismic network



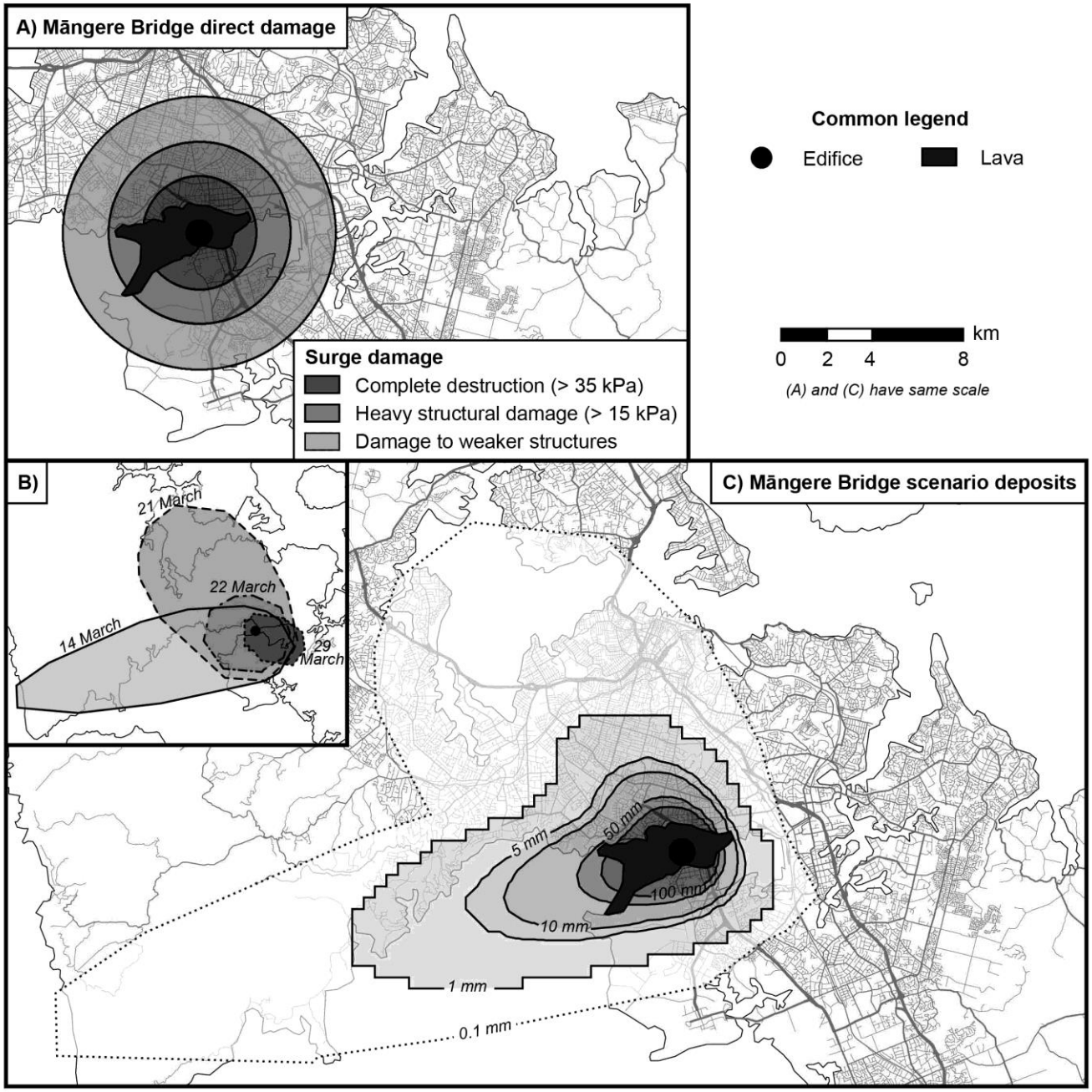
DEVORA

DEVORA scenario development



Māngere Bridge scenario

- Extended scenario based on Exercise Rūaumoko
- Key features:
  - Vent in Manukau Harbour near Māngere Bridge
  - Month-long hypothetical eruption
  - Credible detailed eruption sequence, multi-hazard
  - Evacuation maps created with Auckland Council CDEM
- Hazards: pyroclastic flow (base surge); lava; ballistics; tephra
- Studies have explored consequences for evacuation; transport networks; buildings; and water and wastewater network

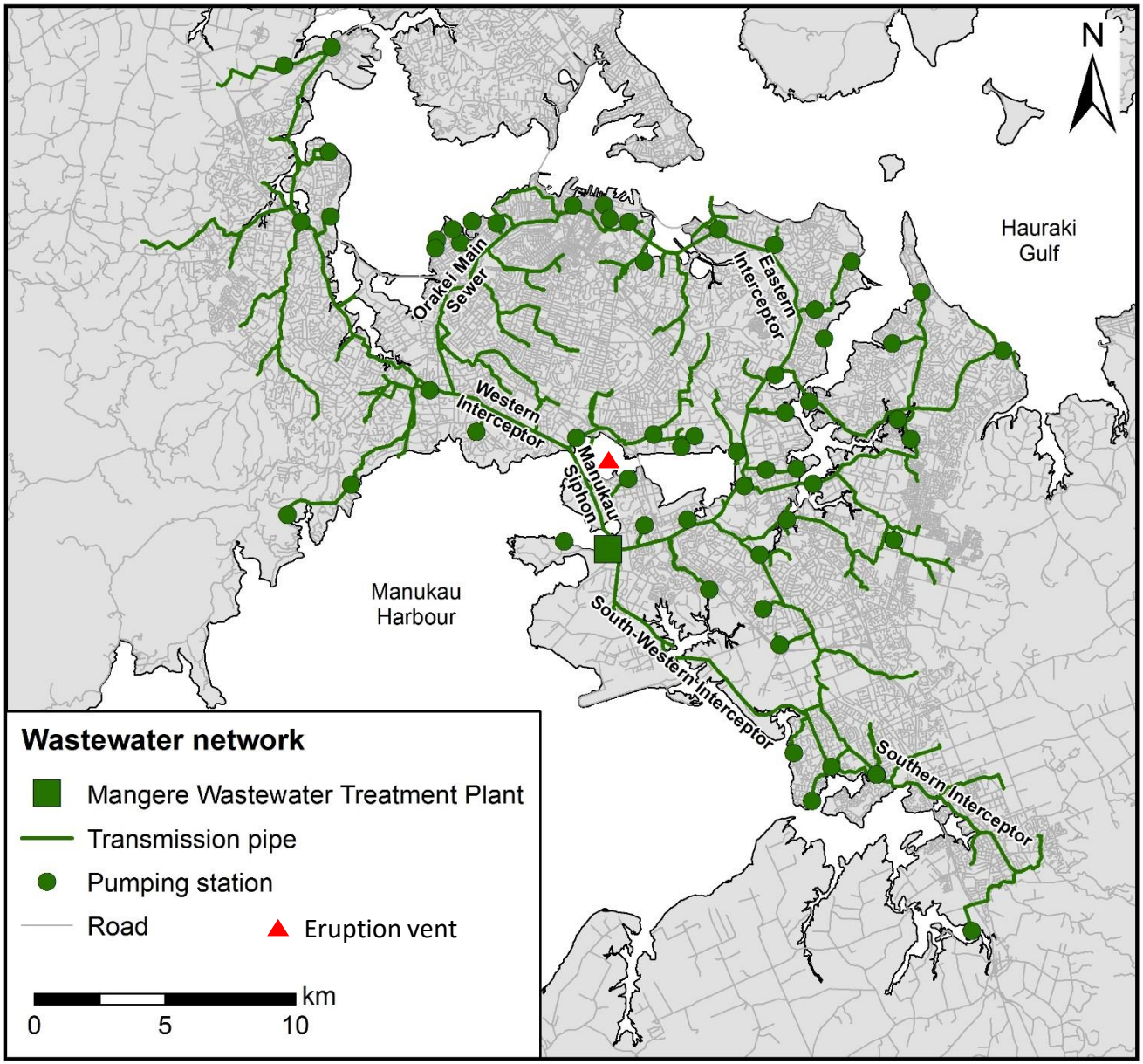


From Deligne et al. (2017)

Auckland's wastewater network

Catchment population:
1.07 million

Asset value:
Pipes 64%
Manholes 19%
Pump stations 4%
Treatment plants 13%



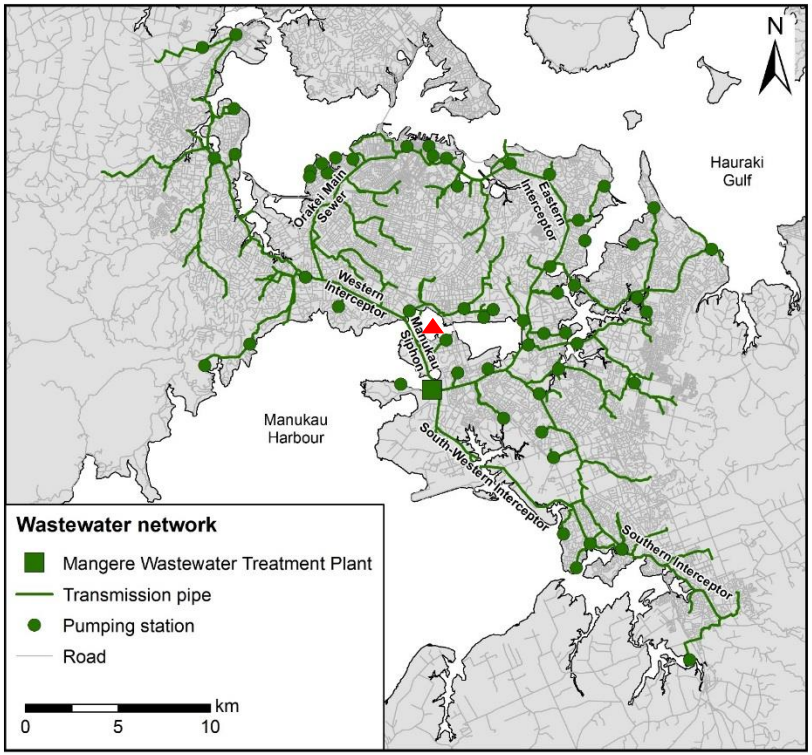
Data from Watercare Asset Management Plan 2016-2036

Eruption damage to Māngere wastewater treatment plant

- Serves 1.07 million people
- Located within zone of heavy structural damage
- >5 years to rebuild
- Partial functionality after 2 years

Eruption damage to transmission pipe network

- Largely undamaged
- Pipes 300-3100 mm diameter
- Manukau siphon
  - Strategically important
  - Old concrete pipe just under seabed
  - <1 km from edifice
  - Assume destroyed by earthquake swarms, ground deformation, overlying lava flow



Eruption damage to local pipe network

- Local pipes 150-300 mm diameter
- Vulnerable to tephra ingress and blockages
- Combined sewer areas highly vulnerable to tephra ingress
- Example: 2 mm tephra on 100 m^2 roof → 200 kg tephra could be washed into combined drain

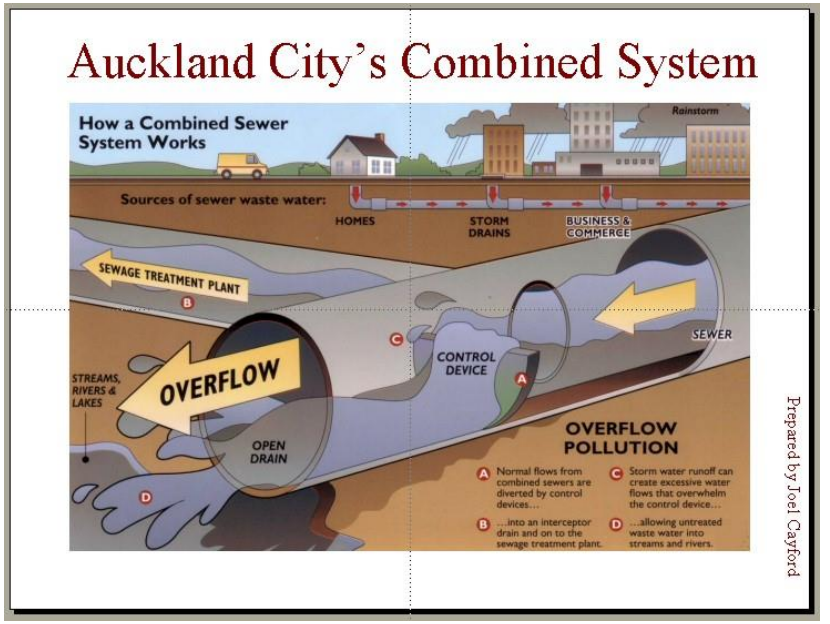
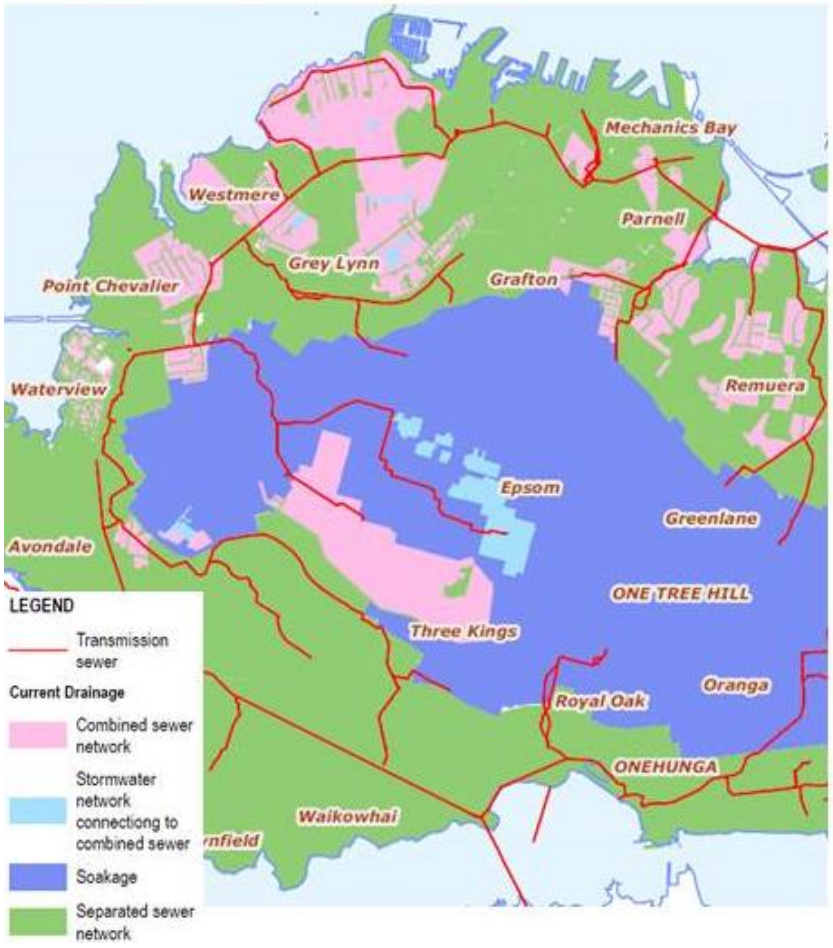


Diagram by Joel Cayford

Combined sewer areas

- Pink areas – combined sewers
- 16,000 homes in pink areas



Thanks to Jo Costello, Watercare Services

What does this mean for wastewater 'levels of service' to households?

- Wastewater 'in service' = ability to remove wastewater from households = ability to flush toilet, run showers, sinks etc
- Depends on:
  - Having water supply
  - Local and transmission pipe networks not blocked
- Doesn't depend on:
  - Mangere WWTP being in service
  - Pumping stations operating

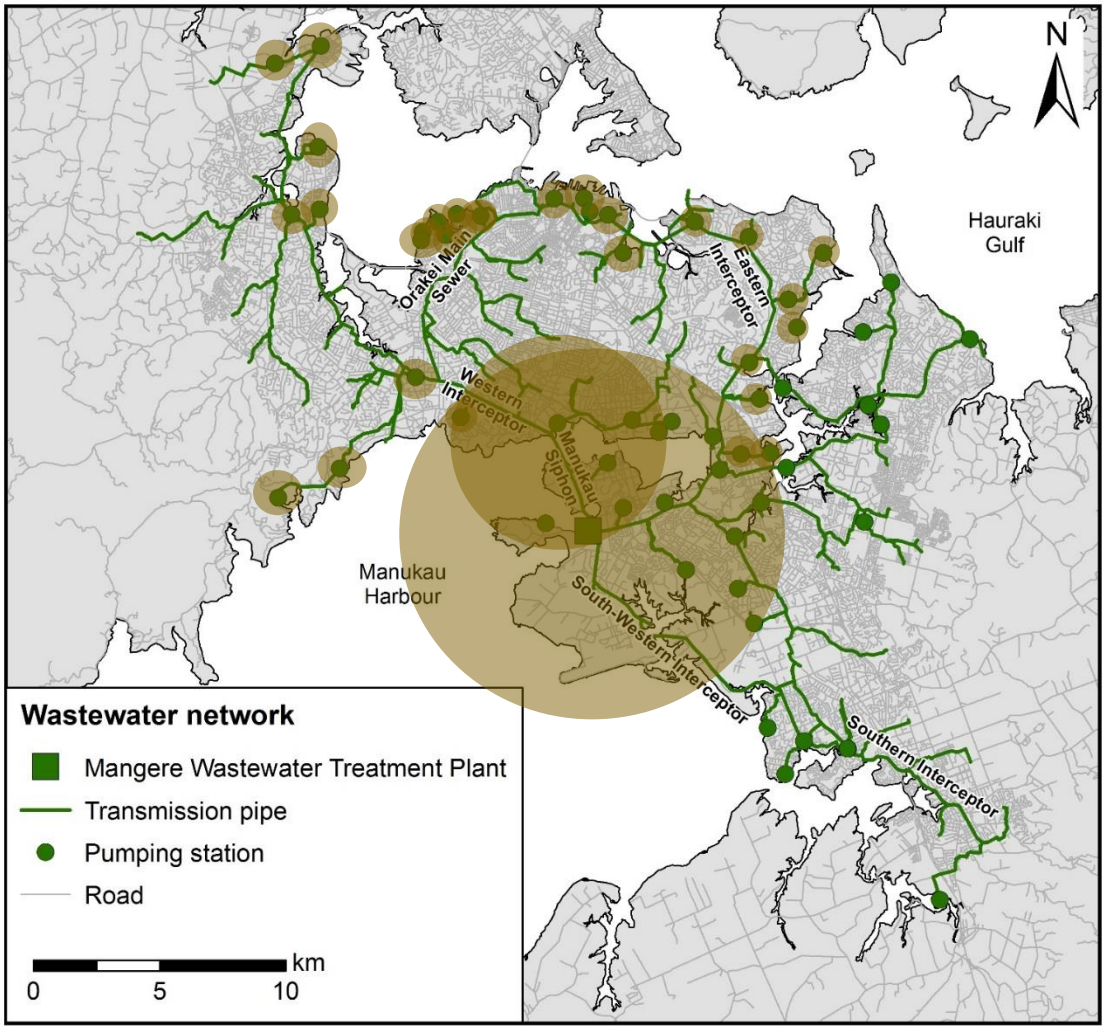
Strategy for minimising public health risks of untreated wastewaster

- *“Where practicable, keep the pipe network operational to allow wastewater to drain away from properties and to be discharged to the environment downstream, preferably at a controlled point”.*

Location of untreated wastewater overflows

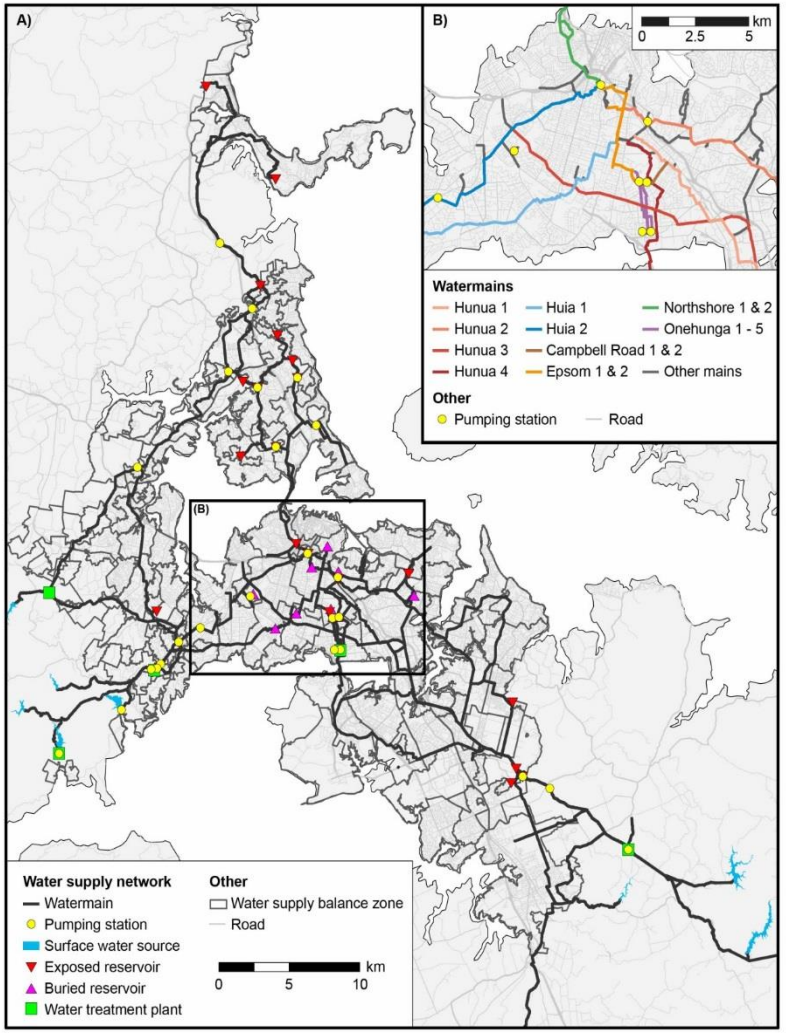
Overflow points

- Māngere WWTP bypass
- Breach in Manukau siphon
- Engineered overflow points at pump stations
- New controlled discharge points
- Combined sewer overflow points (during rainfall)
- Uncontrolled blowbacks on properties and into streets



Impacts of Māngere bridge scenario on water supply

- Very little impact on water production
- Little damage to watermains and distribution system (other than Hunua 4)
- Water restrictions over the whole city for ~8 months
- Boil water notices for some areas (due to depressurisation events)



Air quality impacts?

- Basaltic tephra probably too coarse (>100 µm) to be inhalable
- Gases – SO_2, CO_2, H_2S
- Combustion products from lava

Summary: probable main health consequences of AVF eruption

- Life safety risks should be managed by evacuation zones
- Raw wastewater overflows likely to be extensive and prolonged (years)
- Water restrictions very likely
- Air quality impacts very likely, will need strategy for at-risk groups
- Food safety unlikely to be affected

Questions?

For further information, see:

Annual GNS Volcano Short Course

www.ivhhn.org

https://volcanoes.usgs.gov/volcanic_ash/

https://www.gns.cri.nz/Home/Learning/Science-Topics/Volcanoes/Eruption-What-to-do/Ash-Impact-Posters