FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016

Recovery
from disaster

Organised by FIG NZIS

Platinum Partners Trimble. esri

Diamond Partner Land Information New Zealand Toitū te whenua

EQ Response

- Mark Christison
- David Heiler
- Amber Murphy
- Greg Offer

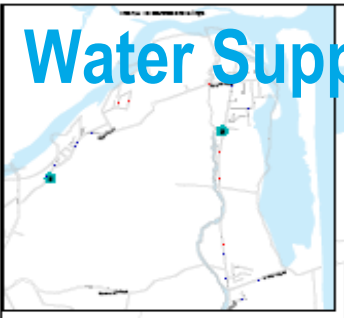
Brutality of 22-2-2012 Earthquake

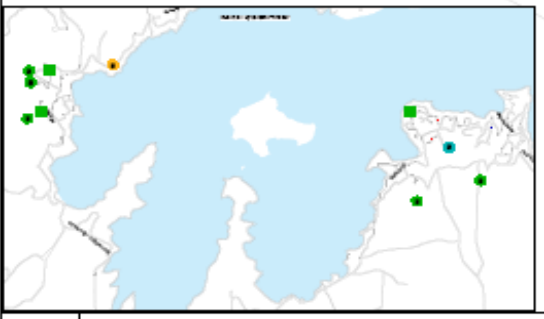
From this

45 seconds later

To this

Water Supply Pipes – recorded breaks

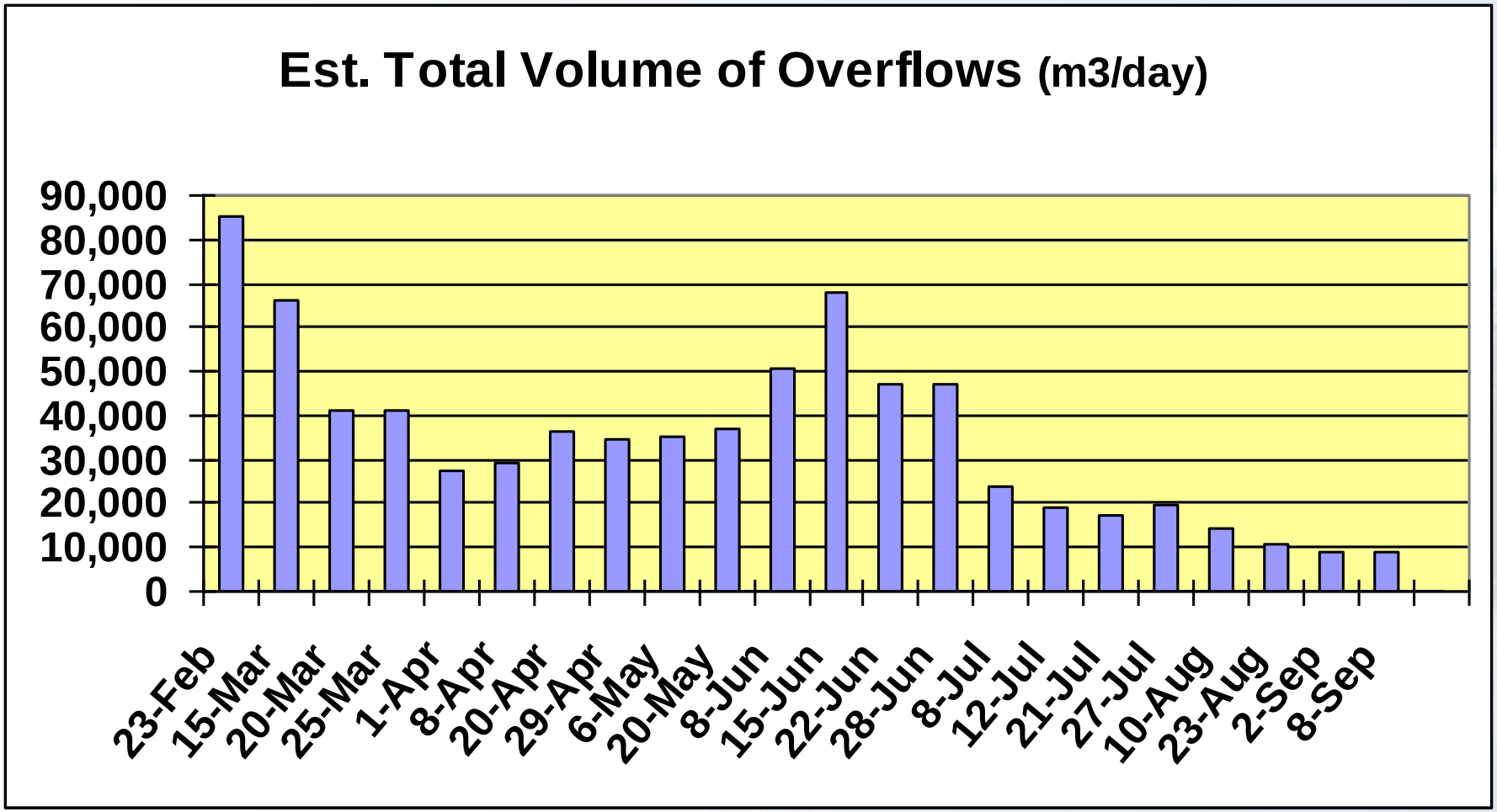




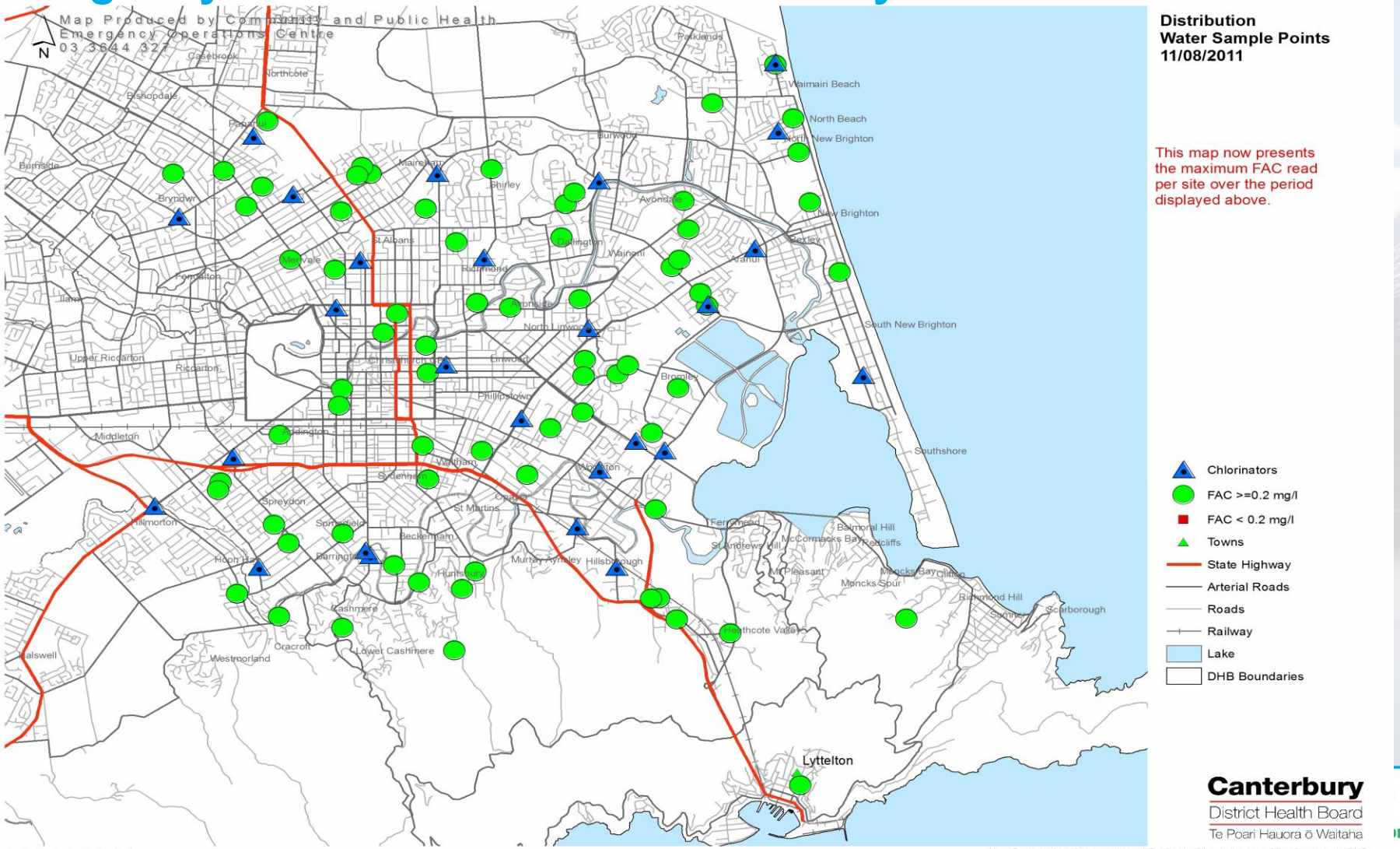
WATER SUPPLY - MAINS BREAKS

Loss of Service - Wastewater Network

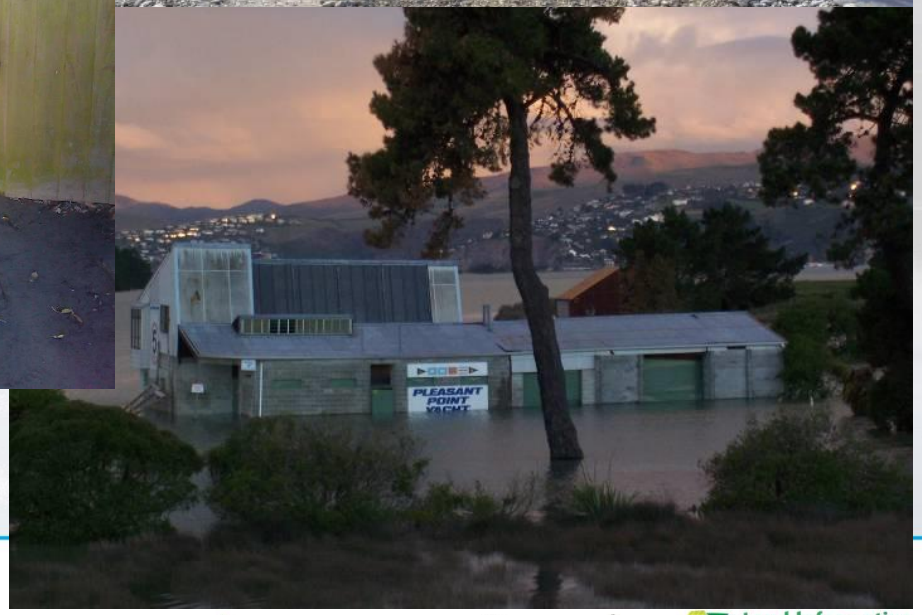
Wastewater Treatment Plant & Network Damage


Est. Total Volume of Overflows (m3/day)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
23-Feb
15-Mar
20-Mar
25-Mar
1-Apr
8-Apr
20-Apr
29-Apr
6-May
20-May
8-Jun
15-Jun
22-Jun
28-Jun
8-Jul
12-Jul
21-Jul
27-Jul
10-Aug
23-Aug
2-Sep
8-Sep

Emergency Chlorination – 50%of the City



Immediate Land Drainage Issues

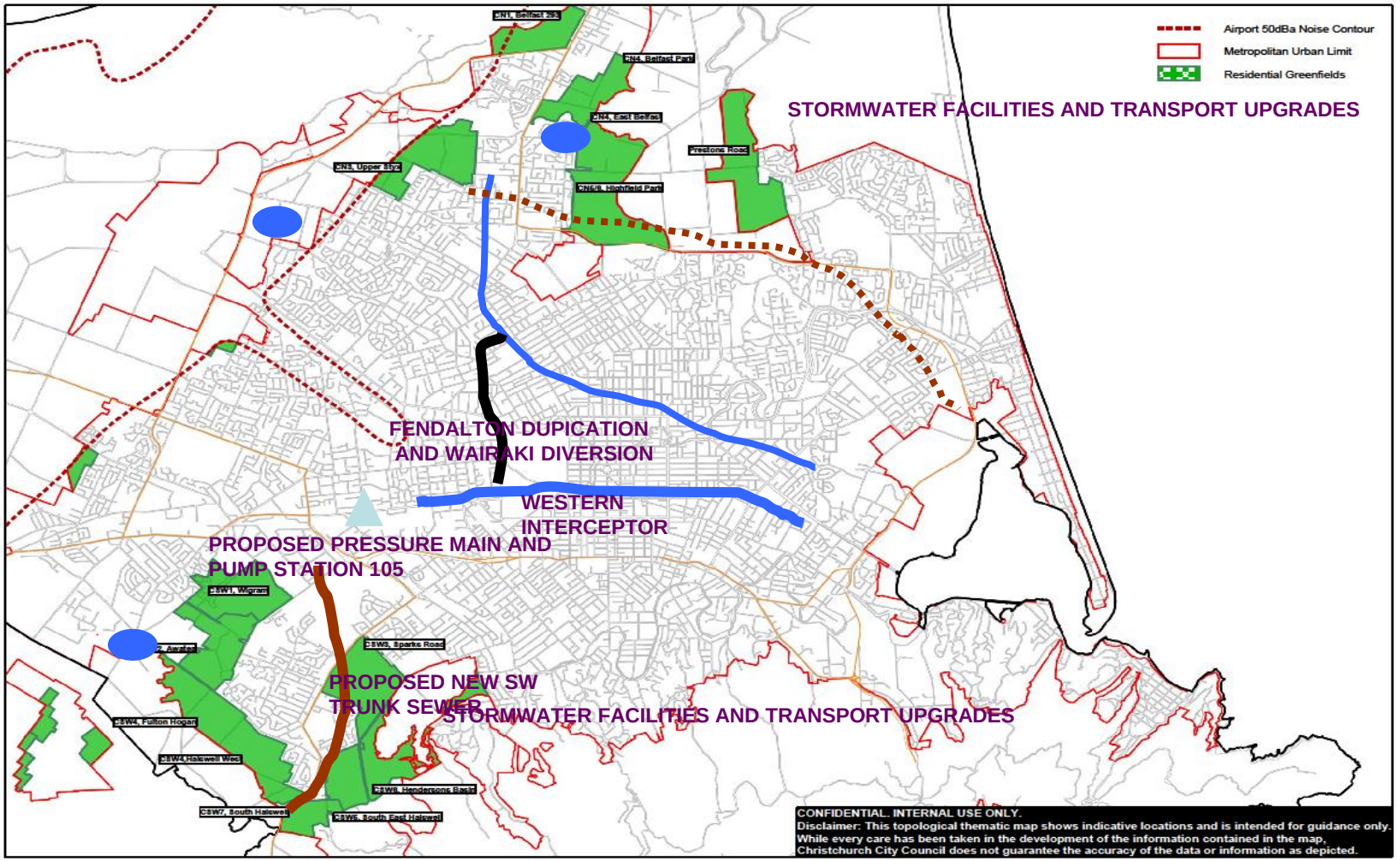


Managing Liquefaction Silt

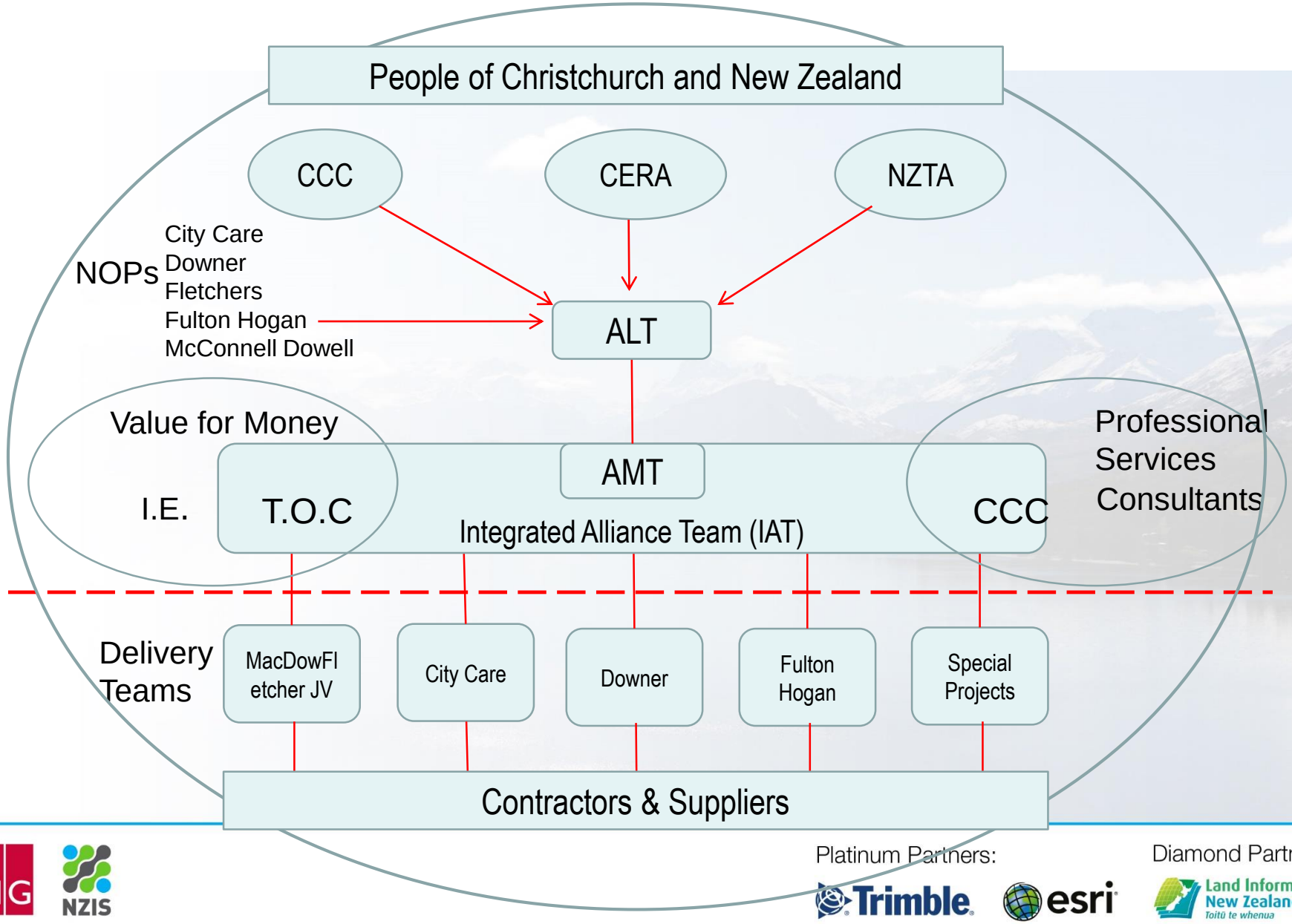
Transportation Issues

Growth and Repair needed at same time!

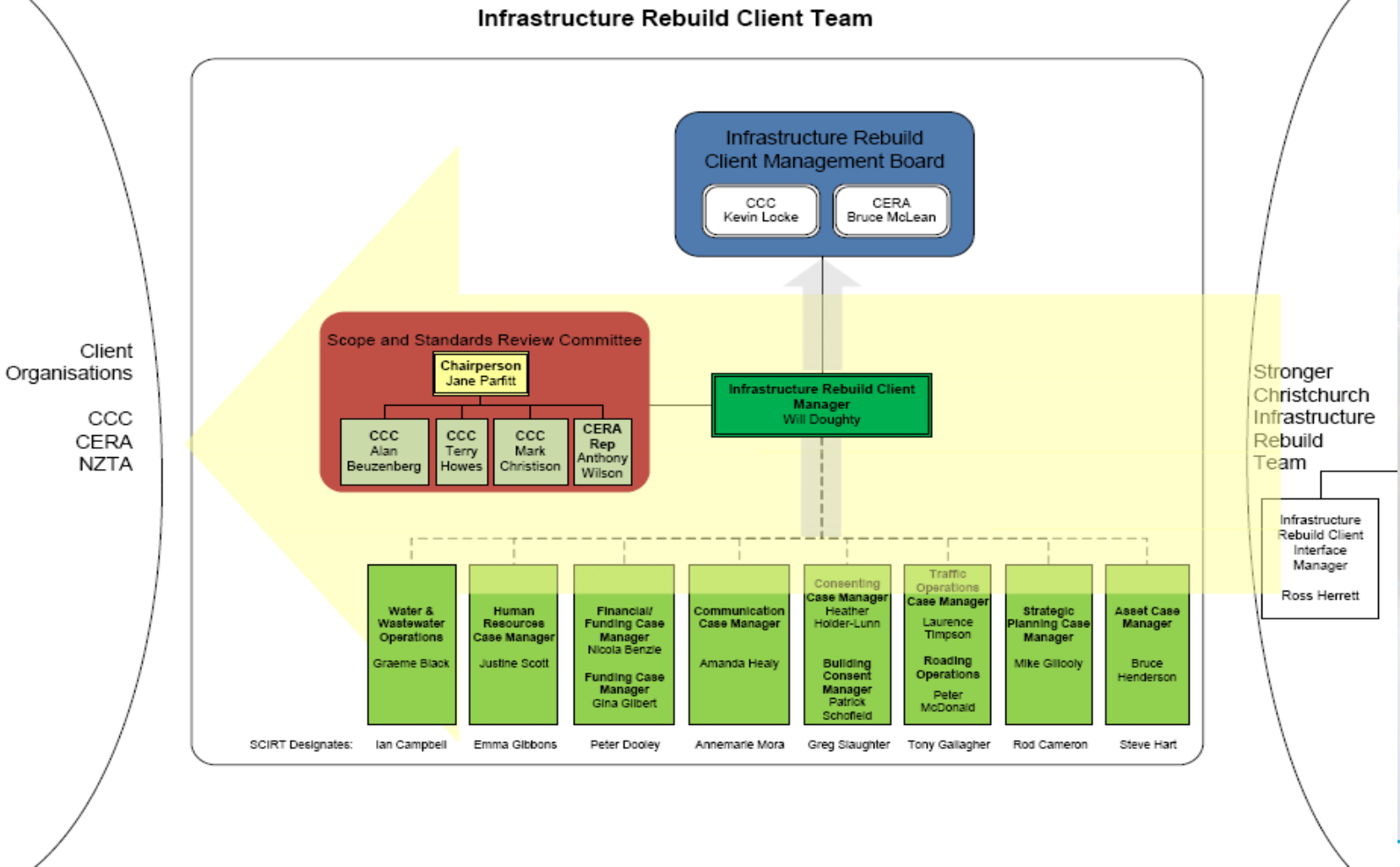
from disaster



The Alliance Infrastructure Rebuild Model



The Client Interface Model for the Rebuild



Recovery Project Prioritisation Process

The prioritisation process is shown below:

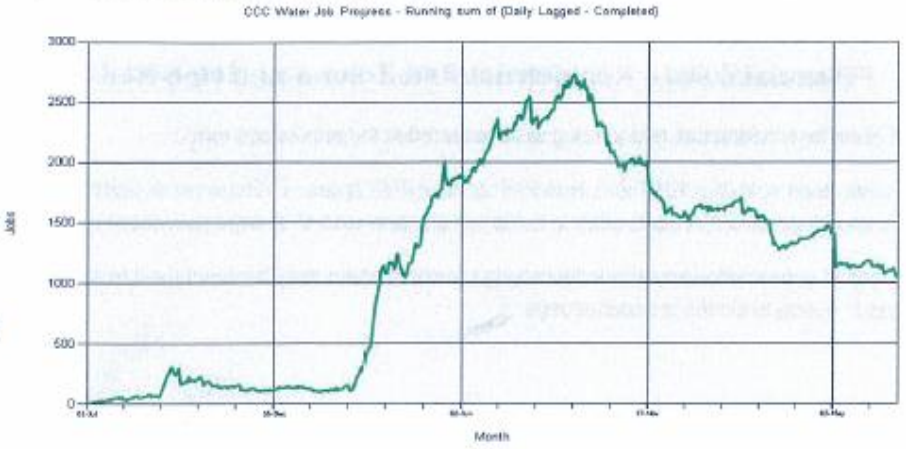
Operational Prioritisation has been calculated by using a Multi-Criteria Analysis tool (MCA) considering damage levels, asset Criticality, operational service levels and on-going cost of maintenance. These scores have been calculated at an asset level.

Capturing Earthquake Operating Costs

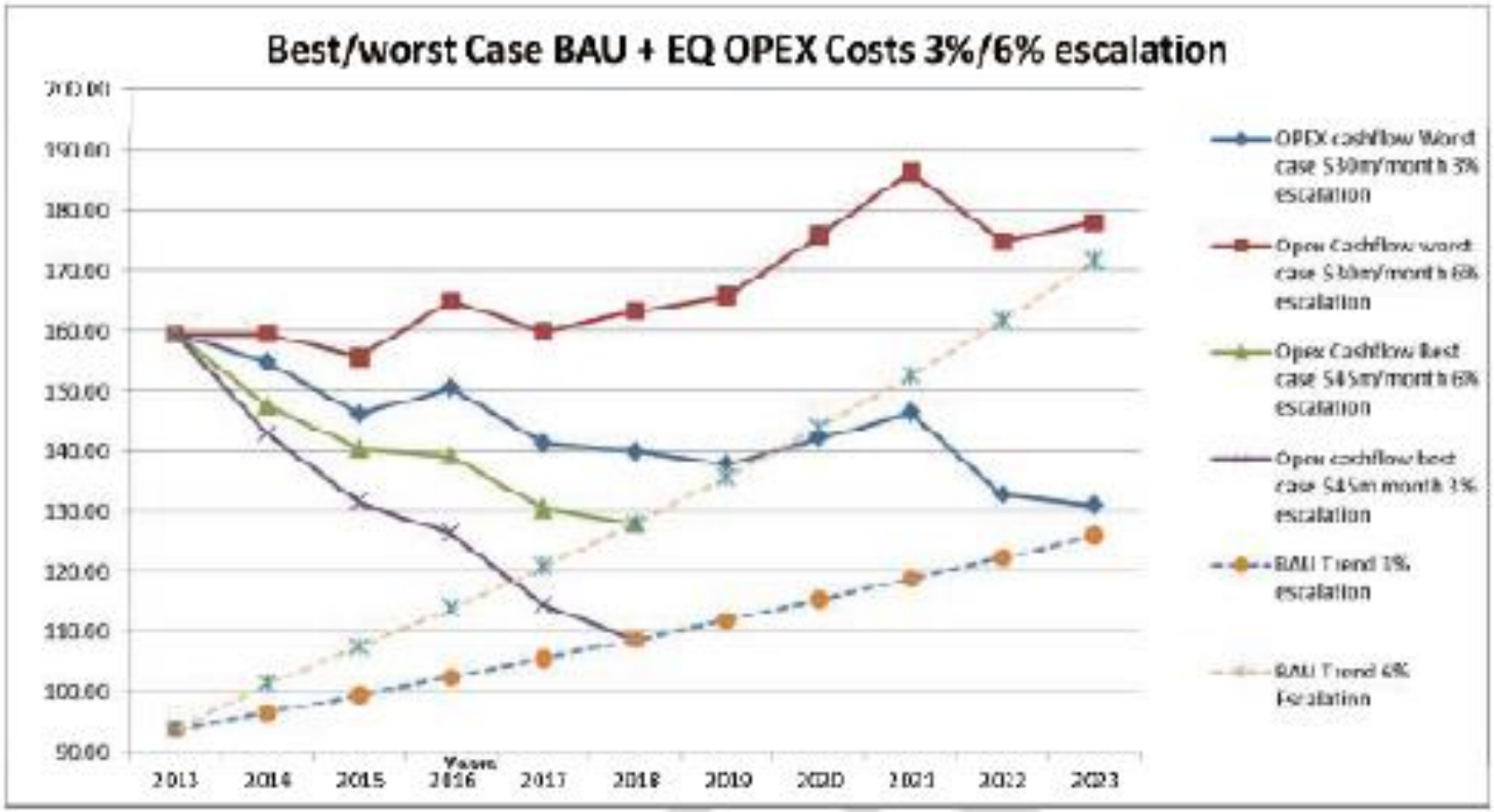
Figure 4 CCC Water & Waste Jobs Logged for Water Reticulation Maintenance

Figure 3 - CCC Water and Waste repair Jobs Logged for Stormwater Contract

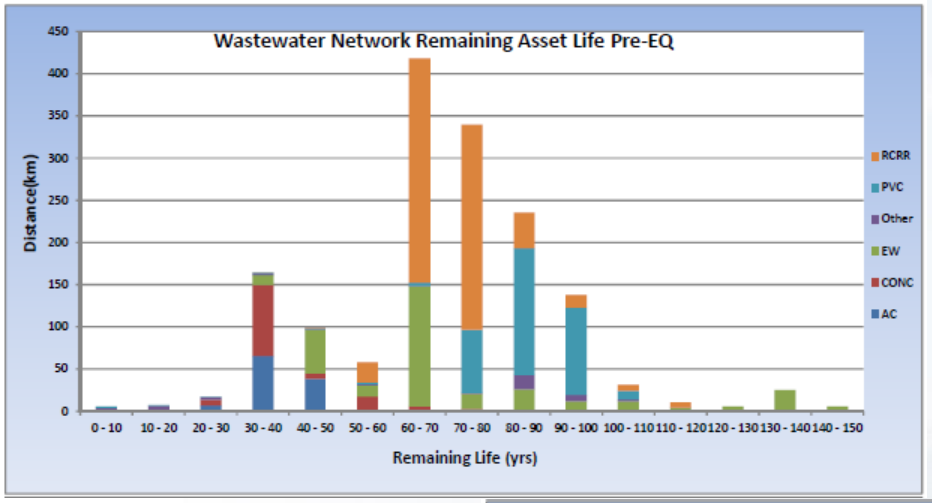
e 2 - CCC Water and Waste repair Jobs Logged for Wastewater Reticulation

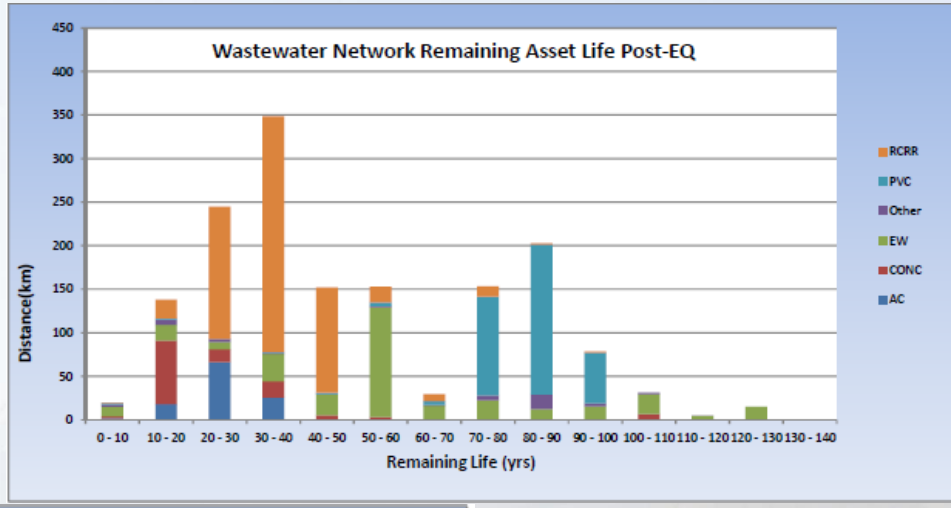


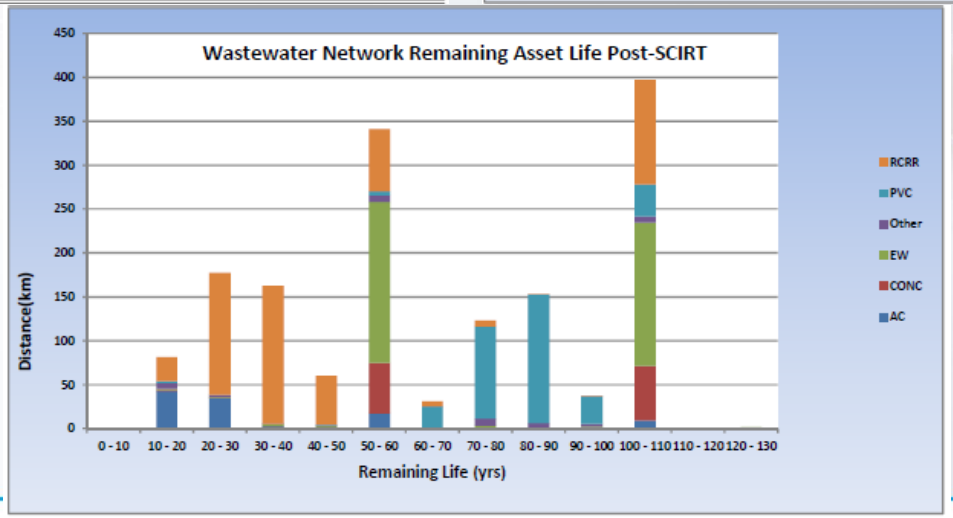
Operating Cost Modelling



Contingent Liabilities – Inter-Generational Issue







Key Response and Recovery Establishment Lessons

- Forge strong relationships in BAU times.
- Resilience Planning is good business (not gold plating).
- Risk management is not risk avoidance.
- Communication of risk to the lay person is critical in emergencies – why can't I water my garden?
- Infrastructure needs compete with social needs – MCA tools are needed to inform decision making.
- Need to focus on outputs not inputs - don't micro-manage.

Acknowledgements

- Staff of Christchurch City Council
- SCIRT Staff
- Beca Colleagues

Damage Investigation and Analysis

David Heiler
SCIRT Data Assessment Lead in the Asset Assessment Team
Technical Director – Water Infrastructure, Beca Ltd

The Damage Assessment Challenge

There are known knowns; there are things we know we know.

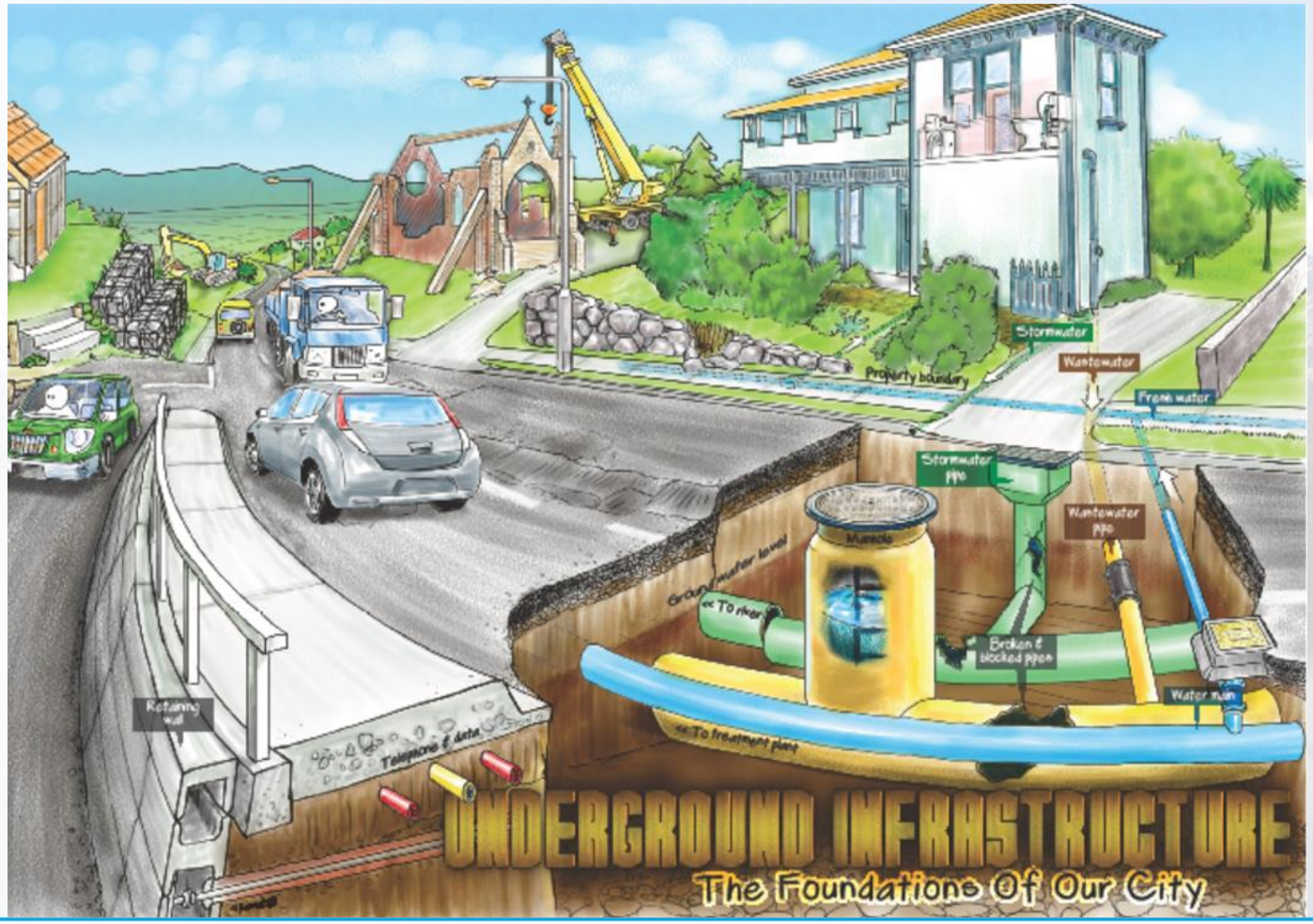
We also know there are known unknowns; that is to say we know there are some things we do not know.

But there are also unknown unknowns – there are things we do not know we don't know.

Donald Rumsfeld – US Secretary of Defence

Some Damage Visible

Other damage harder to assess



Gravity Pipe Assessment

- 50% of rebuild budget

- Identify immediate service issues
- Assess functional and structural damage
- Assess changes in levels of service from pre-EQ

- 1600km of gravity WW network
- 1000km of gravity SW network

Traditional Inspection Methods

Level Survey – Functional Assessment

- GPS and detailed level survey of MH lids and pipe inverts
- Allowed assessment of post-EQ grade against pre-EQ grade and design grades (for solids movement)
- Also required for network hydraulic modelling

Traditional Inspection Methods

CCTV – Structural Assessment

- 20 combined camera, jetting, and suction crew operating
- 150 FTE = half of NZ CCTV resource
- Productivity ~ 50km/month
- Cost ~ $50/metre

The Problem

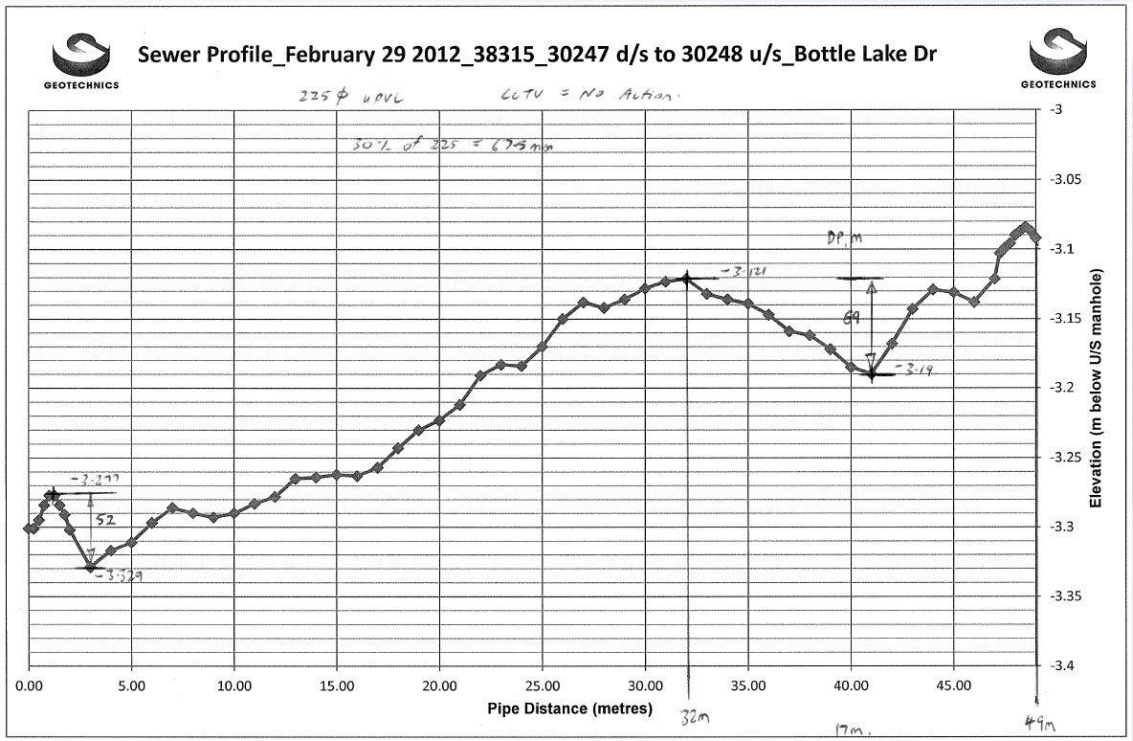
- Structural assessment progress not sufficient to match rebuild programme
  - $40M/month of deliverable outputs required 100km/month of CCTV
  - Insufficient CCTV resources available and investigation costs high.
- CCTV did not provide all damage information (especially grades and dips)

Alternative Methods – Pole Camera

- Structural Assessment
- Used to make fast structural condition assessments of short pipe lengths (generally SW)
- Used instead of CCTV where defects clearly evident or absent

Alternative Methods – Pipe Profile

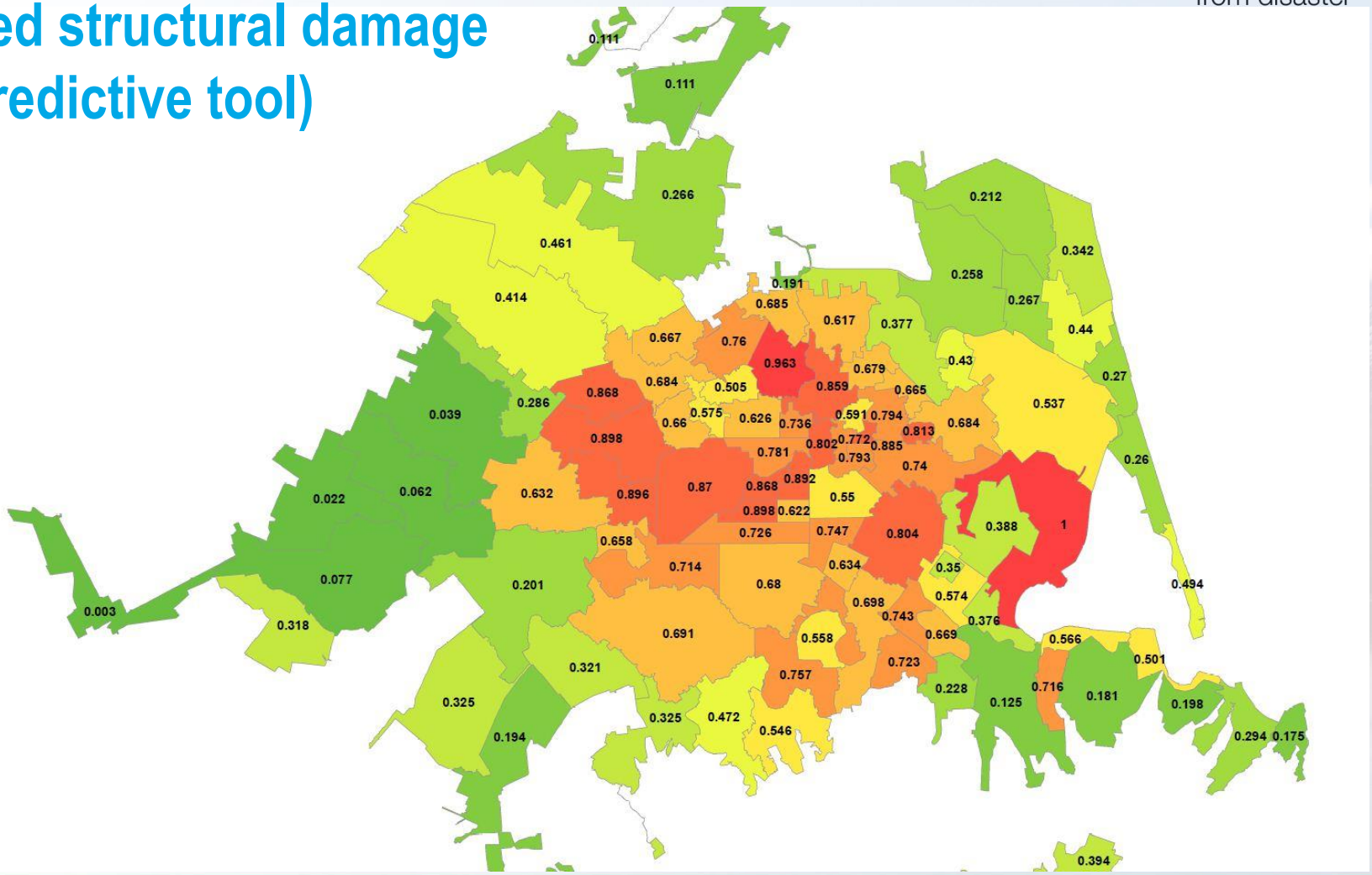
- Functional Assessment
- Provided long section profile of the pipe invert between manholes
- Uses geotech profilometer technology
- Quantitative assessment of dips - not possible with CCTV



Alternative Methods – Predictive Tool

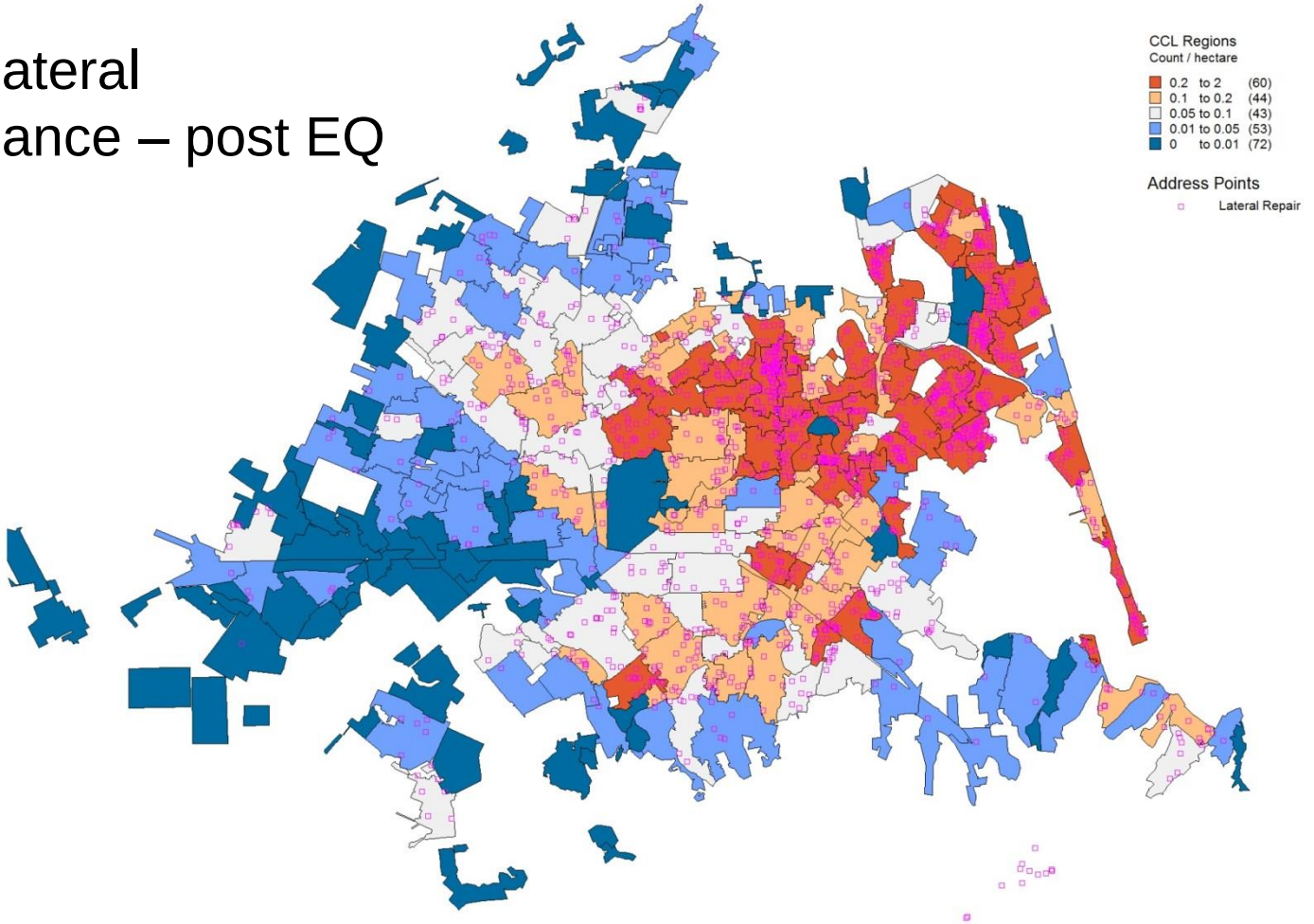
- Pipe Damage Assessment Tool (PDAT)
- Predicts whether pipe requires Renewal, Repair or No Action
- Desktop tool to predict the structural condition of pipes that have not been surveyed using key criteria:
  - Liquefaction index
  - Pipe material type, diameter, depth
  - Geographic location
- Predictive model calibrated against CCTV information (focused on structural condition)
- Used in the rebuild to:
  - Inform concept design and save investigation costs
  - Predict condition of pipes that can't be practically CCTV
  - Assess damage in low damage areas to reduce the amount of CCTV

Predicted structural damage (from predictive tool)

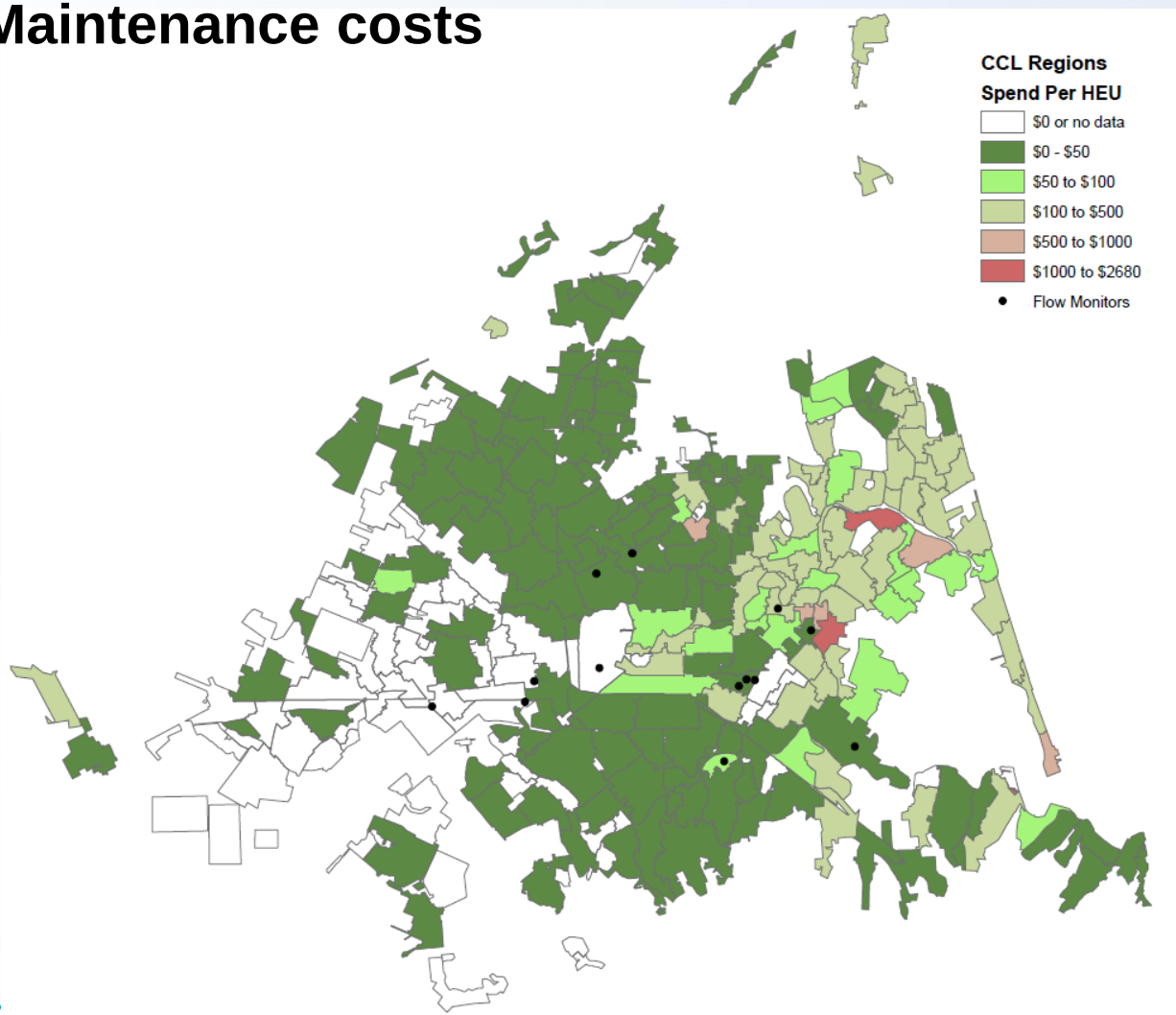


LOS indicators to focus rebuild effort

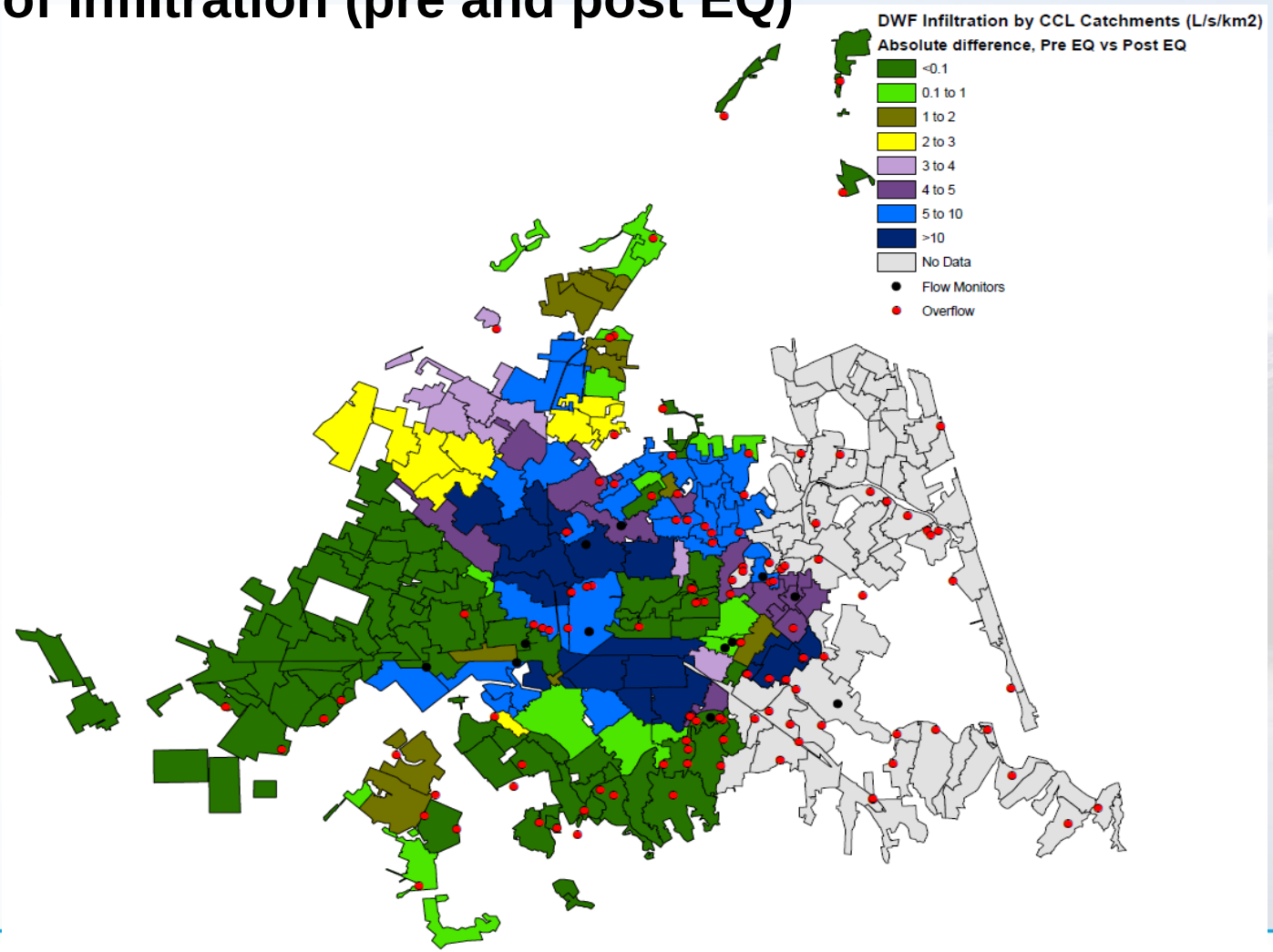
Public Lateral maintenance – post EQ



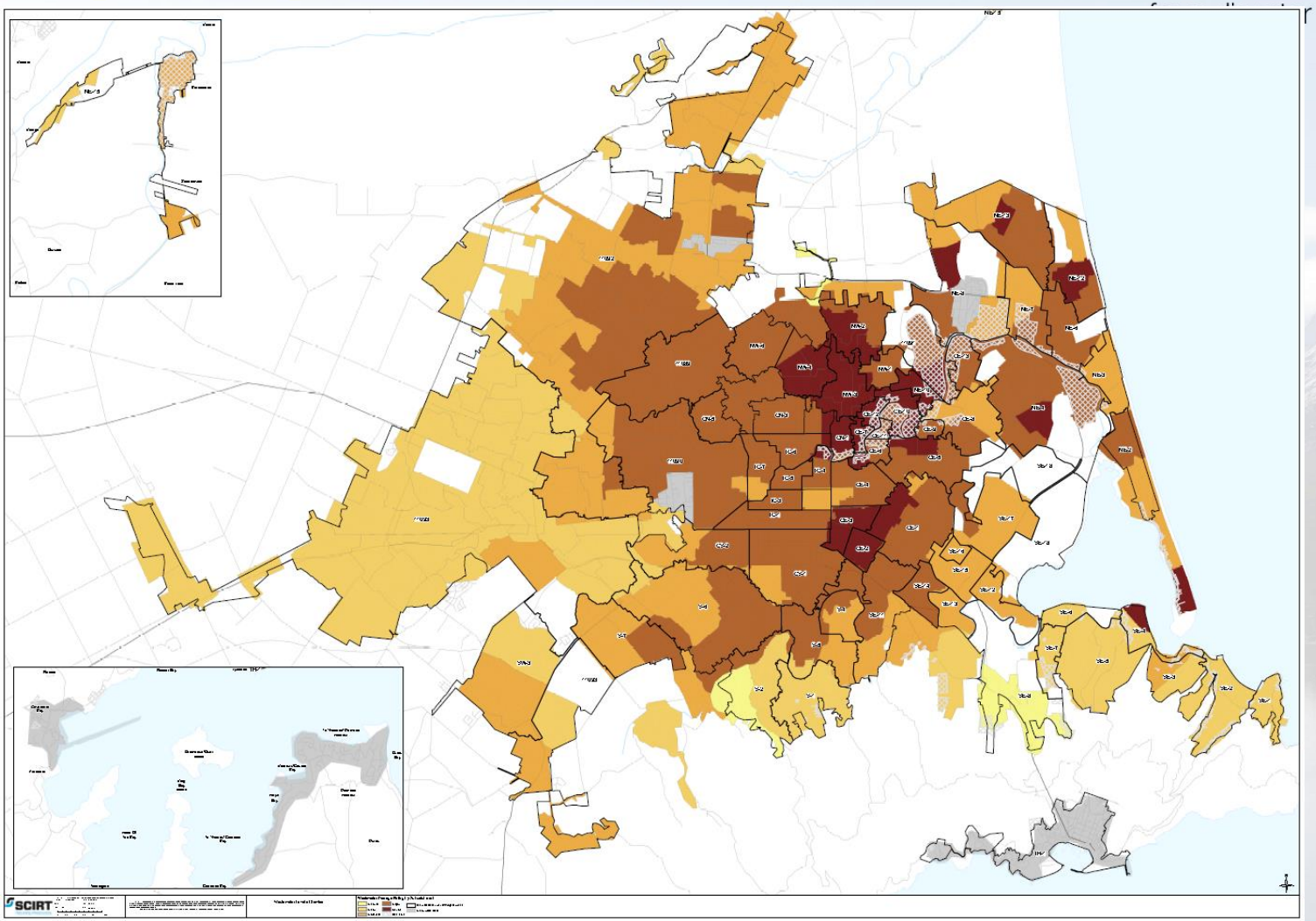
On-going Maintenance costs



Comparison of Infiltration (pre and post EQ)



LOS Score



Lessons from Damage Investigation and Analysis

- GIS for managing asset data and condition surveys
- Understand Levels of Service and monitoring
- Data management systems
- Skilled workforce – condition assessment and rebuild
- Maintain flexibility in approach and stay abreast of technology
- Risk based predictive tools for focusing investigation effort

Design of network repairs

Amber Murphy

Designer in the SCIRT Red Team, chair of SCIRT's Stormwater and Land Drainage technical group and member of the Water Supply technical group

Civil and Hydraulic designer and project manager for various Christchurch City Council Land Drainage Recovery Programme (LDRP) projects

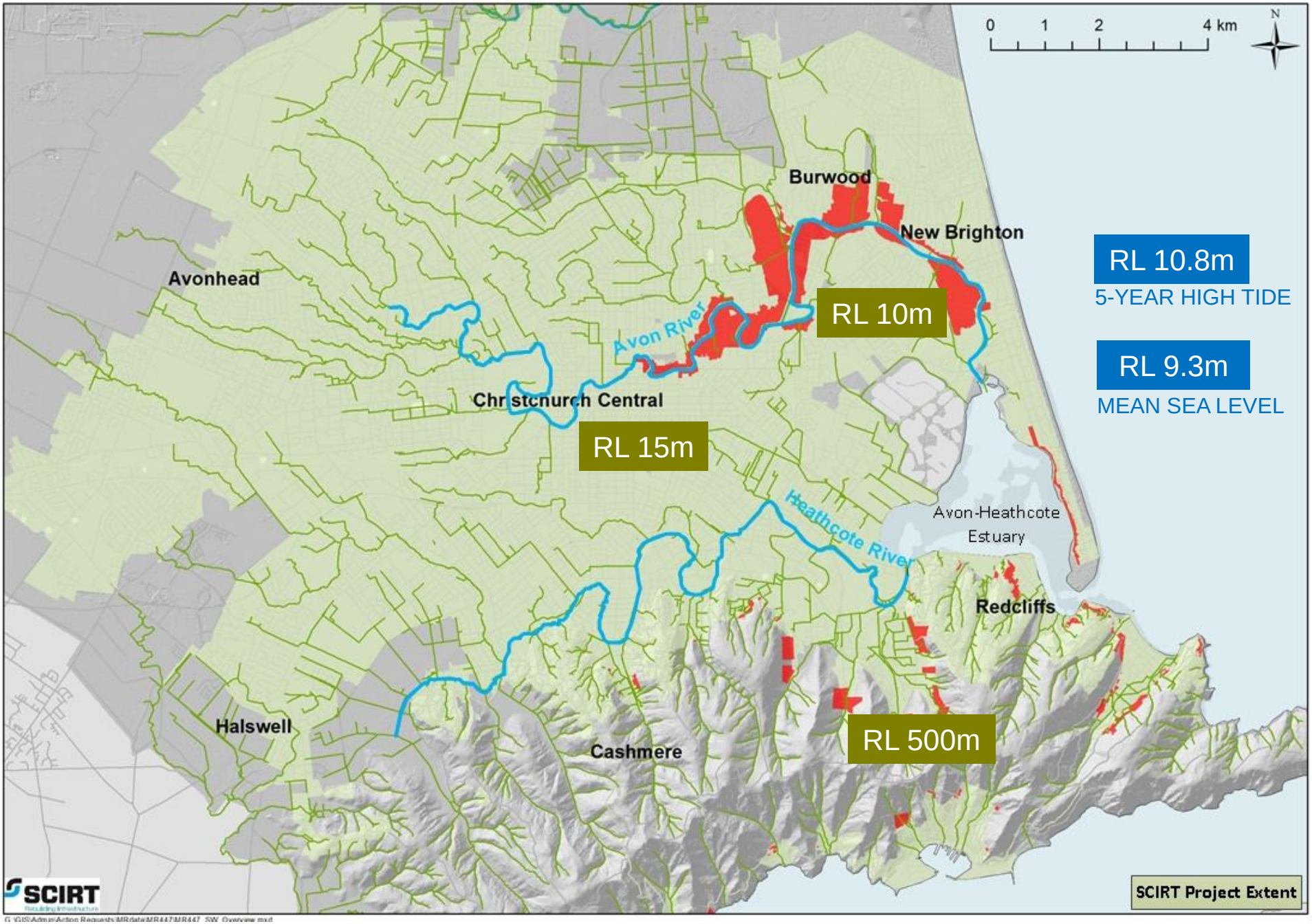
Environmental Engineer – Christchurch Water, Beca Ltd


Pipe breaks


Lateral spread


Differential settlement


Rotation


0 1 2 4 km
N
Burwood
New Brighton
Avonhead
Avon River
RL 10m
RL 10.8m
5-YEAR HIGH TIDE
RL 9.3m
MEAN SEA LEVEL
Christchurch Central
RL 15m
Heathcote River
Avon-Heathcote
Estuary
Redcliffs
Halswell
Cashmere
RL 500m
SCIRT
SCIRT Project Extent

DAMAGED PIPES, BLOCKED PIPES AND OUTLETS, MISSING OR BROKEN FLAP VALVES

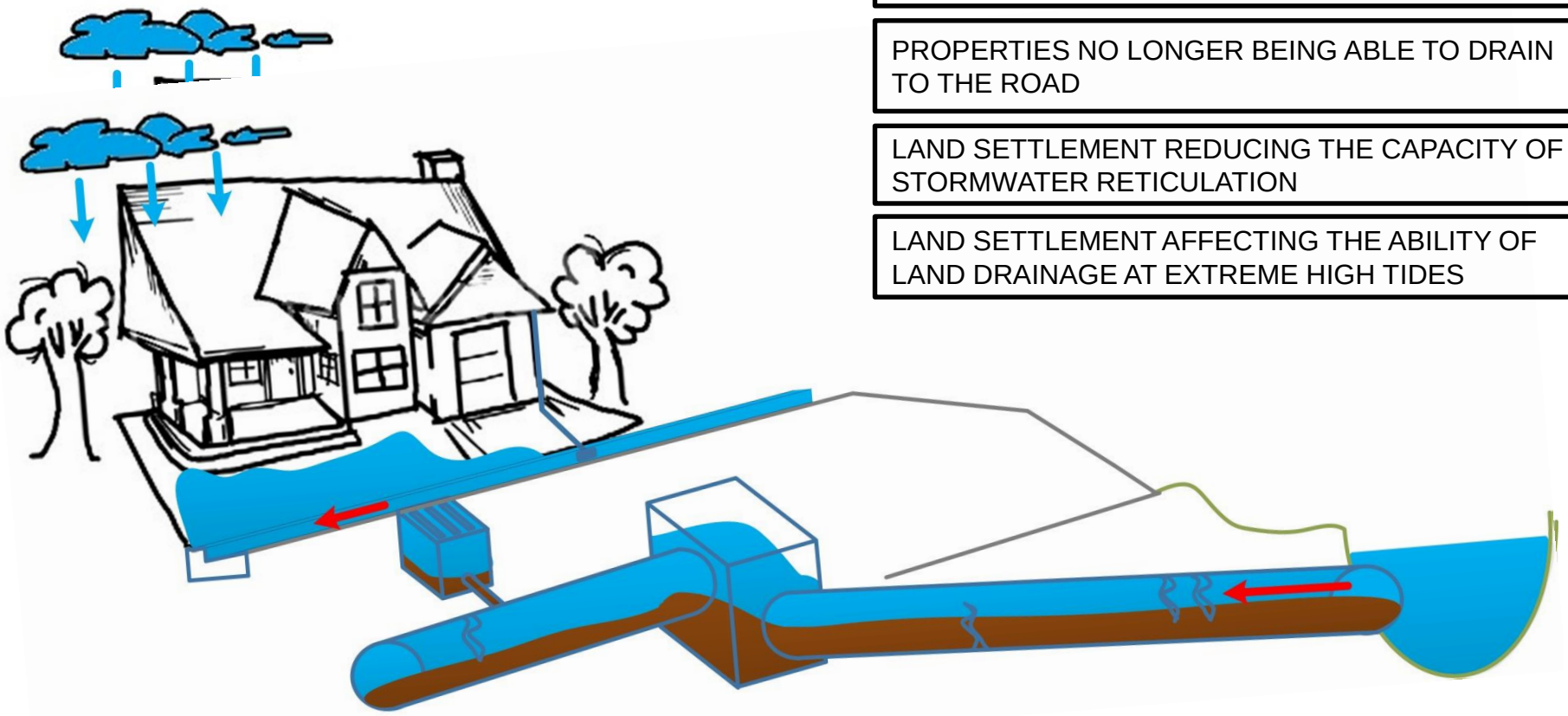
SILT INGRESS INTO PIPES AND SUMPS, CAUSING BLOCKAGES AND A REDUCTION IN PIPE CAPACITY

ROAD DRAINAGE BEING IMPEDED, CHANGES TO SECONDARY FLOW PATHS, AND SUMPS NO LONGER BEING POSITIONED AT LOW POINTS

PROPERTIES NO LONGER BEING ABLE TO DRAIN TO THE ROAD

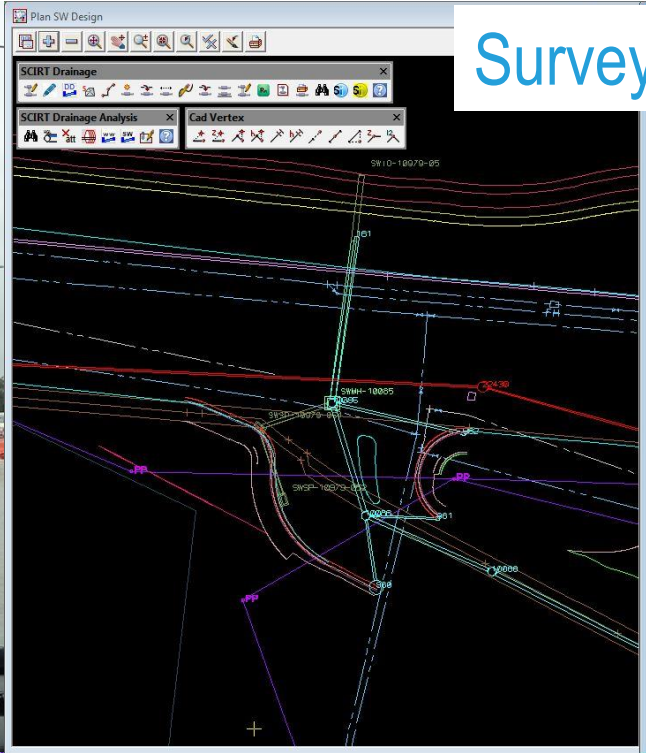
LAND SETTLEMENT REDUCING THE CAPACITY OF STORMWATER RETICULATION

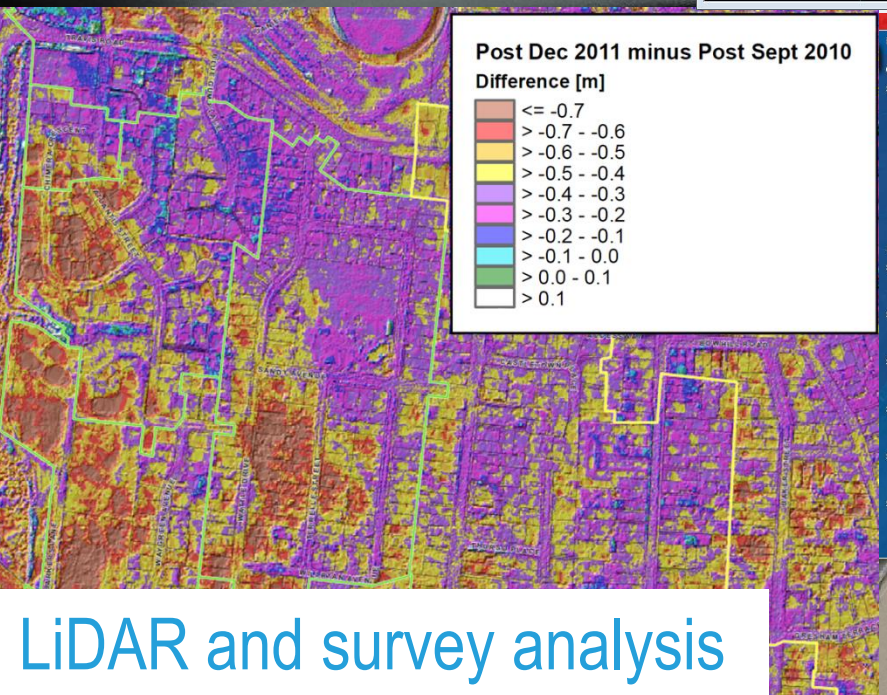
LAND SETTLEMENT AFFECTING THE ABILITY OF LAND DRAINAGE AT EXTREME HIGH TIDES



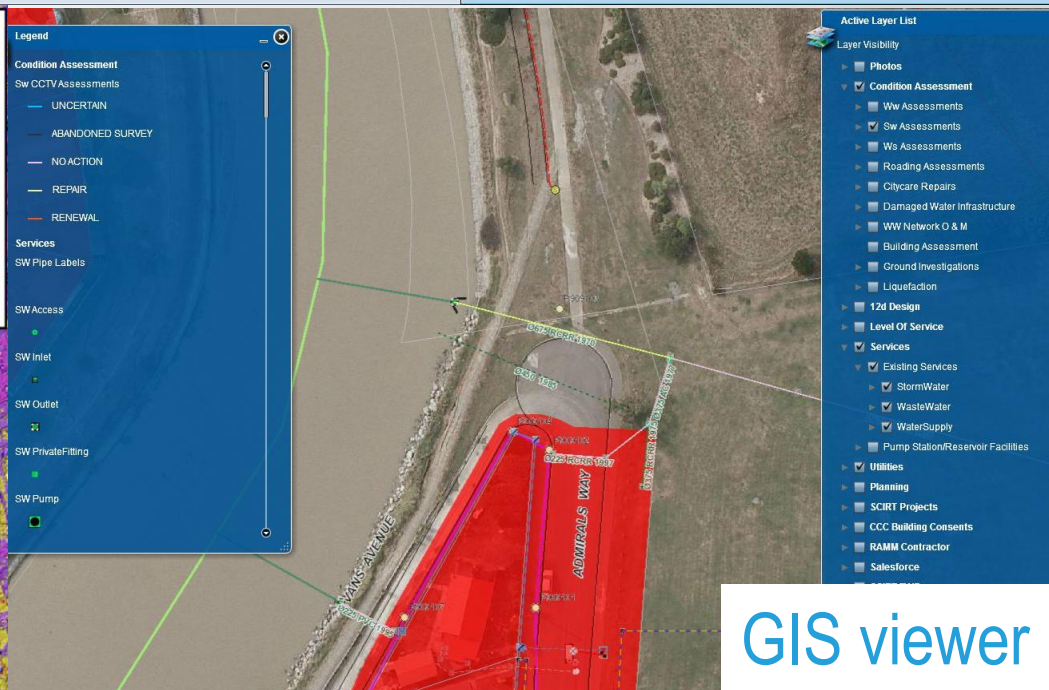
Emergency works

Survey and design software



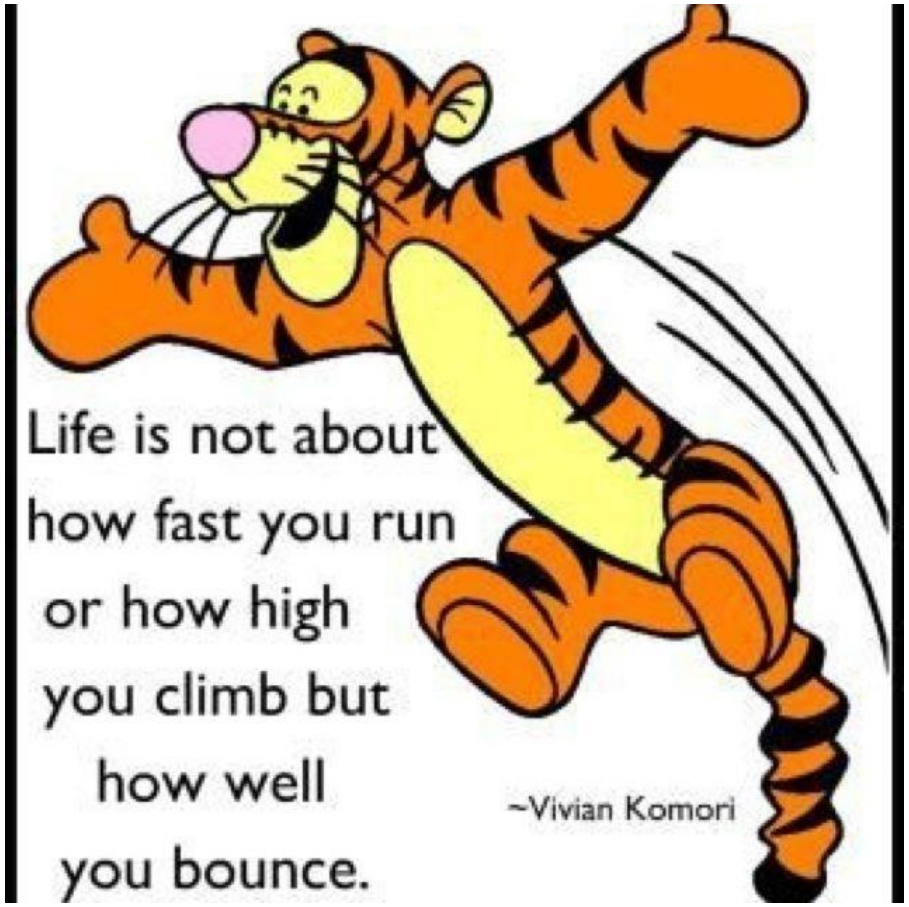


LiDAR and survey analysis

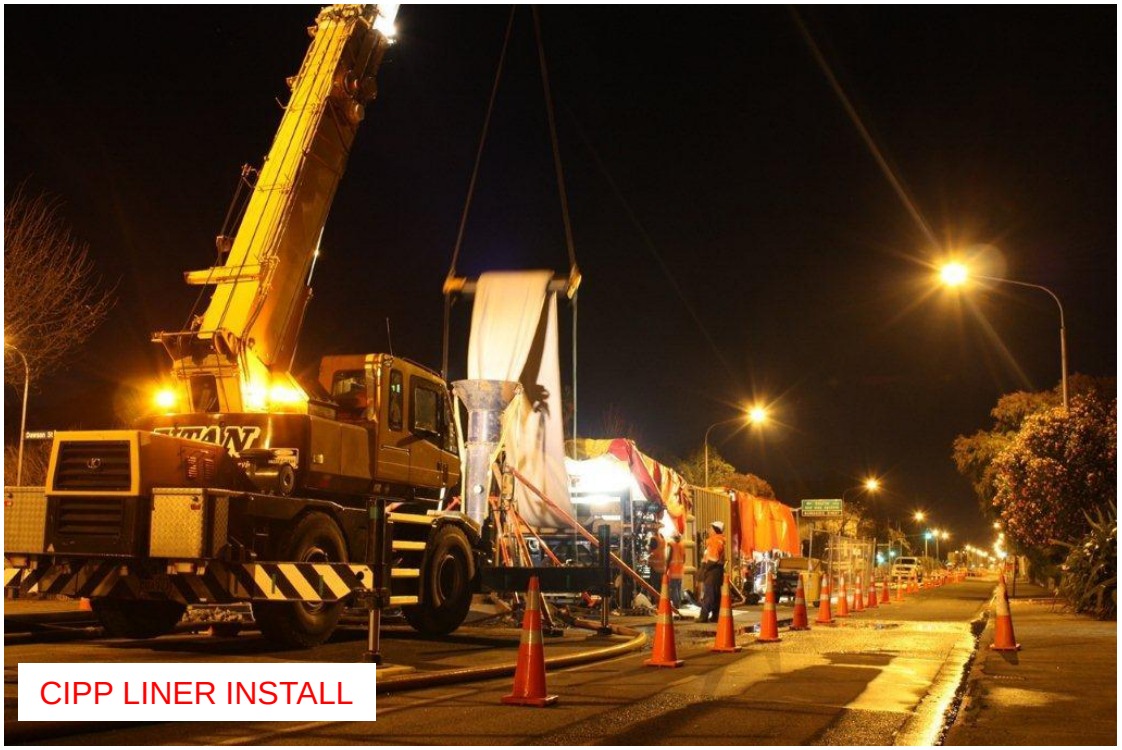


GIS viewer

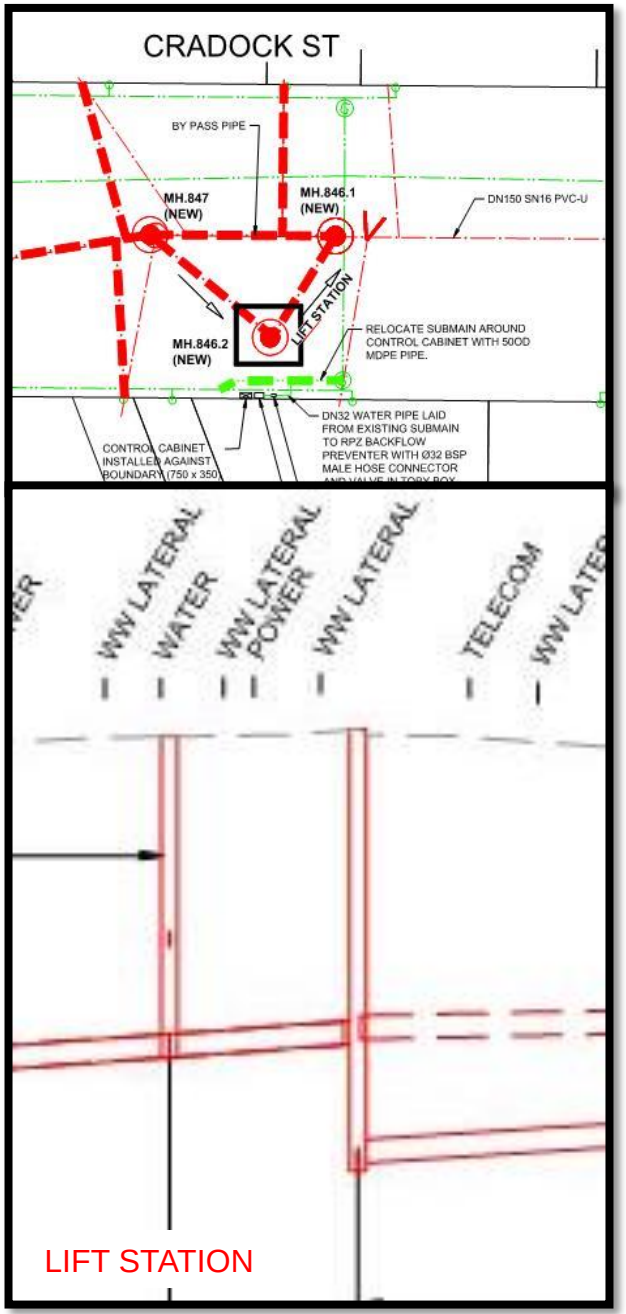
Design – focus on building back resilience



Gravity network repair initiatives



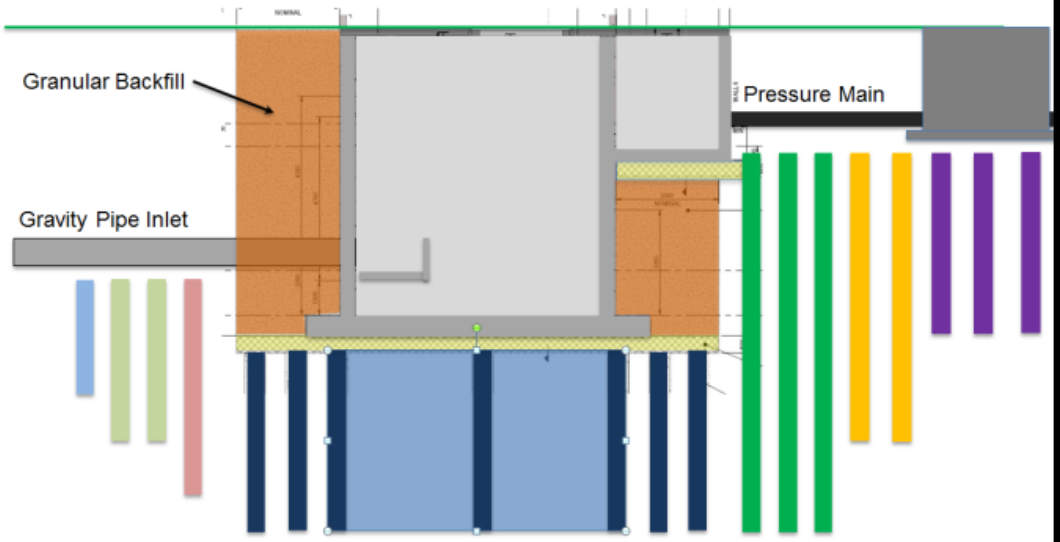
CIPP LINER INSTALL

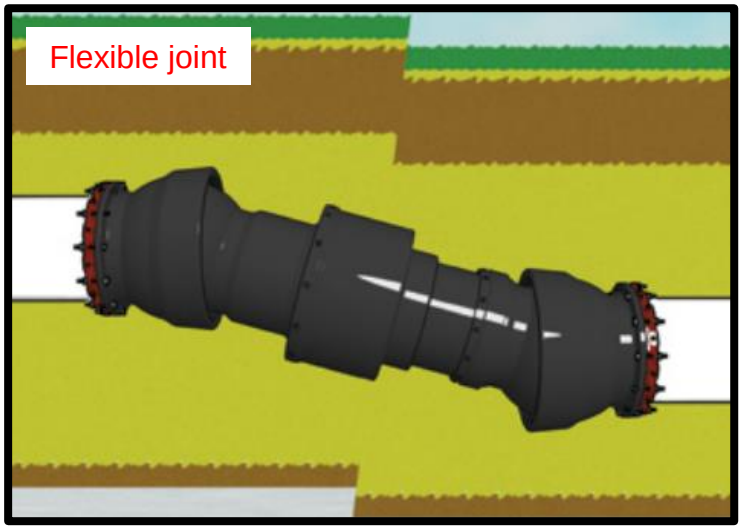


LIFT STATION

Pump Station initiatives

PS136 Foundations





General design features

- Efficient asset assessment
- New guidance documents, and standard details; making design and construction simple where we can
- What is best for this specific project? What is the best value to the rebuild and the people of Christchurch
- How do we make this resilient? can we integrate works? think about safety in design, consider the operation and maintenance
- Legacy – sharing knowledge, data, lessons learnt, best practise

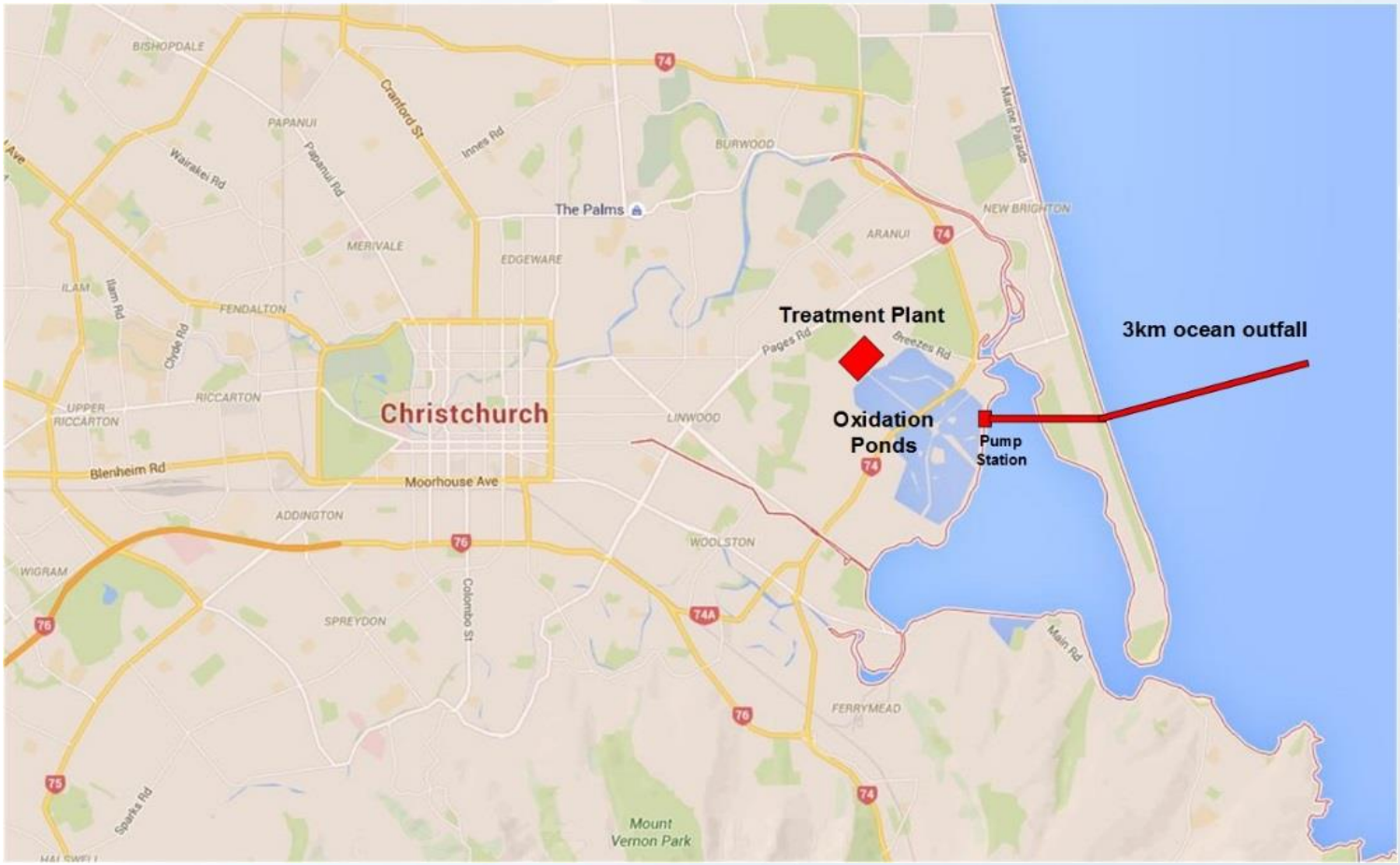
Wastewater Treatment Plant

Greg Offer

Programme manager for earthquake repairs at Christchurch Wastewater Treatment Plant

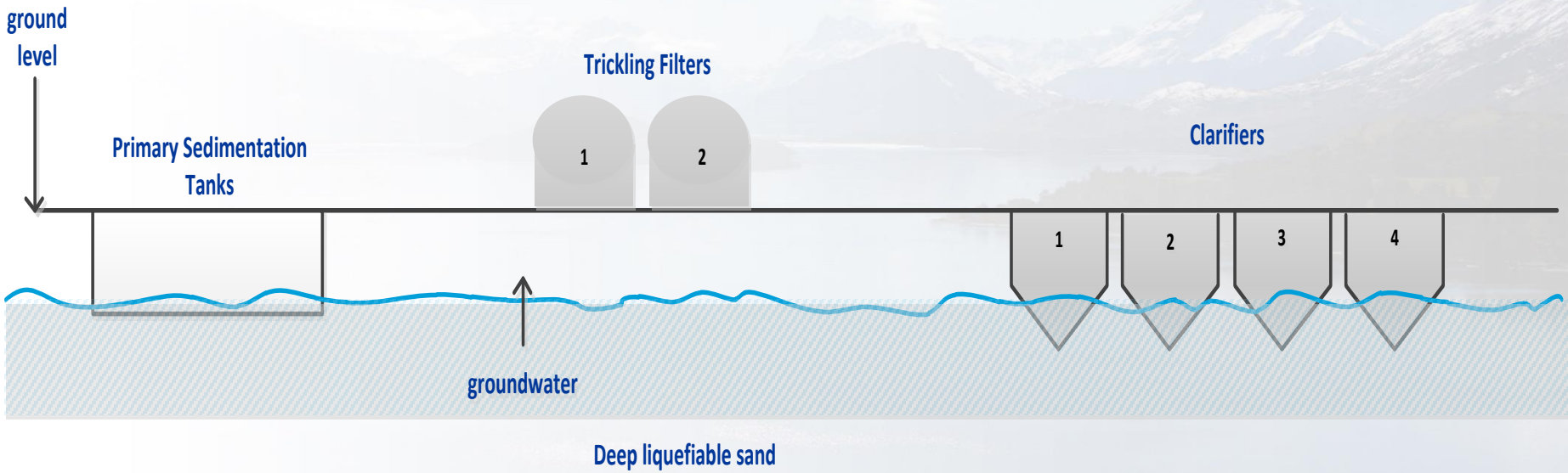
Technical Director – Environmental Engineering, Beca Ltd

Christchurch Wastewater Treatment Plant



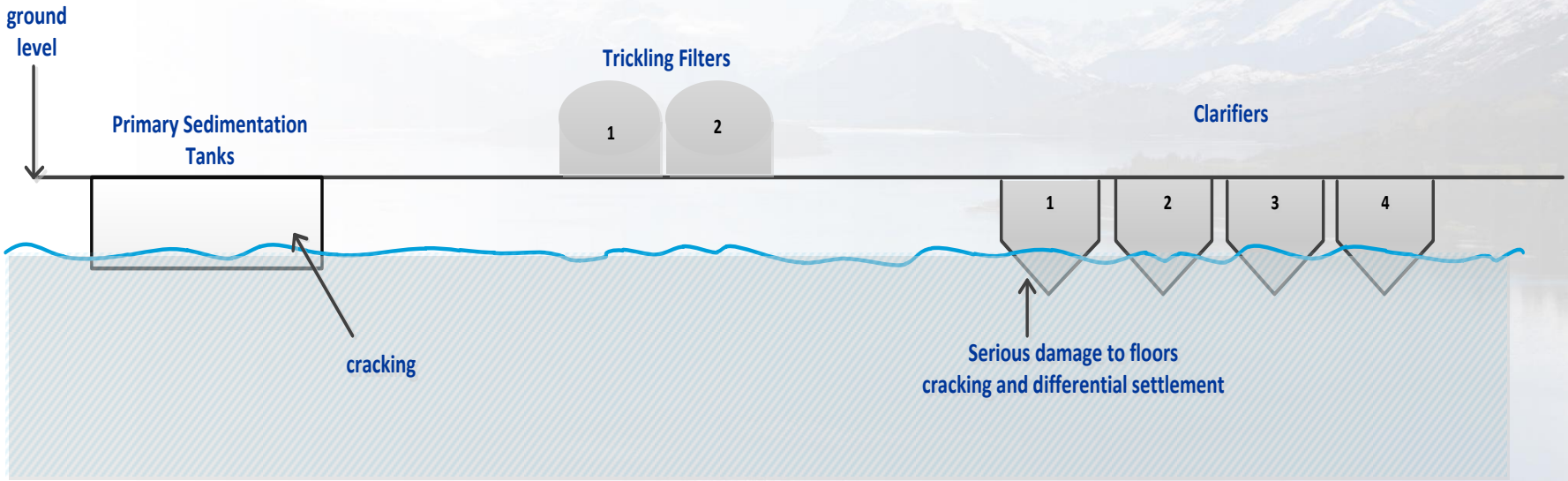
Christchurch Wastewater Treatment Plant

- Plant built in deep sands
- Shallow groundwater
- High risk of liquefaction during earthquake

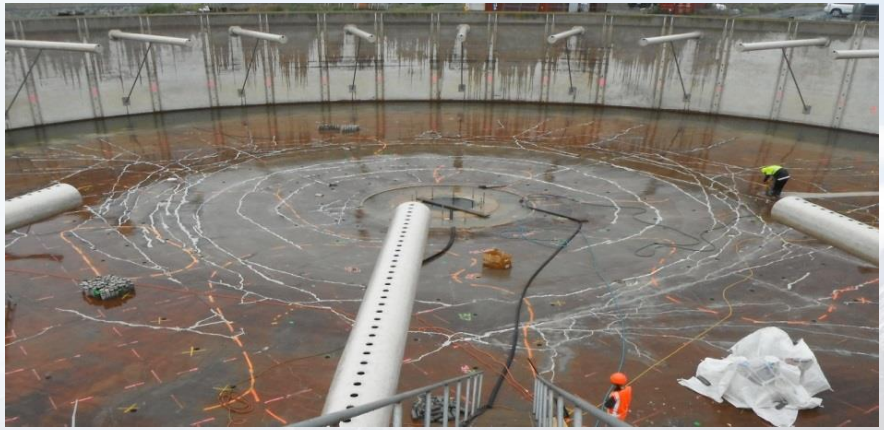


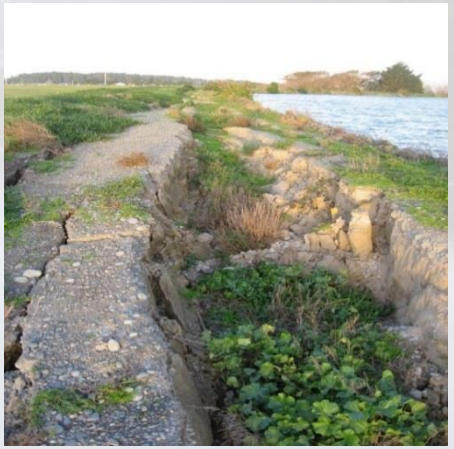
Earthquake impacts

- Shallow structures ok
- Deeper structures seriously damaged

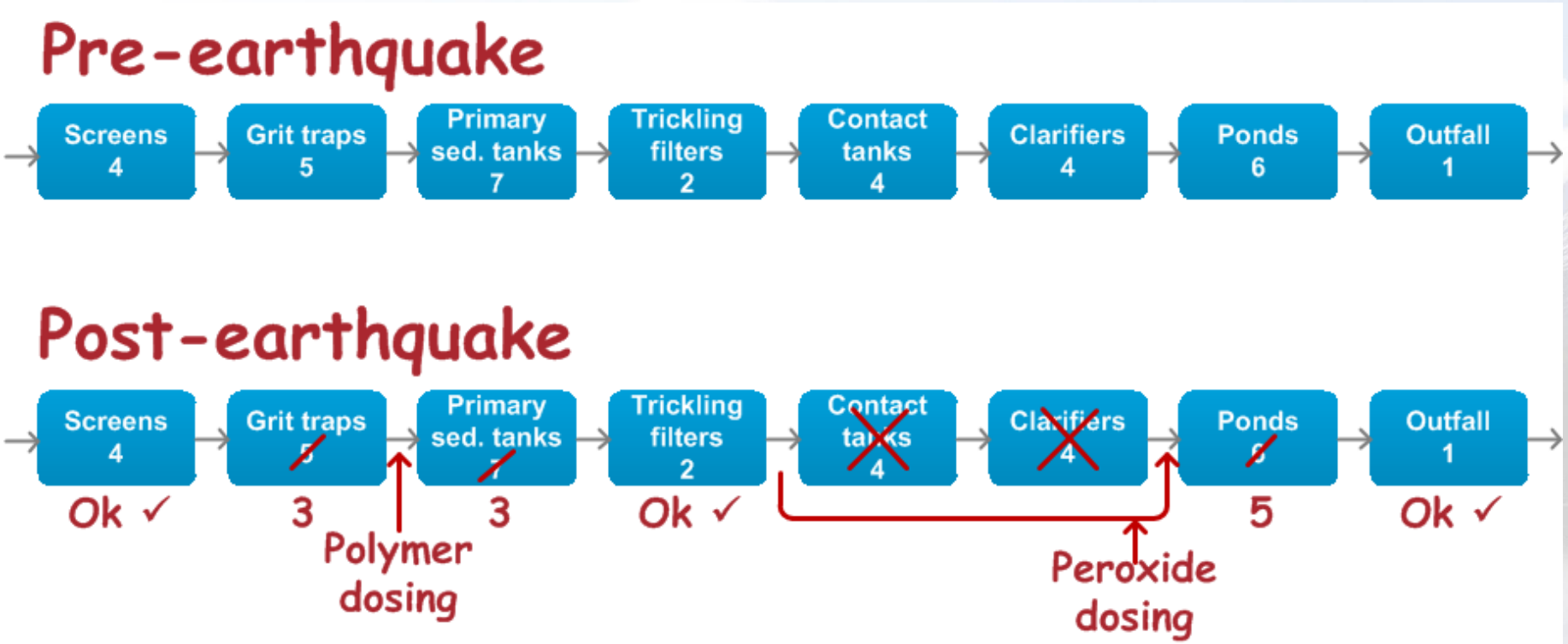


Treatment plant & pond damage





First Response



Sand ingress in grit, primary sedimentation and digesters !

Trickling filters

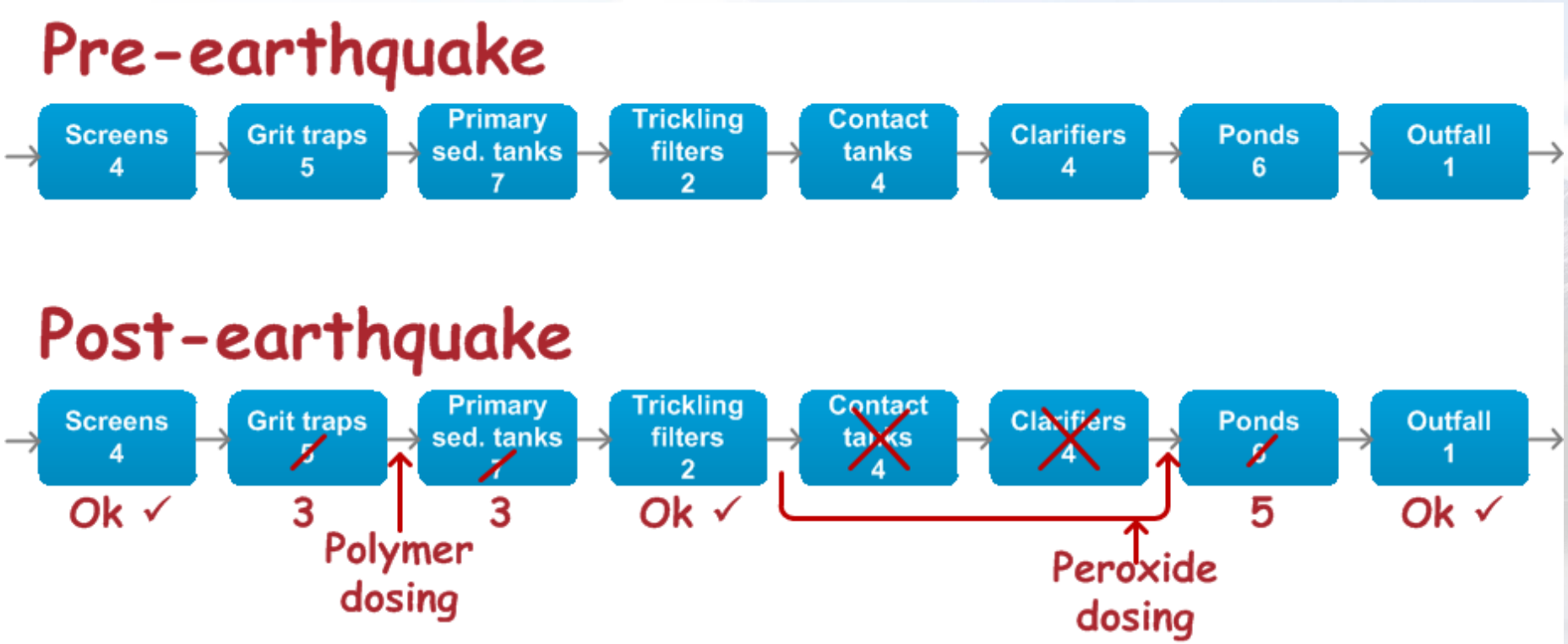
- Built at shallow depth so lightly damaged
- Some media and rotating arm damage
- External ring beam to strengthen tank
- Online 24/7 means inspection difficult… insurer wants “whole of site settlement”

Clarifiers

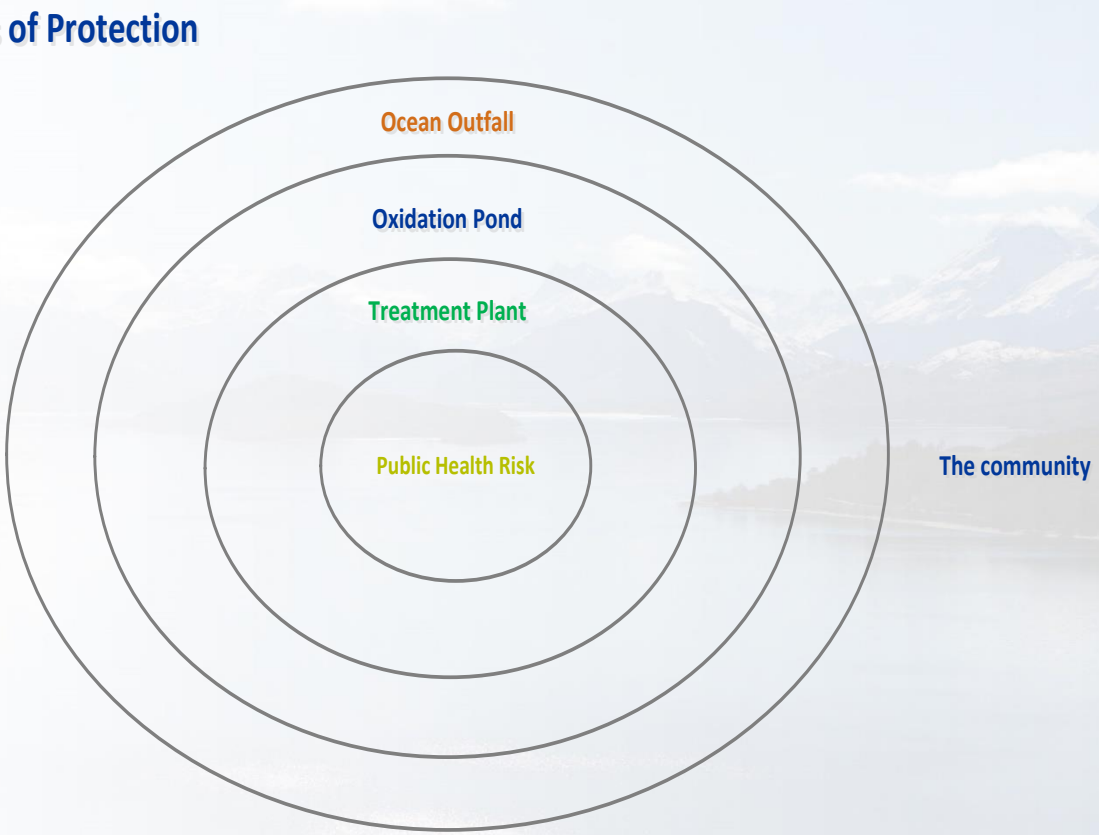



- Two clarifiers severe damage, two minor damage
- Liquefaction pore pressures caused floor deformation
- Repairs based on reinforced concrete overlay
- Cure-in-place liner installed on inlet pipes

Lesson # 1 - Flexibility



Lesson # 2 – Layers of protection



Lesson # 3 - Risk management and resilience

- Don't ignore low probability, high consequence events
- Use risk management and renewal funding to improve resilience – know the weak spots.
- Up to date asset management systems very important to help recovery.
- Have clear design statements on major assets.

Lesson # 4 - Insurance

- What is the extent of cover (for example - does it include temporary working ?)
- Assume a litigious approach from day 1
- Don't start fixing things until the damage is properly documented !
- Need a good understanding of asset condition before the event
- Pipes – were they already leaking?
- Cracking – was it pre-existing?
- Decisions needed to keep plant running – could leave you financially exposed