EQ Response

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- David Heiler
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Brutality of 22-2-2012 Earthquake

From this

To this

45 seconds later
Water Supply Pipes – recorded breaks
Loss of Service - Wastewater Network
Wastewater Treatment Plant & Network Damage
Est. Total Volume of Overflows (m³/day)

- 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

Volume ranges from 0 to 90,000 m³/day.
Emergency Chlorination – 50% of the City

Distribution
Water Sample Points
11/08/2011

This map now presents the maximum FAC read per site over the period displayed above.

Map Produced by Community and Public Health - a division of the Canterbury DHB.
Map data sources may include Ministry of Health (PHL), Stats NZ, Terravision International, LINZ, Geographics Ltd 080214_tempprepare.mxd
Immediate Land Drainage Issues
Managing Liquefaction Silt
Transportation Issues

CTM Zones
- N of Avon
- S of Avon

80,500
16,000
67,000

Platinum Partners:
- Trimble
- esri

Diamond Partner:
- Land Information New Zealand
Growth and Repair needed at same time!
The Alliance Infrastructure Rebuild Model

People of Christchurch and New Zealand

- CCC
- CERA
- NZTA

NOPs
- City Care
- Downer
- Fletchers
- Fulton Hogan
- McConnell Dowell

Value for Money
- I.E.

I.E.

T.O.C

Integrated Alliance Team (IAT)

AMT

Delivery Teams
- MacDowFletcher JV
- City Care
- Downer
- Fulton Hogan
- Special Projects

Contractors & Suppliers

Platinum Partners:
- Trimble
- esri

Diamond Partner
- Land Information New Zealand
Recovery Project Prioritisation Process

The prioritisation process is shown below:

1. Operational Prioritisation
2. Inter-dependencies
3. MESHT
4. External Influences
5. Constraints - resource, geospatial
6. Sense check

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

Figure 2 CCC Water and Waste repair Jobs Logged for Wastewater Reticulation
Operating Cost Modelling

Best/worst Case BAU + EQ OPEX Costs 3%/6% escalation

- OPEx cashflow worst case $3/0m/month 3% escalation
- OPEx cashflow worst case $3/0m/month 6% escalation
- OPEx cashflow best case $4/5m/month 3% escalation
- OPEx cashflow best case $4/5m/month 6% escalation
- BAU Trend 3% escalation
- BAU Trend 6% escalation

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
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

Life is not about how fast you run or how high you climb but how well you bounce.

~Vivian Komori
Gravity network repair initiatives
Pump Station initiatives

PS136 Foundations

Flexible joint

PS229 Intake

PS136 Typical Cross Section B – B'

Granular Backfill

Gravity Pipe Inlet

Pressure Main
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

**Pre-earthquake**
- Screens 4
- Grit traps 5
- Primary sed. tanks 7
- Trickling filters 2
- Contact tanks 4
- Clarifiers 4
- Ponds 6
- Outfall 1

**Post-earthquake**
- Screens 4
- Grit traps 5
- Primary sed. tanks 7
- Trickling filters 2
- Contact tanks 4
- Clarifiers 4
- Ponds 6
- Outfall 1

- Polymer dosing
- Peroxide dosing

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Platinum Partners: FIG NZIS
Diamond Partner Trimble esri
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

Pre-earthquake:
- Screens 4
- Grit traps 5
- Primary sed. tanks 7
- Trickling filters 2
- Contact tanks 4
- Clarifiers 4
- Ponds 6
- Outfall 1

Post-earthquake:
- Screens 4
- Grit traps 1
- Primary sed. tanks 2
- Trickling filters 2
- Contact tanks 4
- Clarifiers 4
- Ponds 5
- Outfall 1

Polymer dosing
Peroxide dosing
Lesson #2 – Layers of protection

Levels of Protection

- Ocean Outfall
- Oxidation Pond
- Treatment Plant
- Public Health Risk
- The community
- The community

Public Health Risk
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