COMMUNICATION OUTAGES DURING EXERCISE BLACK FAULT FEBRUARY 2015

Exercise Black Fault was designed to reproduce conditions that might occur during a major earthquake in the Lower Mainland of British Columbia. The M6.3 Lyttelton Earthquake took place on February 2011 at 1215h; the epicenter was located 10 km outside of Christchurch, New Zealand, was 10 km deep and resulted in more than 180 deaths. This was one of the four major earthquakes that occurred in the Christchurch area in 2010 and 2011. Findings from this earthquake (and others) were used to simulate communication conditions that could reasonably be expected to occur in the Lower Mainland given the similarities in buildings, systems and recentness. It should be noted that the New Zealand earthquake was 100 times **less** powerful than the M8.3 earthquake used in Exercise Black Fault.

PARTICIPANT FEEDBACK ON EXERCISE BLACK FAULT

Participant feedback from the post-exercise focus groups revealed that some pods experienced communication problems and/or had certain expectations about the communication facilities that they would have available during the exercise, or even compared them to communication facilities available during their own EOC training exercises. Some of the communication issues experienced during exercise Black Fault were deliberately built into the exercise to mimic the situation in Christchurch, New Zealand, others unintentionally surfaced during the exercise. Since British Columbia has not experienced a major earthquake in recent history, similar to the one in Christchurch or worse, there is no way of knowing how communication services in the Lower Mainland will perform in the event of a major earthquake. To better prepare ourselves for the impact of a future earthquake we can learn from others, especially those whose built environment resembles ours, like Christchurch or major cities in California, Oregon or Washington. To learn from one of the most recent experiences, the sections that follow summarize the impacts of the Christchurch earthquake on the availability of Emergency Telephone Services and the consequences for first responders.

COMMUNICATION SERVICES DURING THE FEBRUARY 22 2011 CANTERBURY EARTHQUAKE IN NEW ZEALAND[1]

Emergency Service Providers (ESP) were asked about the effectiveness of their own business continuity plans. The Fire Service maintains operational capability that is independent of Telecommunication Service Providers (TSPs). The Fire Service noted that its Land Mobile Radio

[1] Much of the following information has been directly quoted or adapted from *Emergency Telephone Call Services and the February 2011 Christchurch Earthquake: A Review for the Ministry of Economic Development* by Tony Fenwick (August 2011.)

(LMR) network, local ICG repeaters, and satellite connectivity (limited) were available following the earthquake. ***Ultimately, Fire noted that ESPs should be prepared for total loss of all terrestrial and satellite based telecommunications.*** *(Fenwick, 2011, p.29)*

Loss of Landlines: *Widespread electricity outages immediately impacted cordless landline handsets, since they were reliant on electricity*. Handsets and PBXs at commercial premises, schools etc. were affected unless the site had back-up electricity such as batteries and/or a generator. Electricity outages also affected cabinets (battery life is limited). *Landline services were further disrupted due to cable failures*, especially local copper lead-covered cables in eastern suburb liquefaction zones. *(Fenwick, 2011, p.5)*

111 customer service (the equivalent of our 911) was unavailable **due to PSTN network failure** ("PSTN Network" is defined as local exchanges and PSTN Cabinets, not including local access cables): *PSTN customer service loss reached a peak of 9,100 customers on 23 February*, was down to 5,700 customers on 24 February, and reached zero on 25 February. The network failure mode was principally due to batteries failing at sites without generators and was eventually recovered by both generator deployment and commercial mains restoration. 111 customer service was also unavailable due to local access failure: this was due to seismic damage to copper cables (no local access fiber cables failed). There was extensive damage to copper cable networks, principally in eastern suburbs. *Recovery involved cable overlays and jointing – a slow, manual, process*. *(Fenwick, 2011, p.5)*

Communications with Christchurch Emergency Response Centre (CRC). Telecommunication Service Providers (TSP) sought to communicate with CRC authorities in Christchurch but it took *around three days for effective communication to commence (Fenwick, 2011, p.14)*. Almost immediately after the event Telecom deployed two of their EM staff into the CRC with no defined role other than "to make things happen" with respect to telecommunications. They brought their own laptops plus T sticks as the CRC "had no effective communications."[i]

Cellular Coverage: *Physical damage to towers impacted immediate cellular performance*. Cell site coverage generally overlaps and the failure of a cell site does not necessarily equate to a loss of phone coverage, however, multiple failures occurred. One Telecom cell tower was damaged by rock-fall, and another failed through building collapse (PGG Building). Telecom reported that three XT sites and ten CDMA sites were down and that a number of others were running on batteries. Masts at a number of cell sites developed leans. *(Fenwick, 2011, p.5)*

Five Vodafone sites were not recoverable due to damage to buildings on which they were located, and four more were on buildings likely to require demolition. A further 17 Vodafone sites needed relocation due to subsidence, or remedial work. A few sites suffered from transmission failures (damage to buried cable links). *(Fenwick, 2011, p.5)*

2degrees (a telecommunications company) noted four sites with structural damage, including one on the CTV Building (the building was destroyed but the site remained operating for some hours), two with shifted foundations where temporary repairs were possible (these were in eastern Christchurch), and another on a building likely to be destroyed (that cell site however remained operational pending demolition). 2degrees also noted that three of their sites were down, and that 70 of 96 operating sites were running on batteries. *(Fenwick, 2011, p.5-6)*

Electricity supply in central and east Christchurch was the main issue for the TSPs from the first day and subsequently. Batteries generally supported telecommunications systems in the first few hours, but systems came under additional pressure when batteries were depleted. Vodafone commented that, typically, batteries are designed for four hours runtime for an average urban cell site. Some higher priority sites may have 8 or 12 hours battery backup. *Thus, cell phone coverage that may have been available shortly after the earthquake became unavailable as batteries ran down*. *(Fenwick, 2011, p.14)*

Twenty-four hours later

> "Disruption to landline and mobile services continues, and widespread power outages mean large parts of the network are still working off backup power. The mobile network remains significantly affected. A number of cell sites are inoperative with others still heavily congested." *(Fenwick, 2011, p.15)*
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> Early responses to improve services included engineering inspection of key sites, calling up staff and contractors able to assist and initial deployment of generators. Vodafone and 2degrees down-rated their 3G mobile systems, prioritizing voice and texts over data to conserve batteries. Generator deployment began promptly (e.g., Telecom imported 80 generators within 12 to 24 hours from other New Zealand locations - Air Force transport was used). *(Fenwick, 2011, p.14)*
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> In emergencies, TSPs purchase petroleum for generators from service stations. Petroleum distribution, both in bulk to service stations and by TSPs and their contractors after purchase, was impeded by road conditions. Petroleum purchases were generally facilitated by arrangements which treated TSPs (and other lifelines) favorably, as emergency services, e.g. by admitting TSP refuellers to special lanes. *Nevertheless, many logistical difficulties arose in accessing and distributing petroleum. (Fenwick, 2011, p. 22)*

Forty-eight hours later

> The National Crisis Management Centre Situation Report noted on 24 February that 36 Vodafone sites were not operating due to exhausted batteries and that another 23 were running on generators. *(Fenwick, 2011, p.17)*

Texting: NZ Fire Service reported anecdotal comment that delays up to four hours in delivering text messages occurred after the earthquake. Text messaging, in common with voice traffic, increased very substantially after the earthquake. Texting is a "store and forward" service (for this reason it is not well-suited to emergency connectivity although special arrangements are in place for the hearing impaired). Therefore the text system was initially able to cope better than voice with the surge in traffic as messages were stored (rather than failed) when traffic exceeded the capacity of the text interconnect links. *Success rates dropped in the hours immediately after the earthquake due to congestion in Telecom and other mobile networks. (Fenwick, 2011, p.8)*

2degrees noted that, due to prolonged issues with text interconnect infrastructure (notably towards Vodafone) there were ongoing problems with delivery until late on 22 February. Due to the build-up of stored messages, there was a failure in the 2degrees text message infrastructure causing a network element (SMSC) to reset. In turn, this caused the loss of some messages (number indeterminate). Once the interconnect link to Vodafone was restored, the service recovered. *2degrees' text infrastructure operates at a national level so the effects above applied for all text traffic*. *(Fenwick, 2011, p.8)*

Radio Traffic: While almost all emergency calls were successful on 2degrees's Christchurch 2G radio network (i.e. between the handset and the Base Station), *only a small proportion of these were ultimately successful* (the difference was due to congestion at another point, mostly beyond the 2degrees network). Vodafone commented that they *experienced blocking (congestion) in the radio interface* (between the handset and the cell site), which occurred from the time of the earthquake until 1 p.m. on the following day. TelstraClear, which offers cellular and landline services, suffered water inundation and was reliant on generators at two key CBD sites. TeamTalk which provides voice communication services for ambulance (by radio), reported that its key sites were working as normal on mains power, other than at the TVNZ Building in Gloucester Street which was running on a generator. *(Fenwick, 2011, p.7 & 9)*

Several NZ Fire Service brigades and stations worked in isolation for a considerable time without knowing if additional assistance was coming to support them or what the priorities were.[ii] The LMR/VHF radio network continued to operate but was overloaded in the initial stages. The UHF/IGC radios were operating and available however the

duration of the incident high-lighted the need for additional back up batteries. The UHF ICG repeater was knocked out when the earthquake struck thus restricting transmission to line of sight.

AFTERMATH OF THE 2010/ 2011 CANTERBURY EARTHQUAKES

The September 2010 earthquake had a higher magnitude (M7.1) than the February 2011 earthquake (M6.3), however there was no loss of life and only few serious injuries. Some older buildings (mainly those built prior to the 1940's) made of brick and masonry and without proper reinforcement sustained damage. The region experienced many aftershocks until it was hit by the M6.3 earthquake on February 22, 2011. This earthquake led to the deaths of 185 people, most of them were killed by building collapse. There were about 6,600-6,800 people injured in the quake. About one quarter of the buildings in the Central Business District have since been demolished (both older, historic and modern buildings). Uninhabitable homes and lack of basic services (electricity, sewage, etc.) led approximately 70,000 people to leave the city and either move into temporary housing or move to adjacent cities and towns. *(Encyclopedia of New Zealand; http://teara.govt.nz/en/historicearthquakes)*

The earthquake caused intensive damage to the region's publically owned infrastructure. The total damage is estimated at 2 billion NZD, and repairs and replacements are still being carried out (expected completion of the work is by the end of 2016). Of the road network about 1,021 km (52% of the urban sealed roads) need repairs or replacements, excluding work to bridges, footbridges and retaining walls. About 500km wastewater pipes (31% of the total network) were damaged, and 100 sewer pumping stations need repairs or rebuilding. Fresh water services were also affected, about 51km of water mains were damaged, accompanied by damage to water reservoirs and fresh water wells. All but 64 (out of 175) of the fresh water wells needed repairs.
(Stronger Christchurch Infrastructure Rebuilt Team (SCIRT); http://strongerchristchurch.gov.nz*)*

The wide-scale destruction in the central core of Christchurch and the surrounding areas has created the opportunity for the city and the region to redevelop. The Christchurch Central Recovery Plan (CCRP) outlines plans to rebuilt and reshape Christchurch into a "greener, more accessible city, with a compact core and a stronger built identity". The Plan contains 17 anchor projects to be carried out, and addresses issues such as changing in zoning, permitting of activities in certain areas, building heights, consistent good-quality urban design, and more. *(Christchurch Central Recovery Plan; https://ccdu.govt.nz/the-plan/christchurch-cetral-recovery-plan)*

The Land Use Recovery Plan (LURP), which was installed on December 6, 2013, covers the urban area of Christchurch (excluding those areas that are discussed in the Christchurch Central

Recovery Plan), where approximately 10,000-20,000 houses were lost as a result of the earthquakes and aftershocks. The LURP outlines plans for approximately 40,000 new houses and business properties to be built in residential areas in Christchurch and neighboring towns, by rezoning of greenfield areas and by intensification in existing urban areas. *(Canterbury Earthquake Recovery Authority (CERA); www.cera.govt.nz/lurp)*

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[i] McLean, I., Oughton, D., Ellis, S., Wakelin, B., & Rubin, C. (2012). *Review of the Civil Defence Emergency Management response to the 22 February Christchurch Earthquake*. Retrieved from http://static1.squarespace.com/static/5006875e24ac21f35d8de8d2/t/51624a1fe4b080e511781833/1365395999422/ReviewOfTheCDEMResponseTo22FebChchEarthquake_Final+Report_4+July+2012.pdf

[ii] Director of Operational Efficiency assisted by the NZFS Internal Audit team. (2011). *Chief Executive/National Commander's Inquiry into Canterbury Earthquake 22 Feb 2011*. Retrieved from http://www.fire.org.nz/Media/News/Documents/Christchurch%20inquiry%20report.pdf