greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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Committee	CDEM Group
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Lifelines utility restoration times following a Wellington Fault earthquake

1. Purpose

To inform the Committee of the work being carried out by the Wellington Lifelines Group and its members in establishing times to restore utility services following a Wellington Fault earthquake. While the work is incomplete, this interim report provides critical information that will assist in civil defence emergency planning.

2. Overview

The Wellington Lifelines Group (WeLG) was the first Lifelines Group to be established in New Zealand. Previously known as the Wellington Earthquake Lifelines Group, and formed in 1993, WeLG re-named in 2009.

WeLG comprises Lifelines Utility owners that operate in the Wellington Region, including the Territorial Authorities, Crown Entities (such as NZTA) and private companies (such as telecommunications companies). WeLG's primary purpose is to "*co-ordinate the physical risk management activities of Wellington utility and transport service providers in relation to regional scale events that affect a number of interdependent organisations*".

The recent focus of WeLG has been on understanding the likely restoration times for key lifeline utility services, following a major earthquake involving a rupture of the Wellington Fault. A range of projects have been undertaken, as part of an overall work programme to update the original Centre for Advanced Engineering study (1991) which contained a preliminary assessment of restoration times. WeLG has also sought to consolidate what has been learnt over the past decade from the Wellington Region CDEM Group's *Exercise Phoenix* series of exercises.

This work also ties in closely with the *It's Our Fault* project being led by GNS Science, which is supported by a number of members of the Wellington Region CDEM Group.

The physical vulnerability of Wellington's roading and utility networks to earthquake, in conjunction with the strong ground shaking and permanent ground deformation associated with a major fault rupture, gives rise to substantial estimated times to restore lifeline utility services to the community. The implications of these timeframes for the community and local and central government are significant. Risk reduction and readiness initiatives to address the community impacts require careful planning and prioritisation. It should also be noted that the 2010 and 2011 Canterbury Earthquakes have led to a significantly heightened appreciation of the impacts of a major earthquake on Lifeline utility services.

A rupture of the Wellington Fault is considered to represent a worst-case but realistic scenario for CDEM planning purposes. It is acknowledged that it is but one earthquake scenario, with at least four other active faults affecting the Wellington region. In addition to the subduction interface below Wellington, other hazards such as flooding need to be planned for. This report summarises the recent work undertaken by WeLG and other agencies, key findings in relation to likely utility restoration times, and the proposed work to address the issues raised.

3. Context: The principal vulnerabilities

Due to its topography, Wellington is particularly susceptible to a major local earthquake. Although such events are rare, a 'direct hit' from a large event would have serious consequences for the region. Although the recent earthquakes in the Canterbury Region have demonstrated the vulnerability of infrastructure to such events, Wellington, with hilly terrain and relatively restricted corridors for infrastructure, is more vulnerable.

The *It's Our Fault* project identifies that there is a 10% probability of a major rupture of the Wellington Fault within the next 100 years. Such an event would be of a magnitude of about Richter 7.5. The Wellington Fault ruptures on average every 900 years, with the last major rupture having occurred around 400 years ago.

In terms of actual shaking effect, the majority of Wellington's infrastructure lies within a zone that would be subjected to shaking intensity of MM9 or MM10. At the fault line itself, it is anticipated that a Wellington Fault rupture would produce a maximum of 4 to 5m in horizontal movement and up to 1m in vertical movement. The Wellington Fault is, however, just one fault that may produce earthquakes affecting the region [refer Section 3].

The above shaking and fault rupture would have considerable effects on the Wellington lifeline utilities, summarised below in Table 1.

Table 1: Overview of Key Lifeline Utility Vulnerabilities in Relation to the Wellington Fault

Hazard/Threat	Example Locations	Lifeline Utility Affected
Fault Rupture	From Karori through to Kaitoke	Bulk water network (six locations)
		State Highways and local roads
		Bulk gas
		33KV gas-filled electricity cables
	Silverstream crossing	Wastewater pipeline
	Kelburn and Paremata	Fibre optic cables
Landslide	The four land entry-points to Wellington (SH1 Paekakariki to Pukerua Bay, the Paekakariki Hill Road, the Akatarawa Road and SH2 Rimutaka Hill Road)	Roads
	SH58 Haywards and SH2 Horokiwi	State Highways and rail (Horokiwi only)
	All areas, but particularly in hill-side locations	Local arterial and other roads and rail lines
Liquefaction	Petone/Seaview	Access to the fuel terminals at Seaview, roads and buried water and wastewater pipes
	Porirua CBD	Water, wastewater, roads, gas and electricity
	Cobham Drive and Moa Point, near airport, Wellington	Roads
	Aotea Quay	Container Terminal

4. Recent work

The GNS Science-led *It's Our Fault* project set the scene for a greater understanding of the likelihood and impact of a rupture of the Wellington Fault. The 'Likelihood' phase of this project has established that the interval between large Wellington Fault earthquakes appears to be longer. The most recent rupture of the Wellington Fault is younger, and the 1855 AD earthquake on the Wairarapa Fault de-stressed the Wellington Fault. This hasn't diminished the importance of understanding the consequences of such an event, rather it highlights that more frequent, moderate-sized local earthquakes (magnitude 6.0–7.0) or larger distant earthquakes, may be a more important focus in terms of planning and preparedness than infrequent large local events.

In 2010, following work conducted by the Greater Wellington Regional Council (GWRC) on bulk water supply restoration times, in conjunction with WeLG, GWRC worked on the development of a framework for analysing restoration times for various lifeline utilities (roads, electricity, water etc.). The restoration times were created from information provided by the various lifeline utilities.

Recently, the various roading authorities (NZTA and the roading departments of KCDC, PCC, UHCC, HCC and WCC) have been collaborating on understanding the restoration times of the roading network. In addition, NZTA have produced pre-plans for restoring roading access on State Highway 1, and are currently working on similar sets of pre-plans for State Highways 2 and 58.

In addition to these individual agency or sector-led projects, WeLG has been facilitating a series of cross-sector projects. This includes the *Priority Sites for Utility Restoration*, a project which identified lifeline utility interdependencies. An example of lifeline utility interdependency would be a telephone exchange that requires electricity supply to function. Another ongoing WeLG project is the *Critical Areas* project. This project has gathered information on the key areas of Thorndon, which contains a heavy concentration of utilities within a small area, and Petone/Seaview, the location of the main fuel storage depots in the region. In addition to the above projects, work continues on issues such as gas and electricity reconnection protocols and electricity reconnection communications arrangements.

5. Summary of likely restoration challenges

Following a major earthquake of the magnitude outlined above, the various lifeline utilities would have different challenges in restoring services. These can be summarised broadly as follows:

- Road networks would be heavily impacted, with some road structures, particularly bridges, suffering major damage. Large landslips, such as seen at the 2011 Manawatu Gorge landslip event, can be time consuming to clear, particularly where the slip must be tackled 'top-down', or from each end of the slip working towards the centre.
- Water networks by their nature are generally buried and long. This raises the possibility of multiple breaks in the networks, not just at the fault crossings but also, for example, at pipe branches and in liquefaction areas. In restoring service on such a network, breakages are identified from the 'upstream' end of networks (nearer the intakes). Each section of pipework is pressurised to identify the breaks and faults are repaired. Working downstream, the network is progressively re-established. This is a time-consuming but necessary procedure, where multiple sections of upstream and downstream work cannot proceed together, but require the above 'linear' process to be followed.
- Electricity network restoration is similar in nature to water networks, in that restoration starts 'upstream' (from the national transmission grid) and works via the local distribution network towards the end-users, or customers.
- Other lifeline utilities have similar constraints to those outlined above. For example, the gas networks will have similar restoration philosophies to water, and rail and road network restorations face similar issues.

Whilst the above identifies some of the challenges faced in restoring services, it is rather simplified. Some networks may have only partial services working. For example, roads may have damage that limits use to single lane access only, or water may be available in areas but at a reduced pressure. This is why WeLG developed a description of levels of service, as summarised in Table 2.

Table 2: Description of 'Emergency', 'Survival' and 'Operational' levels of service

	Emergency level of service	Survival level of service	Operational level of service	Full (normal)
Land Access	No clear road access. Site storage by end users.	Single lane with speed restrictions; priority usage direction.	Two-way speed restricted; closure periods likely, truck movements from Palm Nth.	
Water	Site storage by end users / distributed from reservoirs / temp plants (Assume 20 litres/person/day.)	Limited/ intermittent supply available through mains; requires boiling; restricted in volume.	Treated water through mains but subject to frequent disruptions for local network repairs.	Meet Drinking Water and normal quantity availability standards with only occasional service disruptions
Power	No service.	~90% of normal coverage, with service disruptions.	~90% of normal coverage, with service disruptions.	

The complexity of describing the restoration of single lifeline utilities, quite apart from summarising across a number of different types of utilities, means that summarising overall effects from a single earthquake becomes relatively simplistic. The earthquake scenario of a Richter 7.5 event and its effects are also hard to accurately predict. This is why the restoration times and their assumed interdependencies in the restoration summary will only ever be indicative. The effects of one earthquake may also be magnified or diminished simply through the availability of one section of road, or one part of a water network. So, whilst all of the lifeline utilities have participated in producing the restoration time summary, the times given are indicative only and not definitive.

It should also be noted that, these restoration times don't take into account other alternative access measures. For example, even if land access is not available, other means of transporting people and goods may be available, or partially available - for example, transport by sea or air.

Some examples of the implications of potential restoration times might be:

- At the Wellington CBD, it could take up to 120 days for land access to be restored, 40 days until 'survival' levels of water supply were restored (limited/ intermittent supply available through mains; requires boiling; restricted in volume.)
- At the Hutt Petone area, it could take 21 days until water supplies are restored to 'survival levels' and up to 120 days until road access is re-established from Wellington to the remainder of the North Island.
- In the central Porirua area, it could take up to 120 days for land access to be restored, and 40 days for 'survival level' water supplies to be available.

In reflecting on the lifeline utility response to the September 2010 and February 2011 Canterbury earthquakes, it should be recognised that the Wellington region is very different to the flatter topography around Christchurch. The various utilities that supply Wellington have to be constructed around and over hills and slopes. This is reflected in the longer

recovery times that would be required following a 'direct hit' earthquake in the region.

6. Forward work programme

The work undertaken by WeLG, and the various lifeline utilities, to understand the vulnerabilities of the region's own networks and assets has led to the identification of the following current and future projects. It is anticipated that this work will be complete by the end of August 2012:

- A set of workshops will be held mainly in June and July 2012 to help ascertain with greater certainty the likely restoration times following a major Wellington earthquake.
- Further work on the *Priority Sites for Utility Restoration* project will lead to a greater understanding of interdependencies of the various lifeline utilities. The project will provide a better platform to plan for a range of hazard events, not just earthquakes.
- Further work on the *Critical Areas* projects, including more work on the Thorndon and Seaview areas.
- Transport access is a key issue that underpins the operations of many lifeline utilities. WeLG is leading a new project to understand better the nature of land access vulnerabilities, which will build upon recent and ongoing work being carried out by NZTA and the various roading authorities in the region. These workshops will take place in July and August 2012.

All of the above work will be carried out in conjunction with the final 'Impacts' phase of the *It's Our Fault* project, which will be actively engaging with lifeline utility providers regarding the effects of a rupture of the Wellington fault.

In addition, the Wellington Regional Emergency Management Office (WREMO) is now working with WeLG to co-ordinate this work with the organisations involved.

7. Summary

Technical studies have been conducted by various Wellington Lifelines organisations over recent years. These studies clearly demonstrate the vulnerability of Wellington to a large Magnitude 7.5 earthquake.

Some examples of the implications of potential restoration times are shown in Section 4. It should be noted that, summarising restoration times involves a range of assumptions and uncertainties. This means that figures should be regarded as being indicative only.

The restoration times demonstrate that in the Wellington CBD it could take 40 days until water supplies are restored to 'survival levels', and even longer for the Eastern and Southern suburbs. It may take 120 days until road access is re-established from Wellington to the remainder of the North Island.

An earthquake involving rupture of the Wellington fault would be a worst-case event, with the likelihood of occurrence being 10% within the next 100 years. Active on-going planning by the Wellington Lifelines Group and utility organisations for such an event (or other earthquake events of lower magnitude but collectively a higher likelihood) is prudent.

Planning for such an event is a task for the newly formed Wellington Region Emergency Management Office, alongside the various Wellington Lifelines organisations that are responsible for the items of infrastructure. Specifically, work continues on understanding these vulnerabilities better, and the potential consequences to the population. Also, discussions are underway regarding logistical arrangements that may be put in place to get essential supplies to Wellington by air and sea.

WeLG and WREMO are continuing these discussions, and will be able to report more on details of the work programme, as the issues are better understood.

8. Recommendation

In view of the above report, WeLG recommends that the Joint Committee:

1. ***Receives** this report.*

2. ***Notes** the additional work to be carried out by WeLG and its members regarding restoration times, for which WeLG intends to provide periodic updates.*

3. ***Directs** WREMO to incorporate the contents of this report into their planning assumptions.*

4. ***Directs** the various Councils, and **advocates** for the various other Lifeline Utility organisations, affected by these restoration times to take this report into account in their infrastructure and civil defence planning.*

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