

# TAKING ACTION ON RESILIENCE, WELLINGTON'S STORY

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## ABSTRACT

Our region is vulnerable to natural disasters, particularly, to earthquakes. This is a fact of life for those living in the Wellington region as it is located on or near major fault lines, such as the Ohariu, Wellington and Wairarapa faults. The Culverden Earthquake of November 2016 demonstrated that significant earthquakes, and indeed other natural disasters, can badly affect our region's buildings and infrastructure while disrupting business and everyday activities. It was a timely reminder that we need to consider how best to prepare our region's water supply network so it can recover as efficiently as possible from a significant earthquake if one was to occur under or near Wellington.

Our long term goal is to provide 80% of our customers, within 30 days of a reasonable seismic event, with at least 80% of their water needs. Our strategy to achieve this long term goal is called Towards 80-30-80. It is premised on the levels of service we have agreed with our client councils, and is underpinned by our strategic thinking that we need to increase community support in the shorter term, whilst focusing on regional risk reduction in the longer term.

Under the status quo, we expect parts of Wellington to be without drinking water for up to 100 days, Porirua to be without drinking water for up to 40 days and the Hutt Valley to be without water for up to 30 days (and on the Western Lower Hutt Hills, up to 50 days). In addition, more than 100,000 people could be displaced following a significant event; many of whom will require immediate access to clean drinking water and sanitation facilities (as well as other lifeline essentials). Displaced customers are not only local residents, but tourists and visitors in the region.

This paper:

- Introduces the strategic thinking that led to the development of 80-30-80; setting out a path of small, incremental milestones that bring us closer to our long term goal
- Outlines how we are converting our strategy into a targeted programme of works to make our network more resilient, underpinned by smart investment principles
- Presents our short term resilience action plan that is underway, designed to bring about a significant step change in emergency levels of service for our communities across the region

Towards 80-30-80 sets in place a pathway that will enable us to stage improvements to our water supply network over time. Doing so will ultimately see our water supply network well-prepared for a significant earthquake – it will be '80-30-80 ready'.

**Key words:** resilience, strategic planning, network planning, innovation, smart investment

## **WHY ACT NOW?**

Within the space of three years, our region has been shaken by three significant earthquake events. Buildings and infrastructure, including our water supply network, were damaged and access to parts of the Wellington CBD were restricted. Our businesses, travel plans and everyday lives were disrupted.

The Culverden Earthquake of November 2016 served as a stark reminder of what might happen if a significant Wellington-centred earthquake was to occur. This includes the following likely impacts:

- Isolation of each city within the region, and isolation of communities within each city.
- Parts of the region will not be accessible for days or weeks.
- There will be limited access to food and water supplies.
- There is likely to be insufficient awareness of what to do, where to go or how to get by.
- And most importantly for us, infrastructure – including the water supply network - is likely to be heavily damaged and inoperable.

The recent earthquakes have exposed our region's vulnerability, and raised awareness that another event could happen at any time. We know that our water supply network is fragile, and is particularly susceptible to damage from a significant event.

These recent events have emphasised that it will take time and commitment to prepare our community and reduce the risk presented to the current water supply network. Our strategy for moving forward is Towards 80-30-80.

Towards 80-30-80 is a plan to make sure that in any given year, we are as prepared as we can be to meet the challenges of recovering from a significant event. Over time major infrastructure improvements will reduce supply risks, while in the shorter term, greater emphasis on personal and community resilience will improve our region's ability to cope with the aftermath of a significant event. Towards 80-30-80 sets out a path of small incremental milestones that bring us closer to our long term goals of resilience and preparedness.

## **OUR JOURNEY**

Our region is vulnerable to natural disasters, particularly to earthquakes. This is a fact of life for our region as it is located on or near major fault lines, such as the Ohariu, Wellington and Wairarapa faults. The Culverden Earthquake of November 2016 demonstrated that significant earthquakes, and indeed other natural disasters, can badly affect our region's buildings and infrastructure while disrupting business and everyday activities. It was a timely reminder that we need to consider how best to prepare our region's water supply network so it can recover as efficiently as possible from a significant earthquake if one was to occur under or near Wellington.

We started this journey with a Water Supply Resilience Strategic Case that set the context for development of this strategy. In particular, it identified the following key problem statements (in summary):

- The network crosses numerous fault lines.
- The network itself is fragile and susceptible to breakage.
- The linear configuration of the network provides no redundancy.

- There will be disruption to other utility providers following an earthquake.

Following the completion of the strategic case, we produced an 'early' draft programme business case. Key aspects included:

- Developing further details on specific individual projects that were likely to make up the final recommended programme.
- Engaging with 'critical customers' (such as, hospitals and lifelines) and with other infrastructure providers (such as, transport and electricity) within our region on how to work better together as a collective.

Feedback from critical customers indicated that most had water storage plans in place, but the amount of water stored varied (with some not making enough provision). Our work with other infrastructure providers indicated that there were key interdependencies between the providers, and that there was a need to work even closer with them in the future to improve the overall resilience of our region.

We recognised that the final recommended programme needed to be one that was achievable, smart and delivered a 'value for money' outcome for our client councils. As a consequence, the draft programme business case evolved into the Towards 80-30-80 strategy.

During development of Towards 80-30-80, when engaging on resilience matters, there were a number of people and businesses who often drew comparisons with the impacts of the Christchurch Earthquakes of 2010 and 2011 and what might occur in this region. The overall impacts of these earthquakes were undoubtedly severe, but from a water supply perspective Christchurch was able to largely ride through the events of 2010 and 2011. This was due to the water supply network being fed by bores distributed throughout the city; in effect a spider's web style system which is adaptable to faults. Wellington's system by comparison is long and skinny and dependent on just a few strands. It is important to highlight this difference as it carried significant weight when evaluating options that eventually made up the recommended programme.

## **UNDERSTANDING THE PROBLEM**

Looking at the number of customers in our region is a helpful way to understand the scale of the restoration gap. We have almost 390,000 people who rely on our water supply network every day. A significant earthquake will likely disrupt water supply to a large portion of the population for a long time.

Figure 1 (over page) depicts the variable restoration times across the region. The restoration times are a culmination of the fact that the water supply network crosses multiple fault lines and many customers are a long way away from one of the region's three water sources that feed the network. With no viable network alternative in many parts of the region, our customers will need to wait until repairs are carried out before drinking water can be restored. It is notable that parts of Wellington City are likely to be without drinking water for up to 100 days. This represents a serious risk to our customers' safety, and to the ability of the region to recover from a significant earthquake.

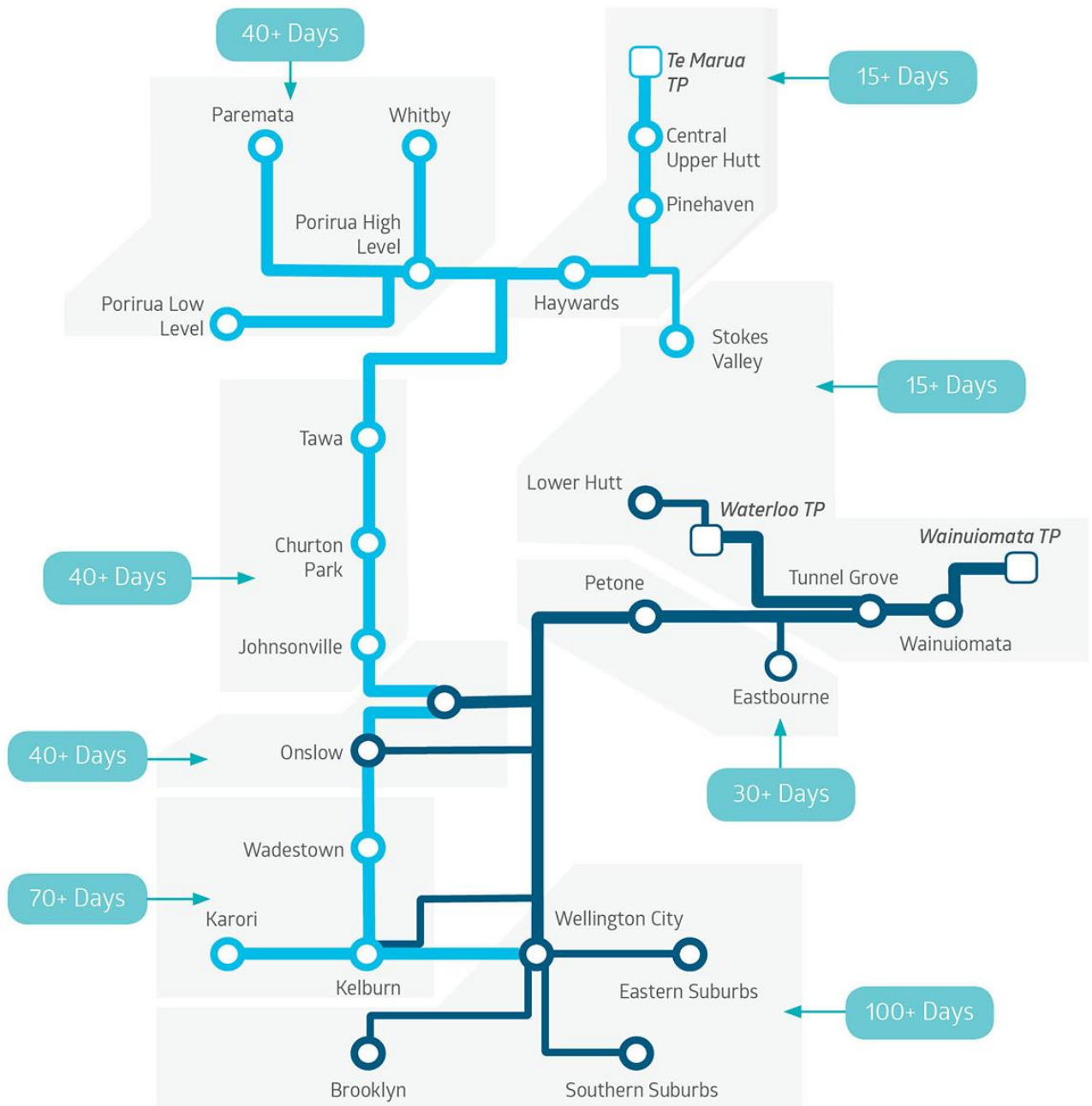


Figure 1: Expected water supply restoration times following a significant event

## PUTTING PEOPLE FIRST

Our long term goal is to provide 80% of our customers, within 30 days of a reasonable seismic event, with at least 80% of their water needs. This is where the term 80-30-80 is derived and marks our end goal whereby the region's water supply network is '80-30-80 ready' prior to a significant event. When developing Towards 80-30-80, we have based our thinking on the following two key concepts:

**Concept 1: We need our region to be made up of 'Resilient Communities, Services and Cities'**

To achieve this position, we need to ensure that our communities and the water supply network is capable of operating as if Wellington was a series of ‘islands’ isolated from the regional network. This means:

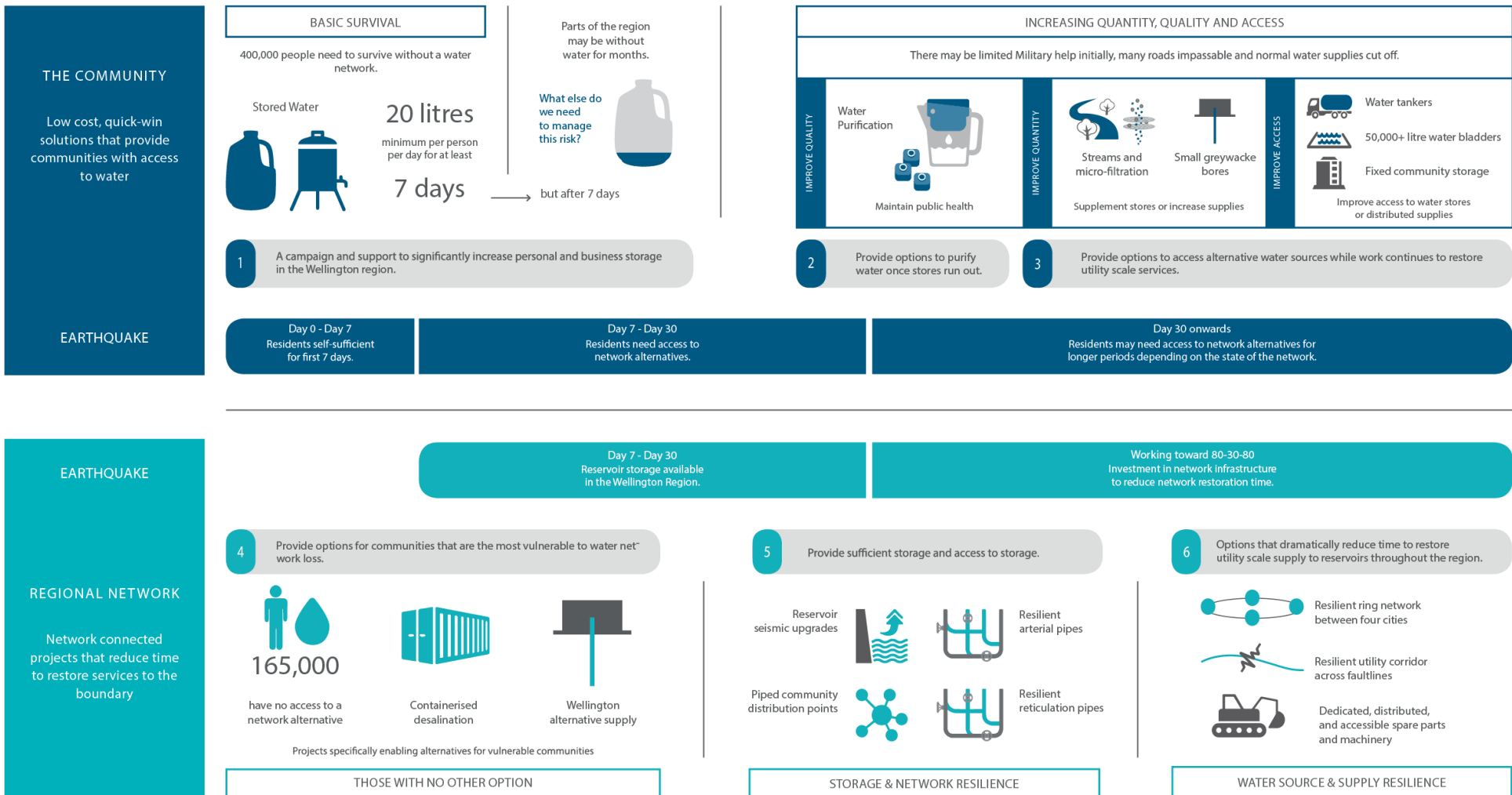
1. **Resilient Communities** – will need to be supplied with clean drinking water, but will also be self-sufficient to enable priority repairs to be made and distribution centres to be established.
2. **Resilient Services** (these are our services) – will be able to supply drinking water to our communities and will be resilient in their own right. Not only will key aspects of the bulk and reticulation network be resilient, but our equipment and operations (including staff) will be resilient as well.
3. **Resilient Cities** – the economic engines of our region, and for which rapid recovery is vital. Our key reservoirs, pump stations and reticulation infrastructure will be resilient, but also ‘smart’ – that is, be able to report improvement state and resume or re-route to quickly achieve near normal operation.

**Concept 2: Our network will progress through four states of operation**

Understanding how each part of our network recovers through various states of operation helps prioritise investment and ensures we deliver outcomes which increase quality, quantity and access to a water supply.

<ul style="list-style-type: none"> <li>• <b>Basic survival</b> – No alternatives. People will need to use their own personal storage along with rain water to get by. They will need at least 20 litres per person per day for the first 7 days, but need to be prepared to be self-sufficient for even longer.</li> <li>• <b>Basic living</b> – Minimum alternatives. The community will access drinking water via local water distribution points. These points will be connected to existing network reservoirs and will be able to supply 3 litres per person per day.</li> <li>• <b>Basic comforts</b> – Increased alternatives. Local water sources such as streams and bores will be used to supplement water supplies. These sources aim to boost supply to at least 20 litres per person per day at distribution points whilst also providing additional distribution points.</li> </ul>	Focus is on the Community
<ul style="list-style-type: none"> <li>• <b>Near normal</b> – People and businesses will be able to access drinking water via bulk and reticulation networks as they are gradually brought back on-line. As the system gradually returns to normal, drinking water sources will need to supply at least 100 litres per person per day (which may well be the state of the water supply for months, as repair work continues).</li> </ul>	Focus is on the Regional Network

The above concepts are brought together in Figure 2 (over page). The projects and activities that make up the recommended programme are premised on turning both concepts into action.



**EARTHQUAKE**

**EARTHQUAKE**

**REGIONAL NETWORK**

Network connected projects that reduce time to restore services to the boundary

**THOSE WITH NO OTHER OPTION**

**4** Provide options for communities that are the most vulnerable to water net work loss.



**165,000**

have no access to a network alternative



Containerised desalination



Wellington alternative supply

Projects specifically enabling alternatives for vulnerable communities

**STORAGE & NETWORK RESILIENCE**

**5** Provide sufficient storage and access to storage.



Reservoir seismic upgrades



Resilient arterial pipes



Piped community distribution points



Resilient reticulation pipes

**WATER SOURCE & SUPPLY RESILIENCE**

**6** Options that dramatically reduce time to restore utility scale supply to reservoirs throughout the region.



Resilient ring network between four cities



Resilient utility corridor across faultlines



Dedicated, distributed, and accessible spare parts and machinery

**EARTHQUAKE**

Figure 2: Creating resilient communities, services and cities

## RESILIENT COMMUNITIES

Resilient Communities are our first priority. A resilient community knows how to look after itself when the normal water network is not available. We need to provide these communities with options, ranging from education on personal water storage to network alternatives such as access to alternative water sources and distribution points.

From a community perspective, our investment programme is shaped by **'bottom up'** thinking. That is, during the initial phases of recovery, communities will be able to survive and function on a combination of personal storage, distribution centres and local water sources rather than a functioning piped water supply system. It is only when services are approaching a 'near normal' state that our communities will begin to require a water supply from a tap. Even then, this may not require connection to the wider bulk water network for an extended period of time.

It is acknowledged that the community approach may not necessarily work for every service zone in our region. However, if implemented correctly, it may significantly reduce our vulnerability to a significant event as well as the overall upfront investment cost.

Our programme provides more **resilient services** to our communities through:

- Public education and raising awareness programmes to ensure people take personal responsibility for their own water supply storage (e.g. personal water storage options and rainwater collection).
- Community knowledge on personal filtration and/or treatment options.
- Planned improvement responses that enable or create access to network alternatives.

Being resilient also means ensuring communities can access enough water to prevent outbreaks of disease. This means investing in outcomes that provide communities with access to at least 20 litres of water per person per day and establishing a network of distribution points that are no more than 1000 metres from a customers' home.

## RESILIENT CITIES

From a city perspective, our investment programme is shaped by **'top down'** thinking. It is focused on providing the key infrastructure we think is required to get our region back up and running again following a significant event.

Our programme builds **resilient services** through:

- Additional distribution centres for water collection supported by a resilient water supply system to those centres.
- Upgrades to, or new, reservoirs, bulk water mains and pump stations.
- Establishment of containerised (local) desalination plants.
- Focused investment in reticulation networks.
- Refined emergency improvement response procedures.
- Better access to stores, machines, equipment and people throughout the region.

Investing in a resilient city will however take time as summarised in Figure 3 below.



Figure 3: Summary of how the Network Investment programme achieves 80-30-80

It shows that our goal will be achieved through implementing a combination of new initiatives and prioritising future improvement expenditure to our singular asset base (e.g. bulk water), the scarce asset base (e.g. core network branches) and the diversified asset base (e.g. reticulation). The approach to making each of the assets more resilient is described in more detail below.

### **Singular Asset Base - Bulk water orientated assets**

At a basic level, if our bulk water assets (e.g. treatment plants, major pipelines) are unavailable, then no water will enter the water supply network. Therefore, ensuring that we have a resilient and operating bulk network is a major focus of the recommended programme. To achieve a resilient bulk water network a number of new initiatives will need to be implemented. Consequently, the following outcomes are expected:

1. Major faults, that would normally take significant time to repair, will be effectively bypassed, and/or
2. Potential for major failures, and the associated lengthy repair times, will be significantly reduced.



### **Scarce Asset Base - Core network branches and assets**

Strategic stores, resilient trunk mains and secondary reservoirs all play a key role in conveying drinking water to the customer. Currently these assets are all relatively scarce, but not entirely without alternative means of replacement. For example, generators can be used as backup power for pump stations.

As Figure 3 shows, the main focus for making our scarce assets more resilient is to ensure our improvement expenditure is oriented towards developing these assets over time. For example, it is recommended that reservoirs within Wellington City are improved over time by focusing business as usual improvement expenditure on such an activity. This approach will gradually mitigate the single largest risk to the City, which is a lack of drinking water due to the lengthy time that will be needed to restore bulk water services. Figure 3 also shows that there is a need to implement some new initiatives in order to make our scarce resources more resilient.

### **Diversified Asset Base - Reticulation**

The supply of drinking water is dependent on a resilient reticulation network. The current reticulation system comprises of over 2000 kilometres of buried reticulation pipe, of which only 35% is currently classified as resilient. Again, by ensuring our improvement is focused on resilience, we will see the reticulation system gradually become 80% resilient over time.

It is important to consider this approach for renewing the reticulation network in the context of the new initiatives proposed for improving self-sufficiency, (i.e. people have 20 litres per person per day for the first 7 days following a significant event) and community preparedness (e.g. community water tanks/bladders). These activities play a crucial role in ensuring people have access to drinking water if a significant event was to strike prior to completion of the reticulation renewal programme.

In summary, initiatives must be implemented at both the Community and Network level in order for us to move from basic survival, where people rely on personal storage, to basic comforts where local water distribution points provide at least 20 litres per person per day after the first 7 days. It also shows the type of projects needed as water supply gradually increases to the near normal state (where at least 100 litres per person per day is provided). The near normal state will require large scale infrastructure improvements to the bulk water network to be implemented.

## **TAKING ACTION NOW**

As stated, Towards 80-30-80 is a plan to make sure that in any given year, we are as prepared as we can be to meet the challenges of recovering from a significant event. We also need to make sure our communities are as prepared as they can be to meet the same challenge.

One of the biggest hurdles in enabling recovery after a significant event is quick restoration of transportation access to communities throughout the region. Until access is restored, these communities are effectively isolated; operating as *'islands'*. This islands approach has subsequently been developed and refined in coordination with lifelines, utilities and regional emergency management authorities in Wellington.

Knowledge of each of the likely islands within the region allows us to plan for possible emergencies and ensure we have provided communities with resources that enable self-sufficiency until road access is restored and additional recovery assistance can be provided.

Toward 80-30-80 identified that reservoirs across the region can provide some emergency water to each island after a significant event. However it also identified that storage alone was not sufficient to provide the community target of at least 20 litres per person per day until network services were restored. There was a gap in our target level of service.

We are taking action and closing this gap through innovation and ingenuity by developing 22 alternative water sources across the region that will supplement water reservoirs in these islands. These alternative water sources tap underground water filtering through the fractured Greywacke in the region, or extract and treat water from various surface water streams. Each source produces between 1 to 15 litres of water per second and dramatically improves the quantity of water that is accessible in each island, allowing us to reach our goal of providing 20 litres per person per day.

We are also taking steps toward improving access to water by investing in a water distribution network. In doing so, we recognise that communities need to be able to draw on the resources available to them within each island in order to effectively implement this distribution network without our help. Our strategy therefore provides for an overland water distribution and access system based on fixed and mobile water bladders.

### ***How does this work?***

Alternative water sources in each island are being explored and developed. Each one of these water sources will be developed into what is known as a Community Water Station. These Community Water Stations serve three purposes:

1. They provide island-based storage for the emergency assets (such as bladders and tap stands) when there is no emergency.

*This enables the community to quickly access these assets and distribute them throughout the community.*

2. They provide necessary infrastructure to access water from a stream or bore.

*Installing infrastructure in the right locations ensures we will be accessing water that will not be contaminated by a significant event (eg sewage leaking into streams).*

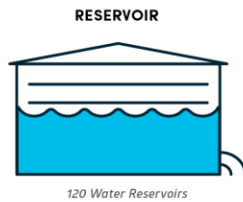
3. They push treated water into a number of large water bladders established on site for access and distribution around each island.

*These sites can produce between 100,000 and 1,000,000 litres of high quality water per day. This water is stored in large bladders (between 15,000 and 100,000 litres capacity). These bladders act as additional temporary reservoirs, emptied and refilled throughout the day as the community accesses them.*

Water is conveyed around each island using small mobile water bladders. These bladders are strapped to the back of utes or trailers and can be filled from either a reservoir or Community Water Station. These utes or trailers then transport water to Community Water Distribution Points established throughout each island. These distribution points are large 5,000 litre bladders, which are unfolded at each site after a significant event, filled from mobile water bladders, and connected to a tap stand allowing the community to collect water. This system is outlined in Figure 4 (over page).

# PROVIDING EMERGENCY WATER

## 1. WATER SOURCES PROVIDE BASIC WATER NEEDS



120 Water Reservoirs

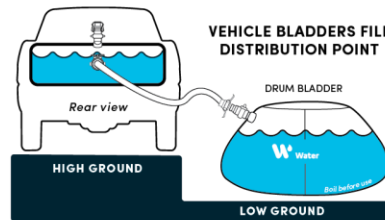
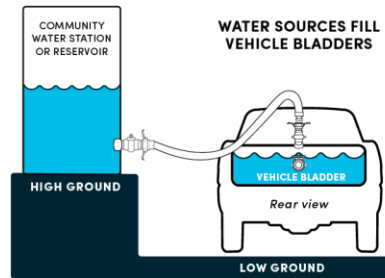
### COMMUNITY WATER STATION



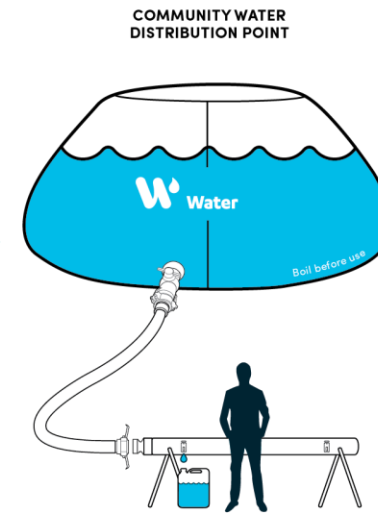
22 Community Water Stations

Residents can also collect water at these water sources.

## 2. MOBILE BLADDERS TRANSPORT WATER TO DISTRIBUTION POINTS



## 3. RESIDENTS COLLECT WATER FROM DISTRIBUTION POINTS



Distribution Points will be established within 500 to 1,000 metres of your home. These will provide 20 litres of water per person per day.

Figure 4: Providing Emergency Water

Installation of all 22 Community Water Stations will be completed by June 2018, along with procurement of more than 300 water bladders for use on utes or trailers and as distribution points. We will also utilise existing water tanks throughout the region as additional water distribution points. This will help us and our communities achieve a step change in emergency levels of service following a significant event.



### ***Why did we adopt this approach?***

We recognised a need to consider three very important factors:

1. Self-sufficiency is best achieved when the community can pool and draw on the everyday items they have access to in an emergency.
2. Value for money.
3. Time to implement a step change in service.

People are the heart of any community. Following a significant earthquake, these communities will be isolated, drawing on each other for support until regional emergency assistance arrives. A bladder based water distribution network empowers the community as residents can draw on many utes, trucks and trailers that are always available within an island. Provided residents can access sufficient stores of water (through reservoirs and Community Water Stations), they can maintain an effective water distribution network until regional assistance arrives.

We also considered both value for money and time in deciding on a preferred approach. With only 35% of the reticulated network considered resilient, we must still undertake considerable investment over the long term in order to provide communities with reticulated water supplies within weeks of a significant earthquake. Such an outcome is best achieved through prioritising renewals over the long term that directly contribute to expediting restoration of such supplies. The alternative to this approach is accelerated investment in a resilient reticulated network that still takes many years to achieve and draws investment away from other areas of need such as reservoirs, pump stations or trunk mains.

Establishing Community Water Stations and investment in a bladder distribution network was recognised as an innovative and cost effective method for achieving a step change in

levels of service. Further, the outcome of providing communities with 20 litres of water per person per day could be achieved within just 12 months at roughly 1.5% of the total cost of the network based approach. The approach further empowered communities with pre-establishment of assets in each island that were easy to use, operate and manage following a significant earthquake.

## **CONCLUSION**

Towards 80-30-80 sets in place a pathway that will enable us to stage improvements to our water supply network over time. Doing so will ultimately see our water supply network well-prepared for a significant earthquake – it will be '80-30-80 ready'.

The investment to achieve an 80-30-80 water supply network is undoubtedly significant. As such, a staged, yet targeted approach to gradually rolling out the recommended programme is required.

Notwithstanding the staged roll-out of the recommended programme, we need to acknowledge that a significant event can occur at any time. Therefore, as a matter of priority, people and businesses need to prepare themselves now, by taking personal responsibility for the first 7 days as soon as possible.