Contents

7. SEVERE STORM

7.1 Summary

Weather events are the most frequent natural hazard to affect the Auckland Region and they vary greatly in magnitude and duration. They can be widespread affecting the whole region or more localised with site specific impacts. Accordingly, they are also the most planned for and practiced.

The main effects of a severe storm event in the Auckland region arise from high winds, heavy rainfall and flooding, slope failure and storm surge.

A 1:100 year return period event is likely to have significant affects on infrastructure, particularly transport and power supply which are two of the critical lifelines for other service providers.

Transport, or more accurately, access through the road network will be affected by flooding, scouring, washouts, slips and debris from high winds. This is particularly true for more remote areas and it is possible smaller coastal communities may be cut off completely.

Secondary affects due to transport impacts are the loss of access to infrastructure for repairs and restoration, particularly in the scenario of a regionally widespread severe storm. This would particularly impact power supply, water supply, wastewater treatment and telecommunications.

The local electricity network is likely to be affected in multiple locations due to flooding, high winds and debris causing damage to lines, poles and pillars. While many lifelines that are reliant on electricity have back up power supplied by batteries and generators, getting access to these sites for refuelling in longer term outages may be problematic. It could take up to two weeks for full service restoration, particularly in more remote areas.

Cellular telecommunications and broadcasting are unlikely to be affected. However, large sections of land line users could be impacted due to the loss of power and also damage to overhead lines from high winds.

7.2 Infrastructure Impacts

During AELP-1, a scenario for an extreme tropical cyclone scenario was developed for Auckland 1:100 year return period. It is based on a number of events which were 'near misses' for Auckland, such as Cyclone Bola, and also 1:100 year return period gust and rainfall information for-the Auckland region. The cyclone was tracked such that its highest impact is on the Auckland metropolitan area.

The original scenario has been assessed with the inclusion of wind and rainfall data collected over the last 15 years and the scenario is still considered to be valid. The risk and vulnerability assessment undertaken in AELP-2 is based on the scenario.

With central pressures of 970hPa (mb) from Day 1 to Day 3, it moves south-east to lie just north-east of Northland on Day 3, before moving across Auckland and then south-east of Wairarapa by Day 4.

The cyclone initially produces wind gusts as high as 74km/hr from the north-east, then winds veer to the east and strengthen to over 140km/hr. By Day 3 the winds have veered south-east, with gusts up to 120km/hr. However the strongest winds occur on Day 4 from the south-west with gusts as high as 170km/hr.

Rainfall rates vary. Maximum hourly amounts occur in the easterlies, with rates as high as 85mm/hr. The accumulated rainfall totals for the duration of the cyclone vary from 415mm at Warkworth in the north to 230mm at Pukekohe in the south.

Wind and rainfall profiles were used to prepare a rain-induced instability hazard map. A uniform flood hazard map was used to give an indication of areas likely to be inundated during a significant (1:100) rainfall event (Figure 1).

Barometric pressure associated with the cyclone was used to develop a storm surge scenario. During the two days when the cyclone is closest to Auckland, the storm surge is estimated to be up to a maximum of 0.9m, above mean sea level (msl) on the east coast. This surge, in combination with tide, seasonal variations and wave setup effects in exposed locations, is estimated to produce a maximum still water level of 3.0m above msl.

In addition to inundation, wave runup will also cause damage. In exposed coastal areas wave runup levels are estimated to be up to 8m above msl in the Hauraki Gulf. The effects of the wave runup are influenced and dissipated by structures located in its path and for this reason a zone of 100m from the coast is considered suitable to assess damage from wave runup.

The likelihood of the 100 year cyclone scenario coinciding with the highest astronomical tide to produce the storm surge effects used for the Auckland Engineering Lifelines Project is an extreme case with a return period of over 100 years. However, storm conditions that occur more frequently can also produce a storm surge similar in size to the one the project used.

The damage to lifelines from wind, rain, flooding, slope failure, surges and wave action for the cyclone and storm surge scenarios has been qualitatively assessed and is presented as a matrix in Attachment 2.

Figure 1: 1:100 Year Flood Plains

7.3 Telecommunications

It is anticipated there will be only minor impact on the cellular service although there may be periods of overloading. The land line network is more likely to be impacted due to overhead lines being damaged by wind and debris. The land line network is also largely dependent on power to continue operating, loss of power for more than 5 hours will begin to affect users. It is unlikely that broadcasting will be affected.

Network and Service Impacts

Network Assets at Risk of Severe Storm	Expected Service Impacts
Chorus ▪ The buried copper network and its attendant distribution points are intrinsically robust against water but a persistent storm would damage overhead drop leads in the older suburban areas. ▪ Fibre optic cable is comparatively immune to water damage, but could be damaged by being stretched or kinked by slips and washouts in unstable areas ▪ Chorus has a large active distributed network throughout the Auckland area, fibre fed and dependent on power. Failure of power to these cabinets and access issues could cause progressive failure of communications from these cabinets. If the cabinets are in a flood plain, then this would also disable communications. **Telecom** ▪ No impact on overall network and only individual customers affected. 12% of Telecom's network nodes identified as being vulnerable. These are generally smaller exchange buildings and the sites are well distributed over the network area. Impact should be minimal provided access for damage assessment and repair can be taken before serious water damage occurs. The impact would be limited to suburban customer lines ▪ The cellular transmitting and receiving site antennae are rated to withstand winds in three ranges from 160-240 kph. Impact on the network assessed as relatively minor apart from the impact on individual affected customers. **Vodafone** ▪ Direct damage to cellsites and fixed-network facilities due to high winds is unlikely. Cellsite structured are typically in exposed places but are designed in line with NZS/AS1170. In practice, winds well in excess of 200kmh have been recorded at hilltop sites without any damage to infrastructure being sustained. ▪ Power outages of hours to days can be expected. This is likely to cause outages to telecommunications services as access to restore	**Chorus** ▪ The likelihood of major fibre damage is low and would only be the result of gross land movement. Most major internodal links are protected by fibre route diversity. Local customers and some Cell Sites will be affected if a fibre is lost. ▪ Services delivered into our suburban networks that have an older style of overhead service lead delivery will probably have a 10% failure. ▪ Crossings prone to flooding or washout could isolate suburbs or in extreme cases will cause short term regional isolation. There may be some route diversity via radio to enable our customers to restore their end user services. ▪ Prolonged Loss of power to the distributed cabinet network will begin to affect customers after approximately 5 hours. Due to the number of cabinets involved, it will not be possible to apply alternative generation to everyone affected. **Telecom** ▪ For sites that are impacted, consumers will not be able to use the PSTN and/or broadband services including making 111 calls. ▪ The mobile network should remain intact so consumers may experience congestion and/ or slowness in the network performance due to volume of calls. **Vodafone** ▪ Localised outages to PSTN and broadband service. ▪ Localised outages to mobile network coverage due to loss of power. ▪ Possible mobile network congestion but unlikely to be severe.

Network Assets at Risk of Severe Storm	Expected Service Impacts
mains power or deploy generators at some sites may be seriously impeded by the conditions. ▪ Critical buildings in Auckland have been assessed against flood maps and core network infrastructure is not judged to be at significant hazard from flooding or coastal surge, though access to sites may be impeded in some cases due to possible flooding in the vicinity. **Kordia** ▪ Towers are designed for 1/2500 year wind return periods and poles for 1/1000 year wind return periods. ▪ Major television broadcast and telecommunications site is at Waiatarua, on the top of the Waitakere ranges. Antennas affixed to these supports have a typical survival wind rating above that of the predicted winds, typically >200kph. ▪ It is probable that power and access to the site and might be lost through broken lines and fallen trees. However the site can be powered from dual diesel generators for typically 10 days before additional fuel is required. The site can be controlled and monitored remotely. ▪ Uplink earth station for Freeview satellite service is located in Lower Hutt so would not be impacted by an Auckland severe storm event. **Johnston Dick & Associates (Sky Tower Broadcasting)** ▪ Sky Tower is designed for 1:1000 year return winds and is certified to survive a 59m/s 3 second wind gust. ▪ Except for low power broadcasts in surrounding areas such as Waiheke Island, all of Auckland's FM broadcasts originate from Sky Tower. ▪ Most of the land mobile systems in Auckland are located at the Tower. These are used not only by various companies such as taxis but also by emergency services such as Police, Fire and Ambulance.	

Table 7-1: Telecommunication Network: Vulnerability to Severe Storm Hazard

Recovery Times

	Day 1	Week 1	Full Service Restoration
Land lines	80%	90%	1-10 days
Cellular Networks	90%	100%	1-4 days

Table 7-2: Telecommunication Network: Recovery Times

7.4 Water Services

All water services are most at risk from damage to pipes and reticulation as a result of scouring, slips, washout and flooding. This is often where water services are combined with assets in the road corridor such as bridges and culverts. Water supply sources could be affected by severe flooding or slips which could impact the quality.

There could be secondary impacts due to power outages affecting pump stations for water, wastewater and stormwater. This could have a knock on affect and exacerbate flooding in vulnerable areas.

Water

Network Assets at Risk of Severe Storm	Expected Service Impacts
Headworks and Sources ▪ Flooding, slips, culvert washouts along roads in catchment areas will restrict access to dams, pipelines and headworks facilities. ▪ Slips and debris into impoundment lakes and flood flows in river sources result in heavy sediment loading and highly turbid conditions. ▪ Bore sources are secure against 1:100 year flood. ▪ Onehunga aquifer subject to contamination from road and land run-off and sewer overflows. ▪ Raw water transmission pipelines may be subject to washout, particularly in the Waitakere Ranges - some pipeline routes are in vulnerable locations. ▪ Power supplies vulnerable, particularly in rural areas. ▪ Dams and spillways capable of MCE event ▪ Dams have rapid draw down valves for emergency use.	▪ Disruption of response and situation assessment ▪ Access for repairs, maintenance and operations may be restricted for extended period. ▪ High turbidity and water quality for extended period long after storm has past may result in restrictions on utilisation of dams and river water sources. ▪ Impact more serious if Hunua Ranges greatly affected. ▪ Cast iron pipes with non-contiguous non-ductile flexible joints are vulnerable. ▪ Repairs to damaged pipelines and structures could take significant time due to remoteness and disrupted access.
Water Treatment ▪ Five metropolitan WTPs geographically diverse should ensure overall supply security. ▪ Rural water supplies Helensville and Warkworth may be vulnerable due to river and impounded sources vulnerability	▪ Challenging water treatment conditions that may prevail for extended periods well beyond duration of storm –weeks/months. ▪ Heavy demand for water treatment chemicals in Auckland region and all areas impacted by storm. ▪ May result in restricted capacity at WTP's particularly in rural communities. ▪ Standby power generators at WTP's. Fuel will be an issue in extended power fail events
Transmission and Reticulation • Transmission and reticulation pipelines may be subject to flooding at stream crossings with washouts in vulnerable ground conditions	▪ Disruptions likely to be restricted to localised areas with difficult access. ▪ Systems redundancy should minimise extent of loss of service. Most repairs effected promptly where access permits

Table 7-3: Water Supply Network: Vulnerability to Severe Storm Hazard

Wastewater

Network Assets at Risk of Severe Storm	Expected Service Impacts
Trunk and Local Collection Systems ▪ Sewers may be subject to washout - some pipeline routes are in vulnerable locations: watercourses, pipe bridges and culverts. ▪ Pumping stations vulnerable to power failure ▪ Surcharging of "combined" sewers due to flooding by stormwater. ▪ Blockages of sewers caused by flood debris. ▪ Storm surges may cause washout of sewers located on harbour/gulf foreshore	▪ Overflows into, watercourses and estuarine and marine environments due to systems blockages and power failure events. ▪ Likely to be numerous and take some time to effect repairs and clean-up. ▪ Clearance of watercourses, culvert blockages and overland flow paths essential to minimise public health effects. ▪ Limited availability of generators in widespread events. Generator fuelling a logistics issue. ▪ Extended duration and difficult repairs.
Wastewater Treatment ▪ High inflows due to flooding of sewers systems. ▪ Effluent ponds at WTPs vulnerable to flooding. Impoundment dams vulnerable to overtopping and erosion.	▪ WTP Plant by-pass of excessive flows, protection of hydraulic profile and processes essential. ▪ Generators maintain essential processes and plant capacity in power fail events.

Table 7-4: Wastewater Network: Vulnerability to Severe Storm Hazard

Stormwater

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ Scouring of earth lined banks and some overland flow paths due to high rainfall and flooding. ▪ Loss of road access by widespread flooding that may impact on down stream flows and wastewater. ▪ Localised and regional flooding due to hydraulic overload of the stormwater system and blockage of cesspits, pipes, culverts, watercourses and overland flow paths by debris ▪ Damming of creeks and waterways from debris and land instability resulting in flooding ▪ Slope failure causing breakages of stormwater pipelines. ▪ Some systems designed for 1:100 year event although there is a risk to infrastructure because of a lack of overland flow path to ensure access into systems is managed and effective if the design is exceeded. ▪ Flooding and scouring in coastal areas ▪ Tidal effects on stormwater as water can't flow during high tides.	▪ Other critical infrastructure at risk of inundation due to surface water and flooding from stormwater network. ▪ Risk of excess flooding due to stormwater blockages (more than just rainfall) where it exceeds design capacity.

Table 7-5: Stormwater Network: Vulnerability to Severe Storm Hazard

Recovery Times

	Day 1	Week 1	Full Recovery
Water supply	Implement Incident Management and response Plans. Situation assessment. Prioritisation of recovery. Sources and distribution systems reconfiguration where required. Stabilisation of treatment processes.	Implementing recovery plan. All but major service failures expected to be repaired, but effects will be localised. Stable water treatment but it may be challenging.	Systems in Headwork's/catchment areas may take weeks to fully reinstate. Some water sources may continue to present challenging water treatment conditions.
Wastewater	Implement Incident Management and response Plans. Situation assessment. Prioritisation of recovery. Complete inundation of coastal regions. Widespread uncontrolled discharges. At risk coastal pump stations and pipelines affected by structural failure would be identified.	Treatment processes stabilised. Pump station maintenance crews at work, with initial repairs or temporary pumping systems in place where possible. Temporary repair to pipe bridges, culvert crossings and coastal pipelines would have started.	Treatment processes stable after 1 week Discharges to the environment may still be occurring after 1 week but will be localised to areas of significant damage.
Stormwater	Assessing damage to essential assets. Removing debris from inlets, outlets and open drains.	Implementing essential repairs. Continue to prioritise remainder. All blockages cleared. Issues with scouring, erosion or slips	1-2 weeks for full service recovery with possible localised effects.

Table 7-6: Water Network: Recovery Times

7.5 Energy

The high voltage (>200kV) transmission network is unlikely to be affected by a severe storm of this magnitude although the local distribution network could be greatly affected by high winds and flooding. This will affect the impact of the storm on other infrastructure.

Fuel distribution is unlikely to be affected except in localised areas where particular service stations are vulnerable. The impact on the Refinery to Auckland pipeline is low likelihood but very high risk as the impacts would be more severe.

Electricity

Network Assets at Risk of Severe Storm	Expected Service Impacts
Local network ▪ Localised failure of overhead distribution lines because of debris and hardware failure due to wind. Repairable once wind abates. Substations would not be affected. ▪ Some power can still be transferred without operational communication systems by using slower, more manual operation. ▪ Localised vulnerability of some poles may due to risk from wind and land instability. ▪ Above ground pillars located in the floodplain are likely to be affected by flooding. ▪ VECTOR's Quay substation may be vulnerable has a floor raised by 0.5m, but water would only need to rise 0.3m above that before the substation was affected. If water level exceeds 0.3m inside the substation, CBD supplies maybe disrupted ▪ Buildings located in the flood plain with transformers and switch gear in the basements may be vulnerable to flooding. Basement flood pumps are sometimes connected to emergency generator systems, the latter also sometimes being located in a low level basement where they maybe most at risk when most needed. **Transpower Transmission network** ▪ Transpower lines would not be affected by wind. ▪ The main towers carrying the six high voltage Transpower lines from the south are not at risk. ▪ In the worst case, only one of the six separate transmission lines would be affected.	▪ Widespread outages and short duration interruptions. ▪ Restoration of major faults once the storm abates. ▪ Some localised areas may have longer term outages (> 1 week).

Table 7-7: Electricity Network: Vulnerability to Severe Storm Hazard

Petroleum

Network Assets at Risk of Severe Storm	Expected Service Impacts
Refinery ▪ Total outage during flooding due to fresh water supply and access to site for staff and essential deliveries.	▪ Leak in the pipeline would mean loss of supply for 3-5 days, rupture could take 5-14 days. Supply would have to be sourced and distributed from elsewhere.

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ Storm surge could affect the supply chain and impact shipping. **Refinery to Auckland Pipeline** ▪ Power and communications are critical for maintaining supply, but two systems (land line and Ethernet radio) are available. ▪ Rupture or buckling of the pipeline by slope failure is low likelihood, high risk and would disrupt supply. ▪ Wellsford pump station is at risk of flooding. ▪ Road access to remote areas cut off by flooding. ▪ Lightning could cause destruction of CP systems/secondary communications and has the potential to puncture the pipeline. **Wiri Terminal** ▪ Avgas pumps are above ground. The chemical pump is not critical ▪ Floating roofs subject to high winds. **Distribution** ▪ Some service stations could be directly affected from localised flooding and land instability.	▪ No power or communications would lead to significantly reduced capacity in the pipeline affecting supply. ▪ Supply chain for refinery (feed stocks in and shipping out) could affect supply. ▪ Limited distribution due to access from localised flooding and debris.

Table 7-8: Petroleum Network: Vulnerability to Severe Storm Hazard

Gas

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ Rupture of the gas main by slope failure is not expected except perhaps in some remote areas. The high pressure trunk pipelines from the south do not pass through unstable ground. Some superficial damage due to land movement cannot be ruled out but it would not be a threat to supply.	▪ No loss of service if no pipelines rupture. Possible supply restriction if pipeline integrity in doubt.

Table 7-9: Gas Network: Vulnerability to Severe Storm Hazard

Recovery Times

	Day 1	Week 1	Full Recovery
Electricity	Local loss of power from debris laden high winds and local flooding or very high storm surge	99%	2 weeks
Petroleum Fuels – Refinery to Auckland Pipeline	Assessment of pipeline and pump stations	100% if no pipeline rupture	3-14 days
Gas	Possible loss of supply if pipeline ruptured by slips (very unlikely)	100% in no pipeline rupture	2-7 days dependent on scale and nature

Table 7-10: Energy Network: Recovery Times

7.6 Transport

The Airport runway would be closed during the peak of the storm but quickly reopened for use. The road network would be severely impacted in multiple locations due to flooding, slips, storm surge and debris although there is generally good redundancy built in to the networks. Smaller coastal communities could become isolated. The effects on the road network will impact the availability of other services.

Road

Network Assets at Risk of Severe Storm	Expected Service Impacts
State Highways ▪ SH1 through Dome Valley (between Warkworth and Wellsford) is at risk of flooding and potential slips. ▪ Southern Motorway underpasses can be affected by flooding when rainfall exceeds the design, particularly in areas of drainage by soakage. Key areas include Ellerslie/Penrose, from Newmarket to Mt Wellington and East Tamaki. ▪ Southern Motorway from Khyber Pass to Gillies Ave is subject to flooding in heavy downpours but with a short duration. Busiest road in New Zealand with approximately 200,000 vehicles per day. ▪ SH16 Woodhill to Kaukapakapa vulnerable to flooding from the Kaipara, particularly at high tide. ▪ SH16 north of West Coast Rd susceptible to slips, potentially major slips but less impact as only 1600 vehicles per day on average. ▪ North-Western Motorway (SH16) vulnerable to storm surge, particularly at high tide through the Rosebank Causeway. SH1 approaches to the Harbour Bridge also vulnerable to storm surge at Shoal Bay and St Marys Bay. Storm surges cause large amounts of debris to be deposited. ▪ Risk to vehicles on bridges (Harbour Bridge, Newmarket Viaduct) in high winds, particularly vans, motorcycles and high sided empty trucks). Wind monitoring is in place. ▪ Potential for damage to exposed steel structures due to lightning. **Local Roads** ▪ Some slips are also possible, overslips being relatively easily cleared, but underslips resulting in roads being closed for significant periods. High risk areas include: - Waitakere Ranges - Tamaki Drive - Bucklands Beach Peninsula - Half Moon Bay - Point View Dr - Redoubt Rd	▪ Potential to moderate speeds and close clip on lanes for the Harbour Bridge in high winds. ▪ Hoteo River has the potential to flood SH1 and SH16 and effectively cut off Northland, particularly at high tide (for the Kaipara). ▪ Reduced capacity and speeds with increased travel times due to flooding and debris. ▪ Damage caused by scouring of roadway may close vulnerable points of roads for a prolonged recovery period, particularly at culvert crossings. ▪ Power outages affecting traffic signals, CCTV and VMS. ▪ Some roads would have reduced capacity or incur closures at times because of flooding, coastal erosion, slips and debris blockages from fallen trees and poles. Delays and alternative routes are to be expected. ▪ Slips and flooding could close roads isolating smaller, more rural communities particularly in the Waitakere and Hunua Ranges and the coastal communities.

Network Assets at Risk of Severe Storm	Expected Service Impacts
- Whitford-Maraetai Rd - Kawakawa-Orere Rd - Redhill Rd - Ardmore Quarry Rd - Hunua Rd - Ararimu Road - Ponga Road - East Coast Road - Moumoukai Road - Moumoukai Hill Road - Otau Mountain Road - Kawakawa Bay Coast Road - Orere-Matingarahi Road - Sky High Road - Monument Road - all roads leading to the Hunua Ranges - Awhitu Peninsula particularly Awhitu Road and several other roads at the top of the Peninsula ▪ Local roads are more vulnerable to flooding because they are common in low lying areas and are built to a lesser standard. Vulnerable areas include: - New Lynn (Rata St) - Bucklands Beach Rd - Whitford Rd - Ti Rakau Dr - Chapel Rd - Highbrook Dr - Murphys Rd - Great South Rd at the Papakura Stream - Mangere Bridge - Favona Rd/James Fletcher Dr - Wattle Downs - Conifer Grove - Kiwi Esplanade in Mangere Bridge - Great South Rd in Papakura and Drury - McNicol Rd - Tourist Rd - Wattle Bay Rd - Logan Dr in Hudsons Bay - Some areas in Pukekohe - Clevedon Valley ▪ Some coastal roads will suffer scouring, particularly: - Bucklands Beach on The Parade - Easterns Beach on The Esplanade - Mellons Bay Beach on Mellons Bay Rd - Howick Beach access road/car park - Cockle Bay Beach on Shelley Beach Parade - East Coast Rd - Maraetai Coast Rd - Orua Bay Rd	

Network Assets at Risk of Severe Storm	Expected Service Impacts
- Kawakawa Bay Coast Rd - Clevedon Kawakawa Rd - Kiwi Esplanade - Coronation Rd in Mangere Bridge - Weymouth Rd in Manurewa. ▪ Many bridges and culverts are susceptible to overtopping in extreme events. Risk of scour to abutments and to downstream embankments. In some cases, risk of scour to roadway and buried utilities. ▪ Some roads will be covered in debris: high winds are more likely to affect local roads because they have more roadside trees, signs and poles. Many roads not flooded are likely to be fully or partly blocked by fallen debris. ▪ Areas at risk of storm surge include: - Rosebank and Avondale up to Wolverton Esplanade - Te Atatu Peninsula - West Harbour - Tamaki Drive - Bucklands Beach on The Parade - Easterns Beach on The Esplanade - Mellons Bay Beach on Mellons Bay Rd - Howick Beach access road/car park - Cockle Bay Beach on Shelley Beach Parade - Mangere Bridge - Favona Rd/James Fletcher Dr - Wattle Downs - Conifer Grove - Kiwi Esplanade in Mangere Bridge - Great South Rd in Papakura and Drury - Kawakawa-Orere Rd - Bucklands Beach - Maraetai-Whitford Rd - Orua Bay - Clarks Beach - Grahams Beach - Wattle Bay - Hudsons Beach - Karioitai Beach - Big Bay - Glenbrook Beach - Waiau Beach - Maraetai Dr - Maraetai Coast Rd ▪ Tornados can cause flying debris from outside the road corridor. Highly reactive and has an effect on both State Highways and local roads. ▪ Popped manholes due to overloading of the stormwater system wreak havoc and can be in the road, footpath or corridors. Most of the stormwater	

Network Assets at Risk of Severe Storm	Expected Service Impacts
system in local roads designed for a 1:5 event which means roads become a secondary overland flow path until the system catches up.	

Table 7-11: Road Network: Vulnerability to Severe Storm Hazard

Rail

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ Most sections of the rail network are likely to be blocked with fallen debris on the tracks and flooding in low lying areas ▪ Large sections of the Main Trunk Line through the Waitakere Ranges have been identified as vulnerable to slope failure in heavy rain. Similar slope problems are likely around the Orakei Basin, although an alternative route is available ▪ Several areas of flooding are likely to the south and debris maybe washed onto the track in places	▪ Some routes inaccessible due to debris on the lines.

Table 7-12: Rail Network: Vulnerability to Severe Storm Hazard

Ports

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ **Buildings** – minor damage to administration buildings (likely damage is windows broken and minor flooding but more extensive flooding if storm surge raises water level more than 3 metres above normal high tide), moderate to severe damage to exposed sheds is likely (these sheds are not critical to operations) ▪ **Wharves** – no damage is expected unless the storm causes a large vessel to impact the wharf (unlikely). Could be damage to under-wharf electrical systems required for crane operations. ▪ **Cranes** – cranes could be blown along tracks, blown off tracks, blown over or suffer structural damage – unlikely as cranes are locked down and structurally designed to withstand high winds (as many major international ports in high risk zones for tropical storms) - but this still remains a serious risk ▪ **Straddles** – straddles could be blown over - unlikely as they would be parked in a tight group ▪ **Vessels** – storm could result in a vessel impacting a wharf or another vessel (unlikely). ▪ **Navigational aids** – beacons & buoys swept away (possible), channel may need to be resurveyed (unlikely) ▪ **Containers** – owned by shipping lines – stacked containers may topple (likely) ▪ **Cargo** – cargo in containers may be damaged by	▪ Prior to storm – Storm preparations would diminish business as usual capability. ▪ Immediately prior to storm - Cranes locked down and straddles parked in tight formation. Non-emergency staff sent home. ▪ During storm event – All BAU terminal operations and marine operations would cease during periods of high winds due to health and safety concerns. ▪ Post storm event – Impact on BAU terminal operations due to clean-up of debris. Potential impact on marine operations due to storm debris in shipping channel and berth areas (such as small vessel wrecks). ▪ Impact due to electrical network outage – Potential for refrigerated cargo damage due to power outages – but have generator back-up. No generator back-up for crane power requirements – so reliance on Vector network (including dependency on Quay St Sub which may be impacted from large storm surge). ▪ Impact due to landside transport route issues – Potential for customers impacted due to delays on cargo movements in and out of port due to issues with road and/or rail network. ▪ Impact due to sea-side transport issues - Ships may choose to not call at Auckland immediately prior to or immediately post a storm event. Ships may be delayed due to storm and port may not be

containers falling, water (rain or sea water from storm surge) penetrating container or refrigerated cargo perished by loss of power (likely, especially for fragile or perishable cargo)	able to accept ship due to high berth demand. Fuel bunker vessel may not be able to provide fuel for ships (impact only on Pacific Islands trade).

Table 7-13: Ports: Vulnerability to Severe Storm Hazard

Airports

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ High tides combined with storm surge could cause the stormwater discharge to be affected creating the possibility of flooding. ▪ Runway will be closed for high rainfall due to visibility and wind speeds. ▪ Lightning warning systems in place and during electrical storms, no fuelling or loading. ▪ Small planes are tied down and parked into the wind. ▪ Two overland flow paths designed to drain away from infrastructure.	▪ Runway closed during peak of the storm. ▪ Airport can be open (retail) while runway is closed.

Table 7-14: Airports: Vulnerability to Severe Storm Hazard

Solid Waste

Network Assets at Risk of Severe Storm	Expected Service Impacts
▪ Landfills rendered temporarily inoperable by saturation of tipping pads and flooding of landfill cells ▪ Transfer station operations restricted by surface flooding, power outages (stationary compactors) and landfill operation limits ▪ Recycling sorting facilities (MRFs) limited by surface flooding and power outages ▪ Collection vehicle operations restricted by flooding and weather risk to operators and equipment ▪ Mobile garbage and recycling bins suffer damage and gross uncontrolled movement from wind forces and debris strikes	▪ Disposal facilities not immediately available for use ▪ MRF operations spasmodic ▪ Collections cancelled or delayed ▪ Streetscape litter management services severely constrained ▪ Bins lost or damaged, requiring replacement or repair

Table 7-15: Solid Waste: Vulnerability to Severe Storm Hazard

Recovery Times

	Day 1	Week 1	Full Recovery
Road	Road closure or reduced capacity in some areas as a result of flooding, debris or slips	Full recovery except in areas of severe underslips or structural damage to bridges and culverts.	0-2 days except in areas of severe underslips or structural damage to bridges and culverts.
Rail	Zero capacity because of debris on tracks	2-7 days to full capacity if only isolated sections of track are affected	A few weeks to several months if there is widespread slope failure

Ports	Closure during storm, 50% capacity by end of day 1[1]	100%	1-2 days subject to no major structural damage.
Airport	Zero to near zero capacity during storm, full capacity once winds drop	100%	As soon as winds drop to 20 knots
Solid Waste	Disposal facilities not available, collection services and streetscape litter services very restricted	Disposal facilities and MRFs fully operational, collection services and streetscape litter services back to schedule after Day 5	By Day 5 except for local areas isolated by road network failure

Table 7-16: Transport Network: Recovery Times

[1] Subject to electricity network availability, no crane failures and no large shipping channel blockages. Serious structural damage to crane could take 1-2 months to repair or 12-18 months to replace.

7.7 Response and Recovery Plans

Auckland's lifeline utilities all have incident/emergency response arrangements and some have storm or cyclone specific contingency plans, as summarised in Table 7-17. The table also covers the extent to which storm risk assessment has been undertaken.

Sector	Planning undertaken	Specific Response Activities
Vector-Electricity	▪ Storm outage plan ▪ Exercises at least annually	▪ Alert/warning system for staff and contractors ▪ Recovery prioritised.
Counties Power	▪ Business Continuity Plan ▪ Scenario testing ▪ Redundancy in communications ▪ Control room testing	▪ Issue an Alert Status to internal staff and contractors. ▪ CDEM Duty Officer notified ▪ Major and critical customers advised of Alert status ▪ Social media updated ▪ Crises recovery prioritised
NZTA (State Highways)	▪ Incident response plan ▪ Key infrastructure inspected monthly	▪ Activate response procedures ▪ Mobilise network contractors for both traffic management and clean up ▪ Issue travel information bulletins
AT (Roads)	▪ Incident response plan ▪ Key infrastructure inspected every 3 months (culverts/bridges)	▪ Activate response procedure. ▪ Mobilise teams for clean up
Auckland Council (stormwater)	▪ Critical SW assets identified	▪ Remove debris from essential catchpits, inlets, outlets and open drains. ▪ Inspect essential assets for damage. ▪ Implement repairs to essential assets. ▪ Continued clean up, inspection and repair of non-essential assets.
Auckland Airport	▪ Business Continuity Plan ▪ Aerodrome emergency plan ▪ Air New Zealand – Group Emergency Management Manual (well practised)	▪ Warning systems for fog, wind and lightning distributed by text, phone and LED signs. ▪ Runway inspection, friction test.
Ports of Auckland	▪ Survey of critical buildings (eg, electrical substations) to understand risk of storm surge and measures that could be undertaken prior to event	▪ **Prior to storm** – Reduce stacked container heights. Where possible import cargo would be moved off port. Export cargo may not be accepted by port prior to the storm. Extra checks on ship mooring lines and container lashings. The Auckland Harbour Master may instruct large vessels to vacate the inner harbour. ▪ **Immediately prior to storm** - Cranes locked down and straddles parked in tight formation. Non-emergency staff sent home. ▪ **Post storm** – remove fallen containers, clean up wind-blown debris at terminal, structural survey of cranes, sheds, seawalls. Check of sea channel for marine debris and condition of navigational aids..
Watercare	▪ Design of infrastructure ▪ 20 year Asset Management Plan ▪	▪
Kordia	▪ Business continuity plans in	▪ Diesel tanks will be topped up where there is

Sector	Planning undertaken	Specific Response Activities
	place and exercised regularly	sufficient warning ▪ Monitor and activate response
Telecom	▪ General framework for incident response ▪ Robust design standards	▪ Review of assets, pre-positioning generators ▪ Activate NOC with duty managers ▪ Monitor remaining battery life. ▪ Remote management of power sites.
Chorus	▪ Business Continuity Plan ▪ Crisis Management Plan	▪ Activate war room ▪ Forecasting ▪ Resourcing ▪ Shutting down programmes ▪ Notify potential customers ▪ Generator/fuel preparation ▪ Network with key utilities
Vodafone	▪ General framework for incident response ▪ Robust design standards	▪ Review of assets, pre-positioning generators ▪ Activate NOC with duty managers ▪ Monitor remaining battery life. ▪ Remote management of power sites.
Vector-Gas	▪ Emergency Response Plans (CIMS based) ▪ Critical Contingency Management Plan ▪ Business Continuity Plans ▪ Crisis Management Plans ▪ Specific Event Guides – generic ▪ Emergency pipe, fittings and equipment	▪ Activate plans ▪ Use specific event guides ▪ Demand Curtailment via Critical Contingency Operator – if required ▪ Retailers communicate with consumers ▪ Media Communications ▪ CDEM communications
Refining NZ (Pipeline)	▪ Pre plans for each event ▪ Exercises and training ▪ Critical spare parts for remedial work ▪ Business resilience plans being reviewed.	▪ CIMS structured response

Table 7-17: Severe Storm Event: Response Plans and Actions

7.8 Future Work

All Sectors

1. Interdependency Study, focus on primary effects from the hazard and secondary effects due to loss of another lifeline.
2. Cordon protocols for access.
3. Coordination of repairs post event to capitalise on roads needing repairs for pipe and cable repairs.

A summary for each lifeline sector and the ways they can improve their response or resilience to a severe storm in Auckland is provided as follows:

Water Sector

1. Ongoing dam safety management for onsite wastewater retention ponds, consider increased capacity.
2. Critical asset model for stormwater to assess the network against other lifelines. To be used as a prioritisation tool for works/upgrades.
3. Investigation/study into localised areas of significant depths of water.

Telecommunications/Broadcasting:

1. On-going program to replace aged battery backup in the network.

Electricity:

1. Create diverse communication paths with Fibre and Wifi Hot Spots for dispatching field staff
2. Develop availability of Real-time updates to customers via social media and mobile devices
3. Create multiple emergency recovery control centres
4. Wider use of water-proof service fuses in low lying areas
5. Use of water-proof connections at substations

Attachment 2: Severe Storm / Structure Damage Matrix

Structure		Wind	Rain	Flooding	Slope Failure	Surge and Waves
Pipes	Pressure	Negligible effect	Negligible effect	Scour of backfill	Small (non-engineered) lines will be vulnerable	Pipelines in wave erosion zone and outfalls
	Non-pressure	Negligible effect	Negligible effect	Scour of backfill	Small (non-engineered) lines will be vulnerable	Pipelines in wave erosion zone and outfalls
Building Structures	Residential	Roof and cladding damage to non-complying houses	Flooding of damaged and flat roofs	Evacuation of limited low-lying areas	Slight vulnerability in recently established hilly areas	Inundation and wave erosion in low-lying coastal areas
	Non-residential	Non-structural damage only	Flooding of damaged and flat roofs	Evacuation of limited low-lying areas	Low vulnerability	Generally lower risk
	Bridges	No structural damage, but may become unserviceable	Negligible effect	Low risk due to small catchments or estuarine location	Similar risk to adjacent bank erosion	Inundation at some motorway locations
Services	Lampposts	Decayed hardwood poles will be vulnerable	Negligible effect	Negligible effect	Low risk	Negligible effect
	Cranes	Will be shut down	Negligible effect	Negligible effect	Negligible effect	Negligible effect
	Power lines	Shorting, falling debris	Negligible effect	Negligible effect	Low risk	Negligible effect
	Pipe bridges	Negligible effect	Negligible effect	Generally comprise steel pipe	Low risk	Pipes strapped to wharfs
Civil Structures	Roads	No structural damage, but may become unserviceable	Un-driveable in downpours, potential for collisions	Flooding, scour where culverts overtop, slips	Motorways engineered for this, other roads susceptible	Some potential for embankment scour and inundation
	Rail	No structural damage, but may become unserviceable	Negligible effect	Risk to rail bridges from debris in flooded rivers	Cuttings susceptible	Some potential for embankment scour and inundation
	Rivers/floodways	Negligible effect	Negligible effect	Scour, bank slumping and reduced capacity	Slumping of banks – not a lifeline hazard	Backwater effects will accentuate flooding
	Embankments	Small (farm) dams only affected by wave chop	Negligible effect	Older stormwater detention dams may overtop	Dams are usually engineered for this risk	Foreshore erosion
Specific Infrastructure	Masts	Engineered masts (eg Telecom) will not be damaged but may be unserviceable	Negligible effect	Negligible effect	Low risk	Negligible effect
	Airports	Some flights re-directed	Visibility effects will not disrupt	AIAL runway will not be flooded, some loss of friction	Negligible effect	Low risk
	Ports	Container cranes shut down	Negligible effect	Negligible effect	Negligible effect	Flooding by wave overtopping, containers moved around
	Wastewater treatment plants	Negligible effect	Negligible effect	High inflows would be bypassed	Negligible effect	Inundation of Mangere ponds, overflows
	Water treatment plants	Negligible effect	Negligible effect	Negligible effect	Negligible effect	Negligible effect
	Electrical	Negligible effect	Negligible effect	Low-lying infrastructure flooded	Low risk	Low risk
Other	Large trees	Moderate impact	Negligible effect	Negligible effect	Not a lifeline hazard	Loss of trees which protect coastline

Table 7-18: Severe Storm Induced Damage to Structures Probability Matrix