Electricity Distribution Service

Vector - Extreme event report

For the assessment period

1 April 2023 – 31 March 2024

Executive Summary

1. On 14 June 2023, with the onset of the first winter temperatures since Cyclone Gabrielle, Vector experienced outages on two of its sub-transmission circuits. These events resulted in the exceedance of the Extreme Event Standard (EES) limit of six million customer interruption minutes in a 24-hour period.

2. While the EES limit was exceeded there is some doubt that the outages met the definition of an Extreme Event. This is due to there being compelling evidence that latent Cyclone Gabrielle impacts on the circuits were strong contributors to the outages occurring. Weather events such as Cyclone Gabrielle are deemed to be a major external factor and are therefore excluded from the Extreme Event definition.

3. The two circuits are 33kV overhead sub-transmission circuits between Warkworth and Wellsford. The circuits provide n-1 security to the northern most region of our network which includes Matakana, Warkworth, Leigh and Omaha. The circuits are supplied from Wellsford and serve approximately 13,000 ICPs. Each circuit is rated to supply the full load for the area under planned and unplanned events i.e., each circuit can be a back-up for the other. Prior to 14 June the circuits had an exceptional reliability record over an extended period.

4. The circuits, along with one-third of Vector's overhead network, experienced outages during Cyclone Gabrielle, a generational storm event starting on 11 February. The magnitude of Cyclone Gabrielle cannot be under-estimated. During the cyclone Vector's overhead network experienced circa 300 outages caused mainly by vegetation affecting over 218,000 customers. The cyclone followed the Auckland Anniversary floods, which had a compounding effect on the already inundated region.

5. Post the cyclone Vector undertook extensive ground inspections of these circuits, as well as the rest of the Vector network, affected by the flooding and the cyclone, to identify and repair any defects that remained following initial restoration efforts. Our inspections were focused on the immediate risks to the assets from the weather events, in particular the risks from ground instability and further high-risk vegetation damage. All actions resulting from these inspections had been completed prior to 14 June 2023.

6. On the morning of 14 June, planned work led to one of the two circuits being de-energised and all the sub-transmission load being transferred onto the other circuit, which is normal practice. The circuit carrying all the load soon experienced an outage caused by failure of an overhead joint. The planned work was immediately stopped and the circuit that had been de-energised for the planned works re-energised. However, soon thereafter it also experienced an outage related to the conductor causing loss of supply. At approximately 2:00pm in the afternoon one

circuit was repaired restoring supply to customers. However, it failed again in the evening approximately an hour before the other circuit was restored. It was this outage that caused the customer interruption minutes to exceed six million minutes. The cause of this outage is unknown as no cause was found.

7. These events were uncharacteristic given the circuits' long history of reliable performance which gave no sign that they would perform as they did on 14 June, especially as the load on the circuits was still within their technical ratings. The circuits also have an extended record of a single circuit supplying all the load for the length of planned works (on average for 6 hours) without causing loss of supply.

8. Following the event Vector accelerated an investment programme for the circuits to ensure any other undetected latent damage would not have the same impact.

Extreme Event Standard

9. The outages on 14 June, in addition to being a Major Event for the reporting of SAIDI under the Default Price Path Determination (Determination), the outages for the 24-hour period exceeded one of the two alternative limits to classify it as an Extreme Event under the EES. The two alternative limbs are that all unplanned interruptions in a 24-hour period exceeds either:

    a. 120 SAIDI minutes; or
    b. 6 million customer minutes.

10. The EES is a new quality standard added to the planned and unplanned SAIDI/SAIFI quality standards set by the Commission for the third Default Price Path.

11. The actual SAIDI (raw) attributable to the 24-hour period was 10.87 SAIDI minutes and the total customer interruption minutes were circa 6.6 million. The full list of outages over the 24-hour period is provided as an appendix to this report. The faults on the two overhead sub-transmission circuits contributed more than 6 million customer minutes for the 24-hour period. Therefore, this report addresses the circumstances of the sub-transmission circuit events.

12. The EES excludes unplanned interruptions that are the result of Major External Factors (MEF) such as natural disasters, fires not originating on an EDB's network and wildlife. Third-party interference is defined by the Determination as dig-ins, overhead-contact, vandalism, and vehicle damage.

13. We considered whether the outages on 14 June were as a result of a MEF and therefore would be excluded from the EES. We have been unable to determine with absolute certainty that the events were the result of a MEF. However, there is compelling evidence this was the case. Vector has therefore taken the prudent and conservative approach of reporting the outages on 14 June as an exceedance of the EES limit. As required by EES we provide this report to meet the requirements of clause 12.6 of the Determination.

14. This report has drawn on the extensive information and investigations Vector has undertaken into the event. In this report we provide further information on:
    a. The reasons for the event resulting in customer interruption minutes being greater than six million minutes;
    b. Trends in the asset condition for the assets related to the event;
    c. The sufficiency of Vector's asset replacement and renewal programme for the affected assets;
    d. Investigations and post-event reviews conducted into the event; and
    e. Independent state of the network reports undertaken on Vector's network.

Wellsford Warkworth circuits (circuit numbers 58 and 59)

15. The overhead parallel sub-transmission (circuit numbers 58 and 59) provide n-1 sub-transmission security between our Wellsford Zone Substation (ZSS) and the Warkworth ZSS. These assets are critical circuits for serving the high growth regions on the east coast of our northern network, with just under 13,000 ICPs served. Therefore, faults on both circuits at the same time are a critical event.

16. The sub-transmission circuits traverse complicated terrain with a 22-kilometre route encompassing the Dome Valley Forest ecological area and private land away from road corridors for significant lengths. The circuits were commissioned in 1966, with the sections of circuits affected on 14 June 2023 dating from 1985. Events affecting both circuits are very uncommon and for separate outages affecting a single day an exceedingly rare event as their performance history shows (discussed later in this report).

Reasons for exceeding six million minutes – 12.6 (a)

17. On 14 June 2023 we experienced two outages within a 24-hour period on our sub-transmission circuits (circuits 58 and 59) between Wellsford and Warkworth. In normal operating conditions the load between Wellsford and Warkworth is shared equally between circuits 58 and 59, although either circuit is designed to carry all the load if a planned or unplanned event impacts one circuit.

18. The morning of 14 June 2023 began with planned works requiring circuit 59 being de-energised to enable a pole replacement on the circuit. All the sub-transmission load for the morning was scheduled to be switched onto circuit 58, which is normal practice.

19. Circuit 58 very soon experienced an outage caused by failure of an overhead joint resulting in loss of service beyond Wellsford. The planned work on circuit 59 was immediately stopped and circuit 59 re-energised. However, very soon thereafter it also experienced an outage related to a conductor section.

20. Table 1 presents a timeline of the 24-hour period for the sub-transmission circuits 58 and 59. The timeline provides some context to how assets and customers were affected over the course of the day and the supply restoration events.

Table 1: Timeline of events covering the sub-transmission circuits for the 24-hour period

Time	Event
7:09 am	Planned event requires circuit 58 to bear full morning load (n supply)
7:22 am	Outage – circuit 58 unplanned event
7:27 am	Service restored - Circuit 59 recalled (n supply)
7:46 am	Outage – circuit 59 unplanned event
12:01 pm	Repair work commences on circuit 58
14:07 pm	Service restored – circuit 58 recalled (n supply)
15:49 pm	Repair work commences on circuit 59
18:01pm	Second outage – circuit 58 unplanned event
19:12 pm	Service restored – circuit 59 recalled (n supply)
23:20 pm	Service restored – circuit 58 recalled (n-1 supply)

21. Table 1 highlights the time without power for customers from the morning events was approximately 6 hour and 45 minutes until the first significant number of customers were restored. The customer minutes accumulated in this time was 4.87 million minutes. Incremental minutes were incurred as network elements were closed to bring more customers safely back from the morning outage.

22. To mitigate the customer impact of the events, our staff and contractors used available tools to provide as much supply to the region including discharging output from Battery Energy Storage Systems (BESS) positioned locally, back-feeding supply from other local circuits and deploying temporary generation.

23. All customers were brought back to service by 15:27pm with the total customer minutes accrued amounting to 5.36 million customer minutes.

24. The last outage at 18:01pm, the unknown transient fault, resulted in more customer minutes being accrued until customers were restored from that outage. The restoration of most customers was achieved by 8pm with the total customer minutes from the events together totalling – 6.6 million.

25. Vector has supported customers affected by the day with our service promise payment amounting to circa $90,000 from the event.

High load conditions on 14 June 2023 – first load test of the circuits post Cyclone Gabrielle

26. The event occurred mid-working week and was the first significant winter loading for the sub-transmission system following Cyclone Gabrielle. The morning demand was driven by the first winter cold snap for 2023 with morning temperatures at least 2 degrees C° cooler than the previous morning, and the coldest so far for the 2023 calendar year.

27. Vector had, prior to 14 June, scheduled planned works to replace a pole near the Wellsford ZSS. This required one of the sub-transmission circuits (circuit 59) to be de-energised. The planned works was supporting a larger programme of work at the Wellsford ZSS of moving outdoor equipment indoors (ODID). The ODID forms part of an overall planning strategy to enable more capacity to be provided to the region including the upgrading of the sub-transmission system for the additional sub-transmission circuit.

28. Managing switching for planned works is a significant undertaking which on any one day involves considering multiple network and customer projects where up to 20 switching events per day are generally performed.

29. Loading is but one consideration that needs to be factored into the scheduling – which includes considerations such as the overall project programme, contractors, traffic management, rescheduling of previous work for reasons such as adverse weather.

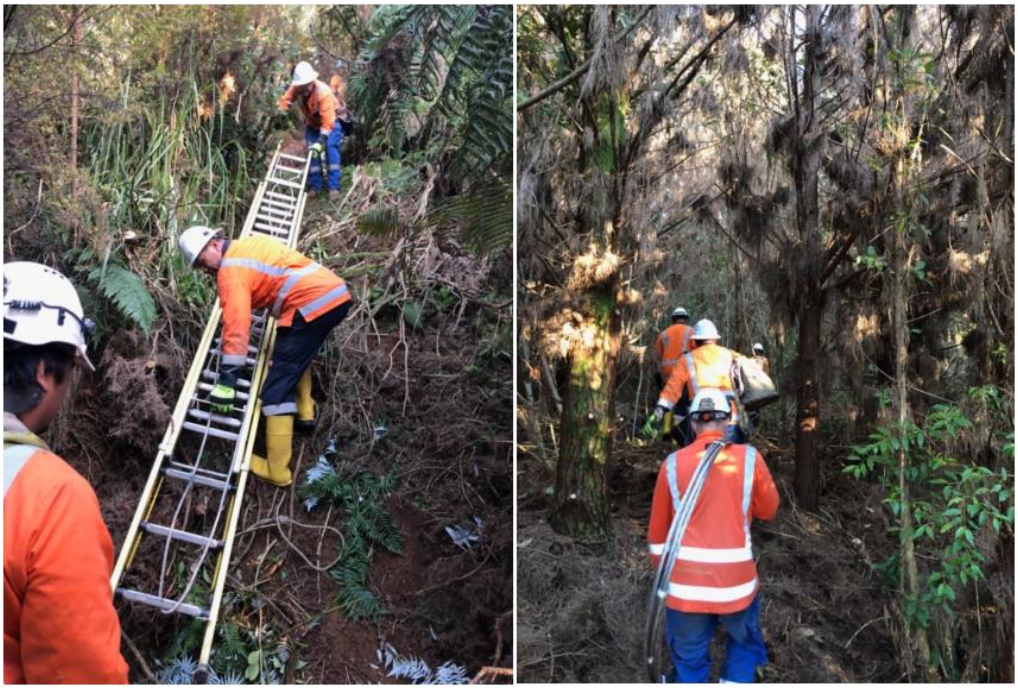
30. The impact of the morning load on the circuits which saw both circuits fault was not expected. However, the circuits' history of reliable performance and their technical ratings all supported that the circuits could manage the morning load.

Fault location – significantly affected the outage minutes

31. The location of the fault on circuit 59 was a key factor for the event exceeding the six million customer interruption minute threshold. The location of the fault caused six hours of effort to be expended finding the faulted section. Both ground and helicopter patrols were utilised. The location also caused considerable time to be spent with the restoration. Crews had to walk in equipment to the fault location from the nearest vehicle access point to affect the repair. The below images 1 and 2 are from the circuit 59 restoration on the day.

32. The time involved with locating and repairing circuit 59 meant that it could not provide n-1 supply for significant parts of the day – including to provide cover when circuit 58 experienced a second outage.

Image 1 and 2: field crews hiking equipment (ladders and conductor) to the fault location



Unknown fault – full circuit patrol

33. On the day, the restored circuit 58, which was providing supply following the morning outages, experienced a second outage when protection on the circuit operated. The event – consistent with our safety protocols for sub-transmission assets, requires the line to be patrolled before it

can be re-energised. This is to be certain the line is clear from hazard and consistent with industry practice. Transient outages are typically caused from temporary vegetation contact or wildlife contact – although these fault causes are more difficult to determine as part of evening patrols.

34. The incremental time from ascertaining there was no continuing fault on the circuit from the line patrol occurred while circuit 59 was being restored to service. This caused the customer minutes to exceed 6 million minutes for the 24-hour period. Accordingly, these outage minutes could not be avoided from switching the load to circuit 59.

Trends in asset condition for assets related to event – 12(6)(d)(i)

35. Historically, these circuits have not had events to cause concern about their performance. We have reviewed faults and SAIDI on both circuits over a 10-year period. The 10-year historical performance for the circuits shows a long history of dependable performance. Table 2 and table 3 below show faults by cause for both circuits over a 10-year period.

Table 2: 10-year history of event cause on circuit 58

Faults on Circuit 58	RY15	RY16	RY17	RY18	RY19	RY20	RY21	RY22	RY23	RY24
Animal (Bird, Possum)	-	-	-	-	-	-	-	-	-	1
Vegetation	-	-	1	-	-	-	1	-	1	-
Other (Third Party, Landslip)	-	-	1	-	-	-	-	-	-	-
OH Asset	-	-	1	-	-	-	-	-	1	1
Unknown/Transient	1	-	2	1	3	4	-	2	2	1
Total	1	0	5	1	3	4	1	2	4	3

Table 3: 10-year history of event cause on circuit 59

Faults on Circuit 59	RY15	RY16	RY17	RY18	RY19	RY20	RY21	RY22	RY23	RY24
Animal (Bird, Possum)	-	-	-	-	-	-	-	-	-	1
Vegetation	1	-	-	1	-	-	-	-	1	-
Other (Third Party, Landslip)	-	1	-	-	-	-	-	-	-	-
OH Asset	-	-	-	-	-	-	1	1	-	1
Unknown / Transient	1	2	-	1	-	1	-	1	2	1
Total	2	3	0	2	0	1	1	2	3	3

36. The 10-year history of fault cause shows both circuits have an average of less than three events per annum. The high incidence of unknown/transient faults is consistent with transient contact from temporary contact from vegetation debris or animal contact. This is consistent with the ecological area region within which the circuits traverse. The circuits have not shown any trend with asset related faults that caused any reason for active asset interventions. Below in table 4 and table 5 we show the SAIDI for each circuit and SAIDI contribution by cause.

Table 4: 10-year history of asset related event SAIDI on circuit 58

SAIDI on Circuit 58	RY15	RY16	RY17	RY18	RY19	RY20	RY21	RY22	RY23	RY24
Animal (Bird, Possum)	-	-	-	-	-	-	-	-	-	-
Vegetation	-	-	-	-	-	-	0.012	-	-	-
Other (Third Party, Landslip)	-	-	-	-	-	-	-	-	-	-
OH Asset	-	-	-	-	-	-	-	-	1.805	5.381
*Unknown / Transient	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0.012	0	1.805	5.381

Table 5: 10-year history of asse related event SAIDI on circuit 59

SAIDI on Circuit 59	RY15	RY16	RY17	RY18	RY19	RY20	RY21	RY22	RY23	RY24
Animal (Bird, Possum)	-	-	-	-	-	-	-	-	-	-
Vegetation	-	-	-	-	-	-	-	-	-	-
Other (Third Party, Landslip)	-	0.191	-	-	-	-	-	-	-	-
OH Asset	-	-	-	-	-	-	0.044	-	-	5.381
*Unknown / Transient	-	-	-	-	-	0.056	-	-	-	2.072
Total	0	0.191	0	0	0	0.056	0.044	0	0	7.453

37. The 10-year history shows the circuits have not provided any meaningful trends for SAIDI. The SAIDI for the 14 June 2023 entire event has been apportioned equally between the two circuits. Prior to RY2024 asset related incidences have not presented any trend warranting direct active management outside of our ongoing programmes of work for asset fleets and asset type.

Cyclone Gabrielle and Auckland flooding in final quarter of RY2023 – post event inspections

38. Cyclone Gabrielle triggered a national state of emergency with Vector's storm response continuing well into March 2023, including the suspension of planned works. Cyclone Gabrielle occurred very soon after Auckland had experienced record rainfall over the 2023 Auckland Anniversary weekend where the city received over 300mm of rainfall over a period of 5 days, typically rainfall volumes that are experienced over six months in Auckland. The suspension of planned works took over two months to catch up on.

39. Following Cyclone Gabrielle, and prior to the 14 June outage, Vector carried out ground-based inspections of 92,000 poles on our Northern Network. The effort involved with the post-inspection review was a significant undertaking. As part of this review, ground-based inspections were conducted on circuits 58 and 59. These inspections assessed assets for immediate risks following the cyclone and flooding events. The effort involved with this activity uncovered issues such as broken binders, dislodged trees near lines and poles with

compromised foundations across the network. However, no significant issues were identified for circuits 58 and 59.

40. The inspections were focused on the risks that the events might pose to network assets and public safety, specifically ground stability (assets and vegetation) and wind (damage from vegetation). This activity was not focused on latent impacts from the events which are difficult to observe. Indeed, latent damage to elements from significant natural events is a common occurrence for electricity networks. As noted in Orion's Customised Price Path Proposal submitted following the 2010 and February 2011 earthquakes that many of its assets – such as underground cables – experienced damage during the earthquake events but do not fail until sometime later either in seasonal wet conditions or as the network gets heavily loaded in winter.

Reviews and investigations following event – independent lab testing and aerial surveys – 12.6(e)

41. In the immediate aftermath of the event, Vector took a series of actions to get a more detailed view on the condition of the circuits. This included having the faulted sections for both circuits namely the faulted joint (circuit 58) and conductor section (circuit 59) to independent labs for testing.

42. The lab results for the faulted sections suggested the high loading of the morning was a contributing factor to both faults. The lab findings for the conductor section found latent damage to the conductor most likely from vegetation contributed to the stress on the asset. These findings are consistent with the recent history of the network which had just been through high duress from Cyclone Gabrielle. The lab findings also identified the location of the failed compressed joint within 1.5 metres from the pole may have also contributed to the stress on the joint.

43. Testing of sections also involved conductor sample and a reference conductor connected in a continuous loop and the temperature of the reference sample is raised to 90°C (or other specified temperature). The temperature of the conductor is measured at different locations and at locations of interest. The temperature rise of the aged conductor is compared to the reference new conductor.

44. Other tests performed on circuit included electrical Resistance Measurement where current is passed through a length of the conductor sample and the resistance found by measuring the voltage drop between two points. The sample conductor performed favourably to the reference

new conductor section achieving 90% with the Resistance Measurement testing with voltage drops.

45. Vector also undertook full aerial drone inspection surveys of the circuits with high resolution cameras. This footage was provided to an independent expert to analyse the health of the circuits. The overall findings of the aerial surveys and testing were that the circuits generally exhibited good health. However, the aerial surveys did observe the circuits did have a relatively high number of joints. The aerial surveys were also used to support targeted reconductoring at certain points.

46. The testing has affirmed Vector's confidence in the circuits as continuing to be suitable for supplying the region.

Immediate actions following the event

47. Following the event, and reviews Vector prudently undertook a series of targeted investments on the circuits to limit the likelihood of further events which could reveal the latent effects of the cyclone. These included:

    a. Targeted reconductoring of sections during the shoulder spring season (September – October 2023) to mitigate sagging and sections of the conductor with a higher volume of in-line joints (sections identified from the aerial surveys) and further testing of replaced spans;

    b. Installing a further 60 fault passage indicators (FPIs) from the 12 already on the circuits to support effective fault finding;

    c. Further targeted vegetation control, based on risk assessments by our expert vegetation assessor to remove and trim hazards – including within the Dome Valley – where special permissions were obtained to cut wider than the regulatory cutting zone and further investment to develop a permanent vegetation corridor; and

    d. Two "community hubs" on the network – fixed standby generation connection points to temporarily improve resilience (supporting the existing circuits prior to the commissioning of a planned third sub-transmission circuit, an underground cable) and supporting other immediate actions such as the reconductoring and targeted vegetation controls.

48. In aggregate these immediate steps cost circa $2 million. Each action was considered in the context of the full immediate programme of work. For example, the standby generation investment provided greater resilience for the area to support the effort needed to implement the targeted reconductoring and vegetation programme. The immediate programme work has been complemented by a long-term planned investment strategy to cater for the demand and resilience for this growing region.

Sufficiency of asset replacement and renewal for assets – Vector's long-term investment for the region – 12.6(d)(ii)

49. Vector's 2024 Asset Management Plan has a thorough long-term view for the region which forms part of the northern Wellsford planning area. The 10-year programme is forecasting investment of circa $60 million in 2024 dollars including developing two additional zone substations for the area.

50. A key investment for the region has been to supplement the sub-transmission network in this area from commissioning a third 33kV circuit, an underground cable delivered in conjunction with the recently upgraded state highway works through the Dome Valley. This was a complex multi-year project requiring significant planning and stakeholder management.

51. We had identified that reinforcement of the two sub-transmission circuits were approaching capacity since 2018, but our modelling showed this capacity constraint to occur much later in the decade.

52. Vector had gone to market to seek registrations of interest (ROI) in January 2022 to solicit non-wire alternatives (NWA) to assist with the deferral of network investment in the third circuit. This was Vector's first market NWA process for network investment deferral. The absence of technically suitable and affordable deferral options brought forward the investment in the third sub-transmission circuit to support sub-transmission capability.

53. The ROI for NWA was to complement modular investments in BESS at Snells Beach 2.5 MW and Warkworth 2MW. The NWA approach was also an opportunity for non-network providers to target a load management solution in an identified location which was what industry and market participants had been requesting of distribution networks.

54. Vector has now livened the third sub-transmission cable on 26 January 2024 well in advance of the 2024 winter peak demand. The new cable had a total cost of circa $50 million and provides a more resilient and hardened sub-transmission network in the face of climate

disruption for now and the long-term. The diversity of the new cable means high loading should not be a contributing factor to any events on the sub-transmission circuits for the area.

State of the Network / Operational Practices Reporting – 12.6(c)

55. The EES reporting must contain any independent reviews of the state of the network operational practices completed in the assessment period or in the three preceding assessment periods.

56. Vector regularly undergoes these types of assessments. In 2022 Vector commissioned engineering firm WSP to provide a Network Security Report for Vector. The report is undertaken at the direction of Vector's majority shareholder Entrust. The scope of the 2022 review considered:

    - Maintenance practices;
    - Network planning;
    - Capacity and growth forecasting;
    - Security; and
    - Managing customer behaviour and uptake of distributed energy resources technology.

57. The WSP team consisted of Chartered Professional Engineers and Certified Asset Management Assessors. The review involved:

    - Assessment of strategies, processes and procedures Vector has in place;
    - Analysis of asset condition, performance and modelling methodologies based on Vector asset data and comparing them with industry practice;
    - Field reviews based on assessment criteria alignment to Vector's maintenance standards; and
    - Interviews with key Vector staff personnel.

58. Overall, WSP found the Vector's processes, strategies and initiatives are generally appropriate to manage the operational risk of the network. They found Vector's processes were well-defined and consistent with peer electricity businesses.

Continuous Improvement

59. Whilst we are confident our immediate actions and long-term investment plan ensure the communities affected from the 14 June 2023 event are well served for the future. Our

investigations highlighted the importance for EDBs to be cognisant of how major weather events are impacting asset performance beyond the immediate recovery. Accordingly, Vector is now undertaking the following:

a. Identifying high risk network sections for aerial surveys during seasonal demand conditions – recognising that ground based inspections cannot sufficiently identify all risks following major weather events.

b. Maintaining surveillance of asset faults following major weather events identifying them for further investigation to ensure any latent impacts are understood.

c. Sponsoring research (potentially using INST funding proposed for DPP4) into latent asset risk to power systems following climate events can be identified and proactively managed. Such as factoring into our Condition Based Asset Replacement Model (CBARM) for asset replacement the risk around accelerated fatigue for vulnerable assets following major weather events.

d. Adopting a dynamic model of asset ratings to limit the opportunity for accelerated fatigue to affect asset performance, which will include deploying new IOT devices on our overhead system to remotely monitor overhead conductors and ground stability for poles at risk.

e. Continuing to challenge the limitations of the *Electricity (Hazards from Trees) Regulations 2003* to effectively manage vegetation risk to overhead assets in their current form.

60. In addition to the above, Vector has made precautionary changes to our design standards for lines affected from climate events ensuring restorations account for the number of in-line joints on sections and to ensure that restorations factor in pole locations so that we adopt the most enduring technique for asset restoration.

61. Vector is confident the suite of actions undertaken following the event to manage the assets in question, long-term planning for the area and adopting continuous improvement learnings put our network in a better position to mitigate the impact of climate change and to avoid any similar event occurring.

Appendix – A list of class C interruption that starts within an extreme event

Event ID	Start date (dd/mm/yyyy)	Start time (hh:mm:ss am/pm)	End date (dd/mm/yyyy)	End time (hh:mm:ss am/pm)	SAIDI value (Raw)	SAIFI value (Raw)
30774	14/06/2023	7:22 am	15/06/2023	2:10 am	10.763	0.0210
30777	14/06/2023	11:35 am	14/06/2023	3:00 pm	0.014	0.0001
30778	14/06/2023	5:14 pm	14/06/2023	7:09 pm	0.052	0.0005
30779	14/06/2023	9:16 pm	14/06/2023	10:42 pm	0.040	0.0027
30784	14/06/2023	11:46 pm	15/06/2023	9:40 am	0.003	0.0000

Schedule 11: Director's certificate for extreme event standard reporting
Clause 12.6(g)

I, Doug McKay, being director of Vector Limited, certify that, having made all reasonable enquiry, to the best of my knowledge and belief, the attached extreme event standard reporting of Vector Limited, and related information, prepared for the purposes of the Electricity Distribution Services Default Price-Quality Path Determination 2020 has been prepared in accordance with all the relevant requirements.

Director

Date 26/08/2024

Note: Section 103(2) of the Commerce Act 1986 provides that no person shall attempt to deceive or knowingly mislead the Commission in relation to any matter before it. It is an offence to contravene section 103(2) and any person who does so is liable on summary conviction to a fine not exceeding $100,000 in the case of an individual or $300,000 in the case of a body corporate.