Investigation into the quality standards breaches by Wellington Electricity Lines Limited

for

The Commerce Commission

Strata Energy Consulting Limited

27 April 2016

This report has been prepared to assist the Commerce Commission with its assessment of the quality performance of the Wellington Electricity Lines Limited's electricity distribution network.

This report relies on information provided to Strata Energy Consulting by Wellington Electricity Lines Limited. Strata Energy Consulting disclaims liability for any errors or omissions, for the validity of information provided to Strata Energy Consulting by other parties, for the use of any information in this report by any party other than the Commerce Commission and for the use of this report for any purpose other than the intended purpose.

In particular, this report is not intended to be used to support business cases or business investment decisions nor is this report intended to be read as an interpretation of the application of the Commerce Act or other legal instruments. Strata Energy Consulting's opinions in this report include considerations of materiality to the requirements of the Commerce Commission and opinions stated or inferred in this report should be read in relation to this over-arching purpose.

Preface

Strata Energy Consulting Limited specialises in providing services relating to the energy industry and energy utilisation. The Company, which was established in 2003, provides advice to clients through its own resources and through a network of Associate organisations. Strata Energy Consulting has completed work on a wide range of topics for clients in the energy sector both in New Zealand and overseas.

This report was prepared by:

Bill Heaps, Managing Director, Strata Energy Consulting
Clive Bull, Director, Strata Energy Consulting
Gavin Forrest, Senior Associate Consultant, Strata Energy Consulting and Associate Director, EMCa.

For further information, please contact:

Strata Energy Consulting Limited

PO Box 25157

Featherston Street

Wellington 6146

New Zealand

Phone:	+64 4 471 0312
Email:	bill.heaps@strataenergy.co.nz
Web:	http://www.strataenergy.co.nz

Authorship

Prepared by:	Bill Heaps Gavin Forrest
Approved by:	Bill Heaps
Date:	27/04/2016 2:42 pm
Version:	V3.1 DRAFT FOR WELL FACTUAL ERROR REVIEW

Contents

Tables

Figures

Executive Summary

1 Strata Energy Consulting (Strata) has been requested by the Commission to undertake a post-breach investigation on the breach of quality standards by Wellington Electricity Lines Limited (WELL). The Commission is seeking expert opinion—*on the causes of, and factors contributing to, the reported non-compliance, and what measures WELL could and should have taken to prevent the non-compliance*—as an input into the Commission's work following these non-compliances. In undertaking its investigation, Strata has sought to identify the underlying causes of the breach and whether this is reflective of systemic issues being present in WELL.

2 WELL stated that there are three key factors that describe the underlying cause for exceeding the reliability limits during assessment periods ending 31 March 2012, 2013 and 2014. and asserted that these factors are largely beyond its control:

a) a period of significantly increased volatility associated with severe weather related events;

b) the regulatory methodology utilised for setting reliability limits and normalisation through the identification of Major Event Days (MEDs); and

c) the scope of vegetation management provided for by the Electricity (Hazards from Trees) Regulations 2003.

3 On the basis of the information and explanations obtained during the course of this review, Strata has formed the view that the reasons provided to the Commission by WELL for exceeding the reliability limits in 2011/12, 2012/13 and 2013/14 may not fully reflect the underlying causes because:

a) while the SAIDI breaches could be considered (as WELL has) to have occurred at times of extreme weather events in the years in which regulatory standards were exceeded, Strata considers that there is a possibility that asset age related failures occur during severe storms;

b) whilst it could not be concluded that it is not the case, there is insufficient information to support an increase in extreme weather events that would be expected to result in a deterioration of reliability performance against the reliability limits;

c) there is insufficient information to support an increase in vegetation related faults that would be expected to result in a deterioration of the reliability performance, however, overhead line faults due to airborne debris is accepted as a main cause for the issues experienced during severe storms.

4 Consideration of the adequacy of the target setting or the broader regulatory framework in place during this review period is outside the scope of this review, and therefore not considered further in this report.

5 Strata found that three events, considered as extreme events, were characteristically different to other events. The ability of WELL to prevent the impact of the following events was limited:

a) the storm event of June 2013 should be considered an extreme event and had a significant impact on the SAIDI and SAIFI in that year; and

b) the snow storm event of August 2011 and the wind borne debris related faults of September 2012 may be considered extreme events and had a significant impact on the SAIDI and SAIFI in the respective years.

6 Strata did not identify any systemic issues associated with WELL's asset management systems and practices as part of this limited scope review. Strata found that WELL has a commitment to continuous improvement. We found that WELL has the capability to forecast the asset related expenditures required to meet its quality standards and incorporates targets into its asset management plans (AMP).

7 WELL has an older network asset. In the recent past the age of the assets does not appear to have required immediate and specific action by WELL. This position was supported by statements by WELL during the on-site review of a consistent, relatively low level of conductor failures, and very few poles failures (typically the larger causes of failures on overhead networks that contribute to SAIDI). Whilst the data suggested a general downward trend of non-storm related events, there is a possibility that underlying conditions that may weaken the distribution network become faults during periods of high winds and associated conditions associated with storms, thereby increasing the storm related events.

8 Strata considers it important to take into account the trends of fault information for storm and non-storm related events; and for events outside of the regulatory period to identify any longer term trends. Strata's experience of other networks of comparable age and design suggest that elevated failure rates are key risks for asset managers. Accordingly, Strata considers that a contributor to the deterioration in reliability performance of the network during storms is likely to be in part due to the fact that the network is aging. Strata recommends that inclusion of predictive asset failure analysis, particularly for cable and overhead lines. The development of asset survival curves will assist WELL to manage prudently potential increases in asset replacement activity for the network in the future.

9 The Commission required an opinion from Strata on the extent to which WELL has undertaken actions to prevent or mitigate similar quality standard non-compliance in the future.

10 During the onsite sessions, WELL stated that it planned to deliver reliability performance within quality standards over the current regulatory period. Strata sought evidence in WELL's documentation to support its claims and assess the likelihood that actions taken will prevent or mitigate similar quality standard non-compliance in the future.

11 WELL's 2016 AMP states that:

> *Wellington Electricity is forecasting capital and operating expenditure to ensure it continues to provide the quality of service required by consumers*[1]

12 To view the validity of the above statement and gain an additional perspective on the actions WELL is taking to prevent or mitigate similar quality standard non-compliance in the future. Strata compared the forecast capital and operational expenditure forecasts that WELL made since 2012 in its Asset Management Plans (AMPs). The results indicate that:

a) each of the 2013/14/15/16 AMPs predict increases in network capital expenditure, yet in the year following each AMP forecast, expenditure was below that forecast in the previous AMP;

[1] WELL 2016 AMP Appendix B Update from 2015 Plan

b) the above effect was largely driven by system growth related forecasts; asset replacement and refurbishment capital actually display the opposite feature with subsequent expenditure forecasts starting at a point above that forecast 12 months earlier; and

c) for each of the 2014/15/16 AMPs capital expenditure for reliability, safety and environment has been forecast to increase sharply in the following year yet this increase has not occurred.

13 In its 2016 AMP, WELL confirms that, in February 2016 it has completed an upgrade of its SCADA master station software to PowerOn Fusion. Benefits claimed for the PowerOn Fusion by its suppliers, GE Grid Solutions,[2] indicate that the upgrade is likely to lead to material improvements in WELL's network management capabilities. These benefits include higher reliability, reduced outage restoration times and lower operating costs[3].

14 The implementation of systems such as PowerON Fusion suggests that underlying SAIDI and SAIFI performance should improve.

15 Taking the 2016 AMP information into account with other findings in this review, Strata concludes that WELL has the capability and has forecast sufficient expenditure levels to enable it to manage the network in a manner that will prevent or mitigate quality standard non-compliance in the future.

16 Strata has included recommendations from this review that, if applied by WELL, are likely to improve the probability of achieving and sustaining reliability performance within the quality standards in the future. These include:

a) increased use of predictive analysis of failure rates for its fleet strategies as part of its condition based risk management approach to asset management;

b) reviewing and simplifying the fault cause descriptors used for reliability reporting to simplify the analysis and avoid incorrect reporting[4];;

c) avoiding the use of 'storms' fault category, and, following investigations of major events such as storms, apply the results of the investigation to reclassify fault causes with known information;

d) proceeding with its analysis of insulated cable technologies as a source of potential reliability improvements to its overhead line network, with a view to implementing the selected option in a field trial;

e) considering reporting SAIDI and SAIFI by CBD/Urban/Rural classifications to improve understanding of the contribution of these areas to the overall reliability performance. Strata understands that WELL already classifies these areas for other purposes in the business;

f) consideration of the optimal location of protection and sectionalising equipment with SCADA is undertaken in its reliability planning to minimise the impact of outages to customers, and that this is considered alongside a review of safety risk; and

g) undertaking a further review of the asset risk management framework, specifically of asset risks arising from network events (such as earthquakes) experienced by other electricity transmission and distribution businesses.

[2] A General Electric and Alstom joint venture

[3] http://www.gegridsolutions.com/products/brochures/uos/PowerOn_fusion.pdf

[4] there are some unreconciled errors in WELL's published and disclosed quality standards data, but in aggregate these have been found not to have had a material impact on the output performance values and have since been rectified by WELL.

17 Strata considers that the Commission should also take note of the following observations:

a) the changes made by the Commission in the DPP 2015-2020 will mitigate the impact of large events on WELL's reliability performance;

b) reporting of regional based SAIDI and SAIFI by EDBs may be valuable when ascertaining the benefits of limits for future DPPs;

c) electricity distributors should establish clear management practices that meet the requirements of Electricity (Hazards from Trees) Regulations 2003 whilst remaining compliant with the quality standards and not exceeding the reliability limits; and

d) WELL's asset related expenditure and its impact on quality standards, including rationale for claims of deferred expenditure in the current period is worthy of further review once the information and data becomes available.

18 In summary, addressing the Commission's specific questions Strata concluded that:

a) the breaches in reliability limits have been mainly due to vegetation management issues emerging during severe storm events causing flying debris connecting with overhead lines. It is possible that some age related deterioration of the overhead assets may have contributed to the failures during severe weather;

b) the asset management strategies developed and implemented by WELL were appropriate and there is no evidence that underinvestment has led to the breaches of the reliability limits;

c) WELL could not have taken any reasonable steps or actions that would have avoided non-compliance due to the effects of severe storm events;

d) there is no reason to conclude that the reliability of the network will deteriorate due to a lack of funding of the vegetation management activities. Strata considers that WELL management is knowledgeable on vegetation issues and has in place appropriate programmes to engage with stakeholders;

e) initiatives being implemented by WELL to develop asset and vegetation management will to some extent mitigate the impact of future severe weather events and enable asset replacement programmes to anticipate potential asset failure;

f) WELL's continuing development of its asset management capabilities, systems and methods are likely to ensure that appropriate steps are taken to mitigate network performance risks.

19 Based on the information provided during the review and included in WELL's 2016 AMP, Strata considers that WELL has forecast expenditure and undertaken a number of actions that should prevent or mitigate similar quality standard non-compliance in the future.

1 Introduction

1.1 Purpose of this review

20 Wellington Electricity Lines Limited (WELL) is subject to a default price-quality path. The latest default price-quality path came into effect on 1 April 2015. The Commerce Commission (the Commission) engaged Strata Energy Consulting (Strata) to investigate the breaches of the quality standards by WELL during its previous price-quality path.

21 WELL breached the quality standards in 2013 and 2014 due to being above the quality limits for the 2012, 2013, and 2014 assessment periods. WELL provided information to the Commission explaining the reasons for exceeding the limits in each of the three assessment periods.

1.2 Scope and objectives

22 This review is intended to inform the Commission of the underlying causes of WELL's non-compliance and to identify whether or not exceeding the regulatory quality standard was the result of a sustained deterioration of the network.

23 In particular, the Commission has asked Strata to provide its advice on the following matters:

a) summarising the circumstances and conduct contributing to the instances of non-compliance;

b) providing a view on whether the non-compliance was avoidable if the circumstances and/or conduct had been addressed, through an assessment of:

   a. the extent to which events outside of the control of the business contributed to non- compliance relative to conduct, circumstances, or events that were within the control of the business; and

   b. whether the business failed to take any action to avoid or reduce the non-compliance;

c) the extent to which the business has already undertaken corrective actions to mitigate the issues identified; and

d) Any recommendations for the Commission's consideration in response to any concerns raised.

24 The Commission requested that Strata conducts a site visit of WELL's network to support the preparation of this report.

1.3 Strata's approach to the investigation

25 Strata adopted the following three-stage approach for this review:

Task	Description
Stage 1	**Desk-top review** Objective: Establish an understanding of and assess WELL's asset management framework and reliability performance and also to inform the on-site review. Carry out a desk-top review of information supplied by the Commission and Strata's independent research on WELL's electricity distribution network.
	Initial report Strata provided the Commission with a briefing on initial issues and observations from the desktop review.
Stage 2	**On-site assessment and analysis** Objectives: Confirm and assess WELL's explanations for the breaches. Identify any additional contributors to the breaches. Assess the extent to which WELL applies its asset management framework in practice. Develop an opinion on the likely future reliability performance. Establish a view of the reliability and accuracy of the information used by WELL to manage its assets. Complete an onsite assessment of WELL's electricity distribution network and asset management practices.
	Preliminary report (verbal) Objective: Provide the preliminary review findings and recommendations.
Stage 3	**Draft and Final report** Objectives: Provide a draft and final report incorporating review findings and justification for conclusions and recommendations. Complete a review session with WELL, and incorporate feedback into draft report prior to issue of final report.
	Objective: Provide the review findings and justification for conclusions and recommendations.

1.4 Structure of this report

26 The sections of this report are structured to provide a high level overview of the information gathered in the review and to provide the key points relevant to the review objectives. A summary of the sections of the report is set out in the following table.

Section	Content
Brief overview of WELL	Provides a brief overview of WELL, its governance structure and key statistics.
WELL's Reliability Performance	Provides the historical performance against regulatory standards.
Assessment of WELL's explanations for reliability performance	Provides an assessment of the explanations for the reliability limit breaches, including review of historical reliability performance.
Potential contributory	Discusses potential contributor to the deteriorating trend

Section	Content
factors to performance breaches	in reliability performance.
Expectations on future quality performance	Provides Strata's assessment of future network performance based on the findings of the review.
Findings and recommendations	Provides a summary of the main observations and findings of the review and the key findings, observations and recommendations.

1.5 Data and information sources

27 The key data and information that this review has relied upon are set out in the following table.

Information/data	Source
SAIDI and SAIFI values	WELL annual compliance statements for 2009/10 to 2013/14.[5] WELL's analysis of worst performing feeders.
Asset age and condition	WELL responses to Strata information requests. Strata sample asset and report review and WELL information obtained at the on-site visit. WELL 2014 - 2016 AMPs.
Asset management framework and practices	WELL responses to Strata information requests. Information obtained from WELL management during the on-site visit. WELL 2015 and 2016 AMPs. WELL compliance reports.

[5] We also reviewed compliance statements prior to and following this period to determine a trend in reliability performance.

2 Brief overview of WELL

28 In this section, a brief overview of WELL, its governance structure and key statistics is provided.

2.1 Introduction

29 WELL's distribution network supplies the cities and council jurisdictions of Wellington, Porirua, Lower Hutt and Upper Hutt. A map of the supply area provided by WELL is reproduced below in Figure 1.

30 WELL states that, as of February 2015, the network included:[6]

a) 165,938 installation control points, ICPs (consumer connections) of which over 89% of this number is residential connections and a further 9% is small commercial connections (the network area does not have large industrial and agricultural loads); and

b) total system length (excluding streetlight circuits and DC cable) is 4,680 km, of which 62.7% is underground.

31 The region includes Wellington's Central Business District (CBD) and widespread residential load interspersed with pockets of commercial and light industrial load.

[6] WELL AMP 2015

Figure 1 - WELL network area

Source: WELL 2015 AMP

2.2 Governance and management

32 In July 2008, the network was purchased by Cheung Kong Infrastructure Holdings Limited (CKI) and Hong Kong Electric Holdings Limited (since rebranded to Power Asset Holdings Limited) to create Wellington Electricity Lines Limited (WELL). Vector Limited previously owned the network. Following this purchase, WELL has re-established its corporate office and operates its business systems for the independent operation and control of the network.

33 WELL assumed all operational control by 2009 and maintained accountability for service and performance during the price quality period 2009-2014.

34 WELL draws upon the resources of the CKI ownership group for its corporate operations and locally International Infrastructure Services Company (IISC) as a separate infrastructure services company which provides management services to WELL. Since taking ownership, the workforce has grown to approximately 50 FTEs.

35 Fieldwork is undertaken by external service providers contracted to WELL including NorthPower (fault response and maintenance), Treescape (vegetation management) and Telnet (call centre). In addition, North Power, DownerTenix and Connectics are used for contestable capital projects.

36 WELL Board of Directors is responsible for the overall governance of the business. The Board approves capital and operational expenditure budgets and business plans. Information is provided to the Board as part of a monthly consolidated business report

that includes health and safety reports, capital and operational expenditure vs budget, reliability statistics against targets and consumer satisfaction survey results.

37 WELL has a capital expenditure governance process that includes the Capital Investment Committee (CIC). The CIC meets on a regular basis to review and approve projects and to be appraised of progress on approved projects. All network capital projects greater than $400,000 require approval from the CIC.

38 WELL's operating structure has changed a number of times including location and accountability for network control and more recently, separation of network management (and strategy) from operational delivery. Recently, a new General Manager Asset Management role has been created, reporting to the CEO.

2.3 Key statistics

39 The following statistics are sourced from the WELL 2015 AMP.

Table 1: WELL asset population

Asset Class	Measurement Unit	Quantity
Subtransmission Lines	km	58
Subtransmission Cables	km	136
Zone Substations	number	27
Zone Substation Transformers	number	52
Zone Substation Circuit Breakers	number	368
Distribution and LV Lines	km	1,682
Distribution and LV Poles	number	36,544
Distribution and LV Cables	km	2,791
Distribution Substations	number	3,588
Distribution Transformers	number	4,335
Distribution Circuit Breakers	number	1,300
Distribution Switchgear - Ground Mounted	number	2,218
Distribution Switchgear - Overhead	number	2,627
Protection Relays	number	1,388
Load Control Plant	number	26

Source: WELL 2015 AMP

40 WELL's largest customers include the following:[7]

a) NZ Parliament and offices of government departments;

b) major infrastructure providers such as Wellington Airport and Centreport;

c) Wellington, Kenepuru and Hutt Hospitals;

d) large education institutions such as Victoria University and Massey University;

e) regional and local authorities, including council infrastructure such as water and wastewater treatment and pumping stations, as well as provision of the streetlight network; and

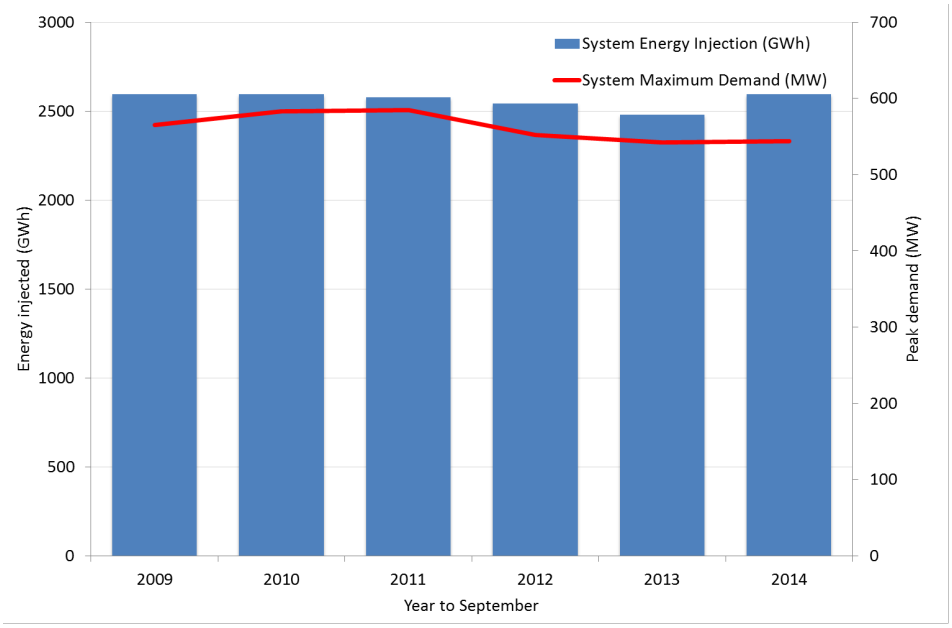
f) the electrified suburban railway and trolley bus networks.

41 WELL's network is a winter peaking system with system maximum demand of approximately 550MW. WELL states that from observation of actual load data, peak demand on the network is rising over the long-term at 0.5% to 1.0% per annum with slight decreases in recent years due to mild temperatures. The system peak demand and

[7] www.welectricity.co.nz/about-us

energy injected into the network, provided in the 2015 AMP, show the recent downward trend, see Figure 2.

Figure 2: WELL maximum demand and injection



Source: WELL 2015 AMP[8]

2.4 Network configuration

42 WELL's electricity distribution system comprises the following network assets.

43 Grid Exit Points (GXPs): WELL's network is supplied from Transpower's transmission grid through nine GXPs.

44 Sub-transmission: WELL's sub-transmission network operates at 33kV and supplied 27 zone substations. The network is radial in design, with each feeder typically supplying its own dedicated power transformer.

45 Distribution: WELL's distribution system operates at 11kV, predominately supplying residential loads through the LV system. Most of the 11kV feeders in the Wellington CBD are operated in a closed ring configuration with radial secondary feeders interconnecting neighbouring rings or zone substations. This arrangement provides a high level of supply reliability. Most 11kV network outside the Wellington CBD, both in the South and Northeast areas, comprises radial feeders.

46 Low Voltage: WELL's low voltage system comprises lines and cable used to connect individual customers via a low voltage fuse, referred to as the installation connection point (ICP).

47 WELL has approximately 14.5MW of embedded generation connected to its network, primarily made up of standby diesel and landfill gas.

48 The network area covers four local councils, namely Wellington City, Hutt City, Upper Hutt City and Porirua City. In addition to the local councils, the Wellington Regional Council covers the entire network area. The different council areas have varying

[8] Data for the chart was sourced from WELL 2015 AMP, Section 1.8, page 24.

requirements relating to permitted activities for an electrical utility, for example, in relation to road corridor access and environmental compliance.

3 WELL's reliability performance

49 In this section, the historical reliability performance against regulatory standards is provided.

3.1 Introduction

50 SAIDI and SAIFI reliability limits for the period 1 April 2010 to 31 March 2014 were:

SAIDI limit: 40.740

SAIFI limit: 0.600

51 The SAIDI and SAIFI limit for the 09/10 year prior to this period was 29.7 and 0.436 respectively. WELL's actual network performance against the above SAIDI and SAIFI limits is shown in the table below.

Table 2: WELL Reliability Performance – SAIDI and SAIFI

	09/10	10/11	11/12	12/13	13/14
No. of customers	163,591	164,081	164,602	164,705	164,797
SAIDI limit	29.7	40.744	40.744	40.744	40.744
SAIDI non-normalised	40.478	34.738	45.879	43.290	190.770
SAIDI normalised[10]	40.478	34.738	45.879	43.290	78.876
Variance	(10.778)	6.006	(5.135)	(2.546)	(38.132)
SAIFI limit	0.436	0.602	0.602	0.602	0.602
SAIFI non-normalised	0.573	0.537	0.715	0.573	1.107
SAIFI normalised[11]	0.573	0.537	0.715	0.573	1.107
Variance	(0.137)	0.065	(0.113)	0.029	(0.505)

52 During the 2010-15 regulatory period, WELL exceeded the regulatory reliability limits for SAIDI in the years 2011/12, 2012/13 and 2013/14 and for SAIFI in 2011/12 and 2013/14.

[9] Reliability limits sourced from WELL compliance statements.
[10] The difference in figures quoted from the compliance statement in the years 09/10 and 11/12 being a normalised SAIDI of 40.629 and 45.858 respectively, were explained by WELL.
[11] The difference in figures quoted from the compliance statement in the years 09/10 and 10/11 being a normalised SAIFI of 0.583 and 0.536 respectively, were explained by WELL.

3.2 WELL's explanations for the breaches

53 WELL stated that there are three key factors that describe the underlying cause for exceeding the reliability limits during assessment periods ending 31 March 2012, 2013 and 2014 and asserts that these factors are largely outside of its control:

a) a period of significantly increased volatility associated with severe weather related events;

b) the regulatory methodology utilised for setting reliability limits and normalisation through the identification of Major Event Days (MEDs); and

c) the scope of vegetation management provided for by the Electricity (Hazards from Trees) Regulations 2003.

54 WELL states that seven major events occurred during the period between August 2011 and October 2013 that have been the direct cause of the non-compliance with the reliability limits. WELL states that excluding these events would result in the annual SAIDI and SAIFI limit being within the reliability limits. The events are:

a) 2011/12: snow storm in August 2011 and storm event in March 2012;

b) 2012/13: storm event in September 2012, which resulted in a metal roof shorting a sub-station circuit; and

c) 2013/14: storm events in June 2013 and October 2013, and earthquake events in July 2013 and August 2013.

55 Prior to the on-site review, Strata made a request to WELL for additional information on its asset management systems and, specifically, details of any investigations and/or analysis initiated by WELL on asset performance, failures and deterioration. WELL was also asked to include any analysis undertaken on assets that contributed most to the SAIDI and SAIFI performance result (e.g. best and worst performing asset types, asset classes, zones, feeders, locations etc.).

56 WELL provided detailed explanations of what it considered to be the underlying causes of exceeding reliability limit in its compliance disclosures and supporting information.

4 Assessment of WELL's explanations for reliability performance

57 In this section, Strata provides its assessment of WELL's explanations for the breaches of reliability limits.

4.1 Review of extreme events

58 WELL stated that seven extreme weather and earthquake related events are the underlying causes of exceeding the reliability limits over the review period. A summary of the extreme events is provided in Table 3.

Table 3: Summary of major events[12]

Major event	Description	SAIDI impact	SAIFI impact
Four days of snow - August 2011	In August 2011, four days of severe weather affected the performance of the Wellington network. The region experienced snow, sleet, high winds, sustained lightning and thunderstorms.	6.719	0.081
Storm, March 3, 2012	On 3 March 2012, a storm hit the Wellington region at approximately 4am and generated sustained wind gusts of over 100 km/h for 20 hours.	4.786	0.042
Storm, September 8, 2012	On 8 September 2012, a storm event resulted in debris and tree branches blowing into the overhead network, damaging assets and interrupting supply causing multiple outages. The storm continued for a period of 17 hours as recorded by MetService.	7.841	0.048
Storm, June 20-22, 2013	On 20 June, a storm described as being similar in magnitude to the "Wahine storm" of 1968 hit Wellington and surrounding Porirua areas. Wind speeds of over 100kph were continuous for the next 30 hour period until they began to reduce later in the evening of 21 June.	24.638	0.359
Earthquakes, July and	Two earthquakes, magnitude 6.5 and 6.6, affected the Wellington region in July and August of 2013	2.635	0.081

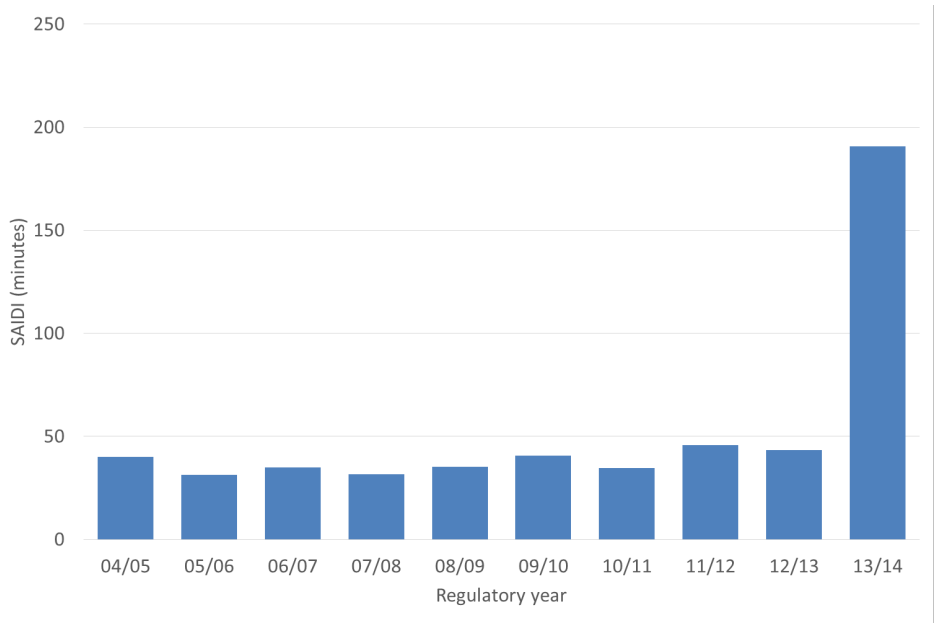
[12] SAIDI and SAIFI performance is shown as normalised SAIDI and SAIFI. Only one event was normalised over the period, for the June 2013 storms. The actual SAIDI was 136.029.

August 2013	respectively. The strong tremors caused mechanical protection relays at the Karori zone substation to operate, tripping both supply transformers on both occasions.		
Storm, October 14 2013	On 14 October 2013 a storm hit Wellington and wind speeds continued above 100 km/h for approximately 22 hours.	9.058	0.080

Source: Information requested by Strata and provided by WELL

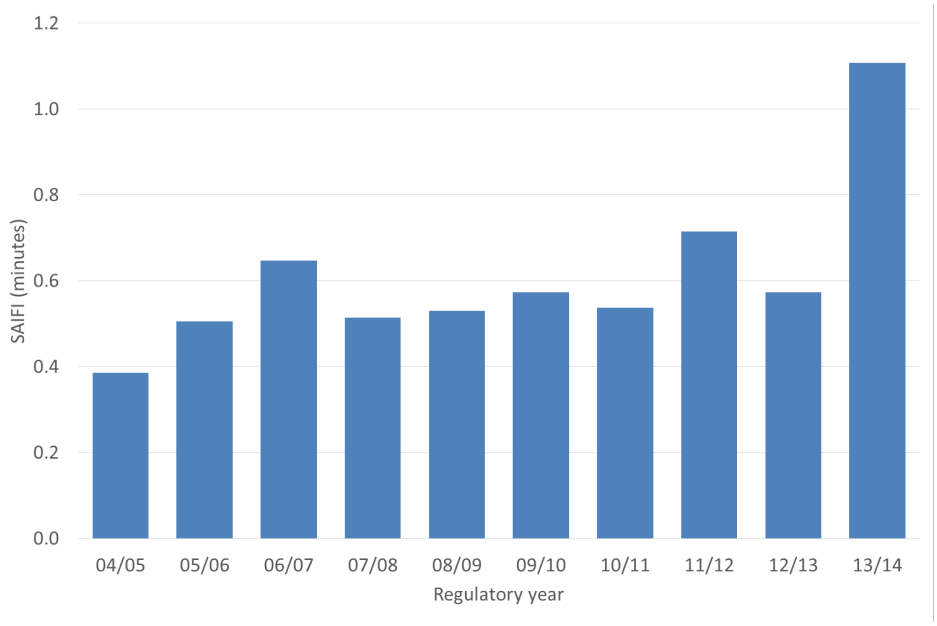
59 From the table above, storms were the most common major event experienced on the WELL distribution network, the most significant of which was the June 2013 storm. The impact of these events can be seen in Figure 3 and Figure 4.

Figure 3: Regulatory year SAIDI - non-normalised (2004 to 2014)



Source: WELL Quality of Supply Information 2004-09 and 2010-14

Figure 4: Regulatory year SAIFI - non-normalised (2004 to 2014



Source: WELL Quality of Supply Information 2004-09 and 2010-14

60 The SAIDI and SAIFI performance in 13/14 is a clear outlier when compared with the other regulatory years shown in Figure 3 and Figure 4.

4.2 Significantly increased volatility associated with severe weather related events

61 Strata's assessment of the major events and WELL's explanations for its breaches of reliability limits are provided in the following subsections.

4.2.1 Review of events

Snow, August 2011

62 Ice and snow build up on lines, as well as heavily snow laden branches on trees, combined with strong winds and lightning led to outages primarily affecting rural areas. Access was hindered due to ice, snow and fallen branches. The total SAIDI and SAIFI impact was 6.719 and 0.081 respectively.

63 According to WELL, the presence of these conditions is not typical for the Wellington area and could be considered an extreme event. The conditions were present for approximately four days. The impact of this event over multiple days had a significant impact on the SAIDI and SAIFI performance of WELL in that year.

Storm, March 2012

64 The largest impact of this storm event was associated with wind borne debris coming into contact with the overhead distribution network. The total SAIDI and SAIFI impact was 4.786 and 0.042 respectively.

Storm, September 2012

65 The largest impact of this storm event was associated with wind borne debris coming into contact with the overhead distribution network. The total SAIDI and SAIFI impact was

7.841 and 0.048 respectively. The SAIDI impact was not sufficient to qualify as a major event day for the purposes of replacing the actual SAIDI with the boundary value.

66 The largest single outage during the storm occurred when metal roofing iron detached from a residential premise shorting a 33kV circuit and communications cable resulting in loss of the Trentham substation. The SAIDI and SAIFI contribution of this event was 5.159 and 0.30 respectively.

67 One of the 33kV circuits remained out of service following the storm awaiting repairs when a landowner felled a tree onto the remaining 33kV circuit, causing another loss of supply to Trentham.

68 WELL has since made changes to the protection systems to reduce risk of the fault re-occurring under similar circumstances.

Major storm, June 2013

69 The storm was characterised by WELL as an intense storm that affected both the Wellington area and the South Island, resulting in significant damage to the electricity network and surrounding infrastructure.

70 The storm resulted in widespread damage and prolonged outages, due to unsafe conditions to repair lines, including:[13]

a) sustained wind speeds exceeding 100 km/h, with gust exceeding 200 km/h on day 1;

b) operating restrictions to ensure safety of workforce;

c) access restrictions, due to both weather, fallen trees and debris that required city councils and vegetation contractors to clear roads for access to lines;

d) 60,260(or approximately 36%) of the connected customers affected by the HV faults and more by LV faults; and

e) post-storm clean-up impeding WELL's ability to respond to other faults for two weeks following the event.

71 WELL states that it brought in 150 additional staff from around the country to restore power as quickly as possible without compromising the safety of the responding crew.

72 WELL states that: [14]

> *There were 103 recorded HV outages due to the major storm affecting 60,260 customers. Out of these customers affected, 94 per cent were restored within 24 hours, 4 per cent were restored within 48 hours and 0.63 per cent was restored within 72 hours. There were also 2963 LV incidents recorded.*

73 The contribution to the SAIDI assessment for 13/14 of this event was 24.638 SAIDI minutes, or approximately 60% of the SAIDI limit.

[13] WELL 2013 storm outage report2.930
[14] WELL 2013 storm outage report2.260

Table 4: 2013 Storm contribution to SAIDI and SAIFI

Date	SAIDI	SAIDI norm	SAIFI	SAIFI norm
20-June-13	104.702	9.724	0.197	0.197
21-Jun-13	26.137	9.724	0.125	0.125
22-Jun-13	2.930	2.930	0.013	0.013
Related events	2.260	2.260	0.024	0.024
Total	136.029	24.638	0.359	0.359

74 As shown in Table 4, the force of this storm over multiple days had a significant impact on the SAIDI and SAIFI performance of WELL in that year.

75 During the on-site review, WELL managers described its response to restore supplies following the June 2013 storm. Its response included:

a) absolute focus on safety of the workforce and the public through-out the event;

b) coordination of information pertaining to the repair and safety of the electricity network;[15]

c) coordination with local councils and contractors to remove identified hazards;

d) significant additional work crews mobilised to assist the restoration of electricity;

e) relocation of work crews and equipment to strategic areas around Wellington due to transport constraints and traffic congestion; and

f) focus on restoration of HV network to restore supplies to the maximum number of customers.

76 Based on the information provided, we consider that WELL undertook reasonable repair and restoration practices to reduce the impact of the outages on its customers caused notably by the storm's wind intensity and duration, given the size and scale of the event.

77 WELL acknowledged areas for improvement in its response including improving dispatch and updating of fault information and asset data. Strata considers that there is evidence to suggest that the focus of review of major events, and introduction of improvements is likely to be similarly applied to other major events.

Earthquakes, July and August 2013

78 The strong tremors in July and August 2013 caused mechanical protection relays at the Karori zone substation to operate, tripping both supply transformers on both occasions. The risk presented by the mechanical protection relays had not been identified by WELL prior to the July earthquake.

79 Strata identified information that suggests that Transpower had a similar problem to WELL with transformers that use mercury switches as part of over-temperature protection.[16] In 2010, Transpower lost supply to several of its substations when the over-

[15] WELL noted that this area of the storm response required improvement

[16] Watson NR, 2010, Impact of the Darfield earthquake on the electrical power system infrastructure, Bulletin of the New Zealand society for earthquake engineering, vol. 43, no. 4, December 2010, viewed at http://www.nzsee.org.nz/db/SpecialIssue/43(4)0421.pdf

temperature protection operated during the Christchurch earthquake. We would consider that this information is likely to have been available to WELL, and would form part of its own risk review and reasonably result in a rectification project as part of the seismic hardening of its electricity network.

80 Given the modifications WELL has since made to the protection relays, we expect that the fault will not re-occur under similar circumstances.

Storm, October 2013

81 Sustained high wind speeds were stated as the primary cause of the outages associated with this storm event. The total SAIDI and SAIFI impact was 9.058 and 0.080 respectively. The SAIDI impact was not sufficient to qualify as a major event day for the purposes of replacing the actual SAIDI with the boundary value.

82 This event includes one significant outage where one 33kV transformer at Wainuiomata was out of service for maintenance, when wind borne debris resulted in a trip of the remaining 33kV line. WELL states that a strategic spare transformer is now located at Wainuiomata, and new rules for the Control Room regarding operation on N security are in place.

4.2.2 Increasing incidence of major weather events (storms)

83 In its explanatory information, WELL cited increasing weather events from a US literary source, however, WELL does not make a correlation between the weather data on which this study was based and weather data relevant to WELL's network.

84 During the onsite discussions, WELL was asked to provide local weather data to support the claims made of increasing incidence of major weather events. WELL provided reports sourced from the MetService as described further below.

85 WELL also produced trend charts of wind speeds[17] re-produced from information provided by the MetService. The charts depicted the number of days the wind speed exceeded 100 kph and 150 kph on the y-axis and calendar year on the x-axis.

86 On review of these charts, there appeared to be a correlation between the major events experienced by WELL and the data from MetService. The charts also showed a number of years where the wind speeds exceed 100 and 150 kph and where major events were not identified in those years, nor contributed as a cause of non-compliance with the reliability limits. The information provided may suggest that the Wellington region regularly experiences high wind speeds as a feature of the location.

87 During the on-site discussions, it was suggested that wind direction and wind speeds above 160 kph were associated with damage on the electricity network.

88 WELL advised that the current design criteria for overhead lines is 167 kph in accordance with AS/NZS7000, however, the design criteria for overhead lines designed and constructed prior to the current standard may be different.

89 WELL also stated that it did not experience a high pole failure or conductor failure rate, which indicates that the design criteria is appropriate for the local conditions and does not indicate a systemic issue in management of the electricity network.

[17] Two charts were produced by WELL showing: (i) the number of days in each regulatory year where wind speeds exceeded 100kph; and (ii) the number of days in each regulatory year where wind speeds exceeded 150kph.

4.2.3 Historical performance

90 Figure 5 shows the regulatory year non-normalised SAIDI. A moving average trendline has been added to the chart that shows an increasing trend.

Figure 5: Regulatory Year SAIDI Non-Normalised (2004 to 2013)

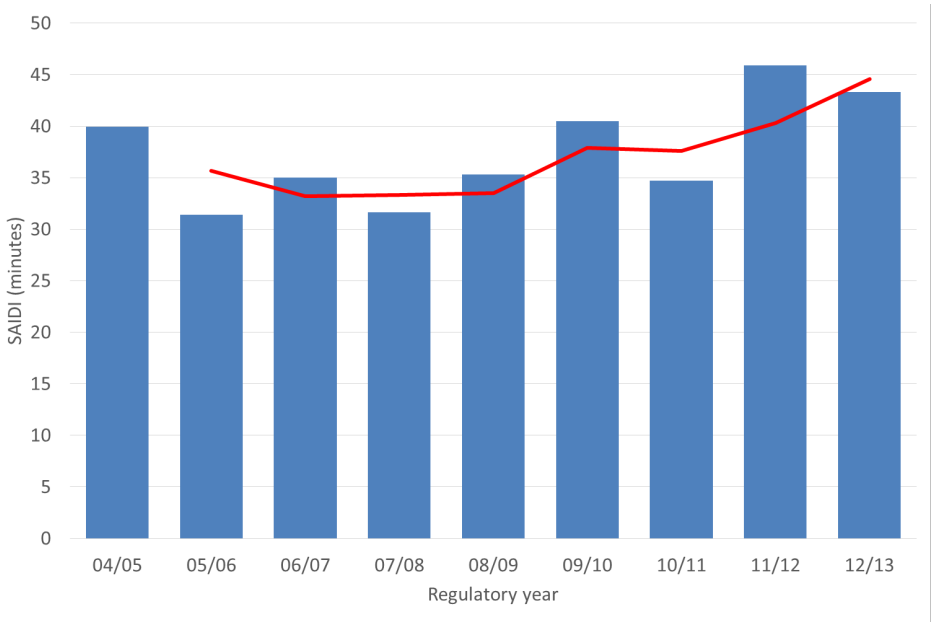
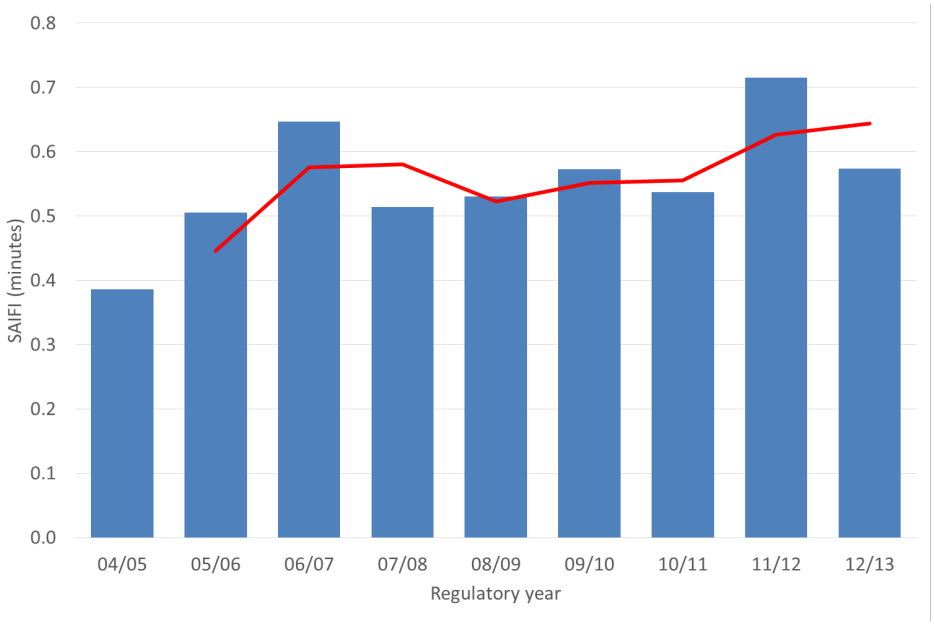


Figure 6: Regulatory Year SAIFI Non-Normalised (2004 to 2013)



Source: WELL Quality of Supply Information 2005-09 and 2010-14

91 Figures 5 and 6 indicate that, over the nine regulatory years to 2012/13, both SAIDI and SAIFI are trending upwards. However, the underlying data[18] does not, in Strata's view,

[18] Reference to "underlying data" is a reference to the composite of information provided by WELL for the

provide strong support of a significant intercede of climate change driven extreme weather.

92 As discussed in Section 3.3, both peak demand and energy injection into the WELL network have been decreasing over recent years. Several other factors such as the improvement in efficiency of electrical equipment and fittings are generally considered to be contributing to the flattening of consumption and demand.

93 Based upon review of historical reliability information commencing in 2004 as provided by WELL, we consider that:

a) there has been an increasing and continuing upward trend in SAIDI and SAIFI;

b) there appears to be a small number of high SAIDI years that, in the absence of better information, may suggest a pattern of extreme weather on a 10-12 year cycle; and

c) there is no discernible pattern to increasing incidence of major weather events.

4.2.4 Summary of increasing extreme weather explanation

94 In relation to storm related events, Strata considers that:

a) the storm of June 2013 should be considered an extreme event. Whilst there is provision in the regulatory methodology and normalisation procedure to cater for such an event, the size and scale of this event resulted in a high SAIDI and SAIFI impact to WELL. WELL undertook reasonable repair and restoration practices to reduce the impact of the outages on its customers caused notably by the storm's wind intensity and duration. This event was a significant factor in exceeding the reliability limits;

b) the events of snow (August 2011) and the impact of wind borne debris events (September 2012) may be considered extreme events due to the nature of the impact to the network and low level of control available to WELL to mitigate the risk;

c) wind borne debris is typically associated with storm events due to the high winds involved. Whilst the reliability impact of damage arising from wind borne debris is not normally considered within the control of a distribution business, minimisation of the impact of these types of events can be made through operating procedures and changes to protection schemes;

d) there is insufficient information from which to conclude a higher incidence of major weather events, in reality, the WELL electricity network is subject to high winds and weather patterns regularly due to its location; and

e) whilst the historical performance suggests that a pattern of major events may be evident on a 10-12 year cycle, the remainder of events appear to be a 'normal variation' in reliability performance associated with network events. In relation to earthquake related events, Strata considers that:

    a. overall, the network proved to be resilient to the 2013 earthquakes and the outages were due to issues with a specific protection component; and

    b. there is evidence to suggest that some network hardening may have avoided earthquake related major events.

95 Strata also notes that a number of events have highlighted the importance of undertaking asset based risk assessments including detailed review of information of knowledge gained during previous events and the sharing of information across the electricity

---

purposes of this review

industry. For example, risks identified following these events have since been mitigated by WELL through changes to its protection systems and/or operating procedures.

4.3 The regulatory methodology utilised for setting reliability limits and normalisation

96 The regulatory methodology in place for the price quality path within this review period was known to WELL at the commencement of the period. WELL's network has a high degree of undergrounding and high level of security which results in a number of zero fault days under the regulatory methodology when compared with its peers.

97 The methodology is based on historical performance and includes a margin for unknown events. It would therefore be reasonable to conclude that WELL must align its asset management and business practices to achieve the reliability limits under the default price path, or submit a customised price path seeking revised reliability standards.

98 Strata considers that the regulatory methodology cannot therefore be used as an explanatory factor in reviewing the reliability performance of WELL.

99 Strata notes that the reliability limit and methodology applied to WELL in its 2015 RCP is different to the period under review. These changes include:

a) reduction of the SAIDI limit from 40.744 to 40.630;

b) reduction of the SAIDI boundary value from 9.724 to 2.103;

c) increase of the SAIFI limit from 0.602 to 0.625; and

d) in calculating SAIDI and SAIFI values, planned interruptions are reduced by 50%.

100 During the onsite review, WELL presented the results of its modelling of the impact of the revised reliability limits and methodology on its reliability performance during 2010-2015. The modelling showed that WELL would have:

a) exceeded the SAIDI limit in one year only within the regulatory period; and

b) exceeded the SAIFI limit in two years out of three consecutive years within the regulatory period.[19]

101 The scope of Strata's review is limited to an assessment of the reasons for the breaches of the reliability performance limits which does not include an assessment of the limits themselves. The above points are provided for information only.

4.3.1 Summary of regulatory methodology utilised for setting reliability limits and normalisation

102 Strata considers that:

a) the regulatory methodology in place at the time that WELL breached the quality standard is not in itself a cause for the breach; and

b) the regulatory methodology and quality standard was known to WELL in advance of the major events cited by WELL as the cause of the breach.

[19] The modelled results suggest that the SAIDI performance would exceed the limit in 13/14 and SAIFI performance would exceed the limit in 11/12 and 13/14.

4.4 Scope of vegetation management regulation

103 During the on-site review, WELL provided numerous examples of vegetation that presented a risk to the electricity network. These included:

a) a tree in the shelter belt on private land that had fallen into adjacent trees, and if not removed, was likely to fall into overhead lines in strong winds;

b) forestry trees of significant height, that, whilst some distance from the line, should they shed branches or fall, would affect the overhead line;

c) council 'at risk' trees that have had their foundations undermined through erosion and are subject to continued erosion that is likely to lead to impact with an overhead line; and

d) private trees in, and close to the road reserve growing into overhead lines.

104 WELL stated that vegetation outside of the 'notice' zone was a significant issue and in the event of high winds associated with major storms, wind-borne vegetation was a cause of network incidents.

105 We inspected sections of feeders through the areas of Trentham, Johnsonville and Makara, both within an urban built-up environment and setting that is more rural. In many places, we observed the line running alongside or through tall hedgerows and shelterbelts.

106 In many areas we visited, vegetation management is clearly an enduring primary maintenance challenge. High amenity values are placed on trees in many areas of Wellington. Vegetation affecting the electricity network was observed in locations within and outside the defined overhead line corridor and road reserve.

107 WELL advised that landowners may declare an interest in trees located near overhead lines and allow only a trim but not complete removal of encroaching trees. After an initial trim, landowners then frequently neglect their obligations under the tree regulations for on-going maintenance and many current line encroachments were observed.

108 Whilst we observed evidence of vegetation management having been carried out in many places, feeders with similar issues are likely to remain fault-prone from tree encroachment and airborne debris during storms. WELL described the primary cause of the vegetation management issues it experienced as being related to trees outside of the 'notice zone' due to:

a) changes to legislation, principally the Electricity (Hazards from Trees) Regulations 2003 Electricity (Hazards from Trees) that sets out rights and processes for managing vegetation near lines; and

b) difficulties gaining agreement from residents to tree cutting.

109 From Strata's discussions with WELL and our field visits, we consider that vegetation management has been a concern for WELL and the predecessor entities for a long period. The high value placed on vegetation by local residents presents an area of difficulty in maintaining adequate clearance from the electricity network, complicated by the barriers in place by the current Tree Regulations.

110 Strata had expected to see, and did not see a higher (and increasing) incidence of vegetation related faults in the reliability fault records provided by WELL. Upon review,

Strata observed that in 2013/14, vegetation accounted for approximately 12%[20] of fault records, being the fourth highest cause of incidents. Over the review period, vegetation accounted for approximately 15% of all recorded incidents.

111 Vegetation related incidents shows a slightly increasing trend, however, this is largely linked to the storm related incidents of 11/12 and 13/14. The underlying non-storm related incidents shows a declining trend which, in the absence of better information, may suggest that focus by WELL on vegetation management is effective. Subject to auditing of the individual incident records, the storm related incidents are likely to be the result of wind borne vegetation or factors outside of the vegetation clearing zone.

112 WELL advised that most incidents are outside of the notice zone, however, we were not provided with a breakdown of historical incidents to confirm this. We understand that WELL is making changes to its reporting to separate in and out of notice zone incidents.

4.4.1 Summary on vegetation explanation

113 The management of vegetation within the tree regulation framework is challenging for electricity networks. The costs of engagement with tree owners increase as trees grow and present hazards to lines. Line faults due to vegetation outside the notice zones are much more difficult to manage proactively and yet account for a high proportion of the recorded faults.

114 The WELL network has a high proportion of underground cables relative to many other distribution networks and its overhead system is within reasonable travelling distances allowing much swifter fault rectification than in locations that are more isolated. It would be expected that this would be reflected in its historical reliability data and therefore in its reliability limits.

115 WELL's vegetation management challenges should be less than other EDBs that have more isolated rural communities. The relatively close proximity of its outlying customers to urban areas should allow WELL much easier access for discussions with tree owners than for most other EDBs.

116 During the review, Strata found that WELL management has a good level of understanding of the Tree Regulations and the responsibilities and limitations they place on WELL. The management activities to engage with tree owners and to identify and prioritise based on risk assessment are considered to be sound. WELL has in place an ongoing vegetation management programme that is supported by a continuing consistent level of expenditure.

117 During the review, we did not find reason to conclude that the reliability of the network would deteriorate due to a lack of funding of the vegetation management activities. Strata considers that WELL is appropriately informed on the vegetation issue and has put in place suitable programmes to engage with stakeholders.

118 Notwithstanding the above, given that the vegetation issue has been identified in other reviews Strata has undertaken for the Commission, we consider that there is a need for electricity distributors to establish vegetation management practices that allow them to comply with the Electricity (Hazards from Trees) Regulations 2003 whilst also complying with the reliability limits set under the price/quality regulatory framework.

[20] Excluding fault records identified as Major storms

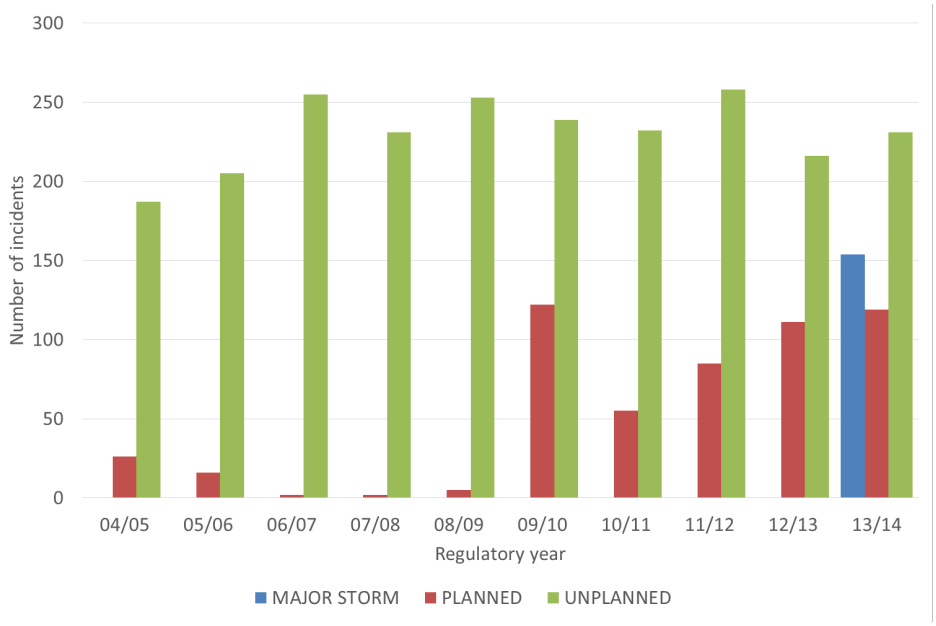
5 Potential contributory factors to performance breaches

119 In this section, we provide a summary of potential contributory factors that may assist in explaining the performance breaches by WELL.

5.1 Review of fault incident records

120 Strata observed a noticeable increase in the number of fault incident records. However, this was largely the result of increases to planned outages and major storm as shown in Figure 7 below. The underlying number of unplanned incidents appears to be relatively stable, whilst the aggregate of incidents is increasing with the growing number of planned outage events.

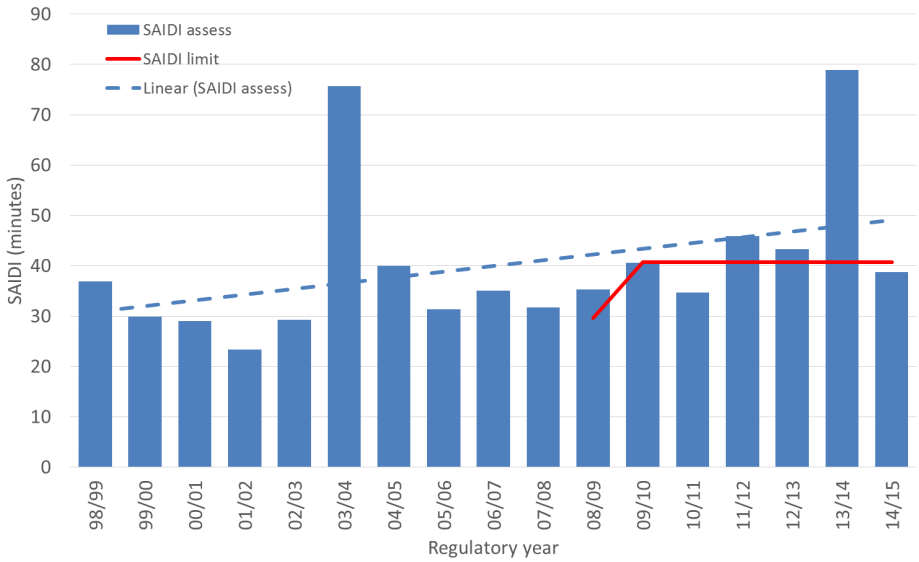
Figure 7 – Fault records



Source: Strata analysis

121 Strata reviewed the data to look for observable trends in performance prior to the review period as shown in Figure 8.

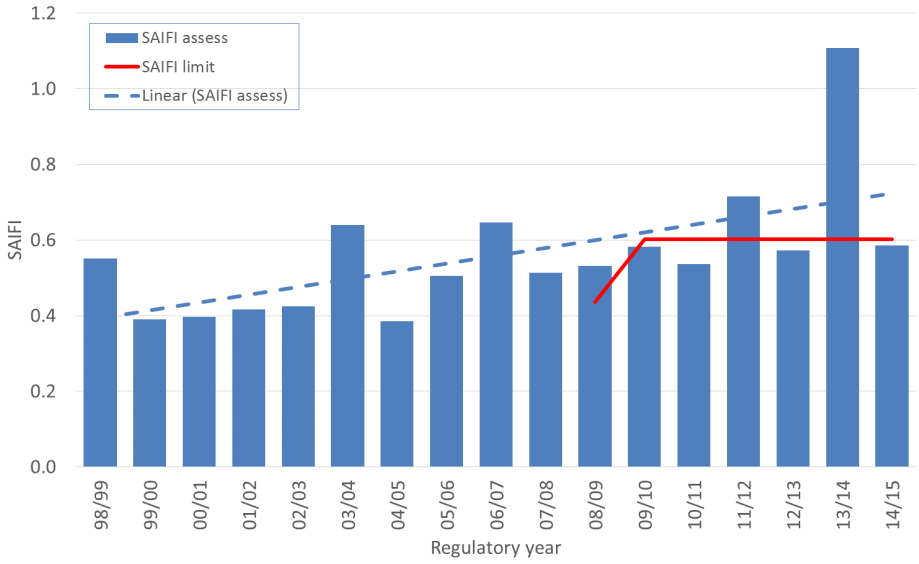
Figure 8 – Comparison of SAIDI normalised



Source: Strata analysis of WELL compliance statements

122 From Figure 8, it can be observed that there is an increasing trend of SAIDI (normalised). When the impact of the June 2013 storms was removed, the increasing trend is still present.

Figure 9 – Comparison of SAIFI normalised



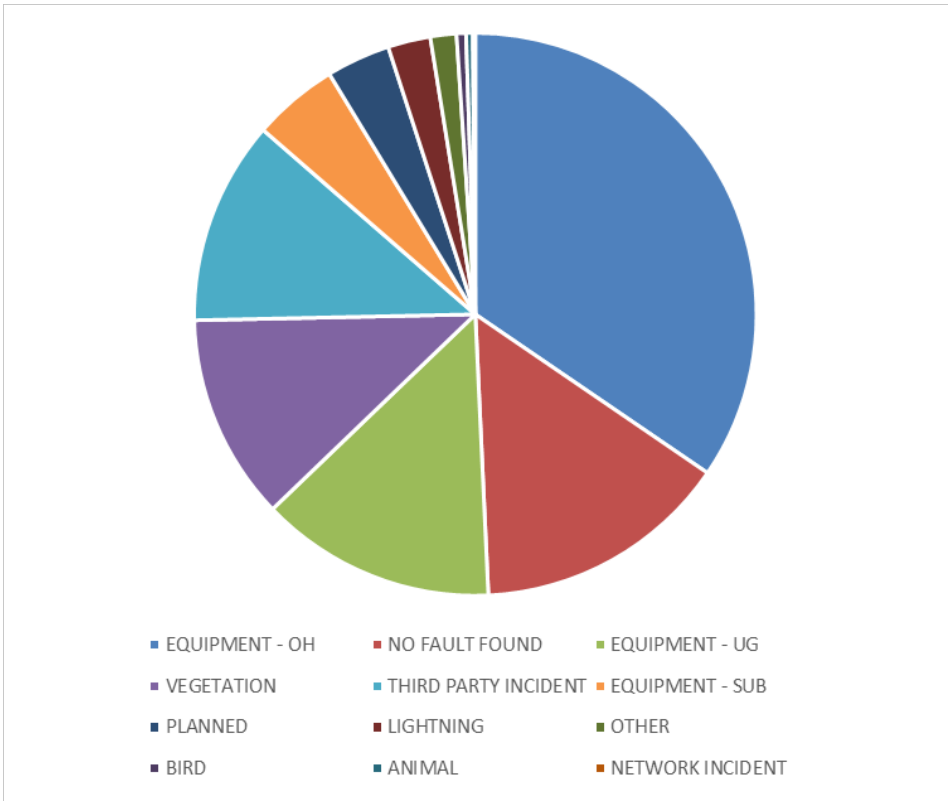
Source: Strata analysis of WELL compliance statements

123 From Figure 9, it can be observed that there is an increasing trend of SAIFI (normalised). As for SAIDI, when the impact of the June 2013 storms is removed, the increasing trend is still present.

5.2 Review of incident cause

124 The upwards trends observed in Figure 8 and Figure 9 would typically suggest an underlying deterioration in the condition of the network that would likely be the result of increases in asset failure and larger consequences of each failure. In Figure 10, the breakdown of incident cause for a single year 2013/14 is shown. The breakdown of cause varies across each year. However, the major categories of EQUIPMENT – OH, NO FAULT FOUND, EQUIPMENT - UG, VEGETATION and THIRD PARTY INCIDENT are generally consistent.

Figure 10 – Breakdown of incident cause by SAIDI contribution, 2013/14



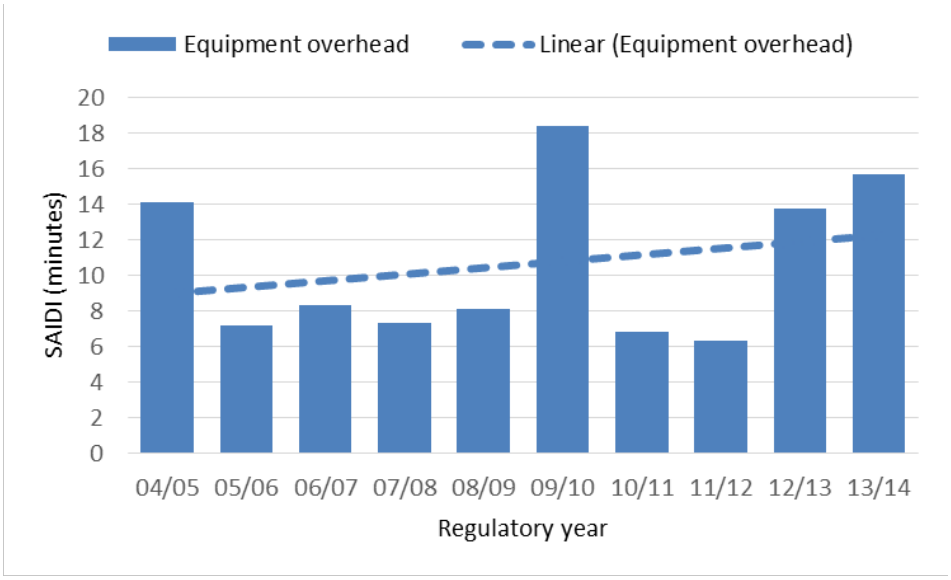
Source: Strata analysis

125 In the following sub-sections, observations relating to the trend of the top five fault categories are provided.

Overhead equipment

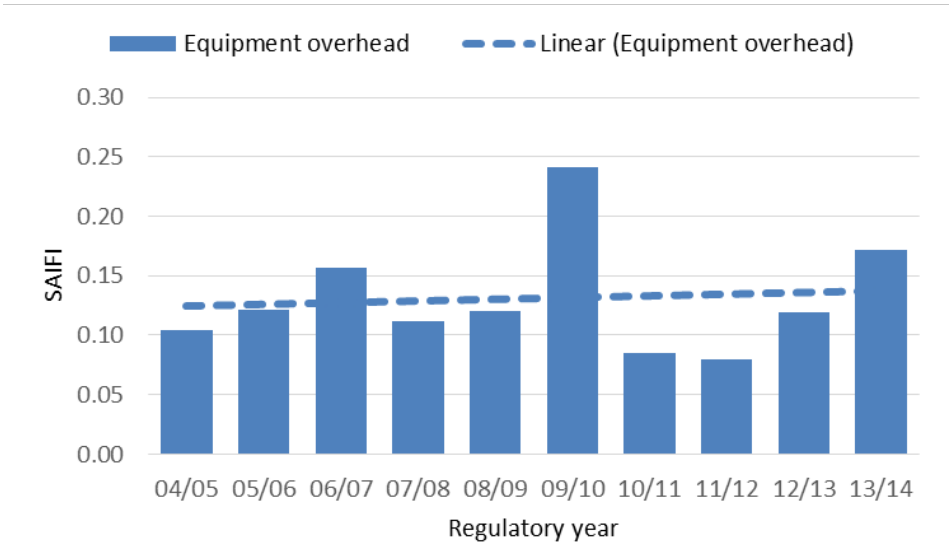
126 From Figure 11, an increasing trend in the SAIDI impact of overhead equipment related causes is observed. This trend is largely due to the contribution of storm related incidents as defined by WELL. The underlying trend for overhead equipment is a declining trend. During the on-site review, WELL advised that the number of pole and conductor failures was very low and stable respectively, and the asset information indicated that these assets were in good condition for their age. The upward trend for SAIFI impact in Figure 12 is not as pronounced, however, it has increased more sharply over the last few years.

Figure 11 –SAIDI incidents with 'Equipment - OH' as the cause[21]



Source: Strata analysis

Figure 12 –SAIFI incidents with 'Equipment - OH' as the cause[22]



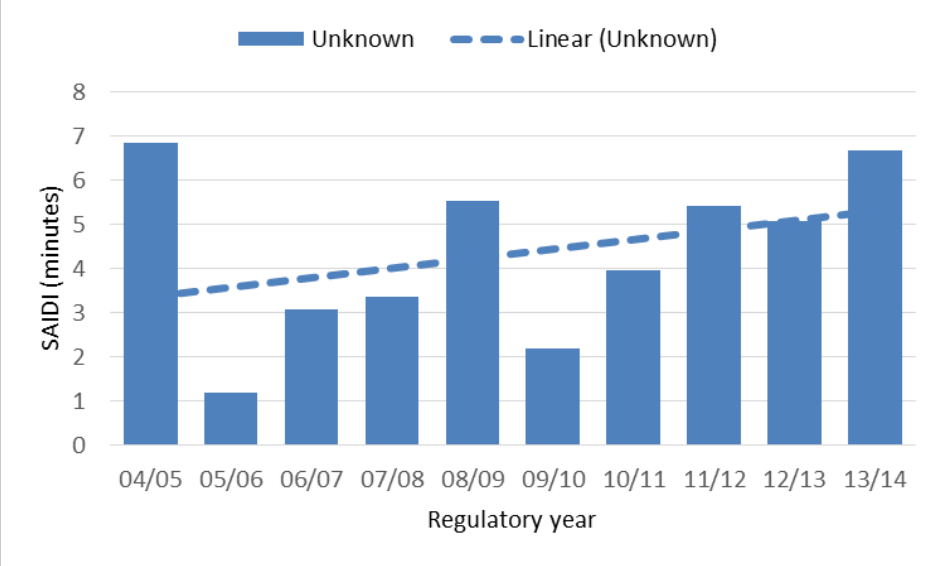
Source: Strata analysis

No fault found

127 From Figure 13, an increasing trend is observed in the SAIDI impact of causes where no fault was identified. This trend is largely due to the contribution of storm related incidents as defined by WELL. The underlying trend for no fault identified is a slight declining trend. A similar trend is present for SAIFI impact in Figure 14.

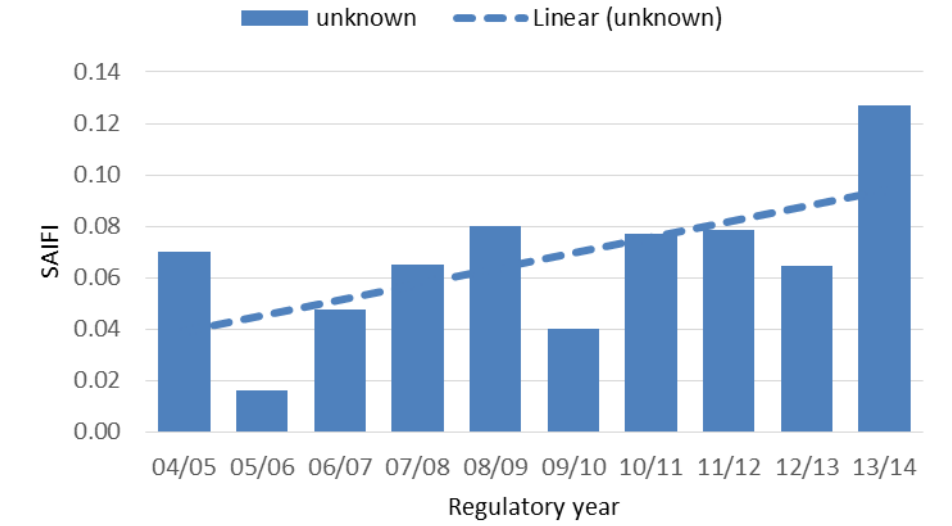
[21] The fault records include the summation of 'EQUIPMENT – OH' and 'EQUIPMENT - OH '
[22] The fault records include the summation of 'EQUIPMENT – OH' and 'EQUIPMENT - OH '

Figure 13 –SAIDI events with 'no fault found' as the cause[23]



Source: Strata analysis

Figure 14 –SAIFI events with 'no fault found' as the cause[24]



Source: Strata analysis

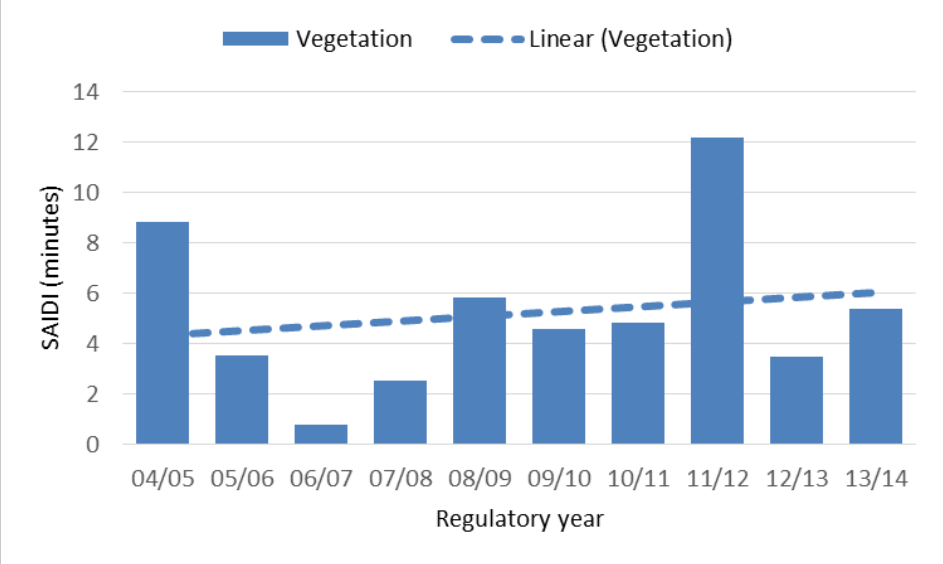
Vegetation

128 From Figure 15, an increasing trend in the SAIDI impact of vegetation related causes is observed. This trend is largely due to the contribution of storm related incidents as defined by WELL. The underlying trend for vegetation identified causes is a slight declining trend, which may support the effectiveness of the vegetation management initiatives. A similar trend is evident for SAIFI impact in Figure 16.

129 WELL has described the increased fault incidence of vegetation as being primarily related to vegetation outside of the notice zone being fallen or wind carried onto the power line.

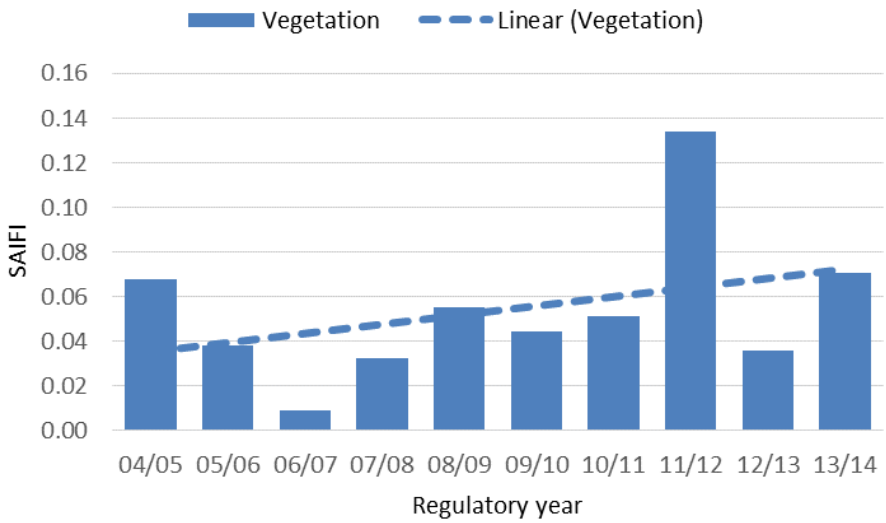
[23] The fault records include the summation of 'NO FAULT FOUND' and 'NO FAULT FOUND '
[24] The fault records include the summation of 'NO FAULT FOUND' and 'NO FAULT FOUND '

***Figure 15 –SAIDI events with 'vegetation' as the cause*[25]**



Source: Strata analysis

***Figure 16 –SAIFI events with 'vegetation' as the cause*[26]**



Source: Strata analysis

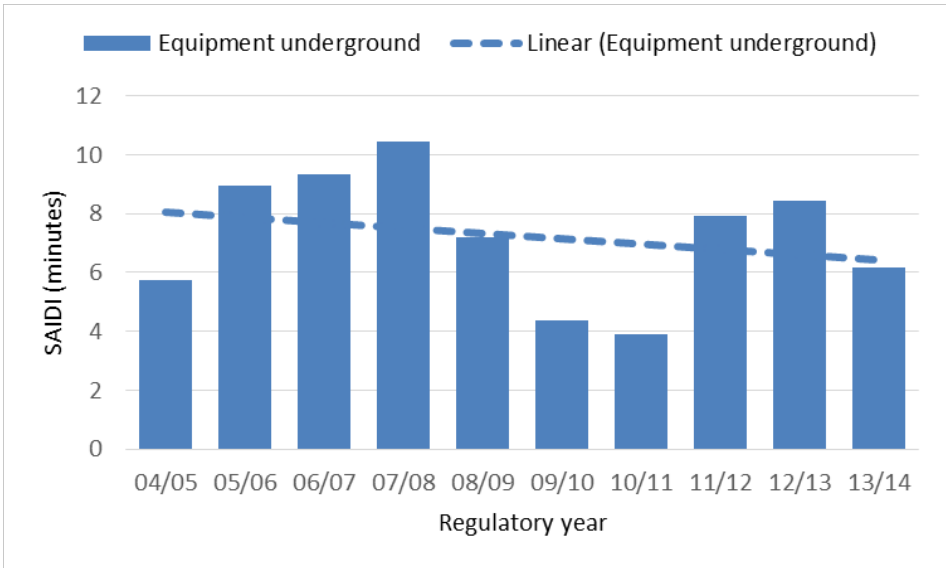
Underground equipment

130 From Figure 17, a decreasing trend in the SAIDI impact of equipment underground related causes is observed. During the on-site review, WELL advised that the number of underground cable failures was low, and the asset information indicated that the cables were in good condition. A similar trend is evident for SAIFI impact in Figure 18.

[25] The fault records include the summation of 'VEGETATION' and 'VEGETATION '

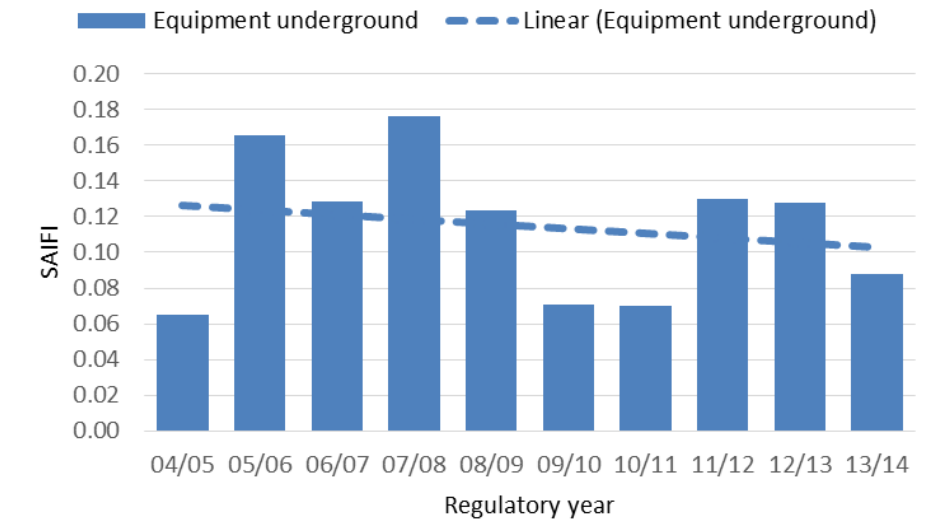
[26] The fault records include the summation of 'VEGETATION' and 'VEGETATION '

Figure 17 –SAIDI events with 'equipment underground' as the cause[27]



Source: Strata analysis

Figure 18 –SAIFI events with 'equipment underground' as the cause[28]



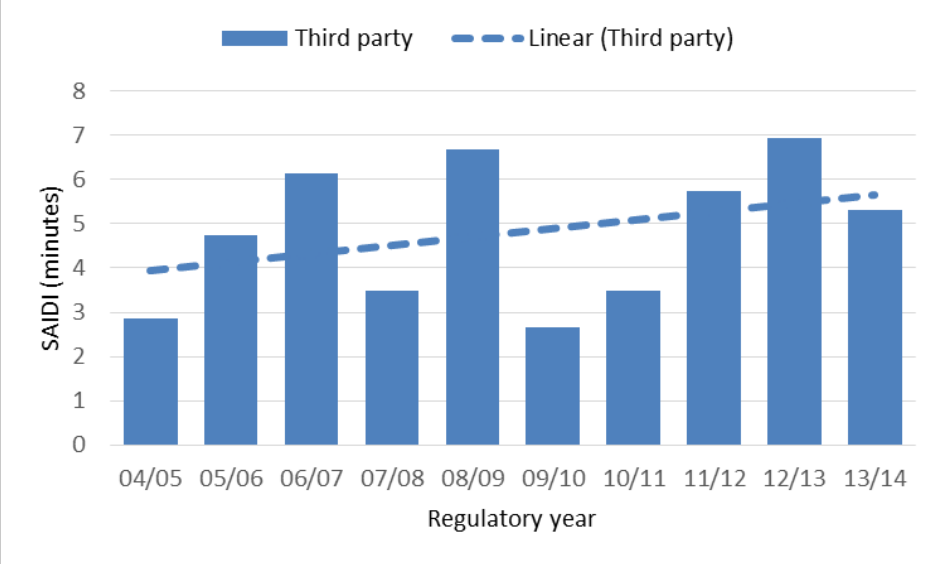
Source: Strata analysis

Third party related

131 From Figure 19, an increasing trend in the SAIDI impact of third party related causes is observed. During the on-site review, WELL explained the increase as being primarily due to increased construction related activity around the assets. WELL had implemented a number of system improvements to mitigate the risk of future events, however, these initiatives will likely take time to take effect. A similar trend is evident for SAIFI impact in Figure 20.

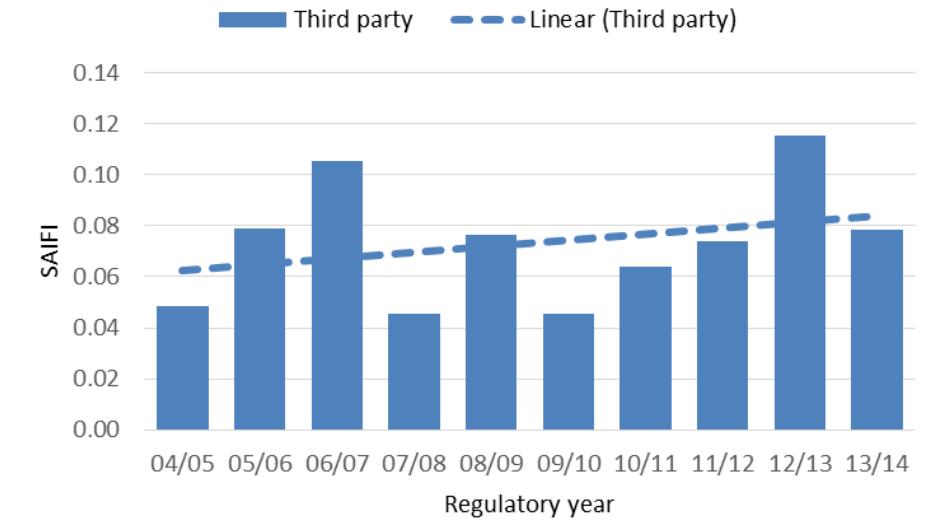
[27] The fault records include the summation of 'EQUIPMENT - UG' and 'EQUIPMENT - UG '
[28] The fault records include the summation of 'EQUIPMENT - UG' and 'EQUIPMENT - UG '

Figure 19 –SAIDI events with 'third party' as the cause



Source: Strata analysis

Figure 20 –SAIFI events with 'third party' as the cause



Source: Strata analysis

Some data issues were observed

132 Small differences in quoted performance for several regulatory years in the fault records submitted to the Commission to support its compliance statements were observed. These differences have since been explained by WELL including:

a) 09/10 was the first year of WELL's ownership of the network. There was a minor error in the SAIDI /SAIFI reported in the Compliance statement for this year;

b) rounding variance in the 10/11 Compliance Statement; and

c) a minor correction was made to source data but not included in the 11/12 Compliance Statement in error.

133 Upon closer review, Strata observed that:

a) seven fault incident records had a stated end date earlier than the start date. These records included SAIDI and SAIFI data that did not appear to be impacted by this anomaly. The existence of an end date of an outage before the start date raises some doubt on the process of auditing, and therefore accuracy of the reported data; and

b) 106 fault incident records had a SAIDI and/or SAIFI value that was not equal to the calculated values using the input variables of (no. of customers affected, customer minutes lost and network customer count). For example:

   a. 14 records included a SAIDI value of 0.000, when the number of customers affected and customer minutes lost were both greater than zero. The records all related to the 09/10 year;

   b. 11 records included a SAIFI value of 0.000, when the number of customers affected and customer minutes lost were both greater than zero. The records were mainly from 09/10 with a single record in 13/14;

   c. 'maximum time off' and 'customer minutes lost values' were often equal, suggesting a data input error; and

   d. some SAIDI values (or corresponding input values) appeared to be transposed between rows.

134 Strata does not consider that the discrepancies materially affect the overall conclusions that can be drawn from the data, however, Strata considers that WELL should identify and address the reasons for the data issues without delay.

5.3 Summary

135 Based upon the information provided, the WELL assets are not showing signs of increased asset class failure indicative of systemic issues in the asset management systems and practices, or systemic failure modes of asset classes. The increased incidents of faults are more likely indicative of underlying conditions in the asset components (insulators, crossarms, armour rods etc.) associated with age based deterioration of the distribution network.

136 Whilst the data suggests a general downward trend of non-storm related events, it is likely that underlying conditions that may weaken the distribution network, become faults during periods of high winds and associated conditions associated with storms, thereby increasing the storm related events. Strata considers it important to take into account the trends of fault information for storm and non-storm related events; and for events outside of the regulatory period to identify any longer term trends.

137 Accordingly, Strata considers that a contributor to the deterioration in reliability performance of the network is likely to be due to the fact that the network is aging. As assets age, the probability of failure increases. Asset managers monitor actual failure rates against standard curves. From this analysis, the point at which it becomes economic to replace of refurbish assets can be established.

138 Currently WELL are undertaking assessments of asset condition and monitoring failures. This is good practice and has enabled WELL to develop asset management strategies based on that information. For key assets such as conductors and poles the condition based approach has led WELL to adopt a structured replacement programme that also takes into account the asset age profile for its portfolio of assets within each category.

139 Based on the information provided by WELL during the review we consider that the approach taken by WELL to manage its assets has been appropriate an in accordance

with good practice. We found no evidence to suggest under investment in the network replacement had occurred.

140 Whilst more replacements could have been undertaken, the information provided by WELL suggests that such investment would likely have been economically inefficient. Accordingly, we found WELL's asset management strategies to be appropriate given the information on the condition of the assets.

141 During the onsite sessions, WELL discussed its intention to develop the tools and skills to undertake predictive failure analysis on its cable and line conductor network assets. Strata considers that development of predictive tools for failure analysis of assets will be essential for the business to manage the ageing asset fleet and to forecast its asset replacement requirements. Predictive analysis will provide critical information to manage prudently WELL's asset expenditure requirements and minimise risks to the network. Predictive failure analysis alongside other asset management tools can also help to minimise price shock to consumers due to large step increases in expenditure.

6 Expectations on future quality performance

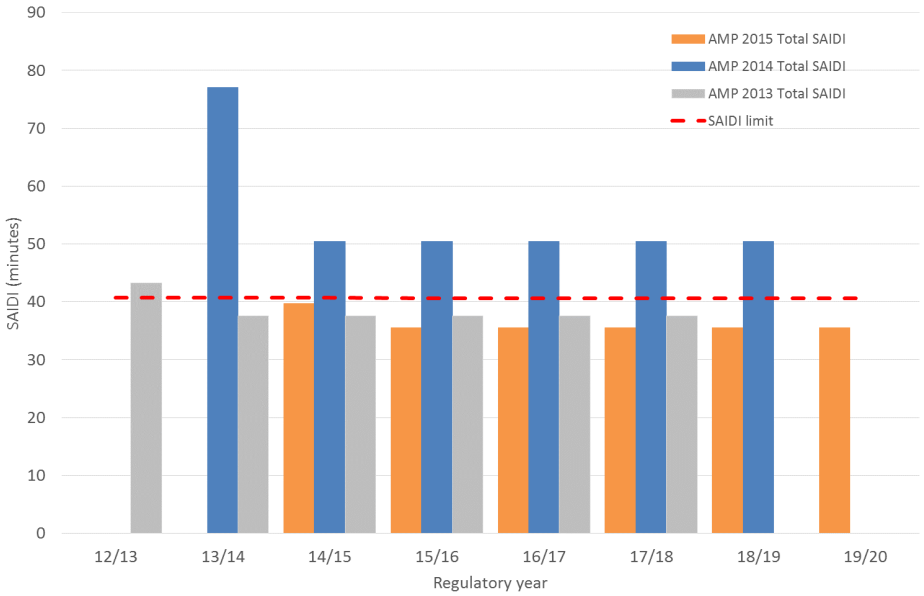
142 In this section, Strata makes a number of observations in relation to WELL's future performance against SAIDI and SAIFI limits.

6.1 Reliability performance targets

143 WELL has established targets for future SAIDI and SAIFI performance that are below the current regulatory limits. Strata notes that the target at the commencement of the AMP is typically the actual of the previous year and in 12/13 and 13/14, the assessed SAIDI performance was above the SAIDI limit.

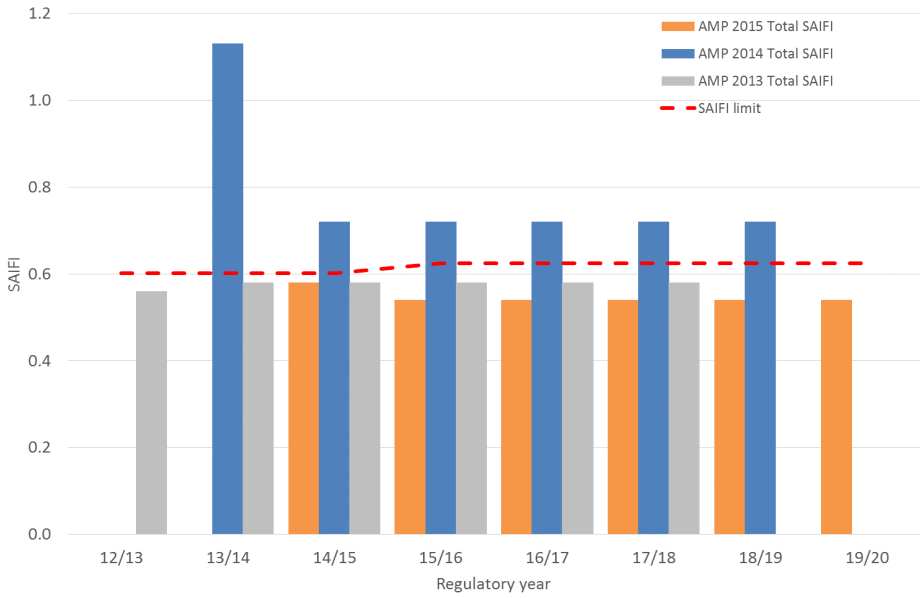
144 The SAIDI performance target in WELL's 2014 AMP shows as being above the SAIDI limit for that year. WELL advise that the target was varied in accordance with a different methodology that was forecast to be used for the regulatory period commencing 2014/15. WELL states that whilst this exists within its published AMP, WELL modified its targets to align with the SAIDI limit. Figure 21 shows this being changed in the 2015 AMP. This is also reflected in SAIFI targets in Figure 22.

Figure 21 – SAIDI targets



Source: Strata analysis of WELL AMP documents

Figure 22 – SAIFI targets



Source: Strata analysis of WELL AMP documents

6.2 Asset management systems

6.2.1 Asset management plans

145 WELL develops its AMP each year. The AMP includes the capital and operating expenditure for the network, and is approved by the Board.

146 During the onsite review, WELL identified the major drivers of expenditure by asset class. Strata understood from discussions that:

a) WELL is forecasting a continuing level of expenditure across asset classes;

b) additional expenditure has been identified for some cables and transformers based on the established asset health indicators and forecast condition;

c) WELL had not forecast step increases in asset failure, or declines in asset or reliability performance associated with the current level of expenditure included in its AMP; and

d) WELL had not forecast step increases in expenditure over the current 5 year period, rather, it expected expenditure to continue at current levels.

147 WELL did not raise the issue of deferral of expenditure, or any impact to its ability to efficiently manage the distribution network within the expenditure allowance under the DPP and achieve the quality standards.

148 The Commission required Strata to provide an opinion on the extent to which WELL has undertaken actions to prevent or mitigate similar quality standard non-compliance in the future. The following subsections discuss this issue in relation to the adequacy of WELL's forecast capital and operational expenditure and other relevant actions that it has undertaken.

6.2.2 Sufficiency of expenditure forecasts to prevent or mitigate quality standard non-compliance

149 Strata has reviewed five most recent WELL AMPs to understand the link between forecast expenditure and performance, and to assess the expectation that WELL has forecast sufficient network related expenditure to prevent or mitigate quality standard non-compliance in the future.

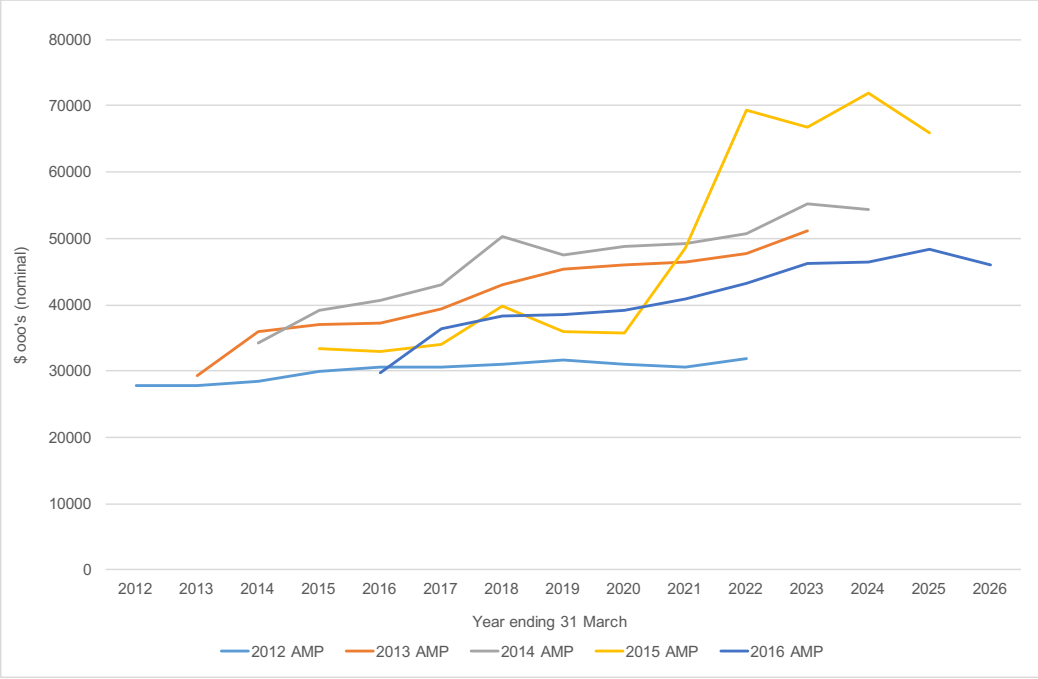
150 Strata notes that WELL advised that its 2015 AMP has been developed prior to the DPP decision and that a new 'Section 0' was added as an explanation of the DPP decision and its corresponding financial impact on WELL. WELL advised that the forecast expenditure information in its 2015 AMP had not been updated following the DPP decision and that its 2016 AMP now included this update.

151 The following assessment of WELL's expenditure forecasts contained in its AMPs includes the most recent 2016 AMP.

152 The comparison of expenditure forecasts can provide valuable insights into changes in the business' views, changes in conditions and the results of changes in asset related data and management practices. Variations during the initial year of each forecast from those made in the previous year can also highlight potential estimating or delivery issues if a consistent pattern of over or under estimation is observed.

153 In Figure 23, the starting point for each AMP capital expenditure forecast can be assumed to be reasonably accurate estimates of actual expenditure levels for the period. Yet, in each of the 2013/14/15/16 AMPs, WELL predicts step changes in network capital expenditure which do not eventuate in the following year.

Figure 23 – Total capital expenditure forecasts in AMPs (excluding cost of financing and value of capital contributions



154 The main driver of the over forecasting was observed to be related to system growth expenditure. Figures 24 and 25 show that system growth and connections capital expenditure have been over forecast in each AMP. Figure 26 shows that, for asset replacement and refurbishment capital, the opposite feature occurs with subsequent expenditure forecasts starting at a point above that forecast 12 months earlier.

Figure 24 – System growth capital expenditure forecasts in AMPs

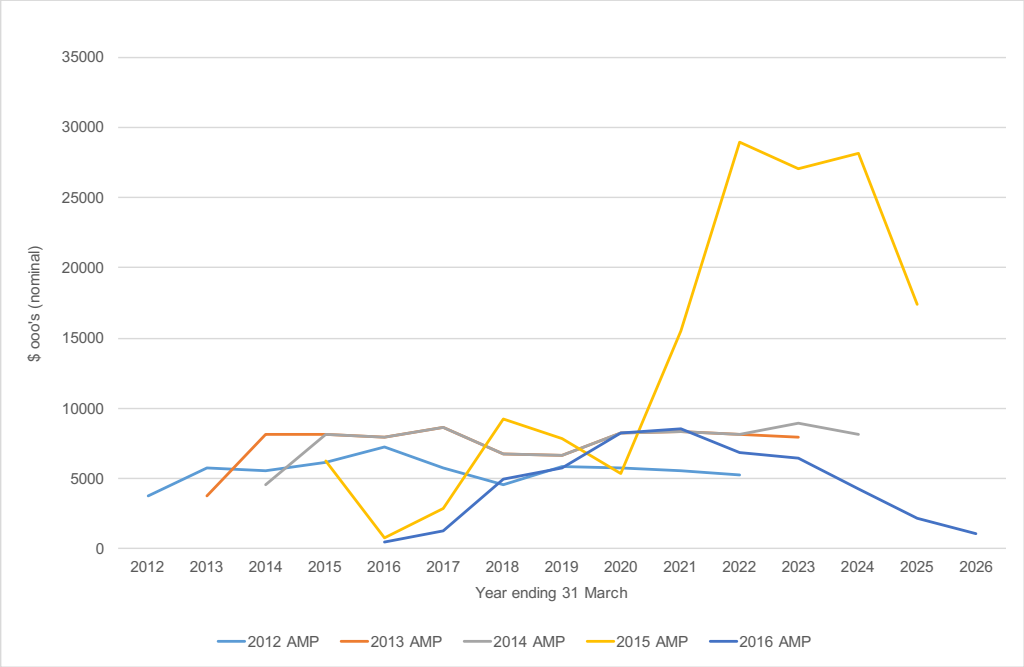


Figure 25 – Connections capital expenditure forecasts in AMPs

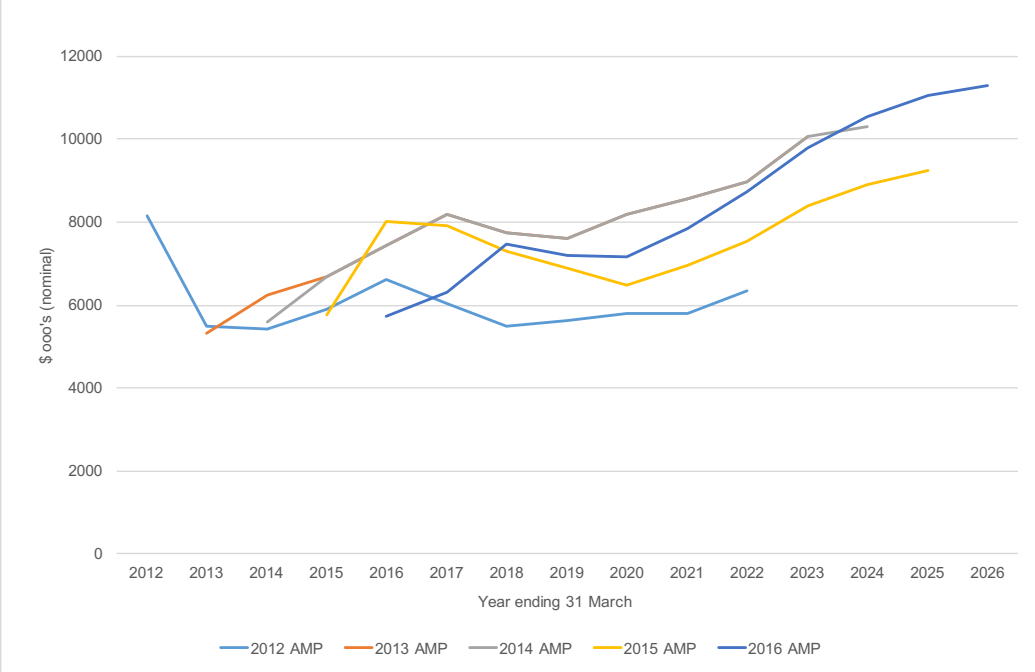
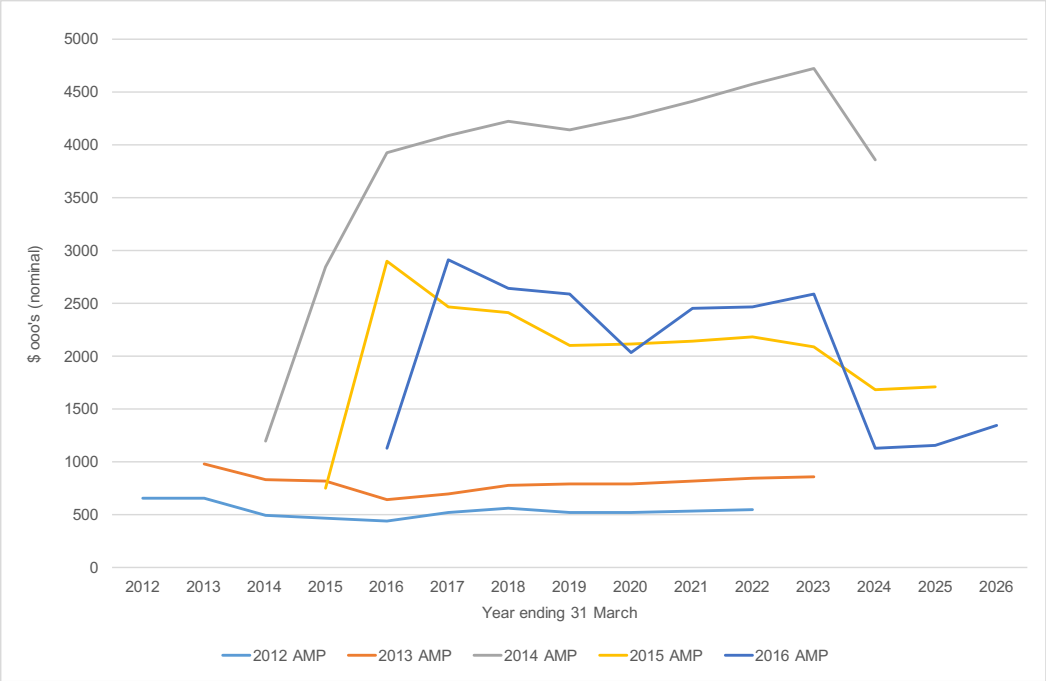


Figure 26 – Asset replacement and renewal capital expenditure forecasts in AMPs

155 In 2013 and 2014 AMPs, WELL was forecasting the need for higher replacement and refurbishment expenditure than is forecast in the 2015 and 2016 AMPs. WELL explained that the changes in forecast were generally due to improved data and information on the condition of its assets and improved asset management planning. Strata considers that WELL's explanation for the reduced asset replacement and refurbishment capital expenditure forecasts in 2015 and 2016 AMPs is reasonable. This view is based on the assurances given by WELL during the onsite sessions regarding the reliance that can be placed on the reliability of asset data. If this data was subsequently found to be less reliable, it would be necessary for WELL to revise its reliability and refurbishment capital expenditure.

156 Figure 27 shows that for each of the 2014/15/16 AMPs capital expenditure for reliability, safety and environment has been forecast to increase sharply in the following year yet this increase has not occurred.

Figure 27 – Total reliability, safety and environment capital expenditure forecasts in AMPs

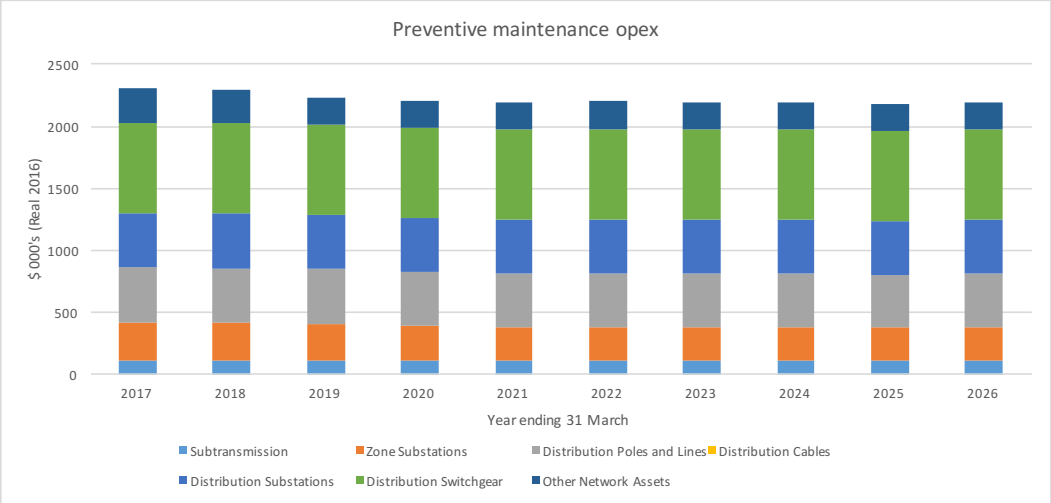


157 Clearly WELL sees the need for increased investment in total reliability, safety and environment capital expenditure and yet, to date, has not implemented its intended projects/programmes. Strata has not identified any reason why WELL would not be in a position to implement its planned expenditure in this category and therefore considers that WELL has the capability to invest appropriately to maintain reliability.

158 Notwithstanding the above observation, in terms of total capital expenditure, Strata considers that WELL has the capability to identify and invest appropriately in its network assets and has undertaken actions to prevent or mitigate quality standard non-compliance in the future. As there appears to be a tendency towards over forecasting capital expenditure, sufficient flexibility should be available to WELL to enable it to respond to changes in circumstances.

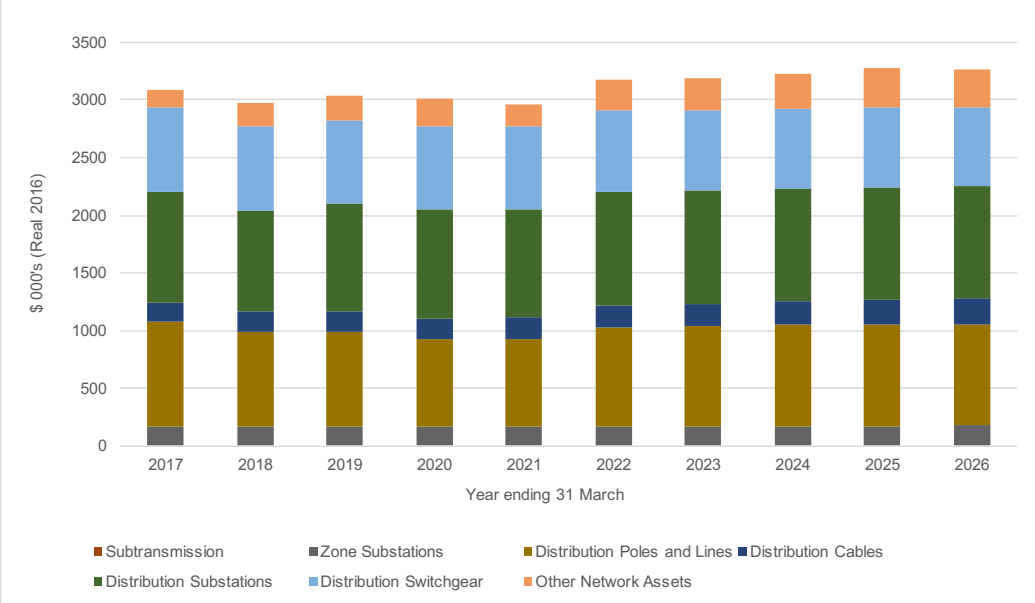
159 For operational expenditure, WELL is continuing to forecast preventive maintenance opex at consistent levels through to 2026. There is a slight reduction in preventive maintenance mainly due to some reductions in zone substation and other network forecasts (see figure 28). Figure 29 shows that corrective maintenance opex will also be consistent until 2022 when a slight increase in the expected need for corrective maintenance across a number of asset classes is forecast to occur.

Figure 28 – Preventive maintenance opex



Source: WELL 2016 AMP

Figure 29 – Corrective maintenance



Source: WELL 2016 AMP

160 Strata found that the level of asset related opex that WELL is forecasting in its 2016 AMP is consistent with the asset management information provided during the onsite sessions. Strata considers that the forecast levels of opex should be sufficient to enable WELL to prevent or mitigate quality standard non-compliance in the future.

6.2.3 Actions taken to to prevent or mitigate quality standard non-compliance in the future.

The condition of the network

161 WELL has developed asset fleet strategies that focus on high risk, high value fleets such as power transformers, 33kV cables and zone substation circuit breakers. Condition assessment data is used to support the fleet strategies.

162 In addition, WELL utilises worst performance asset type analysis and work performing feeder analysis to drive expenditure in other asset classes.

163 Overall, WELL describes the network as being in good condition for its age and is forecasting a stable level of activity.

164 In its 2016 AMP, WELL states:

> *Overall Wellington Electricity is managing a mature set of assets which, when not affected by large natural events, are performing well for the consumers.*

165 During its review, Strata did not find any substantial reason to disagree with this statement.

Asset inspection and condition monitoring

166 During the field visit, Strata observed a wood pole inspection and a deuar pole test by NorthPower of an LV wood pole in the Western Hills area. NorthPower has two field crews that undertake the deuar pole testing for WELL. The deuar pole test has been in place for several years and relies on a number of field measurements to be taken to determine the serviceability and expected remaining life of the wood pole.

167 For wood poles, Strata observed the capture of data in hardcopy and electronic form, for later transmission into the asset management systems. Strata understands that some asset inspection information is maintained in hardcopy form, and that the field contractor is responsible for input into the asset management systems.

168 WELL maintains quality control over the data process, and this forms a regular KPI linked to the commercial conditions of contract for WELL's field contractors.

6.2.4 Reliability improvement strategies

169 During the on-site review, Strata asked WELL to describe the practices to harden the electricity network from vegetation related faults. WELL advised that its reliability planning includes consideration of:

a) auto-reclosers and sectionalisers to isolate unaffected customers;

b) line fault indicators, and cable fault indicators connected to SCADA;

c) reviews of incident (including failure) records as part of asset management planning and operations planning, including optimal use of auto-reclosers, maintenance and asset replacement practices;

d) adoption of asset health indicators, for strategic asset classes;

e) worst performing feeder programme;

f) alternative network technologies;

g) fault management and work dispatch operating procedures and practices;

h) improvements to SCADA and integration of asset management systems; and

i) planned outage minimisation strategies.

Use of reclosers and sectionalisers

170 WELL locates auto-reclosers at the boundary of urban networks to limit the impact of faults located outside of this zone on urban customers. Strata's experience suggests that sectionalising devices are most effective at the transition between the underground network and the overhead network to (i) minimise the impact of faults occurring on the overhead network on customers connected to the underground network, and (ii) minimise

the reclose operations on the underground network and thereby extend the life of the associated assets.

171 WELL advised that its strategy seeks to lower the safety risk to the public associated with auto reclosing onto a fault, by locating these devices at the boundary of the urban network typically associated with a lower customer density. Strata suggests that consideration of the optimal location of protection and sectionalising equipment with SCADA is undertaken in its reliability planning to minimise the impact of outages to customers, and that this is considered alongside a review of safety risk.

Worst performing feeder programme

172 WELL has a 'worst feeder' programme which includes the 10 worst performing feeders by SAIDI and SAIFI being investigated each year to identify areas for improvement. The 10 worst performing feeders usually contribute 50% of the network SAIDI and SAIFI.

173 From 2008-2014, 37 different feeders have been in the SAIDI top ten with 40 different feeders in the SAIFI top ten. The worst feeder for SAIDI averages 5% of the annual SAIDI and SAIFI targets for 2008-2014. Due to the relatively low contribution of SAIDI from the worst feeder and therefore likely to be dependent on individual events, Strata would expect to see a large variation in the list of worst performing feeders consistent with the information presented by WELL.

174 WELL includes targeted responses for improving the reliability performance of identified worst performing feeders in its asset management planning.

Use of alternative network technologies

175 During the onsite discussions, WELL advised that it had previously undertaken a trial of HV Aerial Bundled Conductor (HV ABC) in a location of their network, and was in the planning phase of a further trial of Covered Conductor Thick (CCT) on a standard crossarm.

176 The application of these types of technologies has been very advantageous to other electricity networks, particularly in heavily vegetated areas where the network experiences a high number of transient faults associated with tree contact, tree and bark shedding etc. Strata considers that this technology is likely to reduce the impact of vegetation related incidents in parts of WELL's network, however, its introduction should be subject to a cost benefit analysis.

6.2.5 Operational management strategies

177 WELL advised that all planned outages over 0.05 SAIDI are scrutinised in more detail to include options such as LV back-feeding, generation, live line procedures, temp links etc. Other operational practices to minimise the planned SAIDI include no more than three substations to be left on a radial - or the job must be completed within 24 hours. If not, a through joint must be provided to allow back-feeding capability should it be required.

178 All unplanned outages over 0.45 SAIDI or 0.01 SAIFI are investigated, and reported through to the Executive. WELL provided examples of improvements, including to the capture and processing of asset information from events. All SAIDI data is generated from the SCADA system, and now asset information is progressively being captured using mobile based tools.

179 A number of processes remain on a hardcopy system, however, responsibility for entering data into the asset management systems is placed on the service contractor with KPIs to manage performance with Quality Control maintained by WELL.

180 WELL claimed that its SCADA system automatically calculates the reliability indicators, and that the form of calculation may be more conservative than other network businesses. For example, SAIDI is counted from the first call received and therefore the time taken to group calls to a protection device and recognise a fault is included in the statistics. WELL states that other businesses may only count the time for the identification of the fault. The SCADA system employed by WELL has been in place since 2009 along with the accompanying operating procedures for calculating reliability indicators. As the practice for calculation of SAIDI and SAIFI has not changed for WELL since 2009[29], and the compliance breach is not a result of benchmarking with other network businesses, we consider that this is not a determining factor in WELL breaching its quality standards[30] as the non-compliances occurred several years later. Whilst there is no evidence that under reporting has occurred, Strata notes that if it had occurred prior to 2009, then the boundary values would have been higher from 2010-15.

6.2.6 Vegetation management

181 WELL described the vegetation management approach, and discussed examples of the issues on its network associated with vegetation outside of the notice zone. WELL provided examples of where discussions with community leaders and local councils have resulted in change of practices for some residents, including agreement to remove trees presenting risks to the network.

182 During the field visit, Strata was able to observe the vegetation encroachment on the notice zone and risk posed by vegetation close to but outside the notice zone.

6.2.7 Fault response management

183 WELL described fault restoration practices that seek to limit the customers affected by an incident and restore supply as soon as possible. Feedback from the fault response staff is used to identify whether temporary generation is required for extended outages.

6.3 Improvements to asset management systems

184 During the on-site review, Strata observed evidence of improvements to WELL's asset management systems as part of its normal business processes. This included incidents and major outages, all of which is detailed in its AMP published annually.

185 WELL has implemented incentives for its contractors to achieve the reliability standards. Strata considers that this will have a positive impact on reliability for consumers.

186 Some of the improvement initiatives include:

a) improvements to IT systems and enhancements to SCADA;

b) phone system upgrade;

c) website upgrade;

d) storm recovery plans, training of storm managers;

e) outage planning; and

f) field procedure improvements.

[29] Strata notes that SAIDI limit was set based on 2004/09 data which may have been under less conservative basis of recording data.

[30] WELL exceeded its SAIDI limits in 2011/12, 2012/13 and 2013/14 and its SAIFI limit in 2011/12 and 2013/14.

187 Strata notes that the WELL 2015 AMP identifies three reliability improvement initiatives:[31]

a) incident reporting on all events greater than 0.4 SAIDI minutes;

b) post-event operations analysis; and

c) reporting of asset failure on specific asset types (or modes of failure) through the Asset Failure Investigation Process.

188 In its 2016 AMP, WELL confirms that, in February 2016, it has completed an upgrade of its SCADA master station software to PowerOn Fusion. GE Grid Solutions, the suppliers of the PowerOn Fusion Advanced Distribution Management System (ADMS), state that the system:

> *enables distribution utilities to deliver higher reliability, customer service and reduced operating costs while maintaining workforce safety and addressing major evolving technology challenges.*[32]

189 Directly relevant to WELL's future quality performance, key benefits claimed for the PowerOn Fusion include dramatically reduced outage restoration times.

190 The investment in PowerOn Fusion is likely to lead to material improvements in WELL's network management capabilities. These benefits include higher reliability, faster fault restoration times and lower operating costs. The completion and implementation of improved asset management and network control systems provide confidence that WELL is continuing to invest in and develop its ability to prevent or mitigate quality standard non-compliance in the future.

6.4 Summary

191 WELL's reliability targets and the 14/15 network performance figures indicate that the reliability performance is currently within the SAIDI and SAIFI limit. Strata considers that delivering its asset management plan including planned asset replacement programme, maintaining appropriate levels of maintenance and improvement programmes are all pre-requisites to maintain this level of performance.

192 Strata considers that the asset management systems and capability within WELL, when considered together with the asset management improvement plans evident during our on-site review, provide a sound basis for WELL to manage its distribution network and achieve the quality standards.

193 During the review WELL demonstrated that the management team had developed appropriate asset management strategies based on asset information on the age and condition of the assets. It was recognised by WELL that historically data on assets and in particular failure rates had not been stored electronically and that this had limited access for its use as a management information. The current management team has undertaken a significant data conversion exercise which has now made the data available electronically for analysis.

194 Strata found that the WELL management team included capable asset managers who have implemented and are continuing to develop sound asset management strategies that are based on improving levels of asset information and data. The WELL team

[31] WELL 2015 AMP, page 23

[32] http://www.gegridsolutions.com/products/brochures/uos/PowerOn_fusion.pdf

recognised that developing capabilities for predicting asset failure would be a valuable addition to their asset management toolkit, particularly given the age of the WELL network.

195 Based on the information provided during the review and included in WELL's 2016 AMP, Strata considers that WELL has forecast expenditure and undertaken a number of actions (as set out in section 6.2.3) that should prevent or mitigate quality standard non-compliance in the future.

7 Findings and recommendations

7.1 Findings

196 This section provides a summary of Strata's findings and recommendations relating to the specific matters that the Commission has requested Strata to provide. The main sections of this report provide information, findings and observations that support the above headline and key findings.

7.1.1 Circumstances and conduct contributing to the instances of non-compliance

197 While the SAIDI breaches could be considered (as WELL has) to have occurred at times of extreme weather events in the years in which regulatory standards were exceeded, Strata considers that given the age of the WELL network, asset lifecycle theory and experience would suggest that asset age related failures during severe storms may be occurring. However, to establish if this is the case fault records would need to include more detail and analysis on asset failures occurring during storms.

198 Strata found that there is insufficient information to support an increase in extreme weather events that would be expected to result in a deterioration against the reliability standards.

199 There is insufficient information to support an increase in vegetation related faults that would be expected to result in a deterioration of the reliability performance, however, overhead line faults due to airborne debris is accepted as a main cause for the issues experienced during severe storms.

200 Accordingly, Strata has concluded that the breaches in reliability limits have been mainly due to vegetation management issues emerging during severe storm events causing flying debris connecting with overhead lines. Some age related deterioration of the overhead assets may have contributed to the failures during severe weather.

7.1.2 Whether the non-compliance was avoidable or if WELL could have taken other steps

201 Strata found that the events due to major storm events were largely outside of the control of WELL. Overhead lines had been designed and constructed to appropriate wind tolerance levels. Strata found no evidence that underinvestment in the network had occurred that would have contributed to the reliability limit breaches.

202 Strata's analysis of the supplied information did not identify a systemic issue with the major asset classes reviewed that would suggest further systemic issues in the management of the electricity network. WELL has an older network, however this does not appear to be causing an increasing trend of failures that required specific and immediate action to have been taken by WELL.

203 Whilst more replacements of overhead line assets could have been undertaken, the information provided to us by WELL suggests that such investment is unlikely to have been economically efficient. Accordingly, we found WELL's asset management strategies to be appropriate given the information available on the condition of the assets.

204 The state of vegetation near to overhead lines continues to be an issue having a material impact on the reliability of electricity networks during severe storm events. Strata found that WELL's management practices relating to vegetation control were consistent with industry practice and that specific initiatives introduced by WELL were leading to improved engagement with tree owners and their communities.

205 Whilst more can be done to improve the management of tree related problems Strata could not identify any specific action that WELL could have taken that would have avoided the tree and other airborne debris related incidents during the major storm events.

206 Accordingly, Strata has concluded that there are no reasonable additional steps or actions WELL could have taken that would have avoided non-compliance

7.1.3 the extent to which WELL has already undertaken corrective actions to mitigate the issues identified

207 Personnel changes have occurred in WELL's management team in recent years. This has contributed to changes occurring to the methodologies and systems through which the network assets are managed. These changes had been occurring since the time of WELL's acquisition of the network in 2008 and continued through the period under this review.

208 Strata found evidence that WELL was considering further positive developments to its asset management systems. WELL has implemented and is continuing to develop sound asset management strategies that are based on improving levels of asset information and data. Developing capabilities for predicting asset failure is an important capability that WELL is intending to develop.

209 Strata has found no reason to conclude that the reliability of the network will deteriorate due to a lack of funding of the vegetation management activities. Strata considers that WELL management is knowledgeable on vegetation issues and has in place appropriate programmes to engage with stakeholders.

7.2 Recommendations

210 Strata makes the following recommendations for WELL's consideration:

Asset management strategy

a) increase use of predictive analysis of failure rates for fleet strategies as part of the condition based risk management approach to asset management;

Fault and performance data

b) review and simplify the fault cause descriptors used for reliability reporting to simplify the analysis and avoid incorrect reporting;

c) avoid the use of 'storms' fault category, and following investigations of major events such as storms, apply the results of the investigation to reclassify fault causes with known information;

Application of technology solutions

d) proceed with analysis of insulated cable technologies as a source of potential reliability improvements to overhead line network, with a view to implementing the selected option in a field trial;

Reliability performance analysis

e) consider reporting SAIDI and SAIFI by CBD/Urban/Rural classifications to improve understanding of the contribution of these areas to the overall reliability performance. Strata understands that WELL already classify these areas for other purposes in the business;

f) consideration of the optimal location of protection and sectionalising equipment with SCADA is undertaken in reliability planning to minimise the impact of outages to customers, and that this is considered alongside a review of safety risk; and

Risk assessment

g) undertake a further review of the asset risk management framework, specifically of asset risks arising from network events (such as earthquakes) experienced by other electricity transmission and distribution businesses.

211 Strata considers that the Commission should also take note of the following observations:

a) the changes made by the Commission in the DPP 2015-2020 will mitigate the impact of large events on WELL's reliability performance;

b) reporting of regional based SAIDI and SAIFI by EDBs may be valuable when ascertaining the benefits of limits for future DPPs; and

c) there appears to be a need for electricity distributors to obtain, or be provided with, clarity on how the Electricity (Hazards from Trees) Regulations 2003 are intended to be applied in practice.

212 In summary, addressing the Commission's specific questions Strata concluded that:

a) the breaches in reliability limits have been mainly due to vegetation management issues emerging during severe storm events causing flying debris connecting with overhead lines. It is possible that some age related deterioration of the overhead assets may have contributed to the failures during severe weather;

b) the asset management strategies developed and implemented by WELL were appropriate and there is no evidence that underinvestment has led to the breaches of the reliability limits;

c) WELL could not have taken any reasonable steps or actions that would have avoided non-compliance due to the effects of severe storm events;

d) there is no reason to conclude that the reliability of the network will deteriorate due to a lack of funding of the vegetation management activities. Strata considers that WELL management is knowledgeable on vegetation issues and has in place appropriate programmes to engage with stakeholders;

e) initiatives being implemented by WELL to develop asset and vegetation management will to some extent mitigate the impact of future severe weather events and enable asset replacement programmes to anticipate potential asset failure; and

f) WELL's continuing development of its asset management capabilities, systems and methods are likely to ensure that appropriate steps are taken to mitigate network performance risks.

213 Based on the information provided during the review and included in WELL's 2016 AMP, Strata considers that WELL has forecast expenditure and undertaken a number of actions that should prevent or mitigate similar quality standard non-compliance in the future.

8 Glossary of Acronyms and Abbreviations

Act	Part 4A of the Commerce Act 1986
AMP	Asset Management Plan
CBD	Central Business District
CKI	Cheung Kong Infrastructure Holdings Limited
Commission	The Commerce Commission
CPP	Customised Price Path
DPP	Default Price Path
EDB	Electricity Distribution Business
ICP	Installation Connection Point
kV	Kilovolts (= 1000 volts), a unit of electrical voltage
MW	Megawatt, a unit of electrical power
GWh	Gigawatt-hour, a unit of electrical energy
MVA	Megavolt-ampere, a unit of electrical power
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
Transpower	Transpower New Zealand Limited
WELL	Wellington Electricity Lines Limited

Annex 1 - WELL examples of vegetation management

Takapu Rd Pine tree – this is a WCC no interest tree that could qualify as a risk tree. Residents of Takapu Rd have complained about this tree and others nearby to the council in the past and the council have always referred this back to Wellington Electricity.

Annex 2 - Field visit examples

Example of older style concrete pole line across private property facing north. Recent line outages as a result of wind borne debris

Same line facing south, showing trees planted under line on private property

Trentham substation showing switchroom, outdoor transformers and fencing

Trentham substation indoor switchboard

Trentham 33/11kV transformer showing addition of seismic strengthening

LV wood pole – dueur pole test, Western Hills area

Same LV wood pole showing split in crossarm, loose LV insulator and decay at pole top (not visible on photo)

Same LV pole showing non-regulatory yellow tag following inspection. Pole strength ok, however pole decay at top and requirement for new crossarm is likely to be more efficient to replace pole. Timeframe 12 months

Re-conductoring for worst feeder programme, Johnsonville area

Example of vegetation encroachment on overhead line

Example of vegetation clearing for line corridor

New ground mount distribution substation at Karori substation, separate distribution transformer and switchgear

33/11kV substation transformers within new enclosure, which appear in good condition for their age.

Karori substation showing substation extension for transformers on LHS, and seismic strengthening (exposed concrete block) added to base of existing building on RHS.

Example of substation built in 1925