SA
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GHD
Vegetation
Audits
2015-2018

**2020-2025
Regulatory Proposal**

January 2019

SA Power Networks

2015 Pre Fire Danger Season
Vegetation Clearance Audit Report

March 2016

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

Executive summary

Background & Scope

SA Power Networks regularly reviews the compliance of its vegetation clearance program across all 40 Districts against the provisions of the Electricity Act 1996 and its associated Regulations as part of its fire mitigation program.

GHD were engaged by SA Power Networks to undertake an external audit of the vegetation clearance program. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology with the field component undertaken from 6 October 2014 to 14 December 2014.

The 2015 audit utilised external contractors to assist GHD with their inspections. GHD teamed with Helistar and Arborman to provide audit navigation assistance and in the case of Arborman vegetation growth advice where trees were identified as potential infringements (NCR's). Helistar were engaged for the more remote arid Districts, whilst Arborman were utilised for the Districts with higher vegetation cover and high bushfire risk areas.

Whilst SA Power Networks undertakes its own internal audits on an ongoing basis, it is considered prudent to have an external audit of the clearance program (this commission), as the potential risk and liability arising from failure to adequately comply with legislative provisions is extremely high, particularly in bushfire risk areas.

In addition to the Annual Cyclic program, an Annual Pre-Bushfire Season Patrol is undertaken. The Patrol is programmed to be undertaken in HBFRA Districts only, and on those specific Feeders (or part Feeders) that were inspected prior to 1 May 2015.

Both the Cyclic and Pre-Bushfire Season Patrols were completed by the start of the declared Fire Danger Season (FDS) in each of the prescribed fire regions.

Overall Audit Results

All 40 Districts were audited in 2015. This field audit assessed 82 Feeders between 6 October and 14 December 2015. A full register of the Feeders audited is provided in Appendix A. A Summary Table of the NCR's is provided in Appendix B. It is from this information that the following comments are based. Table 4 provides a summary of the audit and findings.

Table 1   Audit Finding Summary

Measure	2013	2014	2015
Districts Audited	40	40	40
Feeders Audited	83	82	84 (76*/8**)
Audit Sites	563	632	554
Audit Spans	3,360	3,727	3262
Districts with Multiple Feeder Fails	1	1	12
Total NCR's	70	20	58 (41*/17**)
Feeders with nil NCR's	57 (69%)	69 (84%)	58 (69%)
Feeders with NCR's 1-3	22 (26%)	13 (16%)	20 (24%)
Feeders with NCR's >3	4 (5%)	0 (0%)	6 (7%)

A total of 58 NCR's were identified through the audit program. This comprised 46 NCR's observed at selected random audit "sites" and a further 12 NCR's identified whist driving along the Feeders selected for the audit or on adjacent Feeders en route ("Drive By's).

Out of these, 10 of the NCR's were ETS feeders, and the remainder (48) were ATS. The ETS NCRs represent 17% of the NCR's whilst the ETS Feeders audited represent 9.5%. The ETS NCR's are proportionally higher than ATS using this simplistic analysis.

The majority of the analysis of NCR's has been undertaken on the actual audited sites and spans. The Drive By's form part of our observational commentary and additional analysis.

The 58 NCR's were across a total of 46 audit sites. 10 audit sites had multiple span NCR's. There were 84 Feeders audited which comprised 554 audit sites (poles) with 3,262 spans (pole to pole) being assessed.

Over the 40 Districts across both contractor Districts which were subject to the audit, the 46 NCR's (excluding Drive By's) represent a 1.4% fail rate (NCR's/Span) and a 8.4% fail rate (NCR's/Audit Site).

When looking at the ATS scoped and cut sites only, (33 NCR's excluding Drive By's over 37 Districts, 2952 spans and 76 audit sites), the 33 NCR's represent a 1.1% fail rate (NCR's/Span) and a 4.3% fail rate (NCR's/Audit Site). This shows that the ETS performance has a significant effect on the overall vegetation management performance. With the removal of the ETS results we can see an overall improvement in the performance results, however we can see that there is an overall decline in performance when compared to the previous year's results (0.5% and 2.7%).

It is important that these results be considered at the Fire Danger Region and District level to understand the true risk issues that SA Power Networks have exposure to during the FDS.

It should also be noted that with a 1.4% infringement rate over the 3,262 ATS & ETS spans audited, and it can be derived through basic extrapolation that given a network comprising some 433,000 spans in the MBFRA and HBFRA (estimated by SA Power Networks) that there is potentially some 6,063 non-compliant spans across the State that have either not been identified to be scoped or not cut sufficiently to remain out of the CZ for the FDS. This indicates that there remain potential significant unknown risks across the network.

The trend over the five (5) years before 2015 using both NCR's/Site and NCR's / Span assessment is represented in Table 1, which shows a steady year on year improvement, with a drop off in performance in 2015.

Figure 1   Historical Trend Comparison 2010 to 2015
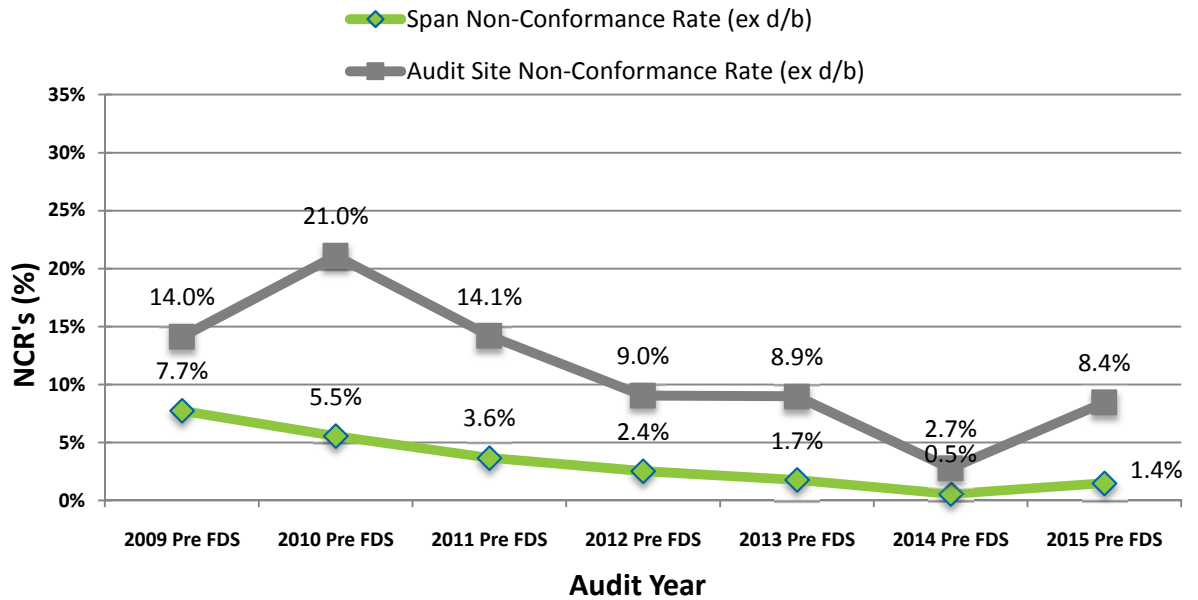
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1 - In 2011 the audit scope increased from 20 to 40 (all) Districts. In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.

2 - Removing ETS audit results changes the 2015 Pre FDS NCR's to 1.1% fail rate (NCR's/Span) and a 4.3% fail rate (NCR's/Audit Site).

Further analysis of the audit findings is shown in the following Table 2   NCR Categories:

Table 2   NCR Categories

NCR	2013	2014	2015
Total	57 (100%)	18 (100%)	46 (100%)
CZ Infringements	48 (84%)	13 (72%)	33 (72%)
Likely CZ Infringements (Bend & Grows)	9 (16%)	5 (28%)	13 (28%)
HBFRA	43 (75%)	13 (72%)	20 (43%)
MBRFA	14 (25%)	5 (28%)	26 (57%)
High Voltage	28 (49%)	11 (61%)	27 (41%)
Low Voltage	29 (51%)	7 (39%)	31 (59%)
Not Scoped	23 (40%)	N/A	N/A
Not Cut (Not cut sufficiently)	34 (60%)	N/A	N/A
Growth (Slow / Fast)	15 Slow Growers / 19 Fast Growers)	11 Slow Growers / 7 Fast Growers	24 Slow Growers /33 Fast Growers
Clearance Method (Ground Crew /	29 Ground Crew / 5 Climbing	N/A	51 Ground Crew / 6 Climbing

NCR	2013	2014	2015
Climbing Crew)	Crew		Crew
Patrolled	17 (30%)	3 (22%)	5 (11%)
Drive By's	13	2	12

Note:

   * ATS scoped and cut;

   ** ETS scoped and cut

Conclusions & Recommendations

The increase in the NCR/Site and NCR/Span measures reported in the 2015 audit indicates a fall in performance in the Vegetation Clearance program when compared to 2014, but still better than in the years before 2014.

The drop off in performance between 2014 and 2015 can in part be attributed to the poor performance of the second contractor ETS, however taking these into account, there is also a drop off in performance on the main contractor ATS. SA Power Networks have recently renegotiated the contract with ATS to cover the complete State with the ETS contract not being extended, so it would be expected that next year's (2016) results in the ETS covered Districts should improve.

The drop off is difficult to attribute to any specific causes. The 6 monthly rainfall from 1 Jun to 30 Nov 2015 shows a rain deficit (below average to well below average) for Districts including and to the West & South of the Yorke Peninsula across to the Victorian border. It would be expected then that this would result in lower NCR's due to lower vegetation growth, although this may become more apparent over the next 12 months. It could also be that 2014 was a good year for compliance which can be difficult to improve upon.

Five of these NCRs were directly attributed to a failure in SA Power Networks record management processes in that 5 NCRs in NL21 were on O/H spans that were removed from the GIS and therefore the maintenance programme, because it was understood by SA Power Networks that they had been undergrounded, although the planned undergrounding had not actually occurred. This incorrect updating of the GIS records represents a breakdown in record management processes within SA Power Networks. We recommend that SA Power Networks undertake a review of the reason why the record management processes in this instance failed to prevent an incorrect update of the GIS system, and identify tactics to ensure this does not occur again. Internal issues aside and noting that different crews undertake the scoping and the cutting, it would be reasonable to hope that the contractor should have observed the spans in question given that they were cutting the rest of the feeder, and either taken appropriate action or notified SA Power Networks.

SA Power Networks must take reasonable steps to clear vegetation from its powerlines in accordance with the requirements set out in the Principles of the Act. While full compliance has not been achieved, on the basis that the clearance program was completed on schedule and that the overall non-conformance rates are still historically trending lower, albeit with a performance drop off in 2015, and with the renegotiation of the contract with ATS and not extending ETS's contract, it is GHD's opinion that SA Power Networks is taking reasonable steps to meet the obligations of the prevailing legislation in regard to taking maintaining clearances in designated bushfire risk areas, however we would recommend that SA Power Networks meet with ATS to try to determine the cause in the drop off in 2015.

With a 1.4% infringement rate over the 3,262 ATS & ETS spans audited, and it can be derived through basic extrapolation that given a network comprising some 433,000 spans in the MBFRA and HBFRA (estimated by SA Power Networks) that there is potentially some 6,063 non-compliant spans across the State that have either not been identified to be scoped or not cut sufficiently to remain out of the CZ for the FDS. This indicates that there remain potential significant unknown risks across the network

As this 2015 analysis shows, there had been significant improvement over the 5 years prior to 2015, with a small drop off in 2015. It is unknown whether there are significant underlying reasons for this drop off that may lead to continued poorer performance in the future, other than the contributing factor of the contractor ETS, or whether this was a one off issue that will be recovered in future years.

In order to maintain the excellent achievements in performance over the last 5 years, the challenge for SA Power Networks is to assess with the incumbent contractor (ATS) reasons for the drop off and identify opportunities to continually improve performance with the clearance and compliance levels and reduce risk further.

The higher risk areas of the Mount Lofty Ranges and the bushfire risk parts of the Adelaide Metropolitan Areas (Elizabeth, Salisbury, Holden Hill and Saint Marys) should continue to be a focus for improvement. These are densely populated areas where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies need to be investigated. This may include a change to when the Feeders are scoped and/or cut or the frequency of cutting. Alternatively, vegetation removal or re-construction options could be assessed.

There remains a relatively high incident of NCR's occurring on Feeders that are patrolled prior to the Fire Danger Season. Given the purpose of a Pre FDS Patrol is to capture late growth or re-growth since the cyclic cut, our conclusion is that a review of the effectiveness of the patrol program is warranted.

Observation	Recommendation	2015 Ref.	Priority
Current Vegetation Management practices and a consistent approach has improved performance over the 5 years prior to 2015, with a drop off in performance in 2015.	Assess with contractor why there was a drop off in performance for 2015 and identify strategies for improving performance.	R1 (i)	1
Continuing to reduce the non-compliance rate will require alternate / additional strategies and technologies to be considered, trialled and implemented.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (ii)	2
There were 8 NCR's identified on 4 Feeders that were subject to a Pre FDS Patrol. The intent of the Pre FDS Patrols are to identify and cut those (few) spans that have had unexpected regrowth since the cyclic cut.	Continue to assess the timing for both the cyclic and pre FDS scoping and cutting as both are critical to the effectiveness of the programs.	R1 (iii)	2
NL21 NCRs were the result of the incorrect updating of GIS	Assess reason why the record management processes failed in this instance and develop tactics to update processes to ensure this does not occur again in the future	R1 (iv)	1
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA. Audit results have been improving for the 5 years before 2015, with a drop off in performance in 2015. The greatest level of NCR's occur on HBFRA Feeders which are the higher risk areas. The overall 6-year trend is still that of improvement; however there would still appear to be opportunities for improvement to further reduce the levels of non-compliance, supporting that alternate audit methodologies be considered for a more mature network	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results.	R2	3
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SA Power Networks GIS platform as required.	R3	2

Observation	Recommendation	2015 Ref.	Priority
GHD as the auditors are currently not required to review and report on what action SA Power Networks has taken on the previous year's recommendations. This potentially leaves a gap in SA Power Networks continual improvement drive.	Increase scope in future audits to incorporate a review of previous recommendations and report on implementation or otherwise.	**R4**	**3**
GHD are aware of the use of land based LiDAR by other SA Power Networks departments, and also of the trialling of airborne LiDAR in 2015 SA Power Networks have advised that the use of LiDAR or alternative technologies will continue to be assessed as a tool to manage vegetation near powerlines We support this objective and recommend ongoing improvement analysis, including the potential to use existing vehicle based LiDAR trials by using SAPN equipment at the same time as the Pre FDS audits. The objective being to identify if audit procedures can be improved (quality timeliness extent) using new technology	Assess / Review opportunities to implement aerial and vehicle based LiDAR trials for future vegetation clearance audits.	**R5**	**3**

1 - Priority

2 - Strategic Improvement

3 - Opportunity for Improvement

Table of contents

Table index

Figure index

Appendices

This 2015 Pre Bush Fire Season Vegetation Audit Report ("Report"):

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- *Were limited to those specifically detailed in Section 2 of this Report.*

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1. Background

SA Power Networks regularly reviews the compliance of its vegetation clearance program across all 40 Districts against the provisions of the Electricity Act 1996 and its associated Regulations as part of its fire mitigation program.

GHD were engaged by SA Power Networks to undertake an external audit of the vegetation clearance program. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology with the field component undertaken from 6 October 2015 to 14 December 2015.

The 2015 audit utilised external contractors to assist GHD with their inspections. GHD teamed with Helistar and Arborman to provide audit navigation assistance and in the case of Arborman vegetation growth advice where trees were identified as potential infringements (NCR's). Helistar were engaged for the more remote arid Districts, whilst Arborman were utilised for the Districts with higher vegetation cover and high bushfire risk areas.

Whilst SA Power Networks undertakes its own internal audits on an ongoing basis, it is considered prudent to have an external audit of the clearance program (this commission), as the potential risk and liability arising from failure to adequately comply with legislative provisions is extremely high, particularly in bushfire risk areas.

Currently vegetation clearance is scheduled to be undertaken in the Bushfire Risk Areas on an Annual Cyclic Program.

In addition to the Annual Cyclic program, an Annual Pre-Bushfire Season Patrol is undertaken. The Patrol is programmed to be undertaken in HBFRA Districts only, and on those specific Feeders (or part Feeders) that were inspected prior to 1 May 2015.

Both the Cyclic and Pre Bushfire Season Patrols were completed by the start of the declared FDS in each of the prescribed fire regions.

2. Scope of Work

The objective of the project was to undertake a compliance audit of selected Feeders to evaluate SA Power Networks' performance in compliance with its obligations under the Electricity Act 1996 and Regulations, Part 5 Division 1 with regard to "Duties in Relation to Vegetation Clearance" and Section 6 "General Principles Governing Clearances by Electricity Entity or Council" and Section 7 Schedule 1 "Vegetation Clearances".

The scope of the project was:

1. To undertake a field audit of SA Power Networks' performance in complying with vegetation clearance requirements in accordance with its obligations under Section 3 Electricity Act 1996, Part 5, Division 1 with regard to "Duties in Relation to Vegetation Clearance", and the Electricity (Principles of Vegetation clearance) Regulations 2010.

2. To undertake the audit to determine and to make a statement as to whether or not, as required under Part 5 Division 1 Section 55(1) of the Electricity Act 1996, SA Power Networks has taken "reasonable steps" to keep vegetation of all kinds clear of public powerlines under SA Power Networks' control; and to keep naturally occurring vegetation clear of private powerlines under SA Power Networks' control. For the purpose of this assessment GHD will take into account, the legal opinion provided by Minter Ellison (for SA Power Networks) in 2011 which includes the following paragraph:

"Meaning of 'duty to take reasonable steps'

SA Power Networks must take reasonable steps to clear vegetation from its powerlines in accordance with the requirements set out in the Principles.

What constitutes 'reasonable steps' will be assessed objectively, taking into account, for example, the characteristics of the powerlines, surrounding vegetation, industry best practice and the Principles.

Compliance with the Principles should be viewed as the minimum benchmark which must be achieved in order to discharge SA Power Networks obligations under section 55(1) of The Electricity Act.

Ultimately, the steps taken by SA Power Networks to discharge its duty should:

- *At least reflect 'good electricity industry practice.*

- *Ideally, reflect industry best practice (taking into account relevant interstate and international standards and operational experiences and any recent authoritative findings or learning's in relation to powerline vegetation clearance - e.g. outcomes from royal commissions, University studies, etc.)."*

In addition, the scope of the field audit is to:

- Audit all 40 Districts classified as being in High Bushfire Risk Areas (HBFRA) & Medium Bushfire Risk Area (MBFRA) areas of South Australia.

- Assess only bare conductor overhead construction within the HBFRA & MBFRA areas of South Australia.

- Be undertaken as close as practicable to the commencement of the Fire Danger Seasons in each of the geographical areas.

3. Vegetation Clearance Audit Methodology

The GHD audit methodology has been based on audit sampling techniques where there are a significant number of infrastructure assets where auditing 100% of assets is neither time nor cost effective, but a reasonably high level of confidence in the audit results is still required.

The vegetation clearance audit methodology involved the following steps:

a. At the start up meeting with SA Power Networks, GHD was advised that the 2015 program was on schedule with cutting in all Districts to be cut prior to the commencement of the Bushfire Fire Danger Season (BFDS).

b. Inception Meeting with Network, Arborman and Helistar to confirm project scope etc.

c. Unlike in recent years, GHD was not provided with a loan computer tablet by the vegetation cutting contractor (ATS) and therefore scoping and cutting data for feeders in the audit Districts was not available. This meant that GHD was unable to determine if a failed site/span was due to a scoping or a cutting issue. Nor were we able to identify spans that were being cut annually (or more frequently) which would have provided further context to the cause of fails in some instances. As such the level of analysis and reporting has been reduced from previous audit reports.

d. GHD randomly selected 2 Feeders (approximately 5%) within each District to provide a base selection of Feeders that could be audited. There were no restrictions on this selection and a cross section of Feeders using criteria of voltage, location and the number of identified cut spans was made.

e. As this audit has been undertaken for a number of years now, a Feeder selection criteria introduced in 2013 was to ensure that 1 of the 2 Feeders selected was a "new" feeder – i.e. that it had not been subject to a Pre FDS audit in the last 10 years. This was introduced and a review of previous audit Feeder selections revealed that some Feeders were being audited frequently. Where a Feeder failed frequently it remained a possible audit candidate.

f. At the start of each Feeder audit, GHD identified up to 5 target poles (per page of the Feeder plans generally) for each Feeder under audit. (A schedule of the Feeders selected is provided in Appendix A.

g. At each audit location the vegetation clearances on up to 3 spans in each direction from the nominated target pole were assessed. The number of spans included was often dependent on span length, accessibility and visibility. NCR's were identified and recorded.

h. In addition, ad hoc visual "Drive By" inspection of clearances on route to the nominated site was undertaken to gain a more comprehensive overview of the clearance programs effectiveness. NCR's were identified and recorded.

i. NCR's observed were recorded in two categories:

   – NCR's of the vegetation CZ, appropriate to the span and voltage, in either the vertical or horizontal direction. These have been labelled as an "Actual" NCR's.

   – Instances where the vegetation CZ requirements are met, but where it is obvious that vegetation will very likely bend or grow into the CZ either during the bushfire season or prior to the next cyclic cut. These have been labelled as a "Bend or Grow" NCR.

j.   All NCR's were identified and emailed to SA Power Networks as soon as practicable for rectification by SA Power Networks. We note that in previous years, the NCR's were entered into SAP by SA Power Networks at the time of each NCR identified.

k.   The GHD auditor was accompanied by either Helistar or Arborman.

l.   Audit inspections were recorded on a tablet using an inspection application called Mobile Data Studio (MDS) database with GIS capability. This functionality enables the audit results to be produced in a GIS visual format. This format provides a meaningful geographic reference of the comprehensiveness of the audit and over time will easily enable geographical "hot spots" to be identified.

4.   Vegetation Program

The SA Power Networks vegetation program for 2015 was based on an Annual Inspection & Cutting Cycle for both the HBFRA's and the MBFRA's of South Australia.

The following table shows the number of spans to be cut as identified from the Vegetation Clearance Program out of the estimated 433,000 spans in bushfire areas across the network:

Table 3   Cut Spans

2013	2014	2015
65,000	63,000	52,869

It should be noted that the distinction between HBFRA and MBFRA for Feeders or part Feeders is a SA Power Networks distinction and not one of the Electricity Act 1996 (The Act) or the associated 2010 Regulations. The Act and the Regulations only distinguish between Bushfire and Non Bushfire areas.

In accordance with the SA Power Networks "Network Directive" all Feeders that were inspected prior to 1 May in the year are to be patrolled for vegetation clearances prior to the commencement of the FDS in each District. This is an additional risk mitigation strategy aimed to capture any missed vegetation or regrowth that may have occurred in the preceding months.

For 2015 the Pre-Fire Danger Season Patrols were only undertaken on Feeders or part Feeders designated by SA Power Networks as being in HBFRA's and inspected prior to 1 May 2015.

5. Winter and Spring Rainfall

The 6 months from 1 Jun to 30 Nov 2015 have seen serious rainfall deficits develop in:

• South-west WA;

• Coastal and agricultural areas of SA;

• Central/west VIC;

• Tasmania;

• South-west slopes/eastern Riverina in NSW and

• Inland tropical QLD

Across large areas of SW WA, eastern SA; central/ western VIC and TAS these deficiencies are severe being in the worst 10% of rainfall which historically are associated with major forest fire season potential.

Early seasonal fire activity in southern WA, SA and central VIC is coincident with the areas where 6 month rainfall deficits are severe.
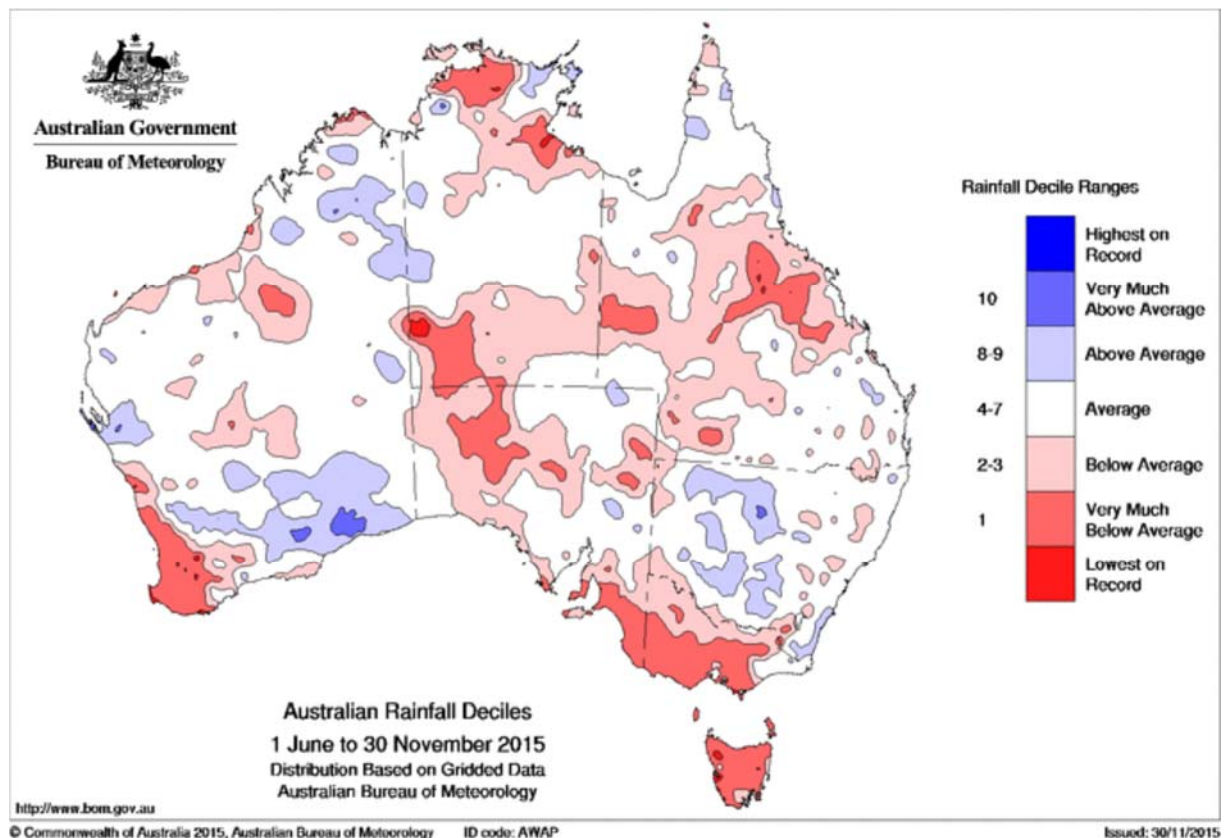

Figure 2   Winter and spring rainfall trends

6. Summary of Findings

6.1   Overall Audit Results

All 40 Districts were audited in 2015. This field audit assessed 84 Feeders between 8 October and 14 December 2015. A full register of the Feeders audited is provided in Appendix A. A Summary Table of the NCR's is provided in Appendix B. It is from this information that the following comments are based. Table 4 provides a summary of the audit and findings.

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Over the 40 Districts across both contractor Districts which were subject to the audit, the 46 NCR's (excluding Drive By's) represent a 1.4% fail rate (NCR's/Span) and a 8.4% fail rate (NCR's/Audit Site).

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It is important that these results be considered at the Fire Danger Region and District level to understand the true risk issues that SA Power Networks have exposure to during the FDS.

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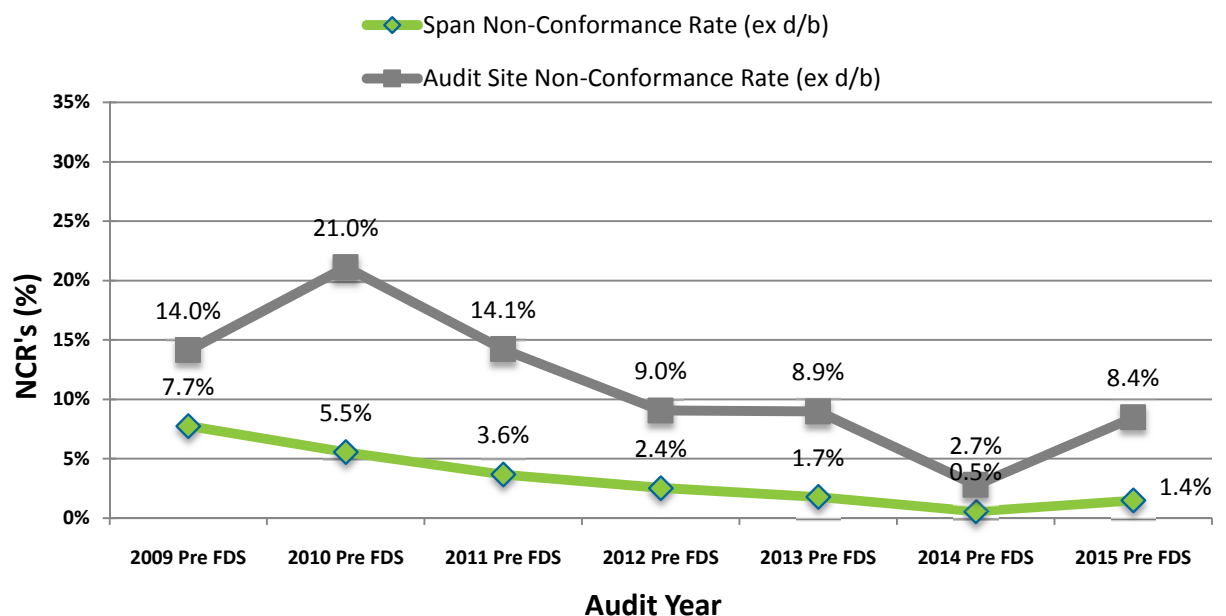
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1 - In 2011 the audit scope increased from 20 to 40 (all) Districts. In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.

2 - Removing ETS audit results changes the 2015 Pre FDS NCR's to 1.1% fail rate (NCR's/Span) and a 4.3% fail rate (NCR's/Audit Site).

Further analysis of the audit findings is shown in the following Table 5.

Table 5   NCR Categories (excl. Drive By's)

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Growth (Slow / Fast)	15 Slow Growers / 19 Fast Growers)	11 Slow Growers / 7 Fast Growers	24 Slow Growers /33 Fast Growers
Clearance Method (Ground Crew / Climbing Crew)	29 Ground Crew / 5 Climbing Crew	N/A	51 Ground Crew / 6 Climbing Crew
Patrolled	17 (30%)	3 (22%)	5 (11%)
Drive By's	13	2	12

6.2   Fire Danger Regions

The 2010 to 2015 Fire Danger Regional results in Figure 4 Annual NCR Summary - Fire Danger Regions 2010 - 2015 show that there has been improvement in many of the Fire Danger Regions over the last 5 years, although there were 5 regions where there was a drop off in performance from 2014. There were increases in NCR's in the higher risk area of the Mount Lofty Ranges. The Riverland also had an increase from 0 NCR's in 2014 to 15 NCR's in 2015. We note that ETS had the scoping/cutting contract for the Riverland and Murray Lands in 2014 & 2015, however these districts have recently (late 2015) been taken over by ATS, the contractor for the reminder of the State.
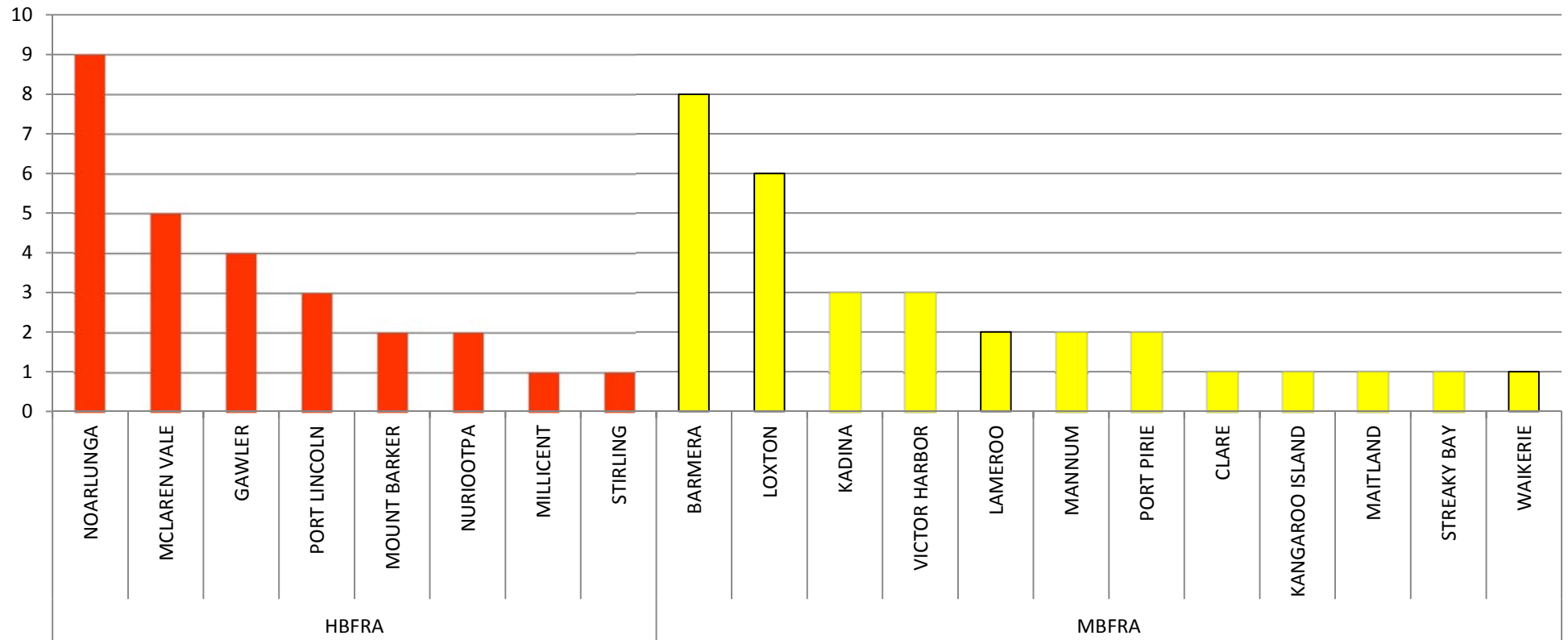
The NCR's at the District level are represented in the following Figure 5.

Figure 4   Annual NCR Summary - Fire Danger Regions 2010 - 2015
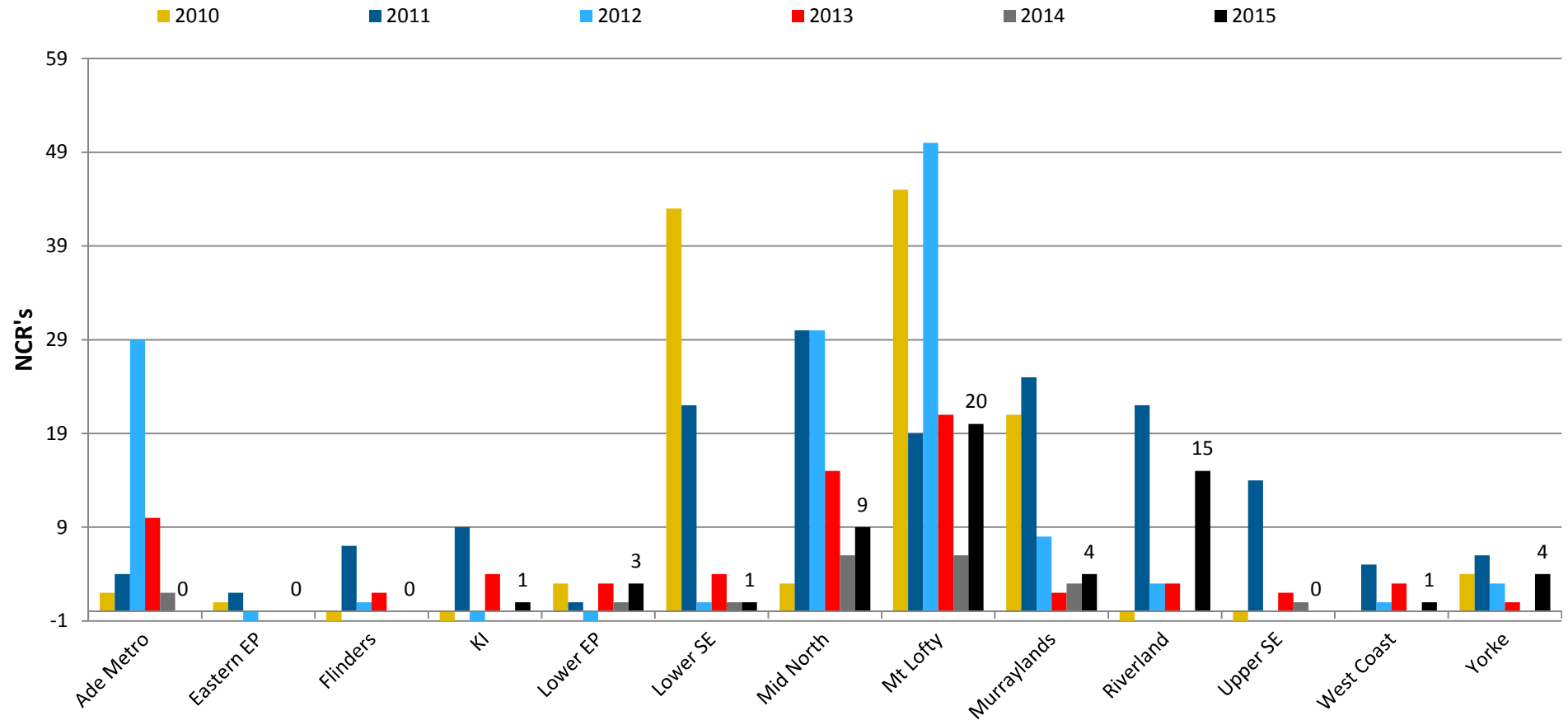
Note – A "-1" indicates that the Region was not audited that year.

Figure 5   Region / District Chart 2015

6.3   Bushfire Areas – HBFRA / MBFRA

6.3.1   NCR's excluding Drive By's

Across the SA Power Networks Fire Risk Areas of HBFRA and MBFRA the site NCR split was:

- HBFRA
  - 2015 - 43%
  - 2014 - 70%
- MBFRA
  - 2015 – 57%
  - 2014 - 30%

The NCR's/Span in the HBFRA is 1.5% compared to the MBFRA of 1.3%. Table 6 and Table 7 includes the comparable results for 2012, 2013, 2014 and 2015.

Table 6   Annual Infringement Summary by Bushfire Risk Area 2012 - 2015

Risk Area	Audit Sites	Site NCR	Site NCR Rate	No. of Spans	Span NCR	Span NCR Rate
2015						
HBFRA	219	20	9.1%	1300	20	1.5%
MBFRA	335	26	7.8%	1962	26	1.3%
TOTAL	**554**	**46**	**8.3%**	**3262**	**46**	**1.4%**
2014						
HBFRA	240	12	5.0%	1395	13	0.9%
MBFRA	392	5	1.3%	2332	5	0.2%
TOTAL	**632**	**17**	**2.7%**	**3727**	**18**	**0.5%**
2013						
HBFRA	243	37	15.2%	1444	43	3.0%
MBFRA	320	13	4.1%	1916	14	0.7%
TOTAL	**563**	**49**	**8.9%**	**3360**	**57**	**1.7%**
2012						
HBFRA	260	33	12.7%	1377	52	3.8%
MBFRA	209	9	4.3%	1162	10	0.9%
TOTAL	**469**	**42**	**9.0%**	**2539**	**62**	**2.4%**

Figure 6 MBFRA / HBFRA Trend Chart - 2011 to 2015
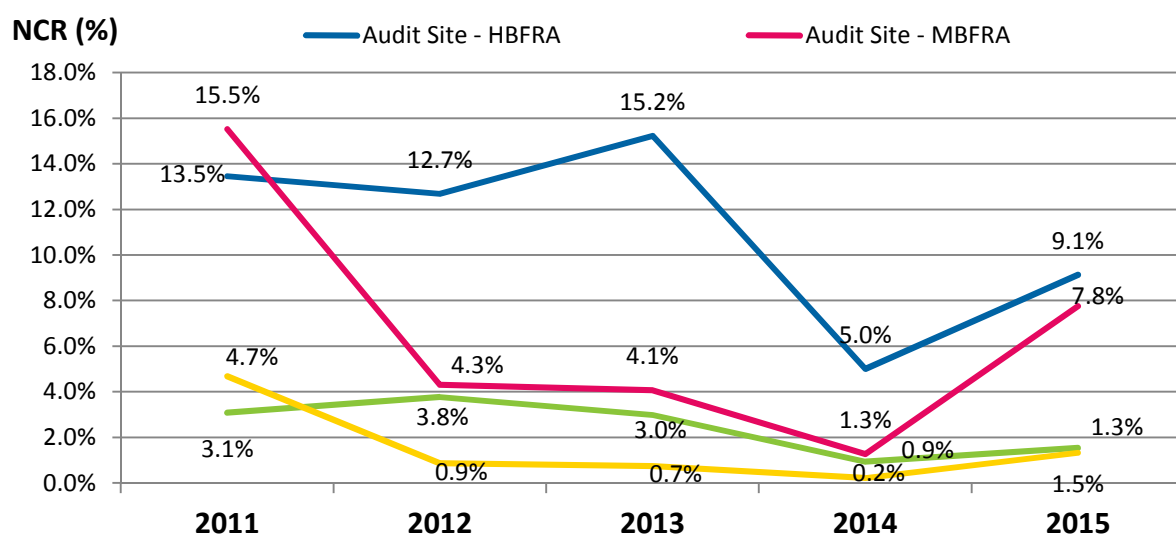
6.3.2 Drive By NCR's

There were 12 Drive By NCR's identified in this 2015 audit, a significant increase from the 2 in 2014, although the previous year had seen a significant decrease from 13 in 2013 and 64 observed in 2012. Whilst Drive By's are not included in the core analysis of the audit, they do provide additional context to the effectiveness of the clearance programs.

A summary of the category of Drive By NCR's is provided in Table 7.

Table 7 Drive By NCR's 2012 - 2014

Measure	2013	2014	2015
Total	13	2	12
CZ Infringements	10	2	9
Likely CZ Infringements (Bend & Grows)	3	0	3
HBFRA	6	1	7
BRFA	7	1	5
High Voltage	3		4
Low Voltage	10	2	8
Not Scoped	7	N/A	N/A
Not Cut (Not cut sufficiently)	6	N/A	N/A
Pre FDS Patrolled	3	0	0

8 Of the Drive By NCR's were identified as ATS, with the remaining 4 being ETS.

There is no identifiable trend with the Drive By's other than there has been an increase from the previous year which generally correlates with the site audit results.

6.4 District & Feeder Specific Results

The following tables and charts include the Drive By NCR's. There were 13 Districts where there were multiple NCR's recorded. These are listed in Table 8 below.

Table 8   Districts – Highest Infringement Rates (Includes Drive By's)

District	Risk Area	Audited Spans	Total NCR's	NCR's / Spans
Districts with multiple NCR sites				
Noarlunga	HBFRA	149	9	6.04%
Barmera	MBFRA	63	8	12.70%
Loxton	MBFRA	120	6	5.00%
Mclaren Vale	HBFRA	116	5	4.31%
Gawler	HBFRA	78	4	5.13%
Port Lincoln	HBFRA	59	3	5.08%
Victor Harbor	MBFRA	57	3	5.26%
Kadina	MBFRA	61	3	4.92%
Nuriootpa	HBFRA	92	2	2.17%
Port Pirie	MBFRA	60	2	3.33%
Lameroo	MBFRA	60	2	3.33%
Mount Barker	HBFRA	140	2	1.43%
Mannum	MBFRA	60	2	3.33%
Districts with single NCR sites				
Maitland	MBFRA	60	1	1.67%
Stirling	HBFRA	91	1	1.10%
Millicent	HBFRA	61	1	1.64%
Kangaroo Island	MBFRA	150	1	0.67%
Streaky Bay	MBFRA	60	1	1.67%
Clare	MBFRA	149	1	0.67%
Waikerie	MBFRA	90	1	1.11%

There were 12 Feeders where there were multiple NCR's recorded. These are listed in Table 9 below.

Table 9   Feeders with Multiple NCR's Including Drive By's

Feeder	Feeder Names	District	Risk Area	Total NCR's in Feeder
LX34	Gurra 11kv	Loxton	MBFRA	6
BM15	Cobdogla 11kv	Barmera	MBFRA	5
NL21*	Clarendon North 11kv	Noarlunga	HBFRA	5
MV13	Mclaren Flat 11kv	Mclaren Vale	HBFRA	4
GA05	Sandy Creek 11kv	Gawler	HBFRA	4
NL760B	Hackham East 11kv	Noarlunga	HBFRA	4
BM44	Berri West 11kv	Barmera	MBFRA	3
PL07	North 11kv	Port Lincoln	HBFRA	3
VH44	Flagstaff Hill 11kv	Victor Harbor	MBFRA	3
KA14	NALYAPPA 19kv	Kadina	MBFRA	3
LM63	Pinnaroo North 19kv	Lameroo	MBFRA	2
M11	Mannum North 7.6kv	Mannum	MBFRA	2

* The 5 NCR's on NL21 are associated with the removal of these spans from the cutting program due to undergrounding works in Clarendon as discussed elsewhere this report.

6.4.1   NCR Observations

Noarlunga

Noarlunga recorded the highest NCR's (8), with one of the Feeders (NL21) recording the highest level of NCR's at 6. These NCR's on NL21 were over 3 sites, with one site recording 4 NCR's, (4 spans in row, all except one in the mid span). Five of these NCRs were a direct result of the removal of these spans from the cutting program by SA Power Networks. These were removed from the maintenance program because the overhead sections were scheduled to be undergrounded, and the GIS had been updated to reflect these works, although the particular removal of the O/H conductors and replacement with U/G cables had not actually occurred. ATS were not required to inspect these sections because the program reflected the updated, but incorrect, GIS records.

This incorrect updating of the GIS records represents a breakdown in record management processes within SA Power Networks. We recommend that SA Power Networks undertake a review of the reason why the record management processes in this instance failed to prevent an incorrect update of the GIS system, and identify tactics to ensure this does not occur again.

Barmera

Barmera recorded the second highest level of NCR's (8), with one of the Feeders (BM15) recording 5 NCR's. These NCR's on BM15 were over 3 sites, with one site recording 3 NCR's,(3 spans in row, all mid span NCR's). Historically Barmera has not been a District where NCR's have been prevalent. Barmera was an ATS District and therefore may be an isolated issue of poor scoping or cutting or insufficient quality control. It should be noted that LX34 was a Feeder that did not require a patrol prior to the FDS.

Loxton

Loxton recorded the third highest NCR's (6), all in the one Feeders (LX34). These NCR's on LX34 were over 4 sites, with one site recording 3 NCR's, (2 mid-span and one at the pole). Historically Loxton has not been a District where NCR's have been prevalent. Loxton was an ETS District and therefore may be an isolated issue of poor scoping or cutting or insufficient quality control by a contractor that is no longer engaged by SA Power Networks. It should be noted that LX34 was a Feeder that did not require a patrol prior to the FDS.

McLaren Vale

McLaren Vale recorded the fourth highest NCR's (5), with 4 in the one Feeders (MV13). These NCR's on MV13 were over 1 site, all Drive By's.). Historically McLaren Vale has not been a District where NCR's have been prevalent. It should be noted that MV13 was a Feeder that was patrolled prior to the FDS and as such should not have had NCR's to this level.

6.4.2   Observations of Good Performance

Stirling

It is noted that there was only the one NCR identified in this District, which is a good result considering it has one of the higher vegetation densities in the State whilst also being a heavily populated District. Maintaining clearances has been problematic historically due to high rainfall and the presence of fast growing species. It is noted that the level of NCR's for 2015 are a significant reduction on previous years, with 10 NCR's being recorded in Stirling in 2013.

Holden Hill

The District of Holden Hill is one where large clearances are not always possible due to community and environmental reasons as such the timing for inspections and cutting is critical to ensure clearances are achieved and maintained during the fire danger season. There were no NCR's observed during the 2015 audit.

6.5   Additional Observations

Proximity to Power Line

Of the 58 NCR's (including Drive By's) 42 (72%) were considered to be NCR's already into the CZ. The other 16 (23%) were assessed as being likely to grow (or bend) into the CZ during the bushfire season.

The below chart represents the spread of NCR's based on the percentage the vegetation actually infringing into (or growing into) the CZ.

From 7 it can be seen that the greater portion of the CZ NCR's are 30% or less into the CZ, however there were a significant portion that were number (6) that were within 80% or greater into the CZ.

Note – -100% is touching the powerline, 0% is on the edge of the CZ, Greater than 0% is a likely bend or grow NCR.

Figure 7   NCR's – Proximity to Power Line – 2015
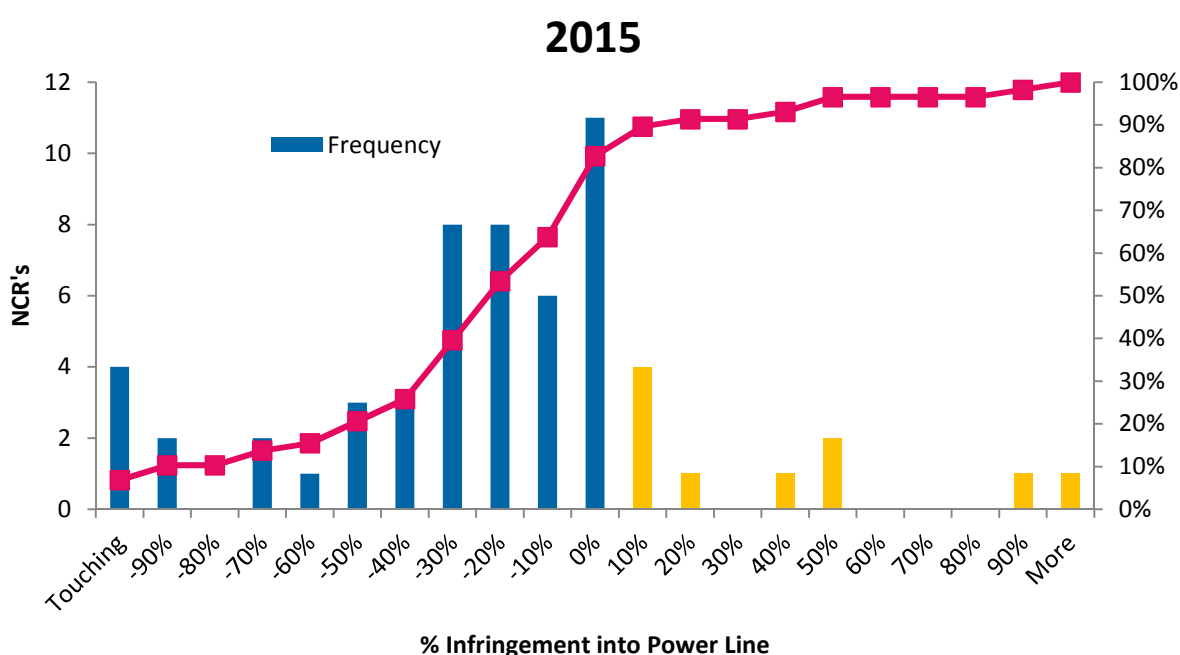
Patrols

Of the 58 NCR's there were 8 that were identified on 4 Feeders that were inspected as part of the Cyclic Program and the Pre FDS Patrol Program.

Table 10 details the 4 Feeders where those NCR's were recorded.

Table 10   Patrolled Feeders with NCR's

Feeder	Feeder Names	District	Risk Area	Total NCR's in Feeder
NU02	Angaston 11kv	Nuriootpa	HBFRA	1
NU24	Gomersal 19kv (537 Sub)	Nuriootpa	HBFRA	1
PL07	North 11kv	Port Lincoln	HBFRA	3
VH44	Flagstaff Hill 11kv	Victor Harbor	MBFRA	3

A reasonable expectation is that the NCR count should be nil on Feeders that are subject to a Pre FDS Patrol.

Vegetation Species

Species information for each NCR was captured and reproduced in Table 11 below.

Whilst it remains prudent to capture this information, from the analysis of this audit, there is no real dominant trend or conclusions we can draw. Whilst gum trees feature as the highest NCR category, they are the dominant species in most of the Districts. Ash trees are fast growers that appear in townships and need to be cut more frequently or removed and the issues associated with pine trees tends to be side clearances above the power lines.

Table 11   Species of Vegetation for NCR's

Species	NCR's #	NCR %
Gum	23	40%
Various / Unknown Species	11	19%
Pine	5	9%
Ash	4	7%
Palm	4	7%
Bamboo	2	3%
Unknown species	1	2%
Ornamental	1	2%
Olive	1	2%
Gum sapling	1	2%
Willow	1	2%
Grape vine	1	2%
Melaleuca	1	2%
Shrubs native.	1	2%
TOTAL	**58**	

7.   Reporting Qualifications

- From the Audit Summary Table at Appendix B it has been calculated that approximately 10% of the total Feeder spans were audited – this only includes those spans assessed as part of the selected audit site, i.e. it excludes the Drive By NCR's observed in adjacent Feeders.

- Whilst the sites subject to the audit are selected at random, they are generally selected across the whole Feeder. By default this does result in a greater proportion of the Feeder being assessed through the "Drive By" observations.

- The 433,000 estimate of total spans (HBFRA & MBFRA) has been provided by SA Power Networks.

8.   Conclusions & Recommendations

The increase in the NCR/Site and NCR/Span measures reported in the 2015 audit indicates a fall in performance in the Vegetation Clearance program when compared to 2014, but still better than in the years before 2014.

The drop off in performance between 2014 and 2015 can in part be attributed to the poor performance of the second contractor ETS, however taking these into account, there is also a drop off in performance on the main contractor ATS. SA Power Networks have recently renegotiated the contract with ATS to cover the complete State with the ETS contract not being extended, so it would be expected that next year's (2016) results in the ETS covered Districts should improve.

The drop off is difficult to attribute to any specific causes. The 6 monthly rainfall from 1 Jun to 30 Nov 2015 shows a rain deficit (below average to well below average) for Districts including and to the West & South of the Yorke Peninsula across to the Victorian border. It would be expected then that this would result in lower NCR's due to lower vegetation growth, although this may become more apparent over the next 12 months. It could also be that 2014 was a good year for compliance which can be difficult to improve upon.

Five of these NCRs were directly attributed to a failure in SA Power Networks record management processes in that 5 NCRs in NL21 were on O/H spans that were removed from the GIS and therefore the maintenance programme, because it was understood by SA Power Networks that they had been undergrounded, although the planned undergrounding had not actually occurred. This incorrect updating of the GIS records represents a breakdown in record management processes within SA Power Networks. We recommend that SA Power Networks undertake a review of the reason why the record management processes in this instance failed to prevent an incorrect update of the GIS system, and identify tactics to ensure this does not occur again. Internal issues aside and noting that different crews undertake the scoping and the cutting, it would be reasonable to hope that the contractor should have observed the spans in question given that they were cutting the rest of the feeder, and either taken appropriate action or notified SA Power Networks.

SA Power Networks must take reasonable steps to clear vegetation from its powerlines in accordance with the requirements set out in the Principles of the Act. While full compliance has not been achieved, on the basis that the clearance program was completed on schedule and that the overall non-conformance rates are still historically trending lower, albeit with a performance drop off in 2015, and with the renegotiation of the contract with ATS and not extending ETS's contract, it is GHD's opinion that SA Power Networks is taking reasonable steps to meet the obligations of the prevailing legislation in regard to taking maintaining clearances in designated bushfire risk areas, however we would recommend that SA Power Networks meet with ATS to try to determine the cause in the drop off in 2015.

With a 1.4% infringement rate over the 3,262 ATS & ETS spans audited, and it can be derived through basic extrapolation that given a network comprising some 433,000 spans in the MBFRA and HBFRA (estimated by SA Power Networks) that there is potentially some 6,063 non-compliant spans across the State that have either not been identified to be scoped or not cut sufficiently to remain out of the CZ for the FDS. This indicates that there remain potential significant unknown risks across the network

As this 2015 analysis shows, there had been significant improvement over the 5 years prior to 2015, with a small drop off in 2015. It is unknown whether there are significant underlying reasons for this drop off that may lead to continued poorer performance in the future, other than

the contributing factor of the contractor ETS, or whether this was a one off issue that will be recovered in future years.

In order to maintain the excellent achievements in performance over the last 5 years, the challenge for SA Power Networks is to assess with the incumbent contractor (ATS) reasons for the drop off and identify opportunities to continually improve performance with the clearance and compliance levels and reduce risk further.

The higher risk areas of the Mount Lofty Ranges and the bushfire risk parts of the Adelaide Metropolitan Areas (Elizabeth, Salisbury, Holden Hill and Saint Marys) should continue to be a focus for improvement. These are densely populated areas where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies need to be investigated. This may include a change to when the Feeders are scoped and/or cut or the frequency of cutting. Alternatively, vegetation removal or re-construction options could be assessed.

There remains a relatively high incident of NCR's occurring on Feeders that are patrolled prior to the Fire Danger Season. Given the purpose of a Pre FDS Patrol is to capture late growth or re-growth since the cyclic cut, our conclusion is that a review of the effectiveness of the patrol program is warranted.

The following observations and recommendations are made for consideration and implementation into the 2015 Cyclic and Pre Fire Danger Season Programs:

Table 12   Observations and Recommendations - 2015

Observation	Recommendation	2015 Ref.	Priority
Current Vegetation Management practices and a consistent approach has improved performance over the 5 years prior to 2015, with a drop off in performance in 2015.	Assess with contractor why there was a drop off in performance for 2015 and identify strategies for improving performance.	R1 (i)	1
Continuing to reduce the non-compliance rate will require alternate / additional strategies and technologies to be considered, trialled and implemented.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (ii)	2
There were 8 NCR's identified on 4 Feeders that were subject to a Pre FDS Patrol. The intent of the Pre FDS Patrols are to identify and cut those (few) spans that have had unexpected regrowth since the cyclic cut.	Continue to assess the timing for both the cyclic and pre FDS scoping and cutting as both are critical to the effectiveness of the programs.	R1 (iii)	2
NL21 NCRs were the result of the incorrect updating of GIS	Assess reason why the record management processes failed in this instance and develop tactics to update processes to ensure this does not occur again in the future	R1 (iv)	1
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA. Audit results have been improving for the 5 years before 2015, with a drop off in performance in 2015. The greatest level of NCR's occur on HBFRA Feeders which are the higher risk areas. The overall 6-year trend is still that of improvement; however there would still appear to be opportunities for improvement to further reduce the levels of non-compliance, supporting that alternate audit methodologies be considered for a more mature network	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results.	R2	3

Observation	Recommendation	2015 Ref.	Priority
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SA Power Networks GIS platform as required.	R3	2
GHD as the auditors are currently not required to review and report on what action SA Power Networks has taken on the previous year's recommendations. This potentially leaves a gap in SA Power Networks continual improvement drive.	Increase scope in future audits to incorporate a review of previous recommendations and report on implementation or otherwise.	R4	3
GHD are aware of the use of land based LiDAR by other SA Power Networks departments, and also of the trialling of airborne LiDAR in 2015 SA Power Networks have advised that the use of LiDAR or alternative technologies will continue to be assessed as a tool to manage vegetation near powerlines We support this objective and recommend ongoing improvement analysis, including the potential to use existing vehicle based LiDAR trials by using SAPN equipment at the same time as the Pre FDS audits. The objective being to identify if audit procedures can be improved (quality timeliness extent) using new technology	Assess / Review opportunities to implement aerial and vehicle based LiDAR trials for future vegetation clearance audits.	R5	3

1 - Priority

2 - Strategic Improvement

3 - Opportunity for Improvement

Below is a copy of the 2014 Observations and Recommendations which has been updated to reflect actions taken.

We suggest that as part of an ongoing improvement strategy that an Action Table is developed to monitor these to ascertain whether or not there has been any improvement as a result of implementing any of the actions.

Observations and recommendations from 2014 report with 2015 SA Power Networks Comments

Table 13   Observations and Recommendations – 2014 with 2015 SA Power Networks Comments

2014 Observation	2014 Recommendation	2014 Ref.	2015 SA Power Network Comments
Current Vegetation Management practices and a consistent approach has improved performance over the last 5 years. Continuing to reduce the non-compliance rate will require alternate / additional strategies and technologies to be considered, trialled and implemented. There were 5 of the 18 NCR's identified on Feeders that were subject to a Pre FDS Patrol. The intent of the Pre FDS Patrols are to identify and cut those (few) spans that have had unexpected regrowth since the cyclic cut.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results. Continue to assess the timing for both the cyclic and pre FDS scoping and cutting as both are critical to the effectiveness of the programs.	R1 (i) R1 (ii)	A number of strategic initiatives were progressed during 2015 which will improve our vegetation management over the long-term. Further initiatives to be implemented in 2016. Further more detailed review of clearance program to be undertaken during 2016 with contractor, following appointment of ATS as clearance contractor to identify opportunities for improvement
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas is disproportionate to that for HBFRA. Audit results have been improving for the last 5 years. The greatest level of NCR's occurring on HBFRA Feeders which is the highest risk area. The improvement in audit results support that alternate audit methodologies be considered for a more mature network	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results.	R2	Further more detailed review of clearance program to be undertaken during 2016 with contractor, following appointment of ATS as clearance contractor to identify opportunities for improvement

2014 Observation	2014 Recommendation	2014 Ref.	2015 SA Power Network Comments
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SAPN GIS platform as required.	R3	Data analysis undertaken to understand 'hot spots' and problem feeders. Further work with contractor required during 2016.
Due to the change in SAPN audit resourcing for 2014 existing vegetation contractor scoping and cutting for the current and prior year's data was unable to be accessed by the GHD audit team. This reduced the team's capability of assessing the cause of NCR's.	Negotiate the supply of scoping and cutting data from the incumbent contractors for future audits.	R4	ATS provide all scoping and cutting data to SA Power Networks.
GHD as the auditors are currently not required to review and report on what action SAPN has taken on the previous year's recommendations. This potentially leaves a gap in SAPN's continual improvement drive.	Increase scope in future audits to incorporate a review of previous recommendations and report on implementation or otherwise.	R5	Not sure this is part of the audit scope but more continuous improvement/ lessons learnt
GHD are aware of the use of land based LiDAR by other SAPN departments, and also of the trialling of airborne LiDAR. We suggest that there may be some benefit in incorporating vehicle based LiDAR trials by using SAPN equipment at the same time as the Pre FDS audits. The objective being to identify if audit procedures can be improved (quality timeliness extent) using new technology	Assess / Review opportunities to implement vehicle based LiDAR trials for future vegetation clearance audits.	R6	A LiDAR trial was undertaken during 2015 and the use of LiDAR or alternative technology will continue to be assessed as a tool to manage vegetation near powerlines.

Appendices

Appendix A – Feeders Audited

Appendix B – Audit Results – Summary Table

Appendix C – Acronyms and Definitions

The following table provides definitions of acronyms used within this report.

Acronym	Definition
ATS	Active Tree Services – A current Vegetation contractor
AUDIT SITE	A randomly selected pole on a feeder – 3 spans either side of the pole are audited where practical.
B & G	Bend and Grow
BFRA	Bushfire Risk Area In December 2013, the EMG approved the transition from 'Bushfire Risk Area" to the new designation "Medium Bushfire Risk Area" (MBFRA).
BFDS (or FDS)	Bush Fire Danger Season
CZ	Clearance Zone – the area around the powerline that must be maintained clear of vegetation at all times.
D/B	Drive By
DRIVE BY	A non-conformance identified on-route to an audit site
ETS	Eastern Tree Services – A current Vegetation contractor
HBFRA	High Bushfire Risk Area
LiDAR	Light Detection and Ranging — a remote sensing method used to examine the surface of the Earth
MBFRA	Medium Bushfire Risk Area
NBFRA	Non Bushfire Risk Area
NCR	Non-conformance record – an audit fail where vegetation is either into the CZ or is likely to bend or grow into the CZ during the FDS.
N/A	Not Available
ND	Network Directive
N/R	Not Reported
PATROL	The Pre Fire Danger Season Patrol - A visual check on those Feeders or part Feeders that were scoped prior to 1 May – a risk mitigation strategy to capture clearance requirements that were missed during the initial scoping and cutting programs. Patrols are either conducted on ground or by helicopter.
SWER	Single Wire Earth Return

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SA Power Networks

2016 Pre Fire Danger Season
Vegetation Clearance Audit Report

February 2017

Executive summary

Background & Scope

Under South Australian legislation, SA Power Networks is required to undertake inspections and implement necessary measures to ensure that vegetation is clear of powerlines – this is in accordance with the Electricity Act 1996 and its associated Regulations.

To this end, SA Power Networks routinely conducts its own internal audits, while also commissioning an independent third party to undertake an external audit of the clearance program. This is considered prudent, as the potential risk and liability arising from failure to adequately comply with legislative provisions is extremely high, particularly in bushfire risk areas.

GHD was engaged by SA Power Networks to undertake an external audit of the vegetation clearance program. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology, with the field component undertaken from 10 October 2016 to 9 December 2016.

External contractors, Helistar and Arborman, were engaged to assist GHD by providing audit navigation assistance. Helistar were engaged for the more remote arid Districts, whilst Arborman – who were suitably qualified to offer additional vegetation growth advice – were utilised for the Districts with higher vegetation cover.

SA Power Networks conduct a range of internal and independent audits as part of the vegetation management program. Together, these audits are designed to measure: the risks posed by vegetation at specific times of the year; the overall effectiveness of the vegetation management strategies; and the performance of the contractor. The Annual Pre-Bushfire Season Audit (this commission) was intentionally undertaken in MBFRA / HBFRA Districts.

Overall Audit Results

97 Feeders across all 40 South Australian Districts were audited between 10 October and 9 December 2016. A full register of the audited Feeders is provided in Appendix A and a summary of the recorded NCR's is provided in Appendix B.

A summary of the audit and findings is provided in Table 1.

Table 1   Audit Finding Summary

Measure	2014	2015	2016
Districts Audited	**40**	**40**	**40**
Feeders Audited	**82**	**84**	**96** *97*
Audit Sites	**632**	**549** *554*	**944** *948*
Audit Spans	**3727** *3729*	**3262** *3274*	**5629** *5633*
Districts with Multiple Feeder Fails	**1**	**11** *12*	**6** *9*
Total NCR's	**18** *20*	**46** *58*	**29** *33*
Feeders with nil NCR's	**69 (84%)**	**61 (73%)** *58 (69%)*	**78 (80%)** *76 (78%)*
Feeders with 1-3 NCR's	**13 (16%)**	**18 (39%)** *20 (24%)*	**16 (17%)** *19 (20%)*
Feeders with >3 NCR's	**0 (0%)**	**5 (11%)** *6 (7%)*	**2 (2%)** *2 (2%)*

Note:

[a] **XXX (bolded)** denotes Audit Site measurements <u>excluding</u> Drive-By measurements

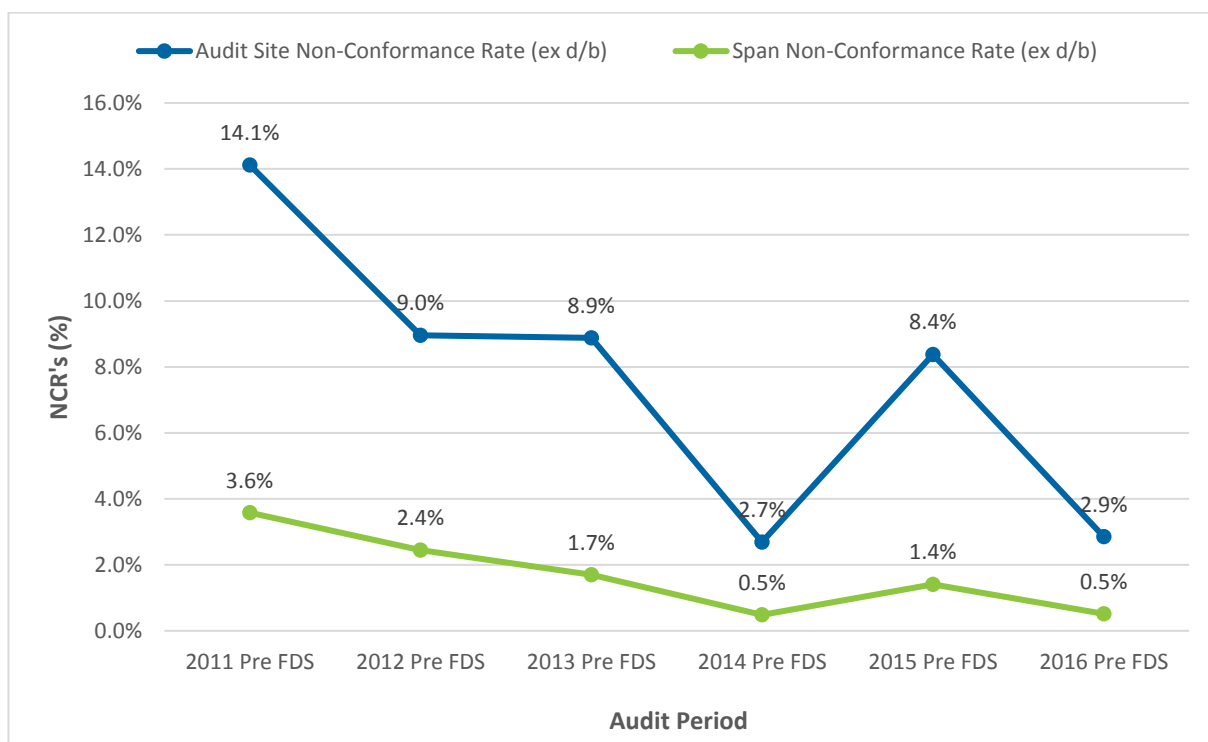[b] *XXX (italicised)* denotes Audit Site measurements <u>including</u> Drive-By measurements

Figure 1   High Level Trend Comparison (2011 to 2016)

Note:

1) In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.

2) Accurate feeder numbers were provided in 2016. Results have been updated to reflect actual feeder number rather than the previously estimated 433,000 spans.

Further analysis of the audit findings is shown in Table 2.

Table 2   NCR Categories

NCR	2014	2015	2016
Total	18	46	29
Actual CZ Infringements	13 (72%)	33 (72%)	13 (45%)
Likely CZ Infringements (Bend & Grows)	5 (28%)	13 (28%)	16 (55%)
HBFRA	13 (72%)	20 (43%)	18 (62%)
MBRFA	5 (28%)	26 (57%)	11 (38%)
High Voltage	11 (61%)	27 (41%)	23 (79%)
Low Voltage	7 (39%)	31 (59%)	6 (21%)
Drive By's	2	12	4

Conclusions & Recommendations

Overall, vegetation compliance in 2016 shows a marked improvement compared to previous years (excepting 2014), with an overall downward trend in logged NCR's across the 13 South Australian Regions.

Although the infringement rate was significantly reduced in 2016, there is still scope for continued improvement – in context, this year's span non-conformance rate (approximately 0.5% in BFRA's) indicates that the network comprising 412,836 BFRA spans may have 2127 NCR's that are yet to be identified.

The Stirling and Mount Gambier Districts, particularly, were noted for poor performance in the 2016 Pre-FDS audit – and as these Districts are both classified as HBFRA's, the risk of fire is significant. It is also acknowledged that these are densely populated areas where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies could be investigated. For example, this may include a change to when the Feeders are scoped and/or cut or the frequency of cutting. Alternatively, vegetation removal or reconstruction options could be assessed.

Similarly, feeders with a high number of NCR's identified (greater than three NCR's) also pose an increased risk of fire. In 2016, more than three NCR's were identified on the MG05 Compton (11 kV), and KI54 Newlands (19 kV) Feeders. Going forward it is recommended that these Feeders be re-scoped and where necessary, cut, to ensure compliance. These Feeders, as well as the SG14 Upper Sturt (11 kV) Feeder (which recorded the highest infringement rate in 2016), should also be included for auditing once again in 2017.

It is noted that a greater proportion of the NCR's identified in this audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone. This indicates that the vegetation program efficiency is improving, and that it is possible that the above-average rainfall may have contributed to accelerated growth rates for some species.

The Electricity Act 1996 stipulates that any electricity entity must 'take reasonable steps' to ensure that vegetation of all kinds is kept clear of public powerlines, and that naturally occurring vegetation is kept clear of private powerlines (Electricity Act 1996). While full compliance has not been achieved in 2016, SA Power Networks has ensured that the vegetation clearance program was completed on schedule, with non-conformance rates trending lower than in previous years (excepting 2014). It is therefore GHD's opinion that SA Power Networks has undertaken necessary measures (reasonable steps) to ensure that vegetation is clear of powerlines.

A summary of observations and recommendations are provided in Table 3 for consideration and potential implementation into the 2017 Cyclic and Pre Fire Danger Season.

Table 3   Observations and Recommendations - 2016

Observation	Recommendation	2016 Ref.	Priority[a]
Improved performance over a six-year period for the vegetation clearance program.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (i)	2
Engaging ATS as the primary vegetation contractor is coincident with improved vegetation clearance performance – likely attributed to their comprehensive knowledge and experience, which provides consistency of performance.	Discuss with vegetation contactor (ATS) ways in which vegetation clearance and overall compliance can be improved for 2017.	R1 (ii)	2
Scoping and cutting data (on a span-by-span basis) was not made available to the GHD team – limiting the team's ability to assess the cause of non-compliances.	It is understood that SA Power Networks has access to this information provided by the incumbent contractor. It would be beneficial to negotiate the supply of this scoping and cutting data to the GHD team for future audits.	R2	2
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SA Power Networks GIS platform as required.	R3	2
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA, particularly where some of these districts have a high proportion of non-vegetated spans.	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results	R4	2
Feeders with a high number of NCR's (greater than 3) represent an increased risk of fire occurrence.	Re-scope those Feeders that had greater than 3 site non-conformances: • MG05 Compton (11 kV) • KI54 Newlands (19 kV) • SG14 Upper Sturt (11 kV)[a] [a] While SG14 Upper Sturt wasn't recorded as having >3 NCR's, it was the Feeder with the highest infringement rate and on this basis, should be included in any intended re-scoping.	R5	1

Observation	Recommendation	2016 Ref.	Priority[a]
It is noted that a greater proportion of the NCR's identified in this audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone – potentially due to. above-average rainfall accelerating growth rates for some species.	Appropriate application of vegetation indices to remotely sensed imagery might be used to monitor vegetation growth and vigour. The NDVI (Normalised Difference Vegetation Index) has been shown to be particularly useful for monitoring vegetation (Huete et al., 2002) - and with the application of change detection imagery (Johansen et al., 2010), it would be possible to document changes in consecutive imagery (of the relevant Districts/Feeders). This method would serve the purpose of assessing localised tree growth and vigour, especially after excessive rainfall events, and would therefore prove invaluable in tailoring site visits and informing scoping and cutting schedules	R6	3
A number of private landowners planting inappropriate vegetation below powerlines (e.g. fast-growing Eucalyptus trees).	Ensure that all private landowners (particularly those in remote regions) are educated (by way of distribution of leaflets/brochures) with regards to appropriate vegetation for planting near powerlines.	R7	3

[a] Priority Categories:

    1 - Priority

    2 - Strategic Improvement

    3 - Opportunity for Improvement

Table of contents

Table index

Figure index

Appendices

Appendix A – Feeders Audited

Appendix B – Audit Results – Summary Table

Appendix C – Clearance Zones

Appendix D – Acronyms and Definitions

This 2016 Pre Bush Fire Season Vegetation Audit Report ("Report"):

1. *Has been prepared GHD Pty Ltd;*

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1. Background

Under South Australian legislation, SA Power Networks is required to undertake inspections and implement necessary measures to ensure that vegetation is clear of powerlines – this is in accordance with the Electricity Act 1996 and its associated Regulations.

Whilst SA Power Networks undertakes its own internal audits on an ongoing basis, it is considered prudent to have an external audit of the clearance program, as the potential risk and liability arising from failure to adequately comply with legislative provisions is extremely high, particularly in bushfire risk areas.

To this end, GHD were engaged by SA Power Networks to undertake an external audit of the vegetation clearance program. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology, with the field component undertaken from 10 October 2016 to 9 December 2016.

The 2016 audit utilised external contractors Helistar and Arborman to provide navigation assistance and assist GHD with their inspections. Helistar were engaged for the more remote arid Districts, whilst Arborman – who also provided vegetation growth advice for potential non-compliant tree infringements (NCR's) – were utilised for the Districts with higher vegetation cover and high bushfire risk areas.

SA Power Networks conduct a range of internal and independent audits as part of the vegetation management program (see Figure 2). Together, these audits are designed to measure: the risks posed by vegetation at specific times of the year; the overall effectiveness of the vegetation management strategies; and the performance of the contractor. The Annual Pre-Bushfire Season Audit (this commission) was intentionally undertaken in MBFRA / HBFRA Districts.

Cyclic Audit

- **Date:** August to October
- **Purpose:** Assess vegetation contractor's performance
- Assess both actual and potential (bend/grow) infringements into the Clearance Zone

Pre-FDS Audit

- **Date:** October to December
- **Purpose:** Assess network risk for the bushfire season
- Assess both actual and potential infringements into the Clearance Zone

Post-FDS Audit

- **Date:** April to May
- **Purpose:** Assess effectiveness of vegetation clearance program
- Assess actual infringements into the clearance zone

Figure 2   Audits Commissioned by SA Power Networks

2. Scope of Work

The objective of the Pre-Bushfire Season Audit was to undertake a compliance audit of randomly selected Feeders to evaluate SA Power Networks' performance in compliance with its obligations under the Electricity Act 1996 and Regulations, Part 5 Division 1 with regard to "Duties in Relation to Vegetation Clearance" and Section 4 "Duty of Electricity Entity or Council" and Section 4 Schedule 1 "Clearance and Buffer Zones around Powerlines".

The scope of the Patrol was:

1. To undertake a field audit of SA Power Networks' performance in complying with vegetation clearance requirements in accordance with its obligations under the Electricity Act 1996, Part 5, Division 1 with regard to "Duties in Relation to Vegetation Clearance", and the Electricity (Principles of Vegetation Clearance) Regulations 2010.

2. To undertake the audit to determine and to make a statement as to whether or not, as required under Part 5 Division 1 Section 55(1) of the Electricity Act 1996, SA Power Networks has taken "reasonable steps" to keep vegetation of all kinds clear of public powerlines under SA Power Networks' control; and to keep naturally occurring vegetation clear of private powerlines under SA Power Networks' control. For the purpose of this assessment GHD will take into account, the legal opinion provided by Minter Ellison (for SA Power Networks) in 2011 which includes the following paragraph:

    "Meaning of 'duty to take reasonable steps"

    SA Power Networks must take reasonable steps to clear vegetation from its powerlines in accordance with the requirements set out in the Principles.

    What constitutes 'reasonable steps' will be assessed objectively, taking into account, for example, the characteristics of the powerlines, surrounding vegetation, industry best practice and the Principles.

    Compliance with the Principles should be viewed as the minimum benchmark which must be achieved in order to discharge SA Power Networks obligations under section 55(1) of The Electricity Act.

    Ultimately, the steps taken by SA Power Networks to discharge its duty should:

    - *At least reflect 'good' electricity industry practice.*

    - *Ideally, reflect industry best practice (taking into account relevant interstate and international standards and operational experiences and any recent authoritative findings or learning's in relation to powerline vegetation clearance - e.g. outcomes from royal commissions, University studies, etc.)."*

In addition, the scope of the field audit is to:

- Audit all 40 Districts classified as being in High Bushfire Risk Areas (HBFRA) & Medium Bushfire Risk Areas (MBFRA) of South Australia.

- Assess only bare conductor overhead construction within the HBFRA & MBFRA areas of South Australia.

- Undertake audits as close as practicable to the commencement of the Fire Danger Seasons in each of the geographical areas.

3. Vegetation Clearance Audit Methodology

The methodology used for vegetation clearance assessment and data processing is described in Sections 3.1-3.5, below.

3.1   Feeder Selection

SA Power Networks provided GHD with a selection of five Feeders for each District, of which two Feeders were selected for the purpose of the audit. There were no restrictions on this selection – however, timing of audits within Districts was dependent on cutting progress in those areas. The scoping and cutting data for Feeders was updated by the by the vegetation cutting contractor (ATS) on a weekly basis with this information passed on to GHD as required. GHD could therefore schedule site visits accordingly, with any NCR's recorded in Feeders with cutting percentage >80% attributed to inadequate vegetation clearance by the vegetation contractors.

Information regarding the frequency with which spans were cut was not made available to GHD, limiting the level of analysis and reporting in regards to the context of vegetation non-compliance in various instances.

3.2   Audit Site Selection

At the start of each Feeder audit, GHD identified up to five potential target poles/audit sites (per page of the Feeder plans generally) for each Feeder under audit.

A schedule of the Feeders selected is provided in Appendix A.

3.3   Data Acquisition

Audit inspections were recorded on a tablet using an inspection application called Mobile Data Anywhere (MDA) database with GIS capability. At each audit location, vegetation clearances up to three spans in each direction from the nominated target pole (typically a transformer or switching point) were classified, in accordance with the categories as shown in Table 4.

Table 4   Categories for Vegetation Classification

Classification			
No Vegetation	**Vegetation All Clear**	**NCR**	
		CZ Infringement	**Bend/Grow**
No vegetation present within span (or likely to grow into span within 10 years from audit)	Vegetation within spans has been cut to compliance	Vegetation has breached the clearance zone (CZ)	Vegetation is likely to bend or grow into the clearance zone (CZ)

Horizontal and vertical clearance zones (Appendix C, Tables I-III) were determined based on the span and voltage of the powerlines specified in the Electricity (Principles of Vegetation Clearance) 2010 Regulations.

A TruPulse 200/B Laser Rangefinder was used for acquisition of span length, and vertical and horizontal clearance data. The number of spans included was often dependent on span length, accessibility and visibility.

3.4 Drive-By Inspections

Ad hoc visual "Drive By" inspection of clearances en route to nominated audit sites was undertaken to gain a more comprehensive overview of the effectiveness of the clearance program. Drive-By NCR's were identified and recorded as described in Section 3.3.

3.5 Data Processing

Following a District audit, SA Power Networks was notified of the NCR's identified so that appropriate action could be taken.

The data collected using the MDA platform was processed and analysed using standard analysis tools available in Microsoft Excel.

4. Vegetation Program

The SA Power Networks vegetation program for 2016 was based on an Annual Inspection & Cutting Cycle for both the HBFRA's and the MBFRA's of South Australia.

The following table (Table 5) shows the number of spans to be cut as identified from the Vegetation Clearance Program out of the 412,836 spans in bushfire areas across the network:

Table 5   Cut Spans

2014	2015	2016
66,502	54,886	49,653

It should be noted that the distinction between HBFRA and MBFRA for Feeders or part Feeders is a SA Power Networks distinction and not one of the Electricity Act 1996 (The Act) or the associated 2010 Regulations. The Act and the Regulations only distinguish between Bushfire and Non Bushfire areas.

In accordance with the SA Power Networks "Network Directive", all Feeders that were inspected prior to 1 May of the audit year are to be patrolled for vegetation clearances prior to the commencement of the FDS in each District. This is an additional risk mitigation strategy aimed to capture any overlooked vegetation or regrowth that may have occurred in the preceding months.

For 2016 the Pre-Fire Danger Season, Patrols were only undertaken on Feeders or part Feeders designated by SA Power Networks as being in MBFRAs and HBFRAs and inspected prior to 1 May 2016.

5.   Annual Rainfall

In contrast to the severe rainfall deficits across large areas of SW Western Australia, eastern South Australia, central/western Victoria and Tasmania in 2015, above-average rainfall was recorded across Australia from May to October 2016 (Figure 3).
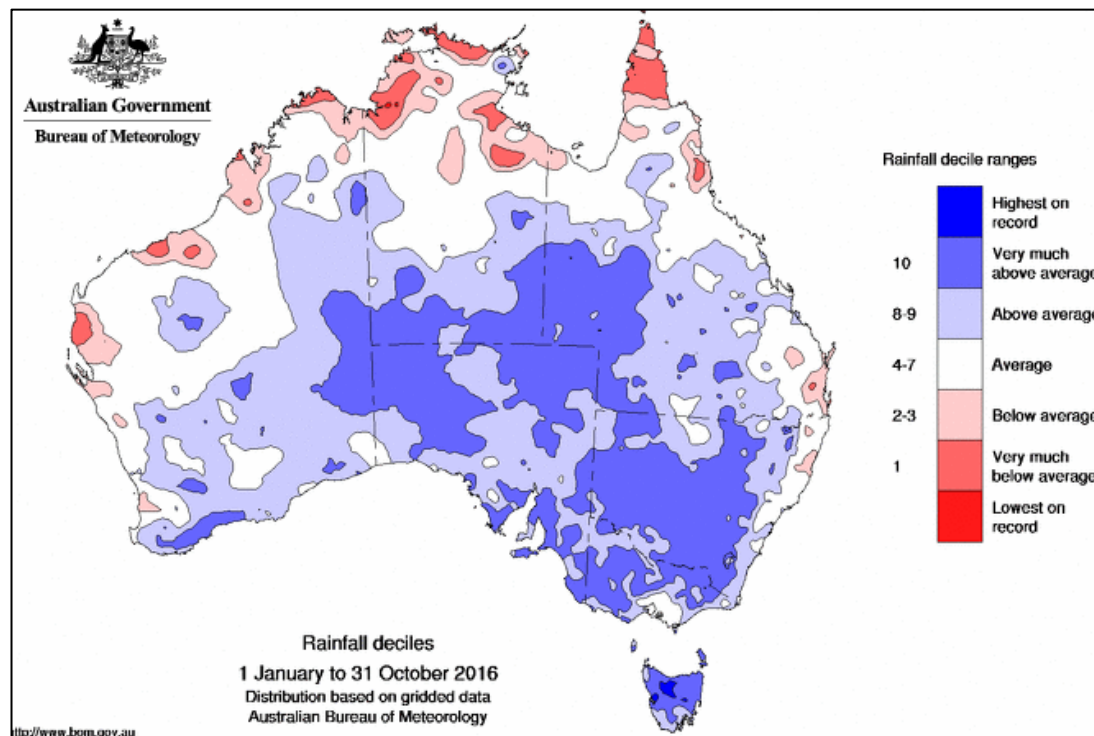

Figure 3   Rainfall across Australia in 2016 (BoM 2016)

In South Australia particularly, the locally heavy rainfall totals (296 mm) are the highest recorded since 2011 (Figure 4)(BoM 2016).
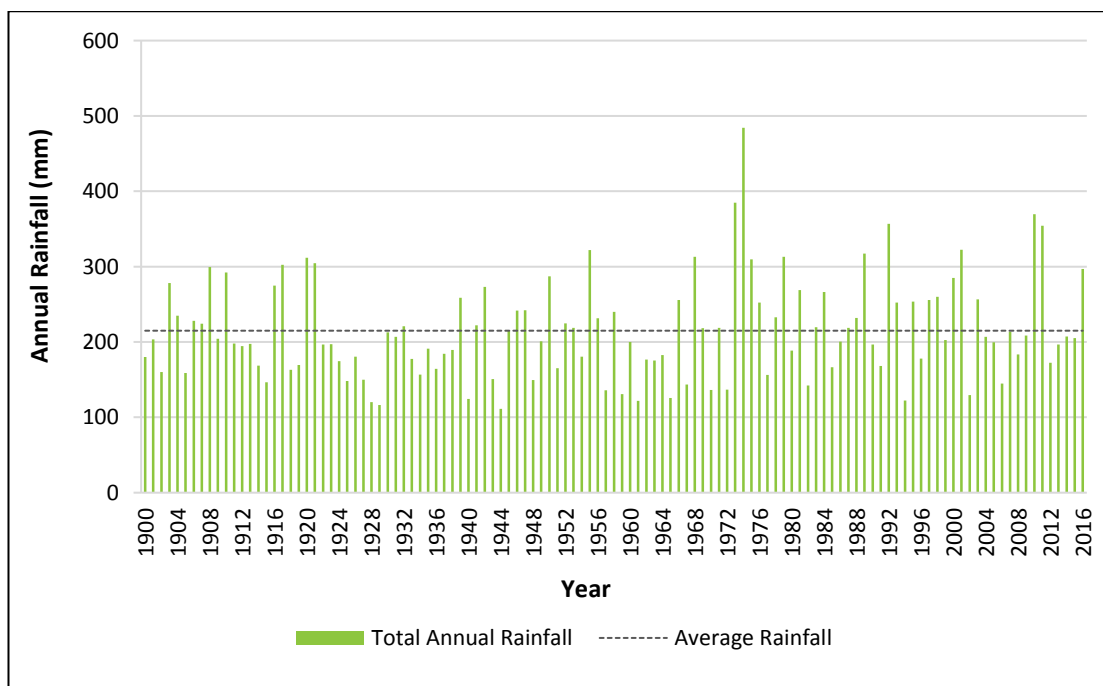

Figure 4   Total Annual Rainfall (1900-2016) for South Australia

6.   Summary of Findings

6.1   Overall Audit Results

97 Feeders across all 40 South Australian Districts were audited between 10 October and 9 December 2016. A full register of the audited Feeders is provided in Appendix A and a summary of the recorded NCR's is provided in Appendix B.

The major findings are summarised in Table 6.

Table 6   Audit Findings Summary[a,b]

Measure	2014	2015	2016
Districts Audited	**40**	**40**	**40**
Feeders Audited	**82**	**84**	**96** *97*
Audit Sites	**632**	**549** *554*	**944** *948*
Audit Spans	**3727** *3729*	**3262** *3274*	**5629** *5633*
Districts with Multiple Feeder Fails	**1**	**11** *12*	**6** *9*
Total NCR's	**18** *20*	**46** *58*	**29** *33*
Feeders with nil NCR's	**69 (84%)**	**61 (73%)** *58 (69%)*	**78 (80%)** *76 (78%)*
Feeders with NCR's 1-3	**13 (16%)**	**18 (39%)** *20 (24%)*	**16 (17%)** *19 (20%)*
Feeders with NCR's >3	**0 (0%)**	**5 (11%)** *6 (7%)*	**2 (2%)** *2 (2%)*

Note:

[a] **XXX (bolded)** denotes Audit Site measurements (<u>excluding</u> Drive-By measurements)

[b] *XXX (italicised)* denotes Audit Site measurements (<u>including</u> Drive-By measurements)

In total, 29 NCR's were identified at audit site locations, and an additional 4 NCR's identified en route to audit sites (Drive-By's). Unless otherwise specified, all results presented henceforth are only those recorded at audit sites, with Drive-By's treated separately in Section 6.2.2.

Vegetation compliance was achieved across 78 feeders, while 18 Feeders (19%) had one or more NCR's. This is an improvement on the previous year (2015) where 31% of feeders audited contained at least one NCR. It should be noted that the contract for vegetation clearance in 2015 was distributed between ATS and ETS, while ATS was solely responsible for cutting in 2016. 2014 remains a noteworthy year with 84% of feeders compliant with vegetation clearance guidelines.

A comparison of Audit and Span Non-Conformance Rates is presented in Figure 5. Span non-conformance rates in 2016 are on par with 2014, while audit site non-conformance rates are slightly higher (2.9% in 2016 compared to 2.7% in 2014). The overall downward trend in 2016 suggests increased effectiveness in the vegetation clearance program.
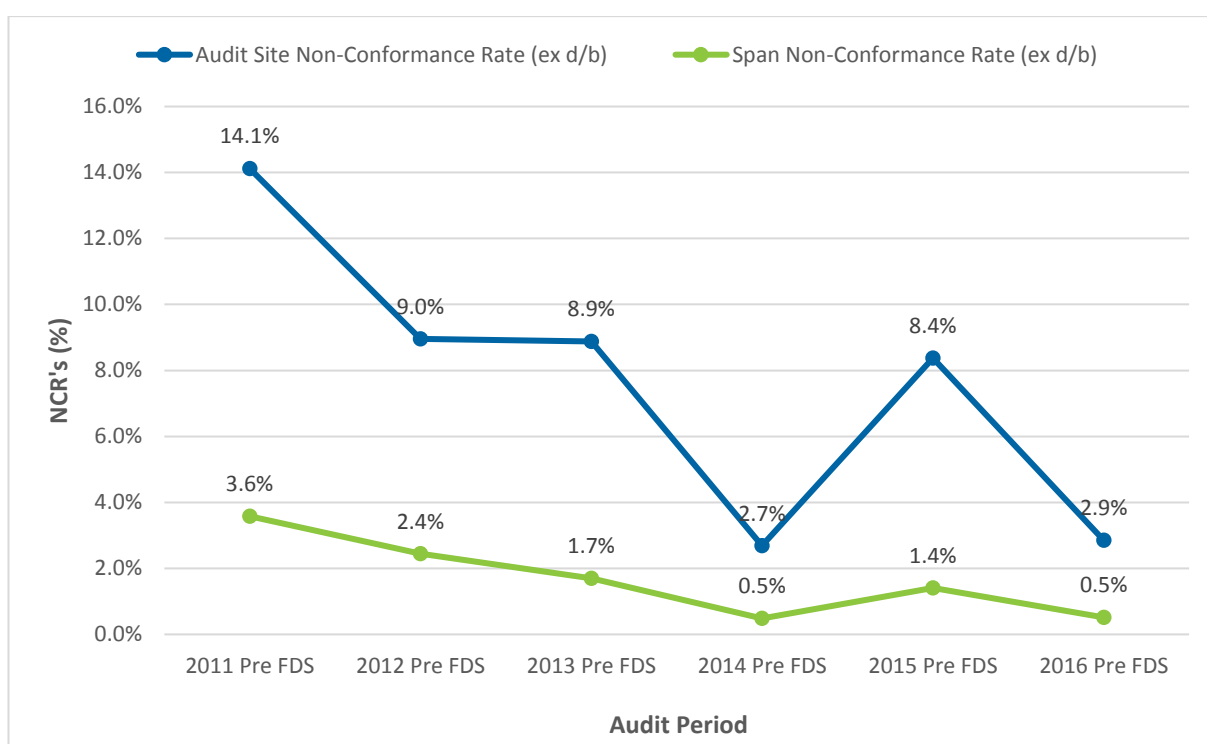

Figure 5   High Level Trend Comparison 2011 to 2016 (excluding Drive-By's)

Note:

1) In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.
2) Accurate feeder numbers were provided in 2016. Results have been updated to reflect actual feeder number rather than the previously estimated 433,000 spans.

As described elsewhere (Section 3.3) vegetation non-compliance falls within two categories: vegetation breaching the clearance zone (CZ Infringements), and vegetation that is likely to bend/grow into the clearance zone (Bend & Grows). As shown in Table 7 and Figure 6, a greater proportion (55%) of the recorded infringements were comprised of bend/grows, while 45% were logged as actual CZ infringements. This would suggest that while a greater number of trees have been cut to compliance in 2016, the extent of cutting may not have been sufficient in maintaining clearance across the ensuing months, or that the above average rainfall (see Figure 4) likely contributed to particularly vigorous tree growth in 2016. This also makes sense in light of audit results from previous years where bend and grows comprised

28% of the NCR's identified and where rainfall was generally below average (see Figure 4, 2014 and 2015).

Table 7   NCR Categories (excluding Drive By's)

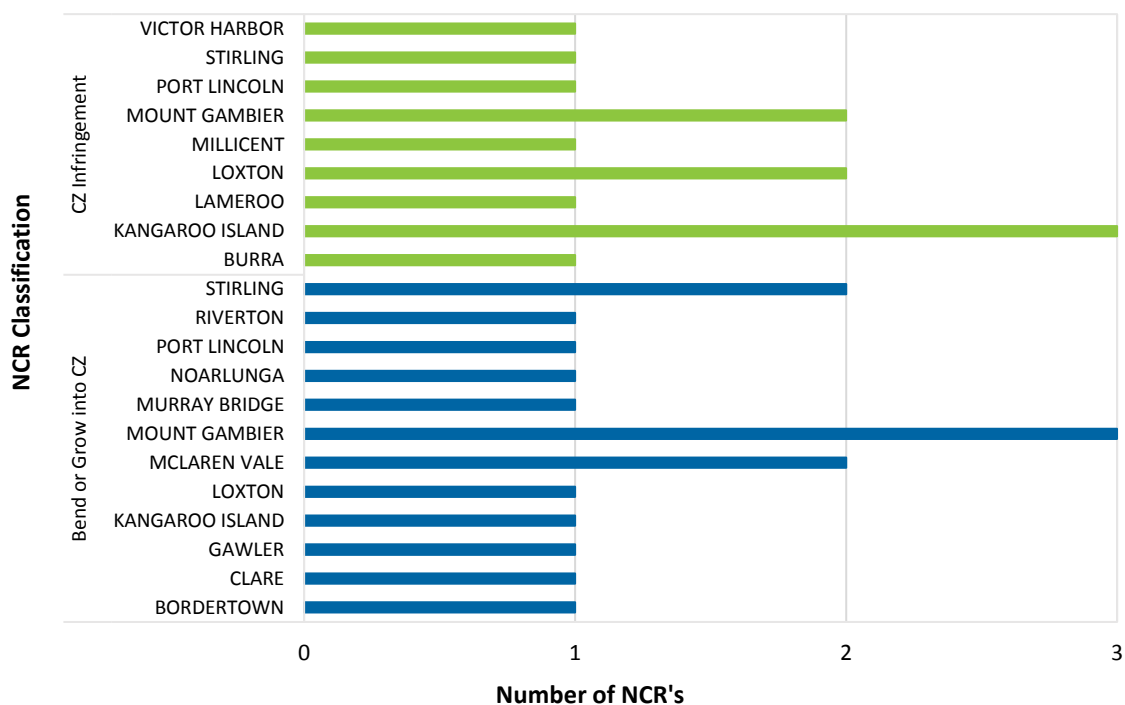| NCR	2014	2015	2016
Total	18	46	29
CZ Infringements	13 (72%)	33 (72%)	13 (45%)
Bend & Grows	5 (28%)	13 (28%)	16 (55%)
HBFRA	13 (72%)	20 (43%)	18 (62%)
MBRFA	5 (28%)	26 (57%)	11 (38%)
High Voltage	11 (61%)	27 (41%)	23 (79%)
Low Voltage	7 (39%)	31 (59%)	6 (21%)
Drive By's	2	12	4

Figure 6   Distribution of Actual CZ Infringements, and Bend/Grows across Districts (excluding Drive-By's)

6.2   Fire Danger Regions

Figure 7 presents the number of infringements (including Drive-By's) per fire-ban region across 2010-2016. Generally, Kangaroo Island, and the Lower and Upper South East regions performed poorly compared to 2015, while the Lower Eyre Peninsula, Mid North, Mount Lofty, Murraylands, Rivlerland, West Coast, and Yorke Peninsula showed marked improvement. It is noted that the Riverland and Murray Lands are areas that were taken over by ATS following poor results from ETS.

The NCR's (excluding Drive-By's) at the District level are represented in Figure 8. As the designated bushfire risk area (BFRA) for Districts will often vary from one Feeder to another, and similarly the BFRA for a Feeder may vary between audit sites, the BFRA ratings presented in Figure 8 are representative of the BFRA at the specific audit site (not for the Feeder generally). In 2016, the highest number of NCR's was recorded in the HBFRA of Mount Gambier, with most of these infringements recorded while auditing the Compton Feeder.
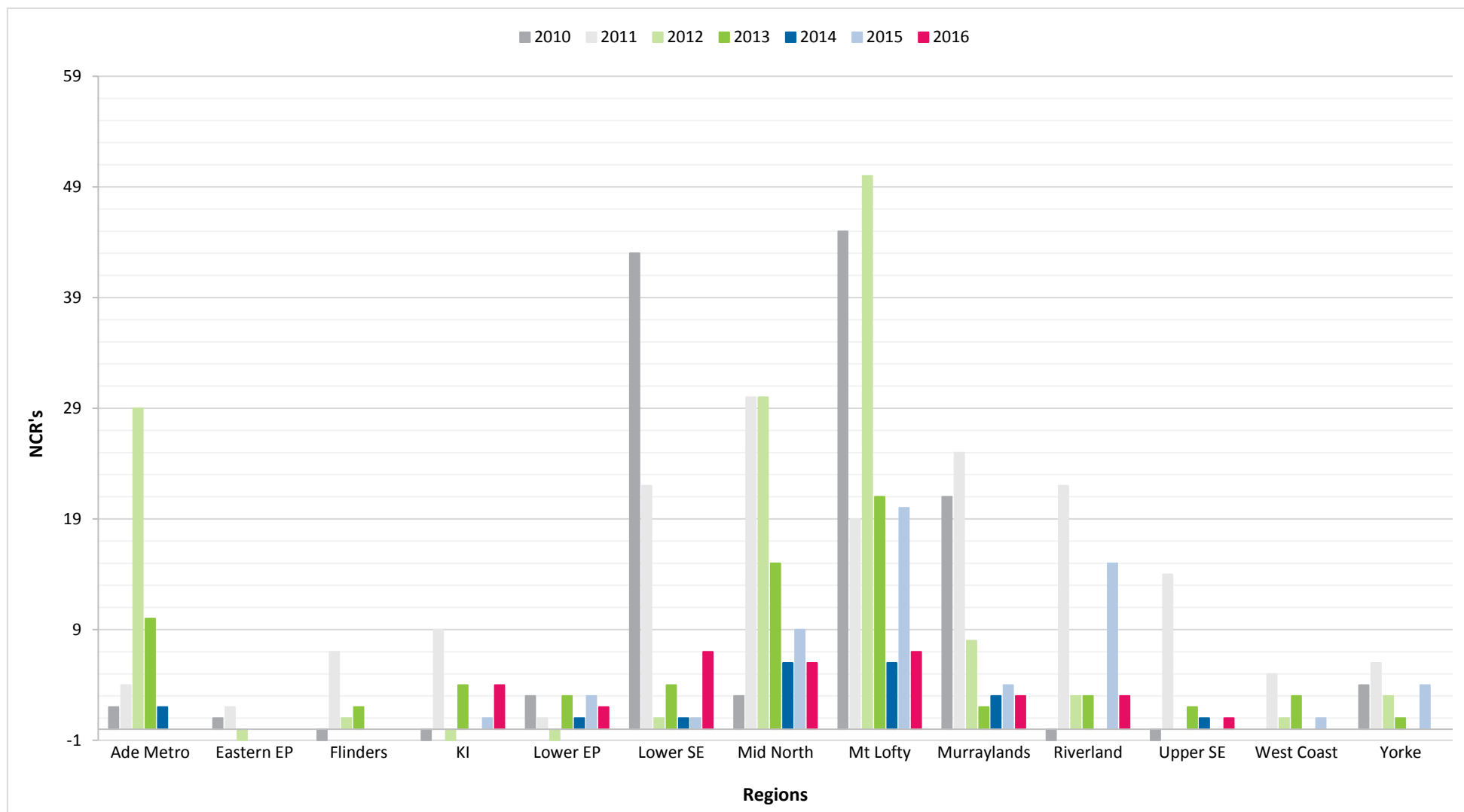
Figure 7   Annual NCR Summary across 13 Fire Danger Regions (2010 – 2016) (including Drive-By's)[a,b]

[a] Values shown as "-1" indicate Regions that were not audited in the relevant year

[b] "Ade Metro" = Adelaide Metro; "Eastern/Lower EP" = Eastern/Lower Eyre Peninsula; "KI" = Kangaroo Island; "Lower/Upper SE" = Lower/Upper South East
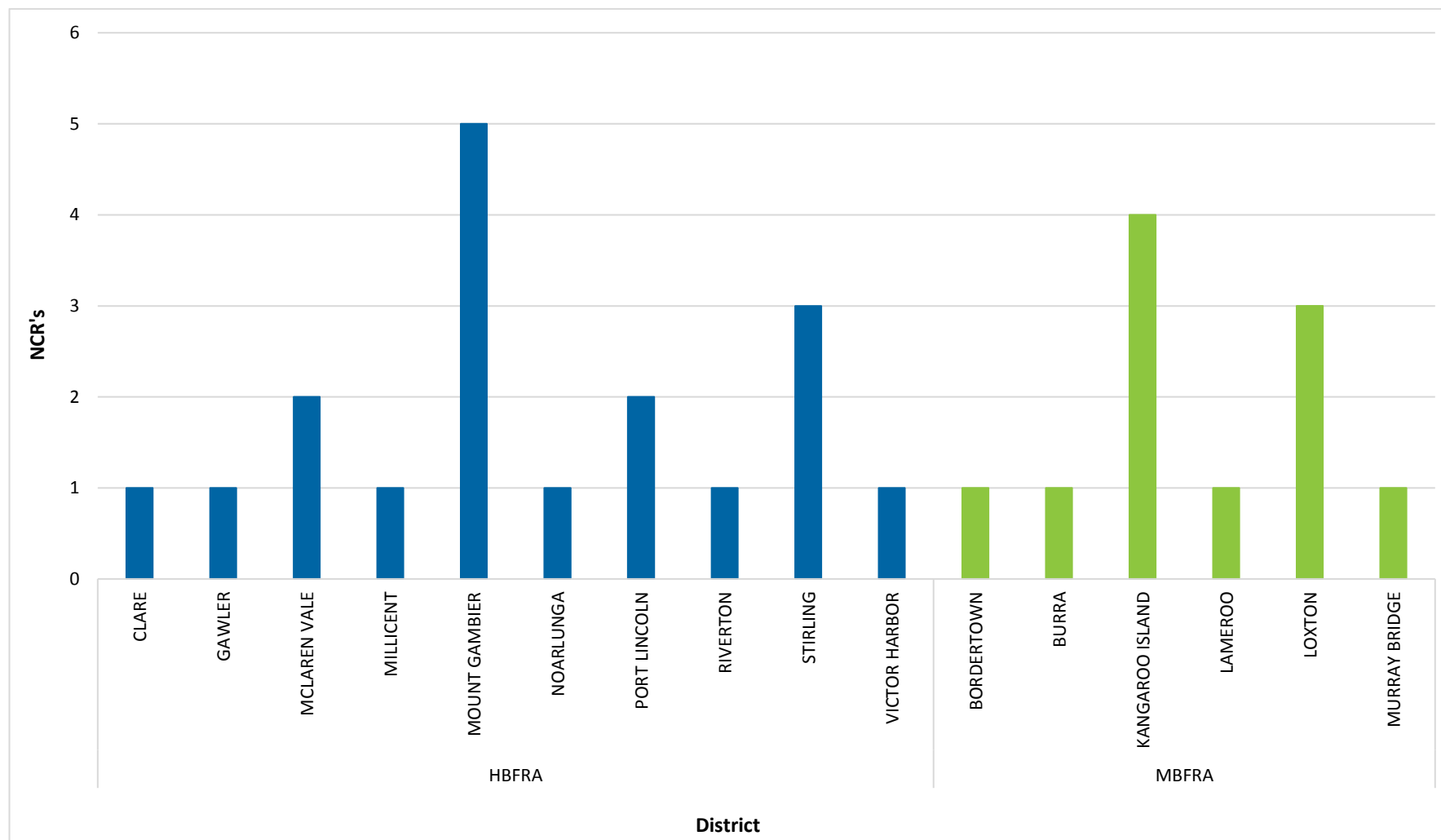
Figure 8   Audit-Site Infringements across HBFRA/MBFRA Districts for 2016 (excluding Drive-By's)

6.2 Bushfire Areas – HBFRA / MBFRA

6.2.1 NCR's excluding Drive-By's

Across the SA Power Networks designated HBFRA's and MBFRA's, the site NCR split was:

- HBFRA
  - 2016 – 62%
  - 2015 – 43%
- MBFRA
  - 2016 – 38%
  - 2015 – 57%

The NCR's/Span in the HBFRA is 0.9% compared to the MBFRA of 0.3%. Table 8 and Figure 9 present the comparable results for 2012-2016.

Table 8 Annual Infringement Summary by Bushfire Risk Area 2013 – 2016 (excluding Drive-By's)

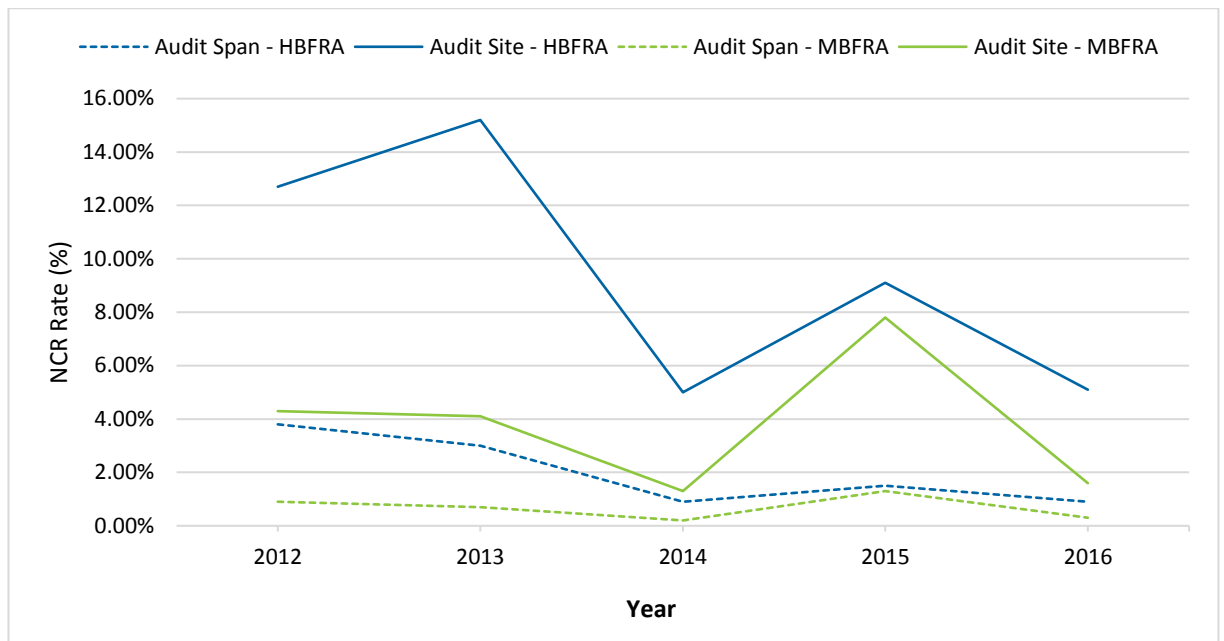| Risk Area	Audit Sites	Site NCR	Site NCR Rate	No. of Spans	Span NCR	Span NCR Rate
2016						
HBFRA	333	17	5.4%	1957	18	0.9%
MBFRA	613	10	1.8%	3672	11	0.3%
TOTAL	**946**	**27**	**2.9%**	**5629**	**29**	**0.5%**
2015						
HBFRA	219	20	9.1%	1300	20	1.5%
MBFRA	335	26	7.8%	1962	26	1.3%
TOTAL	**554**	**46**	**8.3%**	**3262**	**46**	**1.4%**
2014						
HBFRA	240	12	5.0%	1395	13	0.9%
MBFRA	392	5	1.3%	2332	5	0.2%
TOTAL	**632**	**17**	**2.7%**	**3727**	**18**	**0.5%**
2013						
HBFRA	243	37	15.2%	1444	43	3.0%
MBFRA	320	13	4.1%	1916	14	0.7%
TOTAL	**563**	**49**	**8.9%**	**3360**	**57**	**1.7%**
2012						
HBFRA	260	33	12.7%	1377	52	3.8%
MBFRA	209	9	4.3%	1162	10	0.9%
TOTAL	**469**	**42**	**9.0%**	**2539**	**62**	**2.4%**

Figure 9   Audit Span and Audit Site MBFRA / HBFRA Trend Chart – 2012 to 2016 (excluding Drive-By's)

6.2.2   Drive-By NCR's

Drive-By's have necessarily been excluded from the core analysis of the audit results as they cannot be consistently replicated across audit years, leading to potentially invalid comparisons and conclusions. They can however be used to provide additional context to the effectiveness of the clearance programs.

A summary of Drive-By recordings from 2014-2016 are presented in Table 9.

Table 9   Drive By NCR's 2014 - 2016

Measure	2014	2015	2016
Total	2	12	4
CZ Infringements	2	9	2
Bend & Grows	0	3	2
HBFRA	1	7	2
BFRA	1	5	2
High Voltage	0	4	3
Low Voltage	2	8	1

Given the ad-hoc nature of Drive-By's, most NCR recordings will reflect vegetation that is very clearly breaching (or close to breaching) the clearance zone. Thus, a higher number of Drive-By's generally indicates inadequate vegetation clearance – as was the case in 2015. Conversely, the smaller number of Drive-By's in 2014 and 2016 is broadly suggestive of a more effective cutting program.

6.3   District & Feeder Specific Results

A summary of infringement rates for Districts and Feeders is presented in Table 10 and Table 11, respectively. There were nine Districts with multiple (greater than one) NCR's recorded, including Drive-By's, with the District of Stirling (HBFRA) recording the highest infringement rate.

A comparison of overall change in infringement rate from 2015 through 2016 is displayed in Figure 10, with positive y-values representing a decrease in infringement rate (improvement in vegetation clearance) and negative y-values representing an increase in infringement rate. It should be noted that this Figure is not representative of all Districts' performance for 2015-2016, but focuses solely on the Districts presented in Table 8 below, to provide an indication of relative performance (and change in performance) between 2015-16.

Table 10   Districts – Highest Infringement Rates (Includes Drive-By's)

| District	Risk Area	Audited Spans	Total NCR's	NCR's / Spans
Districts with multiple NCR sites				
Stirling	HBFRA	84	3	3.57%
Mount Gambier	HBFRA	150	5	3.33%
Kangaroo Island	MBFRA	120	4	3.33%
Loxton	MBFRA	119	3	2.52%
Millicent	HBFRA	121	2	1.65%
Riverton	HBFRA	122	2	1.64%
Gawler	HBFRA	129	2	1.55%
McLaren Vale	HBFRA	133	2	1.50%
Port Lincoln	HBFRA	173	2	1.16%
Districts with single NCR sites				
Burra	MBFRA	91	1	1.10%
Victor Harbor	HBFRA	108	1	0.93%
Mannum	MBFRA	109	1	0.92%
Murray Bridge	MBFRA	114	1	0.88%
Clare	HBFRA	150	1	0.67%
Noarlunga	HBFRA	149	1	0.67%
Bordertown	MBFRA	150	1	0.67%
Lameroo	MBFRA	180	1	0.60%
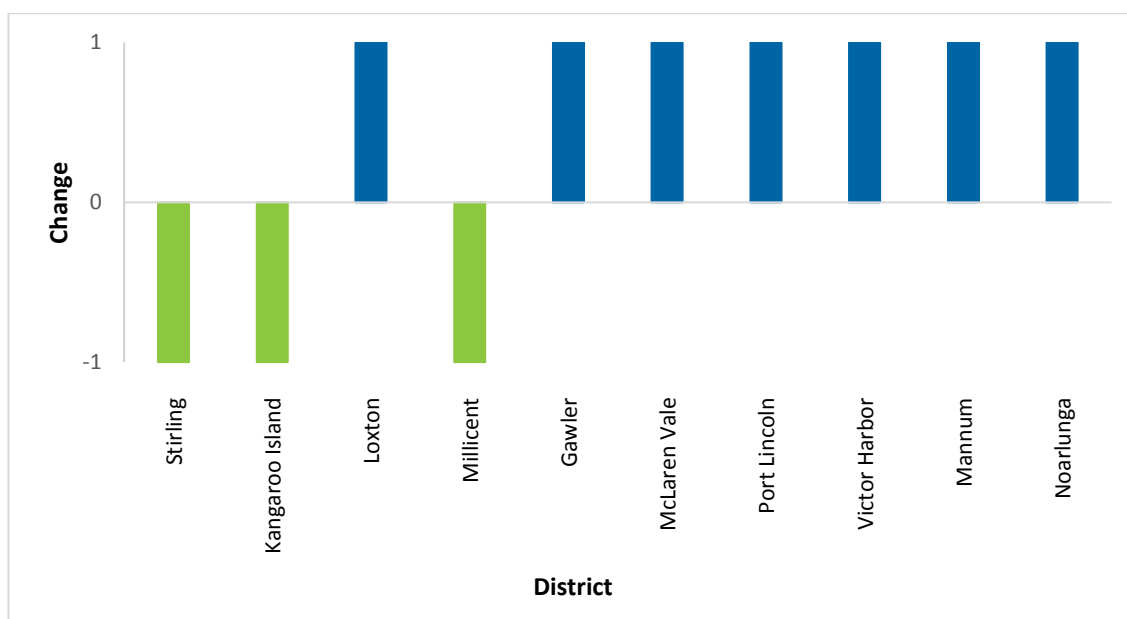
Figure 10 Overall Change in Infringement Rates across 10 Districts for 2016/2016[a,b]

[a] "1" denotes a decrease in infringement rate for 2016

[b] "-1" denotes an increase in infringement rate for 2016

Multiple NCR's were recorded on six Feeders, listed in Table 11 below.

Table 11 Feeders with Multiple NCR's (Includes Drive-By's)

Feeder	Feeder Names	District	Risk Area	Total NCR's in Feeder
MG05	Compton 11kV	Mount Gambier	HBFRA	4
SG14	Upper Sturt 11 kV	Stirling		3
PL14	Shields 11 kV	Port Lincoln		2
R18	Rhynie 11 kV	Riverton		2
KI54	Newlands 19 kV	Kangaroo Island	MBFRA	4
LX34	Gurra 11 kV	Loxton		3

6.3.1 NCR Observations

The Lower South-East Region

The Lower South East Region recorded one of the highest infringement rates throughout the 13 Regions of South Australia in 2016 (see Figure 7), and has the highest number of NCR's recorded for the Region since 2011. In 2016 most infringements recorded were on the Compton Feeder in Mount Gambier District with a total of four NCR's logged on this Feeder.

Millicent District also recorded a higher infringement rate than in 2015 (see Figure 10).

The Mount Lofty Region

A total of seven NCR's (including Drive-By's) were logged for the Mount Lofty region, with three of the NCR's identified in the Stirling District. While Stirling was noted for its good performance in 2015 (with only one NCR logged), it recorded the highest infringement rate (NCR's / Spans) of all the Districts in 2016 (see Table 10). The area is densely vegetated, and as noted elsewhere (PFDS Report 2015), maintaining clearances has been problematic historically due to high levels of rainfall and presence of fast-growing species. The above average rainfall in 2016 likely contributed to accelerated growth of these species.

Kangaroo Island

The KI54 Newlands Feeder (19 kV) in Kangaroo Island recorded a total of four NCR's – which is concerning given the high voltage 19 kV powerline poses a great risk during fire danger season. The NCR's seem to be localised around this Feeder, with no NCR's recorded for the other two Feeders audited.

6.3.2   Observations of Good Performance

Noarlunga

From 2015 to 2016, the infringement rate has dropped from 6.04% (PFDS Report 2015) to 0.67%, a marked improvement in clearance efficiency.

6.4   Additional Observations

Vegetation Species

Species information for each NCR (including Drive-By's) was captured and is reproduced in Table 12 below. Figure 11 shows the distribution of species according to NCR classification (CZ Infringements and Bend & Grows).

Overall, Gum trees feature as the highest NCR category – for both CZ Infringements and Bend/Grows (53% and 56%, respectively). It should however be noted that Gum trees are the dominant species in most of the Districts – thus the likelihood of identifying an NCR associated with a Gum tree is greater.

Pine trees also occurred frequently as non-compliances (CZ Infringements: 30%; Bend/Grow: 23%), with most issues associated to side clearances adjacent powerlines. Ash trees and Japanese Maples were the dominant species in townships and non-compliances were most often associated with Low Voltage powerlines.

Table 12   Species of Vegetation for NCR's (including Drive-By's)

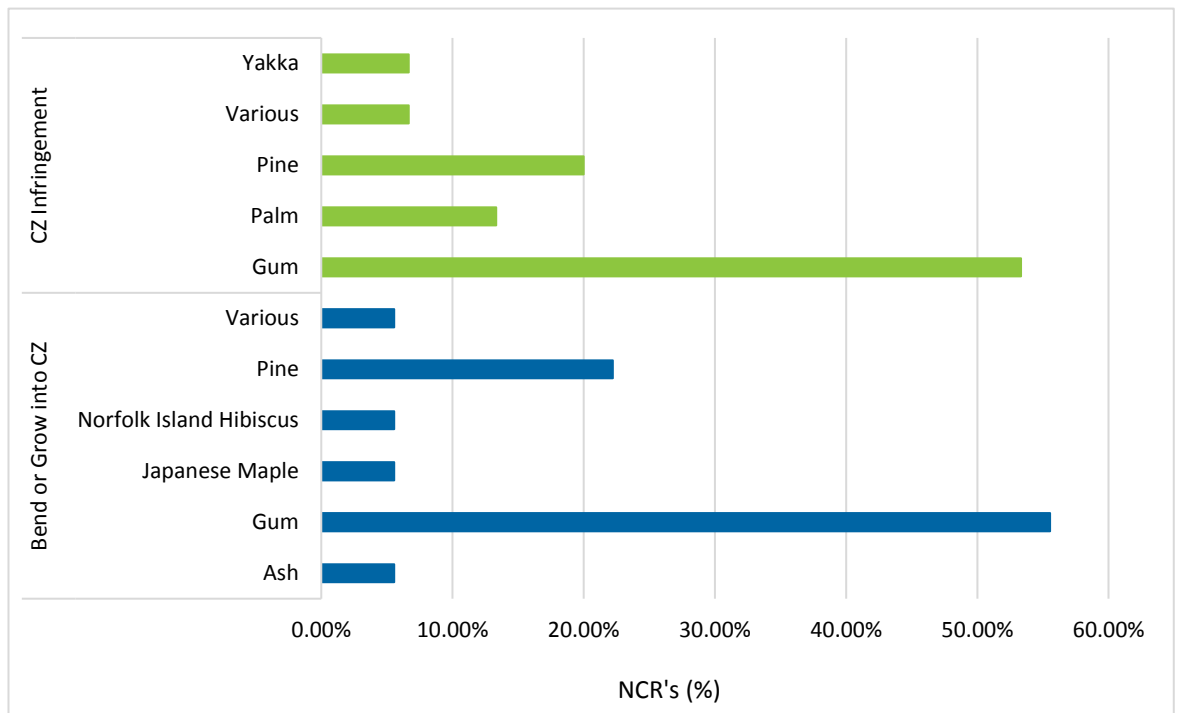| Species	NCR's #	NCR %
Gum	18	54.5%
Pine	7	21.2%
Various / Unknown Species	2	6.1%
Palm	2	6.1%
Ash	1	3%
Japanese Maple	1	3%
Norfolk Island Hibiscus	1	3%
Yukka	1	3%
TOTAL	**33**	**100%**

Figure 11 Species Distribution across NCR Categories (including Drive-By's)

7. Reporting Qualifications

- From the Audit Summary Table at Appendix B it has been calculated that approximately 10% of the total spans on audited Feeders (approximately 55,794) were audited – this only includes those spans assessed as part of the selected audit site (i.e. it excludes the Drive-By NCR's observed in adjacent Feeders).

- Whilst the sites subject to the audit are selected at random, they are generally selected across the whole Feeder. By default, this results in a greater proportion of the Feeder being assessed through the Drive-By observations.

- The 412,836 of total spans (HBFRA & MBFRA) has been provided by SA Power Networks and is confirmed as the Total Spans Scoped in the ATS data provided.

8. Conclusions & Recommendations

Overall, vegetation compliance in 2016 shows a marked improvement compared to previous years (excepting 2014), with an overall downward trend in logged NCR's across the 13 South Australian Regions.

Although the infringement rate was significantly reduced in 2016, there is still scope for continued improvement – in context, this year's span non-conformance rate (approximately 0.5%) indicates that BFRA's in the network comprising 412,836 spans may have 2127 NCR's that are yet to be identified.

The Stirling and Mount Gambier Districts, particularly, were noted for poor performance in the 2016 Pre-FDS audit – and as these Districts are both classified as HBFRA's, the risk of fire is significant. It is also acknowledged that these are densely populated areas where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies could potentially be investigated. For example, this may include a change to when the Feeders are scoped and/or cut or the frequency of cutting. Alternatively, vegetation removal or reconstruction options could be assessed.

Similarly, feeders with a high number of NCR's identified (greater than three NCR's) also pose an increased risk of fire. In 2016, more than three NCR's were identified on the MG05 Compton (11 kV), and KI54 Newlands (19 kV) Feeders. Going forward, it is recommended that these Feeders be re-scoped and where necessary, cut, to ensure compliance. These Feeders, as well as the SG14 Upper Sturt (11 kV) Feeder (which recorded the highest infringement rate in 2016), should also be included for auditing once again in 2017.

It is noted that a greater proportion of the NCR's identified in this audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone. This indicates that the vegetation program efficiency is improving, and that it is possible that the above-average rainfall may have contributed to accelerated growth rates for some species.

To this end, appropriate application of vegetation indices to remotely sensed imagery might be used to monitor vegetation growth and vigour. The NDVI (Normalised Difference Vegetation Index) has been shown to be particularly useful for monitoring vegetation (Huete et al., 2002) - and with the application of change detection imagery (Johansen et al., 2010), it would be possible to document changes in consecutive imagery (of the relevant Districts/Feeders). This method would serve the purpose of assessing localised tree growth and vigour, especially after excessive rainfall events, and would therefore prove invaluable in tailoring site visits and informing scoping and cutting schedules.

The Electricity Act 1996 stipulates that any electricity entity must 'take reasonable steps' to ensure that vegetation of all kinds is kept clear of public powerlines, and that naturally occurring vegetation is kept clear of private powerlines (Electricity Act 1996). While full compliance has not been achieved in 2016, SA Power Networks has ensured that the vegetation clearance program was completed on schedule, with non-conformance rates trending lower than in previous years (excepting 2014). It is therefore GHD's opinion that SA Power Networks has undertaken necessary measures (reasonable steps) to ensure that vegetation is clear of powerlines.

A summary of observations and recommendations are provided in Table 13 for consideration and potential implementation into the 2017 Cyclic and Pre Fire Danger Season.

Table 13　Observations and Recommendations – 2016

Observation	Recommendation	2016 Ref.	Priority[a]
Improved performance over a six-year period for the vegetation clearance program.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (i)	2
Engaging ATS as the primary vegetation contractor is coincident with improved vegetation clearance performance – likely attributed to their comprehensive knowledge and experience, which provides consistency of performance.	Discuss with vegetation contactor (ATS) ways in which vegetation clearance and overall compliance can be improved for 2017.	R1 (ii)	2
Scoping and cutting data (on a span-by-span basis) was not made available to the GHD team – limiting the team's ability to assess the cause of non-compliances.	It is understood that SA Power Networks has access to this information which is provided by the incumbent contractor. It would be beneficial to negotiate the supply of this scoping and cutting data to the GHD team for future audits.	R2	2
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SA Power Networks GIS platform as required.	R3	2
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA, particularly where some of these districts have a high proportion of non-vegetated spans.	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results	R4	2
Feeders with a high number of NCR's (greater than 3) represent an increased risk of fire occurrence.	Re-scope those Feeders that had greater than 3 site non-conformances: • MG05 Compton (11 kV) • KI54 Newlands (19 kV) • SG14 Upper Sturt (11 kV)[a] [a] While SG14 Upper Sturt wasn't recorded as having >3 NCR's, it was the Feeder with the highest infringement rate and on this basis, should be included in any intended re-scoping.	R5	1

Observation	Recommendation	2016 Ref.	Priority[a]
It is noted that a greater proportion of the NCR's identified in this audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone – potentially due to. above-average rainfall accelerating growth rates for some species.	Appropriate application of vegetation indices to remotely sensed imagery might be used to monitor vegetation growth and vigour. The NDVI (Normalised Difference Vegetation Index) has been shown to be particularly useful for monitoring vegetation (Huete et al., 2002) - and with the application of change detection imagery (Johansen et al., 2010), it would be possible to document changes in consecutive imagery (of the relevant Districts/Feeders). This method would serve the purpose of assessing localised tree growth and vigour, especially after excessive rainfall events, and would therefore prove invaluable in tailoring site visits and informing scoping and cutting schedules	R6	3
A number of private landowners planting inappropriate vegetation below powerlines (e.g. fast-growing Eucalyptus trees).	Ensure that all private landowners (particularly those in remote regions) are educated (by way of distribution of leaflets/brochures) with regards to appropriate vegetation for planting near powerlines.	R7	3

[a] Priority Categories:

     1 - Priority

     2 - Strategic Improvement

     3 - Opportunity for Improvement

An updated copy of the 2015 Observations and Recommendations has been included in Table 14 to reflect actions taken.

Table 14 Observations and Recommendations – 2015 with 2016 SA Power Networks Comments

Observation	Recommendation	2015 Ref.	2016 SA Power Networks Comments
Current Vegetation Management practices and a consistent approach has improved performance over the 5 years prior to 2015, with a drop off in performance in 2015.	Assess with contractor why there was a drop off in performance for 2015 and identify strategies for improving performance.	R1 (i)	A key reason for the drop in performance was the high number of NCRs identified in ETS cutting areas. SA Power Networks has since engaged ATS as the sole vegetation clearance contractor. Further to this, a number of strategic initiatives were progressed during 2016 which will improve our vegetation management over the long term. Further initiatives to be implemented in 2017.
Continuing to reduce the non-compliance rate will require alternate / additional strategies and technologies to be considered, trialled and implemented.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (ii)	Further more detailed review of clearance program to be undertaken during 2017 with contractor.
There were 8 NCR's identified on 4 Feeders that were subject to a Pre FDS Patrol. The intent of the Pre FDS Patrols are to identify and cut those (few) spans that have had unexpected regrowth since the cyclic cut.	Continue to assess the timing for both the cyclic and pre FDS scoping and cutting as both are critical to the effectiveness of the programs.	R1 (iii)	
NL21 NCRs were the result of the incorrect updating of GIS (feeder not scoped as GIS showed it as being underground).	Assess reason why the record management processes failed in this instance and develop tactics to update processes to ensure this does not occur again in the future .	R1 (iv)	Development of the Unique Identifier to eliminate this issue.

Observation	Recommendation	2015 Ref.	2016 SA Power Networks Comments
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA. Audit results have been improving for the 5 years before 2015, with a drop off in performance in 2015. The greatest level of NCR's occur on HBFRA Feeders which are the higher risk areas. The overall 6-year trend is still that of improvement; however there would still appear to be opportunities for improvement to further reduce the levels of non-compliance, supporting that alternate audit methodologies be considered for a more mature network	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results.	R2	Further more detailed review of clearance program to be undertaken during 2017 with contractor.
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCR's could be mapped on the SA Power Networks GIS platform as required.	R3	Data analysis undertaken to understand 'hot spots' and problem feeders. Further work with contractor required during 2017.

Observation	Recommendation	2015 Ref.	2016 SA Power Networks Comments
GHD as the auditors are currently not required to review and report on what action SA Power Networks has taken on the previous year's recommendations. This potentially leaves a gap in SA Power Networks continual improvement drive.	Increase scope in future audits to incorporate a review of previous recommendations and report on implementation or otherwise.	R4	ATS provide all scoping and cutting data to SA Power Networks.
GHD are aware of the use of land based LiDAR by other SA Power Networks departments and also of the trialling of airborne LiDAR in 2015 SA Power Networks have advised that the use of LiDAR or alternative technologies will continue to be assessed as a tool to manage vegetation near powerlines. We support this objective and recommend ongoing improvement analysis, including the potential to use existing vehicle based LiDAR trials by using SAPN equipment at the same time as the Pre FDS audits. The objective being to identify if audit procedures can be improved (quality timeliness extent) using new technology	Assess / Review opportunities to implement aerial and vehicle based LiDAR trials for future vegetation clearance audits.	R5	A LiDAR trial was undertaken during 2015 with respect to vegetation management, and the use of LiDAR or alternative technology will continue to be assessed as a tool to manage vegetation near powerlines.

9.   References

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Appendices

Appendix A – Feeders Audited

SA Power Networks | Pre-Fire Danger Season Vegetation Audits | 2016

Districts/Feeders Audited

Region	District	Feeder	Feeder Name	Fire Risk Rating
Adelaide Metropolitan	Elizabeth-Salisbury	EL11	Uley Rd 11kV	HBFRA
	Elizabeth-Salisbury	EL12	One Tree Hill 11kV	HBFRA
	Holden Hill	HH145A	Banksia Park 11kV	HBFRA
	Holden Hill	HH409D	Rostrevor 11kV	HBFRA
	Saint Marys	SM349C	Darlington 11kV	MBFRA/HBFRA
	Saint Marys	SM349D	Seaview Downs 11kV	MBFRA
Eastern Eyre Peninsula	Cleve	CV08	Kimba 11kV	MBFRA
	Cleve	CV23	Mitchellville 19kV	MBFRA
Flinders	Gladstone	G10	Willowie 19kV	MBFRA
	Gladstone	G17	Orroroo 11kV	MBFRA
	Hawker	HK04	Warcowie 19kV	MBFRA
	Hawker	HK05	Cradock 19kV	MBFRA
	Port Augusta	PA12	Wilmington North 11kV	MBFRA
	Port Augusta	PA22	Quorn North 19kV	MBFRA
Kangaroo Island	Kangaroo Island	KI14	Baudin Beach 19kV	MBFRA/HBFRA
	Kangaroo Island	KI44	Menzies 19kV	MBFRA
	Kangaroo Island	KI54	Newlands 19kV	MBFRA
Lower Eyre Peninsula	Cummins	CM02	Yeelanna 11kV	MBFRA
	Cummins	CM18	Butler Dixson 19kV	MBFRA
	Cummins	CM25	Coulta 19kV	MBFRA
	Cummins	CM27	Yallunda Flat 19kV	MBFRA
	Cummins	CM35	Tumby Bay 33kV	MBFRA
	Port Lincoln	PL07	North 11kV	MBFRA
	Port Lincoln	PL11	Little Swamp 11kV	MBFRA/HBFRA
	Port Lincoln	PL14	Shields 11kV	MBFRA/HBFRA
	Port Lincoln	PL25	Greenpatch 19kV	MBFRA/HBFRA
	Port Lincoln	PL33	Uley 33kV	MBFRA/HBFRA
Lower South East	Millicent	MI01	Millicent 11kV	HBFRA
	Millicent	MI08	Robe 7.6kV	HBFRA
	Millicent	MI32	Millicent East 11kV	HBFRA
	Mount Gambier	MG04	Glenburnie 11kV	HBFRA
	Mount Gambier	MG05	Compton 11kV	HBFRA
	Naracoorte	NA02	McIntosh 11kV	HBFRA
	Naracoorte	NA12	Padthaway 11kV	MBFRA/HBFRA
Mid North	Burra	BU01	Burra 11kV	MBFRA
	Burra	BU05	Hanson 19kV	MBFRA
	Clare	CL04	North Clare 11kV	MBFRA/HBFRA
	Clare	CL09	Watervale 11kV	MBFRA/HBFRA
	Gawler	GA03	Mount Crawford 11kV	HBFRA
	Gawler	GA08	Williamstown 11kV	HBFRA
	Gawler	GA26	Evanston 11kV	HBFRA
	Gawler	GA53	Evanston South 11kV	HBFRA
	Nuriootpa	NU06	Kapunda South 11kV	MBFRA/HBFRA
	Nuriootpa	NU13	Seppeltsfield 11kV	HBFRA
	Port Pirie	PP08	Port Germein 11kV	MBFRA/HBFRA
	Port Pirie	PP15	South Bungama 19kV	MBFRA
	Riverton	R18	Rhynie 11kV	MBFRA
	Riverton	R21	Hamley Bridge 11kV	MBFRA/HBFRA
Mt Lofty	Gumeracha	GU17	Inglewood 7.6kV	HBFRA
	Gumeracha	GU31	Birdwood 11kV	HBFRA
	McLaren Vale	MV52	Willunga 11kV	HBFRA
	McLaren Vale	MV62	Sellicks Beach 11kV	MBFRA/HBFRA
	Mount Barker	MTB13	Bugle Ranges 11kV	HBFRA
	Mount Barker	MTB62	Littlehampton 11kV	HBFRA
	Noarlunga	NL21	Clarendon North 11kV	HBFRA
	Noarlunga	NL760B	Hackham East 11kV	HBFRA
	Stirling	SG14	Upper Sturt 11kV	HBFRA
	Victor Harbor	VH14	Hindmarsh Valley 11kV	HBFRA
	Victor Harbor	VH15	Urimbirra 11kV	HBFRA
	Victor Harbor	VH43	Pambula 11kV	HBFRA
Murraylands	Lameroo	LM41	Lameroo 11kV	MBFRA
	Lameroo	LM51	Lameroo 19kV	MBFRA
	Mannum	M13	Mannum South 7.6kV	MBFRA
	Mannum	M51	Swan Reach 11kV	MBFRA
	Mannum	M61	Punyelroo 11kV	MBFRA
	Murray Bridge	MB01	Moorlands 19kV	MBFRA
	Murray Bridge	MB32	Sunnyside 11kV	MBFRA
	Murray Bridge	MB62	Tailem Bend West 11kV	MBFRA
	Strathalbyn	ST11	Strathalbyn West 11kV	MBFRA/HBFRA
	Strathalbyn	ST12	Strathalbyn East 11kV	MBFRA/HBFRA
Riverland	Barmera	BM12	Moorook 11kV	MBFRA
	Barmera	BM15	Cobdogla 11kV	MBFRA
	Barmera	BM44	Berri West 11kV	MBFRA
	Loxton	LX34	Gurra 11kV	MBFRA
	Loxton	LX76	Wanbi North 19kV	MBFRA
	Waikerie	WK61	Morgan 11kV	MBFRA
	Waikerie	WK71	Haylands 11kV	MBFRA
Upper South-East	Bordertown	BT06	Keith 11kV	MBFRA
	Bordertown	BT15	Parsons 11kV	MBFRA/HBFRA
	Coonalpyn	CN33	Pelican Point 11kV	MBFRA
	Coonalpyn	CN81	Coonalpyn 11kV	MBFRA
West Coast	Ceduna	CD03	Kongwirra 11kV	MBFRA
	Ceduna	CD17	Goode 19kV	MBFRA
	Streaky Bay	SB01	Streaky Bay 11kV	MBFRA
	Streaky Bay	SB15	Haslam 19kV	MBFRA
	Streaky Bay	SB16	Chandada West 19kV	MBFRA
	Wudinna	W01	Warramboo 11kV	MBFRA
	Wudinna	W16	Warramboo 19kV	MBFRA
Yorke	Kadina	KA03	Moonta 11kV	MBFRA
	Kadina	KA06	Kadina 11kV	MBFRA
	Kadina	KA14	Nalyappa 19kV	MBFRA
	Maitland	MT06	Ardrossan 11kV	MBFRA
	Maitland	MT07	South Kilkerran 11kV	MBFRA
	Maitland	MT08	Pt Vincent 11kV	MBFRA
	Maitland	MT22	Maitland 11kV	MBFRA
	Yorketown	YK03	Edithburgh 11kV	MBFRA
	Yorketown	YK07	Minlaton 11kV	MBFRA

Appendix B – Audit Results – Summary Table

SA Power Networks | Pre-Fire Danger Season Vegetation Audits | 2016
Audit Results Summary Table

Feeder	Feeder Name	Region	District	Risk Area	Sites Audited (inc DB's)	Spans Audited (ex DB's)	DB Spans Audited	Total Spans Audited	Audit Sites CZ	Audit Sites Bend & Grow	Total Site NCRs	Drive By's CZ	Drive By's Bend & Grow	Total DB NCRs	Total NCR's (Audit Site + DB's)	Infringements per site audited (ex DB) (%)	Infringements per Span Audited (%) (ex DB)	Infringements per Span Audited (%) (inc DB)
BM12	Moorook 11kv	Riverland	Barmera	MBFRA	15	91		91							0	0	0.0	0.0
BM15	Cobdogla 11kv	Riverland	Barmera	MBFRA	5	30		30							0	0	0.0	0.0
BM44	Berri West 11kv	Riverland	Barmera	MBFRA	5	30		30							0	0	0.0	0.0
BT06	Keith 11kv	Upper SE	Bordertown	MBFRA	15	90		90		1	1				1	6.7	1.1	1.1
BT15	Parsons 11kv	Upper SE	Bordertown	HBFRA/MBFRA	10	60		60							0	0	0.0	0.0
BU01	Burra 11kv	Mid North	Burra	MBFRA	5	30		30							0	0	0.0	0.0
BU05	Hanson 19kv	Mid North	Burra	MBFRA	10	61		61	1		1				1	10	1.6	1.6
CD03	Kongwirra 11kv	West Coast	Ceduna	MBFRA	15	90		90							0	0	0.0	0.0
CD17	Goode 19kv	West Coast	Ceduna	MBFRA	15	90		90							0	0	0.0	0.0
CL04	North Clare 11kv	Mid North	Clare	HBFRA/MBFRA	10	60		60		1	1				1	10	1.7	1.7
CL09	Watervale 11kv	Mid North	Clare	HBFRA/MBFRA	16	90		90							0	0	0.0	0.0
CM02	Yeelanna 11kv	Lower Eyre Peninsula	Cummins	MBFRA	5	30		30							0	0	0.0	0.0
CM18	Butler Dixson 19kv	Lower Eyre Peninsula	Cummins	MBFRA	5	30		30							0	0	0.0	0.0
CM25	Coulta 19kv	Lower Eyre Peninsula	Cummins	MBFRA	5	30		30							0	0	0.0	0.0
CM27	Yallunda Flat 19kv	Lower Eyre Peninsula	Cummins	MBFRA	5	30		30							0	0	0.0	0.0
CM35	Tumby Bay 33kv	Lower Eyre Peninsula	Cummins	MBFRA	5	30		30							0	0	0.0	0.0
CN33	Pelican Point 11kv	Upper SE	Coonalpyn	MBFRA	15	90		90							0	0	0.0	0.0
CN81	Coonalpyn 11kv	Upper SE	Coonalpyn	MBFRA	15	90		90							0	0	0.0	0.0
CV08	Kimba 11kv	Eastern Eyre Peninsula	Cleve	MBFRA	15	90		90							0	0	0.0	0.0
CV23	Mitchellville 19kv	Eastern Eyre Peninsula	Cleve	MBFRA	15	90		90							0	0	0.0	0.0
EL11	Uley Rd 11kv	Adelaide Metropolitan	Elizabeth-Salisbury	HBFRA	5	30		30							0	0	0.0	0.0
EL12	One Tree Hill 11kv	Adelaide Metropolitan	Elizabeth-Salisbury	HBFRA	10	58		58							0	0	0.0	0.0
G10	Willowie 19kv	Flinders	Gladstone	MBFRA	15	90		90							0	0	0.0	0.0
G17	Orroroo 11kv	Flinders	Gladstone	MBFRA	14	84		84							0	0	0.0	0.0
GA03	Mount Crawford 11kv	Mid North	Gawler	HBFRA	1	0	1	1				1		1	1	0	0.0	100.0
GA08	Williamstown 11kv	Mid North	Gawler	HBFRA	10	59		59		1	1				1	10	1.7	1.7
GA26	Evanston 11kv	Mid North	Gawler	HBFRA	1	6		6							0	0	0.0	0.0
GA53	Evanston South 11kv	Mid North	Gawler	HBFRA	11	63		63							0	0	0.0	0.0
GU17	Inglewood 7.6kv	Mt Lofty	Gumeracha	HBFRA	5	31		31							0	0	0.0	0.0
GU31	Birdwood 11kv	Mt Lofty	Gumeracha	HBFRA	15	88		88							0	0	0.0	0.0
HH145A	Banksia Park 11kv	Adelaide Metropolitan	Holden Hill	HBFRA	14	74		74							0	0	0.0	0.0
HH409D	Rostrevor 11kv	Adelaide Metropolitan	Holden Hill	HBFRA	9	47		47							0	0	0.0	0.0
HK04	Warcowie 19kv	Flinders	Hawker	MBFRA	10	60		60							0	0	0.0	0.0
HK05	Cradock 19kv	Flinders	Hawker	MBFRA	14	84		84							0	0	0.0	0.0
KA03	Moonta 11kv	Yorke	Kadina	MBFRA	15	90		90							0	0	0.0	0.0
KA06	Kadina 11kv	Yorke	Kadina	MBFRA	9	54		54							0	0	0.0	0.0
KA14	Nalyappa 19kv	Yorke	Kadina	MBFRA	6	36		36							0	0	0.0	0.0
KI14	Baudin Beach 19kv	Kangaroo Island	Kangaroo Island	HBFRA/MBFRA	5	30		30							0	0	0.0	0.0
KI44	Menzies 19kv	Kangaroo Island	Kangaroo Island	MBFRA	5	30		30							0	0	0.0	0.0
KI54	Newlands 19kv	Kangaroo Island	Kangaroo Island	MBFRA	10	60		60	3	1	4				4	40	6.7	6.7
LM41	Lameroo 11kv	Murraylands	Lameroo	MBFRA	14	84		84	1		1				1	7.1	1.2	1.2
LM51	Lameroo 19kv	Murraylands	Lameroo	MBFRA	16	96		96							0	0	0.0	0.0
LX34	Gurra 11kv	Riverland	Loxton	MBFRA	15	89		89	2	1	3				3	20	3.4	3.4
LX76	Wanbi North 19kv	Riverland	Loxton	MBFRA	5	30		30							0	0	0.0	0.0
M13	Mannum South 7.6kv	Murraylands	Mannum	MBFRA	6	36		36							0	0	0.0	0.0
M51	Swan Reach 11kv	Murraylands	Mannum	MBFRA	7	42		42							0	0	0.0	0.0
M61	Punyelroo 11kv	Murraylands	Mannum	MBFRA	6	30	1	31					1	1	1	0	0.0	3.2
MB01	Moorlands 19kv	Murraylands	Murray Bridge	MBFRA	5	30		30							0	0	0.0	0.0
MB32	Sunnyside 11kv	Murraylands	Murray Bridge	MBFRA	4	24		24							0	0	0.0	0.0
MB62	Tailem Bend West 11kv	Murraylands	Murray Bridge	MBFRA	10	60		60		1	1				1	10	1.7	1.7
MG04	Glenburnie 11kv	Lower SE	Mount Gambier	HBFRA	15	90		90		1	1				1	6.7	1.1	1.1
MG05	Compton 11kv	Lower SE	Mount Gambier	HBFRA	10	60		60	2	2	4				4	40	6.7	6.7
MI01	Millicent 11kv	Lower SE	Millicent	HBFRA	5	30		30							0	0	0.0	0.0
MI08	Robe 7.6kv	Lower SE	Millicent	HBFRA	5	30		30	1		1				1	20	3.3	3.3
MI32	Millicent East 11kv	Lower SE	Millicent	HBFRA	11	60	1	61				1		1	1	0	0.0	1.6
MT06	Ardrossan 11kv	Yorke	Maitland	MBFRA	5	30		30							0	0	0.0	0.0
MT07	South Kilkerran 11kv	Yorke	Maitland	MBFRA	12	72		72							0	0	0.0	0.0
MT08	Pt Vincent 11kv	Yorke	Maitland	MBFRA	3	18		18							0	0	0.0	0.0
MT22	Maitland 11kv	Yorke	Maitland	MBFRA	13	78		78							0	0	0.0	0.0
MTB13	Bugle Ranges 11kv	Mt Lofty	Mount Barker	HBFRA	11	66		66							0	0	0.0	0.0
MTB62	Littlehampton 11kv	Mt Lofty	Mount Barker	HBFRA	8	45		45							0	0	0.0	0.0
MV52	Willunga 11kv	Mt Lofty	McLaren Vale	HBFRA	7	43		43		1	1				1	14.3	2.3	2.3
MV62	Sellicks Beach 11kv	Mt Lofty	McLaren Vale	HBFRA/MBFRA	15	90		90		1	1				1	6.7	1.1	1.1
NA02	McIntosh 11kv	Lower SE	Naracoorte	HBFRA	10	60		60							0	0	0.0	0.0
NA12	Padthaway 11kv	Lower SE	Naracoorte	HBFRA/MBFRA	10	60		60							0	0	0.0	0.0
NL21	Clarendon North 11kv	Mt Lofty	Noarlunga	HBFRA	15	89		89		1	1				1	6.7	1.1	1.1
NL760B	Hackham East 11kv	Mt Lofty	Noarlunga	HBFRA	10	60		60							0	0	0.0	0.0
NU06	Kapunda South 11kv	Mid North	Nuriootpa	HBFRA/MBFRA	10	60		60							0	0	0.0	0.0
NU13	Seppeltsfield 11kv	Mid North	Nuriootpa	HBFRA	10	58		58							0	0	0.0	0.0
PA12	Wilmington North 11kv	Flinders	Port Augusta	MBFRA	14	84		84							0	0	0.0	0.0
PA22	Quorn North 19kv	Flinders	Port Augusta	MBFRA	15	90		90							0	0	0.0	0.0
PL07	North 11kv	Lower Eyre Peninsula	Port Lincoln	MBFRA	8	47		47							0	0	0.0	0.0
PL11	Little Swamp 11kv	Lower Eyre Peninsula	Port Lincoln	HBFRA/MBFRA	5	30		30							0	0	0.0	0.0
PL14	Shields 11kv	Lower Eyre Peninsula	Port Lincoln	HBFRA/MBFRA	6	36		36	1	1	2				2	33.3	5.6	5.6
PL25	Greenpatch 19kv	Lower Eyre Peninsula	Port Lincoln	HBFRA/MBFRA	4	24		24							0	0	0.0	0.0
PL33	Uley 33kv	Lower Eyre Peninsula	Port Lincoln	HBFRA/MBFRA	6	36		36							0	0	0.0	0.0
PP08	Port Germein 11kv	Mid North	Port Pirie	HBFRA/MBFRA	17	102		102							0	0	0.0	0.0
PP15	South Bungama 19kv	Mid North	Port Pirie	MBFRA	12	72		72							0	0	0.0	0.0
R18	Rhynie 11kv	Mid North	Riverton	MBFRA	11	60	1	61		1	1	1		1	2	9.1	1.7	3.3
R21	Hamley Bridge 11kv	Mid North	Riverton	HBFRA/MBFRA	10	61		61							0	0	0.0	0.0
SB01	Streaky Bay 11kv	West Coast	Streaky Bay	MBFRA	15	90		90							0	0	0.0	0.0
SB15	Haslam 19kv	West Coast	Streaky Bay	MBFRA	2	12		12							0	0	0.0	0.0
SB16	Chandada West 19kv	West Coast	Streaky Bay	MBFRA	13	78		78							0	0	0.0	0.0
SG14	Upper Sturt 11kv	Mt Lofty	Stirling	HBFRA	14	84		84	1	2	3				3	21.4	3.6	3.6
SM349C	Darlington 11kv	Adelaide Metropolitan	Saint Marys	HBFRA/MBFRA	5	29		29							0	0	0.0	0.0
SM349D	Seaview Downs 11kv	Adelaide Metropolitan	Saint Marys	MBFRA	5	29		29							0	0	0.0	0.0
ST11	Strathalbyn West 11kv	Murraylands	Strathalbyn	HBFRA/MBFRA	15	90		90							0	0	0.0	0.0
ST12	Strathalbyn East 11kv	Murraylands	Strathalbyn	HBFRA/MBFRA	15	90		90							0	0	0.0	0.0
VH14	Hindmarsh Valley 11kv	Mt Lofty	Victor Harbor	HBFRA	5	30		30							0	0	0.0	0.0
VH15	Urimbirra 11kv	Mt Lofty	Victor Harbor	HBFRA	10	60		60							0	0	0.0	0.0
VH43	Pambula 11kv	Mt Lofty	Victor Harbor	HBFRA	3	18		18	1		1				1	33.3	5.6	5.6
W01	Warramboo 11kv	West Coast	Wudinna	MBFRA	15	90		90							0	0	0.0	0.0
W16	Warramboo 19kv	West Coast	Wudinna	MBFRA	15	91		91							0	0	0.0	0.0
WK61	Morgan 11kv	Riverland	Waikerie	MBFRA	10	60		60							0	0	0.0	0.0
WK71	Haylands 11kv	Riverland	Waikerie	MBFRA	5	30		30							0	0	0.0	0.0
YK03	Edithburgh 11kv	Yorke	Yorketown	MBFRA	15	90		90							0	0	0.0	0.0
YK07	Minlaton 11kv	Yorke	Yorketown	MBFRA	15	90		90							0	0	0.0	0.0

Appendix C – Clearance Zones

SA Power Networks | Pre-Fire Danger Season Vegetation Audits | 2016
Clearance Zones (Electricity Act 1996)

Table I: Bare or covered conductor at operating voltages of 240 V to 11 kV

Voltage	All Spans	Span (in metres)									
		0-50		Over 50-100		Over 100-150		Over 150-200		Over 200	
	P	V	H	V	H	V	H	V	H	V	H
Voltage not exceeding 480V in bushfire risk areas only	0.5	1.0	1.0	1.5	2.5	1.5	3.5	-	-	-	-
7.6 kV and 11 kV in bushfire and non-bushfire risk areas	0.5	1.5	1.5	2.0	2.5	2.5	3.5	2.5	4.5	2.5	6.0

Table II: Bare or covered conductor at operating voltage of 19 kV

Voltage	All Spans	Span (in metres)									
		0-100		Over 100-200		Over 200-300		Over 300-400		Over 400	
	P	V	H	V	H	V	H	V	H	V	H
19 kV single earth wire earth return (SWER)	0.5	1.0	1.0	1.0	2.5	1.5	5	2.0	7.0	2.0	9.0

Table III: Bare or covered conductor at operating voltages of 33 kV to 66 kV

Voltage	All Spans			Span (in metres)									
				0-100	Over 100-200	Over 200-300	Over 300-400	Over 400-500	Over 500-600	Over 600-700	Over 700-800	Over 800-900	Over 900
	V	P	B	H	H	H	H	H	H	H	H	H	V H
33 kV	2.5	0.5	2.0	2.5	4.5	6.5	9.5	14.0	19.0	25.0	32.0	39.5	48.0
66 kV	3.0	1.0	2.0	2.5	4.5	6.5	9.5	14.0	19.0	25.0	32.0	39.5	48.0

Appendix D – Acronyms and Definitions

The following table provides definitions of acronyms used within this report.

Acronym	Definition
ATS	Active Tree Services – A current Vegetation contractor
AUDIT SITE	A randomly selected pole on a feeder – 3 spans either side of the pole are audited where practical.
B & G	Bend and Grow
BFRA	Bushfire Risk Area In December 2013, the EMG approved the transition from 'Bushfire Risk Area" to the new designation "Medium Bushfire Risk Area" (MBFRA).
BFDS (or FDS)	Bush Fire Danger Season
CZ	Clearance Zone – the area around the powerline that must be maintained clear of vegetation at all times.
D/B	Drive By
DRIVE BY	A non-conformance identified on-route to an audit site
ETS	Eastern Tree Services – A current Vegetation contractor
HBFRA	High Bushfire Risk Area
LiDAR	Light Detection and Ranging — a remote sensing method used to examine the surface of the Earth
MBFRA	Medium Bushfire Risk Area
NBFRA	Non Bushfire Risk Area
NCR	Non-conformance record – an audit fail where vegetation is either into the CZ or is likely to bend or grow into the CZ during the FDS.
N/A	Not Available
ND	Network Directive
N/R	Not Reported
PATROL	The Pre Fire Danger Season Patrol - A visual check on those Feeders or part Feeders that were scoped prior to 1 May – a risk mitigation strategy to capture clearance requirements that were missed during the initial scoping and cutting programs. Patrols are either conducted on ground or by helicopter.
SWER	Single Wire Earth Return

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SA Power Networks

2017 Cyclic/Pre-Summer Vegetation Audit

Pre-Summer Audit Report

February 2018

Executive summary

Background & Scope

Under South Australian legislation, SA Power Networks is required to undertake inspections and implement necessary measures to ensure that vegetation is clear of powerlines – this is in accordance with the Electricity Act 1996 and its associated Regulations.

SA Power Networks conducts a range of internal and independent audits as part of their vegetation management program (Figure 1-1). Together, these audits are designed to measure: the risks posed by vegetation at specific times of the year; the overall effectiveness of the vegetation management strategies; and the performance of the contractor.

GHD was engaged by SA Power Networks to undertake an external audit of the vegetation clearance program. The pre-summer audit (the findings of which are presented in this report) assesses actual infringements into the clearance zone, as well as the potential for vegetation to bend or grow into the clearance zone. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology, with the field component undertaken from. 9 October 2017 to 29 November 2017. The audit was intentionally undertaken in MBFRA / HBFRA Districts.

External contractor, Helistar, was engaged to undertake audits of the more remote arid Districts, whilst GHD was utilised for the Districts with higher vegetation cover.

Overall Audit Results

105 Feeders across all 40 South Australian Districts were audited between 9 October and 29 November 2017. A full register of the audited Feeders is provided in Appendix A and a summary of the recorded NCRs is provided in Appendix D.

A summary of the audit and findings is provided in Table 0-1.

Table 0-1 Audit Finding Summary [1,2]

Measure	2015	2016	2017
Districts Audited	**40**	**40**	**40**
Feeders Audited	**84** *84*	**96** *97*	**105** *105*
Audit Sites	**549** *554*	**944** *948*	**740** *741*
Audit Spans	**3262** *3274*	**5629** *5633*	**4379** *4380*
Districts with Multiple Feeder Fails	**11** *12*	**6** *9*	**6** *6*
Total NCRs Identified	**46** *58*	**29** *33*	**23** *24*
Feeders with nil NCRs	**61 (73%)** *58 (69%)*	**78 (80%)** *76 (78%)*	**86 (82%)** *85 (81%)*
Feeders with 1-3 NCRs	**18 (39%)** *20 (24%)*	**16 (17%)** *19 (20%)*	**4 (4%)** *4 (4%)*
Feeders with >3 NCRs	**5 (11%)** *6 (7%)*	**2 (2%)** *2 (2%)*	**0 (0%)** *0 (0%)*

Note:

[1] **XXX (bolded)** denotes Audit Site measurements <u>excluding</u> Drive-By measurements

[2] *XXX (italicised)* denotes Audit Site measurements <u>including</u> Drive-By measurements

Vegetation compliance was achieved across 85 Feeders, while 20 Feeders (19%) had one or more NCRs.

A comparison of Audit and Span Non-Conformance Rates is presented in Figure 0-1. Span non-conformance rates in 2017 are on par with 2016, while audit site non-conformance rates are slightly higher (3.2% in 2017 compared to 2.9% in 2016). The overall trend in 2017 suggests increased effectiveness in the vegetation clearance program compared to historical data (pre-2016).
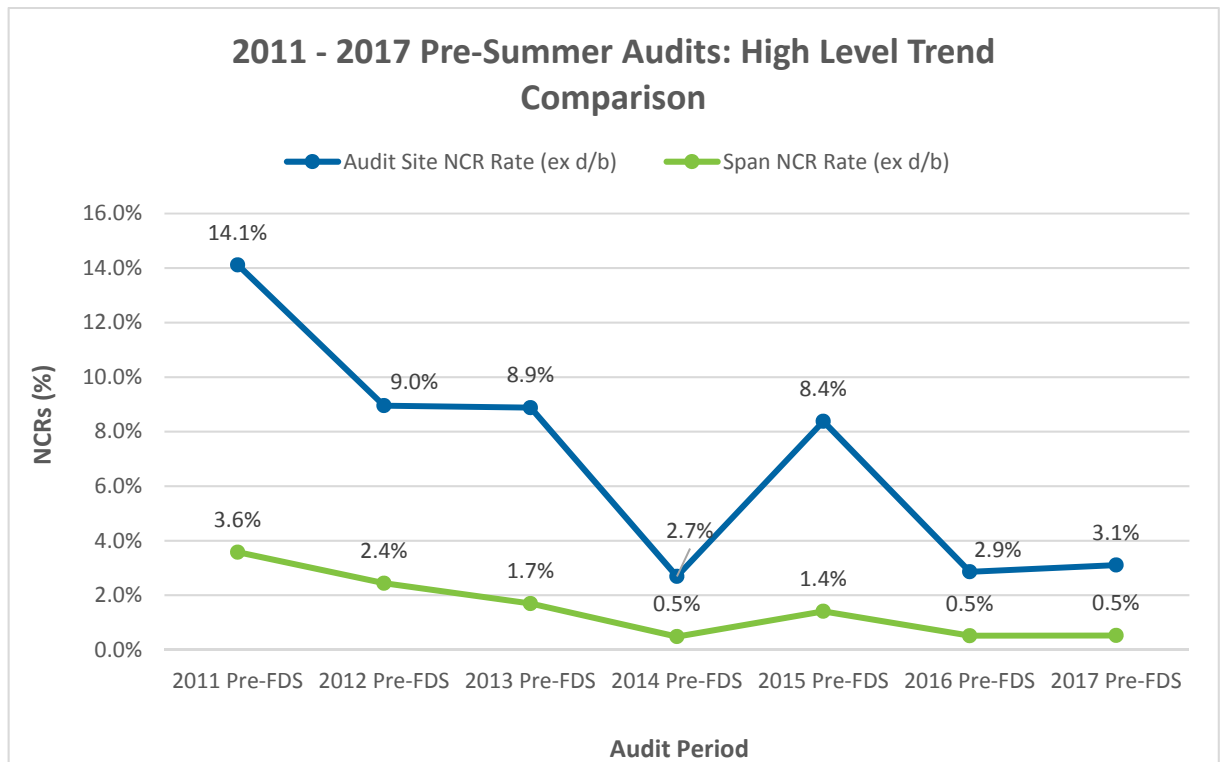
Figure 0-1 High Level Trend Comparison (2011 to 2017)

Note:

1)   In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.

Further analysis of the audit findings is shown in Table 0-2.

Table 0-2 NCR Categories (excluding Drive-By's)

NCR	2015	2016	2017
Total	46	29	23
Actual CZ Infringements	33 (72%)	13 (45%)	17 (74%)
Likely CZ Infringements (Bend & Grows)	13 (28%)	16 (55%)	6 (26%)
HBFRA	20 (43%)	18 (62%)	10 (43%)
MBRFA	26 (57%)	11 (38%)	13 (57%)
High Voltage	27 (41%)	23 (79%)	13 (57%)
Low Voltage	31 (59%)	6 (21%)	10 (43%)
Drive By's	12	4	1

Conclusions & Recommendations

Overall, vegetation compliance in 2017 is on par with results achieved in 2016 and shows a marked improvement compared to historical data, with an overall downward trend in logged NCRs across the 13 South Australian Regions.

In contrast to findings in 2016 where a number of Feeders were identified with a high number of NCRs (greater than three NCRs), no more than two NCRs per Feeder were identified in 2017. The SG14 Upper Sturt (11 kV) Feeder which was highlighted in 2016 for recording the highest infringement rate was revisited in the 2017 audits and only one NCR was identified overall. Other 'problem Districts' that have been flagged in the past, including Noarlunga and Kangaroo Island, also show vast improvement in 2017 as compared to previous years.

Although the infringement rate indicates a downward trend compared to historical data, there is still scope for continued improvement – in context, this year's span non-conformance rate (approximately 0.5%) indicates that BFRA's in the network comprising 412,139 spans may have 2060 NCRs that are yet to be identified.

The St Marys District, in particular, was noted for poor performance in the 2017 Pre-Summer audit – and as this District is classified as a HBFRA, the risk of fire is significant. It is acknowledged that St Marys is a densely populated area where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies could potentially be investigated, such as vegetation removal or reconstruction options.

In 2016, a greater number of the identified NCRs were associated with potential grow-ins, likely a result of the above-average rainfall across the 2016 winter and early spring contributing to accelerated growth rates for some species. The opposite was true for NCRs identified in 2017, with 74% of NCRs corresponding to actual clearance zone infringements. With the below-average rainfall over the winter of 2017, it is not surprising that vegetation vigour would be affected, and consequently that the potential for vegetation to grow into the clearance zone would be lower. The greater number of NCRs associated with vegetation that is already within the clearance zone suggests that growth may have been fuelled by sub-soil moisture from 2016 and early-2017 which was wetter than average. Developing a model to predict vegetative growth patterns arising from climactic variations would be an improvement to the current vegetation program.

The Electricity Act 1996 stipulates that any electricity entity must 'take reasonable steps' to ensure that vegetation of all kinds is kept clear of public powerlines, and that naturally occurring vegetation is kept clear of private powerlines (Electricity Act 1996). While full compliance has not been achieved in 2017, SA Power Networks has ensured that the vegetation clearance program was completed on schedule, with non-conformance rates trending lower than in previous years (excepting 2014). It is therefore GHD's opinion that SA Power Networks has undertaken necessary measures (reasonable steps) to ensure that vegetation is clear of powerlines.

A summary of observations and recommendations are provided in Table 0-3 for consideration and potential implementation into the 2018 Cyclic/Pre-Summer Audits.

Table 0-3 Observations and Recommendations – 2017

Observation	Conclusion / Recommendation	Priority[a]
Improved performance over a six-year period for the vegetation clearance program.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	2
Following on from recommendations in 2016, GHD undertook a greater number of audits within each District in 2017 (e.g. three or four Feeders per District where feasible).	A more holistic snapshot of the network was achieved, inspiring a greater level of confidence in the audit results overall.	-
No Feeders with more than three NCRs were identified in the 2017 vegetation audits.	This is a marked improvement from 2016, where two Feeders (MG05 and KI54) logged three or more NCRs.	-
A number of NCRs were identified as technical infringements – namely, NCRs recorded in the BM56 Cooltong 11 kV and G05 Laura 11 kV Feeders.	SA Power Networks will seek to address these infringements by the addition of a new pole mid-span, or by some other means.	1, 2
In 2016, when rainfall was above average, a proportion of the NCRs identified in the Pre-Summer audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone. In 2017, rainfall was well below average during the winter months, and a smaller proportion of the NCRs identified in the Pre-Summer audit were associated with potential grow-in infringements. A similar trend was observed in 2015 during a period of below-average rainfall.	Forecasting of vegetation growth patterns / vigour with respect to climate conditions will assist SA Power Networks in tailoring site visits and informing scoping and cutting schedules. The team understands that SA Power Networks is already exploring this avenue. One of the recommendations from 2016 was related to the use of remotely sensed imagery to assist in monitoring vegetation growth and vigour. A range of methods could be used (e.g. application of vegetation indices, change detection imagery, the use of geographic image based analysis to isolate trees and extract spectral data and thereby determine vegetation vigour / growth) which would again enable better tailoring of site visits.	2, 3
A large number of saplings were identified in Kangaroo Island, and in some areas of the Mount Lofty Ranges.	GHD understands that SA Power Networks is currently in discussions with local councils and the OTR regarding removal of tree saplings from beneath powerlines. The outcome of this tree sapling audit indicates that this is a priority.	1

Observation	Conclusion / Recommendation	Priority[a]
In a number of the urban areas, some homeowners expressed their frustration with vegetation cutters assuming a 'one size fits all' approach when cutting instead of 'species-specific' approach to cutting.	GHD understands that arborist training has been provided for the cutting crew, and the team generally encountered fewer dissatisfied customers in 2017 as compared to 2016. However, from a visual amenity perspective, assuming a 'one size fits all' approach to cutting simply is not ideal and this is certainly an area for additional improvement.	3
Undertaking sapling audits in 2017 revealed a number of private landowners planting inappropriate vegetation below powerlines (e.g. fast-growing Eucalyptus trees).	Ensure that all private landowners (particularly those in remote regions) are educated with regards to appropriate vegetation for planting near powerlines.	2

[a] Priority Categories:

   1 - Priority

   2 - Strategic Improvement

   3 - Opportunity for Improvement

Acronyms

Acronym	Definition
ATS	Active Tree Services
Audit Site	A randomly selected pole on a feeder – 3 spans either side of the pole are audited where practical.
BFRA	Bushfire Risk Area In December 2013, the EMG approved the transition from 'Bushfire Risk Area" to the new designation "Medium Bushfire Risk Area" (MBFRA).
FDS	Fire Danger Season
CZ	Clearance Zone – the area around the powerline that must be maintained clear of vegetation at all times.
D/B	Drive By
Drive By	A non-conformance identified on-route to an audit site
ETS	Eastern Tree Services – A current Vegetation contractor
HBFRA	High Bushfire Risk Area
LiDAR	Light Detection and Ranging — a remote sensing method used to examine the surface of the Earth
MBFRA	Medium Bushfire Risk Area
NBFRA	Non Bushfire Risk Area
NCR	Non-conformance record – an audit fail where vegetation is either into the CZ or is likely to bend or grow into the CZ during the FDS.
N/A	Not Available
ND	Network Directive
N/R	Not Reported
OTR	Office of the Technical Regulator
Patrol	The Pre Fire Danger Season Patrol - A visual check on those Feeders or part Feeders that were scoped prior to 1 May – a risk mitigation strategy to capture clearance requirements that were missed during the initial scoping and cutting programs. Patrols are either conducted on ground or by helicopter.
SWER	Single Wire Earth Return

Table of contents

Table index

Figure index

Appendices

1.   Background

Under South Australian legislation, SA Power Networks is required to undertake inspections and implement necessary measures to ensure that vegetation is clear of powerlines – this is in accordance with the Electricity Act 1996 and its associated Regulations.

SA Power Networks conducts a range of internal and independent audits as part of their vegetation management program (Figure 1-1). Together, these audits are designed to measure: the risks posed by vegetation at specific times of the year; the overall effectiveness of the vegetation management strategies; and the performance of the contractor.

In the past GHD has been engaged by SA Power Networks to undertake cyclic and pre-summer audits in the months of May to August, and October to December, respectively. In 2017, these audits were undertaken concurrently and entitled the "2017 Cyclic / Pre-Summer Audits". Given that these audits have different core aims, two separate reports have been prepared: a cyclic audit report and a pre-summer audit report.

The pre-summer audit (the findings of which are presented in this report) assesses actual infringements into the clearance zone, as well the potential for vegetation to bend or grow into the clearance zone during the bushfire season. This audit of the SA Power Networks Vegetation Clearance Program and practices was performed in accordance with the agreed audit scope and methodology, with the field component undertaken from. 9 October 2017 to 29 November 2017. The audit was intentionally undertaken in MBFRA / HBFRA Districts.

External contractor, Helistar, was engaged to undertake audits of the more remote arid Districts, whilst GHD was utilised for the Districts with higher vegetation cover.

Cyclic Audit

- **Date:** Historically undertaken in August to October
- **Purpose:** Assess vegetation contractor's performance
- Assess both actual and potential (bend/grow) infringements into the Clearance Zone

Pre-FDS Audit

- **Date:** October to December
- **Purpose:** Assess network risk for the bushfire season
- Assess both actual and potential infringements into the Clearance Zone

Post-FDS Audit

- **Date:** April to May
- **Purpose:** Assess effectiveness of vegetation clearance program
- Assess actual infringements into the clearance zone

Figure 1-1 Audits Commissioned by SA Power Networks

2. Scope of Work

The objective of the Pre-Summer Audit was to undertake a compliance audit of randomly selected Feeders to evaluate SA Power Networks' performance in compliance with its obligations under the Electricity Act 1996 and Regulations, Part 5 Division 1 with regard to "Duties in Relation to Vegetation Clearance" and Section 4 "Duty of Electricity Entity or Council" and Section 4 Schedule 1 "Clearance and Buffer Zones around Powerlines".

In particular, the audit is to determine and make a statement as to whether or not SA Power Networks has taken reasonable steps as required in Part 5 Division 1 Section 55 – "Duties in relation to vegetation clearance" of *The Act*:

- To keep vegetation of all kinds clear of public power lines under SA Power Networks control; and

- To keep naturally occurring vegetation clear of private power lines under SA Power Networks control.

For the purposes of this assessment GHD will take into account the legal opinion of Minter Ellison provided to SA Power Networks in 2011 which includes the following paragraph:

> **Meaning of 'duty to take reasonable steps'**
>
> *ETSA must take reasonable steps to clear vegetation from its powerlines in accordance with the requirements set out in the Principles.*
>
> *What constitutes 'reasonable steps' will be assessed objectively, taking into account, for example, the characteristics of the powerlines, surrounding vegetation, industry best practice and the Principles.*
>
> *Compliance with the Principles should be viewed as the minimum benchmark which must be achieved in order to discharge ETSA's obligations under section 55(1) of the Act.*
>
> *Ultimately, the steps taken by ETSA to discharge its duty should:*
>
> - *at least reflect 'good electricity industry practice'; and*
>
> - *ideally, reflect industry best practice (taking into account relevant interstate and international standards and operational experiences and any recent authoritative findings or learnings in relation to powerline vegetation clearance - e.g. outcomes from royal commissions, University studies, etc).*

The scope

In addition, the scope of the field audit is to:

- Audit all 40 Districts classified as being in High Bushfire Risk Areas (HBFRA) & Medium Bushfire Risk Areas (MBFRA) of South Australia.

- Assess only bare conductor overhead construction within the bushfire risk areas of South Australia.

- Undertake audits as close as practicable to the commencement of the Fire Danger Seasons in each of the geographical areas.

- Undertake an audit of tree saplings that have potential to grow into the clearance zone

- Undertake a basic visual amenity assessment in selected districts.

3. Field Audit Methodology

The methodology used for vegetation clearance assessment and data processing is described in Sections 3.1-3.6, with the tree sapling and visual amenity audit methodologies presented in Sections 3.7and 3.8, respectively.

3.1 Feeder Selection

SA Power Networks provided GHD with a selection of five Feeders for each District, of which two to four Feeders were selected for the purpose of the audit. There were no restrictions on this selection – however, timing of audits within Districts was dependent on cutting progress in those areas. The scoping and cutting data for Feeders was updated by the by the vegetation cutting contractor (ATS) on a weekly basis with this information passed on to GHD as required. GHD could therefore schedule site visits accordingly, with any NCRs recorded in Feeders with cutting percentage >80% attributed to inadequate vegetation clearance by the vegetation contractors.

SA Power Networks provided GHD with access to GeoMaps, an application tailored to specific Feeders proposed for auditing. The application provided information on scoping and cutting remarks from ATS inspectors and supervisors.

3.2 Audit Site Selection

At the start of each Feeder audit, GHD identified up to five potential target poles/audit sites (per page of the Feeder plans generally) for each Feeder under audit.

A schedule of the Feeders selected is provided in Appendix A**.**

3.3 Data Acquisition

Audit inspections were recorded on a tablet using an inspection application called Mobile Data Anywhere (MDA) database with GIS capability. At each audit location, vegetation clearances up to three spans in each direction from the nominated target pole (typically a transformer or switching point) were classified, in accordance with the categories as shown in Table 3-1.

Table 3-1 Categories for Vegetation Classification

Classification				
No Vegetation	**Vegetation All Clear**	**NCR**		
		CZ Infringement	**Bend-In**	**Grow-In**
No vegetation present within span (or likely to grow into span within 10 years from audit)	Vegetation within spans has been cut to compliance	Vegetation has breached the clearance zone (CZ)	Vegetation is likely to bend into the clearance zone (CZ)	Vegetation is likely to grow into the clearance zone (CZ)

Horizontal and vertical clearance zones (Appendix D, Tables I-III) were determined based on the span and voltage of the powerlines specified in the *Electricity (Principles of Vegetation Clearance) 2010 Regulations*.

A TruPulse 200/B Laser Rangefinder was used for acquisition of span length, and vertical and horizontal clearance data. The number of spans included was often dependent on span length, accessibility and visibility.

3.4   Drive-By Inspections

Ad hoc visual "Drive By" inspection of clearances en route to nominated audit sites was undertaken to gain a more comprehensive overview of the effectiveness of the clearance program. Drive-By NCRs were identified and recorded as described in Section 3.3.

3.5   Data Processing

Following a District audit, SA Power Networks was notified of the NCRs identified so that appropriate action could be taken.

The data collected using the MDA platform was processed and analysed using standard analysis tools available in Microsoft Excel.

3.6   Compliance Audit Debriefing

At regular intervals during the field audit (25 October, 23 November and 1 December), SA Power Networks conducted a debriefing meeting with GHD to discuss the findings of the audit. A number of grow-in NCRs were disregarded based on a qualified arborist opinion (SA Power Networks) and historical data indicating that vegetation did not pose a risk of further growth. The NCRs disregarded on this basis have been provided in Appendix C. A number of the disregarded NCRs will be revisited a part of the post-summer audit, where practical.

3.7   Tree Sapling Audit

Further to the compliance audit, GHD also undertook an audit of tree saplings with potential to grow into the clearance zone. For the purposes of this audit, and in keeping with the SA Power Networks regulatory amendments and vegetation management guidelines, a tree sapling has been defined as follows:

- An immature or young tree with a slender trunk
- Typically less than four years old
- A stem diameter up to 80 mm
- A height range of up to 2 m
- Generally does not produce fruit or flowers in this age range

This audit captured:

- The number of saplings within the clearance envelope
- The sapling species (where able to be identified), as a percentage of saplings present

3.8   Visual Amenity Audit

A basic visual assessment audit was also undertaken concurrently with the compliance and tree sapling audits in selected districts. The amenity audit focused on the following factors:

- The outcome of the pruning
- The significance or visual value of the tree(s) in the landscape
- The contribution of the tree(s) to the future landscape
- The general health of the tree

- The percentage of tree canopy

- The number of dead trees within the span

In addition to the above, the following data was captured, where possible:

- Tree species

- The location of the audit site(s) (geographic coordinate)

- A photograph of the audited spans

The visual amenity audits targeted the following HBFRA districts of South Australia, as summarised in Table 3-2.

Table 3-2 Visual Amenity Assessment Areas

Region	District
Adelaide Metropolitan	Elizabeth-Salisbury Holden Hill St Marys
Mount Lofty Ranges	Gumeracha McLaren Vale Mount Barker Noarlunga Stirling Victor Harbor

4. Vegetation Program

The SA Power Networks vegetation program for 2017 was based on an Annual Inspection & Cutting Cycle for both the HBFRA's and the MBFRA's of South Australia.

The following table (Table 4-1) shows the number of spans to be cut as identified from the Vegetation Clearance Program out of the 412,139[1] spans in bushfire areas across the network:

Table 4-1 Cut Spans

2015	2016	2017
54,886	49,653	58,835

It should be noted that the distinction between HBFRA and MBFRA for Feeders or part Feeders is a SA Power Networks distinction and not one of the Electricity Act 1996 (The Act) or the associated 2010 Regulations. The Act and the Regulations only distinguish between Bushfire and Non Bushfire areas.

In accordance with the SA Power Networks "Network Directive", all Feeders that were inspected prior to 1 May of the audit year are to be patrolled for vegetation clearances prior to the commencement of the FDS in each District. This is an additional risk mitigation strategy aimed to capture any overlooked vegetation or regrowth that may have occurred in the preceding months.

For 2017 the Pre-Fire Danger Season, Patrols were only undertaken on Feeders or part Feeders designated by SA Power Networks as being in MBFRAs and HBFRAs and inspected prior to 1 May 2017.

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[1] Based on the 2017 ATS data (the sum of the total spans within each Feeder) provided to GHD by SA Power Networks

5. Rainfall Trends

Above-average rainfall was recorded in parts of southern, western and northern Australia during the summer and autumn of 2016-2017, as shown in Figure 5-1a. The ensuing winter and spring (May to October 2017) was particularly dry across Australia, with the exception of Northern Queensland (Figure 5-1b). Monthly rainfall deciles for the period spanning May to November, are provided in Appendix E.
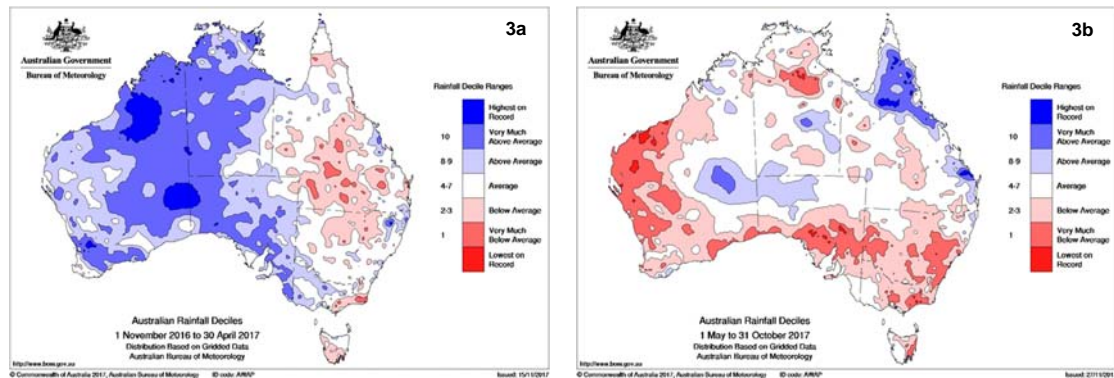

Figure 5-1 Six monthly rainfall trends across Australia for November 2016 to April 2017 (3a) and May 2017 to October 2017 (3b) (BoM 2017)

In 2017, South Australia received notably less rainfall than in 2016 (221 mm and 297 mm for 2017 and 2016, respectively), with the rainfall totals in 2017 only slightly above the calculated average rainfall of 215 mm (Figure 5-2) (BoM 2017).
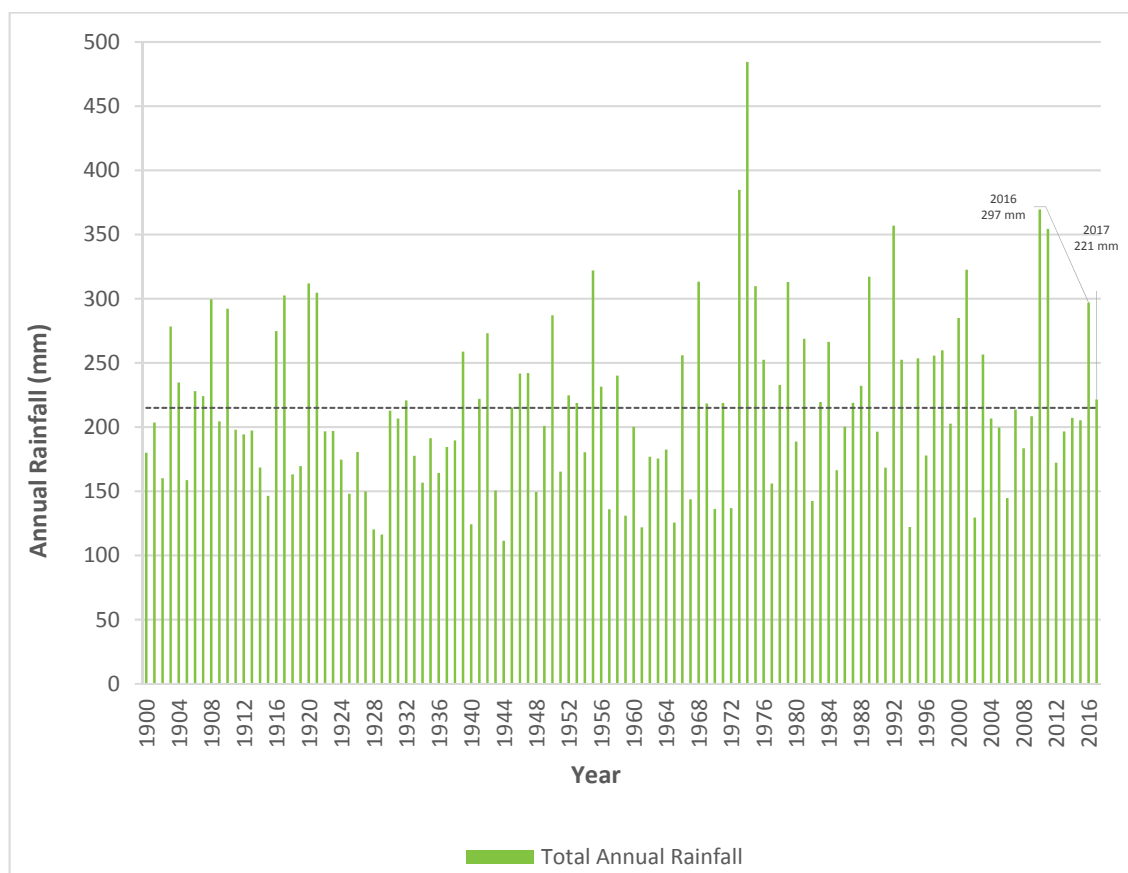

Figure 5-2   Total Annual Rainfall (1900-2017) for South Australia

6. Vegetation Compliance Audit

6.1 Overall Audit Results

105 Feeders across all 40 South Australian Districts were audited between 9 October and 29 November 2017. A full register of the audited Feeders is provided in Appendix A and a summary of the recorded NCRs is provided in Appendix D.

The major findings are summarised in Table 6-1.

Table 6-1 Audit Findings Summary [1,2]

Measure	2015	2016	2017
Districts Audited	**40**	**40**	**40**
Feeders Audited	**84** *105*	**96** *97*	**105** *105*
Audit Sites	**549** *554*	**944** *948*	**740** *741*
Audit Spans	**3262** *3274*	**5629** *5633*	**4379** *4380*
Districts with Multiple Feeder Fails	**11** *12*	**6** *9*	**6** *6*
Total NCRs	**46** *58*	**29** *33*	**23** *24*
Feeders with nil NCRs	**61 (73%)** *58 (69%)*	**78 (80%)** *76 (78%)*	**86 (82%)** *85 (81%)*
Feeders with 1-3 NCRs	**18 (39%)** *20 (24%)*	**16 (17%)** *19 (20%)*	**4 (4%)** *4 (4%)*
Feeders with >3 NCRs	**5 (11%)** *6 (7%)*	**2 (2%)** *2 (2%)*	**0 (0%)** *0 (0%)*

Note:

[1] **XXX (bolded)** denotes Audit Site measurements (<u>excluding</u> Drive-By measurements), where applicable

[2] *XXX (italicised)* denotes Audit Site measurements (<u>including</u> Drive-By measurements)

In total, 24 NCRs were identified at audit site locations, and an additional one NCR identified en route to an audit sites (a Drive-By). Unless otherwise specified, all results presented henceforth are only those recorded at audit sites, with Drive-By's treated separately in Section 6.3.

Vegetation compliance was achieved across 85 Feeders, while 20 Feeders (19%) had one or more NCRs. This is a similar result to that obtained in 2016 where 18 Feeders of the 96 audited recorded one or more NCRs.

It should be noted that two of the 31 NCRs identified while auditing, the BM56 Cooltong 11 kV and G05 Laura 11 kV Feeders, have been classified as technical infringements. In these instances, compliance would be difficult to achieve by additional cutting, and the only means to address the infringements would be to remove the vegetation adjacent the powerline, insert another pole mid-span, or by some other means.

A comparison of Audit and Span Non-Conformance Rates is presented in Figure 6-1. Span non-conformance rates in 2017 are on par with 2016, while audit site non-conformance rates are slightly higher (3.2% in 2017 compared to 2.9% in 2016). The overall trend in 2017 suggests increased effectiveness in the vegetation clearance program compared to historical data (pre-2016, and with the exception of 2014).
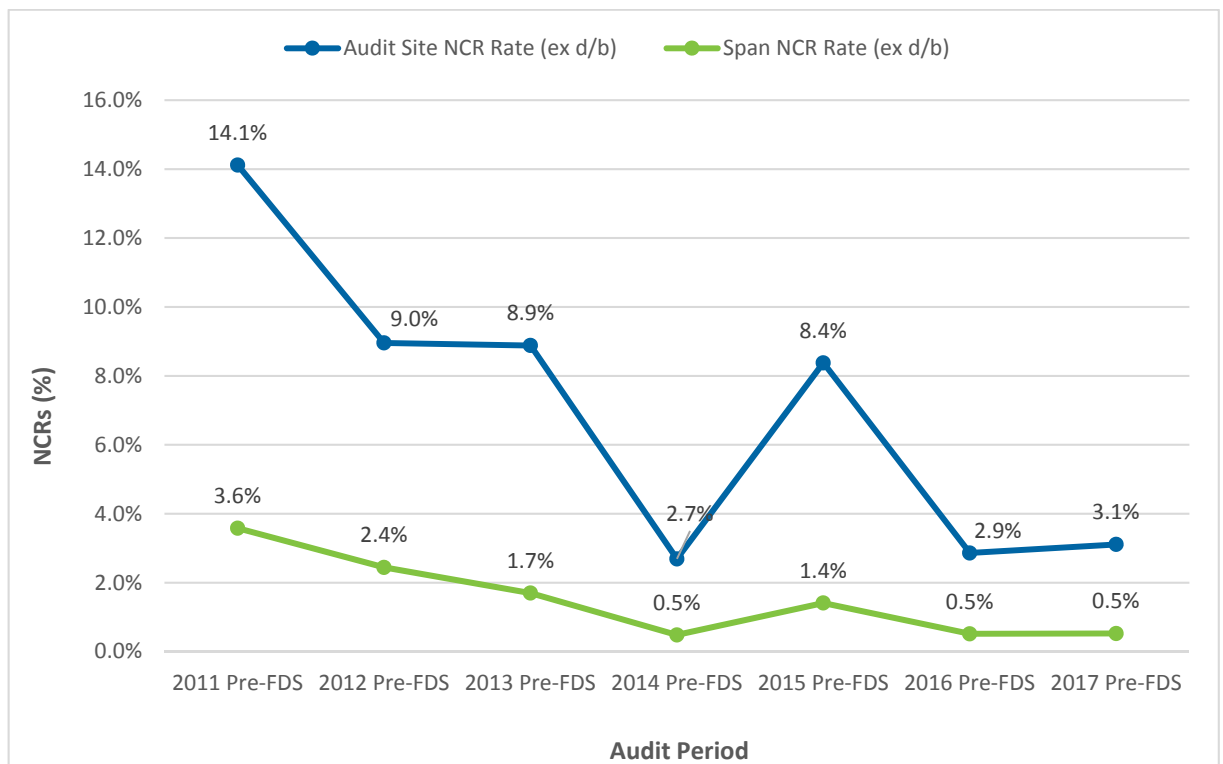

Figure 6-1 High Level Trend Comparison 2011 to 2017 (excluding Drive-By's) [1]

Note:

[1] In 2012 there were only 29 Districts audited due to an incomplete cutting program. Auditing of all 40 Districts commenced in 2013.

As described elsewhere (Section 3.3) vegetation non-compliance falls within two categories: vegetation breaching the clearance zone (CZ Infringements), and vegetation that is likely to bend or grow into the clearance zone (Bend & Grows). As shown in Table 6-2 and Figure 6-2, a greater proportion (74%) of the recorded infringements were comprised of clearance zone (CZ) infringements, while 26% were logged as potential grow-ins.

This result suggests that a greater number of trees have not been cut to compliance for the 2017 pre-fire danger season. Conversely, the smaller proportion of grow-ins identified would suggest that where trees have been cut to compliance, the cutting is likely sufficient to maintain clearance across the summer months. The below-average winter rainfall has also likely contributed to stunted / less vigorous tree growth (see Figure 5-2). This also makes sense in

light of audit results from previous years where bend and grows comprised 28% of the NCRs identified and where rainfall was generally below average (see Figure 5-2, 2015).

Table 6-2 NCR Categories (excluding Drive By's)

NCR	2015	2016	2017
Total	46	29	23
CZ Infringements	33 (72%)	13 (45%)	17 (74%)
Bend & Grows	13 (28%)	16 (55%)	6 (26%)
HBFRA[1]	20 (43%)	18 (62%)	10 (43%)
MBRFA[1]	26 (57%)	11 (38%)	13 (57%)
High Voltage	27 (41%)	23 (79%)	13 (57%)
Low Voltage	31 (59%)	6 (21%)	10 (43%)
Drive By's	12	4	1

Note:
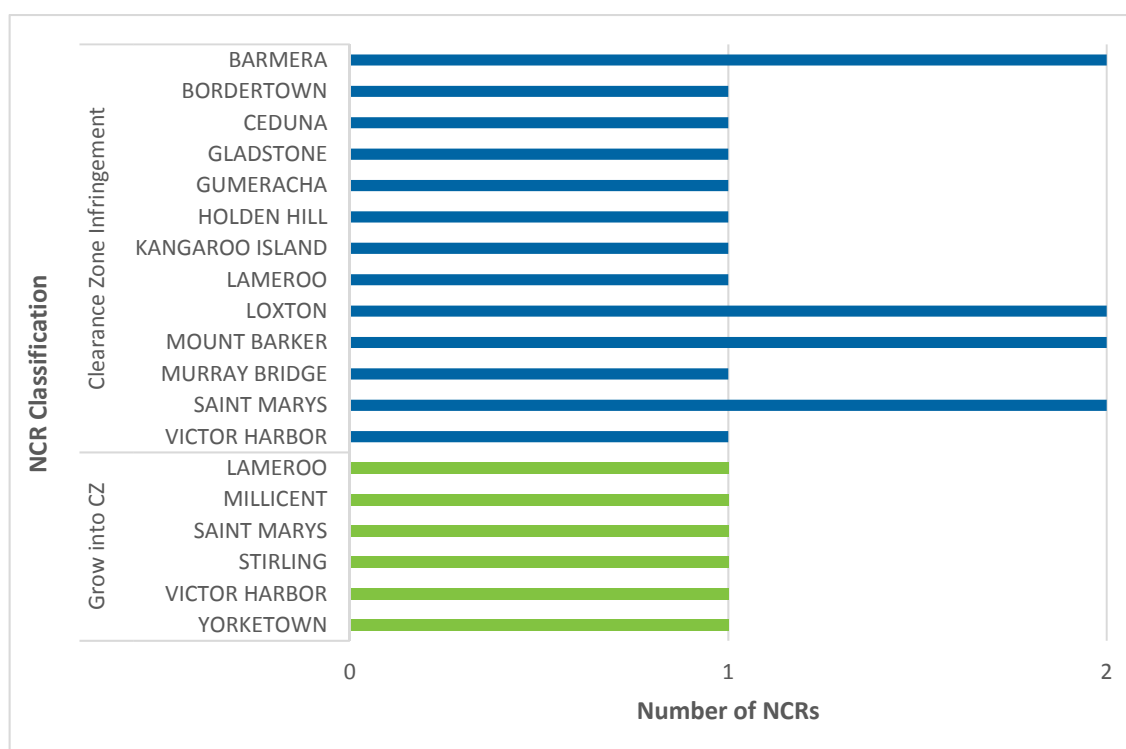[1] Determined based on the specific audit site risk area

Figure 6-2 Distribution of Actual CZ Infringements, and Bend/Grows across Districts (excluding Drive-By's)

6.2   Fire Danger Region Results

Figure 6-3 presents the number of infringements (including Drive-By's) per fire-ban region across 2010-2017. Generally, the Flinders Ranges, the West Coast, the Yorke Peninsula, the Riverland and Adelaide Metropolitan regions performed poorly compared to 2016, while the Lower Eyre Peninsula, Kangaroo Island, Mid North,and the Lower South East showed marked improvement. No change in performance was observed for the Murraylands, Mount Lofty, or the Upper South East regions.
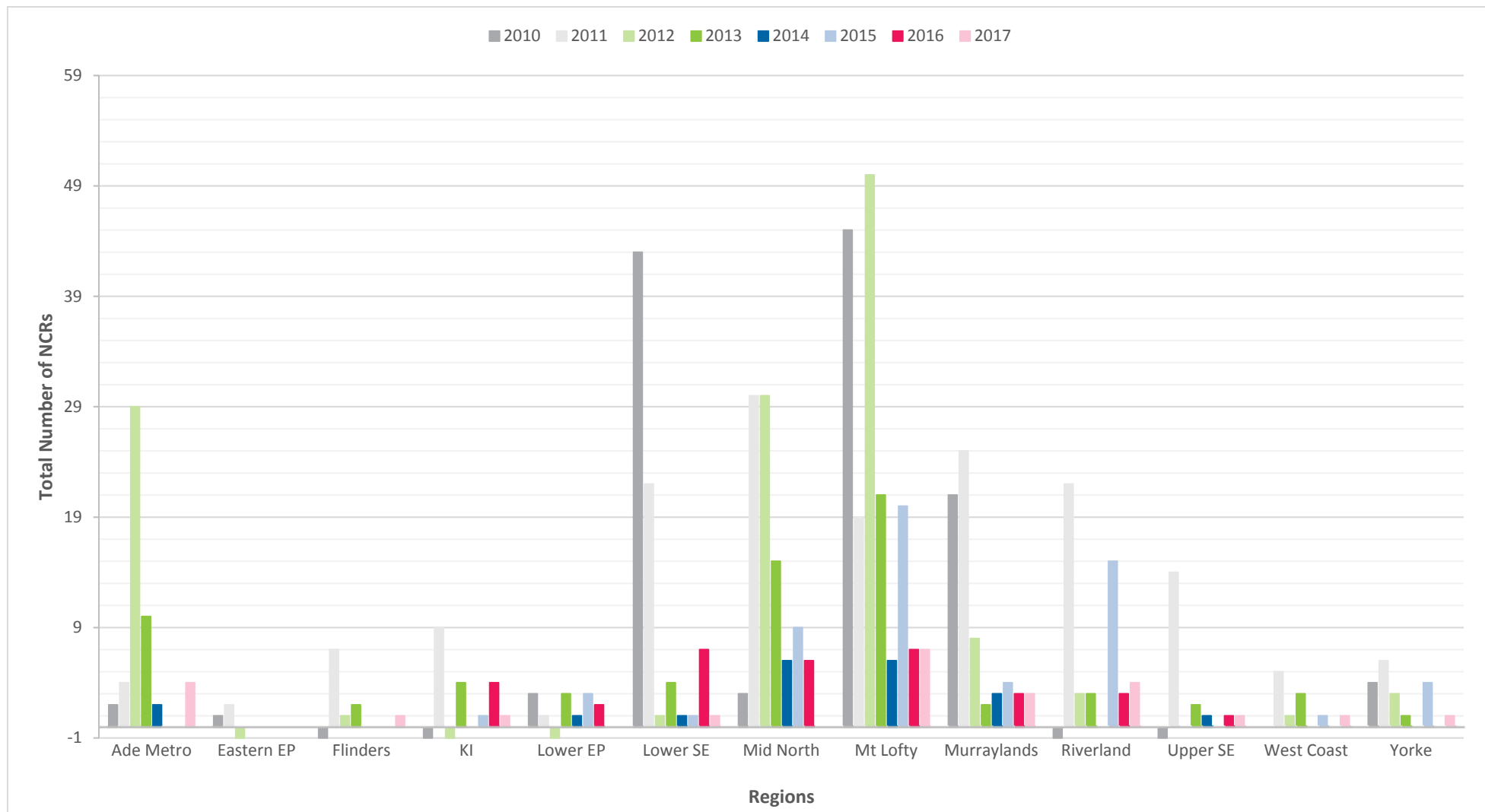
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Figure 6-3 Annual NCR Summary across the 13 South Australian Fire Danger Regions (2010 – 2017) (including Drive-By's) [1,2]

[1] Values shown as "-1" indicate Regions that were not audited in the relevant year

[2] "Ade Metro" = Adelaide Metro; "Eastern/Lower EP" = Eastern/Lower Eyre Peninsula; "KI" = Kangaroo Island; "Lower/Upper SE" = Lower/Upper South East

6.3　District & Feeder Results

A summary of infringement rates for Districts and Feeders is presented in Table 6-3 and Table 6-4, respectively. There were nine Districts with multiple (greater than one) NCRs recorded, including Drive-By's, with the District of St Marys (HBFRA) recording the highest infringement rate.

Table 6-3 District-Level Infringement Rates (Includes Drive-By's)

District	Risk Area	Audited Spans	Total NCRs	NCRs / Spans
Districts with multiple NCR sites				
Saint Marys	HBFRA	113	3	2.65%
Victor Harbor	HBFRA	104	2	1.92%
Barmera	HBFRA	105	2	1.90%
Lameroo	HBFRA	119	2	1.68%
Mount Barker	HBFRA	121	2	1.65%
Loxton	HBFRA	138	2	1.45%
Districts with single NCR sites				
Murray Bridge	HBFRA	78	1	1.28%
Gumeracha	HBFRA	90	1	1.11%
Holden hill	HBFRA	111	1	0.90%
Bordertown	HBFRA	117	1	0.85%
Kangaroo Island	HBFRA	117	1	0.85%
Stirling	HBFRA	117	1	0.85%
McLaren Vale	HBFRA	119	1	0.84%
Gladstone	HBFRA	120	1	0.83%
Millicent	HBFRA	120	1	0.83%
Yorketown	HBFRA	125	1	0.80%
Ceduna	HBFRA	138	1	0.72%

Multiple NCRs were recorded on four Feeders, listed in Table 6-4 below.

Table 6-4 Feeders with Multiple NCRs (Includes Drive-By's)

Feeder	Feeder Names	District	Risk Area	Total NCRs in Feeder
MTB11	Windmill 11 kV	Mount Barker		2
SM126D	Eden 11 kV	Saint Marys	HBFRA	2
VH18	Waitpinga 11 kV	Victor Harbor		2
LX34	Gurra 11 kV	Loxton	MBFRA	2

A comparison of overall change in infringement rate from 2016 through 2017 is displayed in Figure 6-4, with negative y-values representing a decrease in infringement rate (improvement in vegetation clearance) and positive y-values representing an increase in infringement rate. It should be noted that this figure is not representative of all Districts' performance for 2016-2017, but focuses predominantly on Districts presented in Table 6-3 to provide an indication of relative performance (and change in performance) between 2016-17. A number of Districts highlighted in the 2016 pre-fire danger season audit report as having particularly high infringement rates have also been included by way of comparison.
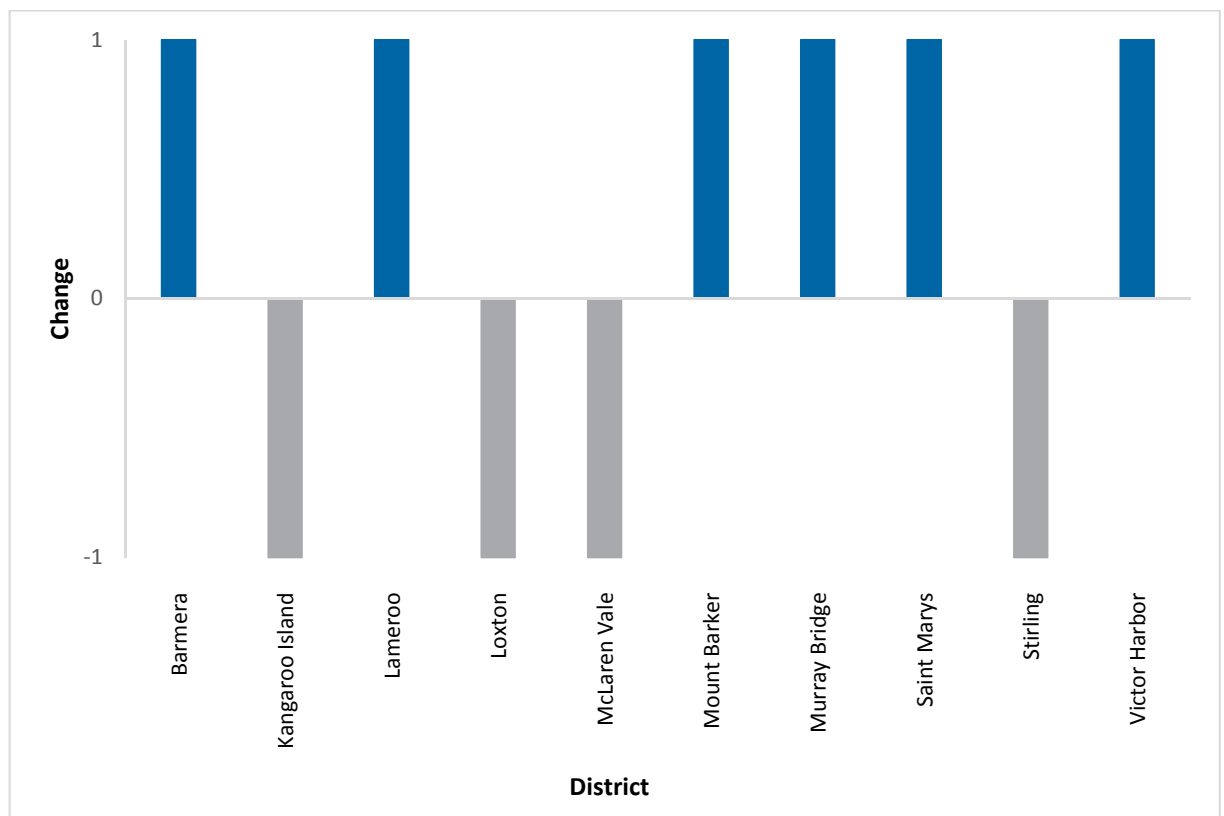
Figure 6-4 Overall Change in Infringement Rates across 10 Districts for 2016/2017 [1,2]

Note:

[a] "+1" denotes an increase in infringement rate for 2017

[b] "-1" denotes a decrease in infringement rate for 2017

6.4   Bushfire Risk Area NCR Analysis

Across the SA Power Networks designated HBFRA and MBFRA areas, the site NCR split was:

- HBFRA
  - 2017 – 44%
  - 2016 – 62%
- MBFRA
  - 2017 – 56%
  - 2016 – 38%

The NCRs/Span in the HBFRA is 0.6% compared to the MBFRA of 0.5%. Table 6-5 and Figure 6-5 present the results for 2012-2017.

Table 6-5 Annual Infringement Summary by Bushfire Risk Area 2012 – 2017 (excluding Drive-By's)

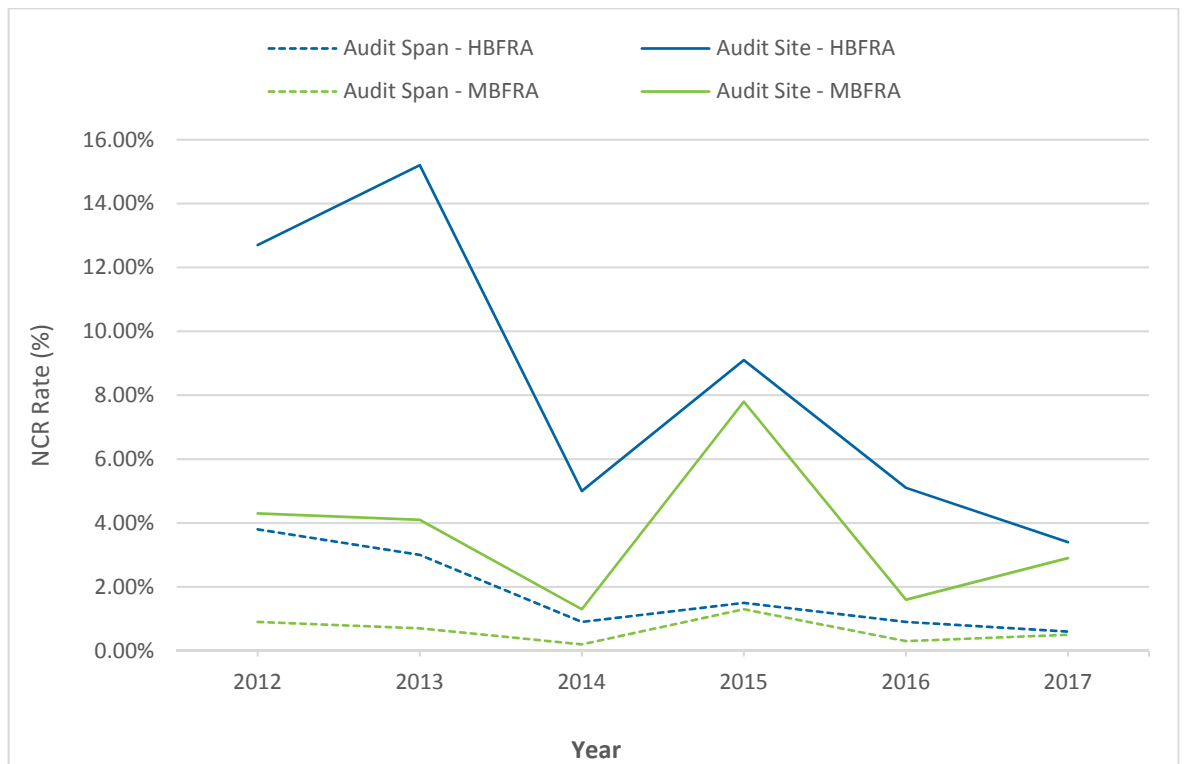| Risk Area	Audit Sites	Site NCR	Site NCR Rate	No. of Spans	Span NCR	Span NCR Rate
2017						
HBFRA	328	11	3.4%	1918	11	0.6%
MBFRA	411	12	2.9%	2461	12	0.5%
TOTAL	**739**	**23**	**3.1%**	**4379**	**23**	**0.5%**
2016						
HBFRA	333	17	5.4%	1957	18	0.9%
MBFRA	613	10	1.8%	3672	11	0.3%
TOTAL	**946**	**27**	**2.9%**	**5629**	**29**	**0.5%**
2015						
HBFRA	219	20	9.1%	1300	20	1.5%
MBFRA	335	26	7.8%	1962	26	1.3%
TOTAL	**554**	**46**	**8.3%**	**3262**	**46**	**1.4%**
2014						
HBFRA	240	12	5.0%	1395	13	0.9%
MBFRA	392	5	1.3%	2332	5	0.2%
TOTAL	**632**	**17**	**2.7%**	**3727**	**18**	**0.5%**
2013						
HBFRA	243	37	15.2%	1444	43	3.0%
MBFRA	320	13	4.1%	1916	14	0.7%
TOTAL	**563**	**49**	**8.9%**	**3360**	**57**	**1.7%**
2012						
HBFRA	260	33	12.7%	1377	52	3.8%
MBFRA	209	9	4.3%	1162	10	0.9%
TOTAL	**469**	**42**	**9.0%**	**2539**	**62**	**2.4%**

Figure 6-5 Audit Span and Audit Site MBFRA / HBFRA Trend Chart – 2012 to 2017 (excluding Drive-By's)

The NCRs (excluding Drive-By's) at the District level are represented in Figure 6-6. As the designated bushfire risk area (BFRA) for Districts will often vary from one Feeder to another, and similarly the BFRA for a Feeder may vary between audit sites, the BFRA ratings presented in Figure 8 are representative of the BFRA at the specific audit site (not for the Feeder generally). In 2017, the highest number of NCRs was recorded in the HBFRA District of Saint Marys, with most of these infringements recorded while auditing the Eden (SM126D) 11kV Feeder.
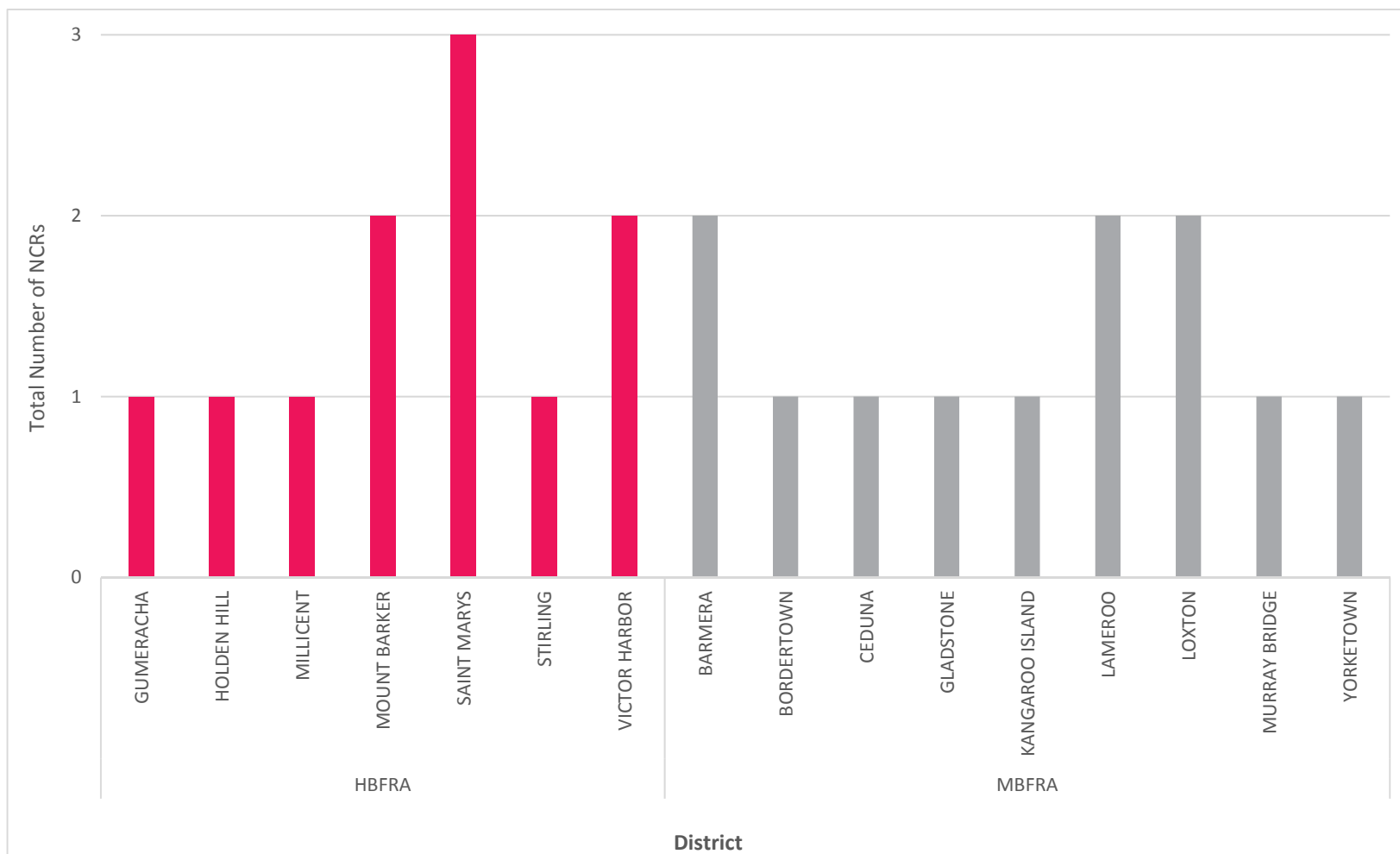
Figure 6-6 Audit-Site Infringements across HBFRA/MBFRA Districts for 2017 (excluding Drive-By's)

6.5   Drive-By NCRs

Drive-By NCRs have necessarily been excluded from the core analysis of the audit results as they cannot be consistently replicated across audit years, leading to potentially invalid comparisons and conclusions. They can however be used to provide additional context to the effectiveness of the clearance programs.

A summary of Drive-By recordings from 2015-2017 are presented in Table 6-6.

Table 6-6 Drive-By NCRs 2015 - 2017

Measure	2015	2016	2017
Total	12	4	1
CZ Infringements	9	2	1
Bend & Grows	3	2	0
HBFRA	7	2	1
BFRA	5	2	0
High Voltage	4	3	0
Low Voltage	8	1	1

Given the ad-hoc nature of Drive-By's, most NCR recordings will reflect vegetation that is very clearly breaching (or close to breaching) the clearance zone. Thus, a higher number of Drive-By's generally indicates inadequate vegetation clearance – as was the case in 2015. Conversely, the smaller number of Drive-By's in 2016 and 2017 is broadly suggestive of a more effective cutting program.

6.6   Species Distribution

Vegetation Species

Species information for each NCR (including Drive-By's) was captured and is reproduced in Table 6-7. Figure 6-7 shows the distribution of species according to NCR classification (CZ Infringements and Bend & Grows).

Overall, Gum trees feature as the highest NCR category with all infringements associated with actual CZ breaches. It should however be noted that Gum trees are the dominant species in most of the Districts – thus the likelihood of identifying an NCR associated with a Gum tree is greater.

Palm trees also occurred frequently as non-compliances (CZ Infringements: 17%), with most non-compliances associated with residential properties. Ash trees and Japanese Maples were the dominant species in townships and non-compliances were most often associated with Low Voltage powerlines.

Xanthorrhoea Quadrangulata species (also commonly referred to as 'kangaroo tails') recorded a 12.5% find rate. These species have spikes that can grow rapidly, and unpredictably – making it difficult to cut to compliance. GHD acknowledges that it is unlikely that these species will ever sustain sufficient vertical growth to reach a high voltage powerline, and that it is not possible to sensibly proactively cut these; however the expectation with all vegetation beneath or adjacent

powerlines is that actual or foreseeable breaches of the clearance zone will be reported. Consequently, the 'kangaroo tail' infringements have been retained in the audit.

Table 6-7 Species of Vegetation for NCRs (including Drive-By's)

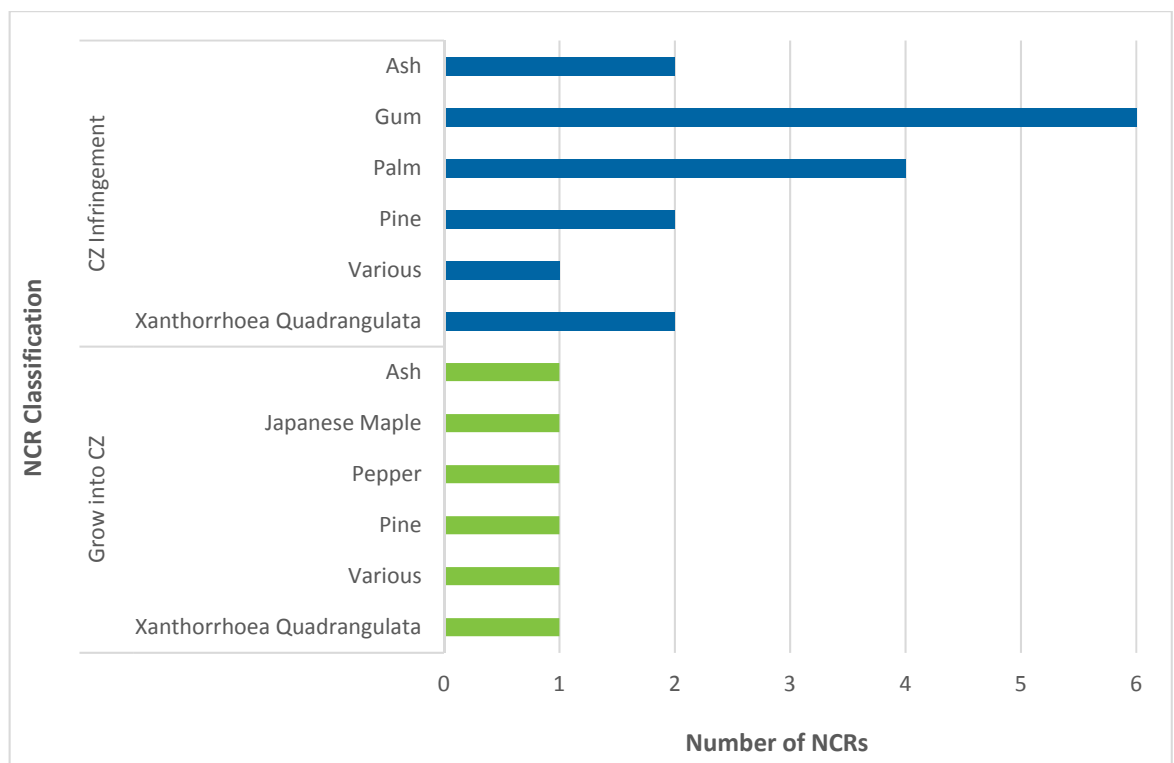| Species	Number of NCRs	Percent of NCRs
Gum	6	25%
Palm	4	17%
Pine	3	12.5%
Xanthorrhoea Quadrangulata	3	12.5%
Ash	3	12.5%
Various	3	12.5%
Japanese Maple	1	4%
Pepper Tree	1	4%
TOTAL	**24**	**100%**

Figure 6-7 Species Distribution across NCR Categories (excluding Drive-By's)

6.7   NCR Observations

The Mount Lofty Region

No infringements were identified in Stirling District, which recorded the highest infringement rate (NCRs / Spans) of all the Districts in 2016.

Similarly, a marked improvement in clearance efficiency has been noted for the District of Noarlunga where the infringement rate has dropped from 6.04% in 2015 to a zero percent find rate in 2017.

On the Regional-scale, the Mount Lofty Ranges shows an overall downward trend in non-compliance as compared to previous years. This is notable considering that the Region is the most densely vegetated, and that maintaining clearances has been problematic historically due to high levels of rainfall and presence of fast-growing species.

Adelaide Metropolitan Region

A total of seven NCRs (including Drive-By's) were logged for the Adelaide Metropolitan region, with three of the NCRs identified in the Saint Marys District. This finding represents an increase in the infringement rate for St Marys compared to 2016, when no NCRs were identified in this District.

The Lower South-East Region

In 2016, the number of NCRs recorded in the Lower South East Region was the highest since 2011 (see Figure 6-3). Notably, only one NCR was recorded in the Lower South East in 2017 – an indication of improved vegetation clearance and management in this region.

The Murraylands Region

Two NCRs were recorded in the Lameroo District, as well as one NCR in Murray Bridge. Historically, NCRs are uncommon in Lameroo, and the logged NCRs highlight a potential weakness in the vegetation clearance program.

7.   Tree Sapling Audit

In addition to the vegetation compliance audit, GHD also undertook an audit of tree saplings with potential to become problematic as they mature and could grow into the clearance zone.

The findings of this audit provide a snapshot of a Feeder at a point in time. Extrapolation of sapling counts to a District or Region level should be treated with caution.

Saplings were identified across 24 of the 40 Districts audited in the 2017 Pre-Summer audits. The highest number of saplings at a District level was observed on Kangaroo Island, with over 500 saplings identified across 117 spans (19 audit sites), as shown in Figure 7-1. A large number of saplings were also observed in Holden Hill, mostly associated with vegetation growing beneath powerlines at the Cleland Conservation Park

Figure 7-1 Total Number of Saplings Identified across 24 Districts in 2017
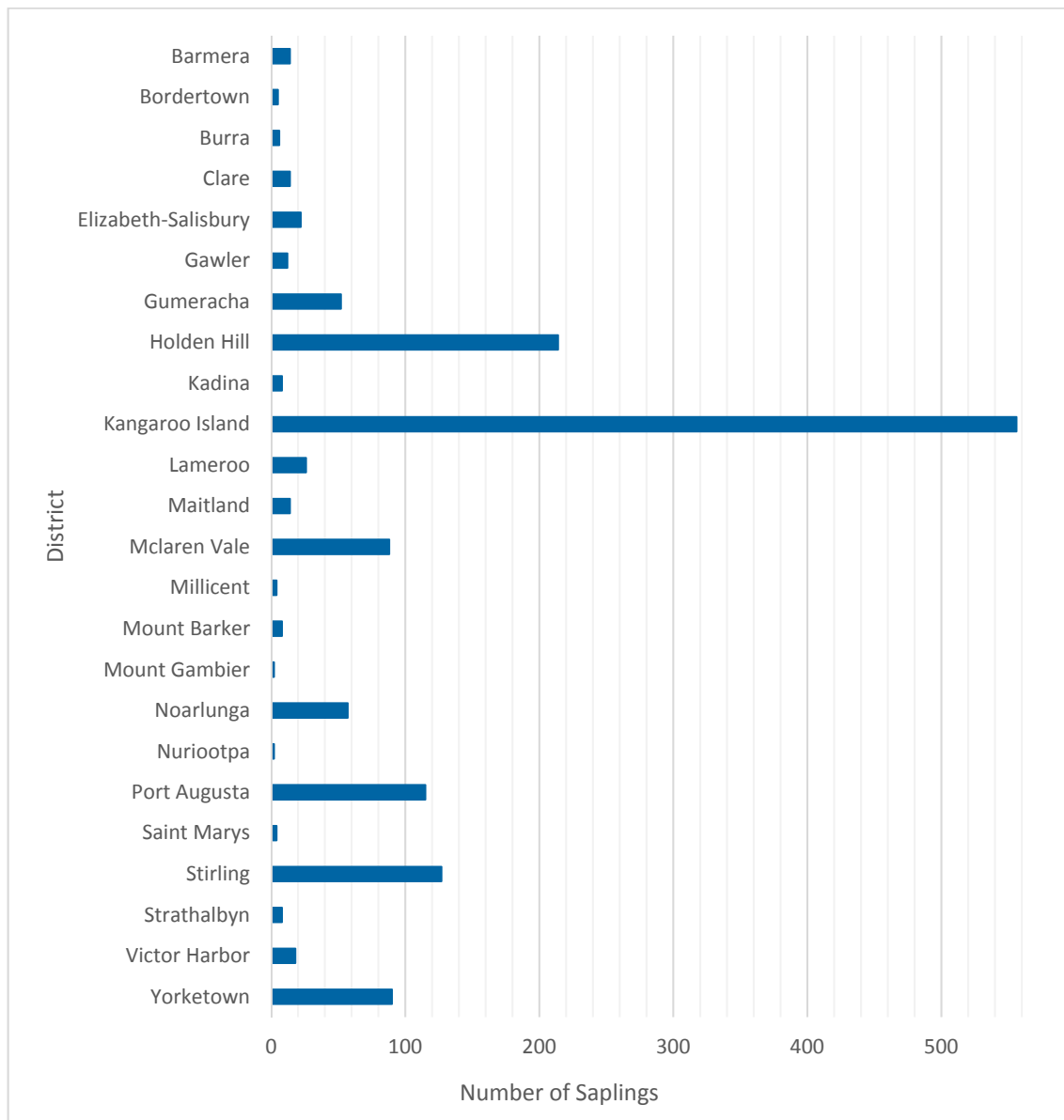
At the Feeder level, the highest number of saplings are again associated with the Kangaroo Island District, localised around the KI13 Island Beach 11 kV and KI16 Brown Beach 11 kV Feeders (Figure 7-2). The HH148D Burnside 11 kV Feeder also contained a high density of saplings. A sapling count above 100 was recorded for Port Augusta and Stirling Districts.
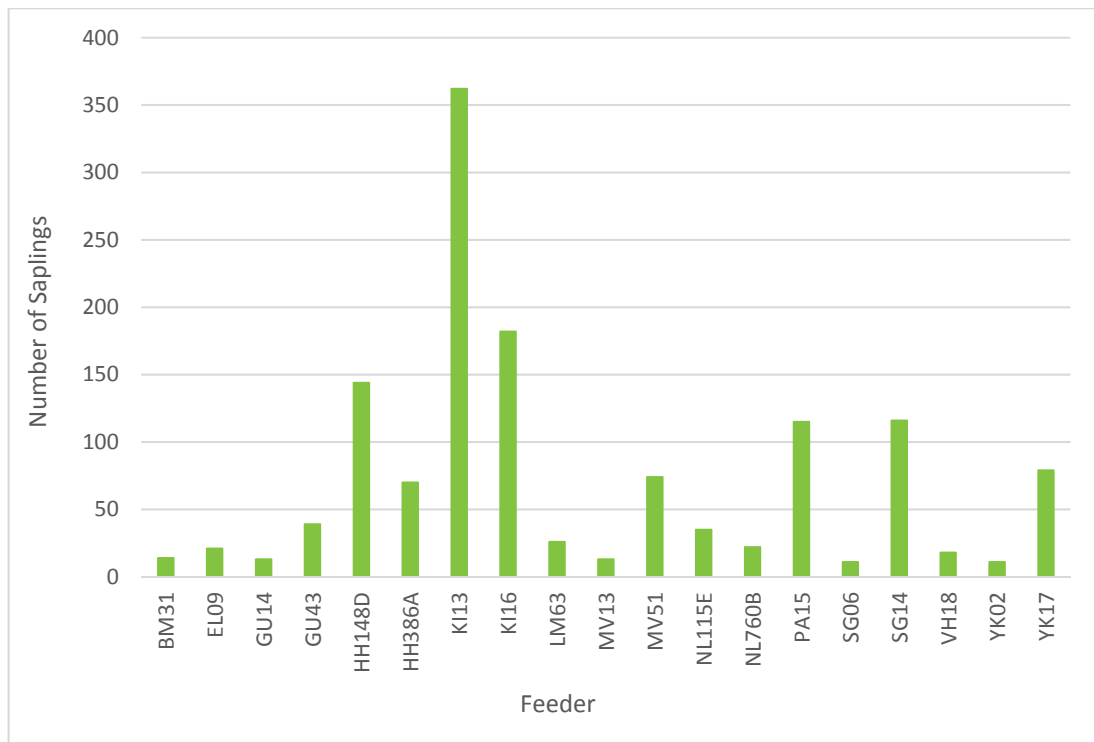
Figure 7-2 Number of saplings identified across a range of Feeders in the 2017 Pre-Summer audit [1]

Note:

[a] Figure 7-2 is a subset of the audit dataset, and does not reflect many of the Feeders which had sapling counts of 10 or less.

Across 14 Feeders, saplings were identified on only one span for each of those Feeders. This is presented graphically in Figure 7-3.

Figure 7-3 The number of saplings observed on only one span within the respective Feeders

At the span-level, sapling predominance in any one span within a Feeder is represented graphically in Figure 7-4. From this figure, the sapling count within any one span was highest in the KI13 Island Beach 11 kV and the YK17 Point Turton 11 kV Feeders.
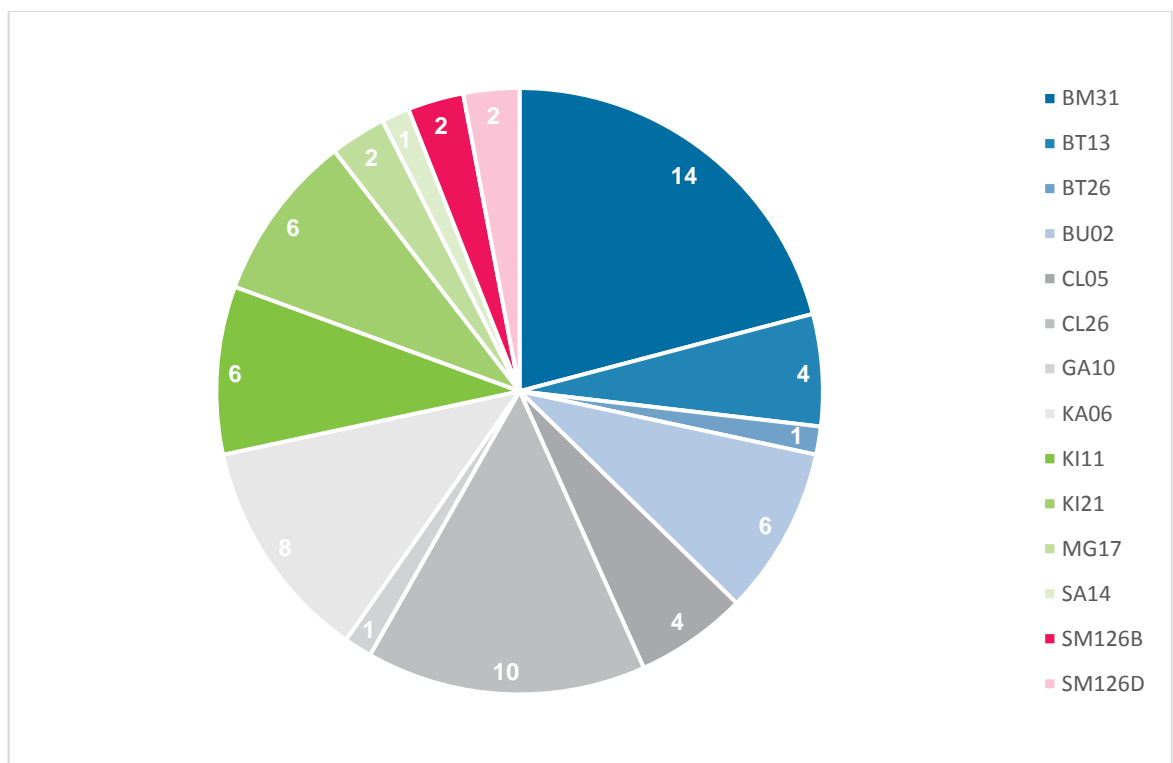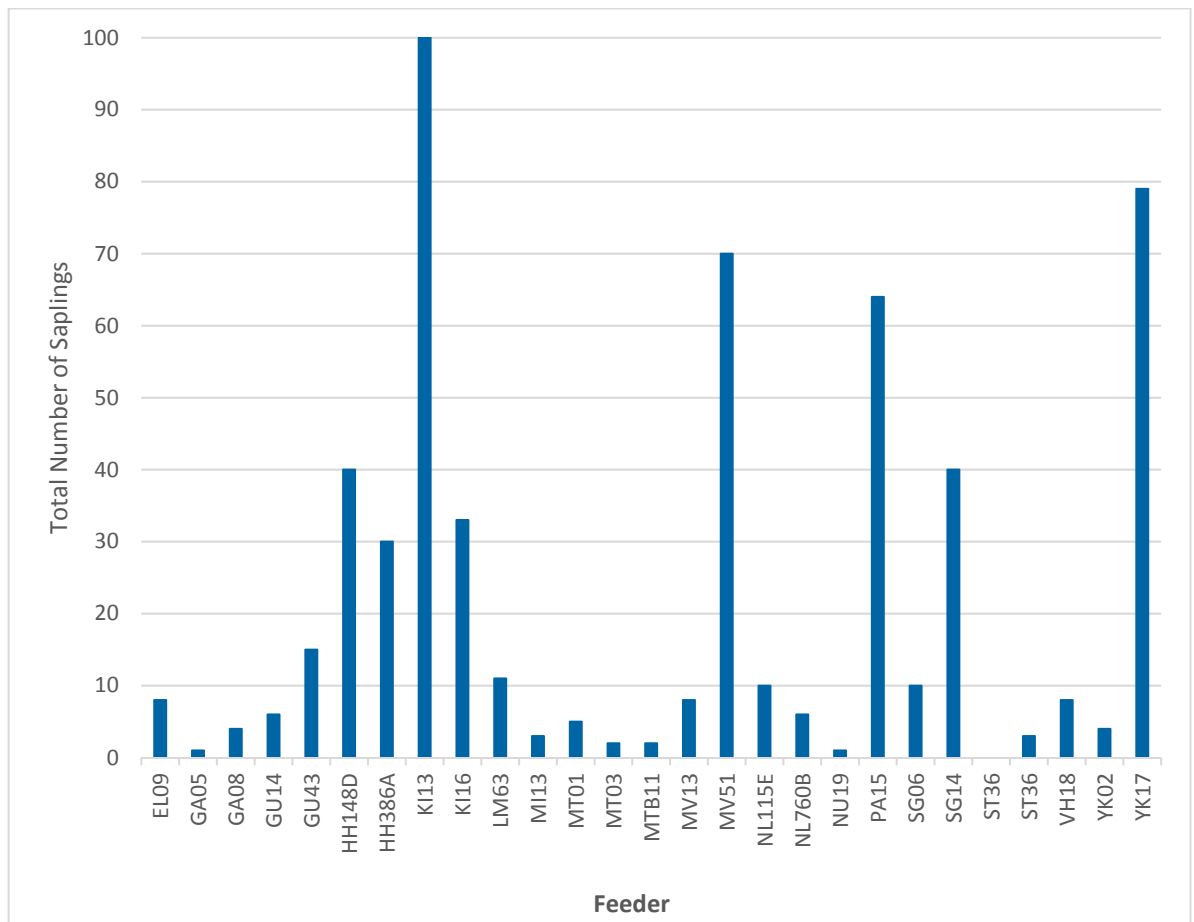

Figure 7-4 Total number of saplings across one span within the respective Feeder

A high level summary is provided below:

- The greatest number of saplings identified on a per span basis was on the KI13 Island Beach 11 kV Feeder.

- Very few saplings were identified in the West Coast and Yorke Peninsula Districts. However, a significant number of saplings (79 in total) were identified in one span on the YK17 Yorketown 11 kV Feeder.

- A significant number of saplings were identified in Holden Hill near the Cleland Conservation Park. Approximately 20 saplings per span were observed for four consecutive spans. These saplings were mostly identified as gums and wattles.

- The high number of saplings identified is indicative of a potentially significant increase in cutting volumes in the future – unless appropriately addressed and managed.

8. Visual Amenity Audit

8.1 Overview

A basic visual assessment audit was undertaken concurrently with the compliance and tree sapling audits in selected districts. The amenity audit focused on the following factors:

- The outcome of the pruning

- The significance or visual value of the tree(s) in the landscape

- The contribution of the tree(s) to the future landscape

- The general health of the tree

- The percentage of tree canopy

Not all sites within a given Feeder were assessed for visual amenity. For the most part, visual assessments predominantly focused on trees that appeared to be in poor health and / or where the results of tree trimming was less than optimum. This has resulted in a skewed dataset, meaning that any conclusions drawn from a statistical analysis of the data would be unreliable.

A subset of the visual amenity audits has been provided in Appendix F. It should be noted that GHD does not have qualified arborists, and that the rankings of visual amenity factors in these audit reports is subjective, and based on the knowledge and experience of the audit team only. No recommendations with regards to removal of trees or pruning practices have been put forth at this time.

8.2 General Observations

A range of trees were identified across the network that provided little to no value to the landscape – either due to poor health or less than optimal pruning. Gum trees below powerlines were generally classified as likely to draw adverse community comment because of excessive trimming to maintain clearance.

9.   Reporting Qualifications

- From the Audit Summary Table at Appendix A it has been calculated that approximately 10% of the total spans on audited Feeders (approximately 46,842) were audited – this only includes those spans assessed as part of the selected audit site (i.e. it excludes the Drive-By NCRs observed in adjacent Feeders).

- Whilst the sites subject to the audit are selected at random, they are generally selected across the whole Feeder. By default, this results in a greater proportion of the Feeder being assessed through the Drive-By observations.

- The 412,139 of total spans (HBFRA & MBFRA) is confirmed as the Total Spans Scoped in the ATS data provided.

10. Conclusions & Recommendations

Overall, vegetation compliance in 2017 is on par with results achieved in 2016 and shows a marked improvement compared to historical data, with an overall downward trend in logged NCRs across the 13 South Australian Regions.

In contrast to findings in 2016 where a number of Feeders were identified with a high number of NCRs (greater than three NCRs), no more than two NCRs per Feeder were identified in 2017. The SG14 Upper Sturt (11 kV) Feeder which was highlighted in 2016 for recording the highest infringement rate was revisited in the 2017 audits and only one NCR was identified overall. Other 'problem Districts' that have been flagged in the past, including Noarlunga and Kangaroo Island, also show vast improvement in 2017 as compared to previous years.

Although the infringement rate indicates a downward trend compared to historical data, there is still scope for continued improvement – in context, this year's span non-conformance rate (approximately 0.5%) indicates that BFRA's in the network comprising 412,139 spans may have 2060 NCRs that are yet to be identified.

The St Marys District, in particular, was noted for poor performance in the 2017 Pre-Summer audit – and as this District is classified as a HBFRA, the risk of fire is significant. It is acknowledged that St Marys is a densely populated area where clearances can be difficult to maintain due to both community and environmental factors. It is in these areas that alternate clearance strategies could potentially be investigated, such as vegetation removal or reconstruction options.

In 2016, a greater number of the identified NCRs were associated with potential grow-ins, likely a result of the above-average rainfall across the 2016 winter and early spring contributing to accelerated growth rates for some species. The opposite was true for NCRs identified in 2017, with 74% of NCRs corresponding to actual clearance zone infringements. With the below-average rainfall over the winter of 2017, it is not surprising that vegetation vigour would be affected, and consequently that the potential for vegetation to grow into the clearance zone would be lower. The greater number of NCRs associated with vegetation that is already within the clearance zone suggests that growth may have been fuelled by sub-soil moisture from 2016 and early-2017 which was wetter than average. Developing a model to predict vegetative growth patterns arising from climactic variations would be an improvement to the current vegetation program.

The Electricity Act 1996 stipulates that any electricity entity must 'take reasonable steps' to ensure that vegetation of all kinds is kept clear of public powerlines, and that naturally occurring vegetation is kept clear of private powerlines. While full compliance has not been achieved in 2017, SA Power Networks has ensured that the vegetation clearance program was completed on schedule, with non-conformance rates trending lower than in previous years (excepting 2014). It is therefore GHD's opinion that SA Power Networks has undertaken necessary measures (reasonable steps) to ensure that vegetation is clear of powerlines.

A summary of observations and recommendations are provided in Table 10-1 for consideration and potential implementation into the 2018 Cyclic/Pre-Summer Audits.

Table 10-1   Observations and Recommendations – 2017

Observation	Conclusion / Recommendation	Priority[a]
Improved performance over a six-year period for the vegetation clearance program.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	**2**
Following on from recommendations in 2016, GHD undertook a greater number of audits within each District in 2017 (e.g. 3 or 4 Feeders per District where feasible).	A more holistic snapshot of the network was achieved, inspiring a greater level of confidence in the audit results overall.	**-**
No Feeders with more than three NCRs were identified in the 2017 vegetation audits.	This is a marked improvement from 2016, where two Feeders (MG05 and KI54) logged three or more NCRs.	**-**
In 2016, when rainfall was above average, a proportion of the NCRs identified in the Pre-Summer audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone.

In 2017, rainfall was well below average during the winter months, and a smaller proportion of the NCRs identified in the Pre-Summer audit were associated with potential grow-in infringements. A similar trend was observed in 2015 during a period of below-average rainfall. | Forecasting of vegetation growth patterns / vigour with respect to climate conditions will assist SA Power Networks in tailoring site visits and informing scoping and cutting schedules. The team understands that SA Power Networks is already exploring this avenue.

One of the recommendations from 2016 was related to the use of remotely sensed imagery to assist in monitoring vegetation growth and vigour. A range of methods could be used (e.g. application of vegetation indices, change detection imagery, the use of geographic image based analysis to isolate trees and extract spectral data and thereby determine vegetation vigour / growth) which would again enable better tailoring of site visits. | **2, 3** |
| Scoping and cutting data (on a span-by-span basis) was not made available to the GHD team – limiting the team's ability to assess the cause of non-compliances. | It is understood that SA Power Networks has access to this information which is provided by the incumbent contractor. It would be beneficial to negotiate the supply of this scoping and cutting data to the GHD team for future audits. | **2** |
| A large number of saplings were identified in Kangaroo Island, and in some areas of the Mount Lofty Ranges. | GHD understands that SA Power Networks is currently in discussions with local councils and the OTR regarding removal of tree saplings from beneath powerlines. The outcome of this tree sapling audit indicates that this is a priority. | **1** |

Observation	Conclusion / Recommendation	Priority[a]
In a number of the urban areas, some homeowners expressed their frustration with vegetation cutters assuming a 'one size fits all' approach when cutting instead of 'species-specific' approach to cutting.	GHD understands that arborist training has been provided for the cutting crew, and the team generally encountered fewer dissatisfied customers in 2017 as compared to 2016. However, from a visual amenity perspective, assuming a 'one size fits all' approach to cutting simply is not ideal and this is certainly an area for additional improvement.	3
Undertaking sapling audits in 2017 revealed a number of private landowners planting inappropriate vegetation below powerlines (e.g. fast-growing Eucalyptus trees).	Ensure that all private landowners (particularly those in remote regions) are educated with regards to appropriate vegetation for planting near powerlines.	2

[a] Priority Categories:

   1 - Priority

   2 - Strategic Improvement

   3 - Opportunity for Improvement

A copy of the 2016 Observations and Recommendations has been provided in Appendix G for reference.

11. References

Australian Government Bureau of Meteorology (2017). Rainfall and temperature records. Accessed 4 December 2017 <http://www.bom.gov.au>.

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Johansen, K., Arroyo, L.A., Phinn, S., & Witte, C. (2010). Comparison of geo-object based and pixel-based change detection of riparian environments using high spatial resolution multi-spectral imagery. *Photogrammetric Engineering & Remote Sensing*, 76, 123-136.

Appendices

Appendix A – Feeders Audited

Summary of Districts and Feeders Audited

Region	District	Feeder	Feeder Name	Feeder Risk Rating	Contractor
Adelaide Metropolitan	Elizabeth-Salisbury	EL09	Elizabeth East 11 kV	HBFRA	GHD
		EL12	One Tree Hill 11 kV	HBFRA	GHD
		EL18	Blakeview 11 kV	HBFRA	GHD
		SA14	Salisbury Plains 11 kV	HBFRA	GHD
	Holden Hill	HH148D	Burnside 11 kV	HBFRA	GHD
		HH386A	Glen Osmond 11 kV	HBFRA	GHD
	Saint Marys	SM126B	Sun Valley 11 kV	HBFRA	GHD
		SM126D	Eden 11 kV	HBFRA	GHD
Eastern Eyre Peninsula	Cleve	CV07	Ticklebelly Hill 11 kV	MBFRA	Helistar
		CV26	Elbow Hill 19 kV	MBFRA	Helistar
Flinders	Gladstone	G05	Laura 11 kV	MBFRA	Helistar
		G08	Bangor 19 kV	MBFRA	Helistar
	Hawker	HK02	Wilpena 19 kV	MBFRA	Helistar
		HK03	Edeowie 19 kV	MBFRA	Helistar
	Port Augusta	PA11	Wilmington South 19 kV	MBFRA	Helistar
		PA15	Partacoona 19 kV	MBFRA	Helistar
Kangaroo Island	Kangaroo Island	KI11	Penneshaw 11 kV	MBFRA	GHD
		KI13	Island Beach 19 kV	MBFRA	GHD
		KI16	Brown Beach 19 kV	MBFRA	GHD
		KI21	American River 11 kV	MBFRA	GHD
Lower Eyre Peninsula	Cummins	CM01	Edlilile 11 kV	MBFRA	Helistar
		CM26	Koppio 19 kV	MBFRA	Helistar
	Port Lincoln	PL14	Shields 11 kV	HBFRA	Helistar
		PL15	Hage 11 kV	HBFRA	Helistar
Lower SE	Millicent	MI02	Tantanoola 11 kV	HBFRA	GHD
		MI13	Long Beach 7.6 kV	HBFRA	GHD
		MI17	Lake Bonney 19 kV	HBFRA	GHD
	Mount Gambier	MG09	Ob Flat 11 kV	HBFRA	GHD
		MG17	Pt Macdonnell 11 kV	HBFRA	GHD
		MG23	Nangwarry 11 kV	HBFRA	GHD
	Naracoorte	NA01	Naracoorte 11 kV	HBFRA	GHD
		NA08	Joanna 11 kV	HBFRA	GHD
		NA33	Katnook 11 kV	HBFRA	GHD
Mid North	Burra	BU02	Burra 19 kV	MBFRA	GHD
		BU04	Hallett 19 kV	MBFRA	GHD
		BU06	Mount Bryan 11 kV	MBFRA	GHD
		BU07	Samin 11 kV	MBFRA	GHD
	Clare	CL02	Kybunga 11 kV	MBFRA	GHD
		CL05	Penwortham 11 kV	HBFRA	GHD
		CL23	Clare 11 kV	HBFRA	GHD
		CL26	Spring Gully 19 kV	MBFRA	GHD
	Gawler	GA05	Sandy Creek 11 kV	HBFRA	GHD
		GA08	Williamstown 11 kV	HBFRA	GHD
		GA10	Lyndoch South 7.6 kV	HBFRA	GHD
	Nuriootpa	NU05	Tanunda 11 kV	HBFRA	GHD
		NU06	Kapunda South 11 kV	MBFRA	GHD
		NU19	Freeling 11 kV	HBFRA	GHD
	Port Pirie	PP04	Pirie South 11 kV	MBFRA	GHD
		PP05	Warnertown 11 kV	MBFRA	GHD
	Riverton	R07	Waterloo 19 kV	MBFRA	GHD
		R21	Hamley Bridge 11 kV	MBFRA	GHD
		R22	Alma 11 kV	MBFRA	GHD
Mt Lofty	Gumeracha	GU14	Kersbrook 11 kV	HBFRA	GHD
		GU43	Cudlee Creek 11 kV	HBFRA	GHD
	Mclaren Vale	MV13	Mclaren Flat 11 kV	HBFRA	GHD
		MV51	Willunga North 11 kV	HBFRA	GHD
		MV53	Dingabledinga 11 kV	HBFRA	GHD
	Mount Barker	MTB11	Windmill 11 kV	HBFRA	GHD
		MTB41	Balhannah 11 kV	HBFRA	GHD
	Noarlunga	NL115E	Woodcroft 11 kV	HBFRA	GHD
		NL760B	Hackham East 11 kV	HBFRA	GHD
	Stirling	SG06	Jibilla 11 kV	HBFRA	GHD
		SG14	Upper Sturt 11 kV	HBFRA	GHD
	Victor Harbor	VH16	Victor Harbor West 11 kV	HBFRA	GHD
		VH18	Waitpinga 11 kV	HBFRA	GHD
Murraylands	Lameroo	LM14	Geranium 19 kV	MBFRA	Helistar
		LM43	Bews North 19 kV	MBFRA	Helistar
		LM55	Pinnaroo South 11 kV	MBFRA	Helistar
		LM63	Pinnaroo North 19 kV	MBFRA	Helistar
	Mannum	M11	Mannum North 7.6 kV	MBFRA	Helistar
		M13	Mannum South 7.6 kV	MBFRA	Helistar
		M71	Nildottie 11 kV	MBFRA	Helistar
	Murray Bridge	MB14	Brinkley 19 kV	MBFRA	Helistar
		MB27	Toora 11 kV	MBFRA	Helistar
	Strathalbyn	ST14	Strathalbyn 19 kV	MBFRA	GHD
		ST36	Bull Creek 11 kV	HBFRA	GHD
Riverland	Barmera	BM15	Cobdogla 11 kV	MBFRA	Helistar
		BM31	Monash 11 kV	MBFRA	Helistar
		BM44	Berri West 11 kV	MBFRA	Helistar
		BM54	Calperum 11 kV	MBFRA	Helistar
		BM55	Renmark West 11 kV	MBFRA	Helistar
		BM56	Cooltong 11 kV	MBFRA	Helistar
	Loxton	LX34	Gurra 11 kV	MBFRA	Helistar
		LX63	Pata East 19 kV	MBFRA	Helistar
	Waikerie	WK33	Taylorville 11 kV	MBFRA	Helistar
		WK81	Portee 11 kV	MBFRA	Helistar
Upper SE	Bordertown	BT13	Geegeela 19 kV	MBFRA	GHD
		BT26	Keith South 11 kV	MBFRA	GHD
	Coonalpyn	CN12	Binnies 19 kV	MBFRA	Helistar
		CN42	Point Mcleay 11 kV	MBFRA	Helistar
West Coast	Ceduna	CD02	Ceduna 11 kV	MBFRA	Helistar
		CD15	Kalanbi 19 kV	MBFRA	Helistar
		CD25	Emu Leg 19 kV	MBFRA	Helistar
	Streaky Bay	SB02	Flinders 11 kV	MBFRA	Helistar
		SB20	Cape Bauer 19 kV	MBFRA	Helistar
		SB21	Gibson Peninsula 19 kV	MBFRA	Helistar
	Wudinna	W04	Elliston 11 kV	MBFRA	Helistar
		W29	Witera 19 kV	MBFRA	Helistar
Yorke	Kadina	KA06	Kadina 11 kV	MBFRA	GHD
		KA10	Moonta 19 kV	MBFRA	GHD
	Maitland	MT01	Sth Maitland 11 kV	MBFRA	GHD
		MT03	Arthurton 11 kV	MBFRA	GHD
	Yorketown	YK02	Stansbury 11 kV	MBFRA	GHD
		YK17	Point Turton 11 kV	MBFRA	GHD
		YK18	Sunbury 11 kV	MBFRA	GHD

Appendix B – Audit Results Summary Table

Region	District	Feeder	Feeder Name	Feeder Risk Rating	Audit Sites (ex DBs)	Audit Spans (ex DBs)	Drive-By Spans	Audit Sites (inc DBs)	Audit Spans (inc DBs)	Audit Site CZ	Audit Site Bend & Grow	Audit Site Total Site NCRs	Drive Bys CZ	Drive Bys Bend & Grow	Drive Bys Total DB NCRs	Total NCRs (Audit Site and DBs)	Infringements per site audited (ex DB) (%)	Infringements per span audited Ex DBs	Infringements per span audited Inc DBs
Adelaide Metropolitan	Elizabeth-Salisbury	EL09	Elizabeth East 11 kV	HBFRA	8	47		8	47								0%	0%	0%
		EL12	One Tree Hill 11 kV	HBFRA	4	19		4	19								0%	0%	0%
		EL18	Blakeview 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		SA14	Salisbury Plains 11 kV	HBFRA	6	33		6	33								0%	0%	0%
	Holden Hill	HH148D	Burnside 11 kV	HBFRA	10	58		10	58								0%	0%	0%
		HH386A	Glen Osmond 11 kV	HBFRA	9	53		9	53	1		1				1	11%	2%	2%
	Saint Marys	SM126B	Sun Valley 11 kV	HBFRA	10	59		10	59	1		1				1	10%	2%	2%
		SM126D	Eden 11 kV	HBFRA	9	54		9	54	1	1	2				2	22%	4%	4%
Eastern Eyre Peninsula	Cleve	CV07	Ticklebelly Hill 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		CV26	Elbow Hill 19 kV	MBFRA	5	30		5	30								0%	0%	0%
Flinders	Gladstone	G05	Laura 11 kV	MBFRA	10	60		10	60	1		1				1	10%	2%	2%
		G08	Bangor 19 kV	MBFRA	10	60		10	60								0%	0%	0%
	Hawker	HK02	Wilpena 19 kV	MBFRA	10	60		10	60								0%	0%	0%
		HK03	Edeowie 19 kV	MBFRA	10	60		10	60								0%	0%	0%
	Port Augusta	PA11	Wilmington South 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		PA15	Partacoona 19 kV	MBFRA	9	54		9	54								0%	0%	0%
Kangaroo Island	Kangaroo Island	KI11	Penneshaw 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		KI13	Island Beach 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		KI16	Brown Beach 19 kV	MBFRA	5	27		5	27								0%	0%	0%
		KI21	American River 11 kV	MBFRA	4	30		4	30	1		1				1	25%	3%	3%
Lower Eyre Peninsula	Cummins	CM01	Edillilie 11 kV	MBFRA	10	60		10	60								0%	0%	0%
		CM26	Koppio 19 kV	MBFRA	5	30		5	30								0%	0%	0%
	Port Lincoln	PL14	Shields 11 kV	HBFRA	13	78		13	78								0%	0%	0%
		PL15	Hage 11 kV	HBFRA	5	30		5	30								0%	0%	0%
Lower SE	Millicent	MI02	Tantanoola 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		MI13	Long Beach 7.6 kV	HBFRA	5	30		5	30		1	1				1	20%	3%	3%
		MI17	Lake Bonney 19 kV	HBFRA	10	60		10	60								0%	0%	0%
	Mount Gambier	MG09	Ob Flat 11 kV	HBFRA	7	42		7	42								0%	0%	0%
		MG17	Pt Macdonnell 11 kV	HBFRA	10	60		10	60								0%	0%	0%
		MG23	Nangwarry 11 kV	HBFRA	5	30		5	30								0%	0%	0%
	Naracoorte	NA01	Naracoorte 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		NA08	Joanna 11 kV	HBFRA	10	59		10	59								0%	0%	0%
		NA33	Katnook 11 kV	HBFRA	5	27		5	27								0%	0%	0%
Mid North	Burra	BU02	Burra 19 kV	MBFRA	5	29		5	29								0%	0%	0%
		BU04	Hallett 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		BU06	Mount Bryan 11 kV	MBFRA	6	36		6	36								0%	0%	0%
		BU07	Samin 11 kV	MBFRA	1	6		1	6								0%	0%	0%
	Clare	CL02	Kybunga 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		CL05	Penwortham 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		CL23	Clare 11 kV	HBFRA	7	42		7	42								0%	0%	0%
		CL26	Spring Gully 19 kV	MBFRA	5	30		5	30								0%	0%	0%
	Gawler	GA05	Sandy Creek 11 kV	HBFRA	10	59		10	59								0%	0%	0%
		GA08	Williamstown 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		GA10	Lyndoch South 7.6 kV	HBFRA	5	30		5	30								0%	0%	0%
	Nuriootpa	NU05	Tanunda 11 kV	HBFRA	6	36		6	36								0%	0%	0%
		NU06	Kapunda South 11 kV	MBFRA	10	57		10	57								0%	0%	0%
		NU19	Freeling 11 kV	HBFRA	14	85		14	85								0%	0%	0%
	Port Pirie	PP04	Pirie South 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		PP05	Warnertown 11 kV	MBFRA	5	30		5	30								0%	0%	0%
	Riverton	R07	Waterloo 19 kV	MBFRA	8	47		8	47								0%	0%	0%
		R21	Hamley Bridge 11 kV	MBFRA	10	60		10	60								0%	0%	0%
		R22	Alma 11 kV	MBFRA	5	30		5	30								0%	0%	0%
Mt Lofty	Gumeracha	GU14	Kersbrook 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		GU43	Cudlee Creek 11 kV	HBFRA	10	60		10	60	1		1				1	10%	2%	2%
	Mclaren Vale	MV13	Mclaren Flat 11 kV	HBFRA	5	27		5	27								0%	0%	0%
		MV51	Willunga North 11 kV	HBFRA	5	35	1	6	36				1		1	1	0%	0%	3%
		MV53	Dingabledinga 11 kV	HBFRA	11	56		11	56								0%	0%	0%
	Mount Barker	MTB11	Windmill 11 kV	HBFRA	15	91		15	91	2		2				2	13%	2%	2%
		MTB41	Balhannah 11 kV	HBFRA	5	30		5	30								0%	0%	0%
	Noarlunga	NL115E	Woodcroft 11 kV	HBFRA	10	52		10	52								0%	0%	0%
		NL760B	Hackham East 11 kV	HBFRA	9	54		9	54								0%	0%	0%
	Stirling	SG06	Jibilla 11 kV	HBFRA	5	30		5	30								0%	0%	0%
		SG14	Upper Sturt 11 kV	HBFRA	15	88		15	88		1	1				1	7%	1%	1%
	Victor Harbor	VH16	Victor Harbour West 11 kV	HBFRA	7	34		7	34								0%	0%	0%
		VH18	Waitpinga 11 kV	HBFRA	12	70		12	70	1	1	2				2	17%	3%	3%
Murraylands	Lameroo	LM14	Geranium 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		LM43	Bews North 19 kV	MBFRA	5	30		5	30	1		1				1	20%	3%	3%
		LM55	Pinnaroo South 11 kV	MBFRA	5	30		5	30		1	1				1	20%	3%	3%
		LM63	Pinnaroo North 19 kV	MBFRA	5	30		5	30								0%	0%	0%
	Mannum	M11	Mannum North 7.6 kV	MBFRA	5	30		5	30								0%	0%	0%
		M13	Mannum South 7.6 kV	MBFRA	5	30		5	30								0%	0%	0%
		M71	Nildottie 11 kV	MBFRA	5	30		5	30								0%	0%	0%
	Murray Bridge	MB14	Brinkley 19 kV	MBFRA	5	30		5	30	1		1				1	20%	3%	3%
		MB27	Toora 11 kV	MBFRA	8	48		8	48								0%	0%	0%
	Strathalbyn	ST14	Strathalbyn 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		ST36	Bull Creek 11 kV	HBFRA	10	57		10	57								0%	0%	0%
Riverland	Barmera	BM15	Cobdogla 11 kV	MBFRA	3	17		3	17								0%	0%	0%
		BM31	Monash 11 kV	MBFRA	2	12		2	12	1		1				1	50%	8%	8%
		BM44	Berri West 11 kV	MBFRA	6	36		6	36								0%	0%	0%
		BM54	Calperum 11 kV	MBFRA	2	10		2	10								0%	0%	0%
		BM55	Renmark West 11 kV	MBFRA	1	6		1	6								0%	0%	0%
		BM56	Cooltong 11 kV	MBFRA	4	24		4	24	1		1				1	25%	4%	4%
	Loxton	LX34	Gurra 11 kV	MBFRA	13	78		13	78	2		2				2	15%	3%	3%
		LX63	Pata East 19 kV	MBFRA	10	60		10	60								0%	0%	0%
	Waikerie	WK33	Taylorville 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		WK81	Portee 11 kV	MBFRA	5	30		5	30								0%	0%	0%
Upper SE	Bordertown	BT13	Geegeela 19 kV	MBFRA	5	27		5	27								0%	0%	0%
		BT26	Keith South 11 kV	MBFRA	15	90		15	90	1		1				1	7%	1%	1%
	Coonalpyn	CN12	Binnies 19 kV	MBFRA	9	54		9	54								0%	0%	0%
		CN42	Point Mcleay 11 kV	MBFRA	10	60		10	60								0%	0%	0%
West Coast	Ceduna	CD02	Ceduna 11 kV	MBFRA	13	78		13	78	1		1				1	8%	1%	1%
		CD15	Kalanbi 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		CD25	Emu Leg 19 kV	MBFRA	5	30		5	30								0%	0%	0%
	Streaky Bay	SB02	Flinders 11 kV	MBFRA	5	30		5	30								0%	0%	0%
		SB20	Cape Bauer 19 kV	MBFRA	5	30		5	30								0%	0%	0%
		SB21	Gibson Peninsula 19 kV	MBFRA	5	30		5	30								0%	0%	0%
	Wudinna	W04	Elliston 11 kV	MBFRA	15	90		15	90								0%	0%	0%
		W29	Witera 19 kV	MBFRA	5	30		5	30								0%	0%	0%
Yorke	Kadina	KA06	Kadina 11 kV	MBFRA	6	36		6	36								0%	0%	0%
		KA10	Moonta 19 kV	MBFRA	10	60		10	60								0%	0%	0%
	Maitland	MT01	Sth Maitland 11 kV	MBFRA	10	60		10	60								0%	0%	0%
		MT03	Arthurton 11 kV	MBFRA	6	36		6	36								0%	0%	0%
	Yorketown	YK02	Stansbury 11 kV	MBFRA	5	30		5	30		1	1				1	20%	3%	3%
		YK17	Point Turton 11 kV	MBFRA	11	66		11	66								0%	0%	0%
		YK18	Sunbury 11 kV	MBFRA	5	30		5	30								0%	0%	0%
					740	**4380**		**740**		**17**	**6**	**23**				**24**	0%	0%	0%

Appendix C – Logged NCRs Removed from Audit

Appendix C: Logged NCRs Removed from the Audit

At regular intervals during the field audit (25 October, 23 November and 1 December), SA Power Networks conducted a debriefing meeting with GHD to discuss the audit findings. Where deemed appropriate, a number of NCRs were disregarded from the audit. The rationale for removing one of these NCRs from the audit has been provided in Table 1, below. The original audit reports have also been provided.

Table 1   Logged NCRs Removed from the Cyclic Audit

NCR Removed	Non Conformance Status	Rationale
BT26_TF50	CZ Infringement	The infringement was noted to be associated with private wiring and consequently not within SA Power Networks' jurisdiction.
		Follow up action recommended, however, to encourage landowner to maintain appropriate vegetation-powerline clearances.

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Record	
Audit Start	2017-11-13 14:12:00
GHD Auditor	Rose-Anne Bell
Veg Contractor	
FDR	BT26
FDR Name	KEITH SOUTH 11KV
Region	Upper SE
District	BORDERTOWN
Feeder Risk Area	MBFRA
Audit Site Number	7
Audit Site Risk Area	MBFRA
Audit Site Location	TF50
Audit Site Identifier	BT26_7_TF50_MBFRA_Span3
Audit Site Coordinate	
Audit Site Coordinate Accuracy	
Span Number Audited	3
Inspection Result: Vegetation - NCR	
Audit Site or Drive By	Audit Site
NCR Coordinate	-36.150002, 140.269665
NCR Coordinate Accuracy	5.0
Electrical Address	TF38 / LV 1-2
Volts / Span	
Span Length	41
Veg Position	Mid Span
Calc V Regs	
Calc H Regs	
Variation Comments	
Veg v location	
Veg h location	
Adj v regs	0.50
Adj h regs	0.50
Nearest V Act	0.5
Nearest H Act	0.4
Non Conformance Status	CZ Infringement
Non Conformance Timeframe	
Fast Grower / Slow Grower	

Species	Various
Schedule Item:	

583 Fairbank Road

Audit Finish Date / Time	
Audit Time (Duration)	

Appendix D – Clearance Zone Criteria

Appendix D
Clearance Zones (Electricity Act 1996)

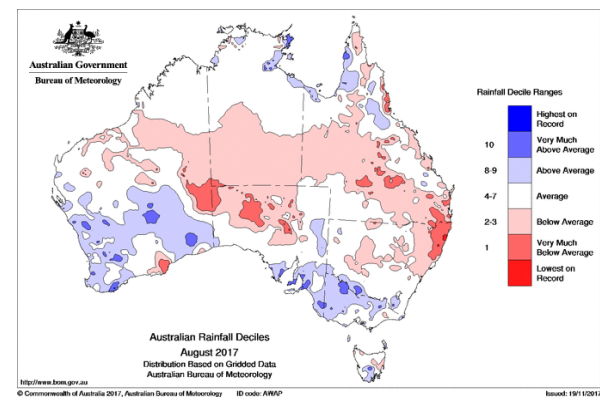## Table I: Bare or covered conductor at operating voltages of 240 V to 11 kV

Voltage	All Spans	Span (in metres)									
		0-50		Over 50-100		Over 100-150		Over 150-200		Over 200	
	P	V	H	V	H	V	H	V	H	V	H
Voltage not exceeding 480V in bushfire risk areas only	0.5	1.0	1.0	1.5	2.5	1.5	3.5	-	-	-	-
7.6 kV and 11 kV in bushfire and non-bushfire risk areas	0.5	1.5	1.5	2.0	2.5	2.5	3.5	2.5	4.5	2.5	6.0

Table II: Bare or covered conductor at operating voltage of 19 kV

Voltage	All Spans	Span (in metres)									
		0-100		Over 100-200		Over 200-300		Over 300-400		Over 400	
	P	V	H	V	H	V	H	V	H	V	H
19 kV single earth wire earth return (SWER)	0.5	1.0	1.0	1.0	2.5	1.5	5	2.0	7.0	2.0	9.0

Table III: Bare or covered conductor at operating voltages of 33 kV to 66 kV

Voltage	All Spans			Span (in metres)										
				0-100	Over 100-200	Over 200-300	Over 300-400	Over 400-500	Over 500-600	Over 600-700	Over 700-800	Over 800-900	Over 900	
	V	P	B	H	H	H	H	H	H	H	H	H	V	H
33 kV	2.5	0.5	2.0	2.5	4.5	6.5	9.5	14.0	19.0	25.0	32.0	39.5		48.0
66 kV	3.0	1.0	2.0	2.5	4.5	6.5	9.5	14.0	19.0	25.0	32.0	39.5		48.0

Appendix E – Climate Data

Appendix E

Rainfall Deciles (May 2017 - November 2017)

GHD

SA Power Networks
Pre-Summer Vegetation Audit
3318665

Australian Rainfall Deciles
May 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
June 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
July 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
August 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
September 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
October 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Australian Rainfall Deciles
November 2017
Distribution Based on Gridded Data
Australian Bureau of Meteorology

Appendix F – Visual Amenity Audit

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	23/10/2017
Region	Mid North
District	Clare
FDR	CL02
FDR Name	Kybunga 11 kV
Feeder Risk Area	MBFRA
Audit Site Identifier	CL02_5_TF01_MBFRA

Visual Amenity Assessment

Outcome of Pruning:	< Optimum	
Value in the landscape:	Low	
Contribution to the future landscape:	Low	
Health and risk of failure:	Average	
Percentage of tree canopy:	Considerable (50-60%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	2/11/2017
Region	KANGAROO ISLAND
District	KANGAROO ISLAND
FDR	KI11
FDR Name	PENNESHAW 11KV
Feeder Risk Area	MBFRA
Audit Site Identifier	KI11_2_TF12_MBFRA_Span4

Visual Amenity Assessment

Outcome of Pruning:	Poor	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Good	
Percentage of tree canopy:	Considerable (50-60%)	

Inspection Report

Audit Date	29/11/2017
Region	KANGAROO ISLAND
District	KANGAROO ISLAND
FDR	KI16
FDR Name	BROWN BEACH 19KV
Feeder Risk Area	MBFRA
Audit Site Identifier	KI16_5_TF74_MBFRA_Span3

Visual Amenity Assessment

Outcome of Pruning:	Poor	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Average	
Percentage of tree canopy:	Considerable (50-60%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	8/11/2017
Region	Mt Lofty
District	MCLAREN VALE
FDR	MV51
FDR Name	WILLUNGA NORTH 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	MV51_5_TF126_HBFRA_Span6

Visual Amenity Assessment

Outcome of Pruning:	Poor	
Value in the landscape:	Low	
Contribution to the future landscape:	Nil	
Health:	Very poor	
Percentage of tree canopy:	Minimal (<20%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	22/11/2017
Region	Mt Lofty
District	NOARLUNGA
FDR	NL115E
FDR Name	WOODCROFT 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	NL115E_1_TF 135_HBFRA_Span3

Visual Amenity Assessment

Outcome of Pruning:	Poor	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Average	
Percentage of tree canopy:	Minimal (<50%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	24/11/2017
Region	Mt Lofty
District	NOARLUNGA
FDR	NL760B
FDR Name	HACKHAM EAST 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	NL760B_2_TF 106_HBFRA_Span5

Visual Amenity Assessment

Outcome of Pruning:	Very poor	
Value in the landscape:	Nil	
Contribution to the future landscape:	Nil	
Health:	Very poor	
Percentage of tree canopy:	Minimal (<20%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	23/10/2017
Region	Mid North
District	NURIOOTPA
FDR	NU05
FDR Name	TANUNDA 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	NU05_4_TF23_HBFRA_Span5

Visual Amenity Assessment

Outcome of Pruning:	Very poor	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Average	
Percentage of tree canopy:	Considerable (50-60%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	1/11/2017
Region	Mid North
District	NURIOOTPA
FDR	NU19
FDR Name	FREELING 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	NU19_3_TF31_HBFRA_Span4

Visual Amenity Assessment

Outcome of Pruning:	< Optimum	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Average	
Percentage of tree canopy:	Considerable (50-60%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	7/11/2017
Region	Mid North
District	RIVERTON
FDR	R22
FDR Name	ALMA 11KV
Feeder Risk Area	MBFRA
Audit Site Identifier	R22_3_DF23940_MBFRA_Span1

Visual Amenity Assessment

Outcome of Pruning:	Poor	
Value in the landscape:	Nil	
Contribution to the future landscape:	Nil	
Health:	Poor	
Percentage of tree canopy:	Minimal (<20%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	23/10/2017
Region	Adelaide Metropolitan
District	ELIZABETH-SALISBURY
FDR	SA14
FDR Name	SALISBURY PLAINS 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	SA14_1_TF02_HBFRA_Span5

Visual Amenity Assessment

Outcome of Pruning:	< Optimum
Value in the landscape:	Medium
Contribution to the future landscape:	High
Health:	Good
Percentage of tree canopy:	Considerable (50-60%)

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	27/11/2017
Region	Adelaide Metropolitan
District	SAINT MARYS
FDR	SM126B
FDR Name	SUN VALLEY 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	SM126B_2_TF46_HBFRA_Span4

Visual Amenity Assessment

Outcome of Pruning:	< Optimum
Value in the landscape:	Low
Contribution to the future landscape:	Low
Health:	Average
Percentage of tree canopy:	Considerable (50-60%)

GHD	SAPN Cyclic/Pre-Summer Audits 2017	SA Power Networks

Inspection Report

Audit Date	20/11/2017
Region	Murraylands
District	STRATHALBYN
FDR	ST36
FDR Name	BULL CREEK 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	ST36_5_TF31_HBFRA_Span4

Visual Amenity Assessment

Outcome of Pruning:	< Optimum	
Value in the landscape:	Low	
Contribution to the future landscape:	Low	
Health:	Average	
Percentage of tree canopy:	Minimal (<50%)	

SAPN Cyclic/Pre-Summer Audits 2017

Inspection Report

Audit Date	10/11/2017
Region	Mt Lofty
District	VICTOR HARBOR
FDR	VH16
FDR Name	VICTOR HARBOR WEST 11KV
Feeder Risk Area	HBFRA
Audit Site Identifier	VH16_6_TF43_HBFRA_Span1

Visual Amenity Assessment

Outcome of Pruning:	< Optimum	
Value in the landscape:	Medium	
Contribution to the future landscape:	Medium	
Health:	Average	
Percentage of tree canopy:	Minimal (<50%)	

Appendix G – 2016 Observations and Recommendations

Observations and Recommendations - 2016

Observation	Recommendation	2016 Ref.	Priority[a]
Improved performance over a six-year period for the vegetation clearance program.	Continue to identify operational and strategic solutions to improve vegetation management practices and NCR results.	R1 (i)	2
Engaging ATS as the primary vegetation contractor is coincident with improved vegetation clearance performance – likely attributed to their comprehensive knowledge and experience, which provides consistency of performance.	Discuss with vegetation contactor (ATS) ways in which vegetation clearance and overall compliance can be improved for 2017.	R1 (ii)	2
Scoping and cutting data (on a span-by-span basis) was not made available to the GHD team – limiting the team's ability to assess the cause of non-compliances.	It is understood that SA Power Networks has access to this information provided by the incumbent contractor. It would be beneficial to negotiate the supply of this scoping and cutting data to the GHD team for future audits.	R2	2
Using available scoping and cutting data to assist in producing span specific programs will improve compliance and reduce risk.	Use existing data at a span level to identify those Districts, Feeders or spans that require specific treatments out of cycle. The GHD audit NCRs could be mapped on the SA Power Networks GIS platform as required.	R3	2
A number of Regions and Districts in MBFRA have sparse vegetation. Time and the cost to inspect these "lower risk" areas are disproportionate to that for HBFRA, particularly where some of these districts have a high proportion of non-vegetated spans.	Consider increasing the level of annual audit in HBFRA and reduce the level of audit in targeted MBFRA Districts to biennial. The HBFRA could be increased to 4 Feeders per District (for example) which would provide more focus on the higher risk areas resulting in a greater level of data in HBFRA and a higher level of confidence in the audit results	R4	2
Feeders with a high number of NCRs (greater than 3) represent an increased risk of fire occurrence.	Re-scope those Feeders that had greater than 3 site non-conformances: • MG05 Compton (11 kV) • KI54 Newlands (19 kV) • SG14 Upper Sturt (11 kV)[a] [a] While SG14 Upper Sturt wasn't recorded as having >3 NCRs, it was the Feeder with the highest infringement rate and on this basis, should be included in any intended re-scoping.	R5	1

Observation	Recommendation	2016 Ref.	Priority[a]
It is noted that a greater proportion of the NCRs identified in this audit corresponded to potential infringements, i.e. trees that might bend/grow into the clearance zone – potentially due to. above-average rainfall accelerating growth rates for some species.	Appropriate application of vegetation indices to remotely sensed imagery might be used to monitor vegetation growth and vigour. The NDVI (Normalised Difference Vegetation Index) has been shown to be particularly useful for monitoring vegetation (Huete et al., 2002) - and with the application of change detection imagery (Johansen et al., 2010), it would be possible to document changes in consecutive imagery (of the relevant Districts/Feeders). This method would serve the purpose of assessing localised tree growth and vigour, especially after excessive rainfall events, and would therefore prove invaluable in tailoring site visits and informing scoping and cutting schedules	R6	3
A number of private landowners planting inappropriate vegetation below powerlines (e.g. fast-growing Eucalyptus trees).	Ensure that all private landowners (particularly those in remote regions) are educated (by way of distribution of leaflets/brochures) with regards to appropriate vegetation for planting near powerlines.	R7	3

[a] Priority Categories:

> 1 - Priority
>
> 2 - Strategic Improvement
>
> 3 - Opportunity for Improvement

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	R-A Bell	J Burdeniuk	███████	D Taddeo	███████	5/2/18

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