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Power and Water Corporation Vegetation Management Forecast for the 2019 to 2024 Regulatory Control Period

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Contents

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1. Executive Summary

Power and Water Corporation (PWC) engaged Pinnacle ArborPro (Pinnacle) to prepare a detailed "bottom up" forecast of its vegetation treatment requirements for the 2019 to 2024 regulatory control period (RCP). The purpose of this work is to inform the next stage of implementation of Pinnacle's previous recommendations related to the implementation of vegetation zones (VZs). The development of new contract requirements and performance measures relies on PWC having a deeper understanding of actual future work requirements and is critical to achieving the goal of creating a more competitive market for services as well as meeting future reporting requirements.

The forecast is based on the recommendations of Pinnacle's previous report[1] being implemented to achieve the forecast expenditure reductions. Historical treatment data sourced from the service provider and PWC records for the 5 years from 2013 to 2018 has been analysed in detail and used as the basis for developing the forecast work volumes. As the current lump sum contract for the routine inspection and trimming affects the ability to determine efficient treatment rates, a "bottom up" analysis based on various input cost variables and productivity rates has been completed to forecast future expenditure requirements. All cost values in this report are quoted in $2018/19 unless otherwise stated.

The vegetation forecast is comprised of typical activities including inspection, trimming, corridor clearance, hazard tree removals and PWC internal management costs. The forecast methodology for the inspection and treatment program uses historical work volumes to predict future work volumes with span treatment rates based on labour rates in the Northern Territory and other costs and productivity rates based on Pinnacle's knowledge and experience in other DNSP's. The corridor and ground clearance program is based on PWC's forecast and hazard trees and internal costs are based on historical trends. The forecast also seeks to estimate the cost of establishing the new VZ strategy including internal costs for systems and process development and implementation, and additional clearing or removals to widen clearances to achieve target VZ cycle times.

Based on the calculated unit rates and assuming typical productivity rates in other businesses, the analysis forecasts an average annual expenditure of [redacted] over the 2019-24 RCP. The forecast demonstrates that a 60% reduction in spans requiring inspection is achievable by implementing VZs and longer cycle times. It also demonstrates that an 11% reduction in the number of spans requiring treatment and 9% reduction in cost is possible by reducing the number of spans requiring treatment more frequently than the recommended cycle times for the respective VZ. Increasing clearances or accepting increased risk associated with reduced clearances on low risk spans will be necessary to achieve this reduction.

There are a number of internal and external factors that will impact on PWC's ability to achieve or exceed the results of this analysis. A risk analysis based on the location, voltage and conductor insulation has been used to estimate the number of spans on which the frequency of trimming can be reduced. There is a risk that this reduction may not be achieved if customer or tree owner approval for increased clearances or tree removals cannot be obtained. There is also a risk that PWC may not be able to achieve the target VZ cycle times and reductions in mid-cycle trimming in the

[1] Pinnacle ArborPro, August 2017, Project PWC16-212 - Darwin Vegetation Management Analysis Project Report.

timeframes assumed in the analysis because of stakeholder engagement processes and the physical ability of service providers to complete higher work volumes in the early years.

This forecast is considered to represent the minimum expenditure required to efficiently and safely manage PWC's responsibilities for management of vegetation in the vicinity of its overhead power line assets, while also transitioning to a more mature approach that will result in longer term reductions in vegetation management costs.

2. Summary of Analysis

2.1 Inspection and Trimming

The routine inspection and treatment program constituted [redacted] of the historical vegetation program expenditure. It therefore provides the greatest opportunities for future cost reductions. Figure 1 shows a comparison of the historical and forecast annual expenditure along with the historical and forecast number of spans inspected and treated for the routine inspection and treatment program.


[redacted]

Figure 1 demonstrates that implementing VZ's with cycle times that match the characteristics of the VZ results in a 60% reduction in the number of spans to be inspected compared to 2016/17 and 2017/18. There was a significant uplift in the number of spans treated in 2016/17 and this level was maintained in 2017/18. The forecast indicates that the annual average number of spans to be treated over the next RCP will be 14,854 spans, 21% less than the average from 2016 to 2018. Expenditure of [redacted] per annum for the routine inspection and treatment program is also forecast to be lower than all previous years based on a bottom up build of the various cost components and productivity rates for vegetation treatment. The expenditure in 2017/18 is not typical of normal annual expenditure because it does not include any expenditure in the remote regions of Alice Springs and Tennant Creek. In addition, work in the Darwin and Katherine regions was stopped for a

period due to the response to Tropical Cyclone Marcus resulting in a reduction of approximately $0.15M in the normal annual lump sum contract expenditure.

The unit cost per treated span is also forecast to be lower than all previous years except 2017/18 as shown in Figure 2. A change in the resourcing of work undertaken in the Alice Springs region resulted in significant savings after 2015/16. This combined with the uplift in volume of work completed in 2016/17 and 2017/18 resulted in the significant reduction in unit cost in the last two years.

2.2 Other Vegetation Management Programs

Corridor maintenance and ground clearance requirements for the next RCP have been forecast based on local knowledge of the condition of corridors and the frequency at which they require maintenance. The total forecast for this work is [redacted] and [redacted] respectively for the next RCP and is 21% and 46% lower than the 5 years from 2013 to 2018. This has been achieved by extending the interval between maintenance as far as possible and forecasting that a cost reduction of 10% on current rates can be achieved in the Darwin region.

The forecast for the maintenance of hazard trees has been based on the average expenditure over the last 3 years on the basis that these hazard trees will require ongoing maintenance.

PWC internal costs have also been forecast to continue at the current levels to ensure effective management of the vegetation program, the service provider and stakeholders. This internal resourcing will be even more critical in the next RCP to ensure effective implementation of the recommendations of the Pinnacle report. An additional GIS resource has also been included in PWC's internal costs in 2019/20 to assist with implementation of the Pinnacle report recommendations.

2.3 Implementation of VZs and Problem Trees

In order to transition to the new VZs and cycle times and realise ongoing cost reductions in the future, the clearances on an estimated 1,948 spans will need to be addressed. Additional costs estimated at [redacted] will be incurred for this clearing and allowance has been made for this expenditure in the forecast.

A number of problem trees that were planted in recent years have been identified. These have now started encroaching on the minimum clearances to power lines and are unable to be maintained to acceptable standards. Ongoing trimming at additional cost in future years will be required until they can be removed. This is a particular issue in Alice Springs where removal of trees requires approval certificates under the Aboriginal Area Protection Authority (AAPA). The program to remove these problem trees over a period of 5 years and additional trimming until removals are completed have been included in the forecast.

2.4 Outcomes of the Analysis

The total forecast expenditure required to fulfil PWC's obligations for management of vegetation around its power line assets for the next RCP is [redacted] or [redacted] per annum as shown in Figure 3.

[redacted]

Full details of the methodology used and analysis undertaken to produce this forecast are provided in this report along with the risks associated with the forecast.

In Pinnacle's view, there are a number of threats to PWC's achievement of this forecast as listed below:

- Market response to future tenders
- Productivity assumptions based on Pinnacle's experience with other DNSPs
- No allowance for service provider risk or network growth included in the forecast
- Customer and tree owner consent for widening of corridors and tree removals
- The state of vegetation clearances has been assumed to be compliant to "nominal" clearance criteria at the commencement of the 2019-20 year. In practice, the network is at varying levels of compliance at any time depending on its trimming cycle.

The management of these risks will be critical to PWC delivering an efficient vegetation program without compromising on current levels of public safety and reliability. No costs have been included for specific customer engagement and consultation, however it is recommended that this be considered by PWC.

The above forecast is therefore considered to be the minimum expenditure required to efficiently manage PWC's responsibilities for vegetation management in the vicinity of its overhead power line assets.

2.5 Comparison to Peers

2016/17 RIN data from other Distribution Network Service Providers (DNSPs) has been analysed and it has been possible to compare PWC 2016/17, 2017/18 and the forecast vegetation management costs against other DNSPs.

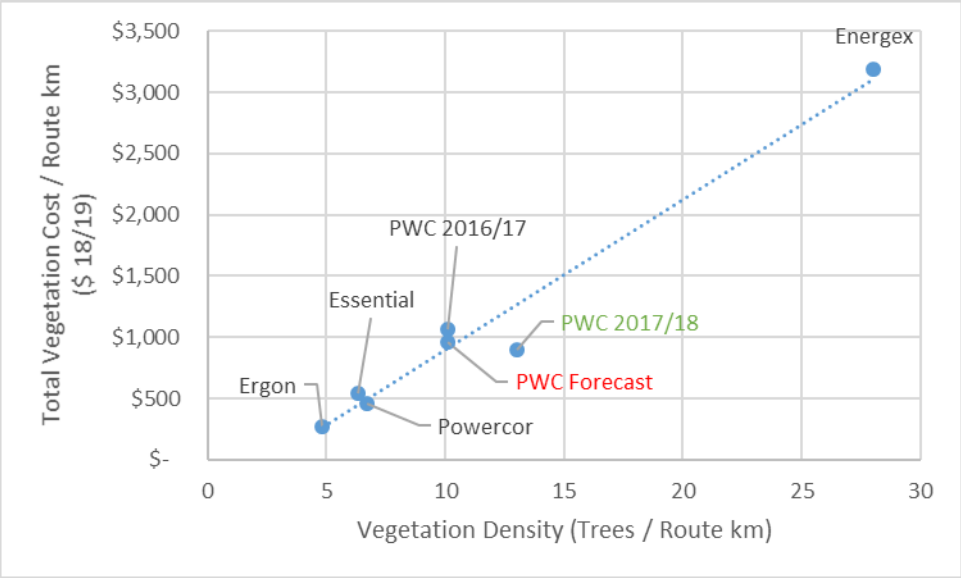

Figure 4 – Total Vegetation Management Cost per Route km versus Vegetation Density

As vegetation management costs will increase as the vegetation density (i.e. trees per km) increase, the total vegetation management costs for each DNSP have been plotted against vegetation density in Figure 4 above. As a detailed breakdown of costs was not available in all DNSP RINs, it is only possible to compare total vegetation management costs. In general, all analysed DNSPs costs are close to the trend line including PWC 2016/17 and forecast expenditures. However, PWC 2017/18 expenditure is significantly below the trend line indicating that 2017/18 expenditure is not typical of normal annual expenditure as discussed previously.

It is also possible to compare PWC's routine inspection and trimming and audit costs with Energex and Powercor as the relevant data is available in their RIN's. Both Energex's and Powercor's cost in 2016/17 was about $65 per tree. The forecast cost per tree for PWC is [redacted], about [redacted] higher than the other DNSP's. This difference in cost can be easily attributed to the higher input costs in the Northern Territory (NT) and lower productivity because of the hot humid conditions.

On both of the above measures, the forecast for the 2019-24 RCP compares well with other DNSPs.

3. Recommendations

It is recommended that:

1. PWC adopt this forecast for their revised regulatory proposal for the period 2019 to 2024 as the minimum expenditure required to meet PWC's vegetation management responsibilities.
2. PWC review this forecast to ensure all of its vegetation management responsibilities have been incorporated within the forecast and also consider the risks associated with this forecast and make adjustments where the risks are considered unacceptable.
3. PWC develop a stakeholder and customer engagement process as soon as possible to gain acceptance of the required changes to implement VZs and therefore minimise potential issues or delays when work commences.

4. Scope of Work

The scope of work for this project includes the following:

1. Prepare a forecast for PWC's vegetation management activities to inform upcoming service procurement as well as the 2019-24 revised Regulatory Proposal. Initial analysis and advice on the forecast is required by 12 October 2018.
2. Identify the primary risks and target unit costs to achieve the forecast.

5. Information Provided by PWC

PWC has provided the following information for this forecast:

- Vegetation treatment data sourced from Active Trees complete with span related data associated with each inspection.
- Financial data sourced from Maximo incorporating a description of each expenditure entry. This data also included information on the length of corridor clearing undertaken and the number of hazard trees cut.
- Span data including the vegetation zone for all spans in the PWC overhead network.

6. Forecast Methodology

The vegetation forecast comprises the following components:

- Routine inspection and treatment program,
- Corridor clearance program,
- Ground clearance,
- Hazard tree treatment,
- PWC internal costs associated with the vegetation program,
- Additional clearing costs to implement the cycle times for the VZ's as recommended in Pinnacle's original report; and
- Removal of problem trees and additional trimming until the problem trees are removed.

6.1 Routine Inspection and Treatment Program

The forecast is based on implementation of the VZs and their inspection and treatment cycle times as recommended in the Pinnacle report. Each span in the network has been assigned a unique identifier (SPAN_ID) and matched spatially to a VZ.

Historical inspection and treatment data for the 5 years from 2013 to 2018 has been used as the basis for developing the forecast treatment requirements. The forecast treatment frequency for each span in each VZ has initially been assumed to be the same as its historical treatment frequency. That is, a span treated historically every 6 months, 1 year, 2 years, 4 years etc. has been assumed to require treatment at these same frequencies in the forecast. Spans that have required treatment more frequently than the recommended cycle time for their VZ have been identified as "cycle buster" spans. These are the spans that require their treatment frequency to be reduced where possible to match the VZ cycle time in order to reduce future vegetation inspection and treatment costs. This will require either additional trimming or removal of vegetation to increase clearances or a change to minimum clearance standards.

The forecast is based on the assumption that a complete network inspection and treatment in all regions will be completed in 2018/19. There is some risk with this assumption in that, spans that only require treatment infrequently such as every 3 or 4 years have only been forecast to require a single treatment in the next RCP. If these spans become due for treatment in the first or second year of the next RCP, they may require a second treatment which has not been included in the forecast. Similarly, spans on a 2 year cycle have only been forecast to require 2 treatments but may require a third treatment. This assumption results in forecast treatment quantities that vary considerably from year to year. **While this assumption results in an acceptable total expenditure forecast for the next RCP subject to the risks noted above, it does not reflect the actual annual treatment and expenditure requirements as the work program will need to be balanced over the 5 year period for efficient program delivery.**

Each span has also been assigned a risk category as follows:

- High risk - Transmission and urban high voltage (HV) spans as these present the greatest reliability and safety risks if vegetation encroaches on the minimum clearance space.
- Medium risk – Rural HV spans as the lower population density and lower load in rural areas reduces the reliability and safety risks. However, there remains a significant risk of fire starts if vegetation approaches HV conductors.
- Low risk – Bare low voltage (LV). The reliability, safety and fire start risks associated with vegetation contacting LV is much lower than for HV spans.
- Very low risk – Insulated LV Aerial Bundled Cable (LV ABC) and services. The main risk associated with contact of vegetation with LV ABC or services is abrasion of the insulating material.

Cycle buster spans in each risk category need to be considered separately as the ability to reduce the number of these spans in each risk category will vary as discussed later in the report.

The forecast number of spans requiring inspection and treatment in each VZ is calculated from the historical treatment frequency for each span minus the number of cycle buster spans whose treatment frequency can be reduced to the nominal cycle time for the VZ. It must be noted that some cycle buster spans will still require inspection and treatment more frequently that the nominal cycle time and these have been included in the forecast for mid-cycle inspection and treatment.

To calculate the forecast inspection and treatment expenditure, an inspection cost per span and treatment cost per span have been developed using a "bottom up" approach based on actual

minimum labour rates, productive working weeks per year, plant types and rates applicable to the area being treated, productivity rates for the area and type of plant being used, mobilisation/demobilisation and living away from home costs for remote areas, labour on-costs and service provider overheads and profit. Full details are included later in the report.

The span rates have been multiplied by the forecast number of spans to be inspected/treated to calculate the forecast expenditure requirement with the mobilisation/demobilisation and living away from home costs added for work in the remote areas where a permanent service provider presence cannot be justified.

6.2 Corridor and Ground Clearance Program

The historical corridor and ground clearance programs have been prioritised to the most critical lines in terms of network security (i.e. 132kV and 66kV lines) or where feeder reliability issues have been identified through analysis of poorly performing feeders. In addition, a budget for this work was not previously defined, rather work being prioritised based on the available funding or specific access requirements for maintenance.

As such, it has not been possible to forecast the requirements for an ongoing program based on the historical data.

Therefore, PWC has developed a forecast corridor and ground clearance program based on local knowledge of feeder priorities (eg. 132kV and 66kV lines having the highest priority), the condition of corridors and the frequency at which treatment will be required.

Costs are based on a rate per km for slashing and mulching for a 6 metre wide corridor treatment with some reduction assumed for the Darwin region on the basis that better pricing may be achieved in future contracts for this region. Ground clearance costs are based on the local knowledge of the costs of ground crews to maintain specific areas where other clearance methods are not practical.

6.3 Other Vegetation Program Costs

PWC also routinely incurs costs associated with managing hazard trees as well as internal costs associated with managing the work program, managing stakeholder issues and auditing the service provider. As these are routine ongoing costs, the forecast is based on the historical trend for these costs.

In addition, provision has also been made for some non-routine expenditure to undertake additional treatment on cycle buster spans to reduce the long term costs associated with the frequent treatment of these spans. A program to reduce long term trimming costs associated with problem trees planted near powerlines, particularly in the Alice Springs region, has also been included in the forecast.

7. Routine Inspection Program

The forecast for the routine inspection program has been based on inspecting all spans in each VZ at the respective cycle time for that VZ. In addition, only the remaining cycle buster spans identified from the treatment analysis below are planned to be inspected at the required treatment frequency for these spans.

The number of spans in each VZ has been calculated from the spatial mapping of the network to the VZ's in PWC's Geographical Information System (GIS).

Table 1 shows the forecast number of spans to be inspected each year before and after the reduction in cycle buster (CB) spans.

Inspection Description	2019/20	2020/21	2021/22	2022/23	2023/24	TOTAL 2019-24
Forecast Spans Inspected before CB Reductions	34,746	59,480	39,770	63,091	37,992	235,079
Forecast Spans Inspected after CB Reductions	33,416	58,505	37,565	62,186	35,669	227,341

Table 1 – Forecast Inspection Quantities

The average number of inspections per year after cycle buster reductions of 45,468 is 60% less than the average of 112,937 spans per year inspected over the last 2 years from 2016 to 2018 as shown in Figure 5.

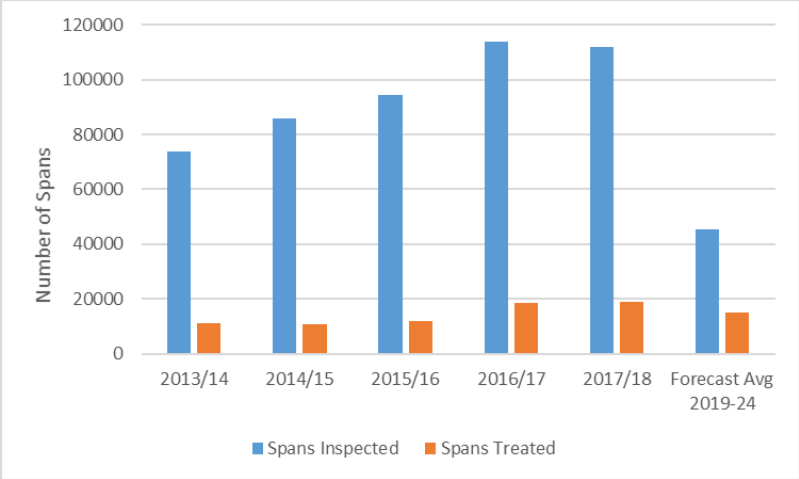

Figure 5 – Historical and Forecast Spans Inspected and Treated

Figure 5 also shows that the ratio of spans treated to spans inspected is forecast to increase from approximately 15% over the 5 years from 2013-2018 to approximately 32% over the next RCP. This will result in an increase in the average time to inspect each span because of the higher percentage of spans requiring treatment data to be recorded. Pinnacle's report has also recommended that additional data be collected and this will add to the inspector's workload. Therefore, although, 60% less spans are being inspected, the cost of inspection will not decrease by this amount.

The reduction in the number of spans to be inspected over the RCP and the increase in the "find" rate for spans to be treated demonstrates that there is a significant improvement in inspection productivity by implementing a VZ approach with inspection cycle times more appropriately matched to the characteristics of the VZ.

8. Routine Treatment Program

The frequency at which each span has required treatment over the previous 5 year period has been analysed and used as the basis for future treatments over the next RCP. When analysing the data, it was found that 3,989 new maintenance spans were treated in 2016/17 that had not been treated between 2013 and 2016, an increase of 23%. A further 4,266 new maintenance spans were treated in 2017/18 that had not been treated between 2013 and 2017, an increase of 20%.

These new maintenance spans treated between 2016 and 2018 resulted in a 68% increase in the number of spans treated annually from an average of 11,199 over the 3 years from 2013 to 2016 to an average of 18,820 over the two years from 2016 to 2018. Some of these new spans were treated multiple times in the 2 years between 2016 and 2018 which would indicate that vegetation not previously requiring treatment had now grown into the clearance space and required frequent trimming while other vegetation may just be beginning to encroach on the minimum clearance space. As these spans are likely to have a significant impact on the forecast, they were examined in more detail to ensure appropriate treatment frequencies as follows are applied to these spans identified in 2016/17 and 2017/18:

- For spans added in 2016/17 and treated multiple times over the two years 2016 to 2018, the treatment frequency was calculated by dividing 2 years by the number of treatments (eg. for a span treated 4 times, the treatment frequency would be 0.5 year).
- For transmission, HV and bare LV spans added in 2016/17 and treated once over the two years 2016 to 2018, the treatment frequency applied was 2 years for VZ's with a cycle time of 2 years or less, or where the cycle time for the VZ is longer than 2 years, the treatment frequency applied was the same as the cycle time for the VZ.
- For spans added in 2017/18 and treated twice, a 0.5 year treatment frequency has been applied.
- For transmission, HV and bare LV spans added in 2017/18 and treated once, the treatment frequency applied was the same as the cycle time for the VZ with the minimum cycle time being 1 year.
- For services and LV ABC spans added in 2016/17 or 2017/18 and only treated once, it was assumed that only one treatment was required over the period that the historical data was available (i.e. 4 years for Katherine and Alice Springs regions and 5 years for Darwin region) so a 4 or 5 year treatment frequency was applied because of the lower risk associated with these spans. This means that only one treatment would be required on these spans over the next RCP.

As historical treatment frequencies don't exactly match the new cycle times, spans have been assigned a required treatment frequency generally closest to a multiple or sub-multiple of the new cycle times for the VZ. Some examples of the required treatment frequencies for the Darwin region are shown in Table 2 below. The same process has been used for other vegetation zones across all regions.

The above process has resulted in a forecast of 83,808 spans (refer Table 3) requiring treatment over the next RCP if no further action is taken to reduce the treatment frequency of any cycle buster spans.

VZ	Cycle Time (Yrs)	Historical Treatment Frequency (Yrs)	Required Treatment Frequency (Yrs)	Comments
1, 2, 4	0.5, 1, 1	< 0.7	0.5	Assumed treatment will be required 6 monthly.
1, 2, 4	0.5, 1, 1	>= 0.7 <1.5	1	Assumed clearances can be increased easily on spans with historical frequency between 0.7 and 1 year.
1, 2, 4	0.5, 1, 1	>=1.5 <=2.5	2	Assumed clearances can be increased on spans between 1.5 and 2 years to achieve 2 year cycle.
1, 2, 4	0.5, 1, 1	>2.5	4	Only 1 treatment forecast in next RCP
5	2	< 0.7	0.5	Assumed treatment will be required 6 monthly.
5	2	>= 0.7 <1.5	1	Assumed clearances can be increased easily on spans with historical frequency between 0.7 and 1 year.
5	2	>=1.5 <=2.5	2	Assumed clearances can be increased on spans between 1.5 and 2 years to achieve 2 year cycle.
5	2	>2.5	4	Only 1 treatment forecast in next RCP

Table 2 – Examples of Assignment of Required Treatment Frequencies from Historical Frequencies

Those spans that have required treatment more frequently than the recommended cycle time for the VZ have been identified as cycle buster spans. It should be noted that for VZ 1 which has a cycle time of 0.5 years, spans requiring treatment at a cycle time of 1 year or greater have been included in the number of normal spans while spans requiring treatment every 6 months have been included in the number of cycle buster spans. This is to enable some focus to be given to reducing the number of cycle buster spans in this VZ with the aim of transitioning this VZ to a 1 year cycle in future if possible.

Overall, 21,036 treatments (25% of total span treatments) on cycle buster spans would be required over the next RCP if no action is taken to reduce the number of these spans. These cycle buster spans present an opportunity to improve efficiency and reduce future vegetation maintenance costs if the number of these spans requiring mid-cycle treatment can be reduced. To achieve this, either increased clearances to ensure intrusions do not enter the minimum clearance space over the normal cycle time and/or accepting greater risk from reduced clearances are required.

To assess the ability to reduce the number of cycle buster spans, the number of treatments on these spans in each risk category were investigated. The number of treatments on cycle buster spans over the next RCP if no action is taken to reduce their number is:

- High risk – 7,746 span treatments. Only 315 of these treatments are associated with transmission spans.
- Medium risk – 6,700 span treatments.

- Low risk – 3,963 span treatments.
- Very low risk – 2,627 span treatments.

The percentage of these spans that could have their cycle time extended to the normal cycle time has been estimated as follows:

- High risk spans – 10%. It is estimated that a reduction of only 10% will be achievable because these spans are in urban and semi-rural areas where the ability to increase clearances is limited because of narrow nature strips and the likelihood of public backlash or that customers will not consent to additional trimming of trees in their property.
- Medium risk spans – 60%. These HV spans are in rural areas so it is estimated that clearances can be increased on a high percentage of these spans to reduce their treatment frequency. However, there will remain spans in protected areas and near residential areas where increased clearing will be limited. Some significant work will however be required in some areas to increase clearances.
- Low risk spans – 80%. It is expected that the treatment frequency on a high percentage of these spans can be reduced through a combination of increasing clearances and/or accepting greater risk by reducing the minimum clearance space required.
- Very low risk spans – 100%. These represent only 12.5% of the total cycle buster spans and because the only risk is abrasion on the insulating material, light vegetation that will not damage may be allowed to contact the insulation and, therefore, the frequency of treatment of these spans can be reduced to the normal VZ cycle time immediately without further work.

It is estimated that 1,948 spans will need to be addressed to achieve the above reductions in the number of cycle buster spans. Given this number of spans, the work required to increase clearances has been allocated over the first 2 years of the period. If the work is not achievable over this period, an increase in costs will result because of additional trimming required to maintain clearances.

The above reductions will reduce the number of treatments on cycle buster spans over 5 years from 21,036 to an estimated 11,496, a 45% reduction after allowing for the 2 years to complete the additional clearing required. This reduction is shown in the total forecast treatment quantities in Table 3 below.

Treatment Description	2019/20	2020/21	2021/22	2022/23	2023/24	TOTAL 2019-24
Forecast Spans Treated before CB Reductions	11,755	20,004	12,760	26,343	12,946	83,808
Forecast Spans Treated after CB Reductions	10,127	18,653	10,179	25,062	10,247	74,268

Table 3 – Forecast Treatment Quantities

After the cycle buster span reductions, the forecast number of span treatments over the next RCP reduced by 11.4% to 74,268.

This forecast compares with a total of 71,238 spans treated in the 5 years from 2013 to 2018. However, no treatment data was available for the Katherine and Tennant Creek Regions in 2013/14. Based on the treatment history for Katherine region alone, an average of 2,240 spans per year have been treated. Therefore, the total spans treated over the 5 years from 2013 to 2018 would be approximately 73,500.

It is difficult to compare the forecast with the historical treatment data because of the significant uplift in the number of spans treated in 2016/17 and 2017/18 as shown in Figure 5. If treatment requirements continued at the same rate as the last 2 years, the number of treatments over the next 5 years would be approximately 94,000. In reality, it is doubtful that the number of treatments would reach this level, nevertheless the forecast span treatments are significantly less than the number that would be expected if no action was taken to implement VZ's with different cycle times and reduce the number of cycle buster spans.

9. Routine Inspection and Treatment Expenditure Forecast

A "bottom up" expenditure forecast has been prepared based on the following assumptions:

- Labour rates based on PWC's Enterprise Agreement 2015-2018 effective as at 27/7/2017. PWC specifies that these are the minimum rates that will apply under any future contracts. The rates used in the forecast are Trade Assistant level 2 for a trained plant operator, level 3 for an inspector and level 4 being the minimum rate for a supervisor. Note that level 1 for an untrained trade assistant is the minimum rate in the trade technical salary table.
- An 8 hour working day.
- 41 weeks productive working time per year (ie 11 weeks allowed for annual leave (5) and personal leave (3), public holidays (2) and training (1)).
- Labour on-costs.
- Estimated hourly rates for plant such as EWP's, Chippers and Jarrafs based on Pinnacle's knowledge and experience of the rates for this plant.
- An estimate of the annual kilometres travelled for inspectors and supervisors to calculate the daily cost of their 4 x 4 vehicles as advised by PWC.
- Daily inspection rates based on Pinnacle's experience with a similar "find rate" for spans requiring treatment for urban, semi-rural and rural areas respectively.
- Daily treatment rates based on Pinnacle's experience in other DNSP's for urban areas utilising 3 elevated work platforms (EWP's) and 1 Chipper, semi-rural areas utilising 3 EWP's and 1 Chipper and rural areas using a Jarraf and a supporting 4x4 vehicle.
- As the service provider is not expected to have permanent staff in Katherine, Tennant Creek and Alice Springs regions because the volume of work does not warrant it, mobilisation and demobilisation costs for plant and crew has been calculated for these regions. In addition, living away from home allowance (LAFHA) has been calculated at the actual rate paid in 2017/18 as well as the cost for staff to return home on a fortnightly basis.
- Estimated service provider overheads and profit have been added to the base estimates.

Forecast costs will not be affected significantly by labour rates, working hours, productive working weeks per year and labour on-costs as these will not vary significantly unless the service provider elects to pay staff above award rates to attract them to the NT in which case, costs would increase and be reflected in future tenders. The service provider may also elect to work overtime particularly in remote areas to improve productivity while away from home. However, any increase from working overtime should be offset by reductions in travel and LAFHA costs. Also, changes to the estimated annual kilometres travelled by inspectors and supervisors will not have a significant impact on the overall vegetation expenditure.

The greatest potential impact on the forecast expenditure is from changes to the rates for plant and the productivity rates for inspection and treatment. These rates are based on Pinnacle's knowledge and experience in other DNSP areas. For all rural areas in Darwin and Katherine regions, a Jarraf has been assumed as the applicable plant for all trimming as it is more cost effective than utilising

EWP's. However, access with a Jarraf will not be possible in all cases and an EWP or hand clearing may be required which will increase costs. Also, an EWP has been assumed to be used in Tennant Creek and Alice Springs regions as it is not economical to transport a Jarraf for the small amount of rural clearing in these regions.

Service provider overheads and profit allowances included in their tender submissions may also impact the forecast. It is unlikely that service provider overheads and profit allowances will be lower than those used in this forecast so any increase in these rates will increase the forecast directly by the amount of the increase. Service providers will also make some allowance for risks such as variations in tree trimming volumes, weather delays, breakdowns etc. in their tenders. No allowance for risk has been included in the forecast so any such allowance a service provider includes in their tender will increase the forecast costs.

Given the above discussion on rates, it is considered that the forecast expenditure for the next RCP is the minimum expenditure required for PWC to effectively manage its routine inspection and trimming activities. Any change to the above rates that a service provider includes in their tender is only likely to result in an increase in the forecast cost.

All forecast costs have been calculated based on the rates applicable in 2017/18. For the purposes of this report, all forecast and historical costs are shown escalated to $2018/19 to facilitate a comparison of forecast and historical values.

Based on the above inputs and the forecast spans (after cycle buster reductions), the forecast cost for the routine inspection and treatment program for the next RCP is as shown in Table 4 below. All forecasts are exclusive of GST.

It is difficult to compare the above average cost per treated span of [redacted] over the RCP with the historical average costs shown in Figure 2 for the following reasons:

- The vegetation maintenance contract is currently a fixed lump sum contract. Therefore, the average cost per span varies from year to year depending on the number of spans requiring treatment.
- The service provider maintained staff in the Alice Springs region for the first three years and this substantially increased costs in this region. This ceased in 2016/17 and instead, a dedicated campaign based on a quoted price resulted in a significant reduction in inspection and treatment costs.
- The number of spans treated in each of the last 2 years increased by approximately 65% to 70% over the average of the first 3 years. As the contract is a lump sum, this has effectively resulted in a significant reduction in treatment cost per span.
- The contract was stopped for a period in 2017/18 due to Tropical Cyclone Marcus. This resulted in approximately $0.15M lower expenditure in 2017/18 compared to previous years even though the number of spans treated was similar to the previous year. In addition, no work was undertaken in the Alice Springs or Tennant Creek regions in 2017/18.

Table 4 - Forecast Inspection & Treatment Costs ($2018/19)

For comparison purposes, the historical average inspection and maintenance costs per treated span are:

- 5 years from 2013/14 to 2017/18 - [redacted] per treated span
- 3 years from 2015/16 to 2017/18 - [redacted] per treated span
- 2 years from 2016/17 to 2017/18 - [redacted] per treated span

Therefore, the forecast cost of [redacted] per treated span is considered to be an efficient cost (albeit with some risks as outlined further below) given the comparison with the last 2 years where a significantly higher volume of work was completed and the cost in 2017/18 was reduced because of Tropical Cyclone Marcus. This conclusion is also supported by the comparison with other DNSPs as discussed in Section 10 below.

10. Comparison of Routine Inspection and Treatment Costs with Other DNSPs

2016/17 RIN data from other DNSPs has been analysed and it has been possible to compare PWC routine inspection and trimming costs with Energex and Powercor as the relevant data was available in their RIN's. Energex has a similar number of trees per maintenance span as PWC but has a much higher number of trees per kilometre and a much lower ratio of rural to urban maintenance spans. Powercor has over twice the number of trees per maintenance span but has a lower number of trees

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

per kilometre and a much higher ratio of rural to urban maintenance spans compared to PWC. Therefore, comparison of costs on a maintenance span basis is not appropriate because the different number of trees per maintenance span will impact the cost per span. Rather, a more accurate comparison between DNSPs is to compare costs on the basis of vegetation density (trees / km) or cost per tree albeit that costs may be expected to vary according to the ratio on rural to urban maintenance spans. For example, urban costs will increase because of the increased need for traffic control and removal of cut vegetation whereas rural treatments will incur higher travel and access costs which will also reduce productivity.

Figure 6 shows that the PWC forecast falls on the trend line between Powercor and Energex. PWC's 2016/17 costs were above the trend line while 2017/18 costs fell below the trend line. This results from the combination of the fixed lump contract and the variations in the volume of trimming, the cost associated with the two year cycle of treatment in Alice Springs and Tennant Creek and the sensitivity to vegetation density. Ergon Energy's cost falls well below the trend line. It is unclear in their RIN, whether Ergon Energy have used the same criteria as other DNSPs for recording the number of trees per maintenance span. This is because Ergon Energy have quoted the same number of route kilometres for maintenance spans and corridor clearance which means that they may have also included the number of spans and trees treated in their corridor clearance program with the spans and trees treated in their tree trimming program. PWC does not include spans and trees treated in the corridor clearance program in their RIN so a comparison with Ergon Energy on this measure may not be valid.

Figure 7 shows the routine inspection, trimming and audit cost per tree. PWC's cost has more than halved since 2013/14 for the reasons previously discussed. Energex's cost has been fairly constant but Powercor's cost has varied considerably. Both Energex's and Powercor's cost in 2016/17 was about $65 per tree.

[redacted]

[redacted]

[redacted]

[redacted]

11. Routine Inspection and Treatment Program Forecast Risks

A number of significant risks exist in the above forecasts as follows:

- The contract rates submitted in the new period contract for the next RCP could be higher than the rates on which this forecast is based because of the lack of competitive tension in the NT.
- Tenderers will make a risk allowance in their tenders for variations in the volume of work forecast over the next 5 years and the impacts of weather on growth rates and access to complete their work program which would effectively increase the rates on which their tender would be based.
- The service provider's overhead rate and profit margin may be higher than the conservative rates assumed in this forecast.
- If a new service provider wins the next contract, they will have establishment costs in the NT. These costs have not been included in the forecast.
- As explained earlier, spans forecast to only require 1 or 2 treatments during the RCP may require an additional treatment depending on when they are next treated.
- Network growth will increase vegetation treatment costs.

No allowance has been made for the above risks in the forecasts.

12. Corridor and Ground Clearance and Hazard Tree Programs

Currently, corridors have been maintained by slashing and mulching techniques as PWC have determined that these have proved the most effective in the Northern Territory. Slashing and Mulching fulfils the dual purpose of managing regrowth and tall grasses which severely restrict visibility and make access along corridors slow and difficult. Ground clearance is required where ground conditions are unsuitable for slashing and mulching equipment such as on rocky or steep ridges, riparian areas and around towers.

The analysis undertaken for Pinnacle's previous report indicated that where standard width corridors are maintained, minimal trimming is required. PWC's historical average corridor treatment cost is [redacted] per kilometre. Based on an average rural span length of 150 to 200 metres, the cost per span is approximately [redacted]. This is less than the historical and forecast average trimming cost per span and therefore a more cost effective approach to managing vegetation on rural corridors where slashing and mulching is appropriate.

A full program for corridor maintenance and ground clearance for the next RCP has been prepared by PWC and reviewed by Pinnacle for reasonableness. The forecast is based on local knowledge of the conditions, vegetation present, growth rates etc. This has resulted in a forecast average of 512km per annum of corridor requiring clearing. This compares with the annual average of 640km per annum for the last 5 years, and represents a 20% reduction. It is forecast that this reduction will be achievable by extending the interval between clearing as far as practically possible.

The forecast total corridor and ground clearance costs for the next RCP are [redacted] and [redacted] respectively. [redacted] These costs represent a reduction of 21% and 46% respectively compared to the 5 years from 2013 to 2018.

Corridor clearance costs have been compared with the 2016/17 costs for Energex and Powercor. Energex's cost was $4,514 per kilometre and Powercor's cost was $1,691 per kilometre. Because of this significant difference between costs it is not possible to draw conclusions on the efficiency of the corridor clearance program relative to other DNSPs, other than that PWC's unit costs appear much lower.

Pinnacle's previous report recommended that a trial using herbicide treatments be considered instead of the current slashing and mulching methods. If investigations indicate that such a trial is feasible, funding for the trial will be provided from the corridor maintenance budget. It is expected that such a trial will take some time to determine the longer term effectiveness and cost benefits so any larger scale implementation and cost benefits will be limited in the 2019-24 RCP.

Expenditure on treating hazard trees (i.e. those trees outside the normal clearance space but which present a significant hazard to electricity infrastructure) has varied considerably over the last 5 years. Again, expenditure from 2013 to 2015 was higher than subsequent years.

There remain significant numbers of hazard trees that need to be managed on an ongoing basis and the average expenditure over the last 3 years 2015-2018 is representative of the ongoing

expenditure required to manage hazard trees. Therefore, the forecast for hazard trees is estimated at [redacted] per annum based on the average cost over the last 3 years.

13. Network Growth

The average growth in network route length was 1.2% per annum from 2013 to 2017. There were transfers from non-regulated to regulated network in 2017/18 so the higher growth rate in 2017/18 has been excluded because it is not considered indicative of the long term trend.

However, no network growth has been allowed in the forecast on the basis that the AER provides a scale factor in the forecast expenditure calculations.

14. PWC Internal Vegetation Management Costs

Internal vegetation management costs in 2017/18 were $0.24M. This compares with an average of $0.24M over the last 5 years.

Therefore, the 2017/18 costs are an accurate representation of the ongoing PWC internal vegetation management costs, so these costs have been forecast at $0.24M per annum for the next RCP. These internal costs are an essential element of the vegetation program to effectively manage the program, the service provider and stakeholders such as government, councils, safety regulators and unions on an ongoing basis. Also, given the high level of management required to transition to new cycles and manage network reliability risk through auditing, the availability of internal resources will be even more critical to successfully implementing the forecast changes to the vegetation program over the next RCP.

In order to implement the recommendations of the Pinnacle report to manage vegetation on a vegetation zone basis and to improve the data capture, analysis and reporting to drive future efficiency improvements, an additional GIS resource will be required in 2019/20 to assist with implementation of recommendations 1, 2, 6, 7, 8 and 13 of the Pinnacle report. This resource will work with internal staff and the new service provider to ensure that the processes, systems and data are updated, developed and implemented. The estimated average annual cost for this resource over the RCP is $0.03M.

15. Additional Vegetation Treatment Costs

As discussed earlier, approximately 1,948 spans will need to be addressed to enable cycle times to be increased to match the VZ cycle time and reduce the number of cycle buster spans requiring mid-cycle treatment. Some significant additional clearing will be required to achieve this so the work is forecast to be completed over the first 2 years of the next RCP. The estimated average annual cost for this additional clearing work over the RCP is [redacted]

Approximately 510 problem trees that were planted in recent years have been identified. These have now started encroaching on the minimum clearances to powerlines and are unable to be maintained to acceptable standards. Ongoing trimming at additional cost in future years will be required until they can be removed. This is a particular issue in Alice Springs where removal of trees requires approval certificates under the Aboriginal Area Protection Authority (AAPA). The program to remove these problem trees over a period of 5 years is estimated to cost [redacted] per annum.

In the meantime, additional trimming of these trees will be necessary until the removal program can be completed. These trees have not previously required trimming so they are not included in the

above forecasts. The additional trimming cost for these trees is estimated at [redacted] per annum over the RCP.

16. Consolidated Forecast

Table 5 below provides the consolidated forecast for the next RCP 2019 to 2024. Average expenditure per year is forecast at [redacted]. This forecast provides for implementation of the vegetation zone approach for future vegetation management, endeavours to reduce the number of cycle buster spans where possible and improves processes, systems and data quality to ensure the targeted cost reductions are achieved and to enable ongoing efficiency improvements in future regulatory periods.

It is therefore considered that this forecast provides for prudent and efficient management of vegetation near PWC's overhead network assets over the next RCP.

[redacted]

Table 5 - Consolidated Vegetation Management Forecast 2019 to 2024 ($2018/19)

17. Implementation of Pinnacle Report Recommendations

This forecast is based on implementation of the Pinnacle Report recommendations. A summary of the status and timing of implementation of the recommendations is shown in Appendix 1. If implementation of the recommendations cannot be completed as planned, then the cost reductions included in this forecast and further efficiencies in future RCP's may not be achievable.

18. Conclusions

As the routine inspection and trimming program has historically constituted [redacted] of total vegetation management expenditure, it provides the greatest opportunity for increasing efficiency and hence cost reduction. The analysis undertaken in this project shows that implementing a VZ approach to vegetation management where the inspection and treatment cycle time matches the characteristics of the VZ results in a reduction in the number of span inspections of 60% over the next RCP. It also

increases the efficiency of inspections by increasing the "find rate" of spans requiring treatment from approximately 15% to 32% of the spans inspected.

The analysis also forecasts that 83,808 span treatments will be required over the next RCP if no action is taken to reduce the number of cycle buster spans which comprise approximately 25% of the total span treatments. Based on analysis of the risk associated with vegetation encroachment on different span types, it is estimated that the cycle time can be extended to the normal VZ cycle on 1,948 cycle buster spans resulting in a reduction in total span treatments of approximately 11%. However, additional trimming or removal of trees to increase clearances and/or acceptance of increased risk from reduced clearances will be required to achieve this.

The "bottom up" build of the expenditure forecast also shows that opportunities exist for cost reductions by providing more accurate forecasts of inspection and treatment quantities to tenderers allowing them to submit more competitive bids with reduced risk allowances. The forecast inspection and treatment expenditure for the next RCP of [redacted] is approximately 9% lower than the expenditure required if no action is taken to reduce the number of cycle buster spans and is also 27% lower than the expenditure over the 5 years from 2013 to 2018.

Corridor and ground clearance have historically constituted approximately 14% of total vegetation management costs. Expenditure for these activities are forecast to be 21% and 46% lower than the expenditure over the 5 years from 2013 to 2018 by increasing the cycle time between treatments as far as practically possible and obtaining more competitive pricing in future tenders.

The total forecast expenditure of [redacted] for the next RCP also includes costs associated with the management of hazard trees, PWC internal management, VZ establishment including additional clearing and the removal of problem trees.

When compared against other DNSPs on the basis of vegetation density (trees per route kilometre) and cost per tree trimmed, the forecast expenditure for both total vegetation management costs and routine inspection and trimming costs benchmark very closely.

It is therefore considered that this forecast represents the minimum expenditure required for the next RCP for PWC to efficiently and safely manage its vegetation responsibilities given the assumptions made and risks inherent in the forecast.

Appendix 1 – Status of Implementation of Pinnacle Report Recommendations

Rec No.	Recommendation Details	Implementation Status
1	PWC implement a vegetation zone (VZ) approach to vegetation management.	Vegetation Forecast for next Regulatory Period prepared based on implementation of the recommended VZ's.
2	A transition plan be developed to implement the VZs and target inspection and treatment cycle times.	In early development and will be completed in conjunction with contract development in 2018/19. Additional GIS Resource required in 2019/20 to help implement transition plan.
3	A workshop be held with the current vegetation contractor as soon as possible to discuss the outcomes of this project and investigate opportunities to commence the transition to the new vegetation zones and cycle times within the current contract.	Complete. Limited opportunities identified to commence transition owing to current contract constraints.
4	Funding requirements to transition to the recommended VZs and cycle times be determined and included in PWC's regulatory submission to the Australian Energy Regulator (AER).	Forecast developed for Revised Regulatory Submission to include funding for transition to recommended VZ's and implementation of report recommendations
5	A set of goals and targets be developed against which progress towards the new vegetation management program can be measured to ensure the desired outcomes are being achieved.	To be developed by PWC in 2018/19 as part of contract development for new period contract.
6	SPAN_ID's be created for each span in the network and linked to the VZ or VMZ. All future vegetation inspection and treatment activities need to collected against the assigned SPAN_ID's. In addition, PWC should review the proposed future data requirements in Attachment 2 and implement collection of as much of the proposed data as required to meet PWC's future business needs.	SPAN_ID's only created and opportunities to increase data collection being negotiated with service provider. Additional GIS resource required in 2019/20 to implement this recommendation in full with new service provider. ICT Capex required for any system changes.
7	The process for recording vegetation inspections be reviewed as up to 30% of the spans in some regions have no inspection record and some areas were found with no inspection record since 2013. Non-vegetated spans or spans not requiring inspection should be identified so that PWC can ensure	Ongoing negotiations with the service provider to align network data between management systems is expected to reduce data inconsistencies and confirm non-vegetated spans. The first update of network records

	that all network spans requiring inspection are inspected according to the vegetation program. A process for updating network records between PWC and the Contractor also needs to be implemented to ensure data is collected against current network records in future.	between the service provider and PWC is in progress utilising the newly created SPAN IDs. Opportunities to increase the data collected under the existing contract, such as non-vegetated spans, are currently being negotiated with the service provider. Additional GIS resource in 2019/20 to continue development of processes and implementation with new service provider.
8	PWC retain a history of vegetation inspections and treatments, updated monthly, for future analysis, further program optimisation and management and regulatory reporting. A set of standardised reports should be developed to provide consistent reporting to measure progress against targets.	To be included as part of scope of work for additional GIS resource to develop and implement in 2019/20. ICT Capex may be required for any system changes.
9	The standard for minimum clearance distances between vegetation and powerlines be reviewed to account for span length, location within the span, conductor type and voltage in urban and rural areas.	Changes to clearance standards have been taken into account in the forecast. Detailed documentation of revised clearance standards will be completed in 2018/19 as part of development of requirements for new contract.
0	PWC ensure that all future powerline corridors are established in accordance with the standards wherever possible, as the analysis indicates that narrower corridors require more trimming and shorter cycle times to maintain vegetation on the edges of the corridor.	PWC has reviewed its construction standards and confirmed appropriate.
11	PWC investigate locations where herbicide treatments could be used as an alternative to slashing and mulching for corridor maintenance to reduce long term corridor maintenance costs. Trials should be conducted in suitable locations to ensure that herbicide treatments are effective in controlling vegetation regrowth and reducing long term maintenance costs.	Provisions for the use of herbicide treatment will be enhanced in the new contract. Trials and implementation of herbicide treatments will require extensive engagement with key stakeholders including the NT Environment Protection Authority, land owners and the community. While the contract will be developed to allow the implementation of this treatment option, the stakeholder engagement is expected to be complex and extended. It is difficult to predict at this stage whether herbicide

		treatment will be adopted and to what level. Previous trials have also had limited success due to the high rainfall but advancements in technology have been made since any substantial trials were completed by Power and Water. If a trial is considered feasible, funding will be provided from Corridor Maintenance provision.
12	A program for corridor maintenance needs to be established and funding allocated for the program rather than the current approach of prioritising corridor maintenance based on available funding each year.	A corridor maintenance program has been developed and funding has been allocated for the program.
13	The data issues identified during this project be investigated, network records updated and other actions taken as required to address any issues found.	Part of scope of work for additional GIS resource in 2019/20.
14	PWC consider the preparation of an Integrated Vegetation Management Plan (IVMP) to establish the future direction for vegetation management in its network.	PWC to determine if they wish to proceed with this recommendation.