Asset Management Plan – Vegetation Management

Power and Water Corporation

CONTROLLED DOCUMENT

Executive Summary

This document articulates Power and Water Corporation's (Power and Water) Asset Management Plan (AMP) in relation to its management of vegetation in the proximity of power lines within the regulated and non-regulated networks of the Northern Territory (NT). The AMP provides the following:

- An outline of the context, objectives, risk-based approach, and strategy for managing vegetation; and
- A summary of the subsequent programs and associated expenditure required to achieve the above over the next five-year regulatory period.

It sets out the strategies to manage vegetation near powerlines in a manner that achieves the key business objectives of:

- Providing safe, secure, reliable, high quality power at a minimal cost; whilst
- Meeting licence and statutory requirements, maintaining service level obligations, and being environmentally responsible.

In assessing the quantum of investment required in relation to the above issues, Power and Water has applied a risk based approach to establish its vegetation programs that focus on:

- Ensuring the safety of its employees and the public;
- Maintaining statutory clearances between network assets and vegetation and delivering duty of care requirements;
- Helping resolve any issues the public and other stakeholders may have regarding the clearance of vegetation;
- Reducing network system damage and supply interruptions, particularly during storms;
- Minimising ongoing vegetation management costs; and
- Collecting appropriate data to facilitate ongoing analysis and optimisation of the program, performance monitoring and reporting.

The operating and maintenance expenditure forecast centres around a balanced approach of cyclic inspections and trimming of vegetation within the clearance zone, the removal of hazard trees and unsuitable species and corridor maintenance to minimise the long term cost of vegetation management.

Average annual expenditure since 2013-14 is $5.4 million however expenditure has been reduced year on year during the period as a result of targeted problem tree removal campaigns and a high focus on contract management.

Figure 1 shows the average expenditure by region since 2013-14. The expenditure in each region varies based mainly on the length of the network, but is also influenced by climate and mobilisation costs. Vegetation growth rates in the tropical regions of Darwin and Katherine are significantly higher than found in the southern NT regions of Alice Springs and Tennant Creek. Mobilising and maintaining vegetation crews in regions other than Darwin also materially impacts the expenditure in these regions. This has led to significant review of

vegetation management activities across each region to identify efficiencies, some of which have already been implemented.

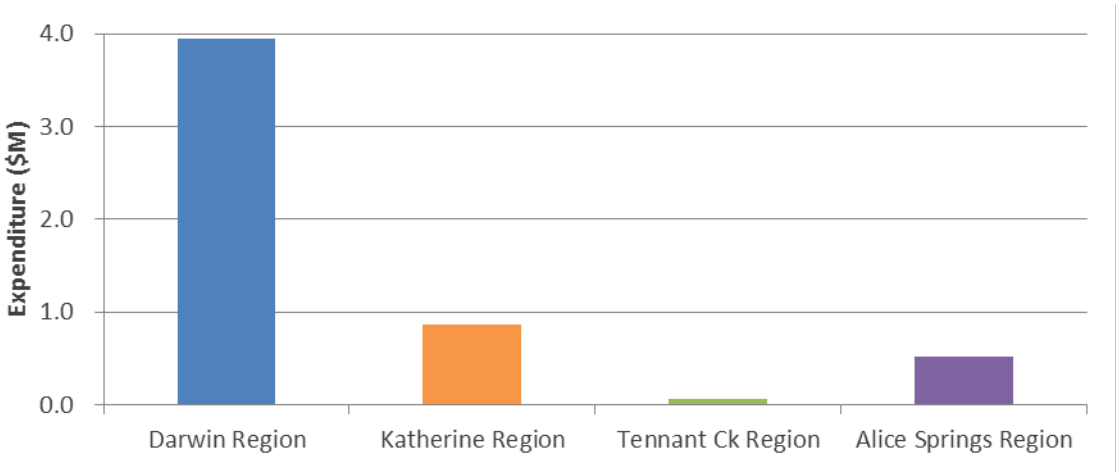


Figure 1 Average vegetation maintenance expenditure by region 2013-14 to 2016-17

Efficiency improvements implemented have clearly reduced expenditure since 2013-14. However the impacts of these improvements on network reliability and safety are being closely monitored to ensure Power and Water's organisational goals are still met. Figure 2 below demonstrates the year on year improvements, although some variability is still expected based on regional rainfall, accessibility after wet seasons to perform maintenance of rural areas and transmission corridors, as well as the limited market for vegetation services in the NT.

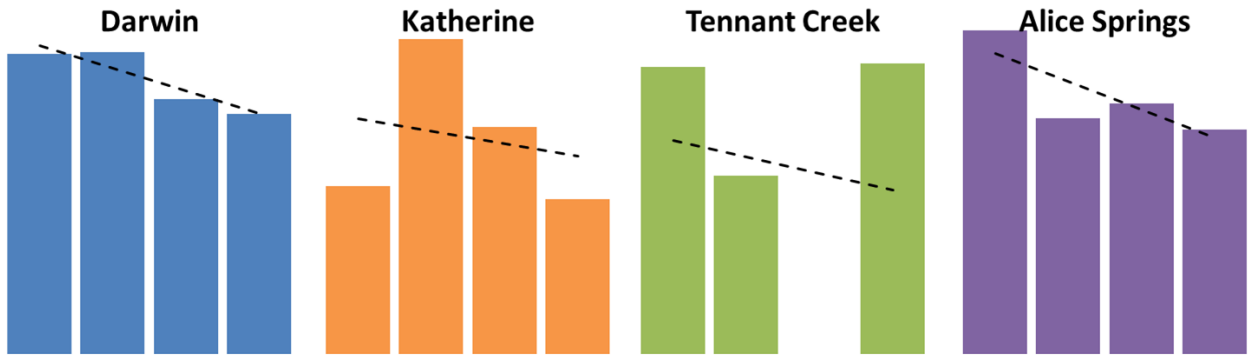


Figure 2 Regional vegetation management historical expenditure trends 2013-14 to 2016-17

Further optimisation of vegetation management is planned to be achieved through a number of initiatives described in the AMP including:

- Development of systems to enable collection and storage of accurate maintenance activity data, including geographical information and species classification;
- Optimisation of vegetation clearance standards in the context of vegetation type and likelihood of causing interruptions;
- Revision of contract model based on engagement with other utilities, lessons learned and regional opportunities and challenges;
- Trials of new technologies and treatment approaches to determine suitability to the NT's unique climate, species and scale.

1 Purpose

The purpose of this Asset Management Plan (AMP) is to define Power and Water Corporation's (Power and Water's) approach to managing vegetation in the proximity of both regulated and non-regulated overhead power line assets and key power network facilities. It frames the rationale and direction that underpins the management of these assets into the future:

- Short Term (0-2 years): Detailed maintenance and capital works plans for the upcoming financial year based on current asset condition.
- Medium Term (2-5 years) 2019-24 Regulatory Period: Strategies and plans based on trends in performance and health indicators.
- Long Term (5-10 years) 2024-29 Regulatory Period: Qualitative articulation of the expected long-term outcomes.

Vegetation is managed to comply with the broad external requirements of legislation, codes and standards. This is achieved within an internal framework of policy, strategy and plans that are enabled through interrelated documents, systems and processes that establish the Power Networks asset management practices. The asset management system is summarised in Figure 3.

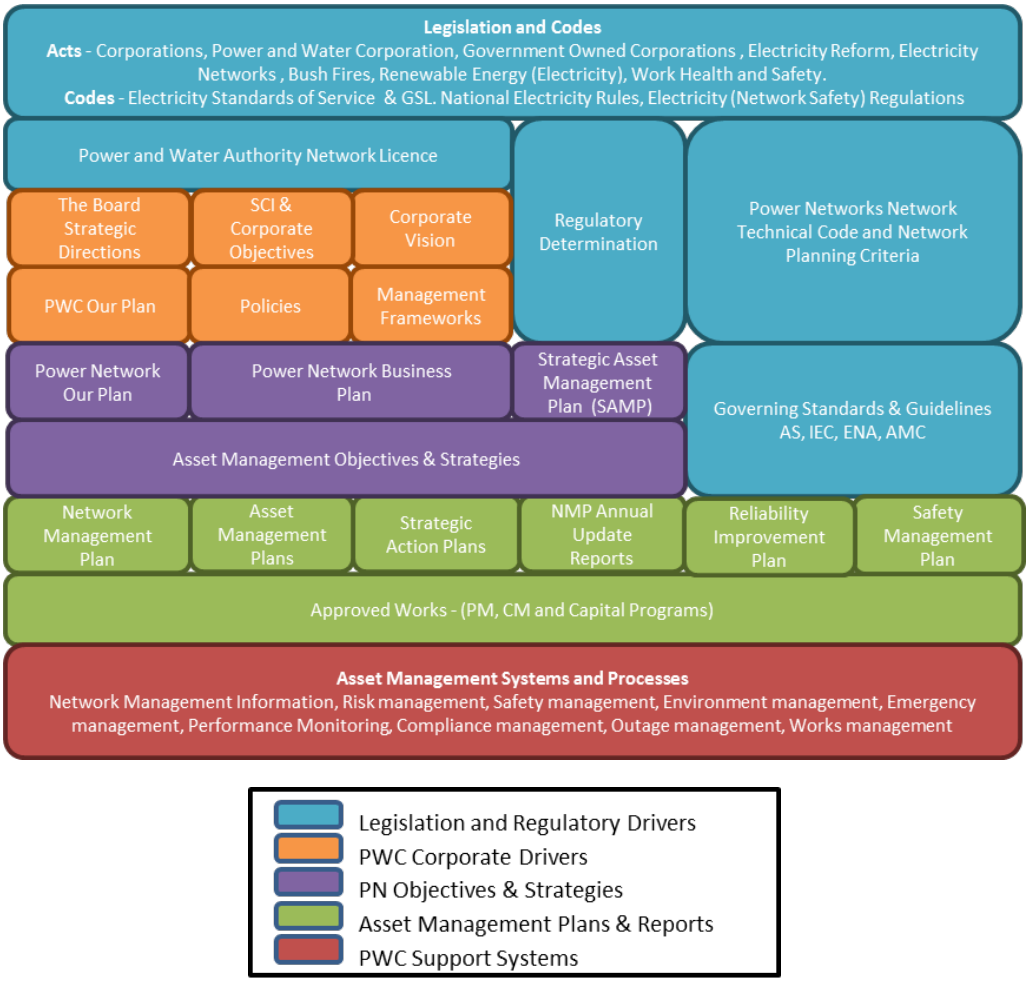


Figure 3: Asset Management System

2 Scope

2.1. Asset Class Overview

This AMP covers all vegetation management work associated with overhead transmission and distribution network assets including:

- Cyclic inspection and trimming of vegetation within the clearance zone;
- The removal of vegetation outside the clearance zone that presents an unacceptable risk of falling over power lines (e.g. hazard trees);
- The removal of unsuitable species that increase risk to achieving reliability outcomes;
- Improvements to and maintenance of transmission and distribution line corridors;
- Systems and data required to facilitate ongoing analysis and optimisation of the vegetation program, performance monitoring and corporate and regulatory reporting;
- Engagement with the community and councils regarding the planting of suitable species around power lines;
- Strategies to deal with the emerging risk associated with bush fires due to the spread of introduced species of grass such as Gamba, which are dramatically changing the intensity and consequences of fires, particularly in the northern region.

Table 1 Overview of in-scope assets

Region	Region	Regulated	Non-Regulated	Total
Transmission Lines (132kV)	All	350km		350km
Sub-transmission Lines (66kV)	All	359km		359km
Urban O/H Distribution Lines (all voltages)	Alice Springs	75km		75km
	Darwin	247km		247km
	Katherine	35km		35km
	Tennant Creek	34km		34km
Rural O/H Distribution Lines (all voltages)	Alice Springs	391km	31km	422km
	Darwin	1,858km	0.6km	1858km
	Katherine	943km	64km	1007km
	Tennant Creek	327km	41km	368km

Note: Both urban and rural distribution lines have been combined for Non-Regulated network and reported under Rural O/H Distribution Lines above.

Further information regarding the number, capacity, voltage, etc. of the assets above is available in the Asset Class Management Plans.

2.2. Asset Class Function

The majority of vegetation management expenditure is associated with overhead line assets comprising 132kV transmission lines, 66kV sub-transmission lines, 22kV and 11kV high voltage

distribution lines, low voltage mains (400/230V), and low voltage services (400/230V) except that low voltage services beyond two metres inside private property boundaries are not the responsibility of Power and Water. Vegetation and fire breaks are also maintained around substation, communication and control centre sites and other key distribution facilities to mitigate bush fire risk and comply with NT land management acts and regulations[1]. The extent of the Power and Water overhead network is shown in Appendix A.

2.3. Asset objectives

The AMP provides a framework which steers the management of the asset class in a manner that supports the achievement of Power and Water's broader organisational goals. The Asset Management strategies are listed in the Strategic Asset Management Plan (SAMP) and are aligned to the Asset Management Objectives and implemented in through Asset Management Plans (specific to asset class) or Strategic Asset Plans as shown in Figure 4.

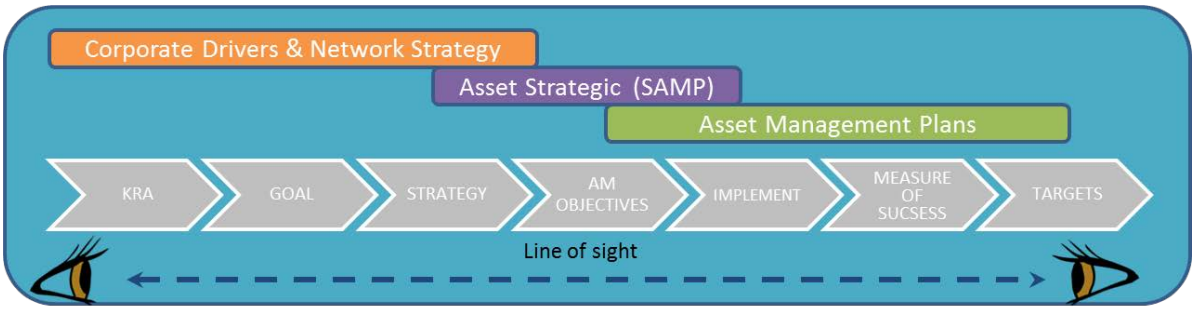


Figure 4 Asset Management Line of sight from Corporate and Network strategies through the Asset Management objective to the targets in the asset management plan

Table 2 provides the asset management objectives from the strategies that are relevant to this asset class along with the measures of success and the targets. This provides a 'line of sight' between the discrete asset targets and Power and Water corporate Key Result Areas.

Table 2: Asset Management Objectives, Measures of Success and Targets

Objectives	Measures	Targets
• Network related operation and maintenance tasks are quantified in terms of risk and used to inform investment decisions that affect Health and Safety outcomes for the organisation • Ensure the safety of its employees and the public.	• Vegetation clearance breaches between cutting cycles	• Total asset class specific safety incidents not exceeding TBA
• Engage with our customers, community and stakeholders to demonstrate that we have delivered the best possible solutions	• Customer Feedback - Track complaints	• Number of Complaints not exceeding TBA
• All environmental risks have been defined, mitigation controls implemented and responsibility for risk ownership has been assigned to appropriate leaders • Develop Environmental Improvement Plans for significant risks to reduce risk exposures and tracked through a governance framework • Develop performance indicators for intended	• Total asset class specific environmental incidents associated.	• Total asset class specific environmental incidents associated not exceeding TBA

[1] Including Bushfires Management Act and Weed Management Act

Objectives	Measures	Targets
environmental outcomes.		
• Ensure that the systems and processes provide sufficient and appropriate data and information to drive optimal asset and operating solutions. • Reduce network system damage and supply interruptions, particularly during storms.	• Asset class contribution to system SAIDI • Asset class contribution to system SAIFI • GSL contribution per year Guaranteed Service Levels	• SAIDI to be no more than 10% for this asset class. • SAIFI to be no more than 10% for this asset class. • GSL contribution per year TBA
• Ensure that the systems and processes provide sufficient and appropriate financial data • Understand the financial risks associated with asset management	• Variance to AMP forecast CAPEX • Variance to AMP forecast OPEX	• Variance to AMP forecast CAPEX +/-10% • Variance to AMP forecast OPEX +/-10%
• Develop systems and data that facilitate informed risk based decisions • Ensure that works programs optimise the balance between cost, risk and performance • Ensure the effective delivery of the capital investment program	• Network risk index quantified (Y/N) • Health and Criticality Parameters defined (Y/N)	• Achieved
• Identify, review and manage operational and strategic risks • Prioritise projects, programs and plans to achieve efficient and consistent risk mitigation. • Achieve an appropriate balance between cost, performance and risk consistent with regulatory and stakeholder expectations. • Define and communicate the level of risk associated with the investment program	• Operator/Maintainer risk assessment completed for asset class and risk register updated	• Achieved
• Ensure that electricity network assets are maintained in a serviceable condition, fit for purpose and contributing positively to Power Networks business objectives.	• All staff are trained and hold appropriate qualifications for the tasks they undertake. • Peer benchmarking, i.e. a reasonableness test of underlying unit costs (capex, opex) • Asset class preventative maintenance completion	• Achieved

3 Context

3.1. Roles and Responsibilities

Power and Water operates using an “Asset Owner / Asset Manager / Service Provider” business model. Although there is extensive collaboration and interfacing between the roles, generally speaking:

- The Asset Owner establishes the overall objectives for the assets;
- The Asset Manager develops the strategies and plans to achieve the objectives; and
- The Service Provider performs activities on the ground to deliver the plans.

3.2. RACI

Section 3.1 sets out the organisational roles and responsibilities. This section sets out the Responsibility, Accountability, Consulted, Informed (RACI) matrix for this asset class. This defines the roles and accountabilities for each task by allocating to specific roles/personnel within Power and Water.

Table 3 RACI Matrix for Vegetation Management

Process	Exec GM Power Networks	Group Manager Network Assets	Chief Engineer	Southern Delivery Manager	Group Manager Service Delivery	Field Services Manager	Works Management Manager	Vegetation Contractor	Vegetation Contract Superintendent	Asset Strategies Team	Asset Quality and Systems
Establish vegetation maintenance standards	A	R	C	I	I	I	C	C	C	R	
Performance and condition data analysis		A	I	I	I		C	I	C	R	
Establish vegetation maintenance contracts	A	R		C	C	I	C	C	C	R	
Execute maintenance plans in relevant region	I	C	I	A	A	R	R	R			
Provide vegetation maintenance data	I	A					R	R			
Auditing and Inspection of contractor	I	I	I	A	A		R		R		
Manage asset data (data entry, verify data)		A	I	I			I	I	R	R	R
Monitor delivery of maintenance plans	I	A	I	R	R	R	R	I	R	R	
Initial response to vegetation related faults and outages				A	A	R		I	I		

- *Accountable **(A)** means the allocated person has an obligation to ensure that the task is performed appropriately*
- *Responsible **(R)** means the allocated person must ensure the task is completed*
- *Consulted **(C)** means the allocated person must be included in the process for input but do not necessarily have specific tasks to do*
- *Informed **(I)** means this person must be kept up to date with progress as it may impact other parts of their responsibilities or accountabilities.*

4 Asset base

4.1. Overview

Power and Water maintains vegetation along approximately 4618km or 61,979 spans of regulated overhead line assets and 137km or 2,167 spans of non-regulated overhead line assets distributed across the four regions of Alice Springs, Darwin, Katherine, and Tennant Creek. The largest population of overhead line assets is located in the Darwin Region.

Power and Water also maintains vegetation around key facilities such as substation, communication and control centre sites and other key distribution facilities. The details of facilities are not broken down in detail however within this AMP. Power and Water operates 33 zone substations and 28 communications shelters and further information is provided in relevant AMPs for these asset classes.

4.2. Asset types

Table 4 Overhead Network Length (km)

Region	Rural / Urban	Voltage				
		132kV	66kV	LV-22kV	Services	Total (km)
Regulated Network						
Alice Springs (ASP)	Rural km		32.5	366.7	23.9	423.1
	Urban km			57.2	18.2	75.4
Sub-Total - ASP (km)			**32.5**	**423.9**	**42.1**	**498.5**
Darwin (DRW)	Rural km	263.5	223.6	1708.3	149.5	2344.9
	Urban km		10.8	194.4	52.8	258.0
Sub-Total - DRW (km)		**263.5**	**234.4**	**1902.7**	**202.3**	**2602.9**
Katherine (KTH)	Rural km	86.4	91.7	916.0	27.4	1121.5
	Urban km			25.8	8.8	34.6
Sub-Total - KTH (km)		**86.4**	**91.7**	**941.8**	**36.2**	**1156.1**
Tennant Creek (TCK)	Rural km			321.5	5.4	326.9
	Urban km			25.9	8.1	34.0
Sub-Total - TCK (km)				**347.4**	**13.5**	**360.9**
Total Regulated (km)		**349.9**	**358.6**	**3615.8**	**294.1**	**4618.4**
Non-Regulated Network						
Alice Springs	Total km			30.0	1.0	31.0
Darwin	Total km			0.6	0	0.6

Region	Rural / Urban	Voltage				
		132kV	66kV	LV-22kV	Services	Total (km)
Katherine	Total km			60.9	3.3	64.2
Tennant Creek	Total km			40.4	0.8	41.2
Total Non-Regulated (km)				**131.9**	**5.1**	**137.0**

Table 5 Overhead Network Spans

Region	Span Type	Voltage			
		132kV	66kV	LV -22kV*	Total Spans
Alice Springs (ASP)	Rural spans		223	6161	6384
	Urban spans			2772	2772
Sub-Total - ASP (Spans)			**223**	**8933**	**9156**
Darwin (DRW)	Rural spans	620	1164	27082	28866
	Urban spans		87	8182	8269
Sub-Total - DRW (Spans)		**620**	**1251**	**35264**	**37135**
Katherine (KTH)	Rural spans	204	765	9112	10081
	Urban spans			1343	1343
Sub-Total - KTH (Spans)		**204**	**765**	**10455**	**11424**
Tennant Creek (TCK)	Rural spans			3143	3143
	Urban spans			1121	1121
Sub-Total - TCK (Spans)				**4264**	**4264**
Total Regulated Spans		**824**	**2239**	**58916**	**61979**
regulated Network					
Alice Springs	Total Spans			463	463
Darwin	Total Spans			248	248
Katherine	Total Spans			919	919
Tennant Creek	Total Spans			537	537
Total Non-Regulated Spans				**2167**	**2167**

*Including services

5 Health and Criticality

This section discusses the health, criticality and resulting network risk associated with vegetation in the proximity of powerlines and facilities. While health and criticality are yet be quantified in a similar way to operating assets, the same approach can be applied to prioritise vegetation inspection, treatments and scheduling of work in a risk based context.

Risk is the product of the probability of an event occurring (determined by vegetation health or clearance) and the consequence should it occur (determined by asset criticality). Network risk can be reduced by maintaining or increasing clearances of vegetation from network assets and appropriate maintenance of power line corridors together with ensuring clearance and maintenance standards are appropriate for the critically of the asset. In some cases, asset changes such as replacing bare conductor with insulated conductor or re-routing assets may be appropriate to reduce the network risk associated with vegetation.

Power and Water manages network risk so it can successfully operate the network safely and reliably at the lowest cost to the customer. The remainder of this section describes the inputs that are being used to inform Health and Criticality, and risk, associated with vegetation management.

5.1. Vegetation Health

Vegetation health can be measured by the likelihood of vegetation impacting on a power line or other electricity facilities. Vegetation health can therefore be determined by assessments of:

- The results of visual inspections of vegetation intrusions into the clearance space and the condition of power line easements;
- Climate and vegetation factors which drive vegetation density and growth rates;
- Managed or hazard trees;
- Bushfire likelihood;
- Maintenance frequency.

These assessments are discussed further in the following sections.

5.1.1. Visual Inspection

Vegetation inspections have been scheduled on a feeder basis at predetermined intervals depending on the locality, clearances that can be practically achieved and vegetation growth rates. Vegetation intrusions are assessed against the clearance standards shown in Appendix D. These standards reflect the criticality of the assets as determined by voltage and conductor type (e.g. bare or insulated). Any vegetation intruding into the clearance space or likely to intrude into the clearance space before the next inspection cycle is scheduled for treatment either by trimming or removal.

Where practical, clearances to be achieved at the time of treatment include a growth margin for the relevant cycle time in addition to the standard clearances.

An analysis of the intrusions from visual inspections enables vegetation health to be determined from the likelihood of these intrusions leading to network safety, reliability or fire initiation

events. In particular, intrusions requiring live line skills to clear significantly increase the likelihood of the above events occurring.

Inspection of corridors is also undertaken periodically to assess when slashing and/or mulching treatment is necessary to address regrowth, access and bushfire risks.

5.1.2. Climate Factors

Climate is a significant driver of the types of vegetation and growth rates across the different regions. Figure 5 shows the climate zones for Australia as published by the Bureau of Meteorology.

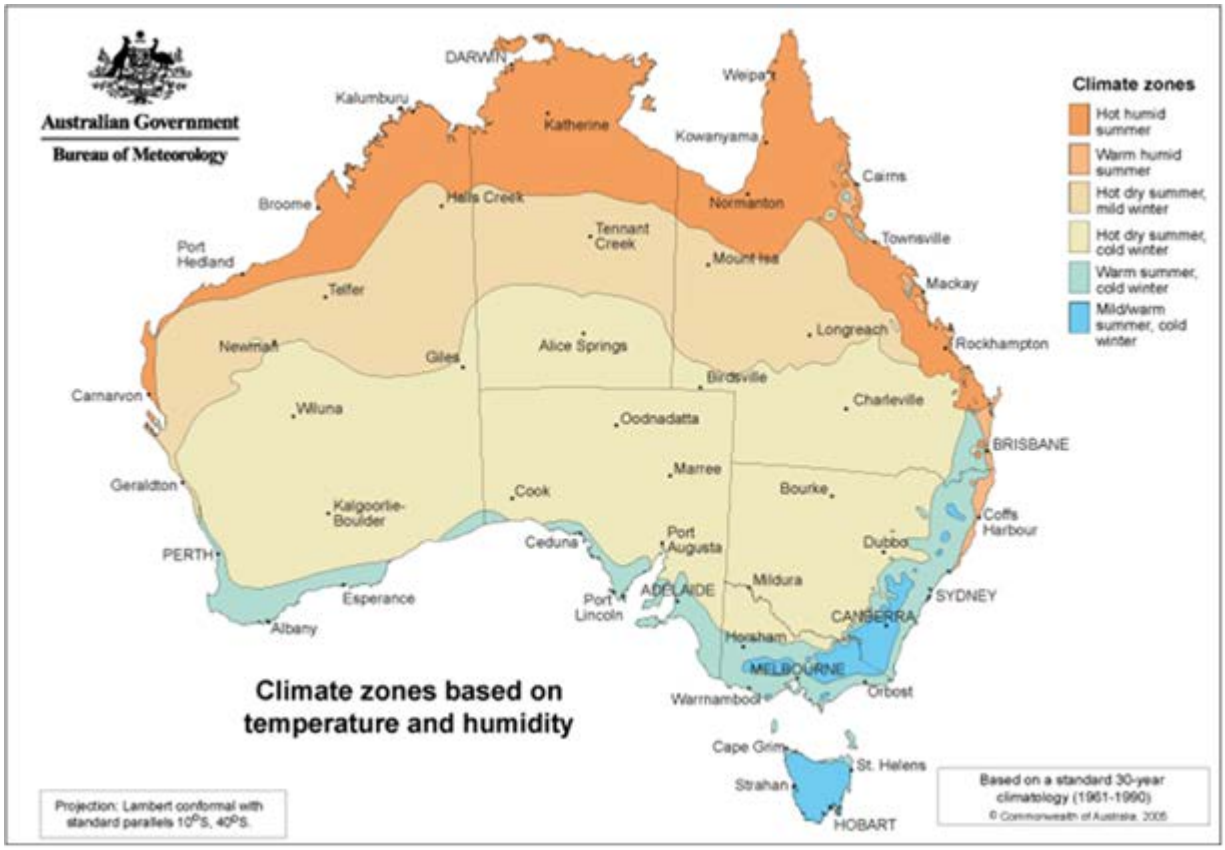


Figure 5 Climate Zones based on temperature and humidity

The Northern Territory is characterised by hot humid wet summers and dry winters in the Darwin and Katherine regions and hot dry summers and mild/cold winters for the Tennant Creek and Alice Springs regions respectively.

Figure 4 shows the seasonal rainfall zones for Australia as published by the Bureau of Meteorology.

Average annual rainfall varies significantly across the regions with greater than 1200mm in the Darwin region, 650 to 1200mm in the Katherine region and less than 350mm in the Tennant Creek and Alice Springs regions. Generally, most rainfall occurs during the period from November to March.

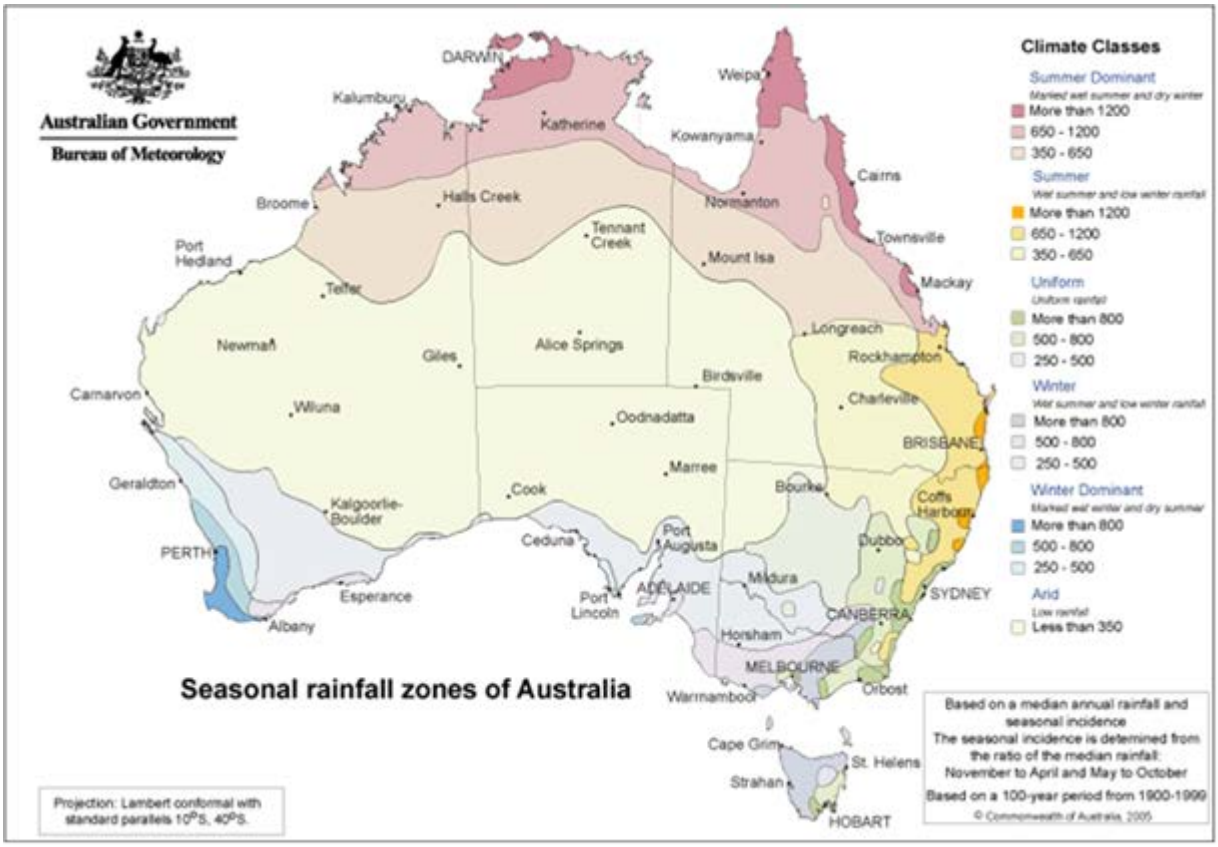


Figure 6 Seasonal Rainfall Zones for Australia

Table 9 shows the annual and wet season rainfall for the major centres for each region from 2012-13 to 2016-17.

Table 6 Rainfall for the Major Centres of Each Region from 2012-13 to 2016-17

Year	Rainfall Period	Darwin	Katherine	Tennant Creek	Alice Springs
2012-13	Annual	1453	1072	364	181
	6 months Nov to April	1383	1068	330	129
2013-14	Annual	1882	814	466	252
	6 months Nov to April	1772	798	455	203
2014-15	Annual	1396	969	484	280
	6 months Nov to April	1367	947	482	251
2015-16	Annual	1185	974	538	311
	6 months Nov to April	1076	962	427	226
2016-17	Annual	2549	1371	711	284
	6 months Nov to April	2354	1276	631	210

This table shows the declining rainfall with distance inland from Darwin and that over 90% of the annual rainfall falls during the wet season from November to April for all regions except Alice Springs, where 70 to 90% of annual rainfall falls during the wet season. Table 6 also shows

that annual rainfall can vary significantly from year to year so the vegetation program needs to be adaptable to these variations in climate conditions. For example, rainfall was significantly greater in 2016-17 for all regions except Alice Springs. This may be a major contributing factor to the increased quantities of trimming required in 2016-17 as shown in Appendix B.

The high average temperatures and humidity and high rainfall during the wet season for the Darwin and Katherine regions provide favourable growth conditions leading to a higher frequency of trimming required in these regions. This is in contrast to the more arid inland regions of Tennant Creek and Alice Springs where less frequent trimming requirements exist.

The Darwin region and to a lesser extent the Katherine region are also exposed to the risks associated with tropical cyclones. It is therefore important in these areas to also consider vegetation that may be outside the normal clearing zone but may present significant risks to network damage during such weather events.

As climate change occurs, extremes in weather conditions are likely to become more frequent and vegetation management plans need to consider these changing climatic conditions over time.

5.1.3. Vegetation Factors

Figure 7 shows the major vegetation types in Australia. It is clear that the climate is a major factor in the vegetation that exists across the Northern Territory from denser open forest in the Darwin region, through woodlands to shrub land in the more arid inland areas around Tennant Creek and Alice Springs.

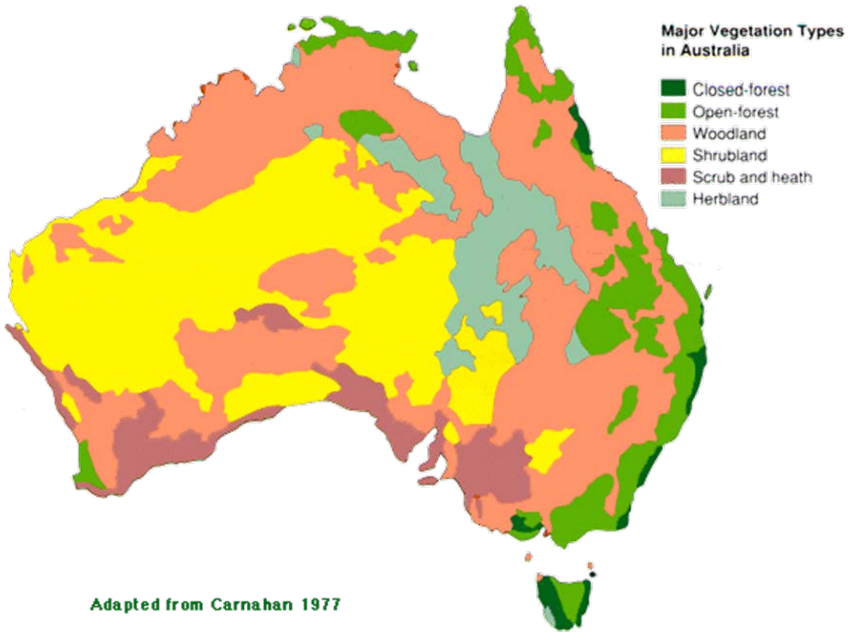


Figure 7 Major Vegetation Types in Australia

In addition to the native vegetation, plantings by property holders and councils also have significant vegetation impacts near power lines in urban areas, around rural dwellings and in some cases from horticultural activities on farms.

Soil conditions are another significant factor which impact vegetation characteristics in an area.

Generally, the density and size of vegetation is greatest in the hot humid wet Darwin region with significant growth during the wet summer months. A growth rate of three metres in six months in some species of trees is not uncommon in the Darwin region. The density and size of vegetation and growth rates reduce as rainfall decreases and soil conditions deteriorate further inland through the Katherine region to the arid areas from Tennant Creek to Alice Springs. However, some significant vegetation can still be found along watercourses and in urban areas where property owners plant and water tree and shrubs.

The change in vegetation characteristics across the Northern Territory following the wet summer months and the dry winter months is illustrated by Figures 6 and 7 which show the Normalised Difference Vegetation Index (NDVI) published by the Bureau of Meteorology. NDVI is an index which provides a measure of vegetation density and condition. It is influenced by the fractional cover of the ground by vegetation, the vegetation density and the vegetation greenness. Its value is always between -1 and +1. Vegetation NDVI in Australia typically ranges from 0.1 up to 0.7, with higher values associated with greater density and greenness of the plant canopy. NDVI decreases as leaves come under water stress, become diseased or die.

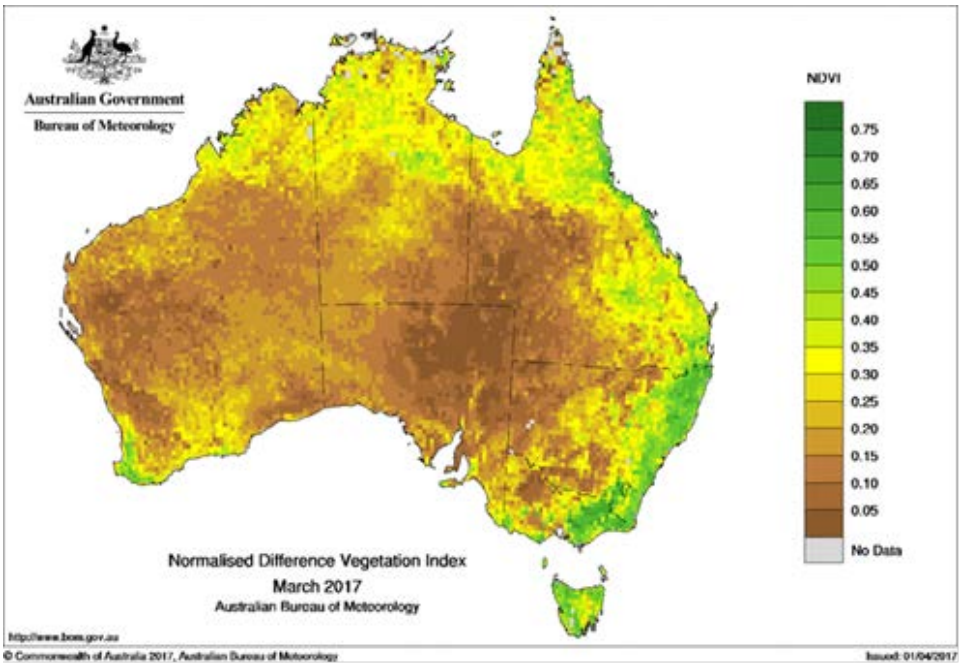


Figure 8 NDVI for March 2017

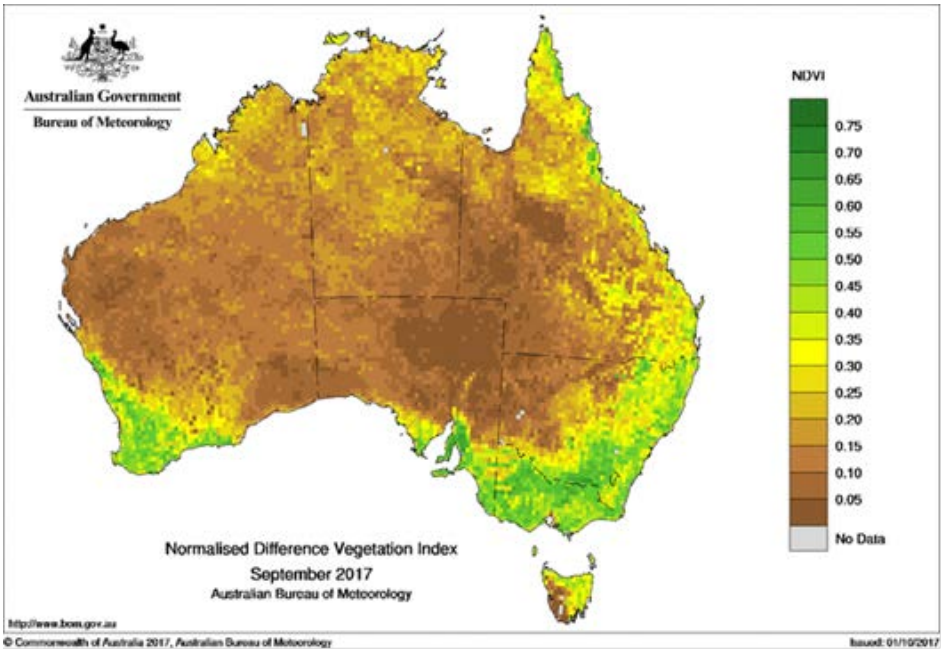


Figure 9 NDVI for September 2017

The above climate and vegetation factors need to be considered when assessing vegetation health and developing vegetation management programs.

5.1.4. Managed (Hazard) Trees

Managed or hazard trees are trees that exist outside the normal clearance space but present a risk to falling or being blown over power lines. These risks are significant during severe weather events that are experienced particularly in the Darwin and Katherine regions as discussed in Section 5.1.2 above. Where the risk is considered unacceptable, the trees are either trimmed or removed. Some trees in the NT are protected or are of significant heritage value and therefore cannot be removed but must be managed appropriately.

There has been significant effort to remove hazard trees in recent years to reduce the risk that these trees present. Ongoing identification and review of managed trees is required to ensure the potential impact of these trees on electricity infrastructure is appropriately managed.

5.1.5. Bushfire

The likelihood of bushfires occurring is also an important consideration for assessing vegetation health, particularly in relation to the maintenance of corridors and fire breaks associated with transmission and distribution assets. Bushfires are a regular occurrence in the dry season in the NT and Figure 10 below shows that most of the Darwin and Katherine regions have been burnt since 2013.

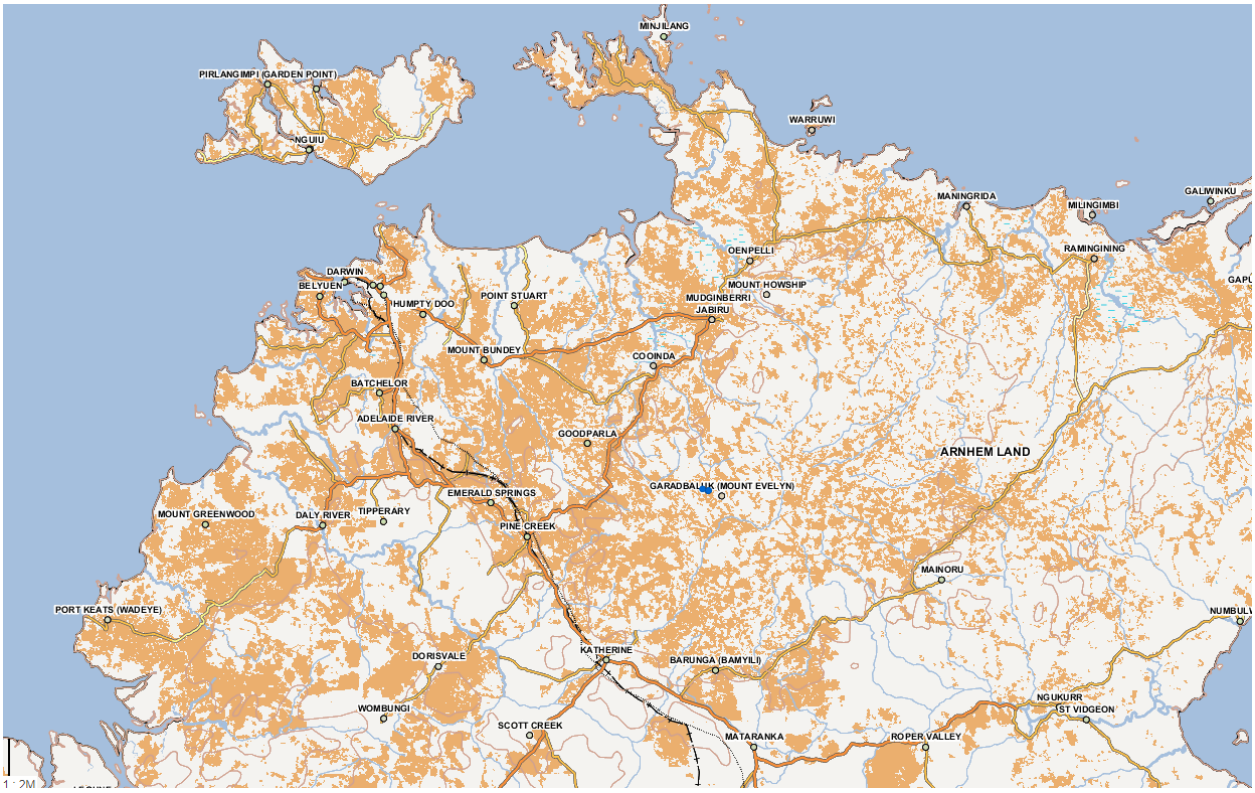


Figure 10 Fire Burn Scars 2017 Source: NAFI website

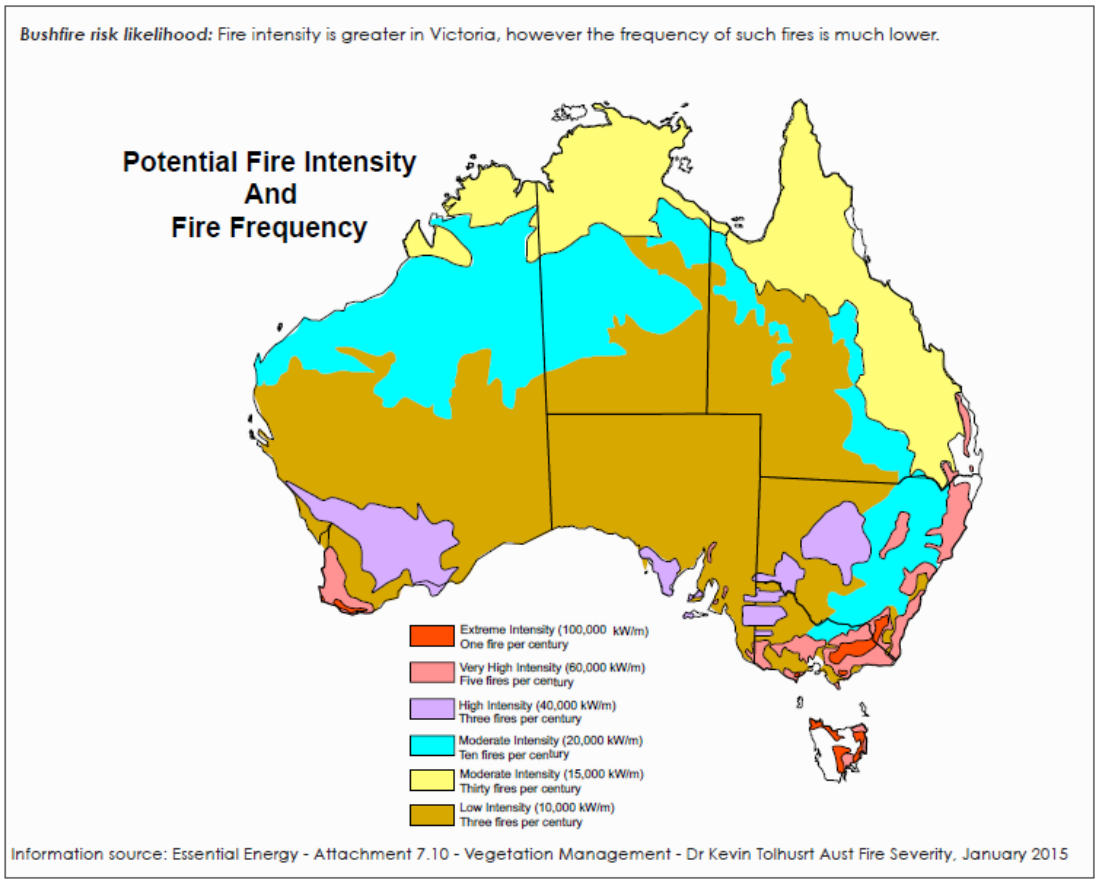


Figure 11 Potential Fire Intensity and Fire Frequency

Figure 11 confirms this and although the intensity of fires in the NT may only be moderate, they occur at a greater frequency (i.e. once every three to four years) than the south eastern areas of Australia. Different regions have varied topography and fuel types with grasses being recognised as the predominant fuel type in the NT (although there are significant areas of tropical savanna). Fuel loadings in the northern region are between 6 –13 tonne per hectare and the southern region between 2-4 tonne per hectare, this is due to the different flora – introduced weeds, etc.

Darwin rural areas, Batchelor and Adelaide River have fuel loadings between 9-13 tonnes due to the introduced grass called Gamba. Gamba grassfires are extremely volatile and fast moving and can produce significant amounts of heat. Whilst all fires are unpredictable and dangerous, these fires present the most challenges if a site is not adequately prepared.

Another consideration is the ability of fire authorities to respond to the location of a wildfire with enough resources to protect the infrastructure. In some areas this is limited due to the remoteness and the availability of vehicles and volunteers to respond.

Therefore, in assessing the likelihood of a bushfire impacting electricity infrastructure the following factors need to be considered:

- Hazards such as fuel loading, hazard level, extent/continuity, flammability/volatility and landscape features
- Weather – severity, duration and dynamics
- Ignition – location, timing number and distribution

Generally, the fire season starts in the Top End on the 1st of June and runs until the first week of December, however the majority of fires happen between April – November (depending on seasonal rain and the curing rate of the vegetation) (bad wet, early fire season - good wet, late fire season).

Central Australian arid and semi-arid regions are generally driven by fuel loads that result from periodic rain events. During these times continuous fuels drive huge fire fronts and significant areas of the interior often burn. 2010-11 saw significant fires impact Central Australia. Central Australia will burn as soon as the vegetation cures after a rain event, however the fire danger increases in line with the arrival of hot weather (Spring, Summer and Autumn).

The fire danger transitions between regions depending on the season. Once the season tapers off in Darwin, it moves south; e.g. Katherine, Tennant Creek, etc. It's all driven on rainfall and curing rates.

Generally, the Fire Danger Index can peak to 75 -100 (Extreme) in the Top End, with unusually rare events above 100+ (Catastrophic - weather and fuel load dependant). Central Australia could peak to 50-74 (Severe - fuel load and weather dependant). Typically, it would peak 12-31 (high).

The tall grasses such as spear grass and gamba grass occurring along power line corridors present a significant fire initiation risk particularly to or from maintenance activities along corridors. Fires beneath power lines may also cause interruptions to power supply.

Therefore, the corridor maintenance program is critical in mitigating the risk of bushfire initiation from power lines or maintenance activities along power line corridors and also in reducing the likelihood of fires causing interruptions to electricity supply.

The maintenance of fire breaks around key facilities such as substations, communication sites and control centres is also an essential part of the vegetation program to ensure the security of these sites.

5.1.6. Maintenance Frequency

Maintenance frequency is essentially driven by the location of the asset such as urban versus rural (where greater clearances and/or corridors can be established) and the climatic conditions and vegetation growth rates discussed in section 6.1.2 above. Typically, shorter maintenance intervals will be required in urban/semi-rural areas where clearances are limited because of property alignments and the planting of fast growth rate species such as palms. The density of vegetation is also generally greater in urban areas because of plantings and maintenance by property owners. As a result, vegetation intrusions into the clearance space are more likely to occur in urban areas. The above drive the frequency of trimming and as the number of intrusions per kilometre are more likely to be greater in areas where limited clearances can be practically achieved (e.g. urban areas), maintenance frequency could be used as a proxy for vegetation health.

5.2. Criticality

Criticality is driven by the assets function and associated safety, network reliability or system security, and environmental or financial consequences of an event.

5.2.1. Safety

Criticality from a safety perspective can be determined from the potential severity of electric shock to workers and the public or the potential for injury or loss of life from interruptions to supply or fire events.

5.2.2. Network Reliability

Criticality associated with network reliability is measured by consideration of the type of customer served, typically broken down into:

- CBD, Urban and Rural for reliability metrics, and
- Residential, Industrial and Commercial for Value of Customer Reliability (VCR)

In assessing reliability, system security aspects below also need to be taken into account:

- Transmission network contingency
- Substation facility capacity
- Communications network control and protection infrastructure

5.2.3. Financial

While network reliability analysis takes into account financial loss to customers from loss of supply, there may also be other financial impacts associated with property loss or damage, loss of income, etc. that may need to be included in criticality analysis.

5.3. Network risk

Network risk is the combination of the health and criticality of the assets being managed. It can be shown in either a qualitative or quantitative manner.

In terms of vegetation management, Power and Water's proposed approach is to move to a "zone" approach as discussed in section 6.4 which considers the health and criticality of the assets being managed, enabling trimming and corridor maintenance activities to be targeted to areas with the highest risk. Therefore, the health, criticality and risk analysis associated with vegetation will be completed as part of the process of transitioning to the new vegetation zones.

5.4. Establishment of Vegetation Zones

A review of the current vegetation program was completed in August 2017. This review found that the current feeder based approach with the same cycle times for both urban and rural areas across much of the Territory was not the most efficient approach to vegetation management - refer Project Power and Water 16-212 - Darwin Vegetation Management Analysis – Project dated 22 August 2017 (Review Project). The review identified a number of different vegetation zones (VZ) with different climatic conditions, land uses and vegetation characteristics and recommended that VZs be established for future vegetation management. Different vegetation treatment programs which may include trimming and removals in urban areas and a combination of trimming, removals and corridor maintenance in rural areas at cycle times appropriate for characteristics of each VZ need to be established. Cycle times varying from 6 months to 48 months are recommended for different VZs across Power and Water's network.
Power and Water plans to establish VZs and enable vegetation treatment programs to be optimised for the specific characteristics of the VZ, ensuring future vegetation management is performed as efficiently as possible.

These VZs will also be divided into smaller vegetation management zones (VMZ) for efficient management of the vegetation program.

Details of the proposed VZs and the target cycle time for each VZ is shown in Section 9 Maintenance Requirements.

6 Key challenges

This section summarises the current and emerging challenges faced by Power and Water in managing vegetation. The section focuses on issues that are driving expenditure and that are unique to Power and Water's network and environmental condition.

The challenges are broken into categories of Environmental, Operational, Asset and Asset Management.

6.1. Environmental challenges

Table 7 summarises the four operating regions covered by the network, setting out the type of environment, unique challenges in that environment and the implications.

Table 7 Environmental challenges in relation to vegetation management

Region	Environment	Challenges	Expenditure / risk implications
Alice Springs	Desert	• Extreme temperature changes both high and low • Remoteness	• Heat related stresses and reduced productivity resulting in increased time to undertake maintenance and inspection tasks • Suitably qualified and experienced resources are limited or non-existent and must be brought in from Darwin or interstate. This results in higher opex costs due to travel costs and time • Equipment and plant must be mobilised from Darwin for even minor defects
Tennant Creek	Desert	• as above	• as above
Darwin	Coastal/Tropical	• High rainfall and high temperature and humidity resulting in: • Limitations on access to network and being able to work on assets during the wet season – heat and rain/flooding (safety issue) • High vegetation growth rates • Vegetation Types • Bushfire risk from tall grasses • Rough terrain affecting accessibility for slashing and mulching of corridors.	• Heat related stresses and reduced productivity resulting in increased time to undertake maintenance and inspection tasks • Work scheduling and balancing resources to complete work in the dry season where wet season assess is limited • More frequent inspection and treatment to manage high growth rates • Specific management required for some species (e.g. African Mahogany) and high trimming and/or removal costs for species such as palms, bamboo, Neem trees. • Access constraints or specific measures required to address safety risks where high bushfire risks exist.
Katherine	Inland/Tropical	• as above	• as above

Specific areas of environmental concern are:

6.1.1. Tropical environment

Approximately 80% of Power and Waters network is located in a coastal tropical environment that is prone to cyclones. High temperature, humidity and annual rainfall result in high vegetation growth rates requiring more frequent inspection and treatment and reduces the ability for Power and Water to undertake maintenance for six months of the year during the wet season particularly in rural areas.

The impact of the environment is also lower worker productivity (discussed below) compared to peer distribution businesses, driving an increased level of opex to maintain vegetation.

6.1.2. Vegetation Types

The fast-growing African Mahogany trees were planted throughout Darwin after Cyclone Tracey to restore vegetation. These are now approaching the end of their life and present a significant hazard to many of the distribution and transmission lines and requires high frequency trimming, but are unable to be removed due to their value to the community. In 2011 during the category 1

cyclone “Carlos” many trees were blown over into lines and the size of African Mahogany trees presented a significant challenge to repair of the network.

Figure 12 Illustration of the damage caused by African Mahogany trees in the NT[2]

Other introduced species that are prevalent in rural areas and that present challenges to vegetation managers include Bamboo, Palms and Neem trees that require extensive root removal to prevent regrowth and grow rapidly in the northern tropical regions. In particular, palm trees are extensively planted throughout Darwin’s urban area and are highly valued by the community. Only limited trimming can be performed on palms without damaging the trees, resulting in a high cutting frequency.

6.1.3. Grasses

Both native and introduced grass species also present challenges in the rural areas and corridors, particularly during the northern region dry season where bushfires occur in most grassed areas in most years and are a significant hazard to maintainers accessing the network. Many grass species in established vegetation corridors also grow higher than light vehicles after each wet season making any travel both slow and hazardous. Where possible, extensive slashing of grasses is avoided unless required for maintenance activities planned; however, action must eventually be taken when fast growing shrubs and trees approach minimum clearances.

6.2. Operational challenges

Operational challenges in relation to vegetation management that pose unique challenges to Power and Water, and drive increased expenditure are listed below.

[2] Source: www.abc.net.au/news/2011-02-16/a-tree-lies-across-somerville-gardens-road-in-parap/1946610

6.2.1. Resourcing

Power and Water's vegetation maintenance is performed by service providers. The low volume of vegetation management work in the NT compared to the overall Australian market places Power and Water at a significant disadvantage when exploring the market for vegetation management service providers. This makes it harder to attract competition to the NT than networks operating on the east coast of Australia.

The remoteness from other major centres requires a significant investment in mobilisation by any service provider willing to enter the NT market increasing their premiums charged to provide services. Staff turnover and recruitment and training costs also lead to higher operational costs for service providers.

The volume of vegetation work in the remote areas of Alice Springs and Tennant Creek does not support a permanent workforce in these areas. Therefore, plant mobilisation, travel to and accommodation in these remote sites that can be up to 1,500 km away increases the time and cost of undertaking vegetation maintenance. This is a unique situation to Power and Water and is not experienced by the distribution businesses in the eastern states of Australia.

6.2.2. Operational effectiveness of field crews due to heat and humidity

Power and Water operates in hot and humid environments. The environments are not comparable to other networks around Australia and have a significant impact on the productivity of the field crews. To assess and quantify the impact of the climatic conditions, Power and Water undertook a study comparing the NT to other locations across Australia[3].

Workability is the term used to describe the productivity impact of climate in both Northern and Southern regions. It is the percentage of time for which work of different physical exertion can be effectively undertaken. These impacts are no different between Power and Water personnel and vegetation management contractors.

Table 8 below describes the work rates used in the study along with a description and examples.

Table 8 Work Rate Descriptions

Work rate	Description	Work examples
Rest	Rest	Lunch and Crib Breaks
Low	Sitting with light manual hand/arm work. Driving. Standing with light arm work, occasional walking.	Driving, work planning, briefings and toolbox meetings, inspections
Moderate	Sustained moderate hand to arm work, moderate arm and truck work. Light pushing and pulling. Normal walking.	unpacking tools, spare parts, dismantle/ replace small electronic components, general switching from ground
High	Intense arm and truck work, carrying, shovelling, manual sawing, pushing and pulling heavy loads, walking at a fast pace.	Climbing ladders, working in trenches and cabinets, remove replace larger components
Very High	Very intense activity at fast to maximum pace.	Carrying larger tools and replacement components, lifting, carrying up ladders, digging trenches, hauling cables, moving cable, pillars, poles

[3] Labour Efficiency and Work Management in Hot Humid Climates, Thermal Hyperformance.

The outcome of the study is shown in Table 9with the impact on Power and Water highlighted in orange. It demonstrates that the climatic conditions, particularly in Darwin where the majority of Power and Water's network is located, result in an average Workability of 65% compared to other major cities in Australia. This would equate to a 35% escalation of labour hours compared with the southern states for similar work and therefore an escalation of opex.

This is supported by feedback received via a heat stress survey which identified that approximately 50% of workers report daily or weekly heat-related impacts on their productivity.

Table 9 Workability for selected Australian locations based upon moderate metabolic rate

Location	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Alice Springs	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adelaide	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Brisbane	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Darwin	41%	44%	45%	60%	100%	100%	100%	100%	74%	46%	34%	32%
Hobart	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Melbourne	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Perth	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sydney	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

6.3. Asset challenges

This section identifies the current and emerging challenges in relation to Power and Water's vegetation maintenance activities. This section focuses on issues which need to be addressed to effectively manage and optimise vegetation management activities in the future.

6.3.1. Systems and Data

Currently, the vegetation work plan is recorded in Power and Water's Enterprise Resource Planning system, Maximo. Work Orders linked to feeders are issued from Maximo and costs are recorded against the work orders. Some information on the lengths and widths of corridors slashed and mulched and trees removed under part B of the contract are recorded against the work orders. Information on trimming and removals completed under part A of the contract is currently held by the vegetation management service provider and has been provided to Power and Water in excel spreadsheets for analysis. Power and Water has no system to collect and hold this data permanently for future analysis and reporting.

While the GPS locations of spans inspected and scoped by the vegetation management service provider have been recorded each inspection cycle, these GPS locations vary from cycle to cycle and are not linked to a unique span identifier. This has created a number of issues identifying the correct network span to link the inspections and treatments to. As part of the Review Project, SPAN_IDs were assigned to every span in the Power and Water overhead network and inspections were linked to these SPAN_IDs. However, spans that had been removed or relocated (i.e. no longer exist) were not assigned a SPAN_ID so inspections previously recorded against these spans could not be linked to a SPAN_ID or were linked to an incorrect span creating some errors in the analysis.

The vegetation management service provider was provided with the Power and Water network data in 2012 when the contract was established and the service provider has used this data to record inspections and treatments. No process has been in place to update the service provider's network data since as network changes have occurred. This disconnection between the service provider's network data and the actual network has created a number of issues around the duplication of or missing inspections and the linkage of inspections to SPAN_IDs that were created subsequently.

In order to improve future analysis of vegetation maintenance activities to enable further optimisation of the vegetation program, the Review Project developed a proposed data set to be collected during future vegetation maintenance activities. From this proposed data set, Power and Water will determine the data set it requires to be collected in future. As a minimum the data collected will:

- enable effective management and monitoring of the vegetation program;
- provide sufficient data for future analysis to further optimise the program; and
- provide all relevant information for management and regulatory reporting.

In the interim, the data currently collected by the service provider will continue but all future vegetation maintenance activities will need to be collected against a SPAN_ID assigned by Power and Water to every span in the network. SPAN_ID's will also need to be linked to VZs and VMZs when they are created.

To address the systems and data issues identified above, Power and Water plans to:

- Develop a set of data requirements to be collected as part of future vegetation management activities;
- Develop and implement integrated systems and/or system changes to manage the vegetation program on a VMZ basis and record the required vegetation inspection, treatment and expenditure data to enable future analysis and reporting requirements;
- Ensure all existing and new network spans are assigned a SPAN_ID linked to VZs and VMZs and all future vegetation inspection and treatment activities are linked to SPAN_IDs;
- Implement a process for the regular provision of the required vegetation inspection and treatment data from the service provider to Power and Water to update Power and Water records so that Power and Water can maintain the history of vegetation management activities and enable timely management reporting;
- Implement a process to provide regular network updates to the service provider.

6.3.2. Vegetation Clearance Standards

In the absence of specific legislative requirements governing minimum clearance distances from power lines, Power and Water has developed its own standards for minimum clearance distances.

Power and Water has also developed a number of policies, procedures and work practices for access to and work on the management of vegetation in the proximity of power lines in order to ensure compliance with relevant legislation in the Northern Territory.

A list of relevant Power and Water policies, standards and work practices are shown in Appendix E.

In addition to the minimum clearance standards and corridor clearance standards shown in Appendix E, Power and Water also identifies and trims or removes trees outside the normal clearance zones if they present an unacceptable risk of falling over power lines. Where agreement can be obtained from property holders and councils, unsuitable species are also removed.

Some changes to the current minimum clearing standards are being considered to assist with the transition to longer cycle times and to reduce the frequency of trimming required on LV spans in particular. The following changes are under investigation:

- LV ABC and Services – Approximately 40 to 50% of LV ABC spans are being trimmed at intervals of less than 12 months. The current clearance space for LV ABC and Services is 0.5 metres. Many utilities allow vegetation to touch LV ABC and Services before it requires trimming providing the vegetation will not cause abrasion to the insulation. Therefore, reducing the clearance for LV ABC and Services to 0 to 0.3 metres plus regrowth allowance is likely to be possible without any significant change in risk.
- Bare LV – The current clearance distance for bare LV is 3 metres plus an allowance for regrowth but there are currently many instances where this clearance is not being achieved. This distance does not consider span length or location within the span. In urban areas where span lengths are short (average about 40m) and conductor sag and sway is much less than the longer spans found in rural areas (average about 100m), a reduced clearance is being investigated. It is anticipated that this clearance distance could be reduced significantly, particularly in urban areas, without any appreciable change in risk.
- Bare HV – Clearance distances to bare HV are also being reviewed. Reduced clearances based on span length may also provide some additional allowance for growth in urban areas where the span lengths are similar to LV.
- Palms – A significant proportion of the trimming in urban areas is associated with palms. Palms grow very quickly but the fronds only tend to reach a certain length before they drop. These are currently trimmed to provide the full 3 metre clearance distance even though the fronds are unlikely to come within the live line distance for HV or contact the LV mains in many cases. The clearing standards associated with palms are being reviewed to allow for reduced clearances particularly for bare LV and insulated conductor. The clearance distance for HV may also be reduced without any significant increase in risk.
- Some species of trees, such as palms, bamboo, and neem trees that grow quickly and require more frequent trimming than the designated cycle time are to be identified in the standards as unsuitable species near powerlines. Such species should then be identified and recorded during inspections to enable a targeted removal program to be developed.
- Vegetation related outages from trees within the normal clearance zones are not significant. Most vegetation related outages result from vegetation outside the normal clearing zone either falling in or being blown in during severe weather events. An ongoing effort is therefore required to clear vegetation that is outside the normal

clearance zone but presents a risk to the continuity of electricity supply. The standards will also include the criteria for the assessment of hazard trees outside the normal clearance zone. This will enable a hazard tree assessment program to be incorporated in future contracts.

6.3.3. Contracting Model

The current contract model has all work externally resourced through a single vegetation management service provider. The contract comprises two parts as follows:

- Part A – Lump sum contract for the cyclic inspection and trimming program and
- Part B – Inspections of 132kV transmission lines and resulting trimming and removal work, "hazard" tree trimming or removal, slashing and mulching work and any other ad-hoc work required. This work is either performed on a schedule of rates basis or by separate quotation.

The service provider is required to undertake his owns audits of work completed to ensure compliance with the contract.

Power and Water's Contracts Coordinator manages the contract for Power and Water and also undertakes random audits to ensure the service provider is fulfilling his contractual obligations.

The current contract has been extended but tenders for a new contract are planned to be released in 2018.

The tender for the new contract will include the previous trimming and removal history completed under part A of the existing contract. This should enable competitive tenders to be received with the aim of reducing future vegetation expenditure. The tender will also incorporate the change to vegetation management zones.

Options for the contract model for the new contract include:

1. Single vs multi service provider - the size of the program in the Darwin and Katherine regions is not large enough to support multiple service providers so a single service provider model will be the likely outcome. However, alternate service providers used for short duration contracts when work is required in the smaller Tennant Creek and Alice Springs regions may be viable. Local staff in these areas may be required to perform reactive work between inspection cycles.
2. Lump Sum Contract – this is the preferred contract type for the main trimming and removal components of the contract. This could also apply for corridor maintenance if a regular corridor maintenance program can be established. For the Tennant Creek and Alice Springs regions, a lump sum contract will still be appropriate but an option for separate quotations to be obtained each cycle after scoping is being considered because of the variation in work volumes experienced in these regions previously.
3. Hourly Rate Contract – this type of contract is not preferred because it does not encourage the service provider to work efficiently and exposes Power and Water to too much risk of cost escalation. It would also require significant Power and Water resources to manage and audit the contractor's work.
4. Unit Rate Contract – While a unit rate contract will require more Power and Water management than a lump sum contract, it is appropriate for some work such as the

trimming or removal of hazard trees and potentially slashing and mulching work if a regular corridor maintenance program cannot be established. There may also be other ad-hoc work required from time to time where unit rates would be beneficial.

5. Performance Based – This type of contract is incorporated with the lump sum contract. Given the change to longer cycle times, it will be necessary to incorporate key performance indicators/performance measures and guarantees in the contract to ensure that service provider is delivering the outcomes required from the contract.

Therefore, the preferred contract model for the next contract is a performance based lump sum contract with provision for some work to be performed under a schedule of rates where it is not realistic for the work to be incorporated in the lump sum contract. An option to seek separate quotations for work in the Tennant Creek and Alice Springs regions may also be incorporated in the contract.

The contract will also require some flexibility to move the work schedule around to enable further optimisation of the program as better information is collected or to react to abnormal changes in vegetation because of significant variations in seasonal conditions or other significant events such as cyclones or bushfires.

6.3.4. Cultural Heritage

Power and Water must ensure that its work activities respect artefacts and/or sites of significance in accordance with heritage related legislation and Aboriginal Areas Protection Authority (AAPA). Permits/clearances must be issued prior to the start of works where artefacts and/or sites of significance exist and on aboriginal lands. These place restrictions on access and the amount of trimming or clearing that can occur. As a result, the vegetation program must be able to accommodate variations from the normal program where these restrictions exist and any additional costs associated with these variations.

Records of these sites are held in Power and Water asset data systems but the records are not complete. A process for reporting and recording any significant sites and/or artefacts including culturally significant trees will be incorporated in future contracts to enable Power and Water systems to be updated with all relevant information.

6.3.5. Environment and Endangered Species

Power and Water and its service providers have an obligation to comply with mandatory legislation requirements related to vegetation management to minimise environmental impacts when undertaking its work activities. A number of sensitive and significant vegetation communities are located across the NT, and are generally associated with areas of high biodiversity or significant habitat for threatened/endangered species and/or migratory birds. These areas include but are not limited to:

- Mangroves;
- Monsoonal rainforests;
- Riparian vegetation; and
- Sand plains – usually associated with rivers and creeks.

Permits are required before work can be undertaken in such areas. As a result, the vegetation program must be able to accommodate variations from the normal program where restrictions exist and any additional costs associated with these restrictions.

Records of sites with sensitive and significant vegetation communities are held in Power and Water systems but the records are not complete. A process for reporting and recording these vegetation communities will be incorporated in future contracts to enable Power and Water systems to be updated with all relevant information.

6.3.6. Weed Management

Weed management is becoming a more significant issue in the NT. While Power and Water expenditure on weed management has been minor in the past, forthcoming changes to enforcement of legislation are likely to impose increased accountabilities and costs on Power and Water for the control of weeds along it power line corridors.

Power and Water will commence recording the types and locations of declared weeds on its power line corridors and will develop programs to control and minimise the spread of weeds to comply with its legislative obligations.

6.3.7. Reactive Maintenance

As cycle times for vegetation inspection and treatment are increased, it is likely that there will be some increase in reactive maintenance costs associated with vegetation near power lines. These costs are a useful measure of the effectiveness of the vegetation program and whether cycle times are appropriate or need to be reviewed. Reactive maintenance costs will be separately recorded in future and targets set to monitor reactive maintenance costs to ensure they remain within acceptable levels.

6.3.8. New Technologies

New technologies are being used or introduced for vegetation management around the world. Examples of these include LIDAR and tree growth regulators.

LIDAR is used for the assessment of vegetation clearances from powerlines for scoping or auditing purposes and enables a utility to gain an overall assessment of vegetation across its network in a very short space of time. LIDAR is now being used by many utilities throughout Australia and costs associated with LIDAR use are reducing.

Tree growth regulator trials are in progress in Australia and may be a viable option to reduce the rate of tree growth and hence increase cycle times and reduce vegetation management expenditure in the future.

Power and Water will monitor progress of these technologies and investigate whether trials of these or other new technologies that may become available are warranted to access their viability for use in the Northern Territory.

7 Performance indicators

Vegetation is managed to ensure reliable, safe and sustainable distribution of electricity. To achieve these objectives, performance indicators will be established based on key risks and performance requirements. These indicators will be monitored and asset management strategies and plans will be adjusted on a periodic basis to ensure the targets are met.

Proposed vegetation performance indicators and their current status are shown in Table 10. The indicators chosen are aimed at ensuring that the corporation's objectives are met.

Table 10 Vegetation Performance Indicators

Objective	Description	Target	Actual	Gap
Sustainability	Vegetation – Variance from Budget	+1% to -10%		
Sustainability	Reactive Maintenance Expenditure	< 5% of Vegetation Budget		
Sustainability	Vegetation Maintenance Index	TBD	TBD	
Sustainability	Non-compliances with Standards	TBD	TBD	
Sustainability	Customer Satisfaction with Vegetation Program	TBD	TBD	
Reliability	SAIDI from Vegetation Interruptions			
Reliability	SAIFI from Vegetation Interruptions			
Responsibility	Safety Incidents associated with vegetation and vegetation work	0		
Responsibility	Number of Legislative non-compliances reported	0		
Responsibility	Number of fire starts from vegetation near power lines	0		

7.1. Sustainability Indicators

Sustainability is critical for the ongoing operations of Power and Water's business. The sustainability performance indicators provide a balanced view of vegetation management to ensure that vegetation management activities are completed within budget while ensuring that the planned program is completed without deterioration in the number of non-compliances with standards or increases in reactive maintenance expenditure. Customer satisfaction with the way Power and Water manages its vegetation program is also a key feedback to ensure customer's expectations are being met.

Figure 13 shows the vegetation maintenance expenditure breakdown from 2013-14 when the new contract commenced to 2016-17. Direct costs associated with tree trimming have decreased approximately 7% over this period. There was significant expenditure on hazard tree trimming, ground clearing and corridor clearing in 2013-14 and 2014-15, but this dropped significantly in 2015-16 and was minimal in 2016-17. As a result a backlog of work may be increasing in these areas which could result in an increase in expenditure requirements in future years.

Previously, there has been no formalised reporting of progress of the vegetation program against plan. It is therefore proposed that a composite index be developed that incorporates all components (i.e. inspections, trimming, hazard trees, ground clearance, corridor clearance) of the vegetation program to ensure that the complete program progresses to plan and to allow variances to be identified and remedial action taken as required.

Non-compliances with standards should also be measured to ensure that the numbers of vegetation intrusions are being maintained within specified limits so that changes to the vegetation program can be made if the variation becomes unacceptable. This is particularly important as changes to vegetation program are made to introduce the vegetation zone approach.

Customer satisfaction surveys with Power and Water's management of vegetation work will also provide valuable feedback to Power and Water about whether it is meeting community expectations in this area. Therefore, it is proposed that these surveys be performed annually to ensure appropriate action can be taken based on community feedback.

7.2. Reliability indicators

The performance of the vegetation asset class over the 10 year period from 2006-2007 is provided in Figure 13 and Figure 14. The charts show the performance based on sustained outages only, i.e. outages with duration greater than 1 minute, and excludes major event days (MEDs). In particular, the following events were excluded from the analysis, in calculating the % contribution of the asset class into NT SAIDI/SAIFI:

a) Planned outages
b) Generation-related outages
c) Outages that were internal to customer premises
d) Outages initiated in the interest of public safety

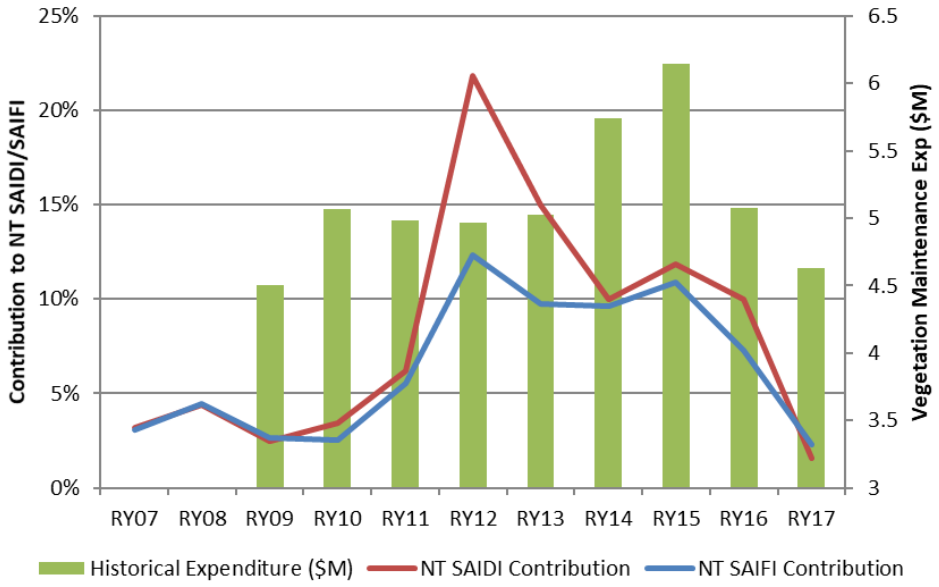


Figure 13 Contribution to SAIDI and SAIFI from Vegetation Related Outages and Maintenance Expenditure 2006-07 to 2016-17

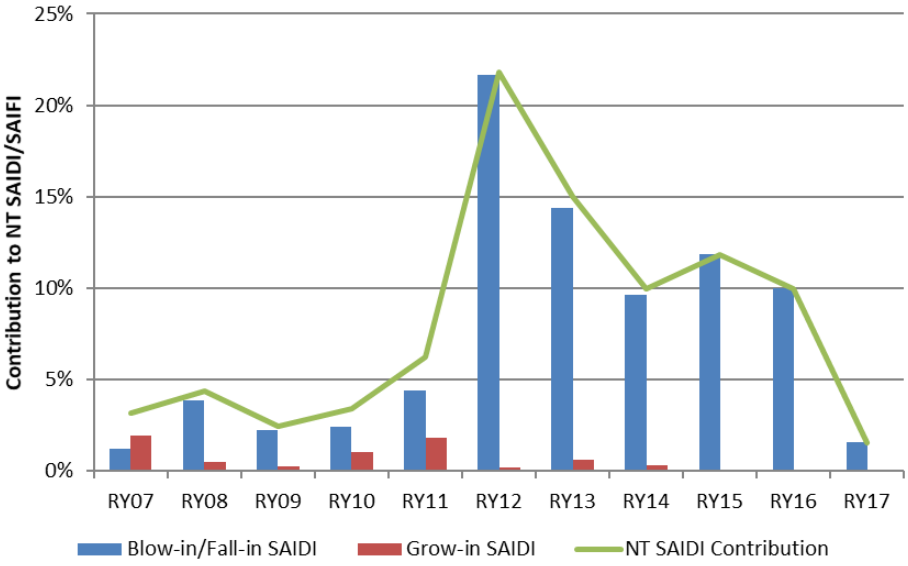


Figure 14: Contribution to SAIDI from Vegetation Blow-in/Fall-in and Grow-in

The contribution to SAIDI and SAIFI from vegetation related outages peaked in 2011-12 prior to the start of the current vegetation maintenance contract. It should be noted that the quality of reporting for vegetation related outages prior to 2011-12 appears to have been poor. Maintenance expenditure increased following the start of the current contract and significant effort was applied to addressing hazard trees and corridor clearance in the first two years of the contract. In addition, there have been a significant number of removals completed each year as part of the trimming work. It is clear that this effort has significantly reduced the contribution of vegetation outages to SAIDI and SAIFI and interruptions from grow-ins has been reduced to zero. While grow-ins are now under control, an ongoing effort is required to maintain vegetation that is outside the normal clearance zone but presents a risk to the continuity of electricity supply.

Again, ongoing monitoring of these performance metrics is essential to ensure that an acceptable level of reliability relating to vegetation outages is maintained as vegetation program changes are introduced.

7.3. Responsibility indicators

A key corporate objective is the safe operation of the network. The number of public and worker safety related events associated with vegetation needs to be recorded so that action can be taken as required to ensure Power and Water is meeting its obligations in this area.

Power and Water also has a responsibility to ensure it meets its legislative obligations so any non-compliance with acts, regulations, codes or practice etc. need to be recorded so remedial action can be taken as required.

A further responsibility of Power and Water to the community is to prevent damage to the environment and property from fire initiated from vegetation in the proximity of powerlines. Monitoring this performance metric will ensure that Power and Water is meeting its obligations in this area.

8 Maintenance Requirements

Vegetation work is currently planned and performed on a feeder basis with costs allocated against each feeder.

The following components make up the current vegetation work plan.

- Cyclic inspection and scoping of vegetation trimming required in maintaining clearances. The current cycle times for inspections are 6 months in the Darwin and Katherine regions, 12 months in the Alice Springs region and 18 months in the Tennant Creek region for both urban and rural areas.
- 132kV transmission lines are inspected separately from the above cyclic inspection program at intervals determined by Power and Water and vegetation treatment scheduled as required from these inspections.
- An active program to trim or remove "hazard" trees (i.e. trees outside the clearance space but which present an unacceptable risk of falling over power lines) is also in place.
- Slashing and mulching on transmission, sub-transmission and rural distribution line corridors to maintain the corridors and in some cases to achieve clearances that were not adequately established when the lines were originally constructed. Priority for slashing and mulching has been given 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. Very little herbicide treatment is used for corridor maintenance. Slashing and mulching activities have only been undertaken in the Darwin and Katherine regions.

Appendix B shows a summary of the results of the analysis for trimming and removals carried out under Part A of the contract and for slashing and mulching work for corridor maintenance. As volume data for the 132kV lines and "hazard" tree trimming and removal was poor, a comparison of this data has been excluded. However, this work only represents 5 to 10% of the total expenditure.

Some observations from the data in Appendix B are:

- There were some significant increases in unit costs for trimming and removals particularly in the Alice Springs region and for 2015-16 in the Katherine region.
- Trimming/removal quantities for 2016-17 were generally significantly higher across all regions compared to the previous years with unit costs lower.
- Because Part A of the contract is a lump sum contract, unit costs will vary from year to year as trimming/removal quantities vary. However, the 2016-17 work in Tennant Creek and Alice Springs region was not completed under lump sum contract; rather a separate price was obtained for this work and a significant reduction in unit costs was achieved.
- Slashing and mulching to clear corridors is undertaken either on a schedule of rates or quoted basis. Therefore, unit costs for slashing and mulching generally do not vary significantly. Slashing and mulching unit costs are dependent on the ratio of slashing and mulching undertaken, the density of vegetation mulched and also on corridor widths.

- Slashing and mulching work was significantly reduced in 2015-16 and 2016-17 compared to previous years because of budget constraints. Therefore, additional corridor clearance work will be required in future to address growth in corridors not cut in recent years.

8.1. Vegetation Zones

A review of the current vegetation program was completed in August 2017. This review found that the current feeder based approach with the same cycle times for both urban and rural areas across much of the Northern Territory was not the most efficient approach to vegetation management - refer Project Power and Water 16-212 - Darwin Vegetation Management Analysis – Project dated 22 August 2017 (Review Project).

This project recommended the establishment of vegetation zones based on vegetation characteristics, climatic conditions and land use to enable a uniform management practice to be implemented for each VZ. Each VZ can be subdivided into smaller vegetation management zones (VMZ) to facilitate efficient management of the vegetation program. Table 11 shows the proposed vegetation zones with a description of each and the target cycle time to transition to. Diagrams of these vegetation zones are shown in Appendix C.

Table 11 Proposed Vegetation Zones

Vegetation Zone Number	Description	Target Cycle Time (Months)
1	Residential areas in the Darwin region with significant quantities of vegetation, high growth rates and limited ability to increase clearance distances	6
2	Residential areas in the Darwin and Katherine regions with less vegetation/better clearances and lower quantities of more frequent trimming required	12
3	Predominately Commercial/Industrial areas with lower quantities of vegetation requiring less frequent trimming	18
4	Semi-rural areas in the Darwin region with significant quantities of vegetation and restrictions on the clearances that can be achieved	12
5	Rural areas in the Darwin & Katherine regions with mainly native vegetation and where corridors or greater clearances can be established	24
6	Rural areas with established corridors with minimal vegetation in the corridor requiring trimming	36
8	Rural areas with minimal vegetation requiring trimming and lower growth rates and/or with established corridors.	48
9	Urban areas in the dry inland regions	24
10	Sub-transmission lines in the Darwin region urban areas and also semi-	12

Vegetation Zone Number	Description	Target Cycle Time (Months)
	rural/rural areas where there is no established corridor and clearances cannot be achieved for a longer cycle time	
11	Sub-transmission lines in the Darwin region rural areas with established and maintained corridors	36
12	Sub-transmission lines in the Katherine and Alice Springs regions with established and maintained corridors	48
13	Transmission lines with established and maintained corridors	36

A list of feeders which fall into each of the above VZs is shown in Appendix D. Some feeders span multiple VZs and are listed separately with the VZs the feeder is to be divided into.

An increase in clearances on spans that have required more frequent trimming will be required to achieve these target cycle times. A change to clearance standards particularly around low voltage lines as discussed in Section 7.3.2.2 should also help to achieve these increased cycle times. It is recognised however, that these target cycle times will not be achieved on all spans as clearances cannot be increased in some cases. These spans will be identified and scheduled for mid-cycle inspection and treatment if required.

8.2. Corridor Maintenance

Power and Water has undertaken extensive slashing and mulching activities on its transmission, sub-transmission and rural distribution line corridors to maintain the corridors and in some cases to achieve clearances that were not adequately established when the lines were originally constructed. Priority for slashing and mulching has been given 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. A budget for this work has not been previously defined; rather work has been prioritised based on the available funding. This has resulted in a significant reduction in corridor maintenance in 2015-16 and 2016-17 compared to previous years. Therefore, additional corridor clearance work will be required in future to address growth in corridors not cut in recent years.

The review of the current vegetation program completed in August 2017 found that minimal trimming was required where corridors have been maintained by slashing or mulching at a width of 12 metres or more. Narrower corridors have required more trimming from vegetation intrusions from the edge of the corridor.

The review of the vegetation program also found that it was difficult to determine optimum cycle times for corridor maintenance from historical data but, based on line criticality, vegetation growth rates in the area and previous corridor maintenance activities completed over the review period, Table 12 shows cycle times that may be appropriate for a future slashing and mulching program. Cycle times on some individual feeders may vary from those proposed. Regardless of these proposed cycle times, all corridor maintenance should only be undertaken when justified by the conditions.

Table 12 Proposed Cycle Times for Corridor Maintenance

Region	Line Type	Proposed Cycle Time (Months)
Darwin-Katherine	Transmission Lines	12 to 24
Darwin	Sub-transmission lines	12 to 24
Darwin	Distribution lines	24 to 36
Katherine	Sub-transmission lines	36 to 48
Katherine	Distribution lines	36 to 48

Power and Water will develop a program and funding requirements for future corridor maintenance across its network.

Herbicide use has been limited for the control of regrowth on power line corridors. Reasons for the limited use of herbicides are:

- Possible contamination of the shallow water tables;
- Contamination of rural properties used for agricultural purposes such as livestock production;
- Application of herbicide is best during the wet season when plants are actively growing but there is limited access along many corridors;
- Fires are a regular occurrence during the dry season and the fire destroys the herbicide treatment and trees reshoot from the bottom.
- Tall spear grass and gamba grass cover many corridors making access along the corridor for maintenance activities extremely difficult and present a significant fire risk.

For the above reasons, slashing and mulching has been found to be the most effective method for maintaining corridors as it controls both the tall grasses and regrowth.

Nevertheless, herbicide treatment may be a more cost effective long term method of controlling regrowth on some corridors or parts of corridors. Power and Water will investigate whether there are viable locations and applications for herbicide treatment and conduct some trials if suitable locations are identified.

8.3. Alignment with Other Maintenance Programs

Aligning the vegetation program with other maintenance programs has not been pursued because of the frequent inspection intervals for vegetation and the specific skills and equipment required for vegetation work.

However, as cycle times are increased particularly in rural areas, the identification of vegetation that is intruding or may intrude into the clearance space before the next inspection cycle may be possible through other asset inspection programs if these inspections can be offset from the vegetation inspection cycles. This would assist in providing assurance that the new cycle times for vegetation inspection are suitable or whether some intermediate treatment at specific locations is required.

Power and Water will investigate the possibility of incorporating the identification of non-conforming vegetation within other inspection programs and consider implementing changes where feasible and economical.

In some cases, electricity supply outages are required for access to trim vegetation or remove unsuitable or hazard trees. Consideration needs to be given coordinating this work with outages for other asset maintenance activities where possible.

8.4. Transition Plan

It will not be possible to implement all of the cycle time changes recommended in this report immediately as additional work will be required in future treatment cycles to increase clearances where required to allow for the additional regrowth. This will require additional funding in the short term so implementation of the VMZ changes can only occur as funding becomes available. Data and system changes are also required to support the new VMZ's and any additional data collection required.

In addition to implementation of the vegetation zone approach for vegetation management discussed above, the review project also made a number of recommendations regarding vegetation treatment standards, systems and data, performance monitoring, contract models, work processes etc. and proposed a transition plan to implement the recommended changes.

A preliminary implementation plan below has been developed but needs to be confirmed when further work is completed on the plan for the VMZ and cycle time changes and the systems changes. The plan is divided into three time periods to align with the regulatory periods. Activities proposed to be undertaken in each time period are:

2017-2019

- Revise the vegetation treatment standards.
- Determine appropriate VMZs for future management of the vegetation work program, develop a plan to transition to the new VMZs and new inspection and treatment cycle times and commence the transition. This will include increasing clearances where possible to enable the new cycle times to be implemented. The transition plan will be subject to available funding, estimated costs to transition and contractor resourcing.
- Scope some typical feeders/VMZ's to determine the quantity of work (trims/removals/slashing/mulching) and additional funding required to achieve target cycle times.
- Determine spans where clearances cannot be achieved for the new cycle times and schedule these for mid-cycle inspection in the work plan.
- Assign SPAN_IDs to every span in the network and link these to the VMZ's and Feeder_IDs. Circuit_IDs for every circuit in a span should also be linked to SPAN_IDs.
- Provide an updated network diagram with SPAN_IDs assigned to the contractor and implement a process for regular network updates to and from the contractor.
- Develop KPIs/performance measures for monitoring and reporting of the vegetation program progress and contractor performance.
- Determine future data capture requirements and the system changes necessary to implement the new vegetation strategy, standards and reporting requirements and implement a process with the vegetation contractor for the capture of this information on a regular basis. The data collected also needs to facilitate all management and regulatory reporting requirements in addition to KPI/performance reporting.
- Develop and implement the necessary systems and system changes to support the above data capture and reporting requirements.
- Deploy the revised standards, transition plan to the new VMZs and cycle times and the new data capture requirements to Power and Water staff and contractors.
- Determine the appropriate contract model for future vegetation contracts and call tenders for new contract(s) based on the new vegetation program. Tenders should contain sufficient historical information to enable competitive tenders to be received.
- Review and update Power and Water's process/procedure/work instruction documents relating to vegetation management where required.
- Commence recording the locations and extent of declared weeds on power line corridors.
- Develop a Stakeholder engagement plan including the potential for legislative changes to improve flexibility and accessibility, confirm the benefits from the revised vegetation strategy are being realised and address any specific stakeholder vegetation issues identified.
- Ensure the regulatory submission seeks funding for the planned vegetation program.

2019-2024

- Review the vegetation work program to align with the funding available from the regulatory determination and Power and Water's customer engagement program feedback and risk appetite.
- Complete the transition to the new work program incorporating the new VMZs and cycle times.
- Develop a program for the management of hazard trees identified during the routine inspection program.
- Investigate a suitable location and commence a herbicide trial or trials to assess the viability of expanding herbicide treatment for the maintenance of power line corridors.
- Develop a program to control and minimise the spread of declared weeds on power line corridors as required to comply with legislative requirements.
- Review the vegetation program as inspection and treatment data becomes available or conditions change and make any required changes to further optimise the program.
- Prepare for the next Regulatory Submission.

2024-2029

- Continue with review and continual improvement of the vegetation program

9 Performance Monitoring and Improvement

Ongoing condition and performance monitoring is a key part of Power and Water's performance evaluation and improvement strategy. Study of the condition and performance data captured over time assists in developing valuable insights on vegetation condition and maintenance performance. These insights provide for informed decision making on whether the vegetation program and contracts are effectively and efficiently delivering the required outcomes or whether changes to the program are required.

Goals and targets against which progress towards the revised vegetation management program can be measured need to be set to ensure the desired outcomes are being achieved. This may require goals and targets to be set in addition to the performance indicators included in section 8. A set of standardised reports will need to be developed to monitor contractor performance and progress to plan/budget.

9.1. Monitoring and Improvement

This Asset Management Plan will be reviewed at least every two years or when there is a significant driver from the network or other events that requires revision.

Improving data resources, undertaking data analysis and deriving insights will be undertaken as business as usual activities. Any improvements in analysis of vegetation performance will be included in this AMP when it is updated.

The RACI Matrix (Table 5) in section 4.2 allocates the responsibility for the task of updating the AMP including performance monitoring and strategy revision.

10 Stakeholder Management

Stakeholder management is a key activity for the ongoing success of the vegetation program. Key stakeholders and their relationship with the vegetation program are shown in Table 13.

Table 13 Key Vegetation Stakeholders

Stakeholder	Relationship
NT Government	Legislation, SCI, Community Issues
NT Safety Regulator	Safety Incidents, Clearance Standards, Work Practices
Australian Energy Regulator	Regulatory Determination
Power and Water Board	Governance Matters associated with Vegetation Program, Community Issues
Customers/Community	Public education programs, Unsuitable species near power lines, Planting programs, Trimming/removals on private property, Clearing Standards, Work Practices
Councils	Public education programs, Unsuitable species near power lines, Planting programs, Trimming/removals on council property, Clearing Standards, Work Practices
Aboriginal Groups	Access to aboriginal lands, sacred/significant sites
Unions	Standards, Work Practices, Safety Issues
Power and Water Staff	Community Liaison, Standards, Work Practices, Work Plans, Safety Issues, Access approvals, Reporting, Network Change Updates; Auditing
Vegetation Management Contractor	Standards, Work Practices, Work Plans, Safety Issues, Access approvals, Progress reporting, Records management, Customer liaison/approvals

A plan for engaging the key stakeholders in their area of interest will be outworked through the relevant groups within Power and Water.

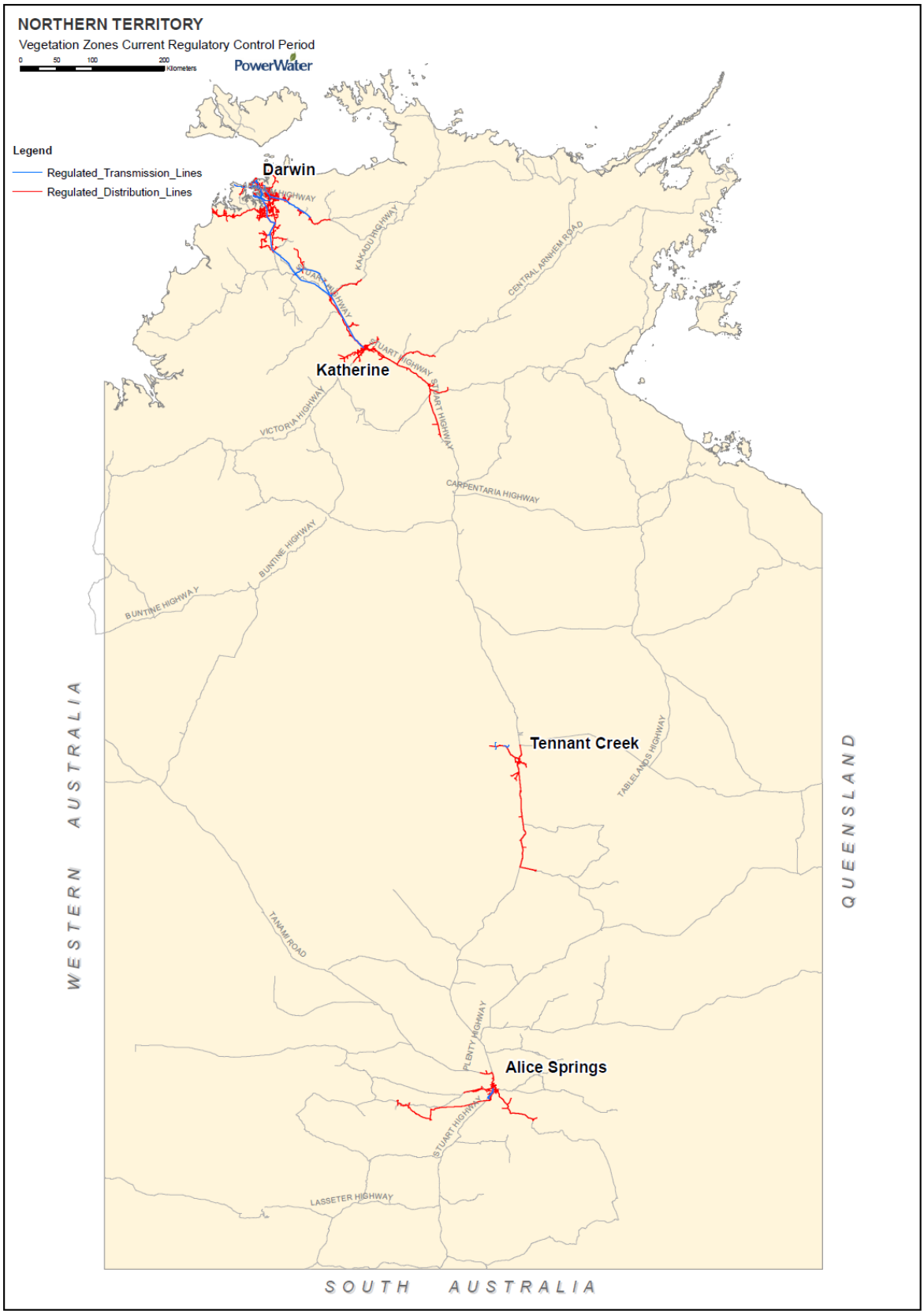
A couple of specific stakeholder issues that needs to be addressed are:

- The implementation of the new vegetation zone approach to vegetation management and the changes to clearing profiles required to achieve this and
- The removal of unsuitable species near power lines.

It is acknowledged that vegetation works have the potential to affect Power and Water's customers in both a positive and negative way.

Power and Water is committed to a high level of customer satisfaction and will implement an external customer satisfaction survey process to monitor customer perception of the vegetation program. This program will be undertaken on a quarterly basis. Benchmark targets will be established and the results published internally. These results will be an essential KPI for both internal vegetation management personnel and contractors.

11 Appendix A – Regulated Network Overview



12 Appendix B – Historical Vegetation Treatment Data

In the tables below, a span treated more than once in any financial year has only been counted once for the number of spans treated in the year.

Costs for the removal of hazard trees and some ground clearance work have not been included below as quantities have not been recorded accurately.

Transmission and sub-transmission lines have been included in the tables below based on the predominant area through which they pass (i.e. Urban or Rural which includes in established corridors near urban areas)

Inspection and audit costs have been included with trimming costs.

12.1. CBD and Urban Treatment Data

Region	Description	2013/14	2014/15	2015/16	2016/17
Darwin	Spans Treated (Part A)	1750	1563	2017	2542
	Trims (Part A)	5472	4240	6792	8769
	Removals (Part A)	1	368	134	269
	Total Cost	$ 1,000,519	$ 784,068	$ 885,631	$ 841,056
	Unit Cost / Span Treated	$ 571.73	$ 501.64	$ 439.08	$ 330.86
	Unit Cost/Trim-Removal	$ 182.81	$ 170.15	$ 127.87	$ 93.06
	km's Slashed/Mulched	1.8	0	0	9.55
	Total Cost	$ 566	$ -	$ -	$ 6,320
	Unit Cost/km	$ 314.55			$ 661.73
Katherine	Spans Treated (Part A)		350	140	310
	Trims (Part A)		913	196	708
	Removals (Part A)		0	0	0
	Total Cost	$ 20,049.32	$ 153,071	$ 91,876	$ 90,564
	Unit Cost / Span Treated		$ 437.35	$ 656.26	$ 292.14
	Unit Cost/Trim-Removal		$ 167.66	$ 468.75	$ 127.92
	km's Slashed/Mulched				
	Total Cost				
	Unit Cost/km				
Tennant Creek	Spans Treated (Part A)		130	0	174
	Trims (Part A)		240	0	393
	Removals (Part A)		0	0	24
	Total Cost	$ 37,539.86	$ 5,338	$ -	$ 33,467
	Unit Cost / Span Treated		$ 41.06		$ 192.34
	Unit Cost/Trim-Removal		$ 22.24		$ 80.26
Alice Springs	Spans Treated (Part A)	417	194	237	960
	Trims (Part A)	1055	290	443	1747
	Removals (Part A)	0	0	0	0
	Total Cost	$ 151,880	$ 104,753	$ 91,054	$ 143,571
	Unit Cost / Span Treated	$ 364.22	$ 539.96	$ 384.20	$ 149.55
	Unit Cost/Trim-Removal	$ 143.96	$ 361.22	$ 205.54	$ 82.18

12.2. Rural Treatment Data

Region	Description	2013/14	2014/15	2015/16	2016/17
Darwin	Spans Treated (Part A)	5866	4769	5473	7588
	Trims (Part A)	18603	10662	14320	21392
	Removals (Part A)	900	3751	5283	6040
	Total Cost	$ 2,466,271	$ 2,265,882	$ 2,377,438	$ 2,222,900
	Unit Cost / Span Treated	$ 420.43	$ 475.13	$ 434.39	$ 292.95
	Unit Cost/Trim-Removal	$ 126.46	$ 157.21	$ 121.28	$ 81.03
	km's Slashed/Mulched	583.5	561.7	178	132.7
	Total Cost	$ 482,312	$ 632,729	$ 167,494	$ 115,329
	Unit Cost/km	$ 826.58	$ 1,126.45	$ 940.98	$ 869.09
Katherine	Spans Treated (Part A)		1539	821	1105
	Trims (Part A)		5259	2019	3492
	Removals (Part A)		0	53	37
	Total Cost	$ 225,251.73	$ 574,006	$ 487,798	$ 472,097
	Unit Cost / Span Treated		$ 372.97	$ 594.15	$ 427.24
	Unit Cost/Trim-Removal		$ 109.15	$ 235.42	$ 133.78
	km's Slashed/Mulched	338	491	298	0
	Total Cost	$ 284,630	$ 357,573	$ 268,625	$ -
	Unit Cost/km	$ 842.85	$ 728.55	$ 901.43	
Tennant Creek	Spans Treated (Part A)		142	0	270
	Trims (Part A)		247	0	707
	Removals (Part A)		0	0	699
	Total Cost	$ 58,472.18	$ 53,971	$ -	$ 60,435
	Unit Cost / Span Treated		$ 380.08		$ 223.83
	Unit Cost/Trim-Removal		$ 218.51		$ 42.98
Alice Springs	Spans Treated (Part A)	721	293	345	1109
	Trims (Part A)	1963	534	670	1945
	Removals (Part A)	0	0	0	0
	Total Cost	$ 477,359	$ 352,140	$ 391,712	$ 279,646
	Unit Cost / Span Treated	$ 662.08	$ 1,201.84	$ 1,135.40	$ 252.16
	Unit Cost/Trim-Removal	$ 243.18	$ 659.44	$ 584.64	$ 143.78

12.3. Non-Regulated Treatment Data

Region	Description	2013/14	2014/15	2015/16	2016/17
Katherine	Spans Treated (Part A)		91	89	146
	Trims (Part A)		282	209	245
	Removals (Part A)		0	0	
	Total Cost	$ 17,095.33	$ 65,681	$ 136,044	
	Unit Cost / Span Treated		$ 721.77	$ 1,528.58	$ -
	Unit Cost/Trim-Removal		$ 232.91	$ 650.93	$ -
Tennant Creek	Spans Treated (Part A)		93		100
	Trims (Part A)	0	191	0	256
	Removals (Part A)	0	0	0	382
	Total Cost	$ 9,916.57	$ 37,957		
	Unit Cost / Span Treated		$ 408.14		$ -
	Unit Cost/Trim-Removal		$ 198.73		$ -
Alice Springs	Spans Treated (Part A)	38			33
	Trims (Part A)	81	0	0	102
	Removals (Part A)	0	0	0	5
	Total Cost	$ 6,428	$ 32,027		
	Unit Cost / Span Treated	$ 169.17			$ -
	Unit Cost/Trim-Removal	$ 79.36			$ -

13 Appendix C – Vegetation Zones

The following diagrams show the vegetation zones in each region.

Figure C.1 – Darwin and Katherine Regions Vegetation Zones

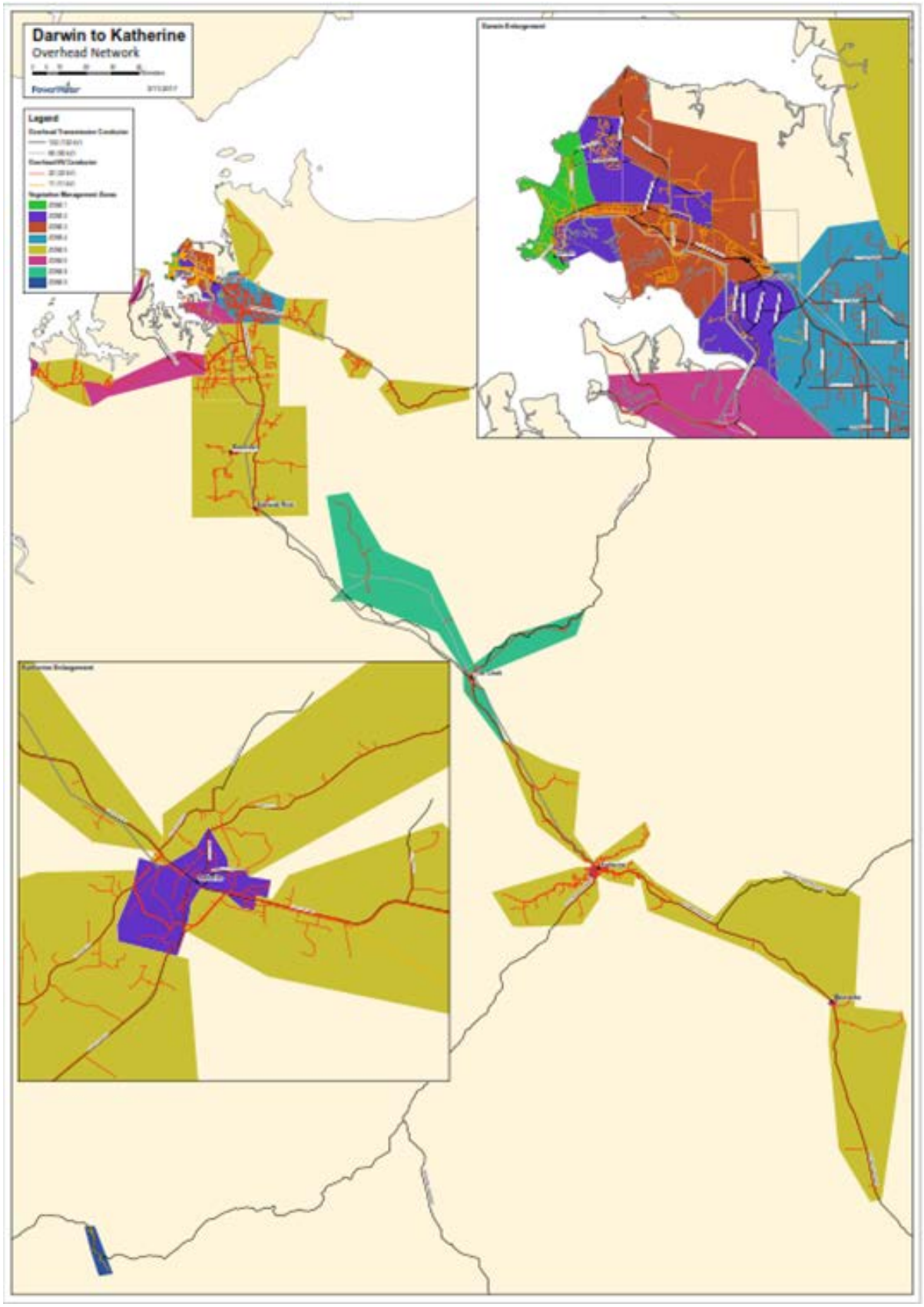


Figure C.2 – Tennant Creek Region Vegetation Zones

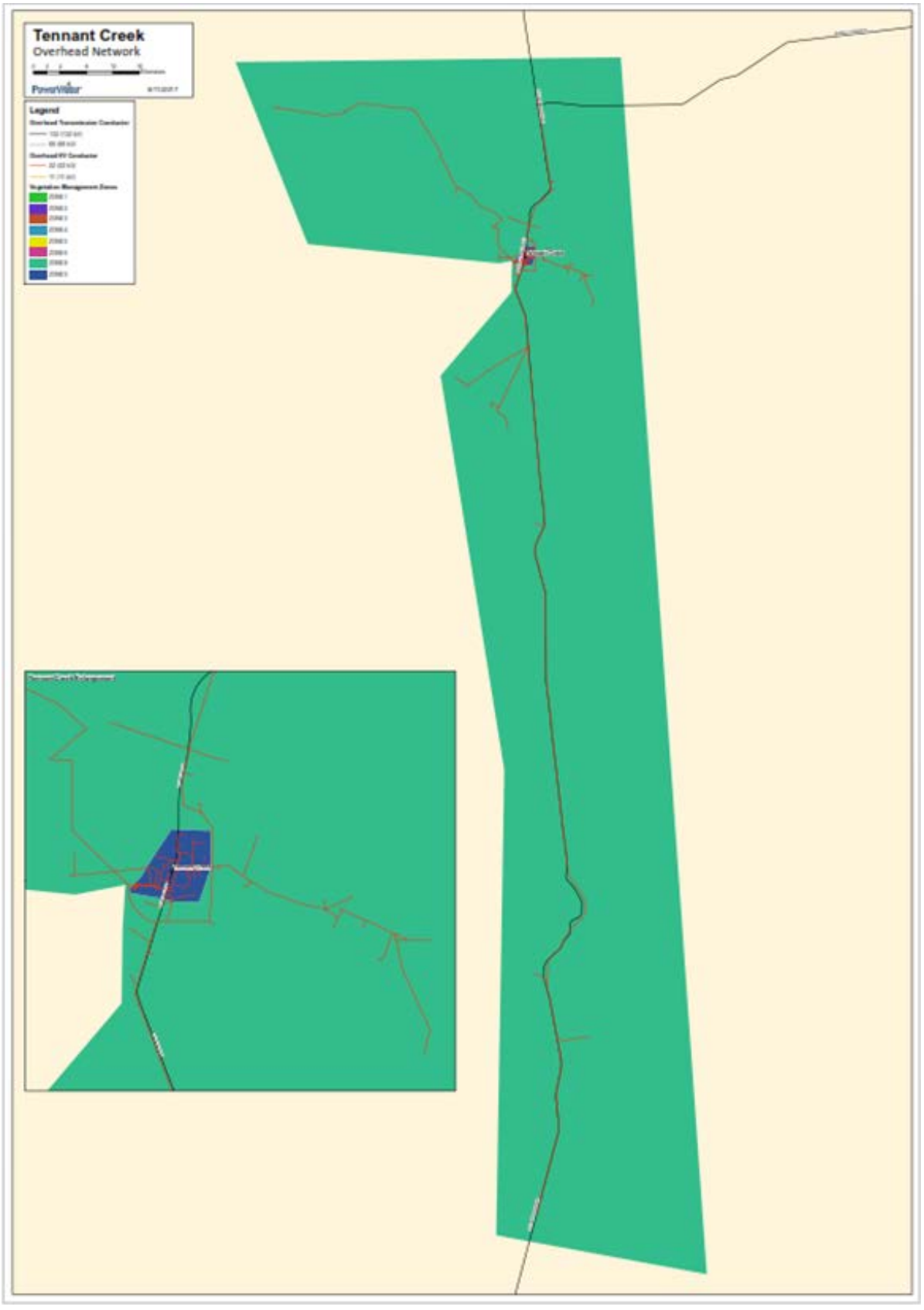
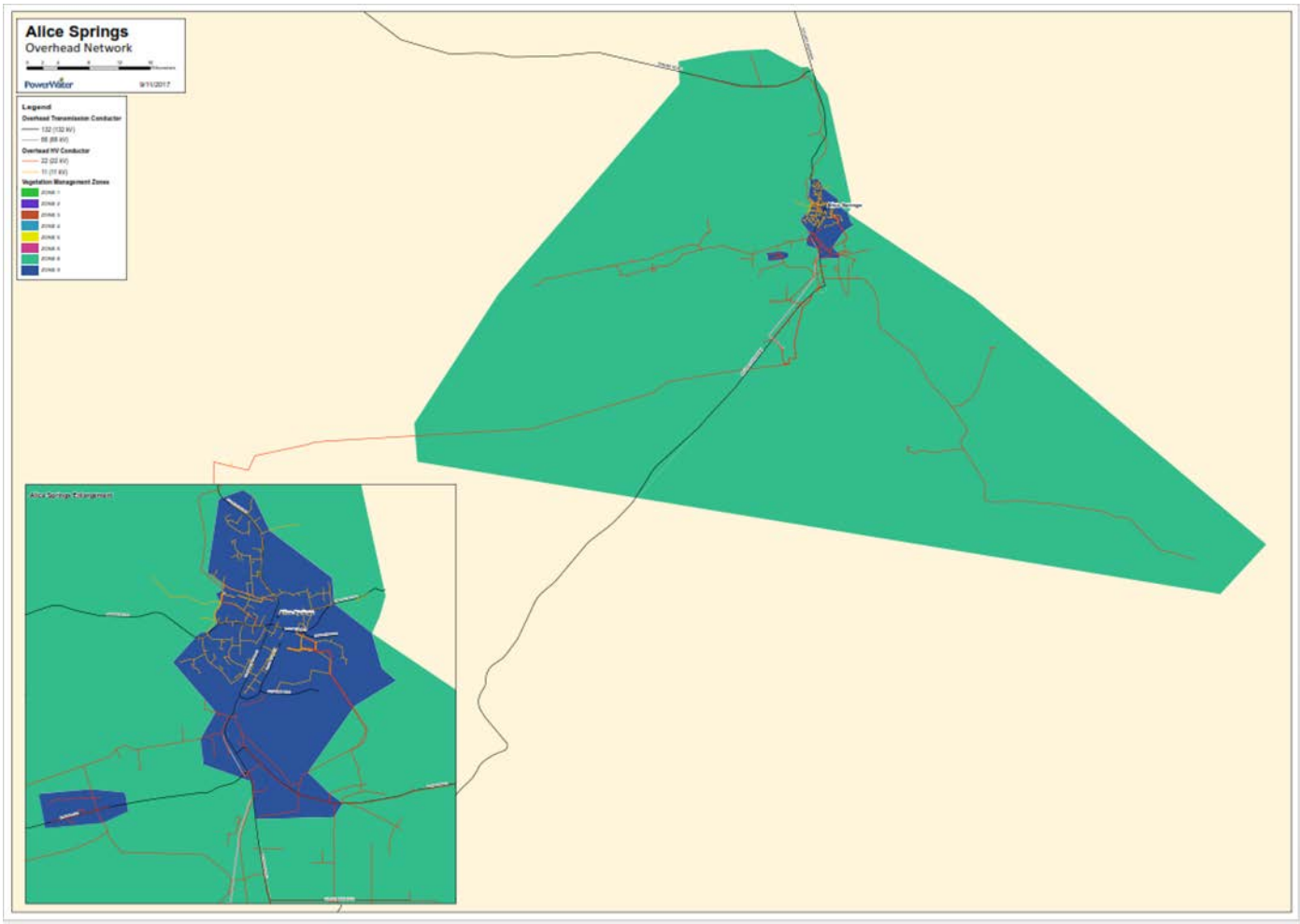


Figure C.3 – Alice Springs Region Vegetation Zones



14 Appendix D – Vegetation Zone Feeders

14.1. Darwin Region Feeders

VEG ZONE 1	VEG ZONE 2	VEG ZONE 3	VEG ZONE 4	VEG ZONE 5	VEG ZONE 6	VEG ZONE 1 & 5
11DA07 DA-WS	11AR03 MARLOW	11AR12 FAIRWAY WATERS	11CP4306 WAGAIT	22BA01 MINE	11CP4307 BELYUEN	22BA04 TOWN
11DA17 DA-ML	11AR13 BONSON	11BE01 LEANYER	22SY02 MCMINNS	22HD402 LAMBELLS	22WD101 JENKINS	22MT06 LAKE BENNETT
11DA19 GARDENS	11BE16 ANULA	11BE03 TDZ	22SY03 VIRGINIA	22HD403 MIDDLE POINT	22WD102 WICKHAM	
11WN01 BAGOT	11CA02 CAS SQUARE 2	11BE06 KARAMA 1	22SY06 WHITEWOOD	22MK103 CORROBOREE	22WD103 BLAYDIN POINT	**VEG ZONE 2 & 3**
11WN02 FANNIE BAY	11CA03 BRADSHAW	11BE09 JAIL	22SY11 HERBERT	22MK303 MARRAKAI		11BE04 MCMILLANS
11WN04 BULLOCKY POINT	11CA07 JINGILI	11BE13 KORMILDA		22MR103 MT BUNDY		
11WN13 GOYDER	11CA08 NTHLAKES	11BE14 ROBERTSON		22MR303 TOMS GULLY		**VEG ZONE 4 & 5**
11WN22 LUDMILLA	11CA10 MILLNER	11BE18 PORT		22MT04 COOMALIE		22PA202 HOWARD SPRINGS
11WN24 PARAP	11CA12 MARRARA	11BE19 HIDDEN VALLEY		22MT07 ACACIA		
	11CA16 NAKARA	11LE03 LYONS 1		22SY12 NOONAMAH		**VEG ZONE 2, 5 & 6**
	11CA23 MOIL	11LE08 PARKSIDE		22SY13 MCMINNS PUMPS		22SY04 DUNDEE
	11DA27 STUART PARK	11PA23 GEORGINA		22SY15 DARWIN RIVER		
	11FB06 FB-MS 1	11PA25 PINELANDS				
	11FB08 MOORING BASIN	11WH02 BLESSER CREEK				
	11FB10 CAREY ST	11WH03 CATALINA				
	11FB16 FB-WS	11WN03 MARRANGA				
	11PA10 DRIVER	11WN11 BISHOP				
		11WN12 WINNELLIE				
		11WN23 COONAWARRA				

14.2. Katherine, Alice Springs and Tennant Creek Region Feeders

VEG ZONE 2	VEG ZONE 5	VEG ZONE 8	VEG ZONE 9	VEG ZONE 9	VEG ZONE 2 & 5
22KA07 KATH EAST	22KA03 FLORINA	22PC306 MOLINE	BORROLOOLA 1	11LG13 ELDER	22KA10 MATARANKA 1
22KA22 KATHERINE	22KA06 TINDAL 2	22TC202 FEEDER 2	BORROLOOLA 2	11LG15 LARAPINTA	22KA15 OPS
	22KA09 PINE CREEK	22TC602 FEEDER 6	DALY WATERS	11LG16 BRAITLING	22KA19 TINDAL 1
	22KA18 GORGE	ELLIOTT 3	TIMBER CREEK 1	11LG21 STOKES	
		11RG02 GOLF	22TC302 FEEDER 3	11RG01 GAP	
		11RG06 SADADEEN	22TC402 FEEDER 4	11RG08 CBD	**VEG ZONE 2 & 8**
		22BR102 BOREFIELDS	22TC502 FEEDER 5	11RG19 NTH STUART HWY	22PC308 TOWNSHIP
		22BR103 BR-SD 2	ELLIOTT 1	11RG20 WILLS	
		22LG29 JINDALEE	ELLIOTT 2	11RG21 GILLEN	
		KINGS CANYON 2	11LG06 BRADSHAW	22RG05 LOVEGROVE 2	**VEG ZONE 8 & 9**
		TI TREE 2	11LG07 ARALUEN	22RG10 LOVEGROVE 1	22BR101 BR-SD 1
			11LG10 GHAN RD	TI TREE 1	22RG09 FARMS
					22RG13 BREWER 1

14.3. Transmission Feeders

VEG ZONE 10	VEG ZONE 11	VEG ZONE 12	VEG ZONE 13	VEG ZONE 10 & 11
66 PA-SY	66 AR-WD 1	66 LG-OS 1	132 CI-HC A	66 CP-DA
66 WN-CA	66 AR-WD 2	66 LG-OS 2	132 CI-HC B	66 HC-DA
66 WN-CZ 2	66 AR-WN	66 PC-PK	132 CI-MT	66 LE-CA
66 WN-DA	66 BE-HC 1	66PC301 COSMO HOWLEY	132 MT-BA-PK	66 MR-SY
66 WN-FB	66 BE-HC 2		132 PK-KA	
	66 BE-LE			
	66 HC-AR			
	66 HC-PA			
	66 HC-WN 1			
	66 HC-WN 2			
	66 WD-SY			

15 Appendix E - Power and Water Policies, Standards and Work Practices

The following is a list of Power and Water's current policies, standards, procedures and work instructions.

Network Policy NP013 - Management of Vegetation Near Overhead Powerlines Policy
Note: Network Policy NP013 was prepared in 2002 but was never been formally approved. This document needs to be revised to reflect current or updated policy requirements of Power and Water.

Network Policy NP021 – Easement Guidelines

Power Networks Procedure 15 - Management of Vegetation Near Overhead Powerlines

Power Networks Procedure 14 - Land Management

Power Networks Procedure - Power Networks Electrical Authorisations

Power Networks Work Practice Standard WPS044 - Fire Management

Power Networks Work Practice Standard WPS046 - Vegetation Management

Power Networks Work Practice Standard WPS054 – Heritage

Minimum Vegetation Clearance Standards – Network Policy NP013 includes a section on clearances. However, this section is not consistent with the minimum clearing standards included in Power and Water contract for vegetation management. The current contract includes the minimum clearing standards shown in Table E.1 below.

Table E.1 – Minimum Clearance Distances of Vegetation from Overhead Power Lines and Poles for All Conductors in All Directions

Type of Powerline	Current Clearances in Use in Power and Water Contracts	Comments
Insulated Low Voltage (Services and ABC)	0.5m	
415V	3.0m	
11kV, 22kV	3.0m	No overhanging branches
66kV	4.0m	No overhanging branches
132kV	6.0m	No overhanging branches
High Voltage Aerial Bundled Cable	1.0m	

The current standard for corridor clearance is shown in Figure E.1.

Figure E.1 - Power and Water Standard Drawing for Route Clearance