Asset Management Plan
Poles and Lattice Towers
2020-25

January 2019

Part of the Energy Queensland Group

Executive Summary

This Asset Management Plan (AMP) focuses on the management of poles and lattice towers.

Poles and lattice towers support electrical assets that deliver electricity to customers and ensure the physical separation of these electrical assets from general public access, within the electricity networks managed by Energy Queensland Limited (EQL). Poles and towers also support additional assets including lighting and telecommunications equipment, owned by EQL as well as third parties such as state government departments, local councils and telecommunications companies.

EQL manages over 1,500,000 poles, comprising around 966,000 poles in the Northern and Southern Regions (Ergon Energy) and 580,000 poles in South East Region (Energex). EQL also manages over 3,700 towers, comprising 2,693 towers in the Northern and Southern (Ergon Energy) region and 1,017 towers in South East (Energex) region.

Poles and lattice towers represent approximately 20% of the total replacement value of EQL's network asset inventory, with a current undepreciated replacement value of $10.72 billion. The population of pole and tower assets managed by EQL is diverse as a result of different historical construction and management practices, consisting of various species of wood, as well as steel, concrete, and composite materials. Poles and towers are also a distributed asset class, located in all terrains and environments.

Overall pole and tower population performance is measured by a three-year moving average reliability standard, as defined in the Queensland Electrical Safety Code of Practice – Works, and must be maintained at greater than 99.99%. Because of the safety risks involved and a legislative duty, EQL strives for higher levels of reliability than those defined by this standard.

This Asset Management Plan (AMP) details a range of management strategies consistent with the size, diversity, and value of these assets. Factors influencing prudent management of pole and tower assets include public safety, the large, geographically dispersed population, assessed condition, range and variability of construction materials, various historical design standards, and diverse environmental and operational conditions.

EQL is proposing line refurbishment strategies to gain works efficiencies across multiple asset classes, including poles and towers, conductors, and other pole top hardware refurbishment.

EQL is actively working to align data collection and record systems relating to poles and towers across all regions, by employing the best and most suitable systems from both legacy organisations. EQL continues to improve safety and the cost-effective management of these assets through use and continuous improvement of inspection and analysis techniques (such as Light Detection and Ranging (LiDAR), imagery and predictive analytics), optimal delivery models and techniques, and industry best practice management, through active participation in Energy Networks Australia (ENA) working groups.

Document Tracking Details

Network and Non-Network Document Hierarchy Reference Number	Regulatory Proposal Chapter Reference	Document	File Name
NET AMP – 011	7.037	Asset Management Plan - Poles and Lattice Towers	EGX ERG 7.037 Asset Management Plan - Poles and Lattice Towers JAN19 PUBLIC

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1 Introduction

Energy Queensland Limited (EQL) was formed 1 July 2016 and holds distribution licences for the following regions:

- South East Region (Legacy organisation: Energex Limited) and
- Northern and Southern Regions (Legacy organisation: Ergon Energy Corporation Limited).

There are variations between EQL's operating regions in terms of asset base and management practice, as a result of geographic influences, market operation influences, and legacy organisation management practices. This Asset Management Plan (AMP) reflects the current practices and strategies for all assets managed by EQL, recognising the differences that have arisen due to legacy organisation management. These variations are expected to diminish over time with the integration of asset management practices.

1.1 Purpose

The purpose of this document is to demonstrate the responsible and sustainable management of poles and lattice towers on the EQL network. The objectives of this plan are to:

1. Deliver customer outcomes to the required level of service.
2. Demonstrate alignment of asset management practices with EQL's Strategic Asset Management Plan and business objectives.
3. Demonstrate compliance with regulatory requirements.
4. Manage the risks associated with operating the assets over their lifespan.
5. Optimise the value EQL derives from this asset class.

This Asset Management Plan will be updated periodically to ensure it remains current and relevant to the organisation and its strategic objectives. Full revision of the plan will be completed every five years as a minimum.

This Asset Management Plan is guided by the following legislation, regulations, rules and codes:

- *National Electricity Rules (NER)*
- *Electricity Act 1994 (Qld)*
- *Electrical Safety Act 2002 (Qld)*
- *Electrical Safety Regulation 2013 (Qld)*
- *Queensland Electrical Safety Code of Practice 2010 – Works (ESCOP)*
- *Work Health & Safety Act 2014 (Qld)*
- *Work Health & Safety Regulation 2011 (Qld)*
- Ergon Energy Corporation Limited Distribution Authority No D01/99
- Energex Limited Distribution Authority No. D07/98

This Asset Management Plan forms part of EQL's strategic asset management documentation, as shown in Figure 1. It is part of a suite of Asset Management Plans, which collectively describe EQL's approach to the lifecycle management of the various assets which make up the network used to deliver electricity to its customers. Appendix 1contains references to other documents relevant to the management of the asset class covered in this plan.

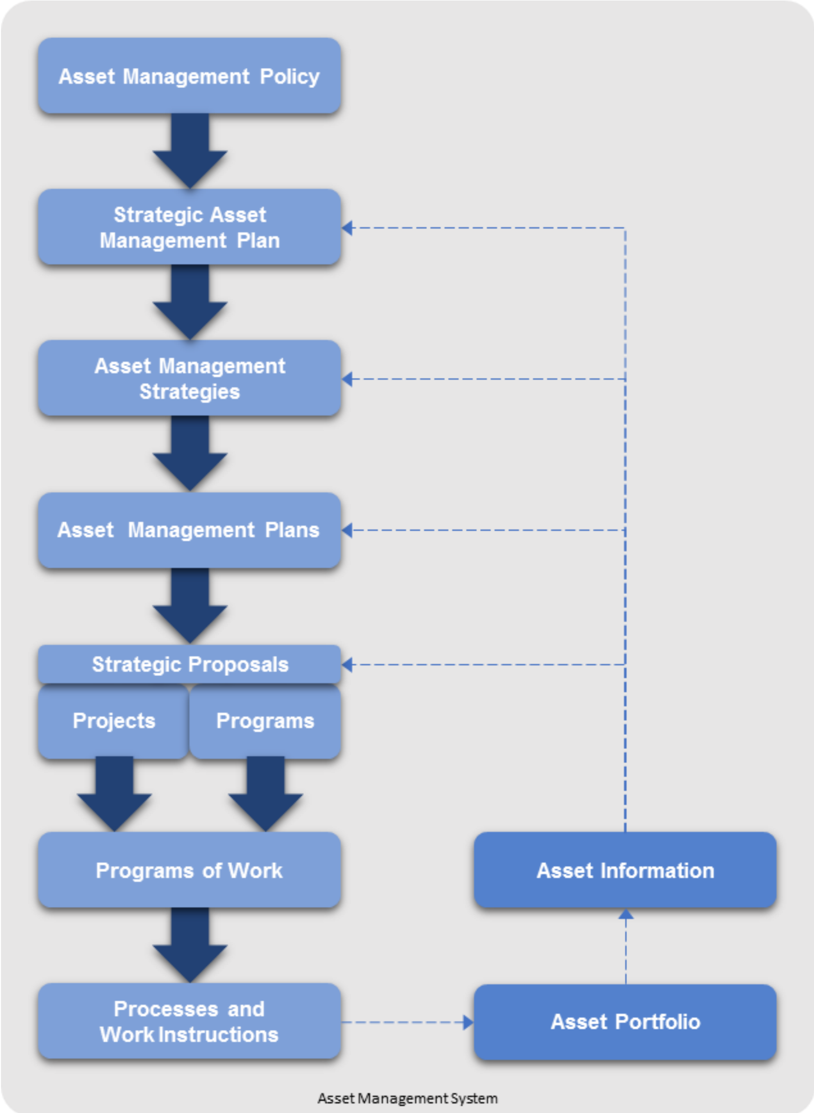

Figure 1: EQL Asset Management System

1.2 Scope

This plan covers the following assets:

- Wood poles including reinforced or reinstated poles
- Steel poles
- Concrete poles
- Steel lattice towers
- Stay poles or bollards; and
- Stay systems.

EQL aims to provide a co-ordinated and optimised approach to the lifecycle management of all assets within the asset base. The scope of this Asset Management Plan has a strong linkage to other overhead assets including overhead conductor and pole top structures. These plans should be considered together.

Many customers, typically those with high voltage connections, own and manage their own network assets including poles and ancillary equipment. EQL does not provide condition and maintenance services for third party assets, except as an unregulated and independent service. This AMP relates to EQL owned assets only, and excludes any consideration of such commercial services.

1.3 Total Current Replacement Cost

Poles are relatively low individual cost assets; however, the very high volume of these assets in the network makes them a significant component of the overall asset base. Based upon asset quantities and replacement costs, the poles in the EQL network have an undepreciated replacement value of approximately $10.72 billion. Figure 2 provides an indication of the relative financial value of EQL poles and towers compared to other asset classes.

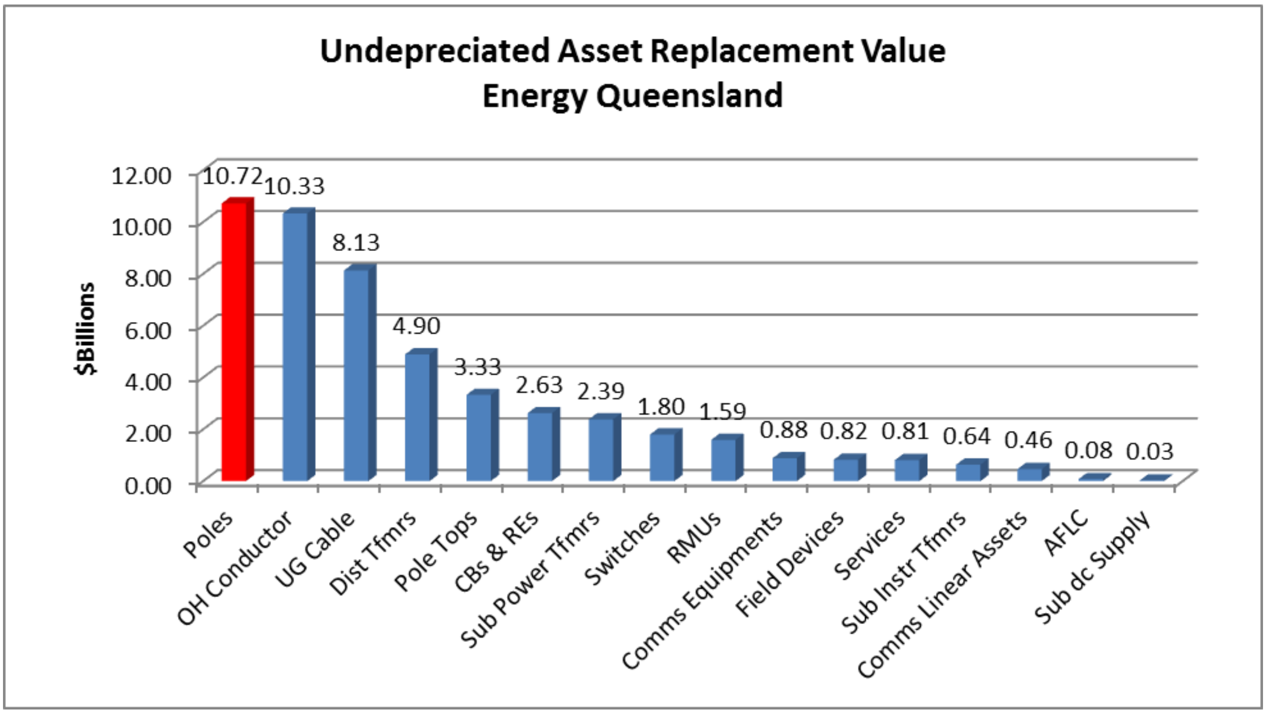

Figure 2: EQL – Total Current Asset Replacement Value

1.4 Asset Function and Strategic Alignment

Poles and towers are important assets as they provide the support mechanism for the overhead distribution network which delivers electricity to customers across Queensland. They also support other services including streetlight and communications assets owned by EQL, as well as assets owned by third parties such as state government departments, local councils and telecommunications companies.

The main function of a pole or tower is to physically separate the electrical network from public access, thereby preventing electrical safety issues.

Poles and towers are a distributed asset class, located in all terrains and environments, including frequented urban areas and remote rural areas.

Table 1 provides a summary of the relationship between EQL's asset management objectives and the pole assets covered in the scope of this plan.

Asset Management Objectives	Relationship of Asset to Asset Management Objectives
Ensure network safety for staff, contractors, and the community	Integrity and condition of poles and lattice towers is a key factor in managing safety hazards and compliance to legislative and regulatory obligations.
Meet customer and stakeholder expectations	The performance of poles and lattice towers supports the safe, cost-effective, secure, and reliable supply of electricity to consumers.
Manage risk, performance standards, and asset investment to deliver balanced commercial outcomes	Failure of poles or lattice towers can result in significant risk to public safety, disruption of the electricity network, and disruption of customer amenity. Understanding asset performance allows optimal investment to achieve intended outcomes. Prudent management of these assets assists in minimising capital and operational expenditure.
Develop asset management capability and align practices to the global ISO 55000 standard	This AMP is consistent with ISO 55000 objectives and drives asset management capability by promoting continuous improvement.
Modernise the network and facilitate access to innovative energy technologies	This AMP promotes modernisation through increased asset utilisation, industry leading condition and health assessment, and replacement of assets at end of economic life as necessary to meet current standards and future requirements.

Table 1: Asset Function and Strategic Alignment

1.5 Owners and Stakeholders

The key roles and responsibilities for the management of this asset class are outlined in Table 2.

Role	Responsible Party
Asset Owner	Chief Financial officer
Operational Control	EGM Distribution
Maintenance Control	EGM Strategy, Asset Safety & Performance

Table 2: Stakeholders

2 Asset Class Information

The following sections provide a summary of the key functions and attributes of the assets covered in this AMP.

2.1 Asset description

Poles and towers in the EQL network have been installed over many decades by various legacy organisations, as the network was expanded or maintenance and refurbishment works were completed. As a result, the population of pole assets is diverse, and construction materials consist of various species of wood as well as concrete and steel. Similarly, as technology has evolved, so has asset management practice.

The following sections provide a summary of the significant populations of poles, and other major factors that influence the management of the asset lifecycle of poles in the EQL network.

2.1.1 Hardwood poles

Hardwood poles support over 90% of the EQL overhead network. The EQL wood pole population consists predominately of Spotted Gum hardwood timber. All new and replacement wood poles are treated with Copper Chrome Arsenate (CCA) as a means of extending the expected life of the asset. Treated wood poles were first used during the 1960’s.

There are a small number (less than 2,000) of hardwood timber poles which use creosote as a pole preservative in the Northern and Southern Regions. Creosote was banned from further use in Queensland during the 1980’s, and creosote treated poles are progressively being phased out at end of life.

Around 10% of the EQL wood pole population are untreated poles (known also by alternative names ‘natural’ or ‘bush’ poles), which are typically iron bark timber. A shortage of these types of pole was the main driver for development and use of treated timber hardwood poles in the 1960’s. Untreated poles are progressively being phased out at end of life.

2.1.2 Reinforced and reinstated wood poles

Reinforced wood poles have a steel stake, referred to as a ‘pole nail’, attached to support the pole, at and near the ground-line. The pole nail is designed to supplement the ground-line structural strength, and to deform in a ductile manner to reduce the potential impact of pole failure.

Reinstated poles are rebutted by enclosing the trimmed butt of the pole in a metal tube, which may also include concrete or foam filling in any resultant voids.

Pole rebutting of an in-service pole is not as cost effective as pole nailing but may be used to increase line ratings and clearances of overhead lines in rural areas. Rebutted poles direct from the supplier are used in termite prone areas of western Queensland to prevent ongoing failures. Pole rebutting is no longer practiced in South East Region.

2.1.3 Steel poles

There are several different types of steel pole construction used across the EQL network. Steel poles are typically used in termite prone areas in the network, where there is limited chance of corrosion due to salt spray or industrial pollution, and on feeders where pole failures due to lightning strikes are a significant contributor to unplanned outages. In recent years a small number of steel poles have been used for 132kV and 110kV lines in the South East Region. Steel poles are typically of hollow tapering pipe construction. Larger steel poles are segmented to support delivery logistics and fitted together on site. Steel poles are more expensive than wood poles.

Approximately 80% of steel poles in the Northern and Southern Regions, and approximately 99% of steel poles in the South East Region, are used for lighting support. There are two basic types - base plate mounted poles, and poles that are directly buried into the ground (BIG). The South East Region also has a population of frangible or slip base mounted steel street light poles, which have been installed on major roads since before 1970. Slip based mounted poles shear at the ground level on vehicle impact and are a requirement on Queensland roads with speed limits greater than 70 km/hr. There has been a transition from BIG to base plate mounted installations since the mid-1990s due to the prevalence of corrosion in BIG poles.

The South East Region has a small population (325) of legacy aluminium street lights which were installed in the Brisbane City Council area prior to 1977.

A Stobie pole is a composite pole consisting of steel components with concrete fill. Current EQL standards do not include use of Stobie poles. There is a small population of these poles in Mount Isa.

2.1.4 Steel lattice towers

Steel lattice towers are structures designed for situations requiring very high strength and or significant clearances. Individual structural members within a lattice which are found to be defective during inspection can be replaced to prolong the life of the tower. Lattice towers have been largely superseded by more modern steel pole and concrete pole designs. Towers are easier to climb than poles, so typically employ anti-climbing infrastructure. The towers are typically self-supporting, with a four-legged square base, or extensively guyed with a single point base.

2.1.5 Concrete poles

Concrete poles are used when the network requires a high level of reliability or additional strength due to mechanical loading. Concrete poles may be either spun or cast and have steel reinforcing. Concrete typically handles compressive forces well, but does not handle tension and torsion forces, which tend to cause cracking and crumbling in concrete poles. Steel reinforcing is employed to provide additional tensional and torsional strength. They are generally more expensive than wood or steel poles, and procurement periods are considerably longer.

In the Northern and Southern Regions, use of concrete poles is not restricted except by specific design requirements. There are several concrete Single Wire Earth Return (SWER) lines in North Western Queensland. In the South East Region, concrete poles are typically used for new sub-transmission lines, and for supporting larger distribution transformers or where high tip loads are required.

The concrete pole population is slowly increasing within the network as they are extremely reliable, have a significantly longer expected life than wood poles and are not subject to the same range of failure modes as wood poles.

2.1.6 Softwood poles

Softwood poles are intended to be a direct replacement for hardwood poles of the same length and strength. Softwood poles require an increased diameter to achieve the same nominal strength as hardwood poles due to the lower strength classifications of the timbers.

Modern timber harvesting practices achieve around 100 softwood poles per acre, which compares favourably with the typical harvest of only three to four hardwood poles per acre. There are a small number of softwood poles installed across the network as a part of an ongoing trial to assess their future use.

2.1.7 Composite Fibre Poles

Composite fibre poles are lightweight, non-conductive, synthetic poles, typically made of fibreglass reinforced composite. Composite poles are not subject to many of the common failure modes of wood poles (such as termites or rot) or steel poles (such as corrosion). There is a very small number of composite fibre poles installed as a trial in regional Queensland.

2.1.8 Stay Systems

Stays are an important part of the mechanical support system for poles and structures, used to balance the forces imposed at the top of a pole or structure. Stay systems typically consist of conductor that is tied to buried steel screw anchors, wooden bedlogs (now obsolete) or concrete blocks. These systems may also include a dedicated stay or bollard pole. Figure 3 shows an example of a typical pole stay system.

Dependent upon the designed application, stay failure can result in the pole falling or leaning (impacting energised conductor heights). In many circumstances, a stay failure will only become evident when the pole top forces are substantial.

Poles used in a stay system are treated in the same manner as all other poles. The other components of the stay system are not recorded as discrete assets in any region.

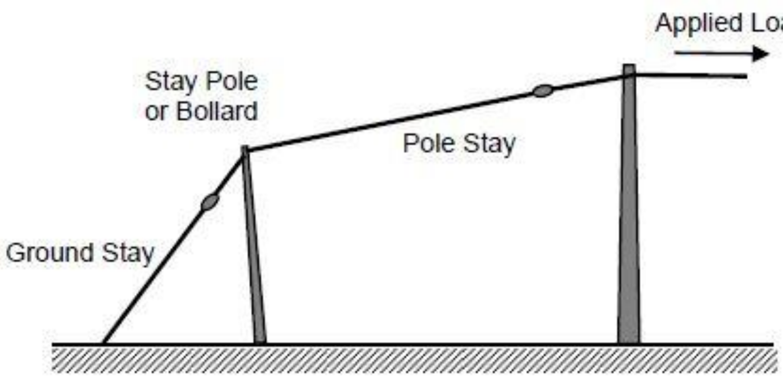

Figure 3:- Example of a Pole Stay System

2.2 Asset Quantity and Physical Distribution

Table 3 details the total quantity of EQL's pole population by type[1].

Pole Type		Northern & Southern Regions	South East Region	Total
Wood	Untreated	122,460	34,972	1,263,999
	Creosote	1,606	0	
	Treated (incl. softwood and composite)	737,892	367,069	
Steel	Steel	72,533	566	239,847
	Streetlight	0	166,414	
	Aluminium	0	334	
Concrete	Concrete	31,222	10,623	42,043
	Stobie	198	0	
Total		965,911	579,978	1,545,889

Table 3: EQL Pole Quantities

Table 4 details the total quantity of reinforced and reinstated wood poles by region[2]. These quantities are included in quantities of wood poles shown in Table 3 above.

Pole Type	Northern & Southern Regions	South East Region	Total
Reinforced (nailed) wood poles	49,950	34,302	84,252
Reinstated (rebutted) wood poles	1,420	1,965	3,385
Total	51,370	36,267	87,637

Table 4: EQL Reinforced and Reinstated Pole Quantities

Table 5 details the total quantity of steel lattice towers by region[3].

Structure Type	Northern & Southern Regions	South East Region	Total
Lattice tower	2,693	1,017	3,710

Table 5: EQL Lattice Tower Quantities

2.3 Asset Age Distribution

Figure 4 provides an age profile of all poles in Northern and Southern Regions[4]. Pole year of manufacture (YOM) is stamped on pole discs, and recorded at site asset inspection. The inspection process is cyclic, with a period of between 4 and 8 years assigned based upon maintenance zone, pole type and locational risk factors of the asset. Poles installed within recent years but not yet inspected may therefore not be represented in Figure 4. This data issue is addressed further in Section 9.2.

1 Source Ellipse : Ergon Energy 2016/17 RIN and Energex 2016/17 RIN
2 Source Ellipse : Ergon Energy 2016/17 RIN and Energex 2016/17 RIN
3 Source Ellipse : Ergon Energy 2016/17 RIN and Energex 2016/17 RIN
4 Source Ergon Energy 2016-2017 RIN

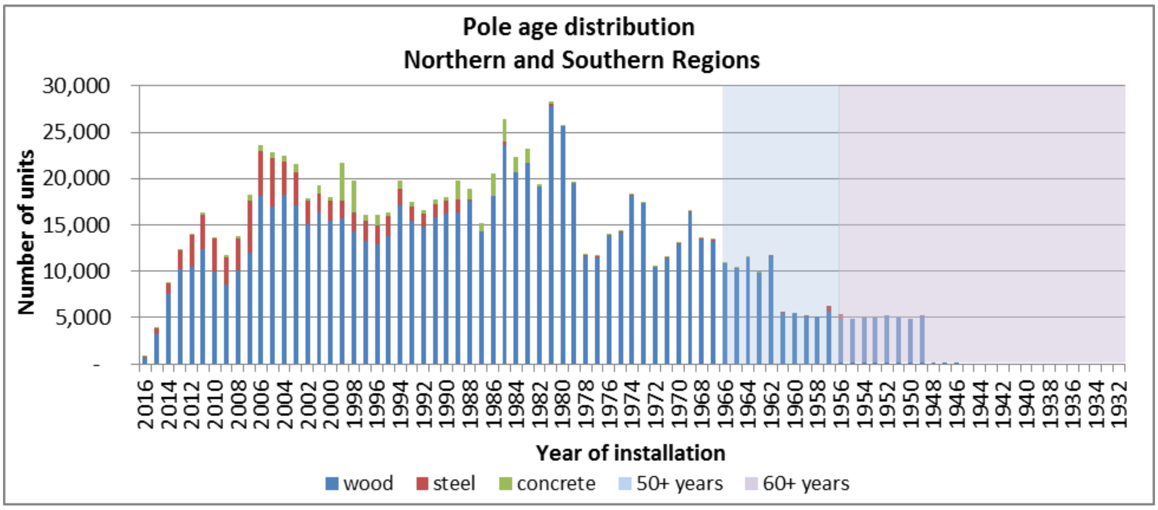

Figure 4: Pole age distribution - Northern and Southern Regions

Prior to 1963, pole discs with stamped year of manufacture were not used and detailed installation records are not available. The actual ages of most "natural poles" are indeterminate, as they do not have pole discs. For modelling purposes, "natural poles" have had their estimated ages distributed over the known installation period between 1949 and 1963.

Around 10% of wood poles have lost their pole discs, and these have had their estimated ages distributed over the entire installation period.

Figure 5 details the age profile of poles in South East Region[5]. The majority of poles in the South East Region are wood poles, or steel poles with streetlights. There are also a very small number of aluminium poles. The majority of wood poles in the region are supporting the 11kV and low voltage (LV) distribution networks in urban and rural areas. A small population of steel poles are also within substations supporting lightning masts.

The concrete poles supporting the 11kV network also support overhead transformers.

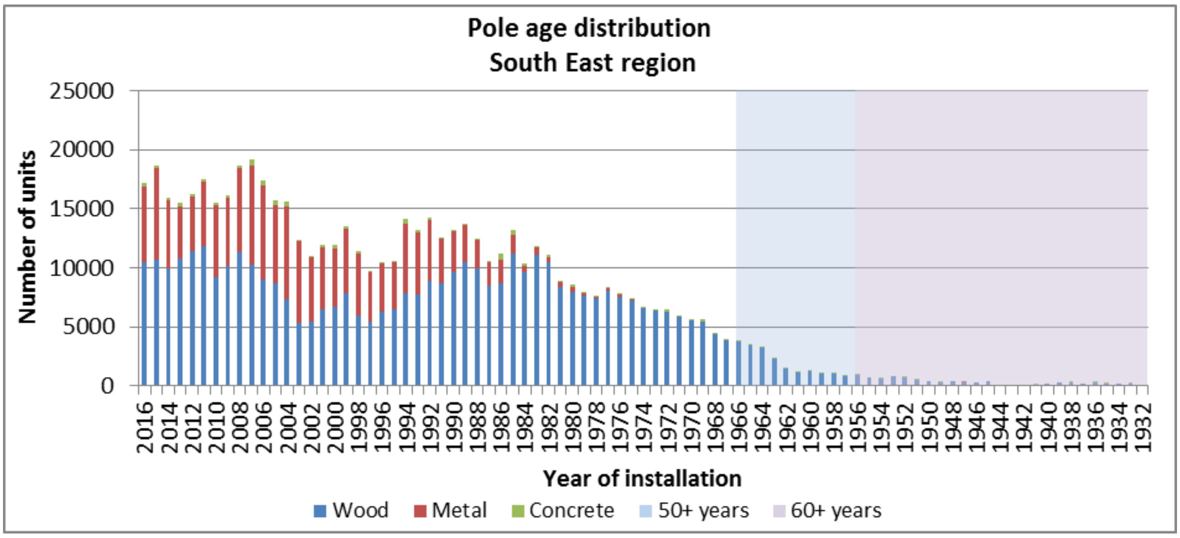

Figure 5: Pole age profile - South East Region

[5] Source: Energex 2016-17 RIN

Figure 6 details the age profile of lattice towers in South East Region. The relatively young lattice towers are supporting the 132kV and 110kV network.

There is no age profile record for steel lattice towers for Northern and Southern Regions.

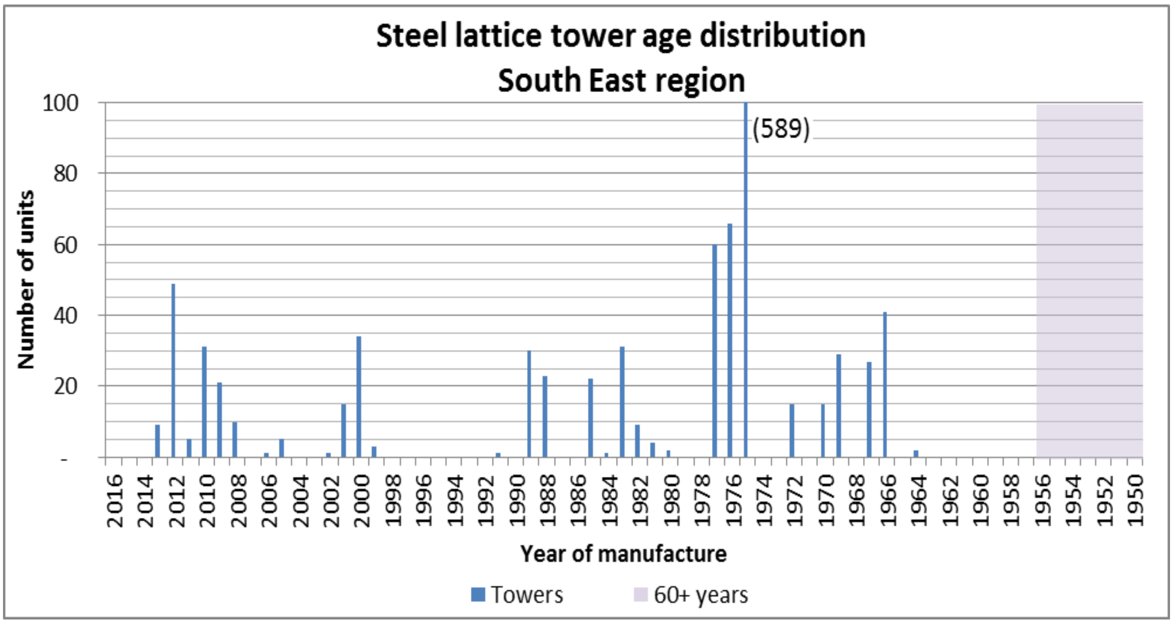

Figure 6: South East Region lattice tower age profile

The tower age profile reflects that in 1975, South Pine 275kV substation was first energised, requiring large scale 110kV network development between 1975 and 1977 across the South East Region network. The actual installation of the towers is likely to have been spread over several years, however historical records are not available.

2.4 Population Trends

The majority of poles in the Northern and Southern Regions are wood poles. The total number of wood pole installations have started to decrease slowly since the early 1990's, with some poles being changed at end of life into steel poles at locations considered higher risk or locations that require higher or stronger poles. There were a small number of concrete pole installations between the period of early 1980's to early 2000's.

The majority of poles in the South East Region are wood poles or steel street lights. There was a large increase in the wood pole population from the 1960's as the South East network expanded. Of the wood pole population, the majority of untreated wood poles were installed between 1945 and 1983 with a peak installation period around 1963-65. The steel pole population supporting street lights increased from approximately 1985 onwards.

Several pole types are being progressively phased out as the individual poles achieve end of life, including creosote preserved poles and untreated poles. Creosote poles are banned from further installation by Queensland legislation. Untreated poles are being slowly phased out, as they were sourced from timber species that are no longer commercially available. The most common timber species used for hardwood poles (spotted gum) is very susceptible to rot and termites without additional treatment.

Pole nailing typically achieves a 15-year pole life extension. Pole nails strengthen the pole at ground level only, allowing the pole to remain in service until end of life indicators at other sections of the pole dictate that the pole must be replaced. It is expected that in the near future the maximum life extension of the installed nail population will be reached, and replacement of nailed poles will increase.

Segmented steel poles have largely supplanted steel lattice towers in 110kV and 132kV overhead construction. As such, the installation of new steel lattice towers is more likely to be the result of individual replacement within an existing tower line than a new feeder construction.

2.5 Asset life limiting factors

Failure of a pole typically leads to energised assets falling closer to ground level, facilitating public access to energised electrical assets and increasing the risk of public contact, shock, and electrocution. Mechanical damage due to falling objects can also occur. The potential safety issues associated with ease of access to energised assets promotes proactive pole replacement once end of life indicators become apparent.

Table 6 describes the key factors that influence the life of various pole types and towers, both above and below ground level. These factors have a significant bearing on the programs of work implemented to manage pole and lattice tower assets.

Factor	Influence	Impact
Third Party Damage (all poles and towers)	Third party damage such as by car impact results in damage to the structural integrity of the pole or tower. This is a random failure mode; however, proximity to a trafficable road is an influencing factor.	Immediate failure.
Bacterial Rot and Fungal Decay (wood poles)	Rot and decay reduces the integrity of the timber within a pole and subsequently the strength.	Reduction in remaining life, increase in defects and failures
Termites (wood poles)	Termites reduce the timber within the pole and subsequently the strength. Termite population densities and species are varied across the state, with some species being more destructive than others.	Potentially sudden and rapid reduction in remaining life, increase in defects and failures.
Lightning (all poles and towers – more destructive in wood)	Lightning strikes result in immediate and destructive forces on the pole or tower and pole fires. This failure mode is random; however, exposed poles in long rural feeders are particularly prone to lightning.	Immediate failure.
Foundation Erosion / Excavation (all poles and towers)	Loss of foundation leads to loss of stability, resulting in pole movement and subsequent failure.	Defects and failure.

Factor	Influence	Impact
Environment (varied)	High rainfall areas promote the growth of bacterial rot and fungal decay in wood poles. Long term exposure leads to: Splitting of wood poles Vibration fatigue in steel poles and towers Cracking, flaking and spalling in concrete poles. Acid soils lead to deterioration of pole material resulting in loss of strength. Corrosive and coastal environments cause corrosion of steel poles, steel reinforcing in concrete poles, and steel towers resulting in loss of strength.	Reduction in remaining life, increase in defects and failures
Design (varied)	Design factors including the material of the pole or tower determines the ability to withstand external forces from third party damage or high winds, as well as environmental influences such as bushfire.	Defects and failures

Table 6: Pole and Lattice Tower life limiting factors

3 Current and Desired Levels of Performance

The following sections define the level of performance required from the asset class, measures used to determine the effectiveness of delivering corporate objectives, and any known or likely future changes in requirements.

3.1 Desired Levels of Service

This asset class will be managed, consistent with corporate asset management policy, to achieve all legislated obligations and any specifically defined corporate key performance indicators and to support all associated key result areas as reported in the Statement of Corporate Intent (SCI).

Safety risks associated with this asset class will be eliminated so far as is reasonably practicable (SFAIRP), and if not able to be eliminated, will be mitigated SFAIRP. All other risks associated with this asset class will be managed to be as low as reasonably practicable (ALARP).

This asset class consists of a functionally alike population, differing in age, brand, technology, material, construction design, technical performance, purchase price, and maintenance requirements. The population will be managed consistently based upon generic performance outcomes, with an implicit aim to achieve the intended and optimised life cycle costs for the asset class and application.

All inspection and maintenance activities will be performed consistent with manufacturers' advice, good engineering operating practice, and historical performance, with the intent to achieve the longest practical asset life overall.

Life extension techniques will be applied where practical, consistent with overall legislative, risk, reliability, and financial expectations. Problematic assets such as very high maintenance or high safety risk assets in the population will be considered for early retirement.

Assets of this class will be managed by population trends, inspected regularly, and allowed to operate as close as practical to end of life before replacement. End of asset life will be determined by reference to the benchmark standards defined in the Defect Classification Manuals and or

Maintenance Acceptability Criteria. Replacement work practices will be optimised to achieve bulk replacement to minimise overall replacement cost and customer impact.

While the reliability performance for poles has a regulatory standard set via the Queensland Electrical Safety Codes of Practice (ESCOP) – Works, occurrence of in-service pole failure in urban areas has much higher associated risk, due to the higher likelihood of public presence. The desired level of service for poles in the Energy Queensland network is to achieve in-service pole failure numbers which deliver a safety risk outcome which is considered SFAIRP, and as a minimum, maintains current performance standards.

3.2 Legislative Requirements

Regulatory performance outcomes for this asset include compliance with all legislative and regulatory standards, including the *Electrical Safety Act 2002 (2002)*, the *Electrical Safety Regulation 2013 (Qld)* (ESR), and the ESCOP.

The *Electrical Safety Act 2002 (Qld)* s29 imposes a specific duty of care for EQL, which is a prescribed Electrical Entity under that Act:

1) An electricity entity has a duty to ensure that its works—
   a) are electrically safe; and
   b) are operated in a way that is electrically safe.
2) Without limiting subsection (1), the duty includes the requirement that the electricity entity inspect, test and maintain the works.

The ESR details some requirements for electric lines, of which poles are classed as associated equipment. These include various general obligations related to the safety of works of an electrical entity and also specific obligations, notably:

- ESR Part 5 – Overhead and underground electric lines
- ESR Part 9 – Works of an electricity entity
- ESR Division 4 – Electric Lines and control cables
- ESR s295 – Clearances for lines built before 1 January 1995
- ESR s297 – Clearances for lines built between 1 January 1995 and 1 October 2002
- ESR Schedule 2 – Exclusion zones for overhead electric lines
- ESR Schedule 4 – Clearance of overhead electric lines (other than low voltage service lines).

The ESCOP – Works details some requirements for maintenance of supporting structures for lines. This document details expectations for supporting structure (poles) reliability, serviceability, and frequency of inspection, as well as timeframes to respond to unserviceable poles, and pole records to be kept. While many of the elements of the ESCOP – Works are advisory in nature, EQL has the intent to achieve all of the key elements described in the document.

The following clauses from the ESCOP – Works are particularly relevant to the management of poles and are used to guide the EQL programs:

- ESCOP s5.1 – must achieve a minimum three-year moving average reliability of 99.99 % per annum.
- ESCOP s5.2.1 – each pole should be inspected at intervals deemed appropriate by the entity. In the absence of documented knowledge of pole performance, poles should be inspected at least every five years.
- ESCOP s5.3.4 – A suspect pole must be assessed within three months; An unserviceable pole must be replaced or reinstated within 6 months.

Dangerous electrical events (DEEs) are defined in legislation[6]. DEEs are typically circumstances involving a high voltage asset, where a person would not have been electrically safe had they been exposed to the event. EQL assigns DEEs into the following two categories:

- Unassisted DEEs – incidents that might have been prevented via a maintenance program (e.g. rot and decay)
- Assisted DEEs – incidents where the root cause of failure occurs outside the control of any maintenance program (eg lightning strike)

3.3 Performance Requirements

The legislative performance targets associated with poles translate to maximum numbers of pole failures in the order of 97 per annum for the combined Northern and Southern Regions, and 57 per annum for the South East Region. EQL has a strategic objective to ensure a safe and reliable network for the community. Performance targets associated with these asset classes therefore aim to reduce in service failures to levels which deliver a safety risk outcome which is considered SFAIRP and as a minimum maintains current performance standards. Current levels of performance are outlined in subsequent sections.

EQL is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS) for reliability, assessed by feeder types as:

- System Average Interruption Duration Index (SAIDI) and
- System Average Interruption Frequency Index (SAIFI).

Individual pole failures usually have moderate impact upon SAIDI and SAIFI, especially when part of radial supply infrastructure.

DEEs are generally reviewed for severity on an individual basis, with response and investigation driven by severity of incident. DEE volumes are reported monthly. Climatic and seasonal variation influences Northern and Southern Regions DEE volumes substantially – accounting for over 20% variation year on year. While there are no specific dangerous electrical events (DEE) targets, EQL are committed to reduce this indicator in compliance with our electrical safety obligations under the regulations.

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[6] Queensland Electrical Safety Act 2002, s12

3.4 Current Levels of Service

Pole Reliability is calculated monthly, as an average of the previous 36 monthly reliability calculations, being

(P-F)/P

Where:

P= total number of in-service poles

F = total numbers of pole failures in the month

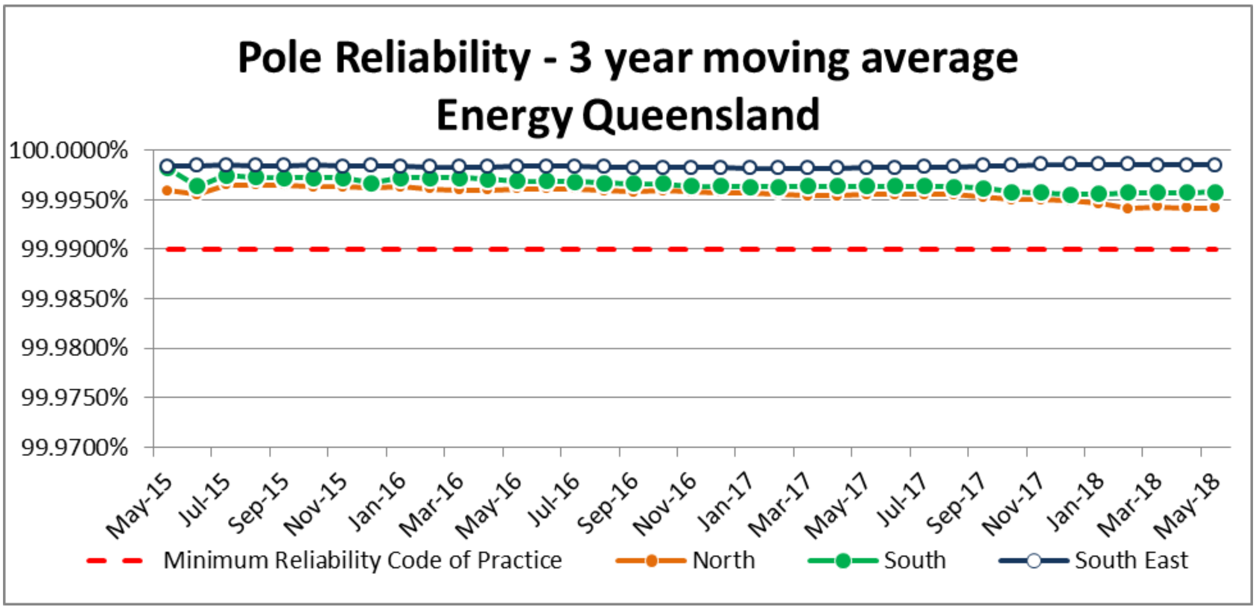

Figure 7: Pole Reliability Performance – EQL

Figure 7 highlights that EQL's three year moving average pole reliability is currently and consistently exceeding the compliance requirement required under Clause 5.1 of the Electrical Safety Code of Practice Works 2010.

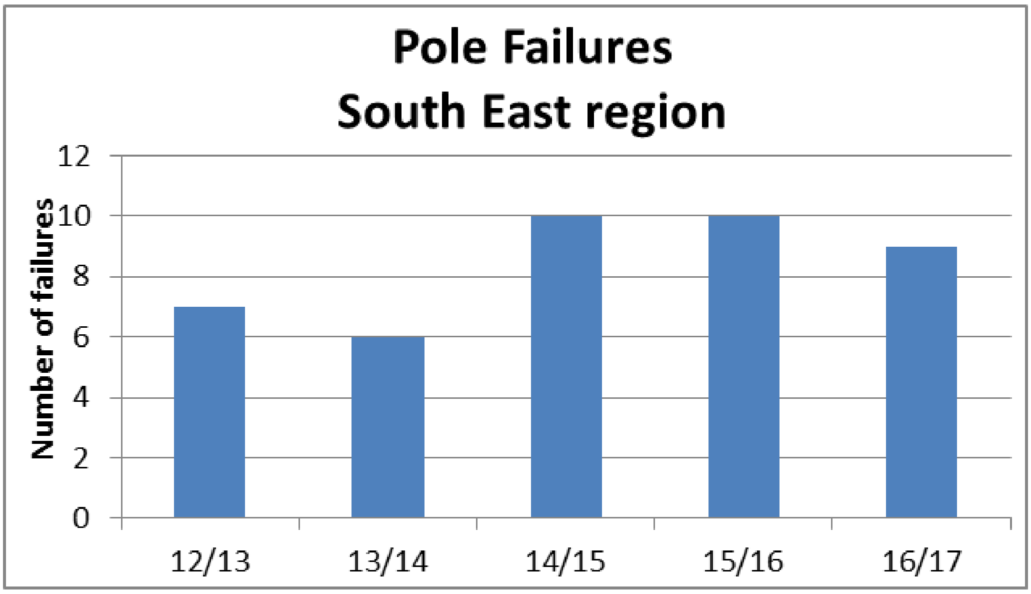

Figure 8: South East Region pole failure history

Figure 8 summarises the wood pole asset failures observed on the South East Region between 2012 and 2017 based on in-service pole failure data. In-service pole failure data does not include pole failure due to third party damage.

The total number of pole related dangerous electrical events (DEEs) is detailed in Figure 9 and Figure 10. Legacy organisations Ergon Energy and Energex interpreted the legislation defining DEEs differently. EQL is working to establish a consistent definition.

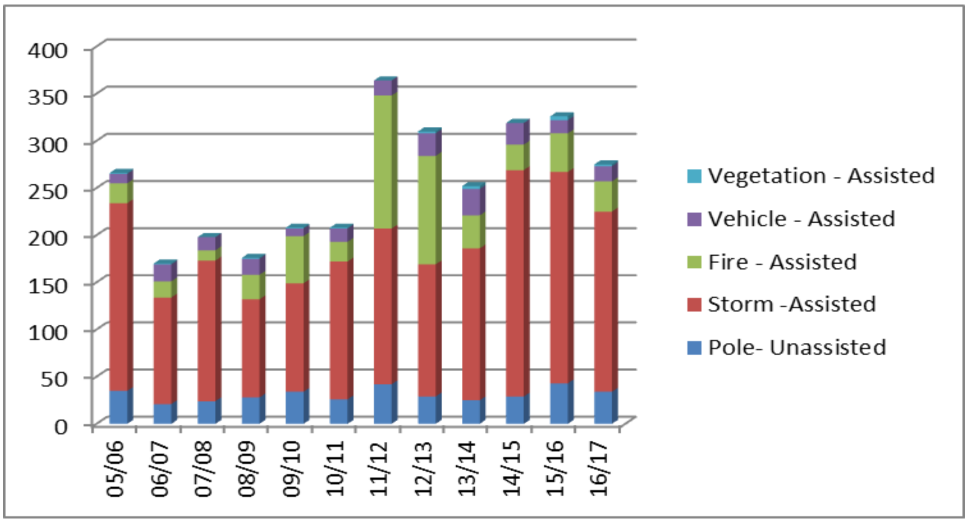

Figure 9: Northern and Southern Regions pole related Dangerous Electrical Events

In regional Queensland, there are typically between 20-40 unassisted pole related DEEs per annum, and around 170-280 assisted pole related DEEs per annum. The impact of storms (lightning and very high wind gusts) is the dominant cause of assisted DEEs in the Northern and Southern Regions.

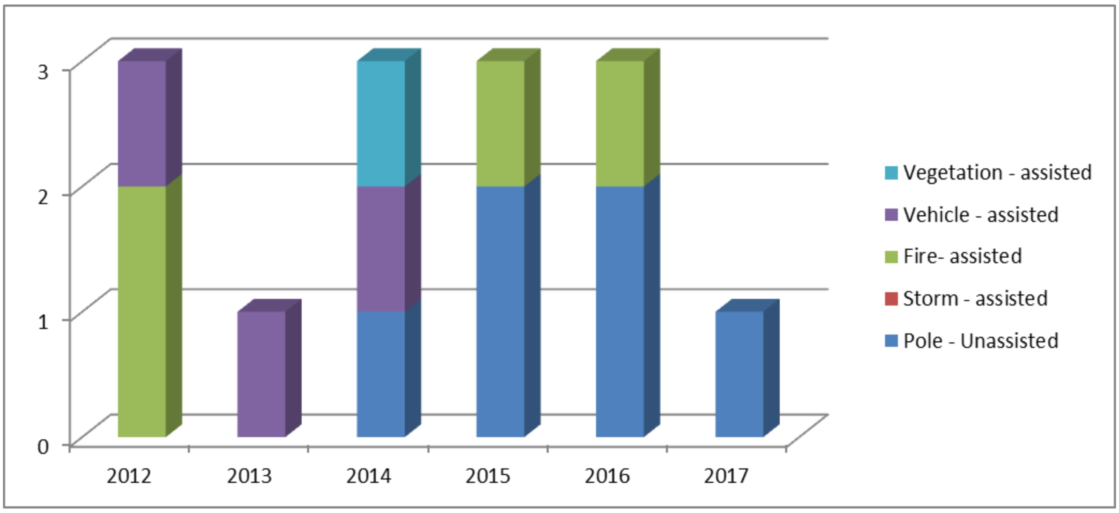

Figure 10: South East Regions pole related Dangerous Electrical Events

The South East Region data reflects a very low volume of pole failures, consistent with a significant capital-based works replacement program and focus, driven by an urban risk profile.

In all regions, all unassisted pole failures are investigated, with the root cause identified and recorded. Investigations also consider the adequacy of the most recent inspection. Most unassisted pole related DEEs occur in rural or remote rural locations, with very low likelihood of public presence, and are caused by termites.

To date, all nailed poles and all rebutted poles removed/replaced at end of life have been removed for causes other than pole nail or pole rebutt failure (e.g. failure at top of pole due to soft rot, or termite infestation). No evidence of severe pole nail corrosion has been recorded at any pole replacement.

Figure 11 demonstrates the number of defects identified on EQL poles. Identified defects are scheduled for repair according to a risk-based priority scheme (P1/P2/C3/no defect). The P1 and P2 defect categories relate to priority of repair, which effectively dictates whether normal planning processes are employed (P2), or more urgent repair works are initiated (P1). Additionally, a classification of C3 aims to gather information to inform or create a “watching brief” on possible problematic asset conditions.

Recognising differences in data recording systems, work order processing systems, and the asset management strategies employed by the two legacy organisations, EQL has been actively working to merge the actual information being managed. Acknowledging that 62% of EQL poles are in the Northern and Southern Regions, and 38% of EQL poles are in the South East Region, the average number of defects per pole is already quite similar between the legacy regions, reflecting some early integration success in asset management approach.

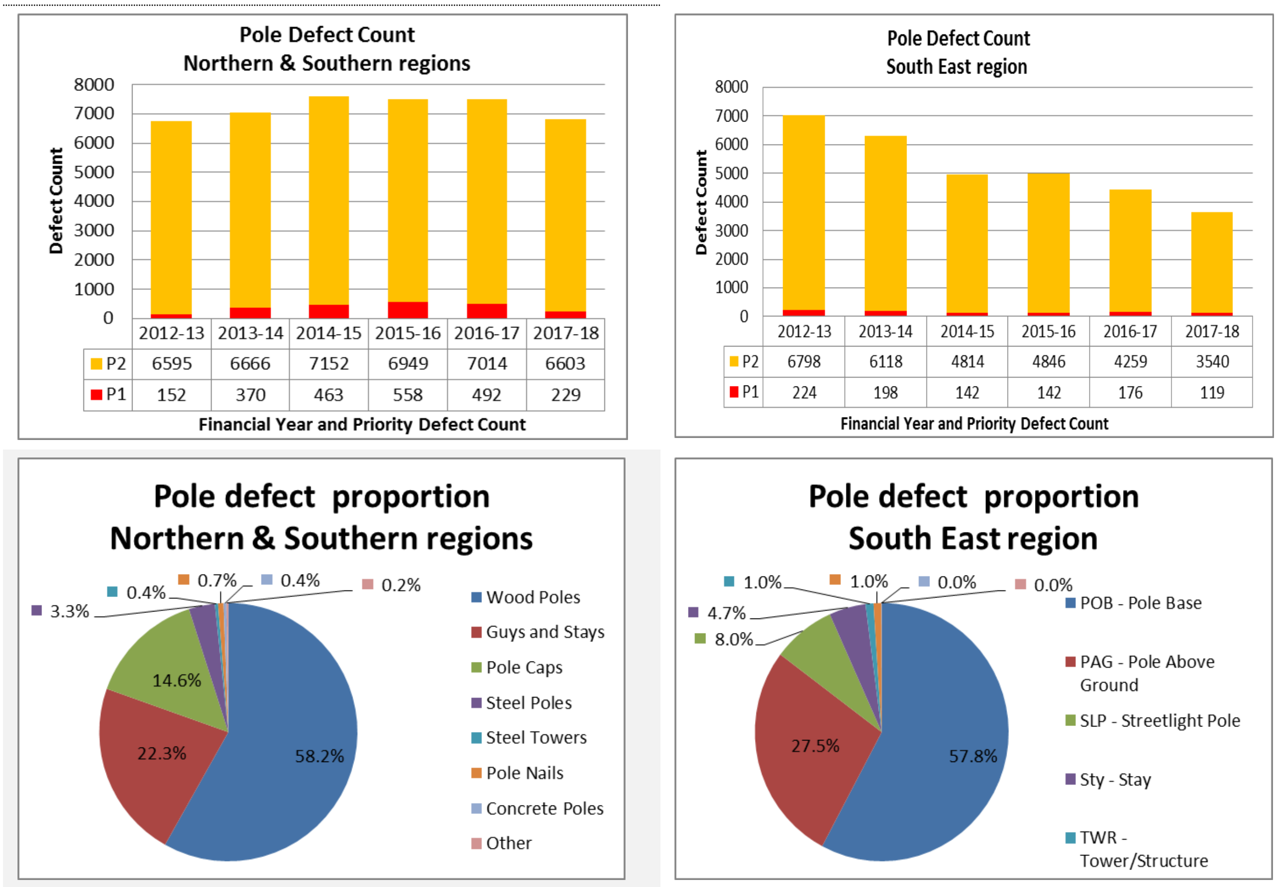

Figure 11: EQL – Pole Defect Data

4 Asset Related Corporate Risk

As detailed in Section 3.2, Queensland legislation details that EQL has a duty to ensure its works are electrically safe. This safety duty requires that EQL take action so far as is reasonably practicable (SFAIRP) to eliminate safety related risks, and where it is not possible to eliminate these risks, to mitigate them SFAIRP[7]. Risks in all other categories are managed to levels as low as reasonably practicable (ALARP).

Figure 12, Figure 13, and Figure 14 provide threat-barrier diagrams for the different pole materials. Many threats are unable to be controlled (e.g. lightning), although EQL undertakes a number of actions to mitigate them SFAIRP. Failure of a pole risks public and staff safety in several ways, most notably:

- Bringing energised electrical conductors to easily accessible heights, risking public contact, shock and electrocution
- Heavy objects physically falling, risking physical harm to anyone in the vicinity or extensive material damage.

EQL's safety duty results in most inspection, maintenance, refurbishment, replacement, and expenditure related to poles being entirely focused upon preventing and mitigating pole failure.

The asset performance standards described in Section 3.3 detail EQL's achievements to date in respect of this safety duty. The following sections detail the ongoing asset management journey necessary to continue to achieve to high performance standards into the future. Action items have been raised in the following sections where relevant, detailing the specific actions that EQL will undertake as part of program delivery of this Asset Management Plan.

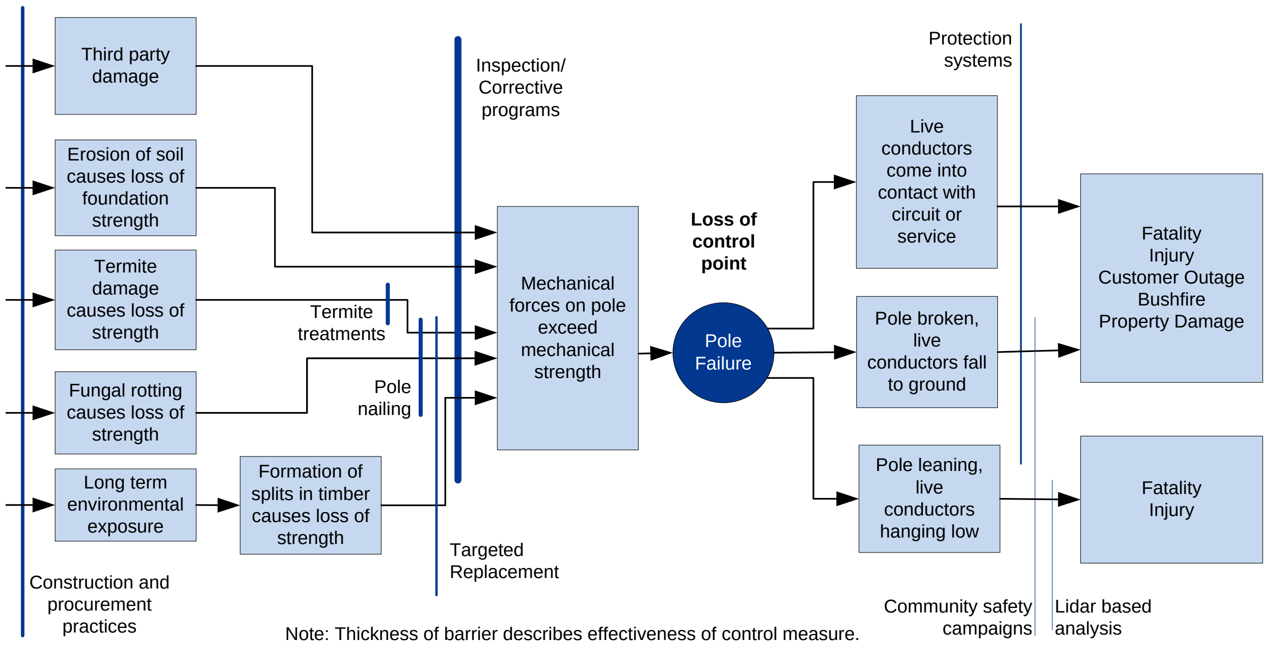

Figure 12: Threat-Barrier Diagram for wood poles

[7] QLD Electrical Safety Act 2002 s10 and s29

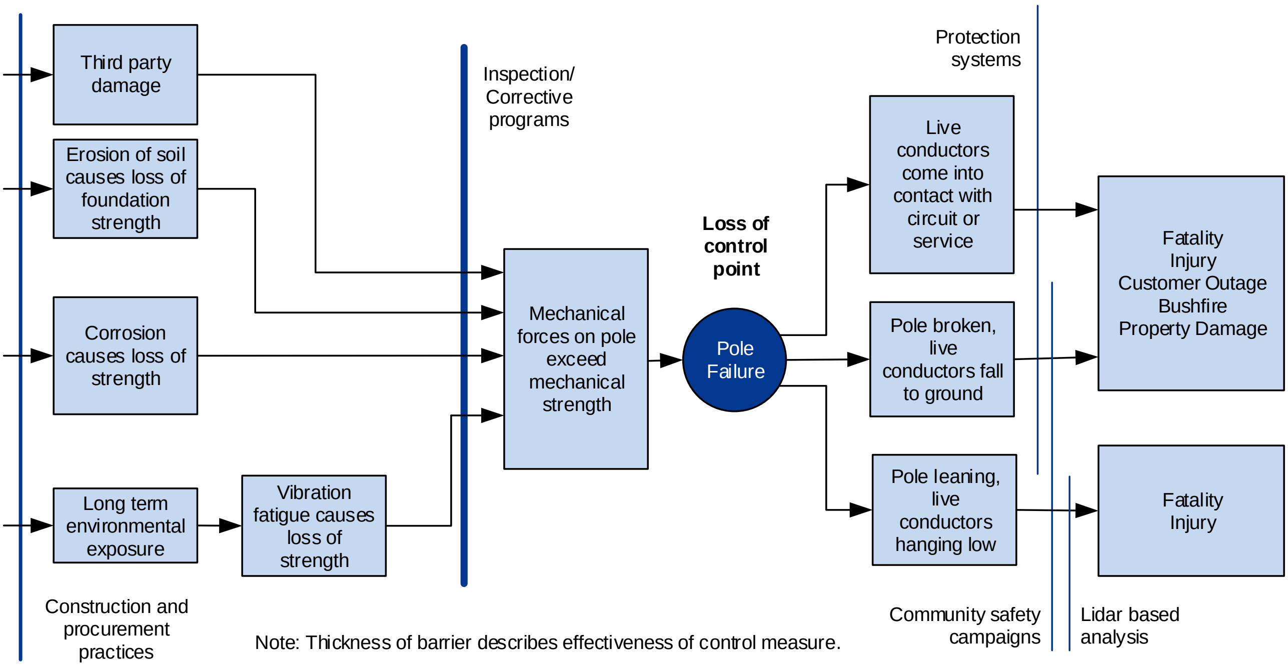

Figure 13: Threat-Barrier Diagram for steel poles

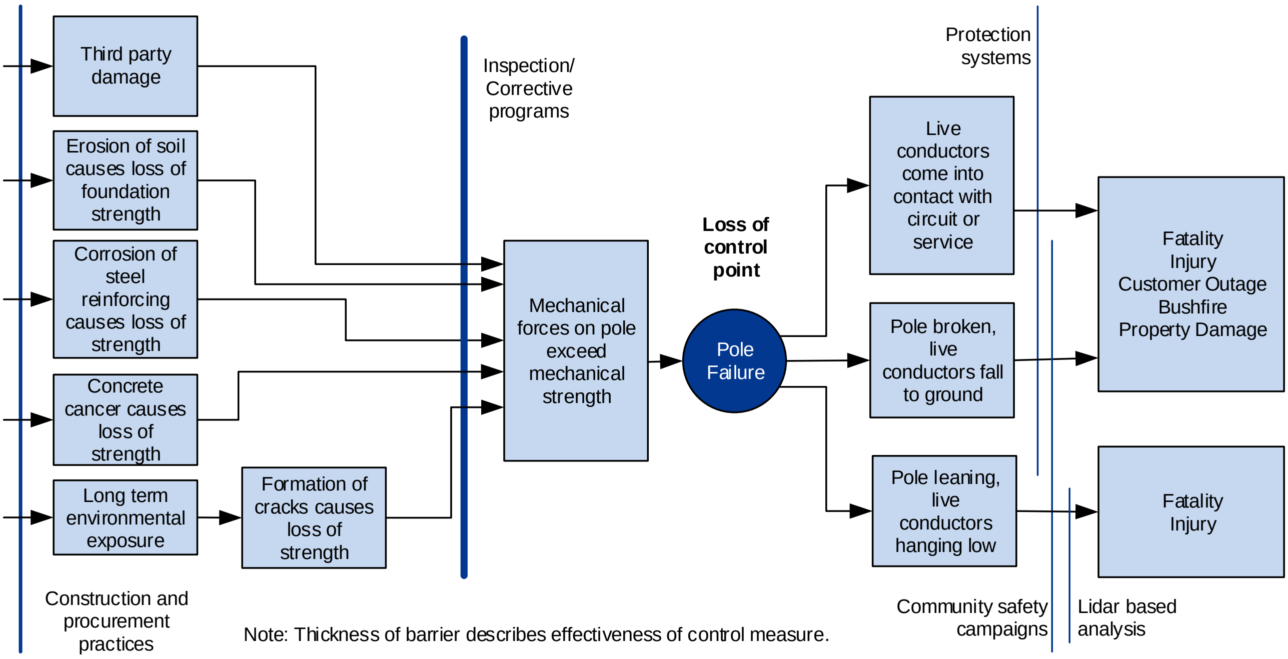

Figure 14: Threat-Barrier diagram for concrete poles

5 Health, Safety & Environment

In the Northern and Southern Regions, the below-ground section of timber poles is wrapped with a boron pellet blanket, as boron acts to reduce soft rot. The boron pellets dissolve in water, so the application becomes diluted over time with rain or changes in the underground water table.

Poles are currently treated with Biflex termite treatment when there is evidence of termite activity. Biflex dissolves in water and becomes diluted over time with rain or changes in the underground water table.

Burnt CCA poles present inspectors and field crews with air borne hazards if the pole char and ash are disturbed, as arsenic is retained after burning within the friable ash and cinders. Operational Updates describe the precautions to be taken when inspecting such poles.

Wood CCA poles are treated as regulated waste and must be disposed appropriately.

6 Current Issues

The following sections outline current issues that have been identified as having the potential to impact EQL's ability to meet corporate objectives.

6.1 Low Strength Pole Resilience

The presence of low strength (strength rating less than or equal to 5kN) poles within the EQL asset base presents a potential cause for concern. Analysis of data from defect and asset failure investigations to date indicate that pole failures in aged, low strength poles, generally occur above the inspection zone; at heights above 2m from ground. These failures are very difficult to detect using current ground based visual inspections, and thus these poles present increased risk.

EQL has identified 470,000 potentially low strength poles across its network. The Northern and Southern Regions has approximately 450,000 poles rated from 2kN to 5kN; the majority of these are used to support SWER networks in regional areas. The South East Region has approximately 18,000 poles rated at 5kN. These are often used as cross street service poles and to support other LV assets.

Installation of these poles was conducted over a 50-year period between 1957 and 2017. There was a small but noticeable increase in the number of low strength poles used in the 1980's. Corporate system data indicates that many of these low strength poles are now greater than 40 years old and are expected to reach end of life in the coming decade. Neither region is currently installing poles rated at or below 3kN in the network.

EQL is undertaking a risk-based approach to address the issues identified with low strength poles and has already implemented a change to inspection practices to cease nailing these lower strength poles and instead remove them from the network.

Several other initiatives are currently being investigated to mitigate the risk associated with low strength poles and will be implemented based on merit as they are assessed. These initiatives are summarised in the actions below.

Action 6.1-1: Review inspection and replacement practices in relation to low strength poles, including consideration of pole inspector training, pole strength algorithms, risk based inspection, and suitable replacement alternatives.

Action 6.1-2: Incorporate the management of the low strength pole population into the priority of targeted line replacement programs across all regions, including consideration of geographical location to ensure appropriate management of safety risk.

Action 6.1-3: Establish appropriate reporting to monitor the performance of the low strength pole population and the effectiveness of the control measures implemented to mitigate the risk.

6.2 High Risk Pole Locations

Legacy organisation Energex developed a policy relating to pole performance in highly frequented locations. The policy requires that poles in locations identified as high risk are unilaterally reinforced at age 25 (by pole nailing), without any serviceability or other condition assessment. The intention of the policy is to address the risk of a pole collapse during times of high public presence near the pole, where there is extremely high risk of physical injury or shock occurring.

The approach aligns with EQL's Duty to eliminate safety risks SFAIRP. A review is required of the application and efficacy of this policy, as the frequency of unassisted pole failure at pole mid-life is extremely low, and the more modern condition and serviceability assessment approaches offer potential cost reductions without any safety impact.

In addition, the principle and application of this strategy needs to be reviewed in the light of the entire EQL pole population, as there may be appropriate application in the Northern and Southern Regions, as well as other offsetting impacts in areas of extremely low population density in remote Queensland country areas.

One initiative is currently being investigated to mitigate the risk associated with high risk pole locations, as summarised in the action below.

Action 6.2-1: Review the Energex High Risk Location Pole Nailing Strategy and establish an appropriate strategy for EQL, taking into account the modern approaches of serviceability and condition assessment.

7 Emerging Issues

The following sections outline emerging issues which have been identified as having the potential to impact on EQL's ability to meet corporate objectives in the future.

7.1 Increasing Pole Replacement Volumes Forecast

Replacement modelling suggests that the annual volume of poles reaching nominal end of life will increase in the near future, due to a combination of the aging asset population and the maximum life extension of a pole nail. This has implications for procurement of sufficient quantities of poles, as well as resourcing to complete the necessary pole replacements within specified rectification periods, and for the overall sustainability of the program. This issue is particularly prevalent in the Northern and Southern Regions.

Targeted pole replacement has been used effectively in the South East Region to mitigate risk while ensuring programs of replacement remain sustainable, within the constraints of resource availability and cost to the customer. Volumes of replacement are offset against forecast replacements from inspection to ensure sustainability and management of historical peaks in age profiles. Replacement forecasting identifies poles which are approaching end of life using a combination of pole age, type, recorded condition, and historical inspection performance. These forecasts are combined with other overhead line assets such as conductor and pole top structures approaching end of life, to form line refurbishment projects as an efficient means of work delivery, customer outage reduction, and risk mitigation.

It is recommended that a line refurbishment program including targeted pole replacement be established in the Northern and Southern Regions to mitigate the risk associated with the aging pole population.

Action 7.1-1: Establish a line refurbishment program in the Northern and Southern Regions, incorporating targeted pole replacements to mitigate the risk associated with the aging pole population.

7.2 Pole Availability

There are concerns of a developing shortage in hardwood poles, predominantly in the 12.5 to 14 m range which accounts for approximately 64% of the pole usage. Ongoing high demand for 11m 8-14kN hardwood poles has meant that stocks are very low, and there is the potential for supply shortages to occur in the near future.

Steel and concrete poles offer immediate alternate solutions, though typically at higher cost. A major supplier of steel poles has recently withdrawn from the steel pole market. There is a risk associated with this withdrawal in terms of steel pole supply, availability and cost. A watching brief is being maintained.

A trial of softwood poles is currently underway to test if the current supply chain is able to supply sufficient quantities of softwood poles of the required quality. The larger diameter of the softwood poles also presents issues with pole replacement in built up areas and requires consideration in the overall solution. This trial is expected to finish by December 2018.

Action 7.2-1: Review market capability for delivery of required pole volumes to meet replacement forecasts. The review should include alternate measures that might reduce the expected volumes involved, possible additional life extension methods, and mechanisms to resource required pole volumes in a sustainable way.

Action 7.2-2: Continue softwood pole trials and consider further widening across all climate and soil zones.

7.3 Steel Lattice Tower End of Life

The population of steel lattice towers in the EQL network is relatively small in comparison to the pole population. As such, the priority and effort directed towards understanding and forecasting the end of life of steel lattice towers has been limited. Coupled with a lack of data on steel lattice tower age in the Northern and Southern Regions, and known data issues in the South East Region, this presents a potential emerging risk.

Whilst low in volume, replacement of steel lattice tower lines is very expensive. The consequence of failure for steel lattice, given that they traditionally support transmission voltages and often a double circuit construction, is significant. Similarly, restoration time in the event of a failure, particularly a cascading failure as a result of high winds or storm events, is substantial and likely to result in long term widespread outages.

At this stage it is not anticipated that the condition of the EQL steel lattice tower population presents an immediate risk, given the development timing across the state and similarity to assets owned by the Transmission Network Service Provider in the same geographical area. However, if understanding of the forecast end of life of the steel lattice tower population is not improved, there is the potential for EQL to be unable to respond in time to deliver a sustainable program of replacement to manage the emerging risk. It is recommended this knowledge gap be addressed.

Action 7.3-1: Develop a methodology for forecasting the end of life of the EQL steel lattice tower population to provide visibility of forward program requirements and network risk. The methodology should be in consultation with industry partners, particularly Transmission Authorities, to leverage their expertise in the field.

8 Improvements and Innovation

The following sections outline any improvements or innovations to asset management strategies relevant to this asset class, being investigated by EQL.

8.1 Termite Treatment

Termites are found all throughout Queensland and are a major contributor to premature deterioration of wood poles, especially north of the Tropic of Capricorn where the Mastotermes species is found.

Current inspection and maintenance processes require inspectors to apply a chemical barrier treatment (Biflex) to poles when termites have been detected in or around the pole. Biflex is a barrier treatment and does not kill the termite nest. Biflex is soluble in water and washes away with water flow, creating long-term maintenance issues and requiring regular re-application of the chemical.

EQL, through its legacy organisations, has been investigating improved treatment and management processes in termite prone areas for some time. The chemical Termidor provides improved protection, as termites transport the chemical back to the nest where it kills the entire nest. Termidor has been established as superior in performance to Biflex in termite protection.

However, Termidor has not been approved for use by the Queensland Department of Agriculture and Fisheries in rural areas, due to a concern that use will impact the live export industry (worth almost $1 billion annually in Australian exports). Termidor is much less prone to washing away but requires specially qualified technicians to apply.

Action 8.1-1: Investigate the use of Termidor termite pole treatments in urban areas as a means of reducing termite related failures and defects without impacting agricultural areas.

8.2 Use of Boron to Protect Against Soft Rot

The South East Region ceased using boron to protect against soft rot in 2014 as it was considered to be ineffective. The practice of using boron to protect against soft rot remains in the Northern and Southern Regions as they determined that the efficacy of the boron treatment has not yet been disproven.

Academic research remains unclear as to the efficacy of boron in preventing soft rot. Some studies indicate that application methods may not be effective unless under ideal circumstances, while others offer alternatives which may help to overcome these limitations. Given the prevalence of rot as a failure mode in the EQL wood pole populations, it is considered prudent to further investigate whether boron application should be continued across all regions.

Action 8.2-1: Establish further research into the use of boron and the available applications to protect against soft rot in the EQL wood pole population.

8.3 Pole Serviceability Algorithms

EQL's legacy organisations had slightly different methods for determining the ongoing serviceability of a pole (a legislated obligation). The methods were embedded in field technology and are still in use today. As a result, there are some slight differences in the criteria for determining whether a pole is serviceable or unserviceable between the different regions.

In the Northern and Southern Regions, pole serviceability calculations are performed and recorded at every pole inspection, and subsequently upon Level 2 assessment for suspect poles, which occurs up to 13 weeks after the original pole inspection.

In the South East Region, pole serviceability calculations are only performed on poles that fail a visual and sounding assessment and are performed in the same visit as the original pole inspection (i.e. no separate Level 2 assessment).

The Field Mobile Computing (FMC) project currently being undertaken in the Northern and Southern Regions is rolling out an updated platform for pole inspection. This change will incorporate the alignment of the pole serviceability algorithms between the Northern and Southern Regions and the South East Region. This project is due to go live in the second quarter of 2019.

Action 8.3-1: Complete the Field Mobile Computing project to align the pole serviceability algorithms between the Northern and Southern Regions and South East Region and continue the alignment of inspection processes for EQL.

8.4 Composite Fibre Poles

Composite fibre poles present a lightweight alternative to traditional wood, concrete, or steel poles used in the EQL network. Technologies used in the construction of composite poles are continuing to advance, with manufacturers advertising comparable strength and longevity to other pole types, making them progressively more viable for use. The lightweight nature of the composite fibre poles also provides numerous logistical and manual handling benefits.

Given the issues discussed in Section 7.2 regarding the procurement of wood poles to meet forward demand, and the cost of alternative concrete and steel poles, it is recommended that EQL investigate the potential use of composite fibre poles as an alternative to wood poles.

Action 8.4-1: Investigate the use of composite fibre poles as an alternative to address forecast shortfalls in wood pole availability.

8.5 Future Technologies to Deliver Inspection Capability

The cost of pole inspection remains a significant portion of the overall operating expenditure for EQL, due to the ongoing need to visit each site and undertake manual inspection activities, such as excavating around the base of the pole or drilling.

Emerging technologies in the field of non-destructive testing techniques will present a viable alternative to traditional inspections, as the technologies are proven, and costs come down. Similarly, sensors which may be used to detect pole failures and defects may become an alternative to traditional inspection in the future. Ongoing monitoring and consideration of these technologies is recommended.

Action 8.5-1: Continue to investigate the viability of non-destructive pole testing and inspection technologies and sensors as an alternative to traditional inspections, in order to deliver efficiency benefits and improved risk mitigation.

8.6 Future Technologies as an Alternative to Replacement

Technology advancement in areas which present an alternative to traditional network is currently increasing at an unprecedented rate. Technologies such as distributed generation, batteries and isolated grids may present a viable alternative to like-for-like replacement in order to mitigate risk; particularly in rural areas.

It is recommended that EQL continue to investigate technology-based techniques to provide an alternative to like-for-like replacement to deliver greater risk reductions at lower cost.

Action 8.6-1: Investigate the use of technology-based solutions such as distributed generation, batteries, and isolated grids as an alternative like-for-like replacement in overhead distribution networks.

9 Lifecycle Strategies

The following sections outline the approach of EQL to the lifecycle asset management of this asset class.

9.1 Philosophy of Approach

Poles are very high volume, relatively low individual cost assets, and are typically managed on a population basis through periodic inspection for condition and serviceability. Poles may be proactively replaced based on risk, where criteria indicating assets are either at or near end of life can be identified. Proactive replacement is typically undertaken with other work such as feeder refurbishment programs or bundled into logical groups for efficiency of delivery and cost.

While both legacy organisations employed a common set of standard processes and inspection defect benchmarks, the practical implementation of the work has been different. This has developed as a result of variations in approach to use of contractors for tasks, contractual obligations, asset environments (e.g. CBD vs long rural), routine travel distances and diversity of environments promoting a range of work practices, and corporate direction and policy.

With the establishment of EQL, there is intent to merge these practices, policies, and procedures where prudent, such as when contracts fall due and are renewed, and to actively pursue opportunities for common approach and service delivery where performance improvement opportunities arise.

Action 9.1-1: Review and align the maintenance and replacement strategy between regions where prudent, to ensure a common approach by EQL, and ensure that industry best practice management of pole assets is maintained.

9.2 Supporting Data Requirements

There is a disparity between asset records being kept in the Northern and Southern Regions and the South East Region. Historical data capture practices restrict the ability to analyse the large volumes of data associated with this asset class without substantial manual effort and offers significant potential for improved asset management.

Legacy organisation Ergon Energy developed and implemented a recording system for all failures, incorporating a requirement to record the asset component (object) that failed, the damage found, and the cause of the failure using the Maintenance Strategy Support System (MSSS) in Ellipse; the current Enterprise Asset Management (EAM) System. Energex maintained detailed records of pole failures in a separate database outside of corporate systems. EQL has adopted the MSSS approach and is building this system of record over time, providing the information necessary to support improvements in inspection and maintenance practices. There is an expectation that this will also support and influence standard design and procurement decisions. Alignment of failure and defect data capture across regions is required to take full advantage of the larger data set available across the state.

In managing pole replacement data, legacy organisation Ergon Energy employed paper-based records. Updating pole replacement records into the EAM therefore became problematic. To manage the problem, asset inspectors check and update basic pole data as part of the periodic inspection. This introduces a delay between asset replacement and record entry into the asset management system, and with an inspection cycle of at least 4 years, Ellipse records may not be updated for this period for recent installations. The recent introduction of wide spread online field staff computing facilities has begun to address this issue however continued focus is required. Energex records this information at time of installation through the commissioning process and so does not have the same issue however there may still be up to six months delay between commissioning and data records being updated.

Action 9.2-1: Incorporate asset data capture processes in the new Enterprise Asset Management system and mobile inspection platforms being proposed for EQL, to ensure pole installation date is captured at the time of commissioning to improve asset data quality.

Action 9.2-2: Align and improve defect, failure, and dangerous electrical event data capture processes and reporting methodologies to ensure consistency across EQL.

9.3 Acquisition and Procurement

Assets are created when new lines are developed, existing lines are upgraded or extended, and when poles are replaced due to condition. A very small volume of poles are “gifted” assets, but the annual number of gifted poles is insignificant.

The overall growth rate of the population of pole assets is less than 1% across all regions due to the prevalence of undergrounding new developments.

Poles are procured via period contracts based on forecast requirement.

As detailed in Section 7.2, there is a developing shortage in hardwood poles, predominantly in the 12.5 to 14m range which accounts for approximately 64% of the wood pole usage. Ongoing high demand for 11m 8-14kN hardwood poles has meant that stocks are very low, and there is the potential for supply shortages to occur in the near future.

Normal procurement time of wood poles and steel poles is typically 1-2 weeks.

Procurement time of concrete poles is typically of the order of several months.

9.4 Operation and Maintenance

Operation and maintenance includes planned and corrective maintenance. Operation and maintenance procedures are supported by a suite of documentation which describes in detail the levels of maintenance applicable, the activities to be undertaken, the frequency of each activity, and the defect and assessment criteria to which the condition and testing are compared to determine required actions. The relevant documents are included in Appendix 1for reference.

9.4.1 Preventive Maintenance

EQL actively manages poles and steel lattice towers using a combination of condition based visual assessment and preventive maintenance tasks, which includes:

- Periodic in-service condition assessment of physical condition and immediate environment
- Routine non-intrusive maintenance activities to ensure correct functionality
- Earthing system integrity testing
- Periodic Light Detection and Ranging (LiDAR) in service condition assessment.

Ground based visual inspections are used to identify defects on other asset classes as well as poles in order to deliver an efficient overhead network inspection program. Ground based visual inspections are detailed in the documents referenced in Appendix 1.

Audit systems are in place to ensure efficacy of the overall inspection process. These are embedded in pole inspection contracts and the governing procedures and standards detailed in Appendix 1 Approximately 5% of all pole inspections are audited.

Under the inspection process, poles are assessed according to a set of pass/fail benchmark criteria documented in the Lines Defect Classification Manual (LDCM). Individual benchmark failure records are labelled “Defects”. The benchmark criteria are reviewed periodically based upon overall pole population failure and refurbishment statistics, as well as reported situational circumstances that have been encountered.

Defects are scheduled for repair according to a documented risk-based priority scheme (P1/P2/C3/no defect). Actual individual repair periods are recorded and monitored, with performance criteria established for the population repair period statistics.

Where pole serviceability calculations suggest the base strength is marginal or inadequate, the pole will be reinstated using pole nails, rebutted, or replaced.

Table 7 provides a summary of the variation in inspection cycles for poles in the EQL network.

Region	Wood urban	Wood rural	Wood rural (high risk)	Concrete	Metal (Includes lattice towers)	Metal (direct buried or coastal)
Northern	4yr	6yr	4yr	8yr	8yr	4yr
Southern	4yr	6yr	4yr	8yr	8yr	4yr
South East	5yr	5yr	5yr	5yr	5yr	5yr

Table 7: Pole Inspection Periods

The frequency of pole inspections in the Northern and Southern Regions varies with pole type, location, function, and assessed risk. Cycle times are defined at 4 years, 6 years and 8 years based in performance history of the pole types and individual poles, as well as assessed site risk.

The frequency of pole inspection for the South East Region is consistent across the population at 4 years and 9 months with intent to ensure all poles were inspected on a 5-year cycle.

LiDAR based inspections are predominately performed for clearance and vegetation issue identification but can also be used to identify obvious pole issues such as leaning and pole movement.

Action 9.4-1: Investigate the benefits for alignment of pole inspection cycles across all regions of EQL, with consideration of impacts on inspection of associated pole top equipment and conductors. Assessment should also consider the efficiency benefits associated with the timing and coordination of routine inspection, targeted inspection, and proactive replacement programs to optimise work delivery.

9.4.2 Corrective Maintenance

Corrective maintenance is generated from preventive maintenance programs, ad-hoc inspections, public reports and in-service pole failure. Non-urgent actions to address asset issues identified through customer notification or ad-hoc inspections may be rectified at the time of inspection or scheduled for a later time through corrective maintenance.

For corrective maintenance, poles and other assets are repaired if cost effective, or replaced with like-for-like to the current standard.

9.4.3 Spares

EQL does not currently employ a documented spares strategy for poles.

Wood poles and steel streetlight poles are managed as stock items within the corporate procurement and inventory systems. Holdings are managed to minimum levels based on historical usage and forecast programs of work, with typical procurement time of 1-2 weeks. Wood and steel poles are stored at most depots to ensure a reasonable supply is available locally for all normal contingencies. Volumes held reflect local seasonal usage requirements considering logistic issues related to efficient site delivery.

Concrete and steel poles are typically ordered on an on-demand basis per design requirements due to their larger size and longer lead times, which can be in the order of months. Concrete and steel poles used for distribution applications are managed with minimum stock holdings in the stores system, though at much smaller quantities.

Concrete poles are relatively expensive (compared to wood and steel poles) and often used in locations where very high reliability is required, very tall poles are required, or future maintenance access is likely to be problematic (such as in natural parks and rain forests, with very long spans in rugged country). While failures of concrete and steel poles are rare, replacement of failed poles is problematic due to the lack of spares. Lead time for procurement is typically measured in months.

9.5 Refurbishment and Replacement

The following sections outline the practices used to either extend the life of the asset through refurbishment or to replace the asset at the end of its serviceable life.

9.5.1 Refurbishment

Where pole serviceability calculations suggest the base strength is marginal or inadequate, the pole may be reinstated using pole nails or rebutting techniques.

Pole nailing is performed as part of the Defect Refurbishment Program, primarily to achieve the intended service life of the pole. This is achieved by fitting a steel stake (pole nail) to support the deteriorated section of the pole at ground-line.

Rebutting of a pole in-situ to raise conductor clearances to ground and increase rating may be performed as part of a refurbishment program. Rebutting to reinstate an unserviceable wood pole in-situ is not normally cost-effective; however, purchasing pre-butted poles direct from the suppliers has proven to be cost effective.

Steel lattice towers can be refurbished by replacing individual structural members to ensure the overall integrity and strength is maintained. The viability of refurbishment is dependent on the number and location of the individual members of the structure requiring replacement.

9.5.2 Replacement

Poles are predominately replaced based upon condition. Poles are usually proactively replaced, where criteria can be identified indicating that assets have either reached or are approaching end of life. These criteria are based on a combination of pole type, age, location, previous strength assessment, and/or the period that the pole has been nailed for. Proactive replacement is typically undertaken with other work such as feeder refurbishment programs or bundled into logical work packages for efficiency of delivery and cost.

The average life extension of poles due to reinforcing or reinstatement techniques was expected to be approximately 15 years when the technique was introduced. Data collected to date indicates that life extension in this order is typical across all regions. Performance data has also shown that the cause of nailed poles reaching end of life has been due to the wood pole failing other inspection criteria and not the nail-enhanced structural strength criteria. The average life extension of a pole due to nailing is being monitored, as there are a growing number of poles remaining in service that have been nailed for over 15 years.

Replacement poles are determined based on design criteria and current standards. Use of steel butts in high risk termite areas is encouraged. Poles are purchased already rebutted to support installation efficiency. Concrete or steel poles may also be considered however are unlikely to be cost effective in most cases.

9.6 Disposal

The disposal of poles varies depending upon the type of pole that is being disposed of. Typical methods of disposal are as follows:

- Any pole butts that have received termiticide or fungicide treatments are disposed of in accordance with health and safety and environmental legislation.
- Untreated pole sections are shredded or mulched or sent to companies that reuse and recycle timber.
- CCA treated pole sections are sent to regulated waste dump sites.
- Disposal of poles treated with now banned chemicals such as creosote and organochlorines is in accordance with current legislation.
- Steel poles are salvaged for scap material where possible or else sent to regulated waste dump sites
- Concrete poles are sent to regulated waste dump sites.

10 Program Requirements and Delivery

The programs of maintenance, refurbishment, and replacement required to outwork the strategies of this AMP are documented in Network Program Documents and reflected in corporate management systems. Programs are typically coordinated to address the requirements of multiple asset classes at a higher level, such as a substation site or feeder, to provide delivery efficiency and reduce travel costs and overheads. The Network Program Documents provide a description of works included in the respective programs as well as the forecast units.

Program budgets are approved in accordance with Corporate Financial Policy. The physical and financial performance of programs is monitored and reported on a monthly basis to manage variations in delivery and resulting network risk.

11 Summary of Actions

The following provides a summary of the specific actions noted throughout this AMP for ease of reference.

Action 6.1-1: Review inspection and replacement practices in relation to low strength poles, including consideration of pole inspector training, pole strength algorithms, risk based inspection, and suitable replacement alternatives.

Action 6.1-2: Incorporate the management of the low strength pole population into the priority of targeted line replacement programs across all regions, including consideration of geographical location to ensure appropriate management of safety risk.

Action 6.1-3: Establish appropriate reporting to monitor the performance of the low strength pole population and the effectiveness of the control measures implemented to mitigate the risk.

Action 6.2-1: Review the Energex High Risk Location Pole Nailing Strategy and establish an appropriate strategy for EQL, taking into account the modern approaches of serviceability and condition assessment.

Action 7.1-1: Establish a line refurbishment program in the Northern and Southern Regions, incorporating targeted pole replacements to mitigate the risk associated with the aging pole population.

Action 7.2-1: Review market capability for delivery of required pole volumes to meet replacement forecasts. The review should include alternate measures that might reduce the expected volumes involved, possible additional life extension methods, and mechanisms to resource required pole volumes in a sustainable way.

Action 7.2-2: Continue softwood pole trials and consider further widening across all climate and soil zones.

Action 7.3-1: Develop a methodology for forecasting the end of life of the EQL steel lattice tower population to provide visibility of forward program requirements and network risk. The methodology should be in consultation with industry partners, particularly Transmission Authorities, to leverage their expertise in the field.

Action 8.1-1: Investigate the use of Termidor termite pole treatments in urban areas as a means of reducing termite related failures and defects without impacting agricultural areas.

Action 8.2-1: Establish further research into the use of boron and the available applications to protect against soft rot in the EQL wood pole population.

Action 8.3-1: Complete the Field Mobile Computing project to align the pole serviceability algorithms between the Northern and Southern Regions and South East Region and continue the alignment of inspection processes for EQL.

Action 8.4-1: Investigate the use of composite fibre poles as an alternative to address forecast shortfalls in wood pole availability.

Action 8.5-1: Continue to investigate the viability of non-destructive pole testing and inspection technologies and sensors as an alternative to traditional inspections, in order to deliver efficiency benefits and improved risk mitigation.

Action 8.6-1: Investigate the use of technology-based solutions such as distributed generation, batteries, and isolated grids as an alternative like-for-like replacement in overhead distribution networks.

Action 9.1-1: Review and align the maintenance and replacement strategy between regions where prudent, to ensure a common approach by EQL, and ensure that industry best practice management of pole assets is maintained.

Action 9.2-1: Incorporate asset data capture processes in the new Enterprise Asset Management system and mobile inspection platforms being proposed for EQL, to ensure pole installation date is captured at the time of commissioning to improve asset data quality.

Action 9.2-2: Align and improve defect, failure, and dangerous electrical event data capture processes and reporting methodologies to ensure consistency across EQL.

Action 9.4-1: Investigate the benefits for alignment of pole inspection cycles across all regions of EQL, with consideration of impacts on inspection of associated pole top equipment and conductors. Assessment should also consider the efficiency benefits associated with the timing and coordination of routine inspection, targeted inspection, and proactive replacement programs to optimise work delivery.

Appendix 1. References

It takes several years to integrate all standards and documents after a merger between two large corporations. This table details documents authorised/approved for use in either legacy organisation (and therefore authorised/approved for use by EQL), that supports this Asset Management Plan.

Organisation	Document Number	Title	Type
Ergon Energy Energex	EPONW01 EX 03595	Network Asset Management Policy	Policy
Ergon Energy Energex	PRNF001 EX 03596	Protocol for Network Maintenance	Protocol
Ergon Energy Energex	PRNF003 EX 04080	Protocol for Refurbishment and Replacement	Protocol
Ergon Energy Energex	STNW0330 EX 03918	Standard for Network Assets Defect/Condition Prioritisation	Standard
Ergon Energy Energex	STNW1160 EX STD00299	Maintenance Acceptance Criteria	Manual
Ergon Energy Energex		Lines Defect Classification Manual	Manual
Energex	EX 00302	Overhead Design Manual	Manual
Ergon Energy Energex	EX 04920	Overhead Construction Manual	Manual
Ergon Energy Energex	NA000403R328 EX 00294	QLD Electricity and Metering Manual	Manual
Ergon Energy	EP26	Risk Management Policy	Policy
Ergon Energy	EP51	Defect Management Policy	Policy
Ergon Energy	SGNW0004	Network Optimisation Asset Strategy	Strategy
Ergon Energy	SGNW0038	Poles and Towers Inspection Strategy	Strategy
Ergon Energy	STNW0717	Standard for Preventive Maintenance Programs for 2017-18	Standard
Ergon Energy	STNW0002	Standard for inspection of Wood Poles	Standard
Ergon Energy	STNW0037	Standard for Use of Alternative Pole Types to Hardwood	Standard
Energex	00569	Network Risk Assessment	Procedure
Energex	354	Overhead Network Condition Assessment Manual	Manual
Energex	357	Wood Pole Management	Standard
Energex	369	Pole Inspection Guidelines	Guidelines
Energex	370	Pole Treatment Guidelines	Guidelines

Organisation	Document Number	Title	Type
Energex	502	Lines Defect Classification	Standard
Energex	629	Asset Inspection Tablet for Pole Inspection Use	Guidelines
Energex	958	Wood Pole Structural Analysis	Standard
Energex	WCS5.1	Work Category Specification 5.1 Poles, Inspect and Treat.	Specification
Energex	WCS12.3	Work Category Specification 12.3 Overhead Low Voltage Service Lines	Specification

Appendix 2. Definitions

Term	Definition
Condition Based Risk Management	A formal methodology used to define current condition of assets in terms of health indices and to model future condition of assets, network performance, and risk based on different maintenance, asset refurbishment, or asset replacement strategies.
Corrective maintenance	This type of maintenance involves planned repair, replacement, or restoration work that is carried out to repair an identified asset defect or failure occurrence, in order to bring the network to at least its minimum acceptable and safe operating condition. An annual estimate is provided for the PoW against the appropriate category and resource type.
Current transformer	Current transformers are used to provide/transform currents suitable for metering and protection circuits where current measurement is required.
Distribution	LV and up to 22kV networks, all SWER networks
Forced maintenance	This type of maintenance involves urgent, unplanned repair, replacement, or restoration work that is carried out as quickly as possible after the occurrence of an unexpected event or failure; in order to bring the network to at least its minimum acceptable and safe operating condition. Although unplanned, an annual estimate is provided for the PoW against the appropriate category and resource type.
Instrument transformers	Refers to Current Transformers (CTs), Voltage Transformers (VTs) and Metering Units (MUs)
Metering Units	A unit that includes a combination of both Current Transformers and Voltage Transformers for the purpose of statistical or revenue metering
PCB	Polychlorinated Biphenyls are synthetic chemicals manufactured from 1929 to 1977, and was banned for use in 1979 in transformers, voltage regulators and switches.
Preventative maintenance	This type of maintenance involves routine planned/scheduled work, including systematic inspections, detection and correction of incipient failures, testing of condition and routine parts replacement designed to keep the asset in an ongoing continued serviceable condition, capable of delivering its intended service.
Sub transmission	33kV and 66kV networks
Transmission	Above 66kV networks
Voltage Transformers	Voltage or potential transformers are used to provide/transform voltages suitable for metering and protection circuits where voltage measurement is required.

Appendix 3. Acronyms and Abbreviations

Abbreviation or acronym	Definition
AIDM	Asset Inspection & Defect Management system
ALARP	As low as reasonably practicable
AMP	Asset Management Plan
Augex	Augmentation Expenditure
CBRM	Condition Based Risk Management
CB	Circuit Breaker
CT	Current Transformer
CVT	Capacitor Voltage Transformer
DEE	Dangerous Electrical Event
DGA	Dissolved Gas Analysis
DLA	Dielectric Loss Angle
EQL	Energy Queensland Limited
ESCOP	Queensland Electricity Safety Code of Practice
ESR	Queensland Electrical Safety Regulation (2013)
HV	High voltage
IoT	Internet of Things
ISCA	In-Service Condition Assessment
LiDAR	Light Detection and Ranging
LDCM	Lines Defect Classification Manual
LV	Low Voltage
LVR	Low voltage regulator
MSS	Minimum Service Standard
MSSS	Maintenance Strategy Support System
MU	Metering Unit
MVAr	Mega-VAr, unit of reactive power
NER	Neutral Earthing Resistor
NEX	Neutral Earthing Reactor
OLTC	On-load tap -changers
OTI	Oil Temperature Indicators
PCB	Polychlorinated Biphenyls
POC	Point of Connection (between EQL assets and customer assets)
POEL	Privately owned Electric Line

Abbreviation or acronym	Definition
PRD	Pressure Relief Device
QLD	Queensland
REPEX	Renewal Expenditure
RIN	Regulatory Information Notice
RMU	Ring Main Unit
SCAMS	Substation Contingency Asset Management System
SDCM	Substation Defect Classification Manual
SFAIRP	So far as is reasonably practicable
SHI	Security and Hazard Inspection
SVC	Static VAR Compensator
SWER	Single Wire Earth Return
THD	Total Harmonic Distortion
VT	Voltage Transformer
WCP	Water Content of Paper
WTI	Winding Temperature Indicators
WTP	Wet Transformer Profile