Asset Management Plan

May 2012

ElectraNet Corporate Headquarters
52-55 East Terrace, Adelaide, South Australia 5000 • PO Box, 7096, Hutt Street Post Office, Adelaide, South Australia 5000
Tel: (08) 8404 7966 • Fax: (08) 8404 7104 • Toll Free: 1800 243 853

Copyright and Disclaimer

Revision Record

Date	Version	Description	Author	Checked By	Approved By
31.05.12	1.0	Initial Version	David Boyce Asset Strategy Manager	Michael Dobbin Senior Manager Network & Asset Strategy	Rainer Korte Executive Network Strategy & Regulatory Affairs

Contents

1. Purpose and Scope

The purpose of this Asset Management Plan is to ensure that adequate resources and systems are provided to manage the regulated transmission network in South Australia to meet the objective of delivering safe, secure and reliable transmission services to customers at the lowest long-run cost. The Plan sets out the forecast asset replacement and maintenance expenditure requirements to achieve this objective in the 5-year regulatory period from 1 July 2013 to 30 June 2018.

The Asset Management Plan is developed within a strategic planning framework that includes taking direction from an organisational asset management policy, a long term vision of the network developed in consultation with stakeholders and Board-approved strategies for network development, asset management and information technology. The strategic planning framework is described in section 2.3 of this Plan.

ElectraNet applies a risk-based approach to its decision making to achieve an efficient balance of maintaining safety, security and reliability of supply at the lowest sustainable cost.

Figure 1.1 describes the asset lifecycle activities and asset management expenditure categories covered in this plan (with the exception of network augmentation which is addressed in Regional Development Plans and the Annual Planning Report published by ElectraNet for the information of market participants and other interested stakeholders).

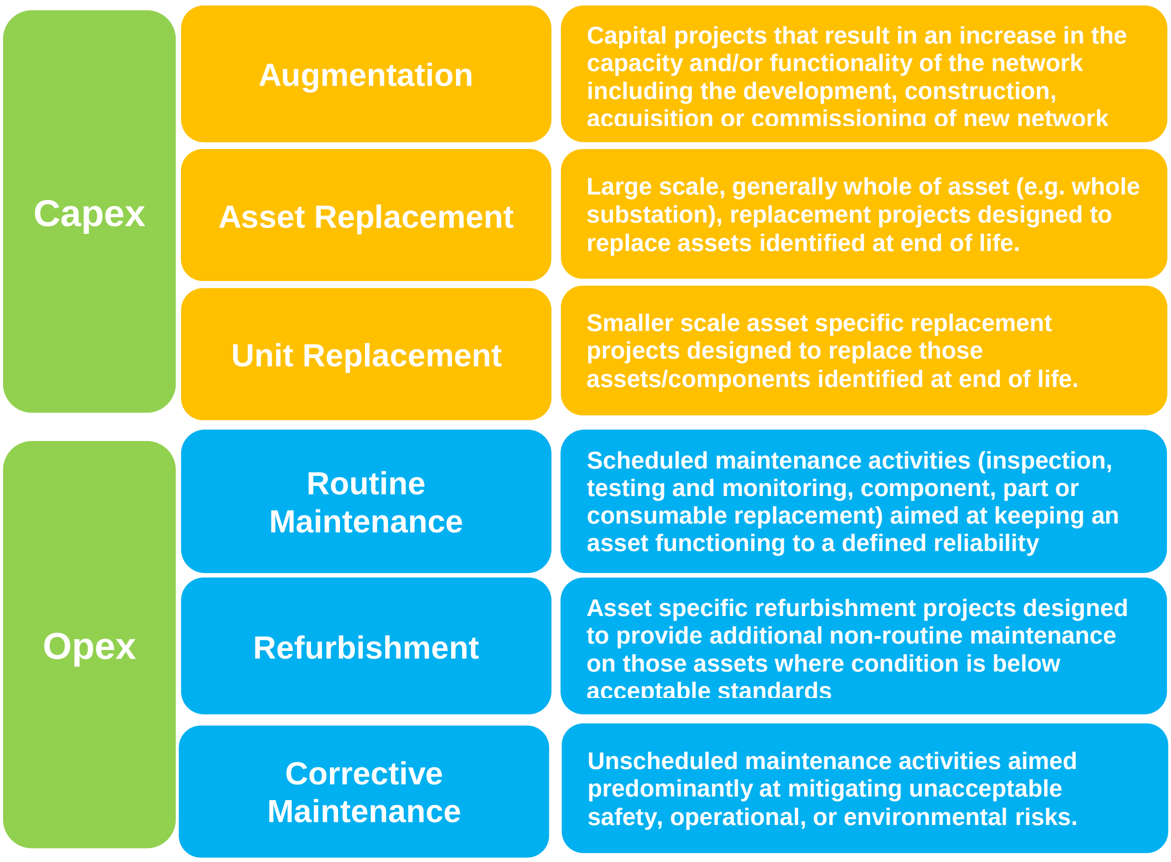


Figure 1.1: Asset lifecycle activities and expenditure categories

2. Definitions

Term	Definition
Asset Sustainability Ratio	Expresses net capital expenditure on renewal and replacement of existing assets as a percentage of the optimal level for such expenditure. A percentage less than 100 on an ongoing basis indicates that capital expenditure levels are not being optimised so as to minimise whole of life cycle costs of assets (having regard to the Infrastructure and Asset Management Plan) or that assets may be deteriorating at a greater rate than spending on their renewal or replacement.
Corrective Maintenance	Maintenance carried out after a failure has occurred, and intended to restore an item to a state in which it can perform its required function. (This may include breakdown or reactive maintenance).
Condition Based Maintenance	A maintenance technique that involves monitoring the condition of an asset and using that information to predict its failure. In other words it is preventive maintenance initiated as a result of knowledge of the condition of an item from routine continuous monitoring.
Defect	An imperfection within an asset that could potentially lead to the premature failure of the asset.
Economic Life	The length of time for which maintaining and operating the asset remains the lowest cost alternative for providing a nominated level of service.
Lifestyle Cost Analysis	A method of assessing which asset option, will be the most economical over an extended period of time.
Maintenance	Any activity performed on an asset with a view to ensuring that it is able to deliver an expected level of service until it is scheduled to be renewed, replaced or disposed of.
MGT	Mobile grazer terminal (a field data collection tool).
Network Asset	An asset that is considered to be part of a network. Network assets are interconnected assets that rely on each other to provide a service. If a network asset is removed the system may not function to full capacity.
Obsolescence	**T**he state of being which occurs when an asset is no longer wanted even though it may still be in good working order. Obsolescence frequently occurs because a replacement has become available that is superior in one or more aspects.
Operation	The act of utilising an asset. Asset operation will typically consume materials and energy.
OPSWAN	operational wide area network (the remote engineering interface to field devices)
Periodic Maintenance	Similar to, but more extensive than routine maintenance. Typically, periodic maintenance involves programmed clearing, programmed painting and programmed upgrades.
Planned Maintenance	Maintenance organised and carried out with forethought, control and the use of records to a predetermined plan.

Term	Definition
Preventative Maintenance	Maintenance carried out at predetermined intervals, or corresponding to prescribed criteria, and intended to reduce the probability of failure or the performance degradation of an item.
Proactive Maintenance	Scheduled maintenance programmed on the basis of condition data.
Reactive Maintenance	A form of maintenance in which equipment and facilities are repaired only in response to a breakdown or a fault.
Redundancy	A system in which critical components are duplicated, so that if one fails the other component can take over the function of the failed component.
Refurbishment	Works carried out to rebuild or replace parts or components of an asset, to restore it to a required functional condition and extend its life, which may incorporate some modification.
Reliability Centred Maintenance	Often known as RCM, is an industrial improvement approach focused on identifying and establishing the operational, maintenance, and capital improvement policies that will manage the risks of equipment failure most effectively
Remaining Useful Life	Estimated length of time remaining before it will need to be replaced.
Renewal	The replacement or refurbishment of an existing asset (or component) with a new asset (or component) capable of delivering the same level of service as the existing asset.
Replacement	The complete replacement of an asset that has reached the end of its life, in order to provide a similar or agreed alternative level of service
SCAR	System condition and risk (a process for assessing asset condition and associated risk)
TALC	Transmission asset lifecycle (a process for assessing asset life cycle)

3. Context

3.1 Transmission network

The regulated transmission system within South Australia consists of a 275 kV network, partially underpinned by interconnected 132 kV and 66 kV systems.

The sparse and remote nature of the country loads served by the transmission network is a significant cost driver for ElectraNet's business. The resulting network topology has a high degree of "radialisation" which can make attaining high levels of reliability challenging.

More detailed information about the transmission network can be found in the South Australian Annual Planning Report[1].

[1] Available at www.electranet.com.au

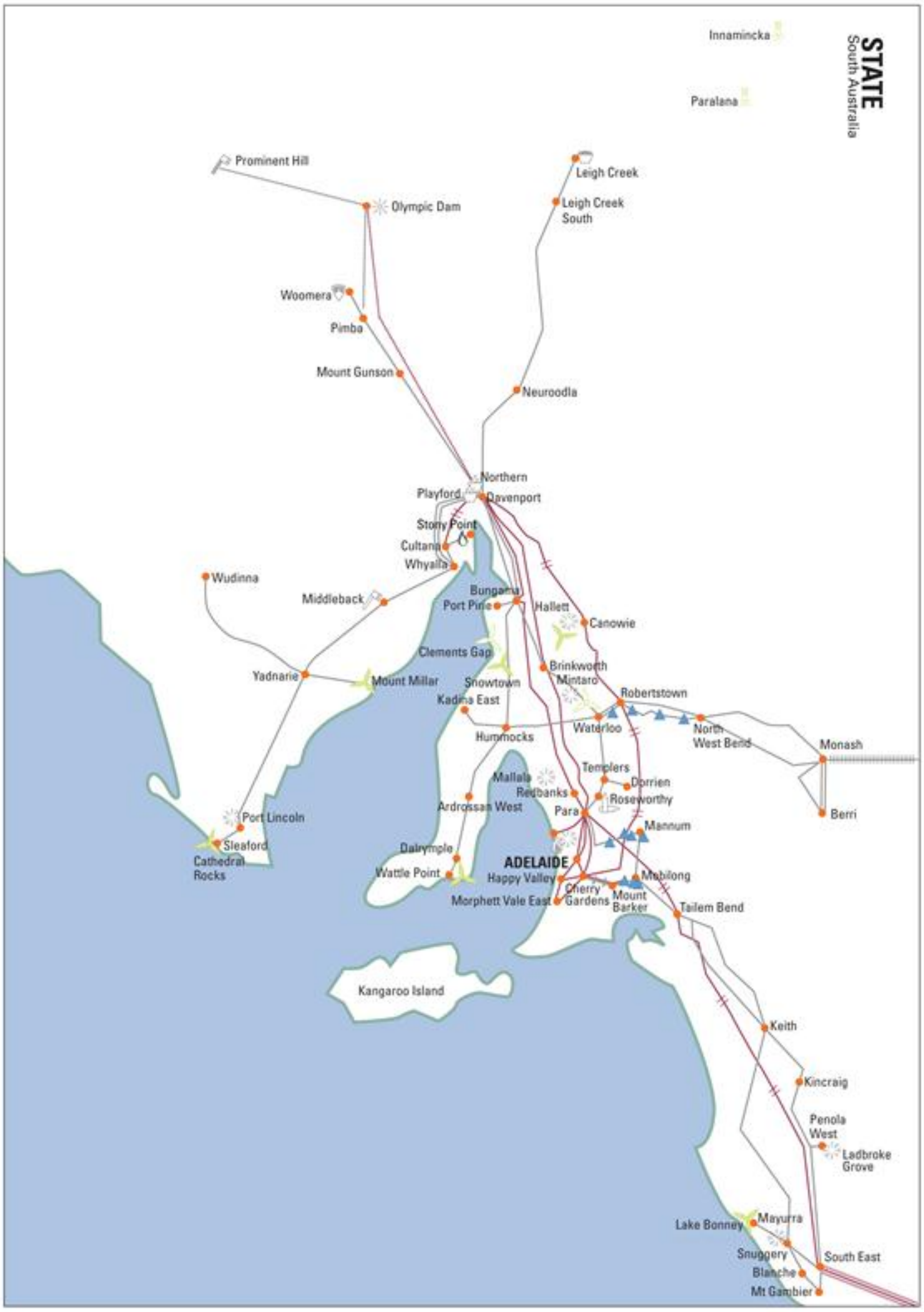


Figure 3.1: ElectraNet Transmission System Map

3.2 The regulatory framework

The Electricity Act 1996 (and regulations) and the National Electricity (South Australia) Act 1996 (and the National Electricity Law and National Electricity Rules made under that Act), together with the Essential Services Commission Act 2002, provide the basis for regulation of the electricity supply industry in South Australia.

The National Electricity Objective, as stated in the National Electricity Law is:

to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –

1. *Price, quality, safety, reliability, and security of supply of electricity; and*
2. *Reliability, safety and security of the national electricity system.*

ElectraNet is committed to achieve sustainable long-term performance in relation to the following objectives;

- Delivering a safe and reliable supply of electricity to customers and the community;
- Delivering transmission services to customers at lowest long-run cost;
- Meeting statutory obligations under the National Electricity Rules, Electricity Transmission Code and other relevant Legislation; and
- Providing fair and reasonable returns to shareholders.

3.3 Strategic planning framework

The Asset Management Plan is developed within a strategic planning framework illustrated in Figure 3.2.

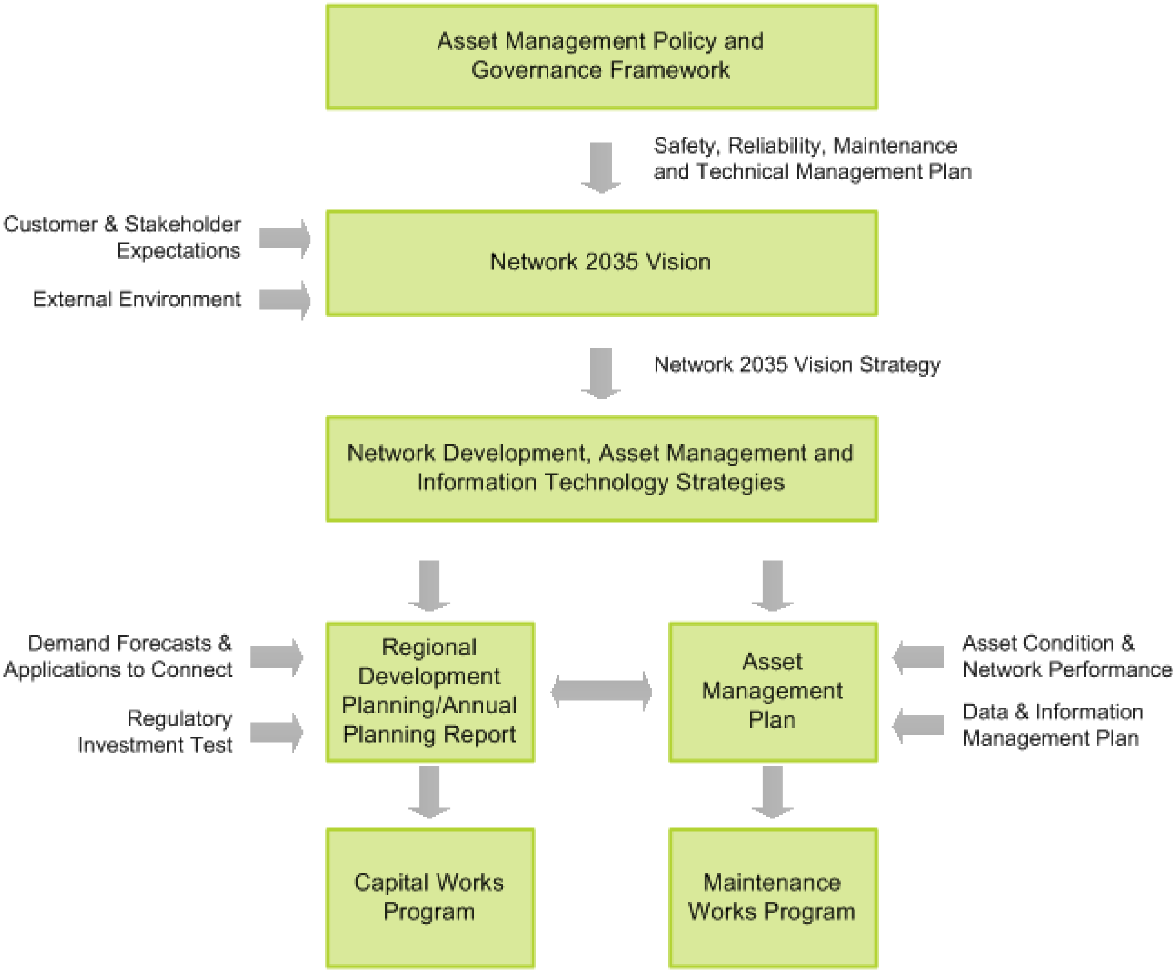


Figure 3.2: Asset Management Planning Framework

Table 3.1 describes the key asset management planning documents that are developed within this strategic planning framework.

Table 3.1: Asset Management Planning Documents

Document	Description	Approval by
Asset Management Policy	An organisational policy that sets out ElectraNet's asset governance framework and gives direction to operational policies and procedures used in the broader business to manage transmission network assets and deliver safe, secure and reliable transmission services to customers at lowest long-run cost. The policy also sets out ElectraNet's commitment to continuous improvement in asset management.	Management in consultation with the Board
Network 2035 Vision	A long term vision of the network developed in collaboration with stakeholders that sets out a framework for development of the transmission network over the long-term. The Vision includes a set of guiding principles that guide integrated decision making on the management and development of the transmission network.	Board
Network 2035 Vision Strategy	Sets out the framework for implementation of the Network 2035 Vision, the guiding principles and the resulting strategic priorities in the forecast regulatory period.	Board
Network Development Strategy	Sets out the strategic priorities for network development in the forecast regulatory period and how ElectraNet plans to deliver on these priorities.	Board
Asset Management Strategy	Sets out the strategic priorities for asset management in the forecast regulatory period and how ElectraNet plans to deliver on these priorities.	Board
Information Technology Strategy	Sets out the strategic priorities for information technology to support the delivery of transmission services in the forecast regulatory period and how ElectraNet plans to deliver on these priorities.	Board
Annual Planning Report	The medium to long term network development plan for the South Australian transmission network that is published for the information of market participants and other interested stakeholders. The Annual Planning Report is supported by a Telecommunications Development Plan.	Management
Asset Management Plan	The plan that sets out the asset management framework over the medium to long term and specific asset plans for substation, transmission line and telecommunication assets.	Management

Document	Description	Approval by
Safety, Reliability, Maintenance and Technical Management Plan (SRMTMP)	This plan is maintained as a condition of ElectraNet's transmission licence and demonstrates that ElectraNet has management practices in place to ensure: • the safe design, installation, commissioning, operation, maintenance and decommissioning of electricity infrastructure owned and/ or operated by ElectraNet; • that ElectraNet complies with the safety and technical requirements imposed by or under the applicable legislation, codes and licenses; and • that ElectraNet complies with good electricity industry practice. ElectraNet's compliance with the SRMTMP is subject to an annual audit requirement.	Essential Services Commission of South Australia on recommendation of the Technical Regulator

The Asset Management Plan should be read in conjunction with the other key asset management planning documents described above.

3.4 Transmission network assets

3.4.1 Substations

Substation assets include both substation plant and secondary systems assets with a total replacement value of approximately $2bn. ElectraNet operates and maintains 86 substations, which include 10,673 MVA of installed transformer capacity. Substation assets are summarised by voltage level in Table 3.2.

Table 3.2: Summary of Substation Assets

Voltage Substations	Number of Substations	Number of CBs	Number of Transformers	MVA
275 kV	28	181	42	7,557
132 kV	55	194	104	3,116
66 kV	3	66	0	0
Total	86	441	146	10,673

There are a range of equipment types in each asset category. Recent asset replacement and augmentation projects have introduced a significant number of new assets in the early life phase with transformers and isolators representing assets with a greater population towards end of life.

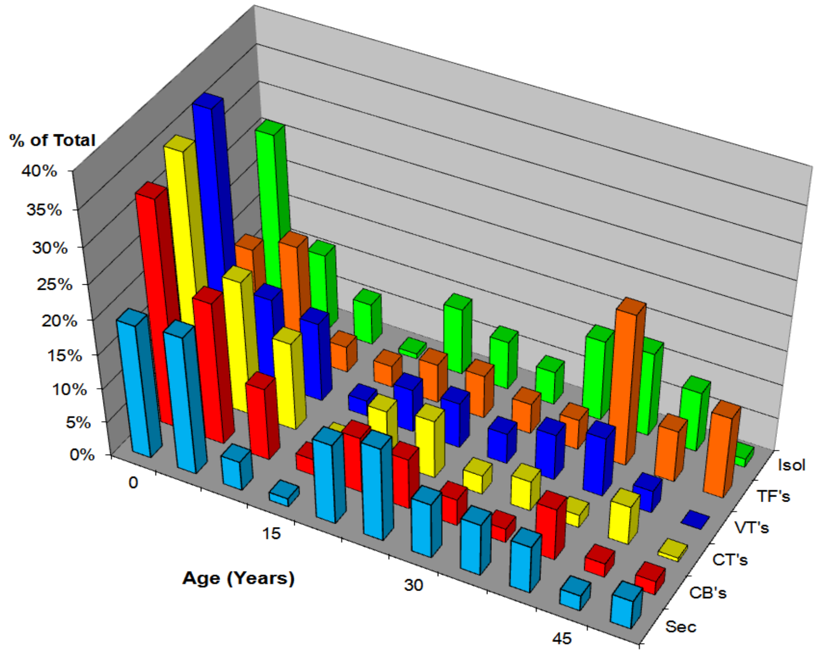


Figure 3.3: Substation Primary Plant Asset Profile

3.4.2 Substation asset sustainability

In order to assess the adequacy of asset replacement over the asset lifecycle the substation asset renewal profile (based on an average technical life of approximately 45 years) is modelled below. The capital expenditure profile for asset replacement is compared with actual and planned replacement programmes.

The profile below shows, that apart from some differences in timing, actual and planned replacement has been will be adequate based on forecast expenditure levels to sustain the asset and network reliability (i.e. the replacement profile, based on the current understanding of end of technical life of the assets shows that the overall level of replacement is reasonable as indicated by the overlapping profiles).

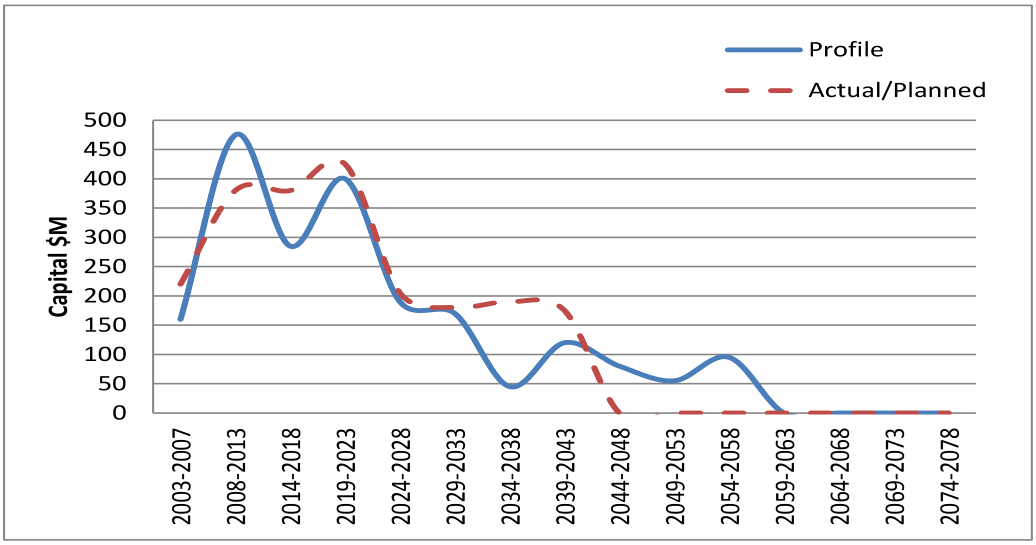


Figure 3.4: Substation Asset Replacement Capital Profile

3.4.3 Transmission lines

The transmission network consists of approximately 5,600 circuit kilometres of transmission lines that operate at nominal voltages of 275 kV, 132 kV and 66 kV with a total replacement value of approximately $3.5b. The length of lines for each voltage is given in Table 3.3.

Table 3.3: ElectraNet - Transmission Line Summary

Transmission Lines	
275 kV ElectraNet Feeders (Number)	41
132 kV ElectraNet Feeders (Number)	66
66k V ElectraNet Feeders (Number)	11
Total No. of ElectraNet Feeders	**118**
275 kV Circuit Length (km)	2,543
132 kV Circuit Length (km)	3,005
66 kV Circuit Length (km)	23
Total Circuit Length of ElectraNet Lines (km)	**5,572**
Route Length of Single Circuit Pole Line (km)	1,212
Route Length of Double Circuit Pole Line (km)	279
Route Length of Single Circuit Tower Line (km)	2,132
Route Length of Double Circuit Tower Line (km)	995
Route Length of Triple Circuit Pole Line (km)	24
Route Length of UG Cable (66, 132 & 275kV) (km)	28
Total Route Length of ElectraNet Lines (km)	**4,670**

132 kV transmission lines represent the majority of higher age profile assets.

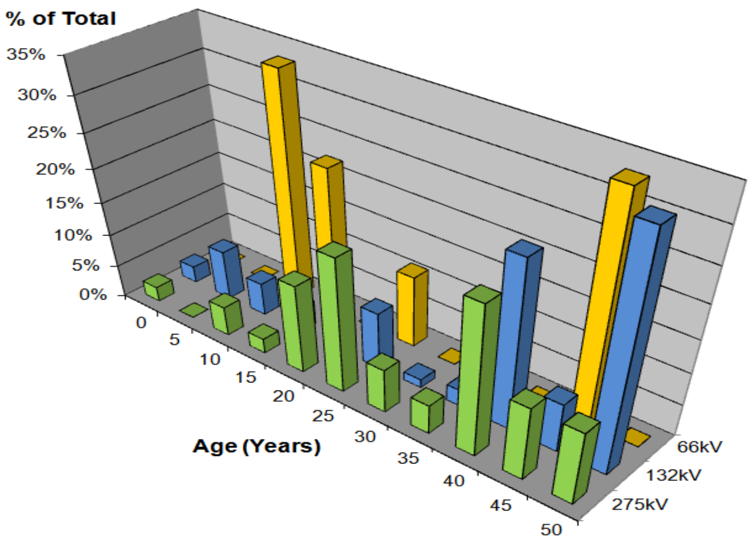


Figure 3.5: Transmission Line Asset Profile

3.4.4 Transmission line asset sustainability

In order to assess the adequacy of replacement and renewal over the asset lifecycle the transmission line asset renewal profile is modelled below. The capital expenditure profile for asset replacement is compared with actual and planned replacement programmes.

The figure indicates that transmission line asset replacement planning is required from approximately 2025 (based on indicative assumptions) in order to adequately sustain the asset. The current asset management plan is based on a program of transmission line component refurbishment in order to manage those elements of the transmission line asset with shorter life cycles.

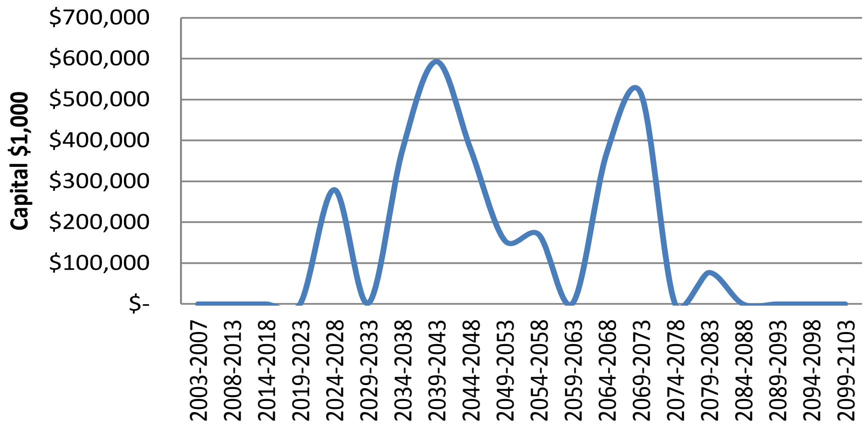


Figure 3.6: Transmission Line Asset Replacement Profile

3.4.5 Telecommunications

ElectraNet operates a substantial telecommunications network (estimated replacement value $75m) for the operational support of the electricity transmission system. The telecommunications network requires a level of availability adequate to meet the objective of providing efficient transmission services to customers and the meet the operational requirements of the power system.

The predominant services carried are:

- Protection and control signalling
- Data links for SCADA/RTU connections
- Operational speech services
- Network weather data

The infrastructure of the network consists of:

- Radio links (digital PDH)
- Power line carrier (analogue and digital)
- Fibre optic cable (predominantly OPGW)
- Pilot cable (owned by others - with and without digital multiplexing)

Table 3.4: Communications Sites & Weather Stations

Telecommunications Statistics	
ElectraNet sites	37
Other Sites used by ElectraNet	20
Total Sites	**57**
Weather Station Statistics	
ElectraNet Weather Station Sites	26

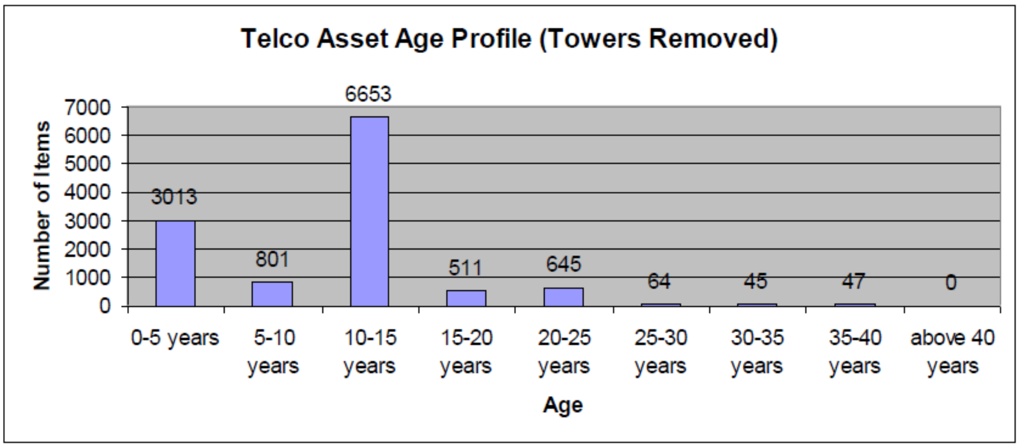


Figure 3.7: Telecommunications Asset Profile

3.5 Transmission network performance

The transmission network is a single entity made up of many network assets. The relationship between transmission network performance and network assets is the basis for understanding the threshold for unacceptable asset performance.

3.5.1 Asset reliability

As the transmission network is an interconnected meshed network with some radial connections, where radial connections are generally relatively small loads:

- Single asset failures in most cases do not directly materially affect transmission performance indices;
- Single asset failures may expose the network to significant risk of constraint or load shedding considering the next contingency;
- Multiple, coincident asset failures are likely to affect performance indices as they will involve the loss of more than one element of the network.

Considering the above it may be concluded that:

- Transmission network performance indices are lagging indicators of asset reliability (that is, asset performance has deteriorated across a range of assets before a material impact is evident);

- The threshold for unacceptable asset risk is aggregate asset reliability where coincident asset failure is becoming likely;
- The ability to quickly restore the network following an asset failure is increasingly critical in order to minimise exposure to next contingency events particularly in more heavily loaded sections of the network;
- It is possible to effectively operate and maintain the network with a number of unreliable assets however at some point aggregate unreliability will affect network performance as well as long run asset maintenance effort and associated cost.

The Asset Management Plan is based on:

- Understanding asset risk in order to manage exposure to aggregate asset unreliability, coincident asset failure and associated long run maintenance effort and cost;
- Developing network control and protection assets to provide levels of response that support remote fault diagnosis and restoration in order to meet required levels of performance.

3.5.2 Performance metrics

Network performance measures used for asset management purposes are the number of system events with loss of customer load of greater than 0.2 and 1.0 system minutes.

Performance profiles based on these two indicators are shown in Figure 3.8 and Figure 3.9 to identify emerging trends.

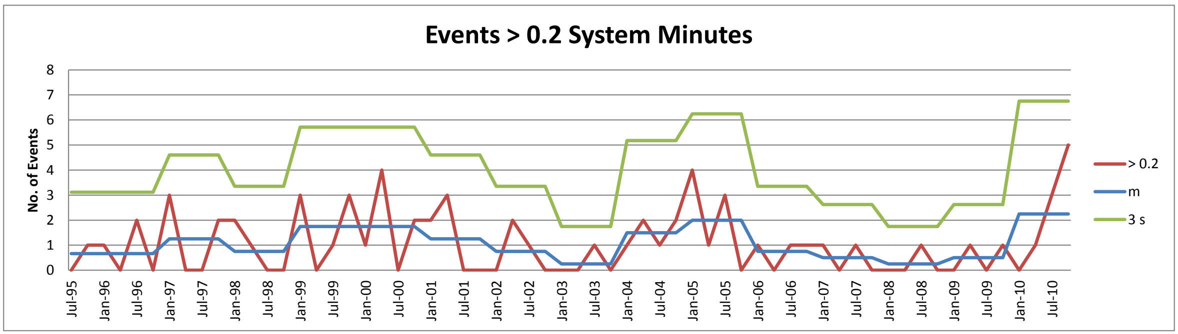


Figure 3.8: ElectraNet – Number of LOS Events Greater Than 0.2 System Minutes

Figure 3.8 shows Network Events >0.2 System Minutes since 1995, including the annual mean and three standard deviations plots. It shows a recently increasing trend. In 2010, a number of events were driven by severe storm activity impacting on the Eyre Peninsula transmission system. An investigation of line reliability and performance is currently underway with the aim of improving lightning protection of the effected line.

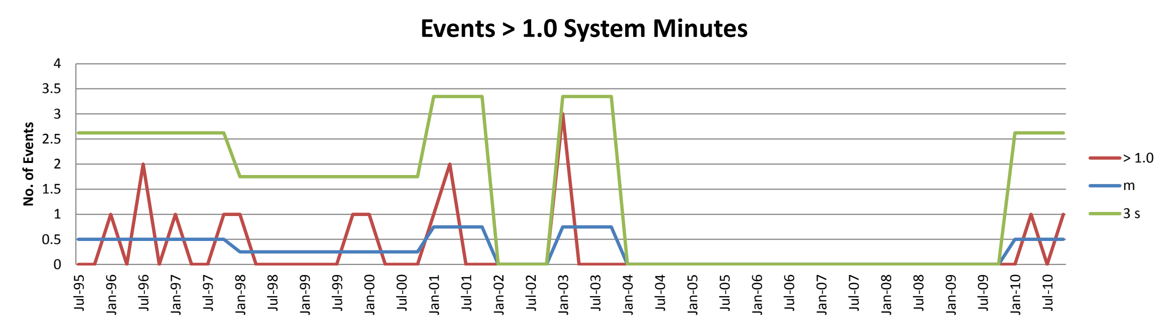


Figure 3.9 ElectraNet - Number of LOS Events Greater Than 1.0 System Minutes

Two > 1.0 system minute events shown in 2010 are also related to transmission line outages following storm activity (one event related to Eyre Peninsula, the other to the non-regulated Olympic Dam 275kV transmission line[2]). Time taken to respond to the outages has resulted in the >1.0 system minute event.

Plant Events are defined as equipment failures that result in a protection system operation on the network, which may or may not result in lost customer load. Figure 3.9 shows the number of plant events as well as the annual mean and three standard deviations for the trend. The plant events indicator reflects more general asset performance issues and shows a generally consistent trend during the previous two regulatory periods.

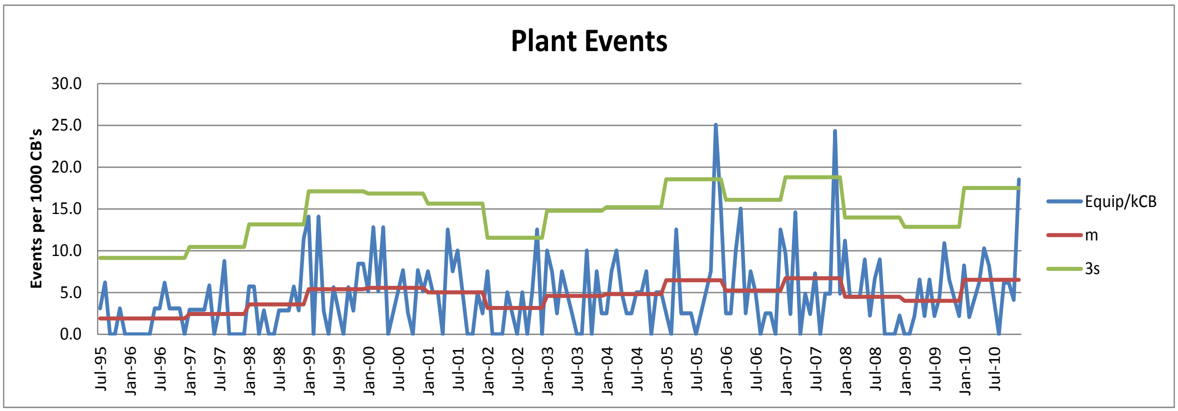


Figure 3.10: Number of Asset (Plant Failure) Events

Plant events by category are shown in Figure 3.11. A large percentage of plant events result from equipment mal-operation (e.g. related to configuration management and performance of control and protection systems). The increasing trend in 2010 is driven by an increasing rate of mal-operations and communication system faults. Improved device configuration management systems and processes have been identified to address the root cause of this problem.

[2] Response determined by the asset owner BHP Billiton

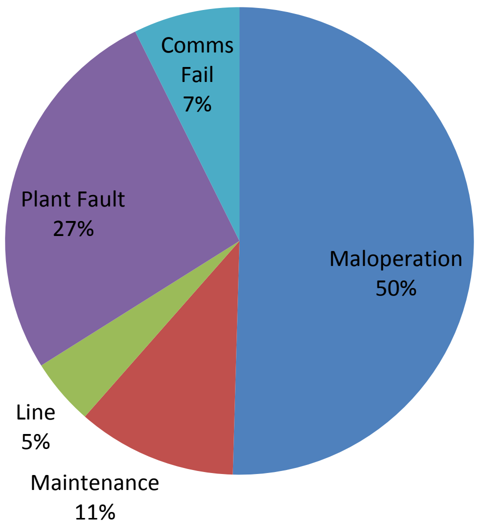


Figure 3.11: Plant Events 2007 - 2010

3.6 ElectraNet business model

In accordance with its obligations under the National Electricity Rules and associated South Australian legislation, ElectraNet operates and maintains the Transmission Network as well as planning and managing the medium to long term development and replacement of the Network and associated network assets.

Asset management functions are carried out internally, based on information relating to asset condition, performance and capacity. All field work (construction and maintenance) is outsourced to construction and maintenance service providers. A key aspect of the ElectraNet business model for asset management is that planning and decision making processes are remote from the assets and that decisions are based on information gathered by service providers. The business model is outlined in Figure 3.12.

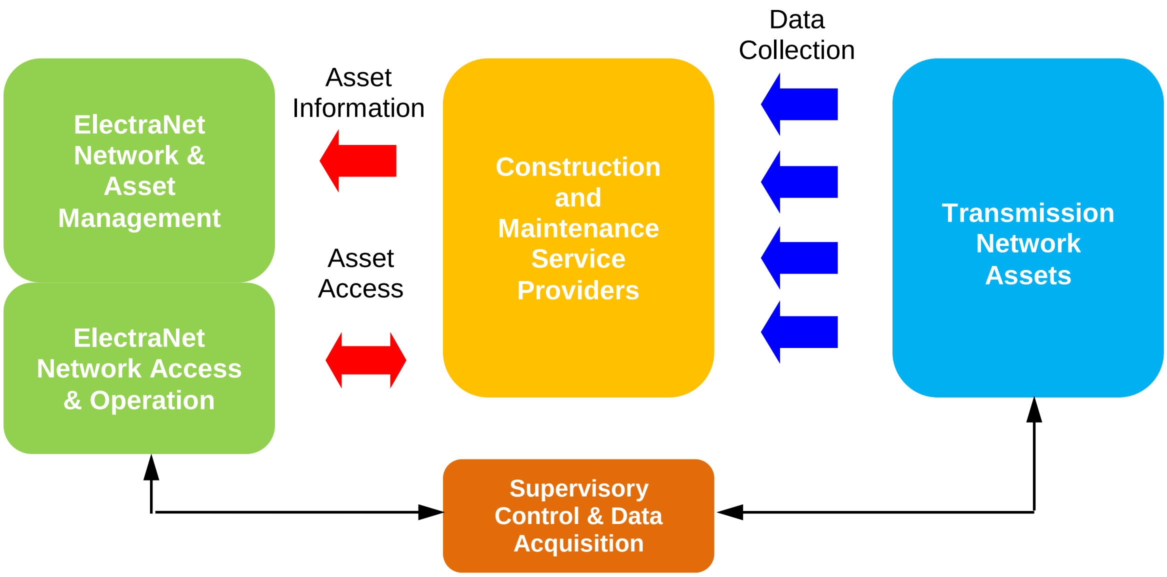


Figure 3.12: ElectraNet Business Model

A key aspect of the model is:

- Data is generated/collected by the service providers;
- Data is provided directly to ElectraNet's Asset Management System (SAP is the Asset Management System);
- There is an expectation that the service provider has the capacity to interpret asset condition in the process of collecting asset data.

All asset management decisions are made on the basis of data and information provided by service providers. ElectraNet recognises that asset data is in fact an asset in its own right and it is, therefore, important that the integrity of data collection is a key focus of the Asset Management Plan.

3.7 Previous regulatory period

This Asset Management Plan builds on the previous plan that has applied in the 5-year regulatory period from 1 July 2008 to 30 June 2013.

3.7.1 Asset data collection and analysis processes

Development of the Asset Management Plan relies upon collections of data and information accumulated over the life of the asset which may in some cases exceed 50 years. Ultimately the quality of the plan and its recommendations depends on underlying data and information.

> *Good asset management needs to manage the risks associated with incomplete and inaccurate data and disparate systems whilst still facilitating investment decisions that are as effective as possible.*[3]

In developing plans that effectively balance risk and investment, questions such as the following are typical:[4]

- *"What is the residual life of aged asset populations?"*
- *"Are remedial measures available which would extend the life and if so for what cost and for what benefit in terms of years of life extension?" or*
- *"If existing maintenance practices and costs are continued, what failure rates can be expected and therefore what investment in spare components will be needed?"*

This Asset Management Plan is based upon significant improvements to underlying asset management systems that improve the effectiveness of the plan by:

- Providing asset condition data based on documented inspection guidelines in order to maintain consistency and integrity of the data;
- Linking defect management to a documented risk management framework;
- Improving asset condition inspection and life cycle analysis;

[3] Asset Management of Transmission Systems and Associated CIGRE Activities (Working Group C1.1 December 2006) page 12

[4] Asset Management of Transmission Systems and Associated CIGRE Activities (Working Group C1.1 December 2006) page 7

- Defining and applying asset end of life assessment criteria.

Improvement to asset data and information is an ongoing process. This plan represents the outcome of improvement work conducted in the regulatory period from 2007-08 to 2012-13. Data and information is more mature in some areas compared to others, for example:

- Collection and classification of substation asset defect data is well advanced due to the relatively short maintenance inspection cycle;
- Collection and analysis of transmission line condition information is in earlier stages due to the long inspection cycles associated with these assets (note acceleration of inspection programmes has been applied where possible, however this data and process is less mature than substations).

Development of the Plan is based on the following specific work undertaken to improve asset data collection and analysis processes during the 2007-08 to 2012–13 regulatory period:

SAP Asset data improvement

- Improved quality of Asset Condition Data and Information;
- The establishment of improved field data collection tools and process;
- Revision of Asset Management Policy and Procedure to support improved data collection and analysis.

Improved risk management

- Defined response criteria for asset defects based on a documented risk framework;
- Verification of transmission line easement vegetation profiles;
- Verification of transmission line ratings.

Improved condition assessment

- Development and implementation of transmission line and substation condition assessment guides;
- Development and implementation of transmission line component condition assessment and testing.

Transmission Asset Life Cycle analysis

- A framework for assessing overall asset condition (health) of transmission assets during the asset life cycle.

3.7.2 Managing substation risk

A key focus of the Asset Management Plan for the regulatory period from 2007-08 to 2012-13 was managing substation asset risk. Key objectives were to:

- Manage asset risk in order to limit further increase in maintenance effort and associated aggregate asset reliability risk;
- Implement substation routine maintenance plans based on industry best practice;
- Improve overall network functionality by replacing substation secondary systems with digital control and protection schemes and deployment of OPSWAN;
- Meet the requirements of the SA Transmission Code (augmentation of some sites was required to meet new code requirements);
- Replace substation assets where unacceptable levels of asset safety or defect performance were identified; and
- Undertake planned maintenance on asset types not previously covered by the maintenance plan for substation plant.

In this period implementation of improved asset inspection and data collection processes, increases to planned maintenance and replacement of poorly performing assets has produced a clearer understanding of substation asset performance and future asset risk.

Based on the asset information now available substation asset risk is more fully understood and this provides the basis for future risk mitigation work (corrective maintenance, opex refurbishment and capex asset replacement).

3.7.3 Transmission lines

The focus of the Asset Management Plan in relation to transmission lines was to transition from defect inspection to condition based maintenance of transmission lines. Key objectives were to:

- develop and implement condition based maintenance plans for transmission lines based on industry best practice;
- undertake condition assessment of high risk lines;
- improve understanding of transmission line asset life cycle analysis.

In this period implementation of condition based maintenance, detailed condition assessment of high risk lines and application of structured life cycle analysis has revealed an increasing requirement for transmission line refurbishment projects.

Due to long inspection cycles the full extent of transmission line risk and associated mitigating strategies will not be fully understood until well into the 2013-14 to 2017-18 regulatory period.

3.7.4 Network 2035 Vision

The Network 2035 Vision and guiding principles have been developed to provide the guiding framework for development of the Asset Management Strategy and this Asset Management Plan.

An external environment study and an associated risk analysis were undertaken in the development of this Vision. A key outcome of this analysis is that the future environment will be more dynamic and less stable in nature leading to greater uncertainty in forward planning.

The Network 2035 Vision is for ElectraNet to own and operate a modern network which:

- Has the optimised balance of lowest whole of life cost against net long term benefits;
- Has an optimum network topology whilst leveraging current voltage levels;
- Is capable of handling dynamically changing power flow directions;
- Comprises assets that are flexible, modular and plug in/plug out;
- Can operate all primary assets to thermal limits;
- Has full remote monitoring and control of all assets;
- Requires minimal maintenance;
- Achieves continual quality of supply improvements;
- Minimises environmental impact; and
- Is not reliant on any particular maintenance, construction or equipment provider.

The external environment study and an associated risk analysis undertaken in the development of this Vision have also indicated a need to improve data and information management systems supporting the following aspects of asset management:

- Operating Manual (process safety);
- Device configuration and security management;
- Training and competency assessment;
- Outage management;
- Transmission line rating;
- Transmission line asset inspection; and
- Telecommunications network performance.

This Asset Management Plan and the accompanying Data and Information Management Plan recognise and address the identified need for improved data and information management systems.

4. Asset Management Fundamentals

4.1 Asset management overview

In general all assets exhibit asset life behaviours that form the basis for critical asset management decisions, these are:

Potential Failure - Condition of the asset changes (slow deterioration) to a point where resistance to failure is compromised (a potential failure)

Functional Failure - Condition of the asset continues to change following a potential failure (the rate of change is dependent on a wide range of internal and external factors) to a point where failure occurs (functional failure)

End of Technical Life – Condition of the asset and external supporting frameworks (for example availability of spare parts, technical obsolescence, operational performance) continue to deteriorate to a point where it is no longer fit for purpose (end of technical life). End of technical life may be reached before reaching functional failure.

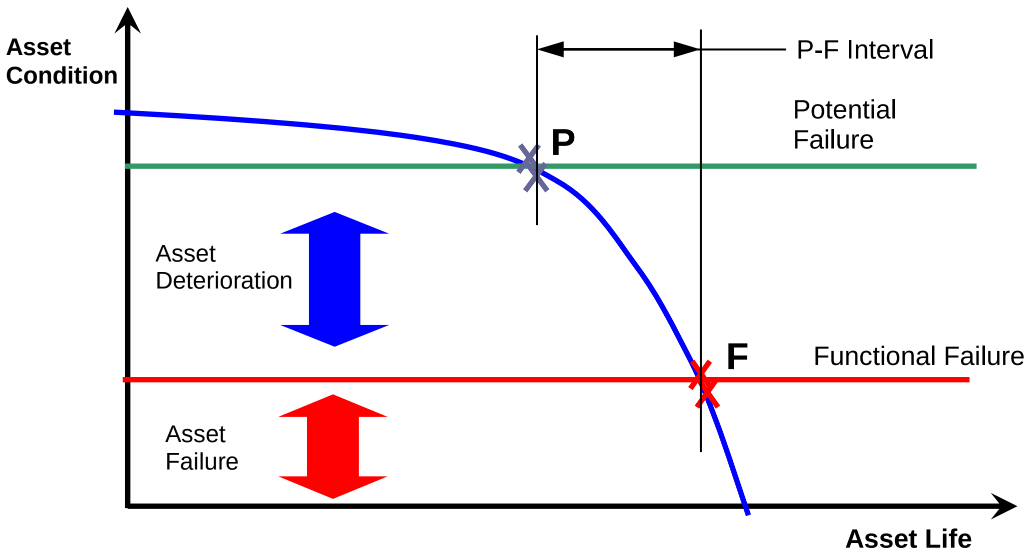


Figure 4.1: Asset Life Condition Curve

Note:

- The time taken to cross the P-F interval varies widely depending on factors both internal and external to the asset
- The shape of the curve is indicative only and will vary widely.

Entering the asset "end of technical life" period is not usually defined by a single event but rather is the culmination of a number of unrelated and independent events, these events are time driven.

While the culmination of these end of life events may not in itself result in the catastrophic failure of the asset, there is a significant risk that, in conjunction with a broad enough group of assets in a similar time condition, failure of fitness for purpose will decrease performance and increase unit costs. A typical asset end of life profile is developed below.

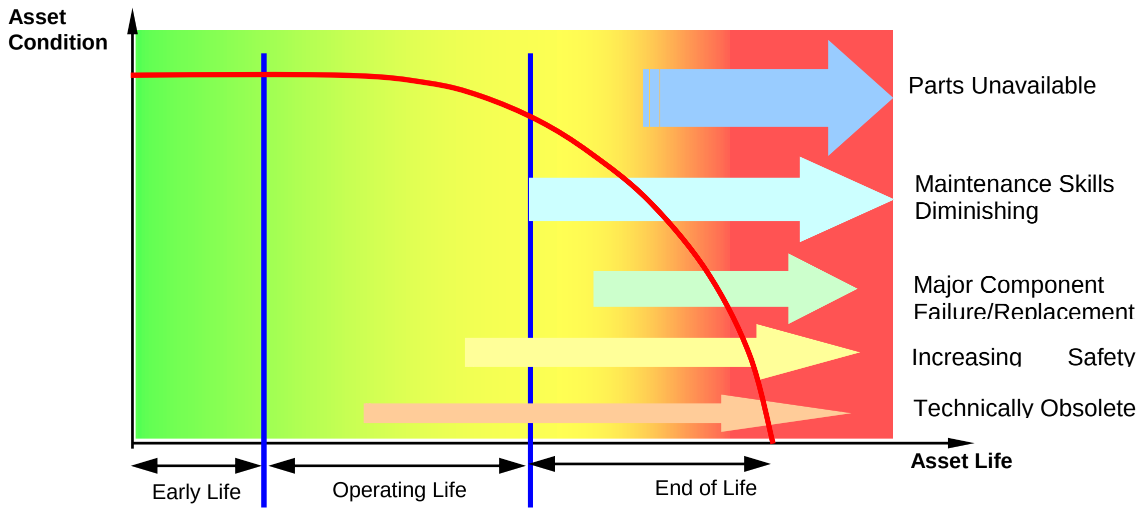


Figure 4.2: Asset End of Life Profile

The primary purpose of the asset management process is to manage the asset life cycle by:

- Understanding the P-F interval for each asset (or at least discover assets within the P-F interval with time to intervene before the failure point is reached);
- Understanding asset condition and the remaining life of the asset;
- Understanding asset failure modes and their consequences; and
- Determining the most appropriate response to changing asset condition in order to appropriately manage cost and risk.

4.2 Managing the asset life cycle

A combination of routine and defect maintenance responses are used to manage the asset lifecycle:

- Routine and Condition Based Maintenance plans have been developed based on manufacturer's recommendations and reliability centred maintenance (RCM) analysis – ideally the routine maintenance plan would maintain all assets at the point just prior to potential failure;
- Defect Maintenance is ideally responding to assets within the P-F interval and to gain information that may allow cost effective improvement to routine or condition based maintenance;
- Refurbishment Projects are planned where the most cost effective manner of dealing with deterioration of a group of assets is to perform additional one off refurbishment; and

- Condition Monitoring is used to track the rate of deterioration and provide the basis for asset condition assessment.

SAP is the asset management system used to collect, manage and analyse all asset maintenance, defects and response, the figure below shows the relationship of the asset life cycle to maintenance response and SAP data collection.

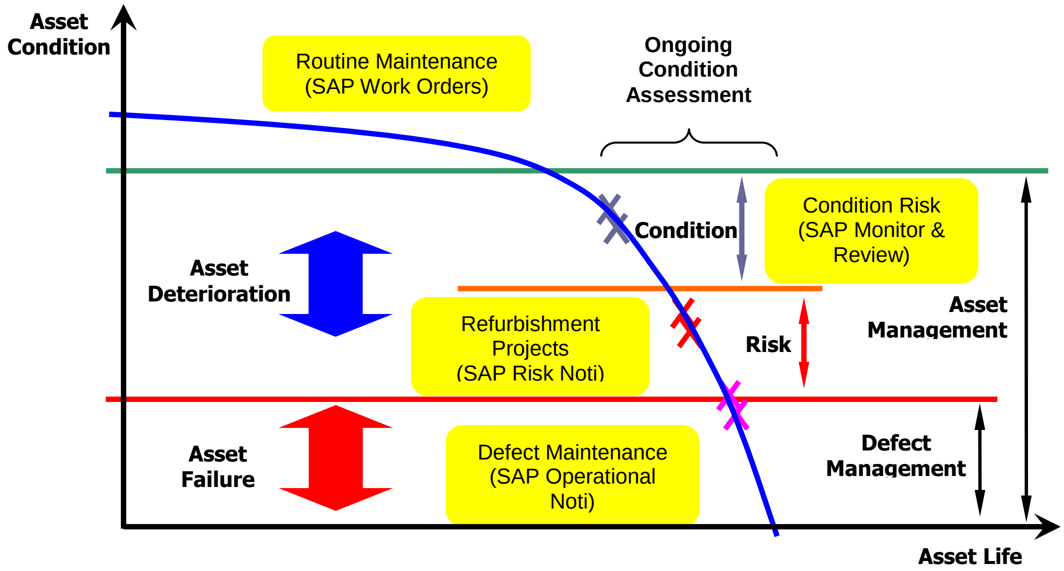


Figure 4.3: Managing the Asset Life Cycle

4.3 Understanding asset end of life

Traditionally Transmission Network Service Providers (TNSP's) have not developed a well-defined understanding of transmission asset end of technical life as:

- The vast majority of world-wide transmission assets are only now reaching the end of their technical and economic lives, therefore relevant statistical data and experience is still to be gained;
- Transmission equipment by its nature operates infrequently, which inherently limits the ability of TNSP's to collect statistically valid reliability and performance data;
- In high growth areas, TNSPs have focussed on managing rapid demand growth, which has led to augmentation works replacing equipment populations before they reached end of life.

As a result, there are no universally understood or agreed measures of transmission equipment reliability on which to base equipment replacement decisions.

ElectraNet has developed the Transmission Asset Life Cycle (TALC) assessment framework to provide an indicator of asset health and beginning of the end of life phase of the asset life cycle. TALC is a combination of the technical health of the asset and its strategic importance in the network (related to the value of load at risk).

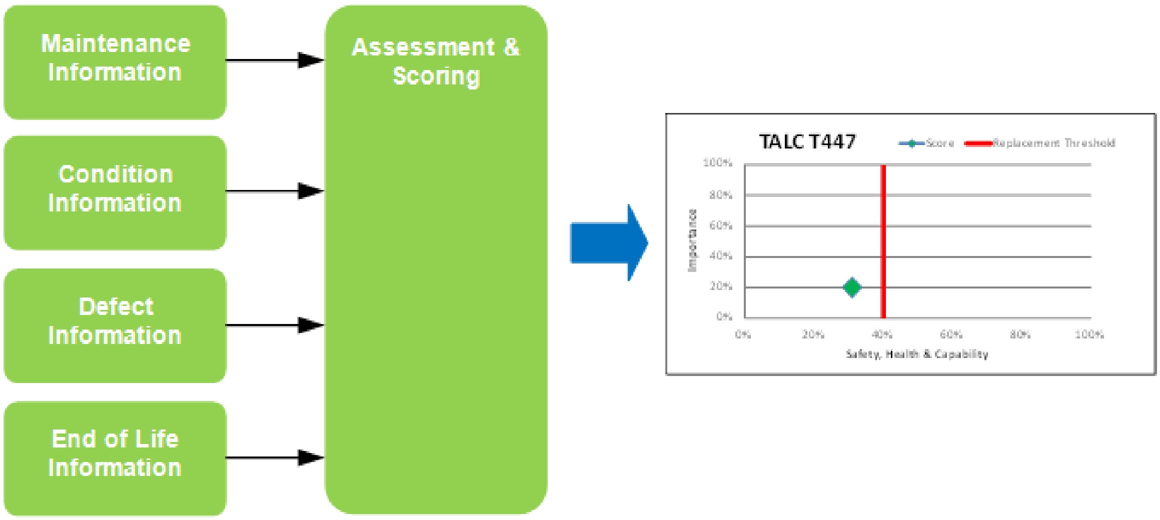


Figure 4.4: TALC Assessment Framework

4.4 Failure modes and consequences

Each asset may have more than one failure mode which means there may be multiple P-F intervals relating to an individual asset. Similarly each of these failure modes will have different failure rates and consequences. A different response is required for the range of possible failures and associated consequences.

ElectraNet has developed System Condition and Risk (SCAR) assessments of all common failure modes for substation and transmission line assets in order to define the most likely consequence and, therefore, the required response time and effort (cost) to address asset defects. Asset defects are categorised by consequence as follows:

- Sudden, very short time frame failures (in most cases the prime consequence is safety or environmental impact);
- Failure rates less than 12 months (the prime consequence is most likely to have an operational impact);
- Failure rates exceeding 12 months (usually associated with eventual failure of the asset).

Combinations of these consequences can exist for a single failure mode.

The risk profile developed by application of SCAR coding of defects is a leading indicator of future network reliability and availability.

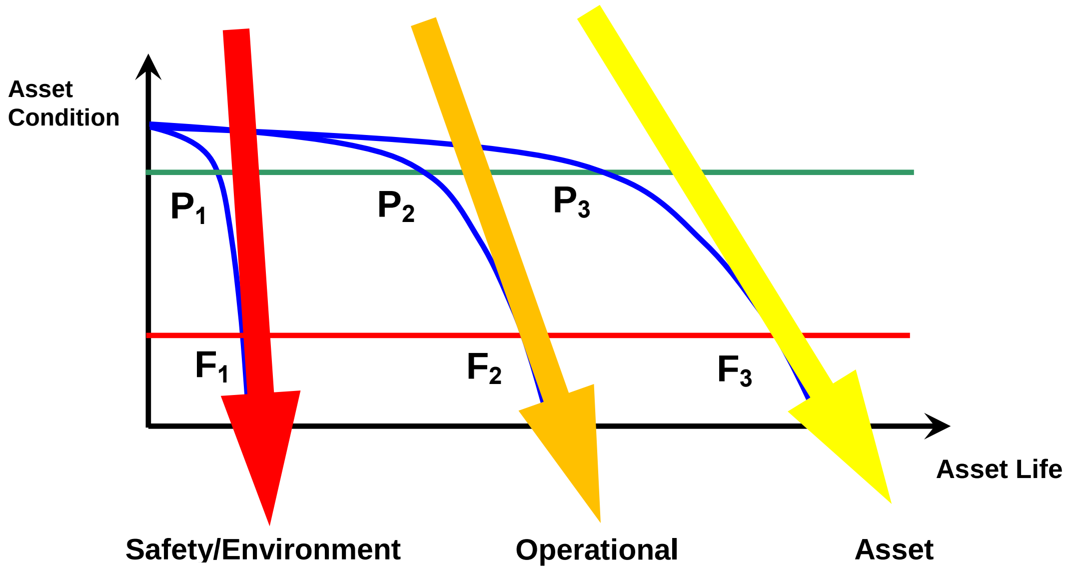


Figure 4.5: Asset Failure Basic Consequences

4.5 Asset management response

The aim of asset management is to maintain required levels of performance with the lowest possible long run maintenance effort (unit cost). Influences impacting asset performance/condition and cost are shown in the figure below and may be summarised as follows:

- Asset Deterioration represents changes in asset condition that eventually lead to higher cost and decreasing performance;
- Routine Maintenance is designed to counteract the effects of deterioration of the asset – ideally this is the most efficient response and should match asset condition;
- Asset Refurbishment is used to re-set asset condition (where routine maintenance is not adequate by itself) to a point where cost and performance are acceptable and routine maintenance will then be effective;
- Defect Maintenance is a reactive response to impending asset failure, it is the least efficient response and if allowed to dominate will lead to increasing unit cost and poor performance.

Ongoing efforts to improve efficiency in all maintenance activities will over time improve unit cost.

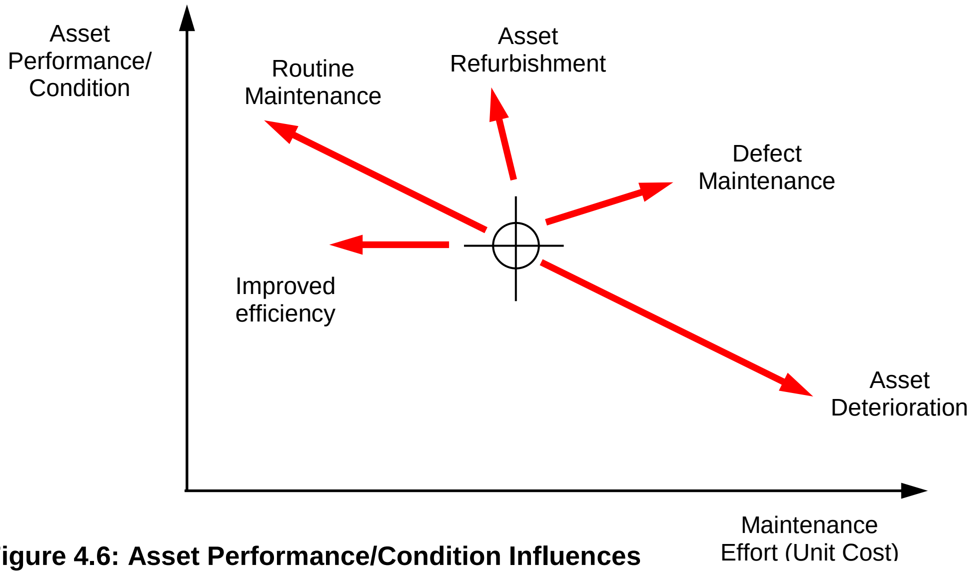


Figure 4.6: Asset Performance/Condition Influences

As the asset moves through its lifecycle the relative effectiveness of maintenance on the asset changes. Therefore, maintenance decisions change as represented in Figure 4.7.

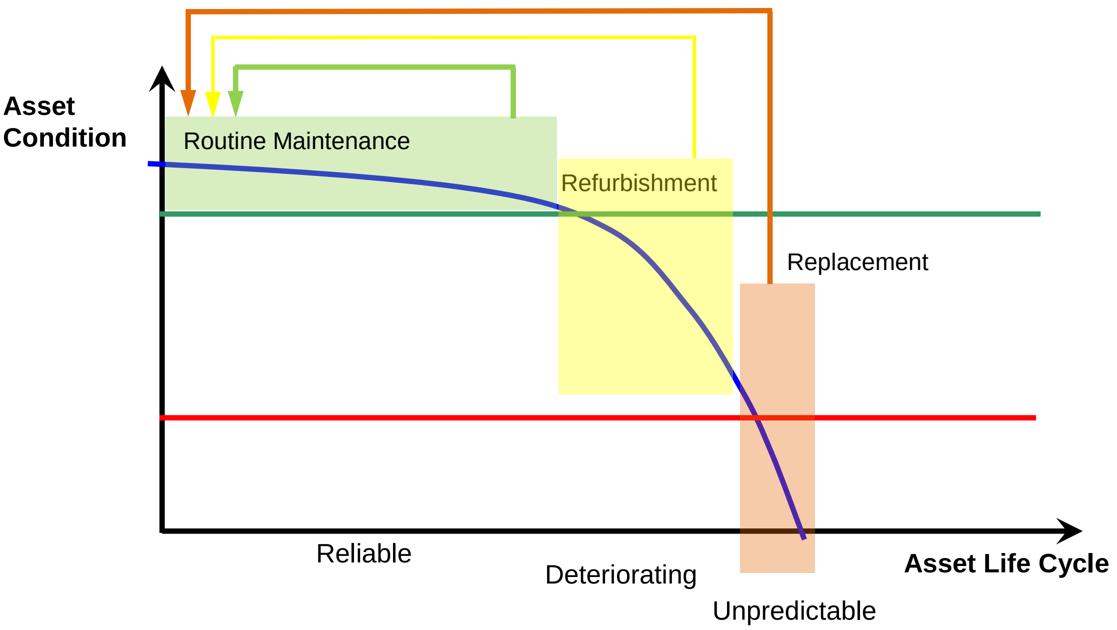


Figure 4.7: Asset Management Actions

The Asset Management Plan is developed based on the following asset management decisions for each asset:

- Asset Profile – assessment of plant/equipment profiles to confirm life cycle performance/cost (TALC – Equipment Profiles);
- Maintenance Plan – review of routine maintenance plans in order to optimise routine maintenance (Reliability Centred Maintenance analysis);

- Refurbishment Plan – review of plant/equipment defect profiles in order to identify problems common to groups of plant and it is cost effective to reset asset condition for ongoing routine maintenance (System Condition and Risk – Defect Analysis);
- Replacement Plan – identify assets approaching end of technical life where refurbishment is no longer cost effective, unpredictable behaviour is unacceptable (TALC – Life cycle assessment).

4.6 Investment decisions

The framework for making investment decisions is described below and is managed in the larger context of minimising the life cycle cost of the asset while maintaining acceptable levels of risk (associated with safety and performance of the network).

4.6.1 Routine maintenance

Routine maintenance costs for an asset are determined at the time of purchase of an asset as each asset brings with it a requirement to undertake routine maintenance in order to ensure that its performance is maintained for its working life.

In general the main characteristics of routine maintenance are:

- The lifecycle cost is largely determined at the time of purchase of the asset based on its design and manufacturers recommendation;
- Optimisation of routine maintenance cost (as more experience of the asset performance is gained) may be possible using optimisation techniques such as reliability centred maintenance (RCM);
- Routine maintenance is the most cost efficient method for maintaining the asset as the routine nature of the work makes it possible to optimise the maintenance plan and make the best use of resources;
- Routine maintenance costs are fixed costs.

4.6.2 Asset refurbishment

Asset refurbishment is work specifically undertaken to restore the condition of assets in the case that routine maintenance by itself is unable to do so. The cost of refurbishment work is specific to the task being undertaken.

In general the main characteristics of asset refurbishment are:

- Refurbishment work is undertaken where likelihood of accelerated end of technical life is significant and the early replacement of the asset is not the least cost option;
- Optimisation of refurbishment project cost may is possible by packaging work associated with similar or common assets into single work packages;
- Refurbishment projects, particularly for packaged works, are an efficient form of investment as work plans may be optimised to make the most efficient use of resources (and to identify those assets that may be replaced by other projects such as augmentation);

- The number and size of refurbishment projects (but is significantly influenced by the long run effectiveness of the routine maintenance plan and the asset age profile);
- Asset refurbishment projects are a variable cost.

4.6.3 Corrective maintenance

Corrective maintenance is scheduled in response to asset defects and associated levels of risk (safety, environmental or operational). Only defects that have high levels of risk and short response timeframes (less than 12 months) are classified as corrective. Defects with lower risk and longer response times are either packaged as refurbishment projects, asset replacement projects or scheduled to align with routine maintenance tasks.

In general the main characteristics of corrective maintenance are:

- Corrective maintenance is conducted in response to defects with unacceptable levels of long run risk;
- Defect maintenance by its nature is reactive and is therefore unplanned and relatively less efficient both in terms of allocation of funds and resources;
- The number and nature of asset defects is related to the long run effectiveness of the asset management framework and may severely lag changes to asset management practice;
- Costs associated with corrective maintenance are specific to the defect;
- Corrective maintenance is a variable cost.

4.6.4 Asset replacement

Asset replacement improves the asset risk profile (risks associated with safety, environment and performance as well as the ability to effectively manage the assets in the long run).

In general asset replacement decisions are made when:

- Assets have reached the end of their technical lives;
- Asset performance has become unpredictable and has unacceptable long run risk; and
- Asset refurbishment is no longer cost effective;

Asset replacement changes the routine/ corrective cost ratio (a reflection of long run asset risk). A high level measure of whether efficient levels of asset replacement are being undertaken is the asset sustainability profile, which is based on indicative asset lives. Ideally an asset sustainability ratio of one is maintained over time (indicating optimal replacement is undertaken based on the best understanding of useful life).

It is important to note that all asset replacement projects are aligned where possible with augmentation projects in order to gain efficiency of scale and reduce capital cost.

4.6.5 Cost optimisation

The aim of the Asset Management Plan is to minimise asset lifecycle cost while maintaining acceptable levels of performance and risk. The diagram below sets out the mechanisms incorporated into the asset management plan to optimise investment and funding decisions based on whole of life cost, performance and risk.

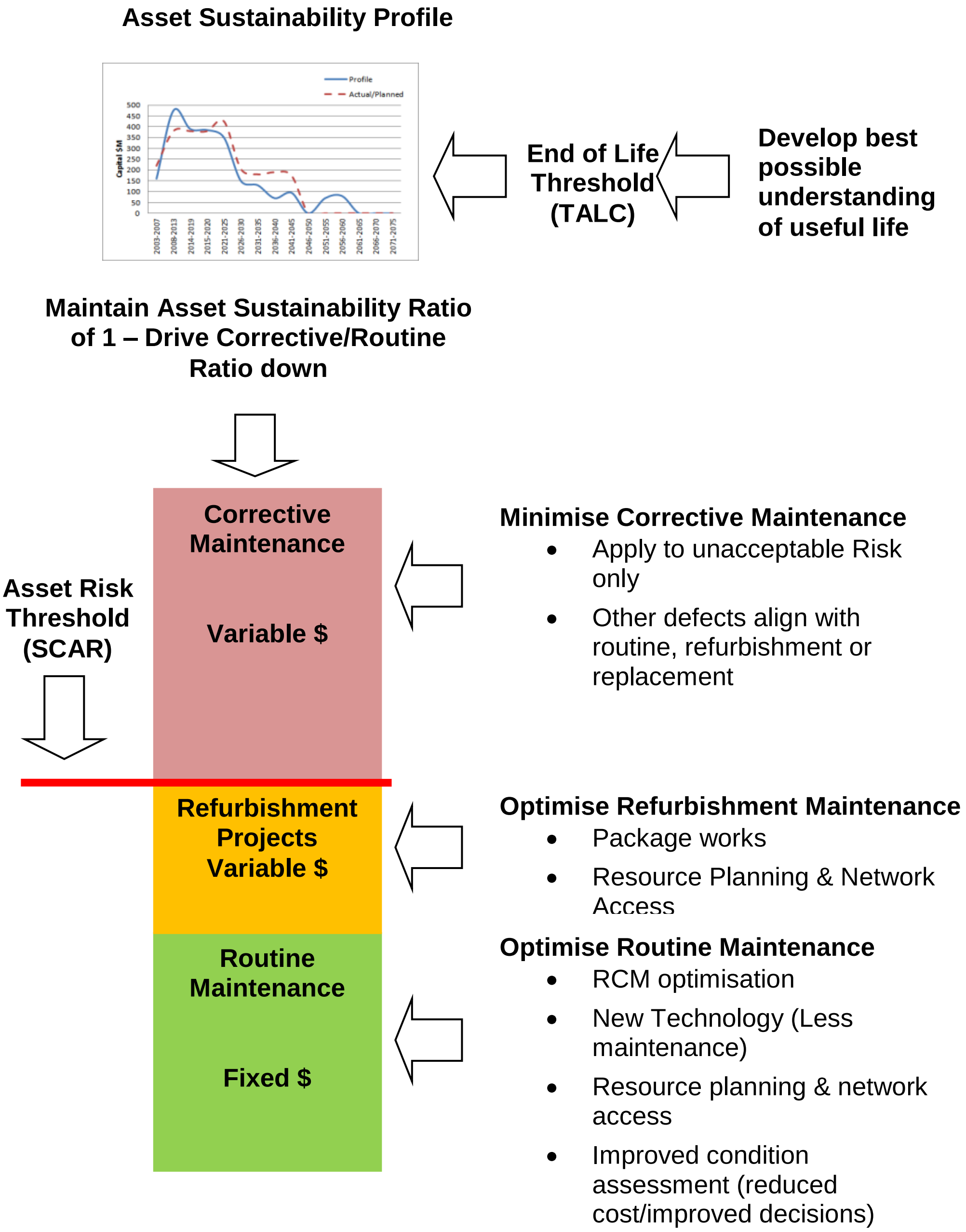


Figure 4.8: Asset Management Plan - Cost Optimisation Framework

5. Asset Management Framework

The Asset Management Plan is based on understanding and managing the lifecycle of each of the transmission network assets in order to maintain acceptable levels of risk and performance at the lowest possible long run cost.

The asset management process is described by the diagram shown below showing a series of planning, action and analysis steps, each associated with understanding and managing each of the assets that make up the transmission network.

The condition of each asset (or components of larger assets) changes over time depending on a wide range of factors including environment, maintenance history, design and the skills available to maintain those assets.

- The asset management process is designed to understand risk and cost associated with changing asset condition and the response appropriate to that risk
- The Asset Management Plan is the result of understanding the asset condition and defining a coordinated response for the future management of the asset.

Figure 5.1: Asset Management Process

Each of the frameworks and associated processes used to develop the asset management plan are described in more detail the following sections:

- Maintenance Policy and Procedure
- Refurbishment Planning
- Defect Management Process

- Capital Project Development
- Long Run Risk assessment

5.1 Maintenance policy and procedure

In 2005, ElectraNet began implementation of a new transmission network maintenance policy and procedure framework based on that used by Powerlink Queensland. This framework was developed using reliability centred maintenance and asset condition monitoring techniques and was applied directly to the South Australian transmission network with modifications to meet local statutory and environmental conditions as required.

The following maintenance policy frameworks are in place:

- Transmission Lines – Condition assessment based on routine inspection of transmission line components with inspection and test of selected components based on age and performance;
- Primary Plant – Routine maintenance plan based on reliability centred maintenance analysis;
- Secondary Systems – Routine testing of protection schemes where the test regime is based on the scheme technology;
- Communications – Routine maintenance of communication systems based on reliability centred maintenance where the maintenance regime is based on system technology.

Maintenance policy and associated procedural documentation is currently under review with emphasis on:

- Development of task lists for all routine maintenance in order to improve task and associated data management definition;
- Development of electronic checklists in line with the task list in order to structure data collection and provide a consistent framework for data analysis and asset condition and performance reporting;
- Reformatting of all documents (from Powerlink to ElectraNet document format);
- The expected completion of this review by June 2012.

Routine review of maintenance policy is based on asset performance using asset lifecycle performance reporting. These performance indicators are based on:

- Improved provision of maintenance and condition data from maintenance tasks, provided by task-list and checklist implementation;
- Improved provision of asset defect data (SAP Notifications) provided by implementation of System Condition and Asset Risk (SCAR) coding and field inspection tools;
- Development of SAP Asset Condition reporting tools.

The maintenance policy and procedure framework also includes specification for maintenance tasks, data collection and management, the overall structure is set out below, a full document list is provided in Appendix A Maintenance Policy and Procedure Listing

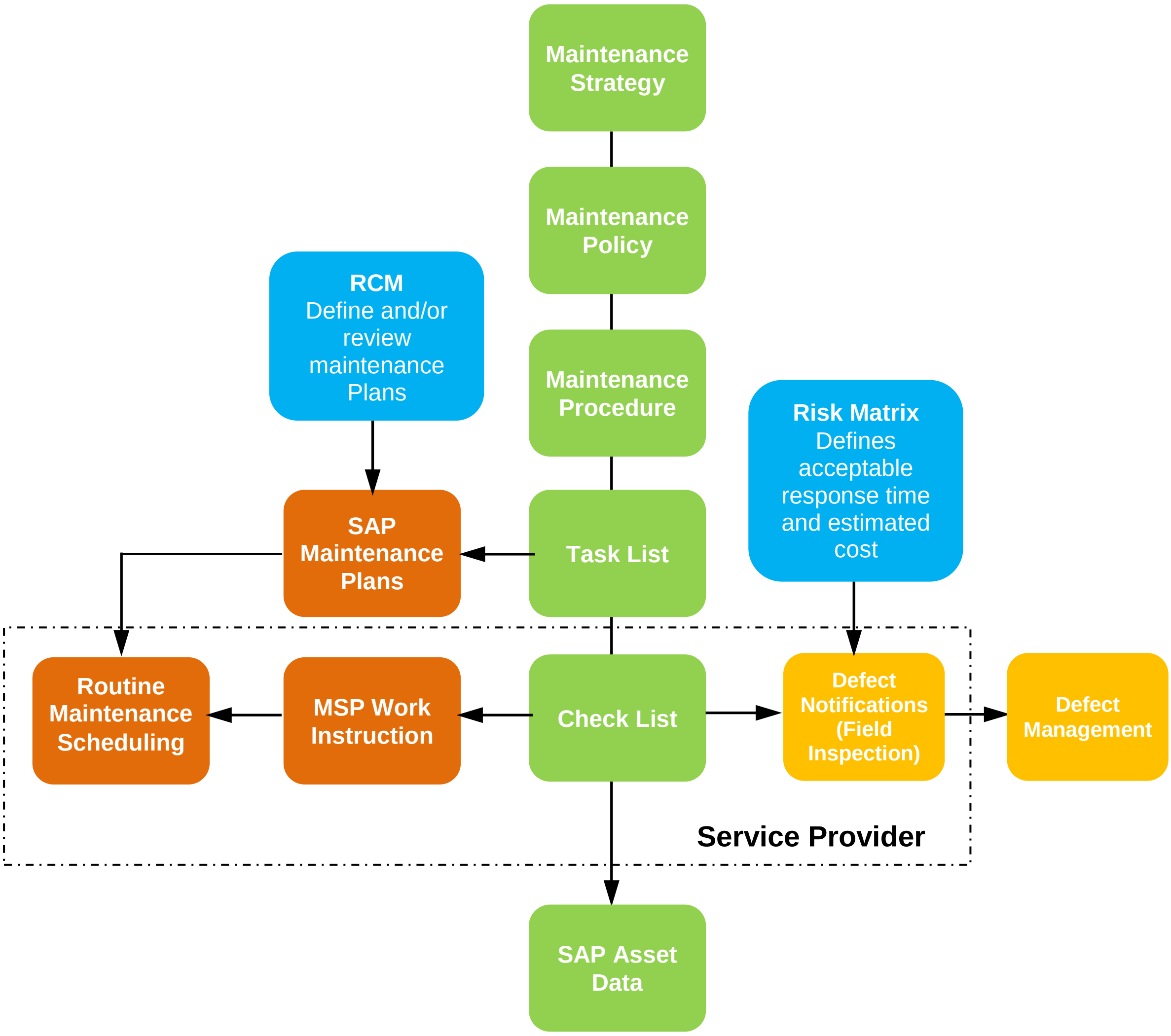


Figure 5.2: Maintenance Policy and Procedure Framework

5.2 Refurbishment planning

Refurbishment projects are determined by grouping asset defects and identifying the most cost efficient approach to effectively resolve defects while maintaining acceptable levels of asset safety, environmental performance, operational and asset risk.

Asset defect project lists are developed from SCAR coded non-immediate asset defects shown diagrammatically below.

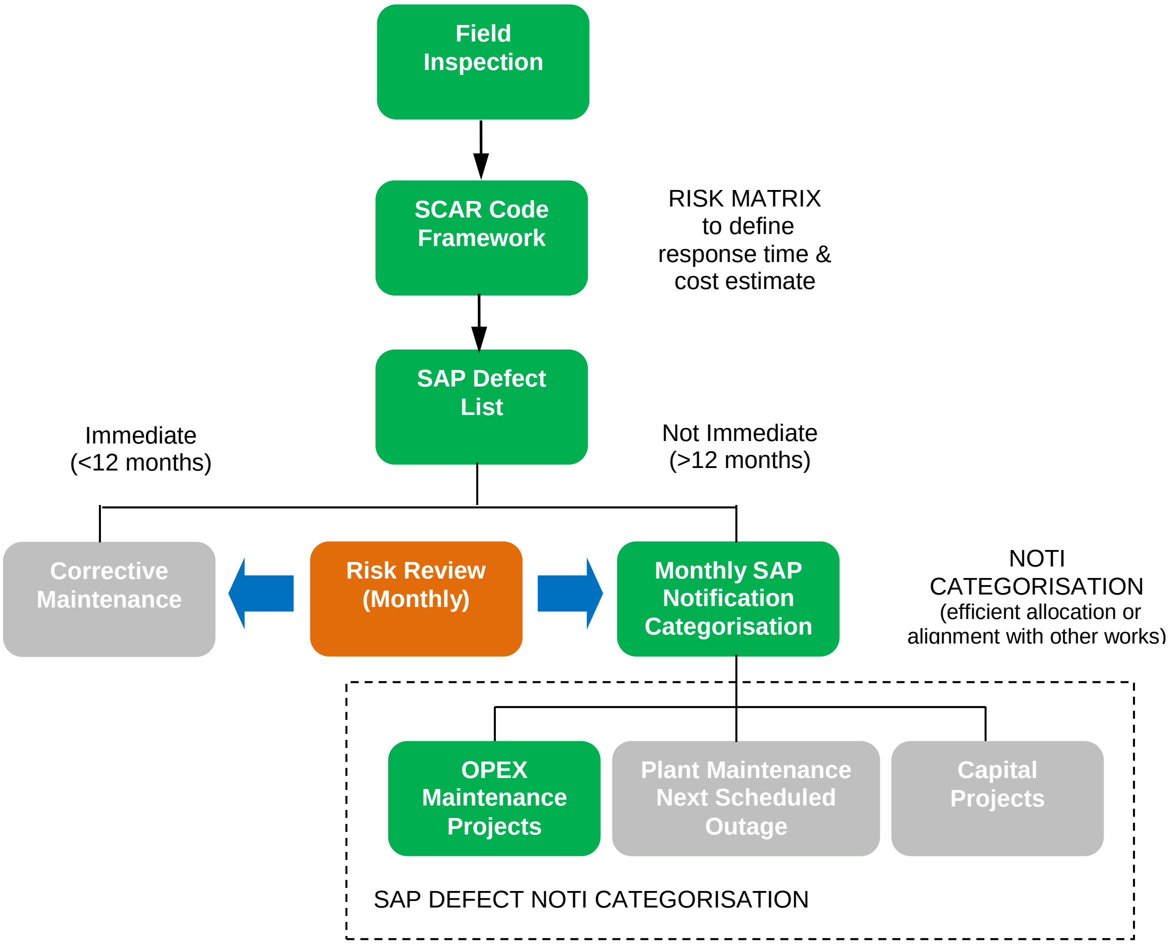


Figure 5.3: Refurbishment Project Development

OPEX refurbishment project briefs are developed for each maintenance project for the purpose of:

- Identifying the most efficient project framework and timing for undertaking the refurbishment work;
- Developing a detailed scope and estimate;
- Obtaining approval to proceed.

Note the SAP Defect Notification Categorisation process enables efficient allocation or alignment with other works of the non-immediate defects. This allows, where possible, the non-immediate defects to be planned to be completed during the next scheduled maintenance of the asset or addressed by other capital projects.

5.3 Defect management

Asset defects are managed in accordance with the risk associated with specific asset defects. The decision making process for classification of asset risk, response time and cost estimate is defined in the System Condition and Risk (SCAR) risk management process outlined below.

The SCAR risk matrix is designed to drive efficient cost by grouping as many asset defects as possible to future maintenance or capital projects. Only safety, environmental, operational and high risk asset defects are allocated to immediate defect response. The SCAR risk matrix is based on ElectraNet's corporate risk framework.

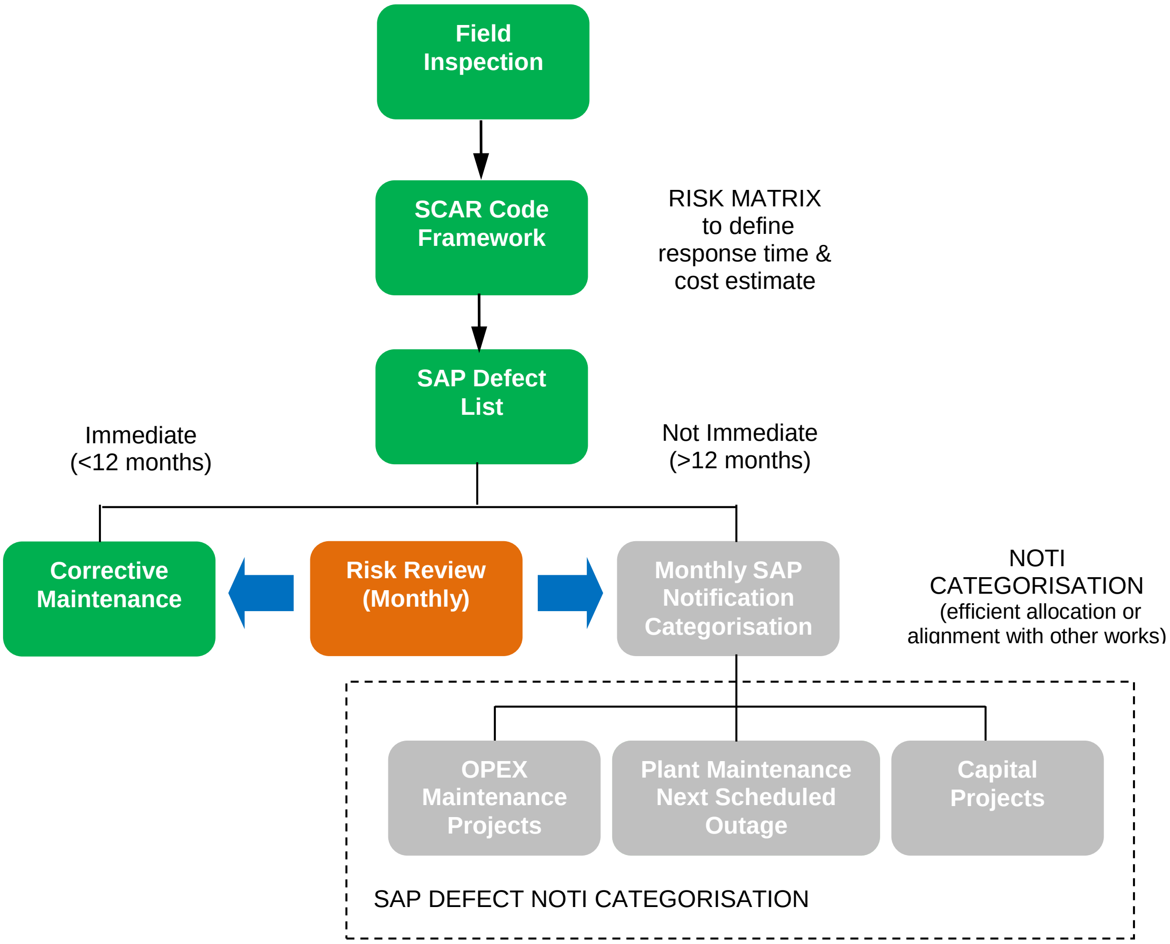
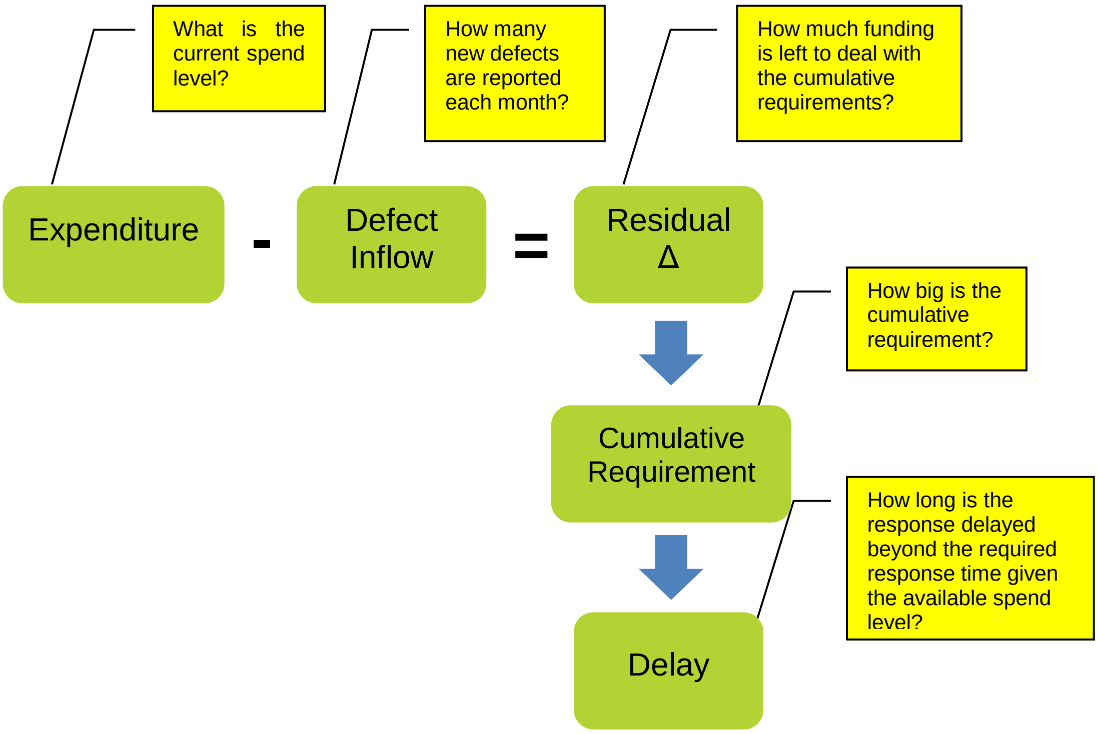


Figure 5.4: Defect Management Process

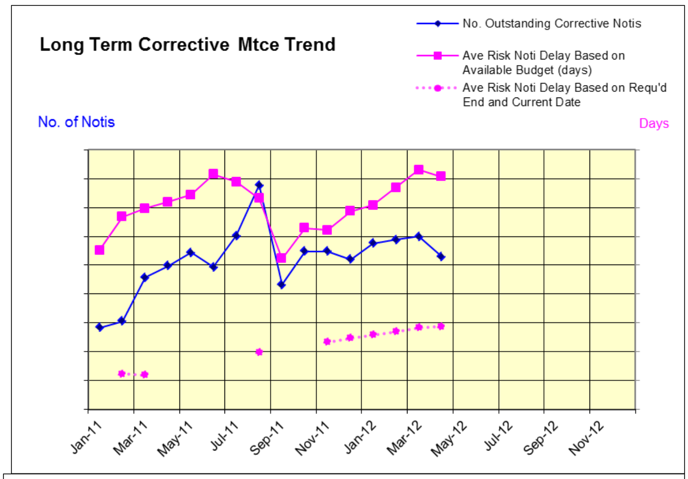
SCAR coding of all SAP asset defect notifications provides a consistent view of asset defect profiles, SCAR coding also provides an estimate of cost for each defect code therefore allowing a financial estimate of the accumulated defect effort to be characterised by:

- Asset defect budget – estimated cost to deal with immediate defect profile;
- Asset defect delay – a measure of risk exposure relating to the available budget time to respond compared to the risk assessed time to respond.

The process shown diagrammatically in Figure 5.5.



Substation & Secondary System Monthly trend of SAP notification defect response and cumulative requirement



Substation & Secondary System Monthly trend of SAP notification defect budget and $ estimate incoming rate

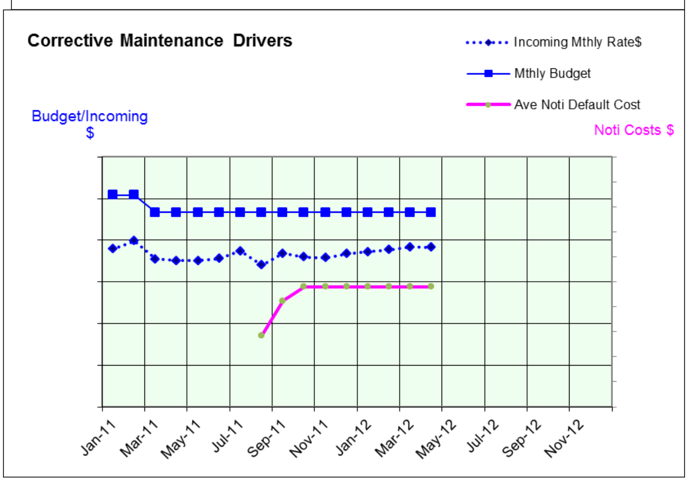


Figure 5.5: Defect Management Characterisation

All SAP defect notifications for Substation, Secondary System and Transmission Lines have been SCAR coded, this system of coding also allows the incoming rate of defects to be analysed and projected in order to estimate future corrective maintenance budgets.

5.4 Capital project development

The Asset Management Plan identifies four types of capital project, these are:

- Unit Asset Replacement Capital Project – where specific assets of a unit of property are identified to have reached end of life;
- Substation Replacement Capital Project – where a substation is identified as end of life;
- Transmission Line Capital Replacement – where a transmission line is identified to have reached end of life; and
- Communications Asset Replacement – where a communications asset is identified to have reached end of life.

Note that transmission network augmentation capital projects are identified in the Regional Development Plans and are summarised in the Annual Planning Report. Where possible asset replacement capital projects are planned to coincide with asset augmentation capital projects in order to improve the efficiency of project delivery.

Asset replacement capital projects are identified by determining asset end of life, timing of the project is then aligned with other capital projects as possible. The end of life decision process is summarised in Figure 5.6.

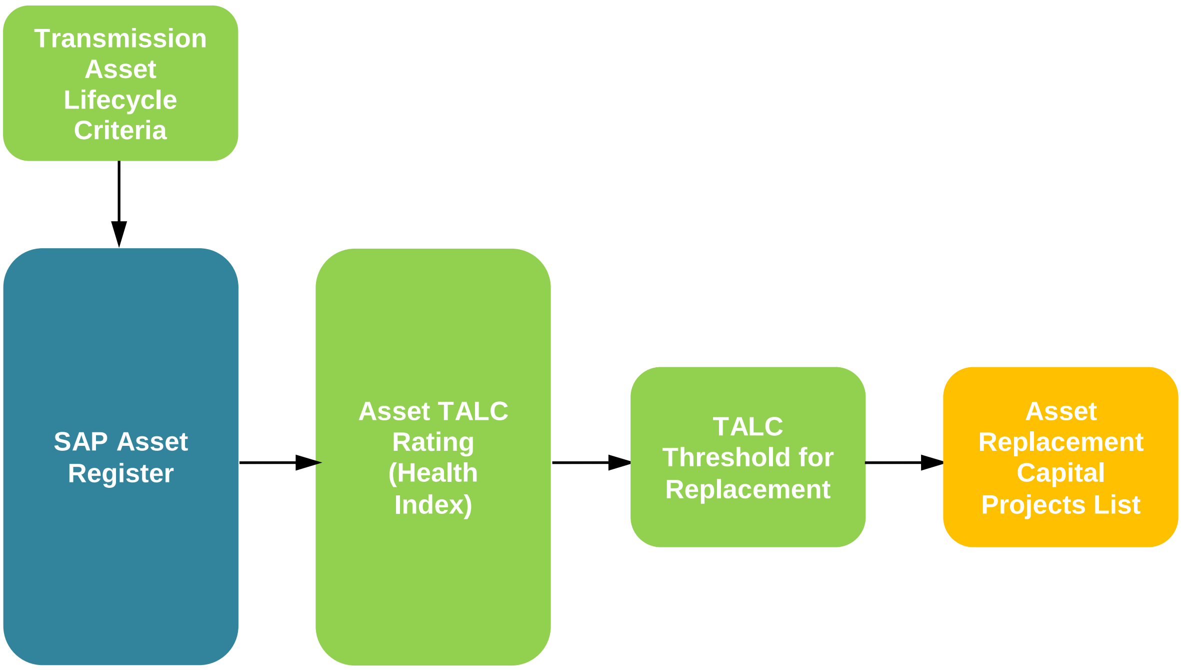


Figure 5.6: Asset End of Life Decision

Transmission Asset Life Cycle (TALC) has been developed to provide an indicator of asset health and signal when the end of life phase of the asset life cycle has begun. TALC is a combination of the technical health of the asset and its strategic importance in the network (related to the value at risk).

The process for undertaking a TALC assessment is set out in the following block diagram. This information is then used in the Asset Condition Assessment Report to summarise the overall lifecycle condition of the asset.

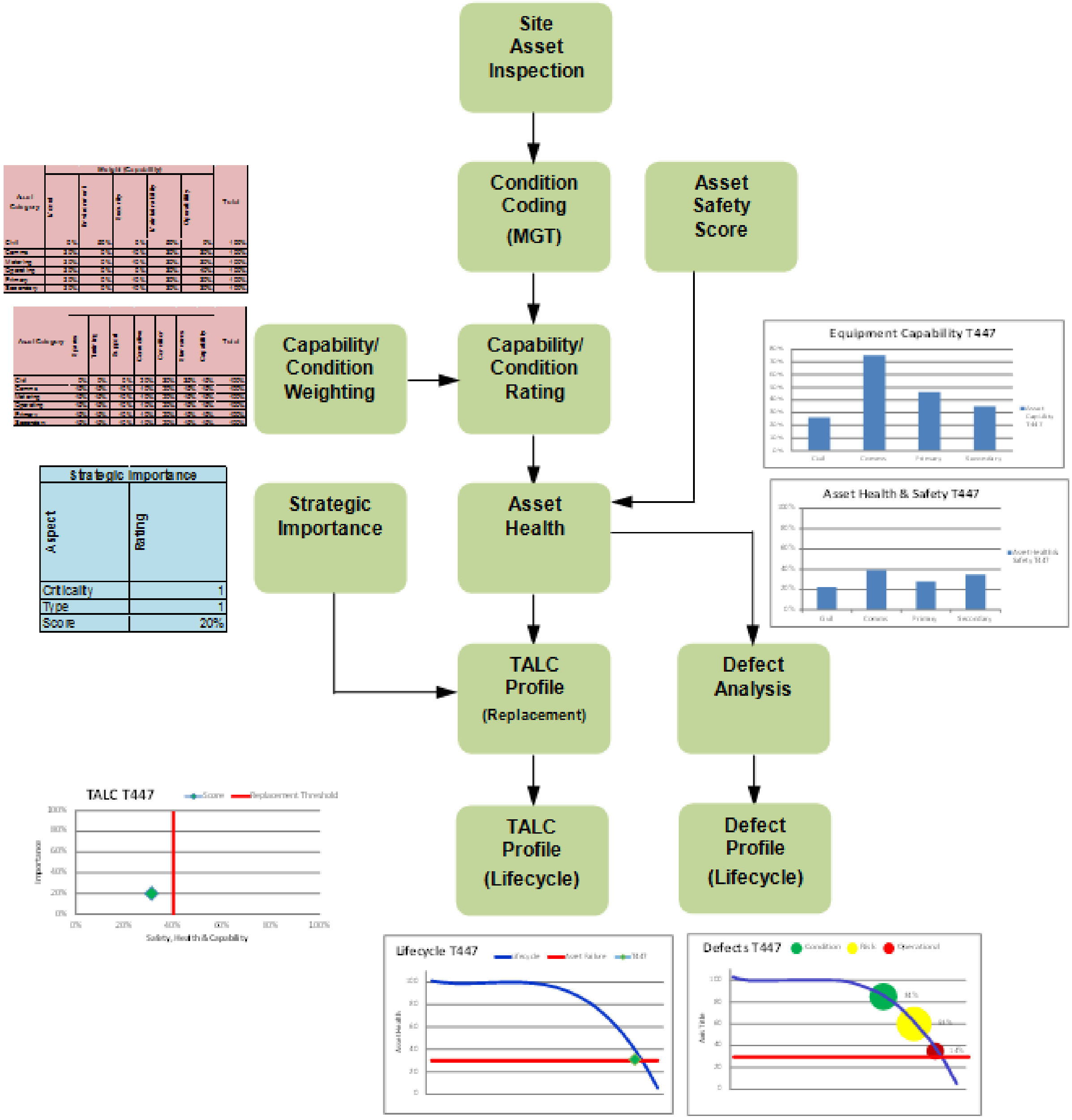


Figure 5.7: TALC Assessment Process

Each component is assessed based on the following criteria:

5.4.1 Substation Assets

Safety

Capability

- Model (evaluation of obsolescence)
- Environment
- Security
- Maintainability
- Operability

Asset Health

- Spare Parts
- Training (available maintenance skills)
- Support (available technical support)
- Corrective Maintenance Effort
- Condition
- Standards

Weightings are applied to each of the above categories based on the type of asset being assessed in order to ensure that relevant emphasis is given to the key aspects of the asset groups as follows:

- Civil
- Comms
- Metering
- Operating
- Primary
- Secondary

Note: Safety has 100% weighting under all conditions.

5.4.2 Transmission Line Assets

Condition of major components considering:

- The condition of line components at the time for the assessment;
- How long the asset can be expected to operate before failure (based on inspection, testing and assessment in accordance with international standards and practice.

Each assessment is based on a scoring system represented below:

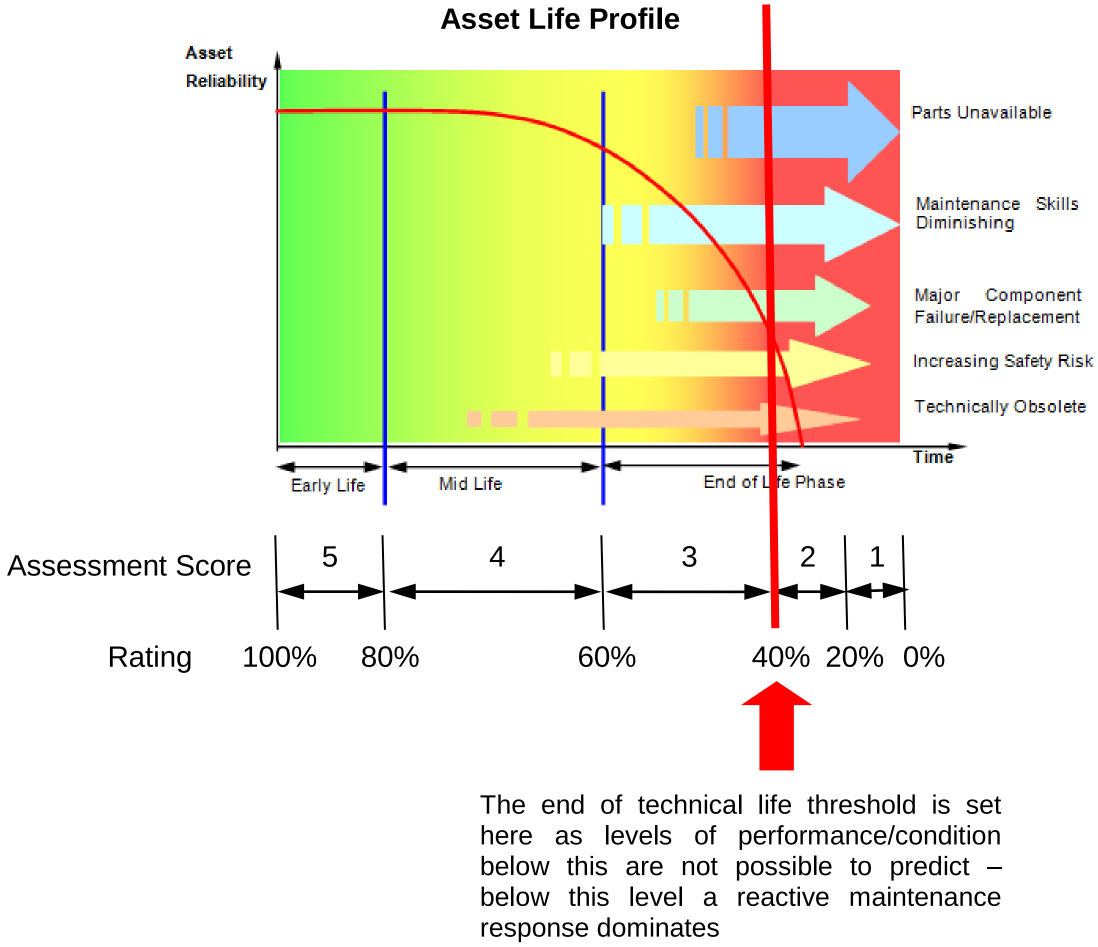


Figure 5.8: Asset End of Technical Life Threshold

The TALC framework provides a composite view of each major asset based on the sum of component scores as well as providing a view of each major component. The end of life threshold is the point at which asset behavior and performance becomes unpredictable and begins to dominate corrective maintenance effort and reduced reliability.

5.5 Long run risk – condition and cost

Identification of asset replacement and refurbishment thresholds is undertaken through application of SCAR and TALC. The aggregate asset risk analysis is used to evaluate the long run aggregate effect of asset replacement timing on defect maintenance effort and strategic functionality of the transmission network, a model is used to:

- Develop a prioritised project list based on SCAR (Refurbishment) and TALC (Asset Replacement) outcomes;
- Determine the timing of projects on the prioritised list in order to maintain an acceptable aggregate asset risk profile and meet network functionality requirements.

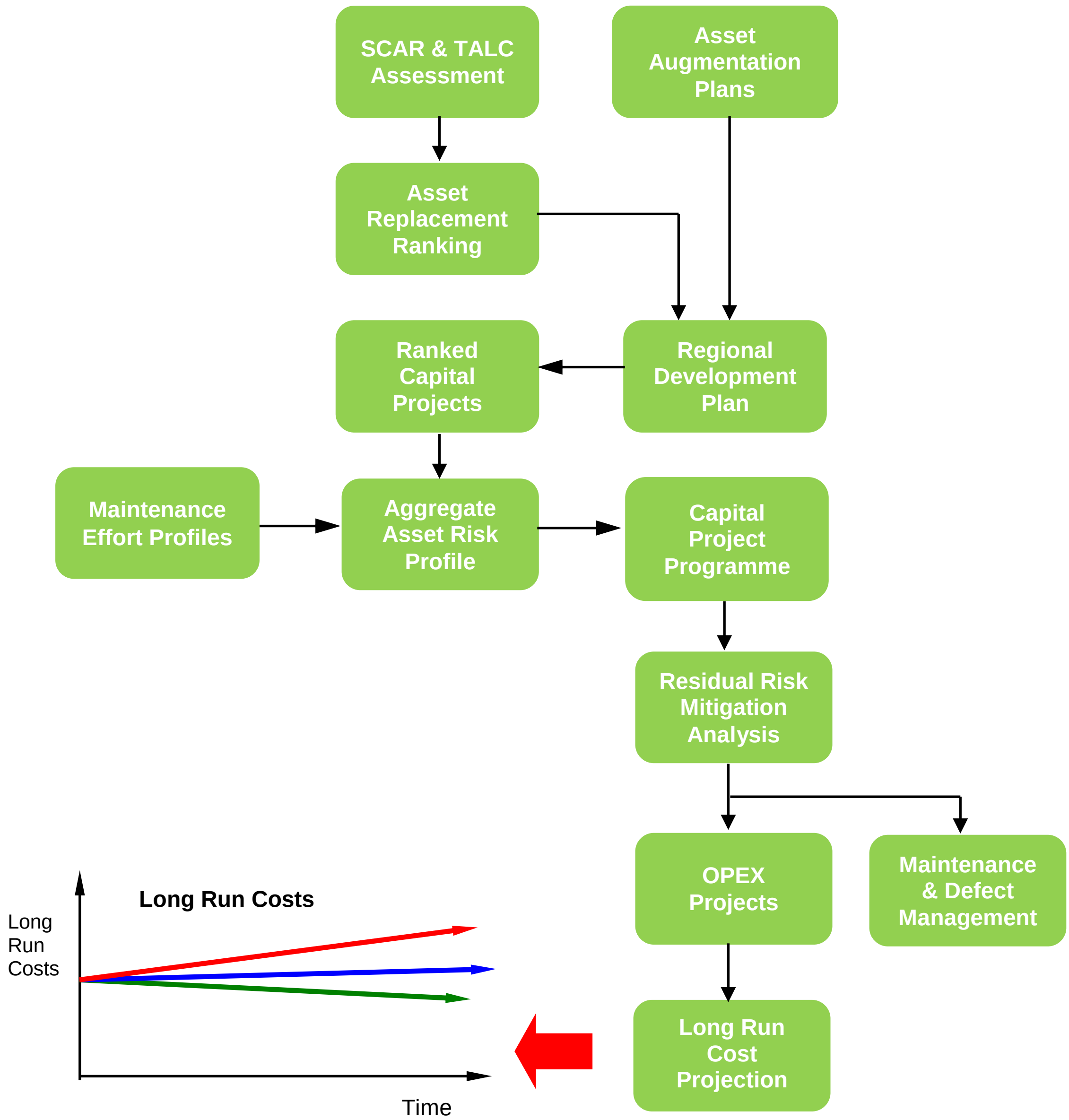


Figure 5.9: Risk Analysis

Asset maintenance effort may be characterised by the "bathtub curve" shown in Figure 5.10. As assets enter the end of life phase, performance begins to be dominated by maintenance issues, reducing MTBF and increasing time to repair.

There are two primary areas which present higher than desired levels of risk and cost. These areas are the "early life" period and the "end of life" period.

The cost implications associated with the early life period are largely managed through the procurement process which demands warrantee support for assets and construction workmanship. The partnering philosophy that ElectraNet has in place with its Dual Contractor arrangements further enhances ElectraNet's ability to transfer risk and get longer term commitment from service providers which mitigates cost impacts from early life failures.

The end of life phase is there area where the majority of ElectraNet's asset management focus must therefore be applied.

In order to model the effect of a particular asset replacement programme on long run costs, the asset maintenance effort profile is approximated using estimates of failure rates based on case studies of asset end of life (where failure is defined as any maintenance required outside the specified routine maintenance programme – unscheduled maintenance).

The Asset maintenance effort profile has been developed as described above, this profile then allows the incremental increase in corrective maintenance effort for each asset to be estimated in the period from the present to its scheduled replacement, providing the following estimates:

- The estimated OPEX Project spend to replace high risk assets
- The projected increase in defect maintenance costs if the high risk assets remain in service until a capital project replacement

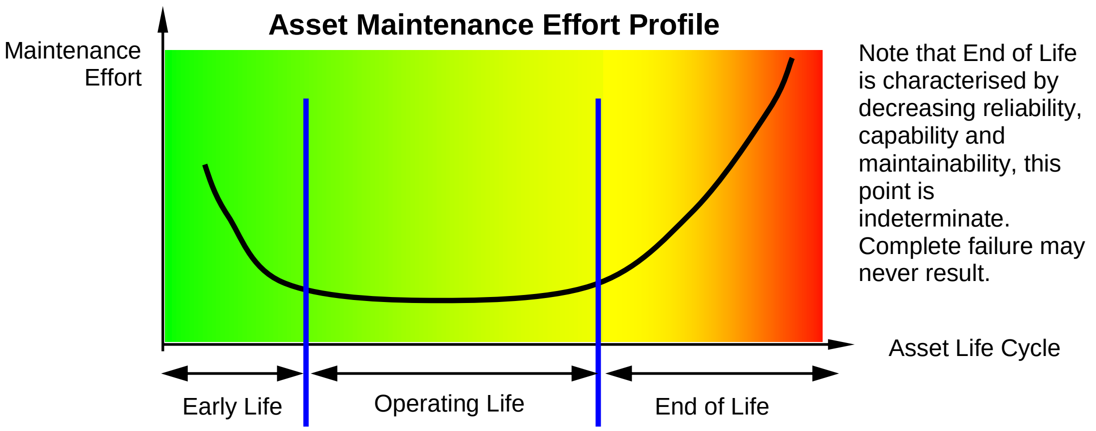


Figure 5.10: Asset Maintenance Effort Profile

The Asset Maintenance Profile is used:

- In the Asset Condition Assessment and scoring in order to be able to rank and support justification for asset replacement;
- To identify high risk assets for OPEX Projects;
- To develop an input for the modeling of long run maintenance costs.

The asset risk profile is based on a two dimensional risk model:

- **The Risk of Additional Maintenance Effort** - The asset risk model is based on estimating the effect of the asset maintenance effort profile on long run costs (that is the corrective maintenance costs associated with assets with decreasing MTBF and increasing MTTF). The key driver for the reliability estimates is the asset age at the projected time of replacement.
- **The Risk of Limited Secondary System Functionality** - A key element of these objectives is to drive improvement in performance by using new control and protection technology to provide the ability to remotely manage control and

protection maintenance and fault response in place of field attendance. The control and protection equipment technology profile (measured by equipment age) is used as an indicator of technology roll out by 2025.

The risk profile is based on estimating substation risk. The risk profile is developed in two stages, these are:

- The functionality and maintenance effort risks;
- The OPEX long run cost forecast consequence.

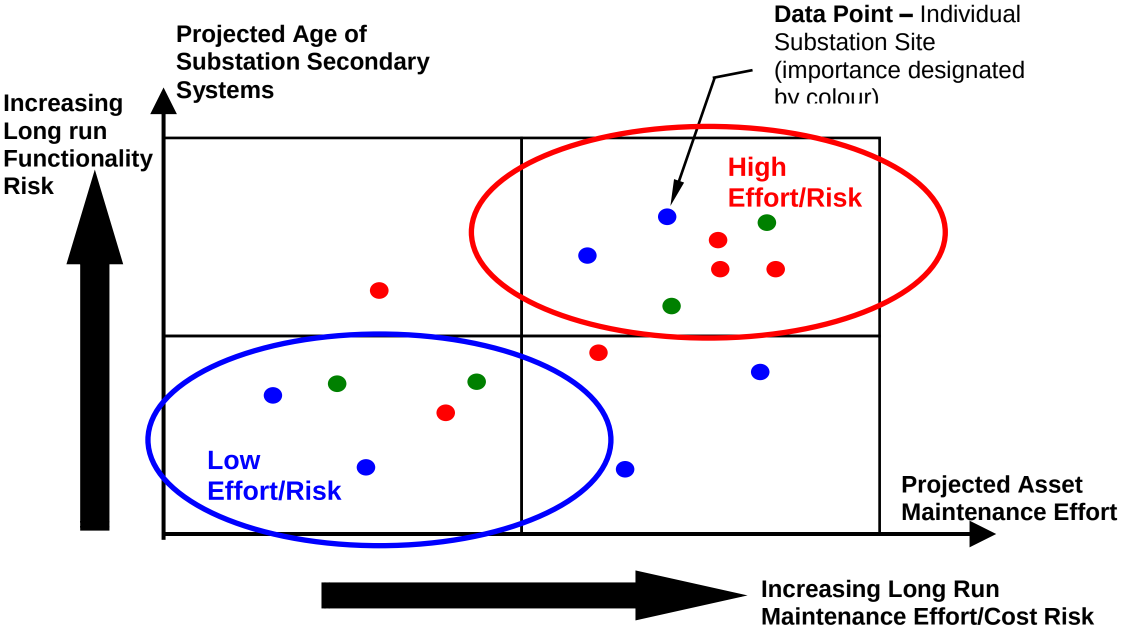


Figure 5.11: Development of the Long Run Substation Risk Profile – Example

The model output shown in Figure 5.11 shows:

- The projected risk of increased maintenance effort at each substation resulting from the underlying asset replacement programme – the model is intended to help answer the question *"Is the Asset Replacement Programme Timely by maintaining an acceptable long run corrective maintenance effort";*
- The projected profile of substation secondary system replacement (functionality) resulting from the underlying asset replacement programme – the model is intended to help answer the question *"Are adequate levels of functionality being built into the network in order to meet network performance targets".*

The transmission line risk model is a based on:

- Asset Health and Maintenance Effort;
- The OPEX long run cost forecast consequence.

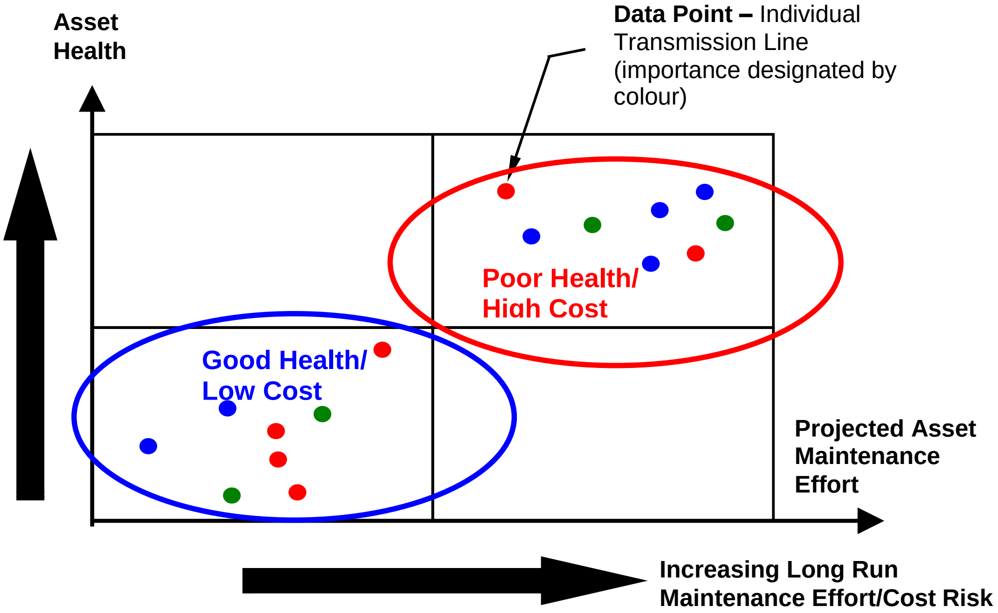


Figure 5.12: Development of the Long Run Transmission line Risk Profile – Example

The model output shown in Figure 5.12 shows:

- The relationship between maintenance effort and asset health – the model is intended to answer the question *"Is the maintenance effort being applied appropriate to the health of the asset".*

6. Asset Plans

The details of the Asset Management Plan for the 2013-14 to 2017-18 regulatory period are set out in the following asset plans and associated projects.

Details of each plan are provided in the following sections. The Data and Information Management Plan is a separate document.

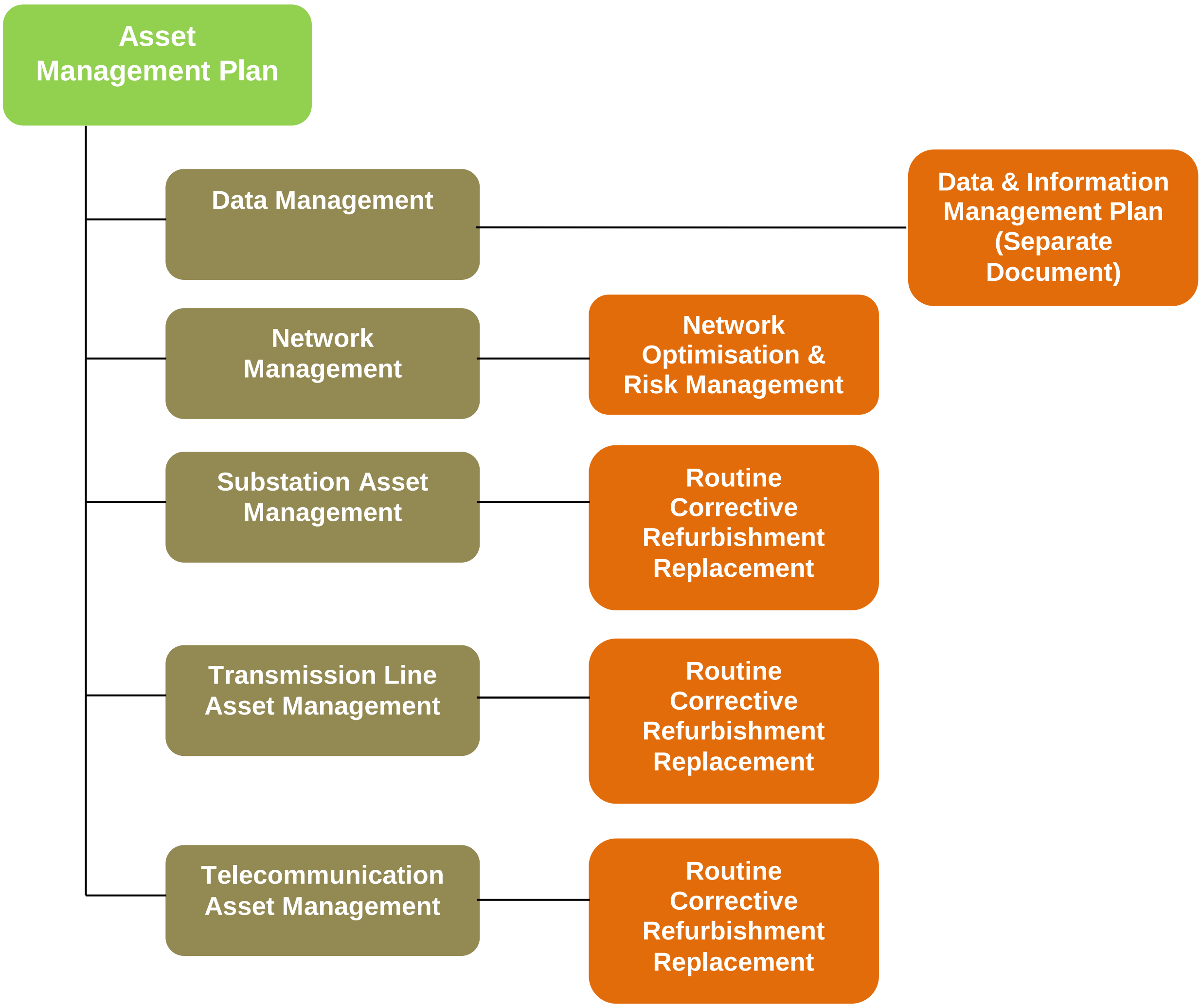


Figure 6.1: Asset Management Plans

6.1 Network optimisation and risk management

For the purpose of the asset management plan Network Optimisation and Risk Management (NORM) is defined as:

> *Those assets, asset information systems or asset management practices required to improve the operation and management of transmission network power flows, asset utilisation or asset management.*

The current status of NORM projects is summarised in Table 6.1.

Table 6.1: Summary of NORM Project Status

Project	Notes	Status
Remote monitoring of transmission network assets	Network control and protection IED communications	OPSWAN deployment and upgrades (CAPEX) – in progress
Automation of network control systems	Distributed control systems to provide the platform for increasing levels of automation	Project for configuration management and standardisation to be included in 2013 to 2018 period (CAPEX) IEC61850 deployment (as part of CAPEX Replacement or Augmentation projects) – in progress
Improve management of network power flows	Improved automation of voltage control schemes	Automation improvement project to be included in 2013 to 2018 period (CAPEX)
Improve network asset utilisation	Replace/modify under-rated substation assets limiting power flows	Project for replacing under-rated assets (minor plant - CAPEX) and secondary systems reconfiguration (OPEX) to be included in 2013 to 2018 period
	Improve automation of transformer dynamic rating	Project for deployment of transformer dynamic ratings to be included in 2013 to 2018 period (CAPEX)
Improve transmission line asset utilisation	Address line rating issues as improved line rating information is developed	ALS and line rating projects in place to improve line rating information (CAPEX) – In progress Project to provide allowance for management of line rating non-compliance to be included in 2013 to 2018 period (OPEX)
	Base line ratings on local weather conditions using regional weather stations	Project to provide regional weather stations to be included in 2013 to 2018 period (CAPEX)
	Improve dynamic line process	Project to provide time of day improvement to dynamic line rating automation to be included in 2013 to 2018 period (CAPEX)

Table 6.2: NORM Project Expenditure

Project	CAPEX ($2012/13)	OPEX ($2012/13)
Automation of network control system	$820,000	-
Improve management of network power flows	$3,600,000	-
Improve network asset utilisation	$360,000	$3,000,000
Improve transmission line asset utilisation	$2,000,000	$10,300,000
Total	$6,780,000	$13,300,000

6.2 Substation management plan

Implementation of the substation management plan (the substation management plan includes both substation primary plant and secondary systems) for the 2013–2018 regulatory period is based on the following considerations:

- Substation maintenance is now entering the second routine maintenance cycle (each routine maintenance cycle is approximately one regulatory period);
- Review of routine maintenance effectiveness will be conducted during this period using Reliability Centred Maintenance techniques, the aim of the review is to optimise routine maintenance effort and reduce long run unit costs;
- Refurbishment projects are based on high risk asset maintenance priority, two major plant refurbishment projects have also been included;
- Substation defect maintenance rates projections for 2013–2018 are based on current defect profiles; and
- Substation replacement projects focus on high cost radial sites with assets operating at the end of the asset life cycle.

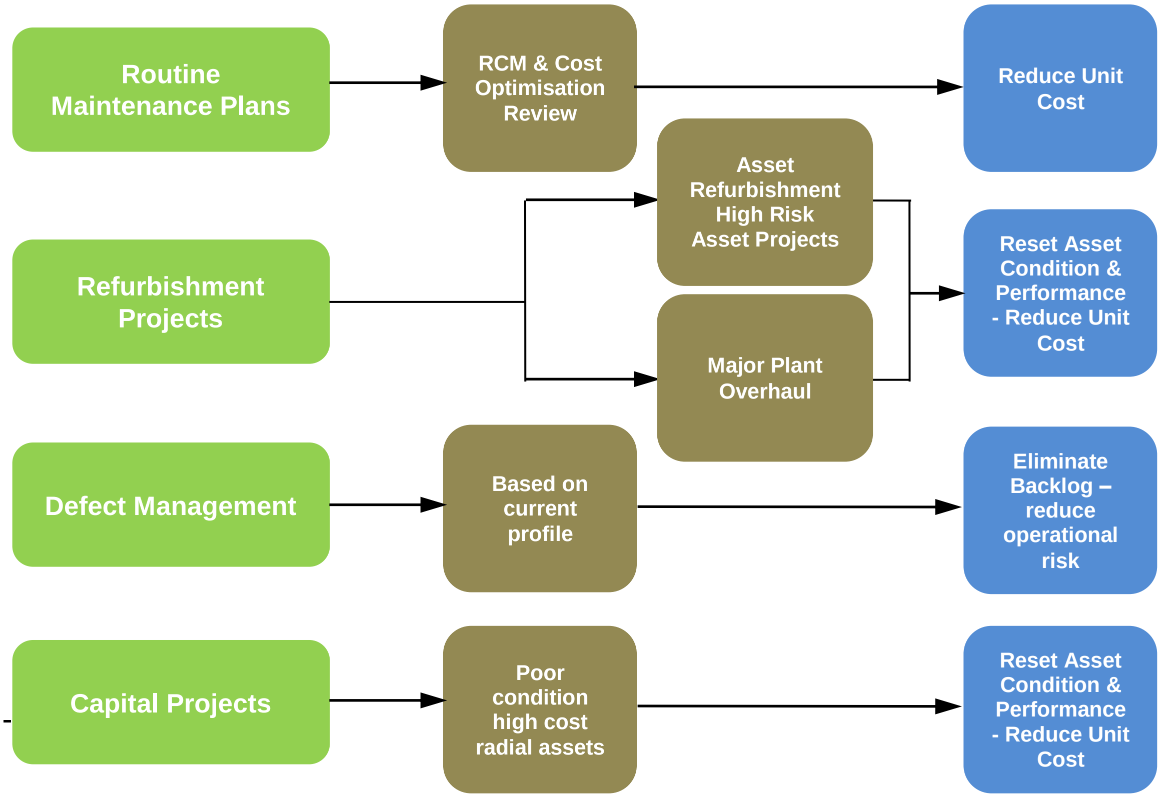


Figure 6.2: Substation Management Plan Summary

6.2.1 Substation asset profile

Substation functionality and maintenance effort profile at the end of the 2008–2013 period is estimated based on the current asset replacement and refurbishment program and updating substation condition assessment inspection data and scoring based on TALC criteria. A summary of the analysis is shown in Figure 6.3 below.

Sites with poor functionality and high effort risk (highlighted) have been identified as asset replacement projects for the following regulatory period. The aggregate effect on the overall substation asset functionality and maintenance effort performance is demonstrated on the following pages.

Note timing of replacement at some sites has been modified based on specific issues at that site, please refer to Table 6.8 for further detail.

Where high risk unit assets are identified specific replacement of those assets is identified in Table 6.4.

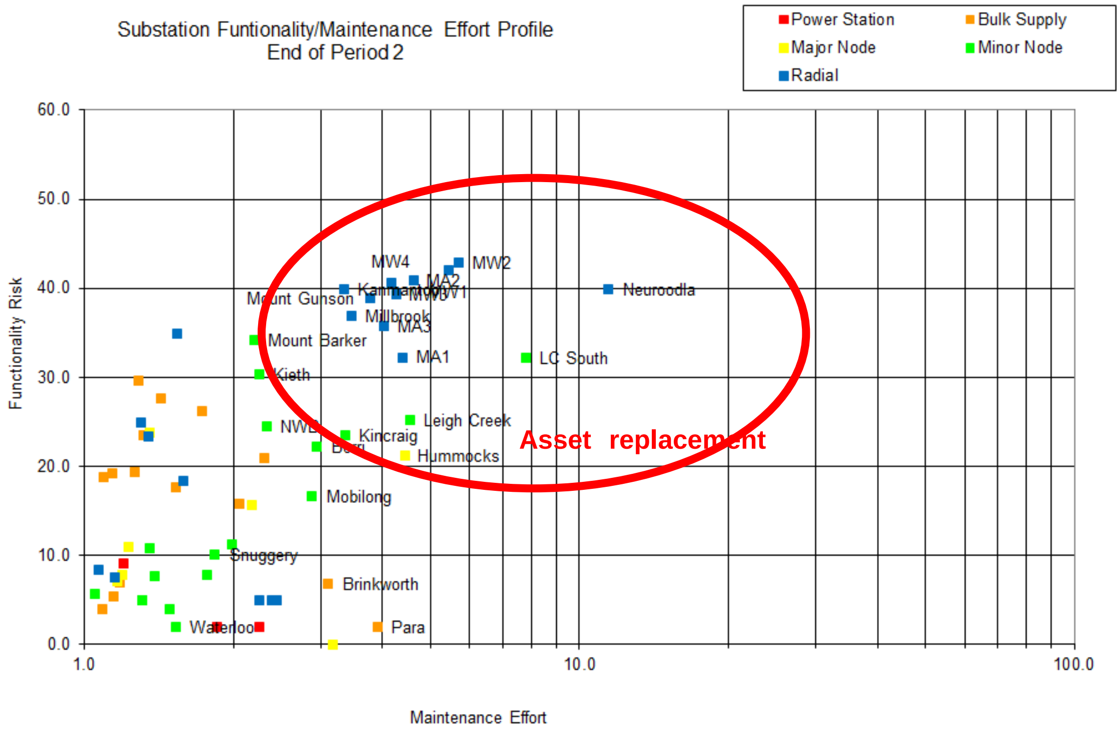


Figure 6.3: Substation Functionality and Effort Profile (Current)

6.2.2 Substation routine maintenance

Substation management includes all aspects of substation maintenance with the exception of telecommunications maintenance which is covered separately. Management of substation assets is represented in Figure 6.4 showing the overall relationship between maintenance policy, asset performance and strategic review.

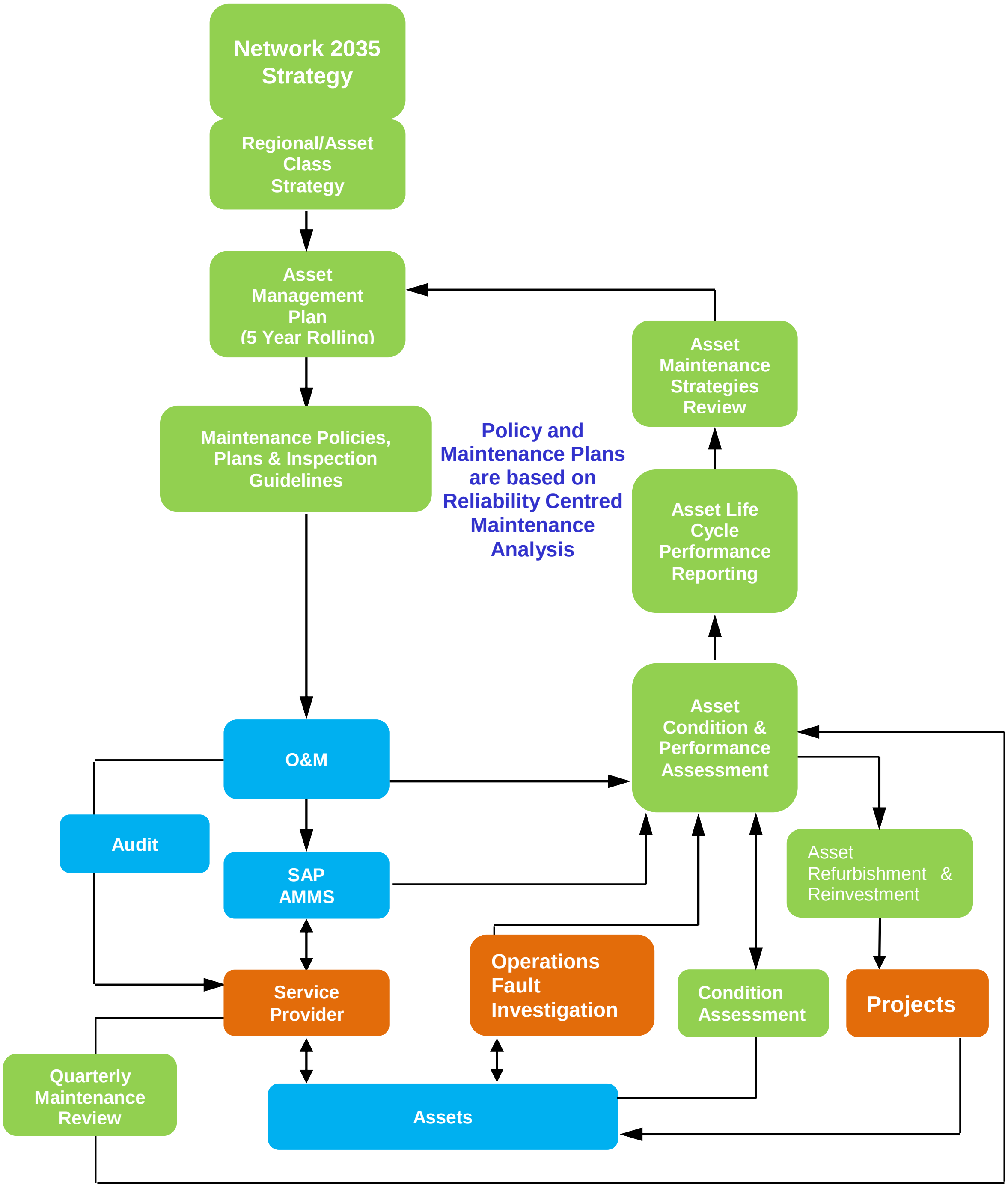


Figure 6.4: Asset Management Cycle - Substations

Current status of the maintenance plan is as follows:

- Powerlink maintenance plans have been implemented for a period of approximately five years;
- Considering the overall maintenance frequency of these plans most equipment is now completing the first maintenance cycle (up to six years);

- No material change to the maintenance plan is proposed, during the 2013–18 regulatory period a Reliability Centred Maintenance Review of all Substation Maintenance Plans is proposed in order to further optimise the maintenance plan.

Table 6.3: Substation Routine Maintenance Plan – Cost Estimate

Routine Maintenance	5yr Estimate ($2012/13)
Primary Plant Routine Maintenance Plan	$36,600,000
Secondary Systems Routine Maintenance Plan	$7,200,000
Total	$43,800,000

6.2.3 Substation refurbishment projects

Secondary systems refurbishment and plant overhaul projects identified using the SCAR coding process are summarised in Table 6.4, Table 6.5 and Table 6.6. Further detail is shown in Appendix E.

Table 6.4: Substation Refurbishment Projects – High Risk

Project	Estimate ($2012/13)
Substation Refurbishment – High Risk	$23,200,000
Total	$23,200,000

Table 6.5: Secondary Systems Refurbishment Projects – High Risk

Project	Estimate ($2012/13)
Secondary Systems Refurbishment – High Risk	$1,100,000
Total	$1,100,000

Table 6.6: Plant Overhaul Projects – High Risk

Project	Estimate ($2012/13)
Plant Overhaul – High Risk	$9,600,000
Total	$9,600,000

6.2.4 Substation corrective maintenance

Based on the current incoming rate of defect notifications, accumulated defects and the projected replacement of unreliable assets, the defect rate for the next regulatory period is estimated from the current incoming defect notification rate shown in Figure 6.5 below.

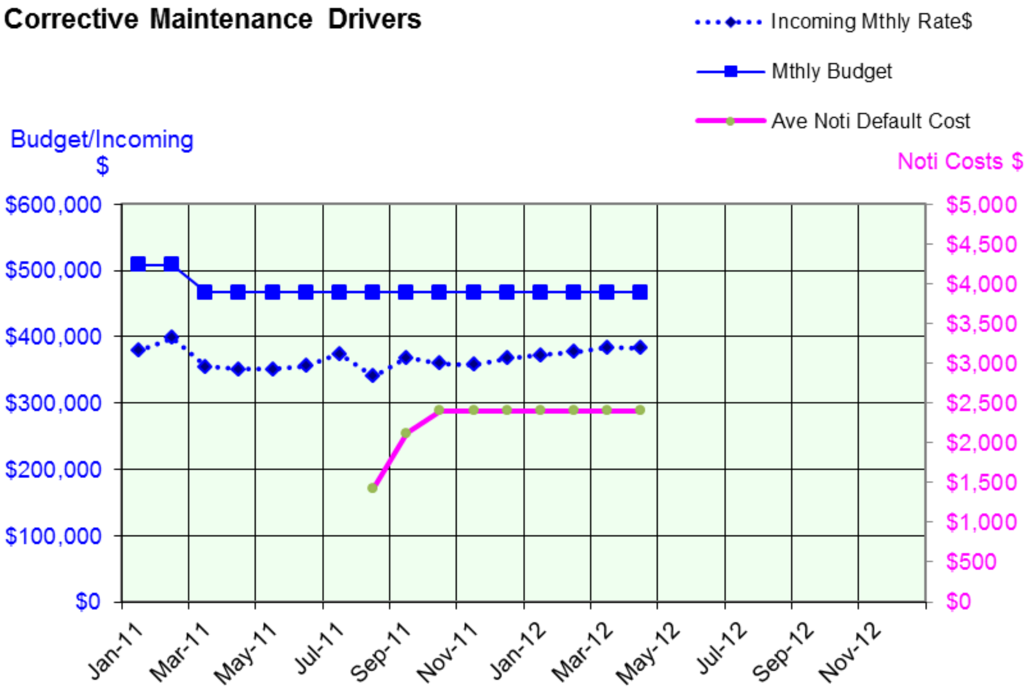


Figure 6.5: Incoming Substation and Secondary Systems Defect Rate

Figure 6.5 above shows:

- The estimated value of incoming monthly defect notifications compared to the current expenditure level;
- The expenditure level is currently higher than the incoming rate in order to deal with the accumulated corrective effort of defect notifications (it is estimated that with the current expenditure level the accumulated corrective effort will be completed by 2014-15).

To adequately manage the incoming defect notifications for Substations and Secondary Systems requires an ongoing annual budget of $4,500,000 ($2011-12).

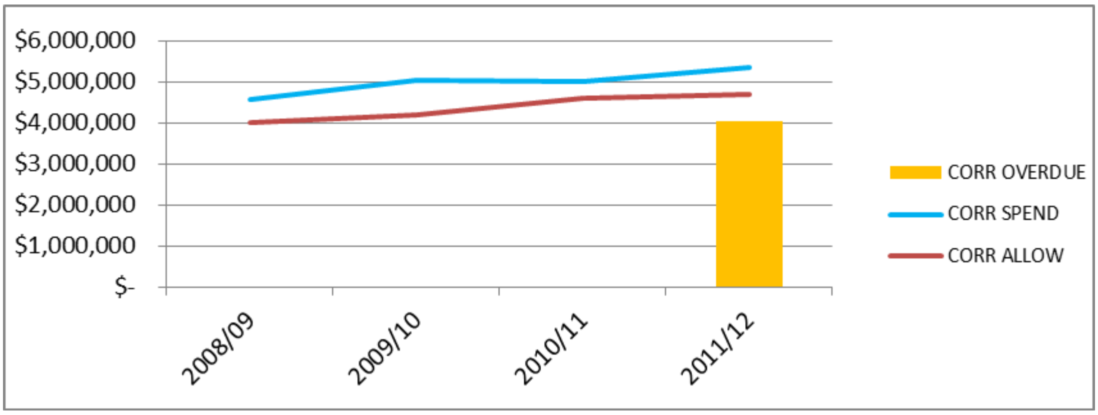


Figure 6.6: Substation and Secondary Systems Accumulative Requirement to Annual Expenditure

To address the accumulated corrective effort a total budget of $2,500,000 ($2011-12) over two years (2013-14 – 2014-15) is required.

Note that ElectraNet has throughout the current regulatory period already reprioritised its maintenance effort over and above this category allowance to address higher asset risk issues – to the extent possible with available resources.

Table 6.7: Substation and Secondary Systems Defect Maintenance Cost Estimate

Defect Maintenance	Annual Estimate Yr1 ($2012/13)	5 Yr Estimate ($2012/13)
Substation Defect Maintenance (Ongoing)	$4,100,000	$21,100,000
Substation Defect Maintenance (Accumulated – Yr1 and 2 only)	$1,100,000	$2,300,000
Secondary Systems Defect Maintenance (Ongoing)	$720,000	$3,700,000
Secondary Systems Defect Maintenance (Accumulated – Yr1 and 2 only)	$210,000	$430,000
Total	$6,130,000	$27,530,000

Refer to Appendix C for a full discussion of the SCAR framework and forecast estimation.

6.2.5 Substation capital projects

Substation replacement projects for the 2013 to 2018 regulatory period are summarised as follows:

Table 6.8 Substation Replacement Projects

Substation	Region	Comment on replacement driver	Estimate ($2012/13)
Millbrook substation	Eastern Hills	Asset replacement - condition based	$13,400,000
Kanmantoo substation	Eastern Hills	Poor Condition of Substation assets and emergency transformer deployed in 2011	$14,400,000
Kincraig substation	South East	Poor asset condition and augmentation transformer capacity (2013-2018)	$41,600,000
Baroota substation	Mid North	Poor Condition of Substation assets and connection point reclassification	$17,600,000
Neuroodla substation	Upper North	Primary and secondary assets at end of life	$11,200,000
Morgan / Whyalla #1 substation	Riverland	Primary and secondary assets at end of life	$23,300,000

Substation	**Region**	**Comment on replacement driver**	**Estimate ($2012/13)**
Morgan / Whyalla #2 substation	Riverland	Primary and secondary assets at end of life	$16,300,000
Morgan / Whyalla #3 substation	Riverland	Primary and secondary assets at end of life	$12,700,000
Morgan / Whyalla #4 substation	Riverland	Primary and secondary assets at end of life	$13,100,000
Mannum / Adelaide No.1 substation	Eastern Hills	Primary and secondary assets at end of life	$17,500,000
Mannum / Adelaide #2 substation	Eastern Hills	Primary and secondary assets at end of life	$15,900,000
Mannum / Adelaide #3 substation	Eastern Hills	Primary and secondary assets at end of life	$12,000,000
Mount Gunson substation	Upper North	Primary and secondary assets at end of life	$11,400,000
10509 Whyalla Terminal Substation Replacement	Eyre	Poor Condition of Substation assets & connection point reclassification	$33,100,000 (WIP _ 2008-13) $8,800,000 (WIP _ 2014-18)
10503 Waterloo Substation Replacement	Mid North	Poor Condition of Substation assets & connection point reclassification	$21,900,000 (WIP _ 2008-13) $4,800,000 (WIP _ 2014-18)
Keith Substation	South East	Poor asset condition and augmentation transformer capacity (2013-2018)	$18,800,000 (WIP _ 2013-18) $15,200,000 (WIP _ 2019-23)
Leigh Creek Substation	Upper North	Delayed pending long term future of supply point	_
Leigh Creek South Substation	Upper North	Delayed pending long term future of supply point	_

The Unit Asset Replacement program is aimed at efficiently addressing plant and equipment risk at the unit level to enable the overall substation asset to achieve its full intended service life, avoiding the need for full asset replacement.

Table 6.9: Substation Unit Asset Replacement

Project	**Estimate ($2012/13)**
Unit Asset Replacement (Primary Plant & Secondary Systems)	$35,400,000
Total	$35,400,000

Table 6.10: Secondary System Replacements

Project	Estimate ($2012/13)
Para 275kV Secondary Systems Replacement	$31,500,000
Para SVC Secondary Systems Replacement	$16,700,000
NGM CT, VT & Meter Replacement	$16,700,000
Asset Condition Online Monitoring Equipment Replacement	$12,000,000
Total	$76,900,000

6.2.6 Long run substation asset profile

Timing of capital replacement projects determines long run maintenance effort and functionality risk. The objective is to maintain an acceptable level of risk which is reflected by the maintenance effort and asset functionality. Modelling of these profiles based on the proposed capital replacement plan for the next three regulatory periods is shown below.

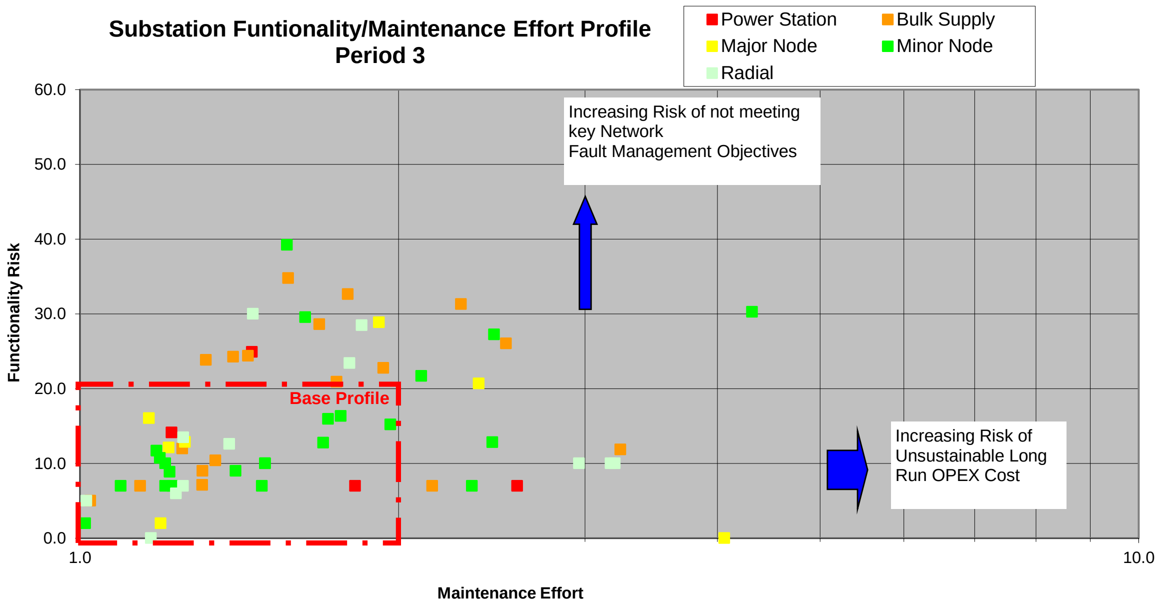


Figure 6.7: Substation Asset Profile (2013-14 to 2017-18)

Figure 6.7 above shows the effect of asset replacement programs for the 2013-14 to 2017-18 regulatory period indicating an overall reduction in high maintenance effort/poor functionality assets (compared to Figure 6.3 which shows the current position)

The following figures show the effect of future replacement programs based on replacement at end of technical life.

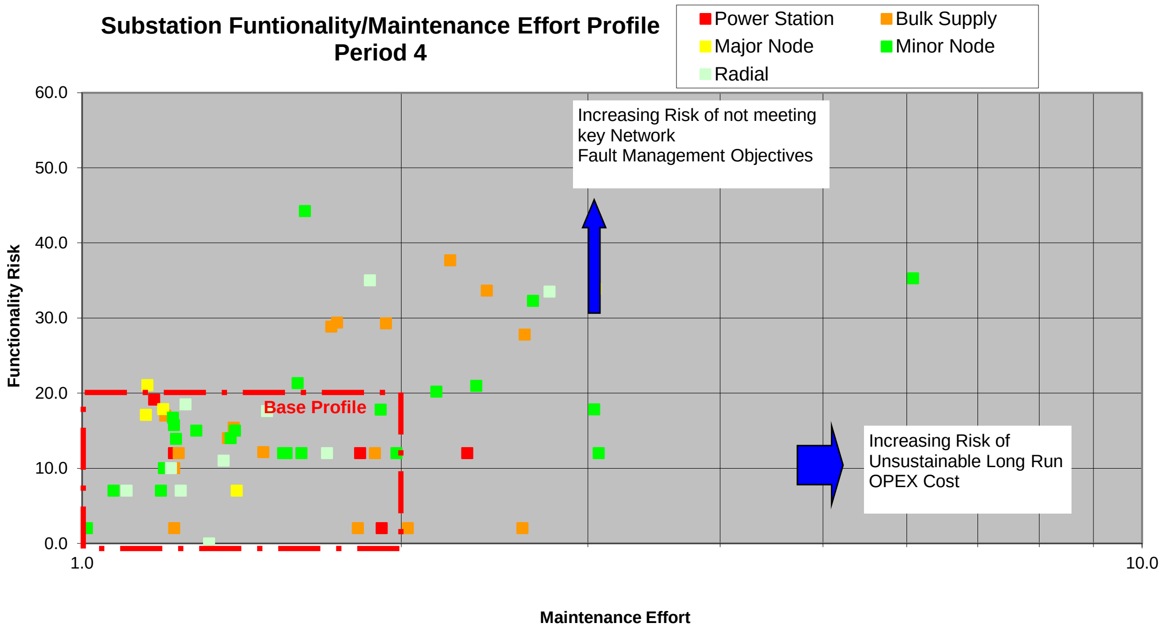


Figure 6.8: Substation Asset Profile (2018-19 to 2022-23)

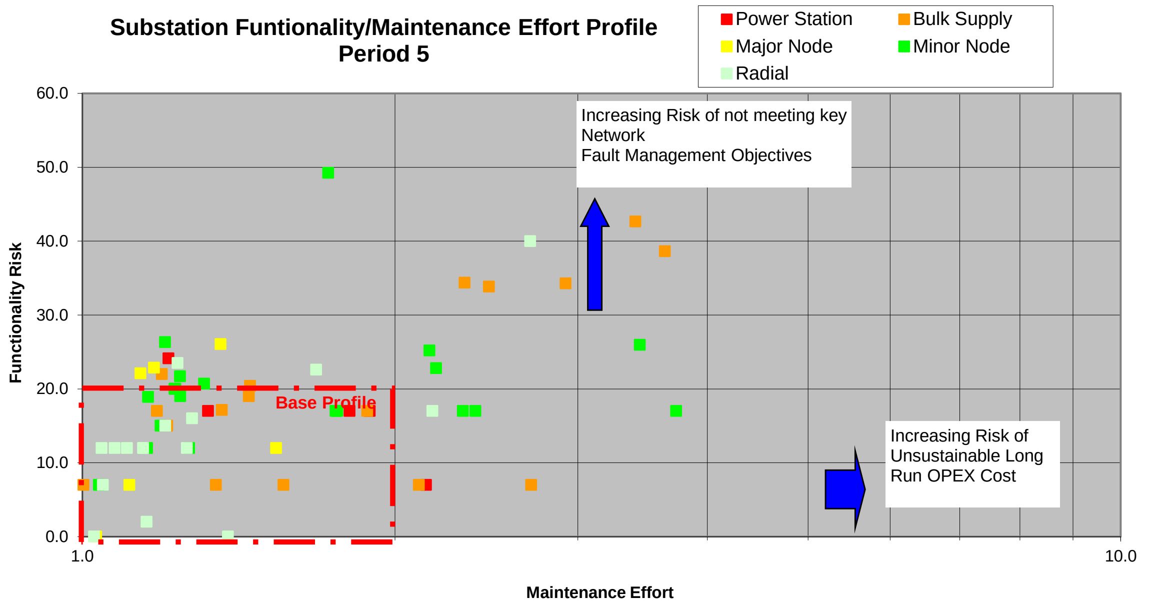


Figure 6.9: Substation Asset Profile (2023-24 to 2028-29)

Aggregating the diagrams above, the long run effect of the substation asset replacement program is shown in the figure below indicating a long run reduction in maintenance effort (corrective). In later periods the need to replace secondary systems begins to dominate functionality risk.

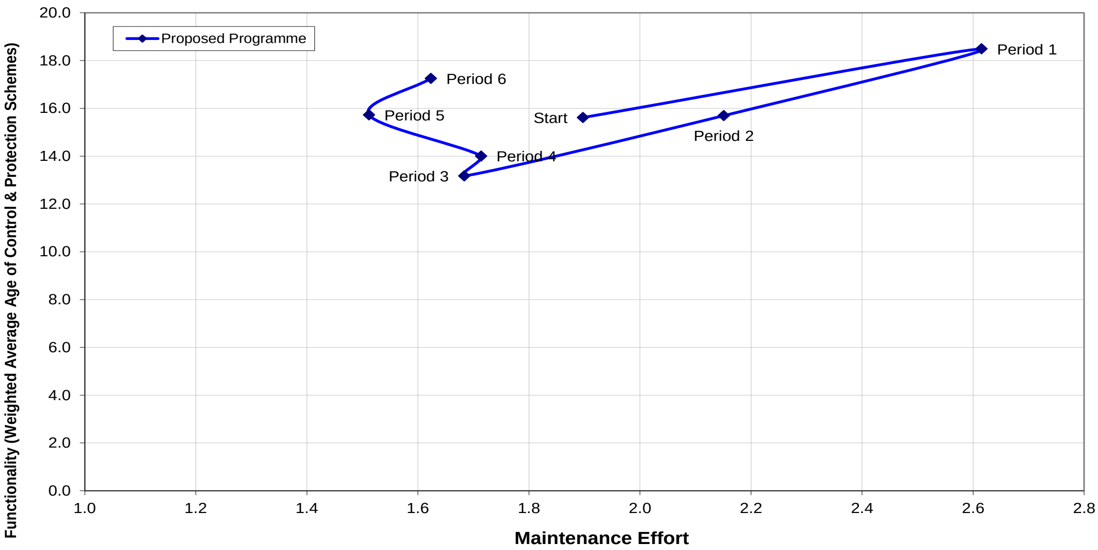


Figure 6.10: Asset 20 Year Risk Profile

6.2.7 Substation maintenance expenditure profile

A summary of substation and secondary systems operating expenditure for the current and following periods is shown below indicating:

- A sustained routine maintenance effort;
- An increased refurbishment maintenance effort (driven by large asset overhaul, isolator refurbishment and transformer oil containment and maintenance requirements);
- An initially increasing defect maintenance effort required to mitigate accumulated corrective maintenance requirements.

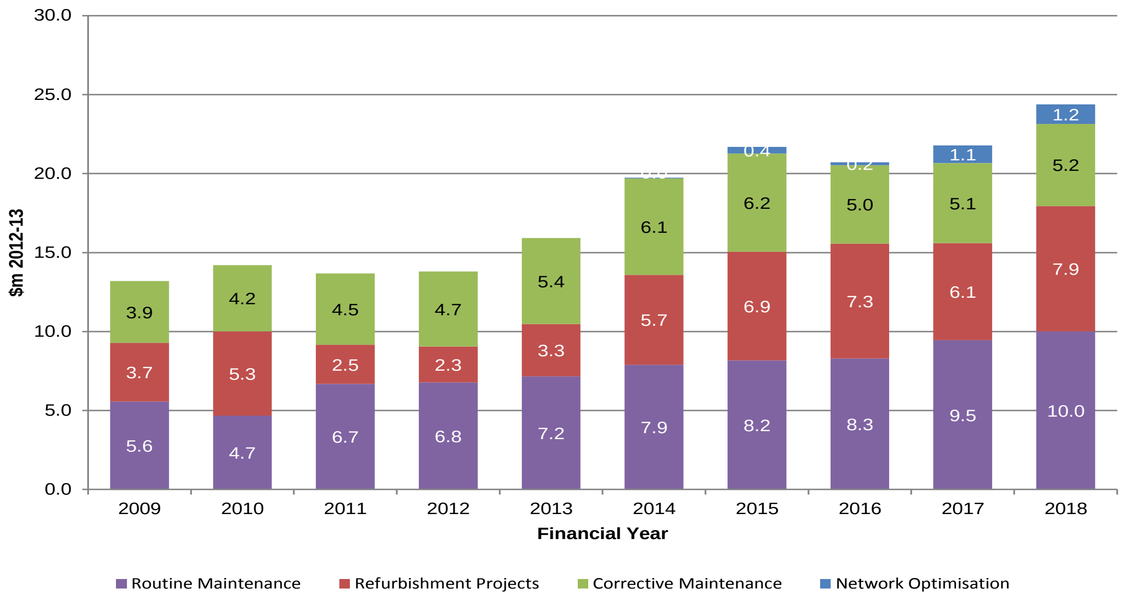


Figure 6.11: Substation maintenance expenditure profile

6.3 Transmission line management plan

Implementation of the Transmission Line Management Plan for the 2013–2018 regulatory period is based on the following considerations:

- Transmission Line maintenance will complete the 1st routine maintenance cycle during the 2013-14 to 2017-18 regulatory period;
- Condition assessments conducted during the current period indicate the need to bring forward inspection of line components on some transmission lines (the increased inspection requirement is based on the need to collect and analyse component condition data in order to fully assess the P-F interval as quickly as possible given the indicators of asset deterioration);
- Refurbishment projects are based high risk asset maintenance priority, identified by condition assessment already completed;
- Defect maintenance rates projections for 2013-14 to 2017-18 are based on current defect profiles – an increased annual defect maintenance spend to $6m per annum is indicated;
- Substation replacement projects focus on replacement of line insulation identified by line voltage drop tests completed during the current condition assessment program.

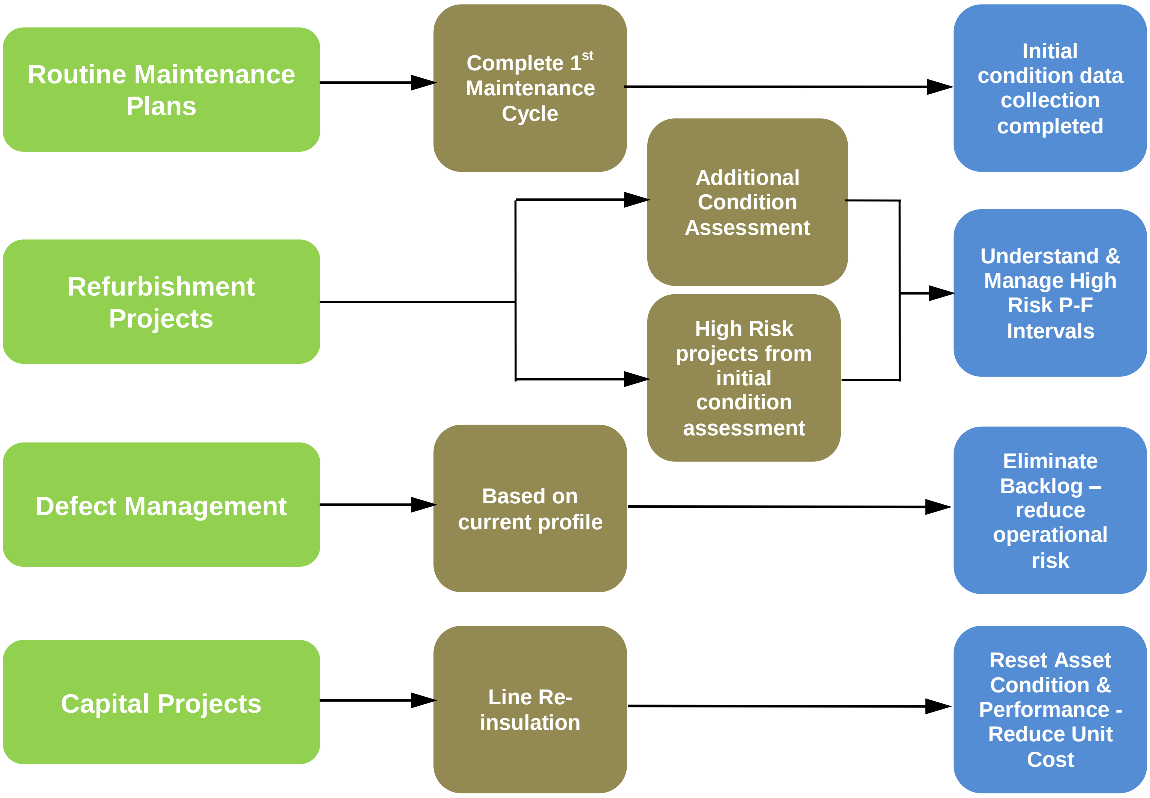


Figure 6.12: Transmission Line Management

6.3.1 Condition assessment

The aim of condition assessment is to establish where on the lifecycle curve the various components that make up a transmission line fit, to provide an estimate of both the general condition and the expected remaining life of components that make up the asset.

An estimate of where a component is on its technical life cycle requires the input of any three of the following typical parameters:

- Environmental aggressiveness
- Age of component
- Current condition
- Replacement criteria

The following graph shows the interdependency of each parameter. This approach is used as the basis for all transmission line condition assessments (note this approach takes into account the environmental conditions, these usually are the main drivers of transmission line asset deterioration).

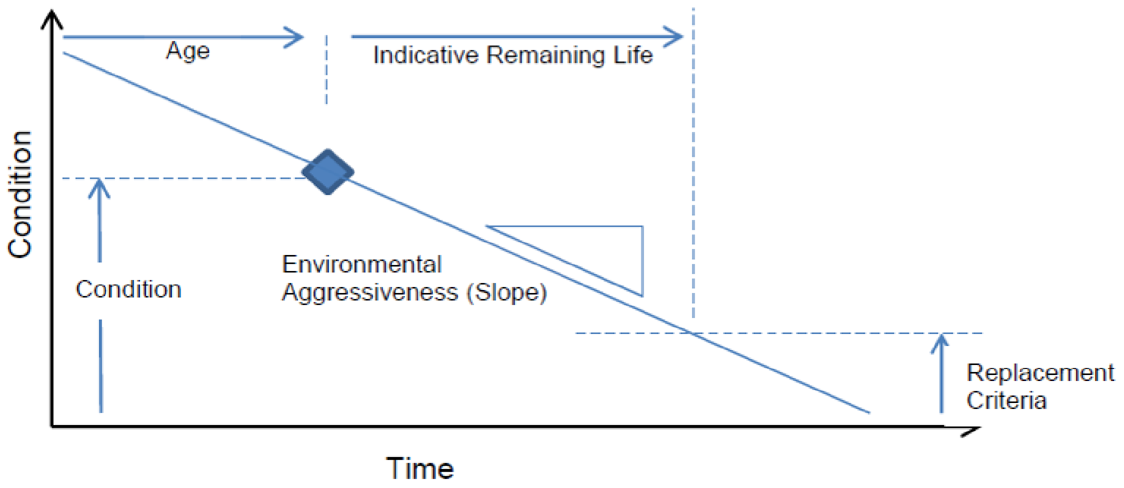


Figure 6.13: Simple (Linear Degradation) Condition Assessment Model

6.3.2 Transmission line asset profile

Condition and maintenance costs for each transmission line feeder have been assessed by:

- Undertaking a detailed condition assessment of those feeders known to have asset component deterioration based on all currently available data and field inspection reports;
- Undertaking a desktop assessment of current information for all feeders with no significant component deterioration;
- Identifying defect maintenance cost/km for each feeder using SAP defect notification work order costs (for the previous five year period).

A summary of the transmission line asset profile is shown below indicating the condition score and corrective maintenance cost for all feeders. Analysis of the assessment and proposed response are discussed in the following section.

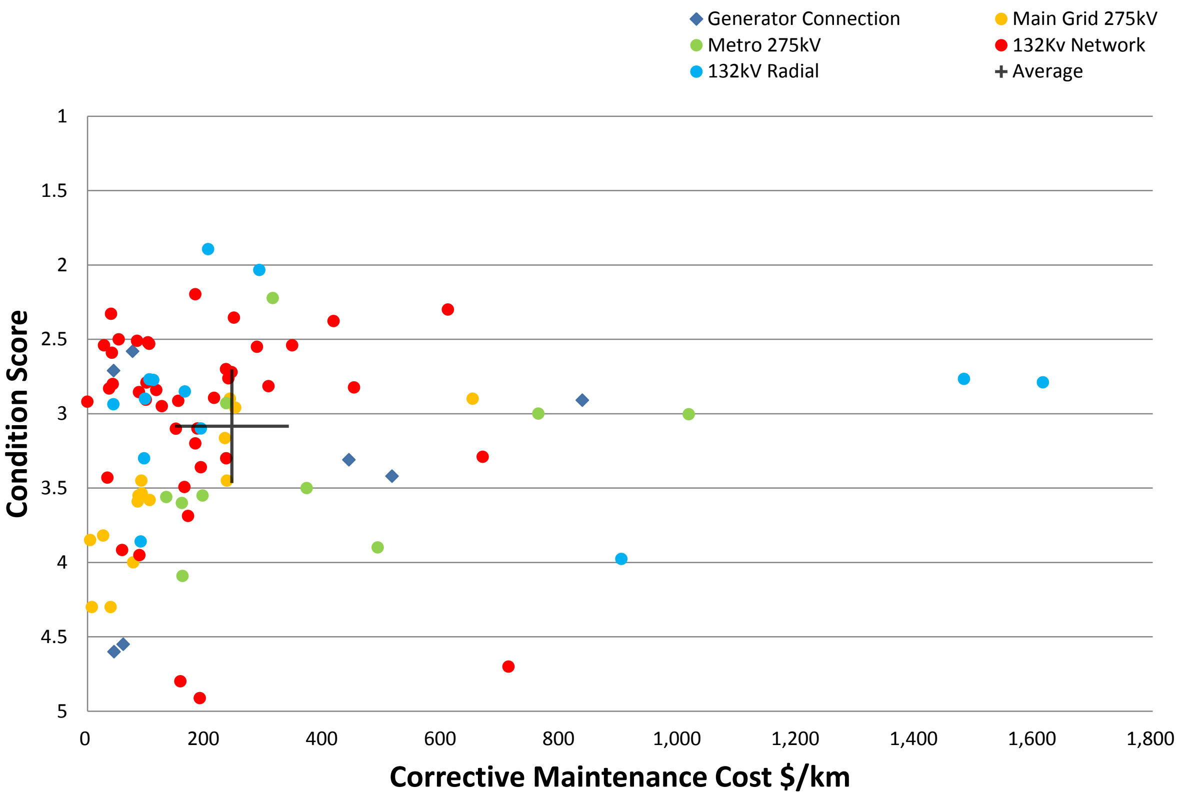


Figure 6.14 Transmission Line Asset Profile

Note:

- A condition score of 5 indicates good condition and high confidence in assessment data
- A condition score below 3 indicates component deterioration and/or low confidence in assessment data.

As systematic collection and analysis of transmission line asset data has commenced in the current regulatory period and is yet to complete a full maintenance cycle, response to the transmission line asset profile is as follows:

- Where condition data clearly indicates component deterioration approaching end of life, component replacement/refurbishment projects have been developed in order to mitigate functional failure risk;
- Where confidence in condition data is poor, specific condition assessment projects (in addition to routine maintenance inspection) have been developed in order to correctly determine remaining life and to understand the P-F interval;
- For those feeders showing good condition scores but above average defect costs further assessment of performance is required.

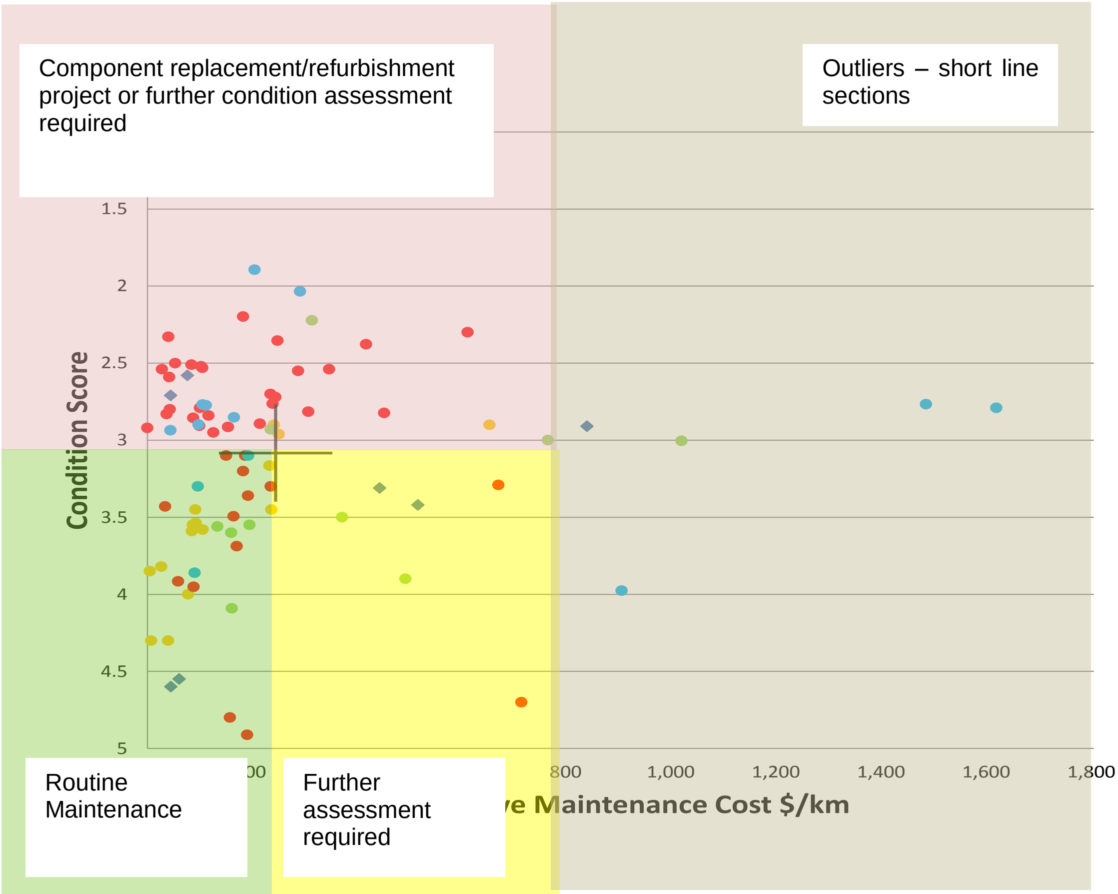


Figure 6.15: Transmission Line Asset Profile Analysis

Figure 6.14 indicates the response to asset condition incorporated in the asset management plan for each segment of the condition/cost chart:

- Low condition scores indicate the need for detailed field assessment and potential refurbishment;
- High condition scores indicate continuing routine maintenance only is required;
- Higher unit cost assets indicate need for specific investigation.

6.3.3 Transmission line routine maintenance plans

Routine maintenance includes all aspects of transmission line maintenance including easements and vegetation management. Management of transmission line assets is represented in Figure 6.16 showing the overall relationship between maintenance policy, asset performance and strategic review.

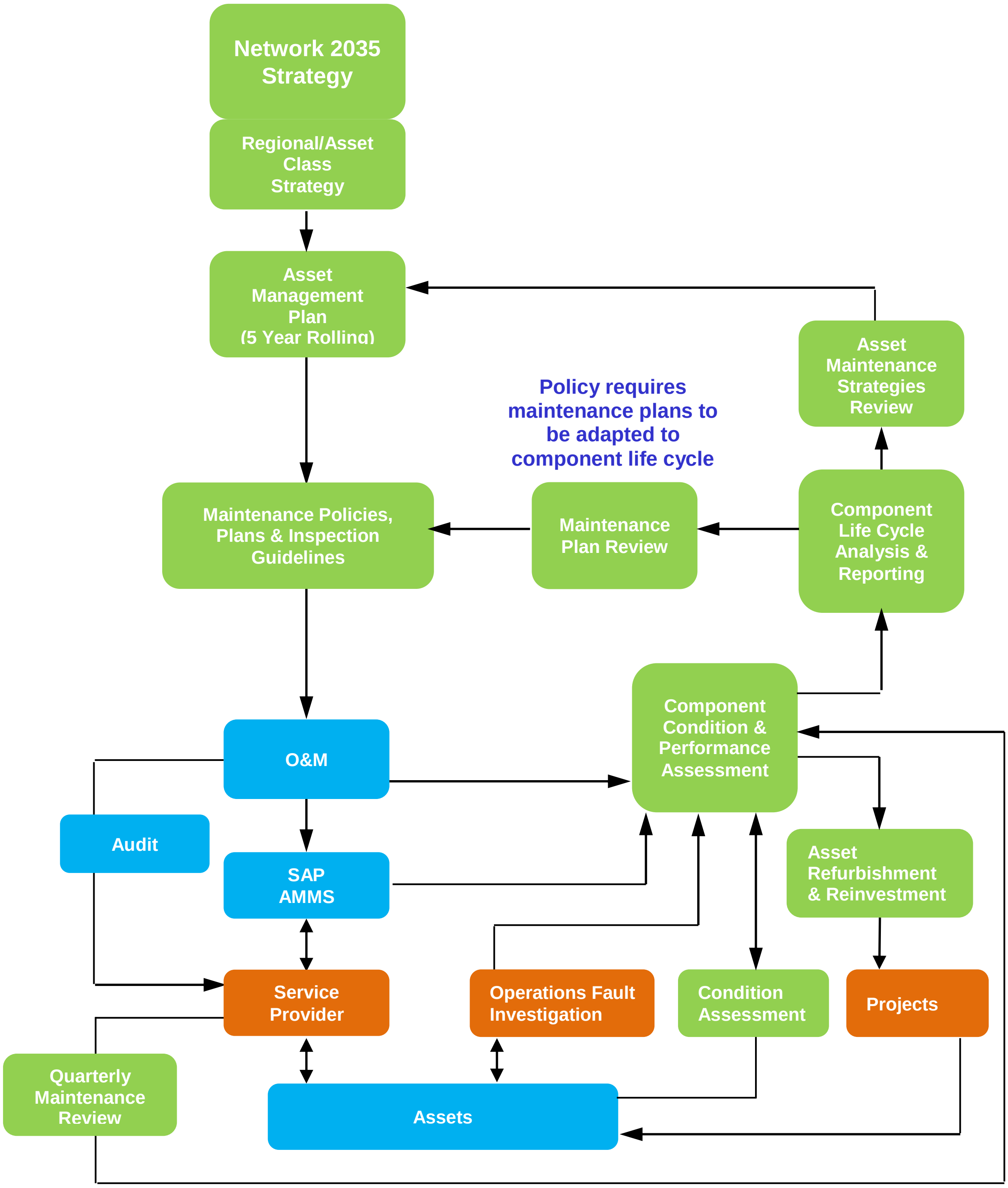


Figure 6.16 Asset Management Cycle - Transmission Lines

Current status of the maintenance plan is as follows:

- Powerlink maintenance plans have been implemented for a period of approximately two years;
- Considering the overall maintenance frequency of these plans most assets will not complete the first maintenance cycle until part way through the 2013-2018 Regulatory Period;

- Based on a review of inspection practice, fire start risk and asset condition transmission line pre-bushfire season aerial inspection tasks have been increased;
- No material change to maintenance plans is proposed; during the 2013-18 regulatory period analysis of condition assessment data will be used to further optimise the maintenance plan.

Table 6.11: Transmission Line Routine Maintenance Plan Estimated Cost

Routine Maintenance	5yr Estimate ($2012/13)
Transmission Line Routine Maintenance Plan	$22,000,000
Vegetation Management	$7,000,000
Total	**$29,000,000**

6.3.4 Transmission line corrective maintenance

As full development of SCAR coding and deployment to MGT was only completed in December 2011 a well-developed defect maintenance trend is not yet available. Preliminary cost and defect information for incoming defect rates are shown in the figure below.

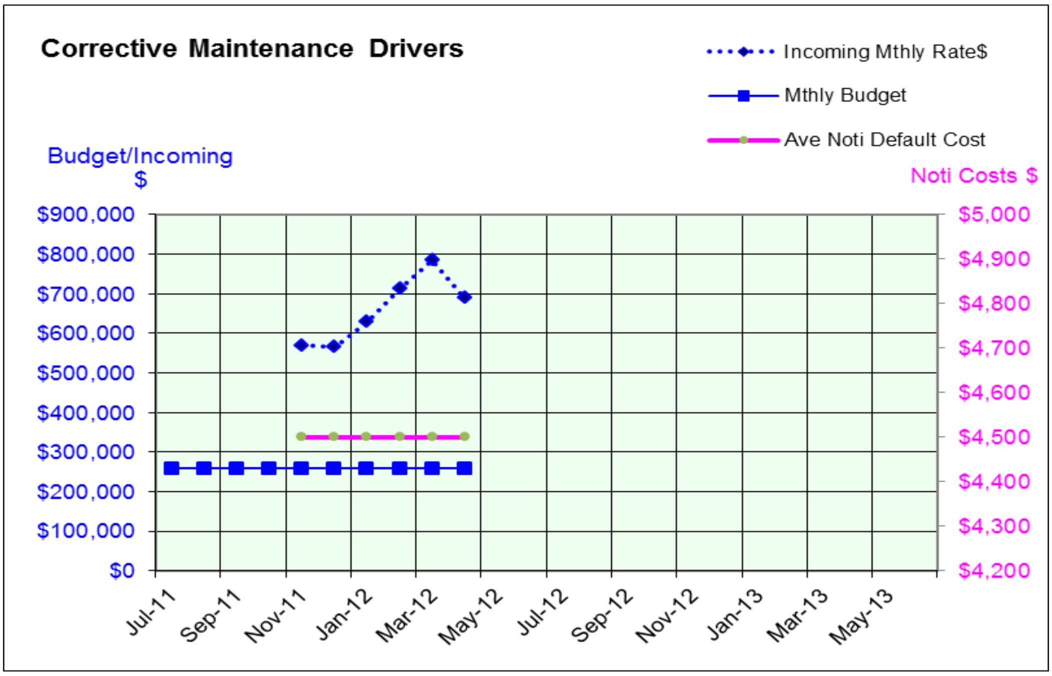


Figure 6.17 Incoming Transmission Lines Defect Rate

Figure 6.17 indicates that:

- The estimated value of incoming monthly defect notifications is greater than that of the current expenditure level;
- The current annual expenditure is adequate to deal with incoming Operational, Safety and Environment (urgent high risk defect notifications) only;

- To adequately manage the incoming defect notifications for asset risk notis (known as R defect notis) requires an additional annual expenditure of $3,000,000 ($2011-12).

To adequately manage the incoming defect notifications for Transmission Lines requires an ongoing annual budget of $6,000,000 ($2011-12).

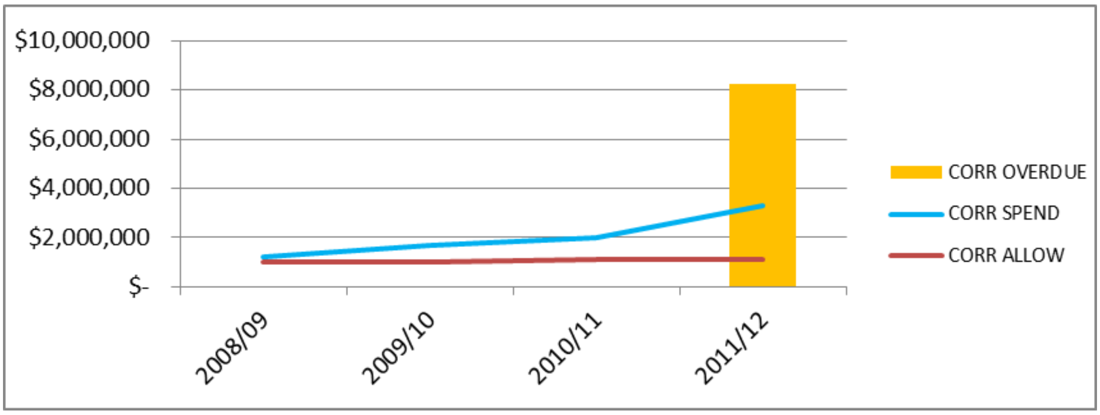


Figure 6.18: Transmission Lines Accumulative Requirement to Annual Expenditure

To address the accumulated corrective effort a total budget of $6,000,000 ($2011-12) over three years (2013-14 – 2015-16) is required.

Note that ElectraNet has throughout the current regulatory period already reprioritised its maintenance effort over and above this category allowance to address higher asset risk issues – to the extent possible with available resources.

Table 6.12: Transmission lines defect maintenance cost estimate

Defect Maintenance	Annual Estimate Yr1 ($2012/13)	5 Yr Estimate ($2012/13)
Transmission Lines Defect Maintenance (Ongoing)	$6,400,000	$33,200,000
Transmission Lines Defect Maintenance (Accumulated – Yr1, 2 and 3 only)	$2,100,000	$6,500,000
Total	$8,500,000	$39,700,000

Refer to Appendix C for a full discussion of the SCAR framework and methodology for developing expenditure forecasts.

6.3.5 Transmission line asset refurbishment

The Asset Refurbishment Plan has been generated by utilising asset condition assessment information to identify OPEX Maintenance Projects to undertake replacement/refurbishment of groups of asset components based on risk and cost justification. The Asset Refurbishment Plan has also been based on the overhead transmission line functional element groups. Refer Appendix L.

Underground HV Cable Management Plan has been specifically developed to address asset risks which are specific to underground HV cables of both oil-filled and XLPE cable types. Refer Appendix O.

Separate from managing asset condition risk, the Asset Rating & Risk Management Plan and an Easement Management Plan aim to provide asset information for ElectraNet to manage its legal and regulatory risk by being able to demonstrate compliance with its legal obligations of managing its transmission lines according to the SA Electricity Act and Regulations as well as relevant industry guidelines. Refer Appendix I and Appendix N respectively.

Due to the long cycle time of routine maintenance and therefore asset condition data collection, a Transmission Line Condition Assessment Plan has been developed to accelerate condition assessment information collection and analysis on high risk assets. This information directly informs the Transmission Line Refurbishment Plan via an efficient and timely process. The Transmission Line Condition Assessment Plan has also been based on the overhead transmission line functional element groups so to match the structure of the refurbishment plan. Refer Appendix M.

Together these Plans allow a structured risk managed and cost efficient approach to transmission line management.

A summary of the OPEX Projects to be conducted as per the various Plans are summarised below, a more detailed description of each plan is shown in the appendices:

Table 6.13: Transmission Line Refurbishment Projects – High Priority

Project	Estimate ($2012/13)
Transmission Line Refurbishment	$6,700,000
Total	**$6,700,000**

Table 6.14: Underground Cable Refurbishment Projects – High Priority

Project	Estimate ($2012/13)
Underground Cable Refurbishment	$660,000
Total	**$660,000**

Table 6.15: Asset Rating and Risk Management Projects – High Priority

Project	Estimate ($2012/13)
Asset Rating and Risk Management	$290,000
Total	**$290,000**

Table 6.16: Transmission Line Condition Assessment Projects – High Priority

Project	Estimate ($2012/13)
Transmission Line Condition Assessment	$15,200,000
Total	**$15,200,000**

Table 6.17: Easement Management Projects – High Priority

Project	Estimate ($2012/13)
Easement Management	$4,300,000
Total	**$4,300,000**

6.3.6 Transmission line removal

Specific transmission lines have been identified for decommissioning and removal and are summarised below. Refer to Appendix J for full discussion.

Table 6.18: Transmission Line Decommissioning and Removal Projects - High Priority

Project	Estimate ($2012/13)
Line Decommissioning and Removal	$2,400,000
Total	**$2,400,000**

6.3.7 Transmission line capital projects

No transmission line replacement projects are proposed for the 2013-14 to 2017-18 regulatory period. However, line re-insulation projects have been identified for a number of transmission feeders where the insulator components have reached end of technical life.

Table 6.19: Transmission Line Capital Project List

Project	Estimate ($2012/13)
F1910/1911 Para To Davenport Line Hazard Mitigation (Re-insulation)	$34,100,000
F1827 Tailem Bend to Keith No 2 Line Refurbishment (Re-insulation)	
F1804 Brinkworth to Mintaro Line Refurbishment (Re-insulation)	
F1905 Magill to Happy Valley Line Refurbishment (Re-insulation)	
F1844 Cultana to Stony Point Line Refurbishment (Re-insulation)	
F1864 Penola West to South East Line Refurbishment (Re-insulation)	
F1914 Magill/East Terrace Underground Cable Pit Construction	$21,800,000
Total	**$55,900,000**

6.3.8 Transmission line maintenance expenditure profile

A summary of transmission operating expenditure for the current and following period is shown below indicating:

- A sustained routine maintenance effort (based on the full implementation of condition based routine maintenance);
- An increased refurbishment maintenance effort (driven by accelerated condition assessment and tower/footing refurbishment requirements);
- An initially increasing corrective maintenance effort required to mitigate accumulated asset defect corrective requirements.

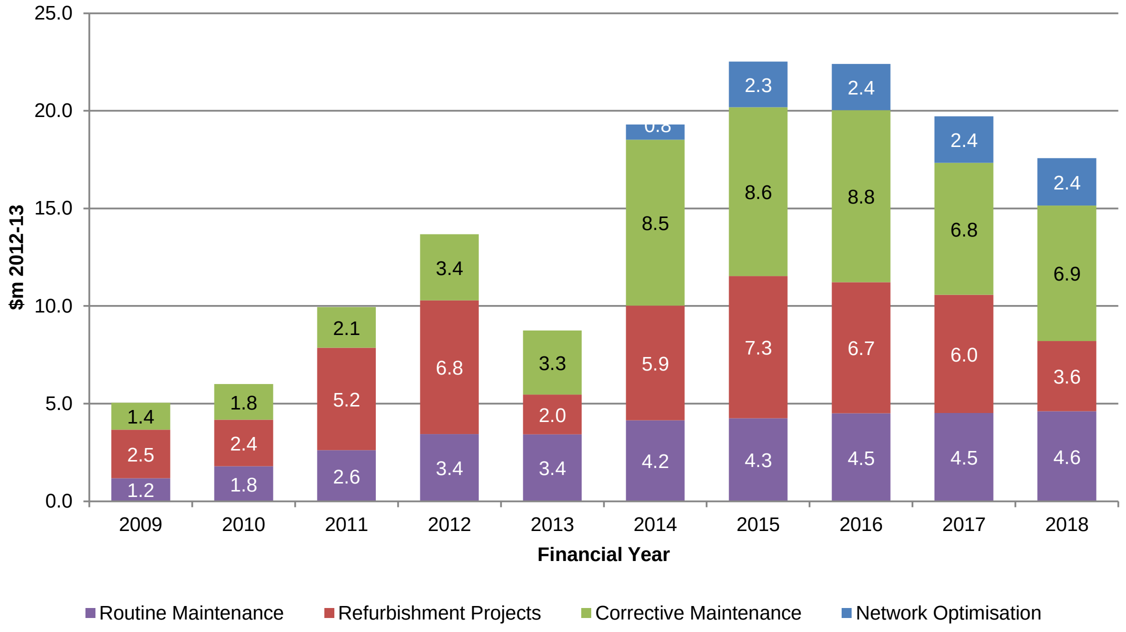


Figure 6.19: Transmission Line Maintenance Expenditure Profile

6.4 Telecommunications management plan

The Telecommunications Management Plan is based on the Telecommunications Strategic Development Plan, the overall structure of which is shown below.

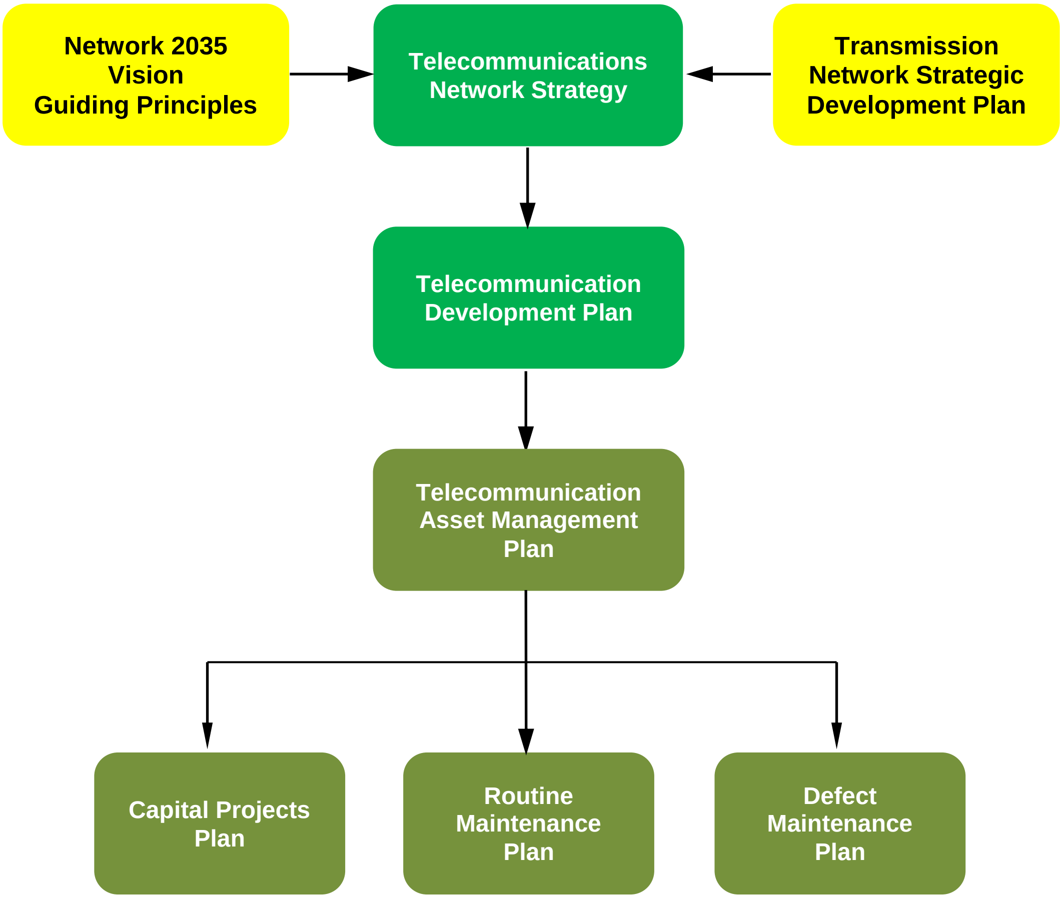


Figure 6.20 Telecommunications Management Planning Structure

Development of the telecommunications network is driven by:

- The requirement to provide specific levels of service across the transmission network (e.g. link reliability and availability for protection signalling);
- Transmission Network augmentation projects.

The Asset Management Plan considers augmentation to develop required new capacity and to maintain service level requirements of the communications network; as well as routine, refurbishment and defect maintenance requirements.

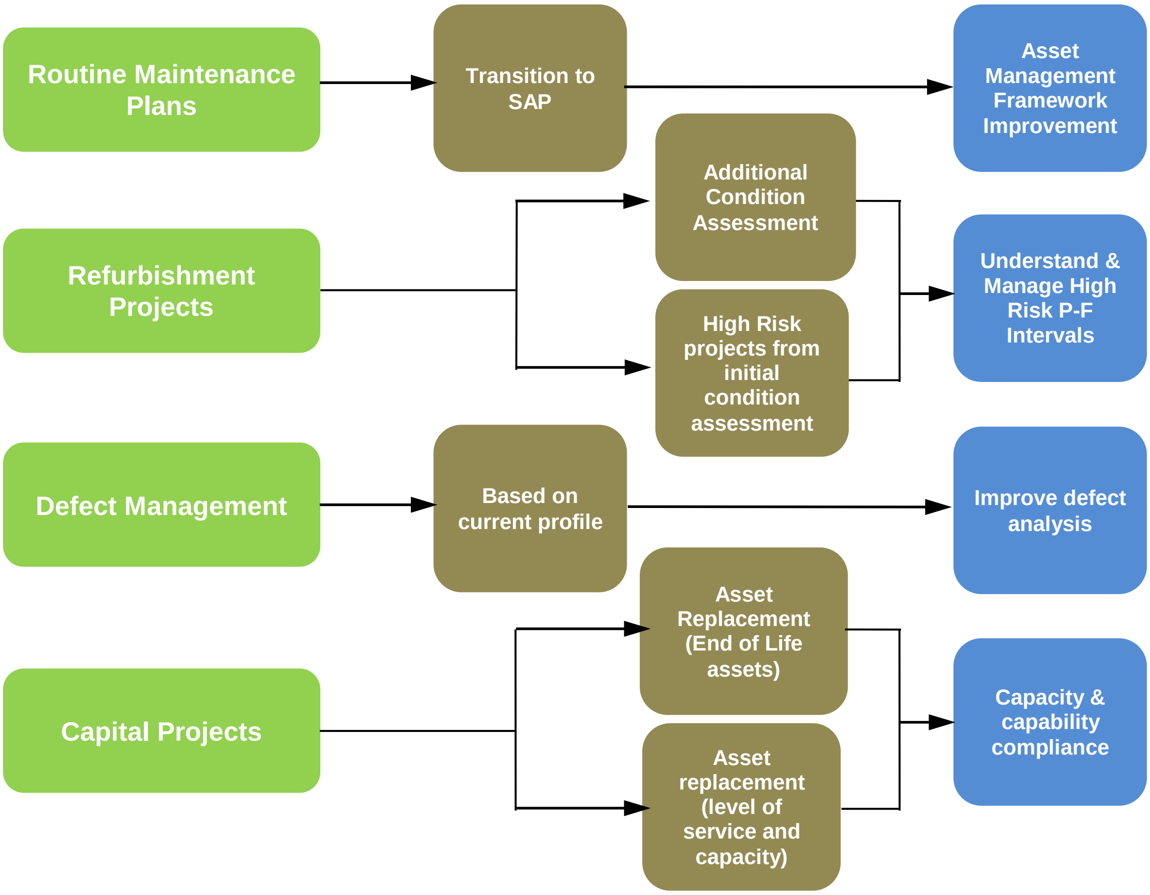


Figure 6.21: Telecommunication Asset Management

6.4.1 Communication asset profile

The overall profile of communication network assets is represented below, the main aspects of the profile are:

- Asset capability is becoming increasing important as more efficient communication protocols become available and significant increases in traffic volume and associated performance requirements impact on existing assets;
- Assets at end of life will impact on the ability of the network to provide reliable services and meet increasing performance requirements (link reliability and availability).

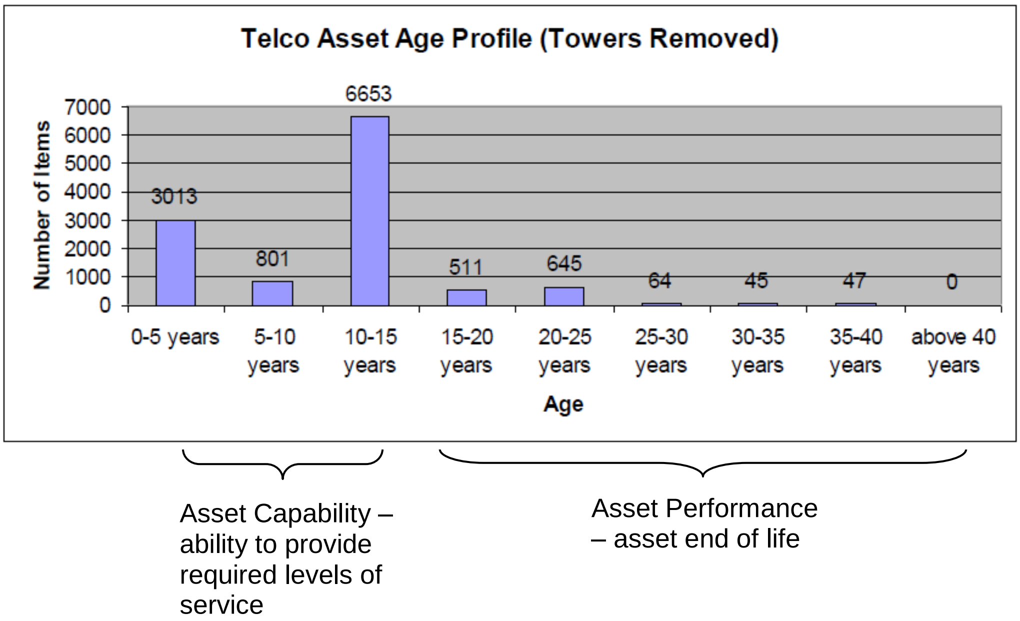


Figure 6.22 Communication Network Asset Profile

6.4.2 Telecommunications routine maintenance

Routine maintenance of telecommunication assets is based on routine maintenance cycles for main equipment types. Most of the electronic card and rack based assets are maintained on a defect basis as required.

The basic routine maintenance framework is set out below.

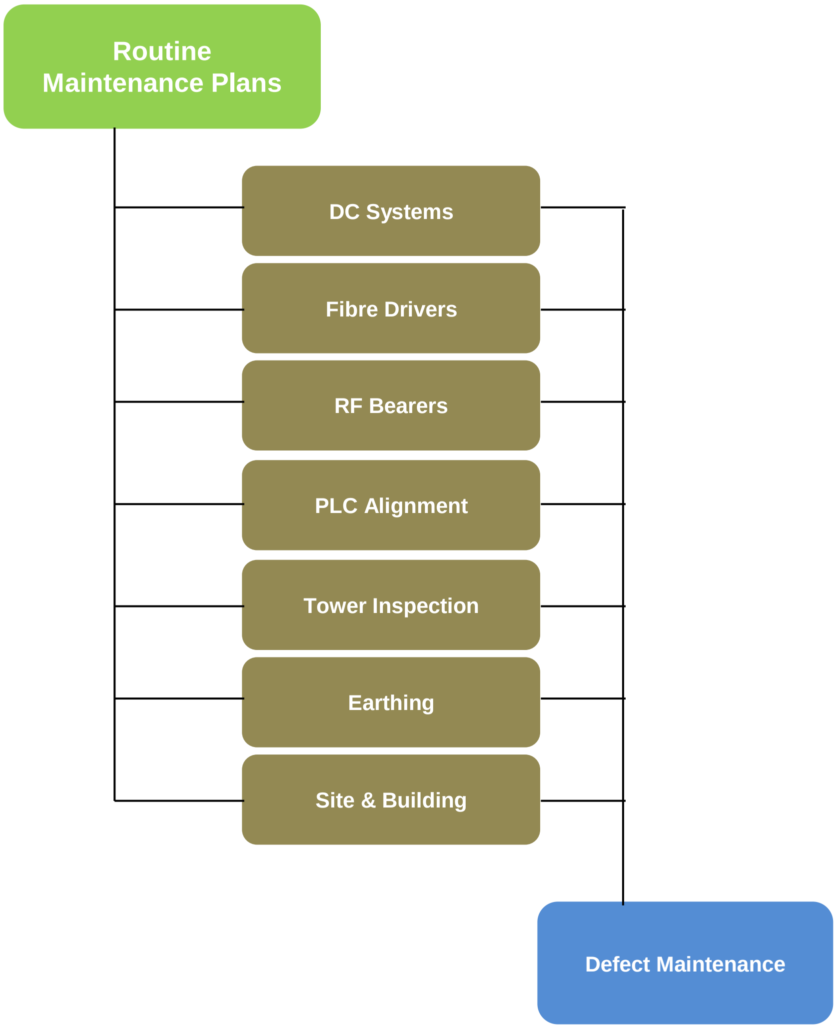


Figure 6.23 Telecommunications Routine Maintenance Framework

Table 6.20: Telecommunications Routine Maintenance Estimate

Routine Maintenance	5yr Estimate ($2012/13)
Telecommunications Routine Maintenance Plan	$8,100,000
Total	**$8,100,000**

6.4.3 Telecommunications asset refurbishment

The Telecommunications Refurbishment Plan is generated by utilising asset condition assessment information to identify OPEX Maintenance Projects to undertake replacement/refurbishment of groups of asset components (generally related to communication tower structure safety and maintenance).

The OPEX Maintenance Projects to be conducted per project type are summarised below:

Table 6.21: Telecommunications Refurbishment Projects

Refurbishment Projects	Estimate ($2012/13)
Telecommunications Refurbishment Projects	$1,100,000
Total	**$1,100,000**

6.4.4 Telecommunications Defect Management

Defect maintenance rate is estimated on a per annum basis according to the current defect profile.

Table 6.22: Telecommunications Defect Maintenance Cost Estimate

Defect Maintenance	Annual Estimate Yr 1 ($2012/13)	5 Yr Estimate ($2012/13)
Telecommunications Defect Maintenance	$270,000	$1,400,000
Total	**$270,000**	**$1,400,000**

6.4.5 Telecommunications Capital Projects

Capital projects are based on asset replacement at end of life (refer to Telecommunications Asset Management Plan) or network augmentation projects (refer to Telecommunication Development Plan).

Table 6.23: Telecommunications Capital Projects

Project	Estimate ($2012/13)
Asset Replacement (End of Life)	
Tel Asset Replacement - Metro Region	
Tel Asset Replacement - Mid North Region	
Tel Asset Replacement - South East Region	
Tel Asset Replacement - Eyre Region	
Tel Asset Replacement - Upper North Region	
Tel Asset Replacement - Eastern Hills Region	
Tel Asset Replacement - Riverland Region	$14,700,000
Asset Replacement (Capability)	
South East Substation to Heywood Telecommunications Bearer	
Yadnarie - Port Lincoln Backbone Telecommunications Links	
Riverland Telecommunications Bearer	
Barn Hill telecoms Bearer Replacement	$18,400,000
Total	**$33,100,000**

6.5 Research and development

ElectraNet routinely undertakes an internal and external SWOT analysis to identify current business risks that have changed or emerging risks. The outcomes from this process may drive Research and Development - Engineering Investigations (R&D) to determine the most appropriate risk mitigation strategy.

Current investigations and recent industry events has identified the R&D works to be conducted in the 2013-2018 period – refer to Appendix S.

Table 6.24: Research and Development Projects Cost Estimate

Research and Development Projects	Estimate ($2012/13)
Research and Development Plan	$430,000
Total	**$430,000**

6.6 Summary of Asset Management Plan forecasts

The asset management plan expenditure forecasts are shown diagrammatically below for each asset category.

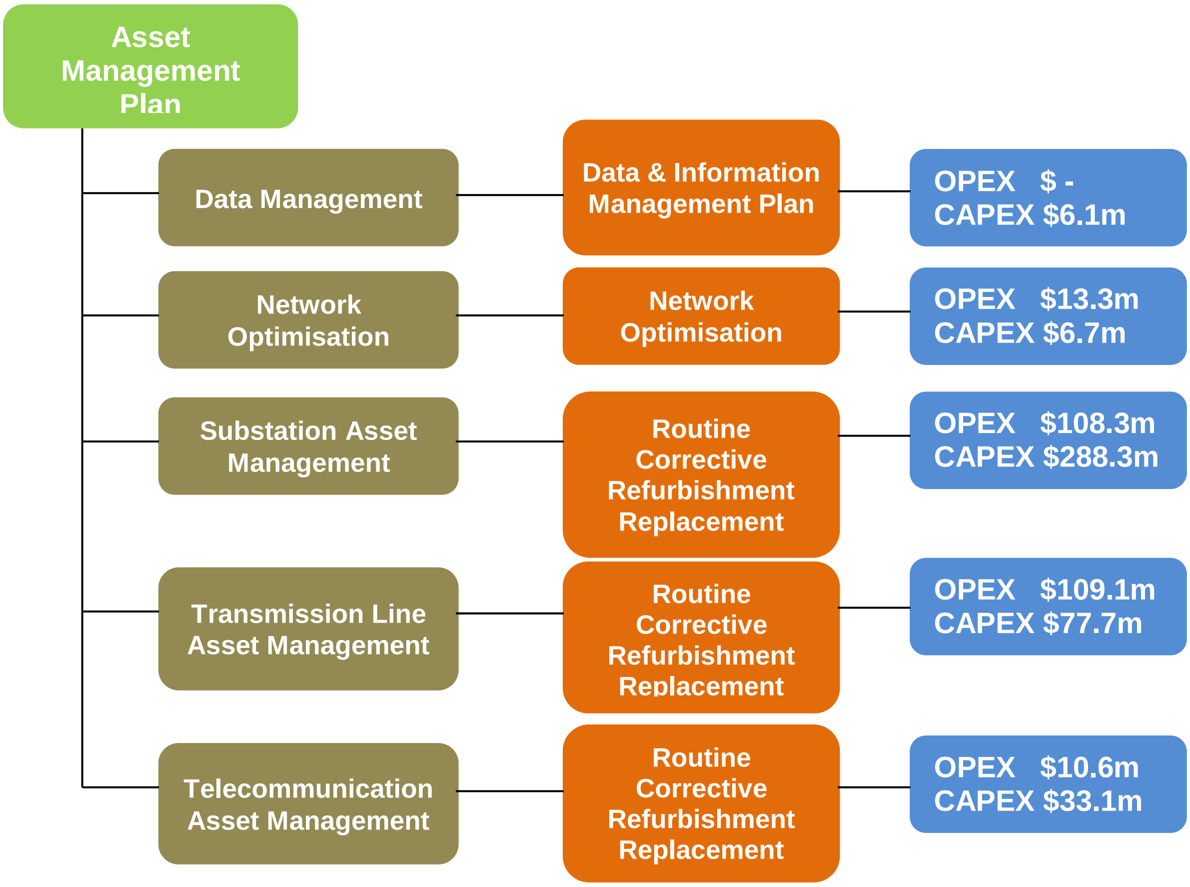


Figure 6.24: Asset Management Plan Outcomes ($2012/13)