Asset Management Plan

Underground System - Distribution

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Authorisations

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Responsibilities

This document is the responsibility of the Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Asset Strategy Team Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

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Record of revisions

Section number	Details
	New Document

Table of Contents

1 Purpose

The purpose of this asset management plan is to define the management strategy for the Underground System. The plan provides:

- TasNetworks' approach to asset management, as reflected through its legislative and regulatory obligations and strategic plans;
- The key projects and programs underpinning its activities; and
- Forecast CAPEX and OPEX, including the basis upon which these forecasts are derived.

2 Scope

This document covers the underground system and the associated furniture. The assets covered by this management plan include:

- Underground cables
- Associated joints and terminations
- Associated underground furniture

The following assets are excluded from the underground system asset group:

- All control and metering cables
- All streetlight cables from turret to streetlight poles and to the street lighting head.

3 Strategic alignment and objectives

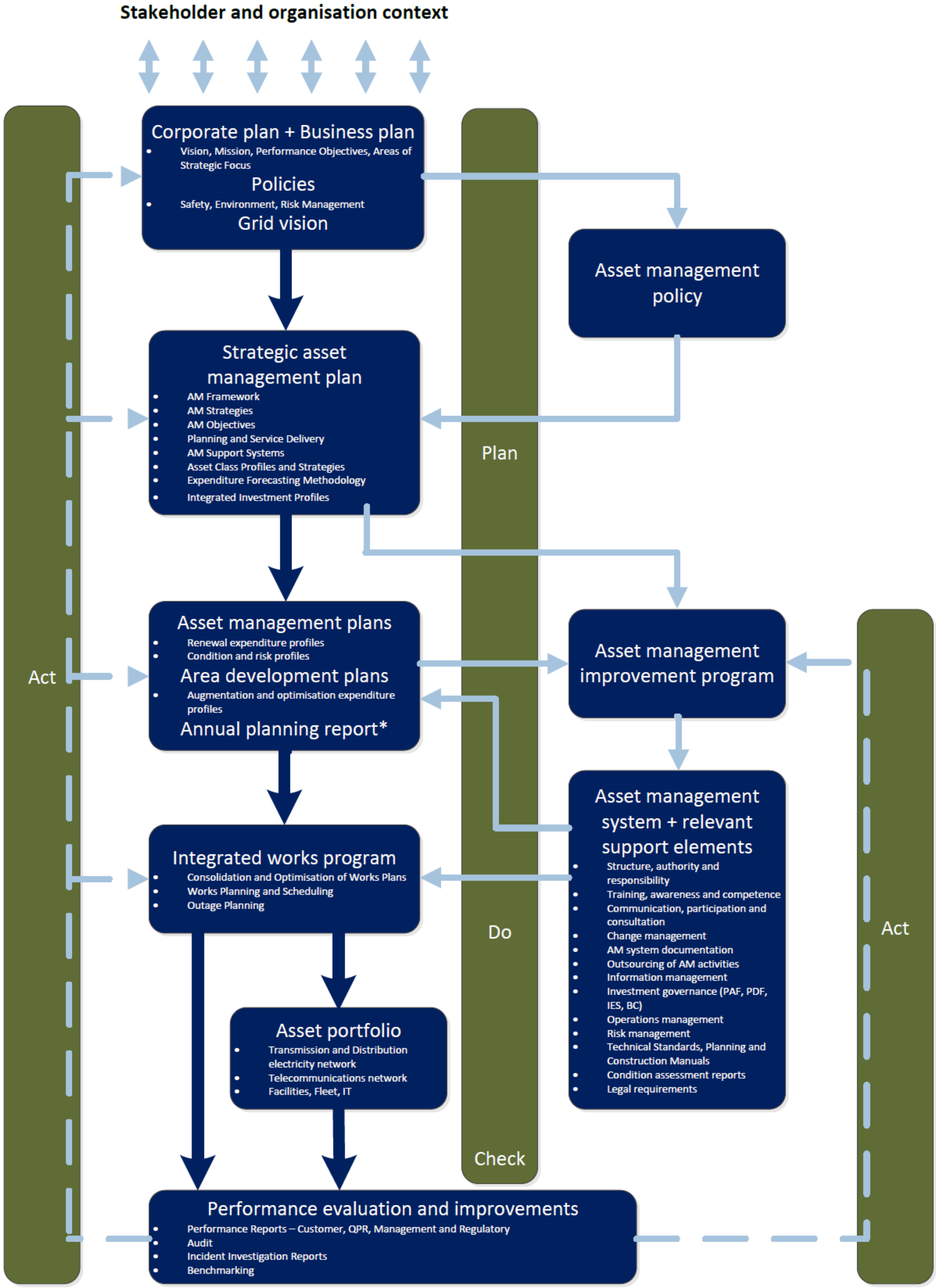
This asset management plan has been developed to align with both TasNetworks' Asset Management Policy and Strategic Objectives.

The asset management policy, contained within the Strategic Asset Management Plan, states 'Consistent with our vision and purpose, we strive for excellence in asset management and are committed to providing a safe working environment, value for our customers, sustainable shareholder outcomes, care for our assets and the environment, safe and reliable network services, whilst effectively and efficiently managing our assets throughout their life-cycle'.

It is part of a suite of documentation that supports the achievement of TasNetworks strategic performance objectives and, in turn, its mission. The asset management plans identifies the issues and strategies relating to network system assets and detail the specific activities that need to be undertaken to address the identified issues.

Figure 1 represents TasNetworks documents that support the asset management framework. The diagram highlights the existence of, and interdependence between, the Plan, Do, Check, Act components of good asset management practice.

Figure 1 – TasNetworks asset management documentation framework



* The Annual Planning Report (APR) is a requirement of sections 5.12.2 and 5.13.2 of the National Electricity Rules (NER) and also satisfies a licence obligation to publish a Tasmanian Annual Planning Statement (TAPS). The APR is a compilation of information from the Area Development Plans and the Asset Management Plans.

The asset management objectives focus on six key areas:

- Zero Harm will continue to be our top priority and we will ensure that our safety performance continues to improve.
- Cost performance will be improved through prioritisation and efficiency improvements that enable us provide predictable and lowest sustainable pricing to our customers.
- Service performance will be maintained at current overall network service levels, whilst service to poorly performing reliability communities will be improved to meet regulatory requirements.
- Customer engagement will be improved to ensure that we understand customer needs, and incorporate these into our decision making to maximise value to them.
- Our program of work will be developed and delivered on time and within budget.
- Our asset management capability will be continually improved to support our cost and service performance, and efficiency improvements.

4 Asset support systems

4.1 Systems

TasNetworks utilises Asset Management Information Systems which are maintained to contain up to date, detailed information with regard to the underground system.

The asset information related to the underground system is managed using a spatial data warehouse (G/Tech). This data base stores critical attributes for each site, including the site location and its interconnection to the network.

A works management system (WASP) is used to manage asset management activities and for the recording of asset performance.

4.2 Asset information

Asset related information is stored and accessed through the asset management systems. Where asset information is insufficient audits are undertaken to gather the information.

5 Description of the assets

The underground system asset group consists of:

- **Underground cables** to transport electricity at both high voltage (HV) and low voltage (LV) levels, including the cable fittings, easements and earthing systems
- **Joints and terminations** both outdoor and indoor to connect cables to each other and to other components of the distribution system including the LV cable terminations in wide based street light poles
- **Underground furniture** including turrets, cabinets, pillars, link boxes and service posts etc. To provide a safe and secure place for cable terminations and fittings, both above and below the ground

5.1 Underground cables

There are several different types, sizes and makes of underground cable within the distribution system. They operate at voltages of 33 kV, 22 kV, 11 kV and 400 V and are installed predominantly in the urban areas throughout the distribution system. There are several submarine cables located throughout the state crossing waterways or rivers of varying widths.

Table 1 provides a summary of the underground cables installed on the distribution network by voltage.

Table 1: Underground cables on the distribution network by voltage (September 2015)

Description of cables	Installed length (km)
33 kV cables (Sub Transmission Cables)	69
22 kV cables	522
11 kV cables	620
Other HV cables	1
Total length HV Cables (Including submarine cables)	1212
LV cables	1226

Figure 2: Comparison of cable lengths in service by voltage

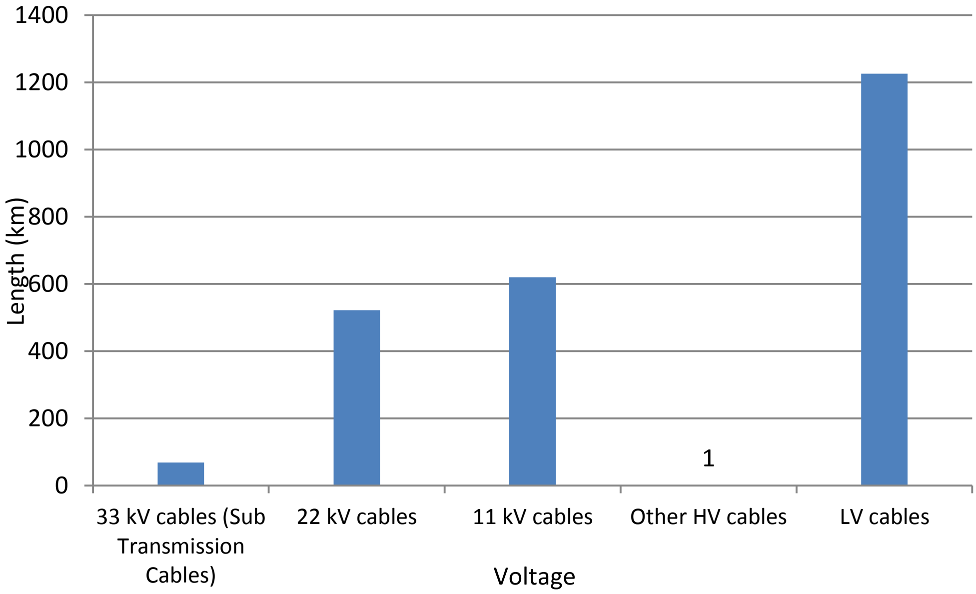


Table 2 provides a summary of the underground cables on the distribution network by type.

Table 2: Underground cables on the distribution network by type (September 2015)

Description of cables	Voltage	Installation period	Installed length(km)
Paper insulated, oil draining	HV	1920-1960	30
Paper insulated, Oil-filled Cable (Sub-transmission)	HV	1964-1971	16
Paper insulated, mass impregnated non-draining (MIND)	HV	1960-1992	505
Submarine cable	HV	1949 - Current	30
XLPE insulated, PVC/HDPE sheathed	HV	1992- 2010	447
XLPE-TR insulated, PVC/HPDE sheathed	HV	2007 -Current	184
Paper insulated, oil draining	LV	Pre-1960	15
Paper insulated, mass impregnated non-draining (MIND)	LV	1960-1978	207
CONSAC	LV	1971-1980	182
XLPE insulated, PVC sheathed (single to four core)	LV	1978- current	822

Table 3 details the 33 kV oil-filled cables on the distribution network

Table 3: 33 kV Oil-filled cables (September 2015)

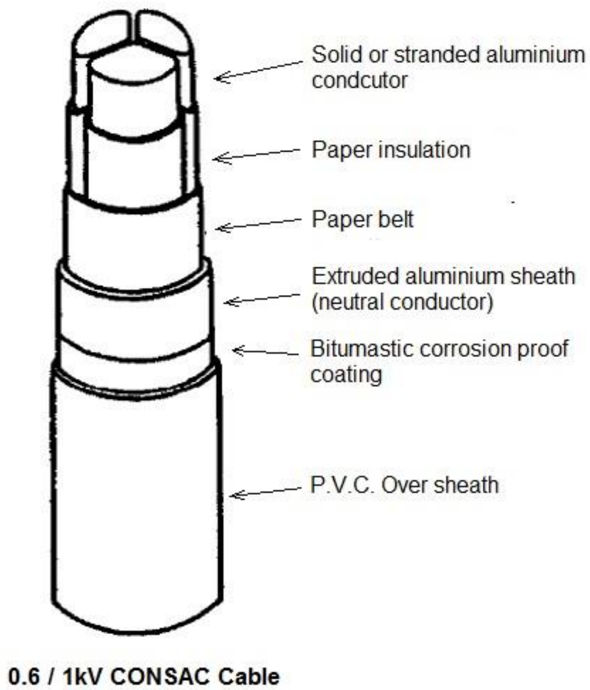
Feeder	Installation Year	Length (m)
East Hobart 4	1964	1834
East Hobart 5	1964	3656
East Hobart 6	1964	3146
Sandy Bay 8	1967	1122
New Town 23	1967	1443
New Town 24	1967	468
Claremont 26	1967	2,109
Bellerive 305	1971	1219
Bellerive 310	1971	685
	Total length :	16 054 metres

5.1.1 CONSAC cables

Concentric Neutral Solid Aluminium Conductor (CONSAC) cables are low voltage cables with the neutral conductor in the form of concentric aluminium sheath acting as a combined neutral and earth connection. They are paper insulated and covered with bitumen corrosion proof coating and PVC over-sheath.

TasNetworks installed these cables in underground residential subdivisions from 1971 until 1980. Current asset records indicate there are approximately 182 kilometres of CONSAC cable in the system.

Figure 3: CONSAC Cable Diagram



5.1.2 Oil filled cables

Oil-filled cables were introduced into the 33kV sub-transmission system in the early 1960s to supply a number of TasNetworks' zone substations. They have a corrugated aluminium metallic sheath to contain the oil within the cable and PVC over-sheath.

Oil filled cables are highly efficient and can operate at much higher temperatures (85˚C) than solid paper type cables (65˚C). This is due to the oil in the cables being maintained under a constant pressure so that it totally impregnates the cable paper insulation and fills any voids with oil so that ionisation is suppressed.

The cables, joints, terminations and tanks collectively contain approximately 26 000 litres of oil. Approximately 20 000 litres of spare oil is stored at TasNetworks' Oil Farm to meet the emergency needs of TasNetworks.

New oil must be treated prior to use to reduce unacceptable levels of moisture and gases. TasNetworks maintains two mobile oil treatment plants for the purpose of treating any oil prior to use.

The cables runs are divided into sections based on the gradient of installation and length of the section, so that the pressure in each section is maintained within controlled limits. Each section is fitted with its own oil tank that is specifically designed for that section.

The oil pressure is monitored in each tank through oil pressure gauges with a low-pressure alarm system. The alarm circuits are also monitored to ensure they are operational. These alarms are connected to TasNetworks' Supervisory Control and Data Acquisition (SCADA) system via pilot communication wires.

Although there are a relatively small number of these cables on the network and oil-filled cables have a low failure rate, the consequence of failure of these cables is significant because:

- The cables supply zone substations, so failure of a cable may result in large system outages
- Failure of oil-filled cables pose an environmental hazard because of the volume of oil they contain
- Repairs of failed oil-filled cables are expensive and time consuming requiring specialised skills (including freezing of the cables)

Oil-filled cables pits have been identified as a confined space. Any work requiring entry to the pits has to follow the procedures for working in a confined space in compliance to AS 2865: 2009, Confined spaces and Work Health and Safety Act and Regulations 2012 (references 2 and 4).

5.2 Joints and terminations

All underground cables have joints and terminations associated with the installations. Joints are used for connecting sections of underground cable together. Terminations are used for connecting the underground cable to other parts of the distribution network (for example to the overhead system or to ground mounted switchgear).

Table 4 details the types of terminations and joints installed in TasNetworks' distribution system as per G-Tech records at March 2014.

Table 4: Cable termination installed on the distribution network (September 2015)

Description	Voltage	Installation period	Number installed
Cast iron potheads	HV	Pre-1973	85
Heat Shrink terminations	HV	1973 - Current	1621
Total cable terminations on poles	HV	Current	2060
Cable termination on poles without surge arrestors	HV	Pre-2004	1536

5.3 Underground furniture

Underground cables are joined or terminated in various above- and below- ground enclosures collectively known as underground furniture. Underground furniture (HV and LV) is designed to provide a safe, secure and weatherproof environment for cable terminations, joints and associated equipment. The majority of LV enclosures contain LV switching devices, circuit breakers or service fuses for customer installations.

Table 4 provides a summary of the different types of underground furniture on the distribution network.

Table 5: Underground furniture installed on the distribution network (September 2015)

Description	Voltage	Number installed
HV Pillar (introduced 2006)	HV	<10
Cabinets (200 A and 400A)	LV	3801
Turrets (PE, HDPE, Fibreglass)	LV	16 205
Service posts (metallic)	LV	~50
Distribution pillars and switching devices	LV	193
Underground link boxes (UGLB)	LV	5

5.4 Cable accessories, easement and earthing systems

Cable fittings such as saddle plates, stand-off brackets, breakout boots, end caps and heat shrink sleeves are used to secure the cables at poles and for cable terminations. Surge arresters are also installed on HV cable poles to prevent damage to equipment in the event of a lightning strike to assets through overhead wires.

TasNetworks installs visual and mechanical protection for its cables to reduce the risk associated with inadvertent digging up of cables. Although AS 3000: Electrical Installations/ Wiring Rules [5] deems marker tape and cable covers as sufficient protection for cables and mitigation of public risks, TasNetworks also installs above ground cable markers and signs in limited areas. The above ground signage is restricted to only where the cable installation is not obvious or to cover any special circumstances, such as railway property easements, submarine cables, and oil-filled cables or in the case of special installation methods such as the plough-in of cables.

TasNetworks maintains easement records for locations where cables pass through a customer's private property in order to provide electricity supply to other customers in the area. No easement records are maintained if a cable is installed through a customer's private property to supply electricity to that single customer.

Earthing systems are installed at cable ends to earth the cable screens for safety and correct protection operation purposes in accordance to relevant Australian standards and Electricity Network Association (ENA) guidelines.

6 Associated risk

An assessment of the risk associated with the underground system has been undertaken in accordance with TasNetworks' risk management framework (2). For each asset in this asset class a detailed assessment has been made based on:

- Condition of underground system currently in service across the network
- Criticality of underground system and associated assets
- Probability of failure (not meeting business requirement)
- Consequence of failure
- Performance
- Safety
- Environment
- Customer

Based on these assessments a recommendation to control the associated risks has been made.

6.1 Underground system

6.1.1 Condition of assets

Underground system assets currently in service in the network are prone to several specific issues as discussed in the following sections:

6.1.1.1 Hot spots and overloading

Where TasNetworks' condition monitoring program (AIUCM) identifies either hot spots on assets or overloading conditions then actions are undertaken to remediate the risk if there is the potential of a failure occurring. This rectification work would be done under either the Asset Repair (OPEX) program or planned upgrade works (CAPEX).

6.1.1.2 Cathodic protection issues

Cathodic protection (CP) is used to protect critical steel infrastructure, such as bridges and steel pipelines (water and gas), from electrical interference or minor electrical currents through earthing systems. These systems are used mainly by other utilities, however, these CP systems can affect the earthing systems installed by TasNetworks and hence can affect the equipment enclosures (including cable metallic sheaths and armouring) attached to these earthing systems.

TasNetworks is approached by other utilities from time to time to install these CP systems and uses these opportunities to conduct a specialised test to check the effect of the CP on TasNetworks' infrastructure or vice versa. The testing is conducted in consultation with external assistance, as TasNetworks does not have the expertise and resources.

TasNetworks is also required to cooperate in the restriction and monitoring of possible CP issues by actively participating in state-wide corrosion committee meetings run by Workplace Standard Tasmania (WST).

6.1.1.3 Dial-Before-You-Dig

Dial-Before-You-Dig (DBYD) is a free national community service that connects users involved in all forms of excavation with the infrastructure owners of underground services to prevent the incidence of third party damage to underground infrastructure. TasNetworks is a member of this service and provides asset information and cable location marking on request through DBYD.

As an addition to the normal DBYD services, TasNetworks also provides a cable watcher to supervise any excavation activity within 2 m of any oil-filled cables due to the criticality of these assets (Refer Section 5.1.2).

The main aim of the program is to avoid costly damage. No change is proposed in current strategy or volumes.

6.1.1.4 Third party damage

Each year TasNetworks experiences approximately 20 incidents where third party excavation contractors dig up TasNetworks' cables. Excavation activities are on the rise due to the introduction and expansion of the natural gas network in the state. In addition to this there are on average 30 incidents per annum of accidental damage or vandalism to TasNetworks' underground furniture reported in TasNetworks' Outage Management System.

6.1.1.5 Sub-standard installations

Through routine inspections and third party notification, TasNetworks can become aware of installations that do not comply with the current standards. These standards may be set by TasNetworks or a legislative requirement.

Sub-standard installations can significantly increase the likelihood of an asset failure occurring and also present a significant safety risk to the public.

6.1.2 Criticality of asset

The underground System consists of components critical to the network. The majority of the sub-transmission supplies to the urban zones comprise one or more underground sections. Failure of these cables would result in a significant reduction in network security and can also result in a significant customer disruption.

Failure of high voltage cables and connections can result in part or full feeder loss and notable supply disruption.

The low voltage underground network, although critical for customer supply in underground areas, the relatively low number of connections to individual assets minimises the customer disruption in the event of an asset failure occurring.

6.1.3 Probability of failure

Where the probability of failure can be quantified to a reasonable level of accuracy and the consequences of failure are known, the level of risk can be quantified. This assessment is undertaken in accordance with TasNetworks' Risk Framework. The quantified risk is used to determine if a treatment plan is required to reduce this risk down to a manageable level.

The historical failure for the asset classes can be summarised as follows:

6.1.3.1 Cables

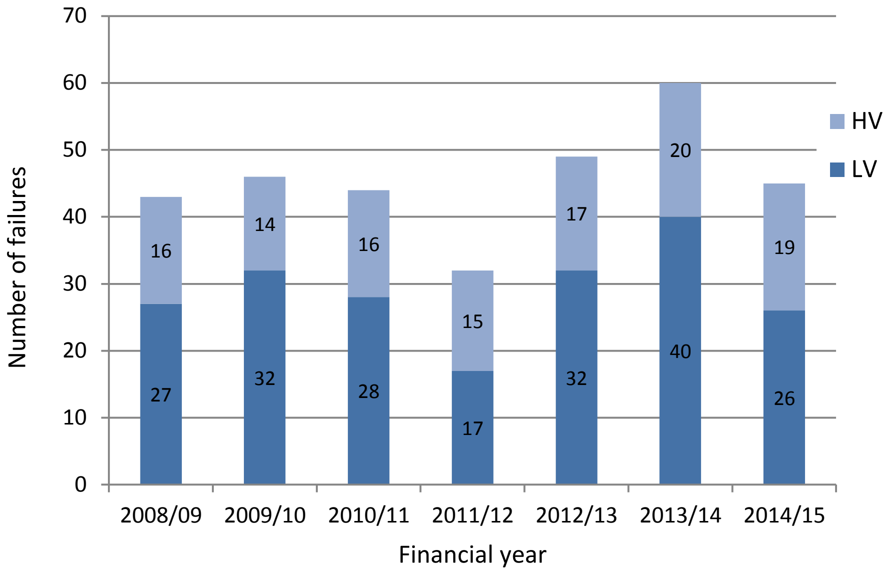
The number of cable failures on the network has remained relatively constant over the last 5 years with 45 failures in the last full year of 2014/2015.

There were 26 cable failures on the low voltage network, with 19 failures the high voltage network. Of the 26 cable failures on the LV network, 13 were on CONSAC cable. With CONSAC cable only representing 15 per cent of the underground LV network, the failure rate for this cable type is considerably higher than the average.

For the 33kV sub-transmission network, although no failures have occurred in recent years, some of the oil filled cables are showing sign of deterioration, and in some instances loss of oil has resulted. This situation requires ongoing monitoring to ensure the loss of oil does not result in an asset failure. Due to the criticality of these cables asset repair and replacement will be required prior to an in service failure occurring.

Figure 4 provides a summary of the number of LV and HV cable failures on the network since the 2008/09 financial year.

Figure 4: Instances of annual cable failure per financial year



6.1.3.2 Underground furniture

Underground furniture is designed to provide a safe, secure and weatherproof environment for cable terminations, joints and associated equipment.

Due to the environmental exposure the furniture does deteriorate over time. Where the condition has deteriorated to the point that they are no longer achieving their purpose they are replaced. Failures on the network are also caused by third party damage, usually from vehicle contact,

On average TasNetworks replaces 15 to 20 cabinets and turrets per annum.

6.1.4 Consequence of failure

The consequences of an asset failure occurring are varied, and dependent upon the criticality of the assets. The consequences of a failure can be categorised under the following main groups

- Performance on power quality
- Safety risk due to the exposure of live equipment loss of oil
- Environmental hazards due to oil and gas spills.
- Disruption to customer supply

The loss of a sub-transmission cable can result in a significant customer supply disruption impacting several thousand customers, where as a low voltage cable failure can result in loss of supply to just an individual customer.

The failure of other assets e.g. cast iron cable terminations, as well as disrupting customer supply, can also have the potential to cause harm to the public, with the likelihood dependent on the location of the asset.

The consequence for asset failure can be both broad and varied dependent on the type of asset. This large variance in consequence results in an equally large variance in risk.

7 Management plan

7.1 Historical

TasNetworks is satisfied that its expenditure on inspection and monitoring is prudent to manage the risk around oil and submarine cables as per current industry practices.

Consideration has been given to investigate some of the new technologies now on the market in an attempt to fill the void of condition monitoring for cable assets, but it is acknowledged that this is not an easy exercise.

Although reducing, the disproportionally higher failure rate of CONSAC is expected to remain until this cable type has been removed from the network. Failures require either reactive repairs or cable replacement to be undertaken. The level of consumer disruption is currently at a tolerable level (as per trend of contribution to System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI), but if the impact increases during the period of the program, the replacement program may require acceleration.

7.2 Strategy

7.2.1 Inspection and monitoring

Options for the inspection of cable systems are limited due to the fact they are installed underground, but inspections can be undertaken at terminations and at the shoreline for submarine cables.

Thermal scanning is a viable option to check pole top terminations. Whilst monitoring techniques are available (for both thermal and partial discharge), these systems are generally very expensive and often reserved for the most critical installations e.g. higher voltage cables (33 kV and above) and key circuits.

7.2.2 Routine maintenance versus non routine maintenance

There is minimal preventative maintenance that can be undertaken on underground cables due to the nature of the assets. Corrective maintenance of underground cables normally involves new cable joints to replace a section of cable after failure. HV jointing in particular is a skilled activity and reliability of the joint is highly dependent on the skills of the jointer.

Preventative measures to identify movement in soil levels or excavations by third parties can be proactively identified and remedied.

7.2.3 Refurbishment

Whist there are some life extending technologies currently available on the market to restore (refurbish) dielectric strength in HV XLPE cables, these assets have not demonstrated any performance issues to date.

As no performance issues are foreseen in the near future given the relatively young age of the XLPE cables, historically good installation practices and relatively cooler climatic conditions in Tasmania, this activity does not form part of TasNetworks' management plans.

7.2.4 Planned asset replacement versus reactive asset replacement

Due to the difficulty predicting the remaining life of cable assets, a large proportion of replacement work tends to be reactive following an asset failure. This approach is also driven by the time frames needed to plan a cable replacement and secure appropriate road opening permits etc. from councils and other affected parties. In some cases, where particular classes of cables have been identified as having a high likelihood of failure (such as CONSAC cables), planned asset replacement does occur which minimises customer supply disruptions and reduces the safety risks associated with the failures.

7.2.5 Non-network solutions

Cables are a fundamental requirement of the network with no viable non-network alternatives.

In most instances the distribution network has adequate redundancy to allow reconfiguration of the network when necessary to manage asset failures until repairs/replacement can be undertaken. Where this cannot be achieved the business has access to mobile generators to provide an alternative point of supply.

A significant non-network initiative to drive an improvement in the condition monitoring of network assets has been the introduction of Cable PI to the consumer population to allow customers to check for faulty neutral conductors.

7.3 Routine maintenance

7.3.1 Underground system condition monitoring (AIUCM)

The conditions of the HV and LV cables are, in general, unknown due to the prohibitive costs associated with proactive condition monitoring. Therefore, it is very hard to define any prudent cable replacement program or strategy in the absence of any historical condition information other than failure rates.

To overcome this difficulty TasNetworks is investigating options for condition monitoring some of the critical cables on the network. Possible condition monitoring methods include partial discharge and dielectric loss angle testing.

The main aim of condition monitoring will be to accurately (as much as practically possible) assess the remaining life of the old and critical cables using information from tests in conjunction with historical failure and load data.

The output of the condition monitoring program will allow for targeted asset replacement program where there is high likelihood of a critical cable failing.

If condition monitoring of cables is required it will most likely to be contracted out to an external service provider, as TasNetworks does not have the equipment necessary to conduct the specialised testing.

7.3.2 Underground cable Inspection and monitoring (AIUCT)

This program includes the following:

- Inspection and general testing
- Testing of earthing
- Pot holing
- Thermal inspection

Each of these activities is described in the following sections.

7.3.2.1 Inspection and general testing

Where defects may be present inspection and testing may be undertaken to determine if specific issues exist. Testing may comprise thermal scans which can detect hot spots or overloading conditions.

The use of cathodic protection systems on steel infrastructure (such as steel pipelines and bridges) can lead to degradation of cables and earthing systems. If situation may exist then specialised testing can be undertaken to make sure the assets are not adversely affected.

LV distribution pillars (or boxes) are above ground link boxes used for switching and reconfiguration of LV circuits. The pillars are constructed from either steel or fibreglass. The metal enclosures, although small in number, are in poor condition due to rust and corrosion. A small number of fibreglass pillars have also been identified to be in poor condition due to weathering or damage from vehicles. When defective installations are identified they are either repaired or replaced.

7.3.2.2 Testing of earthing

TasNetworks has identified a need to improve its knowledge of earthing systems associated with underground furniture to ensure compliance to AS3000 (Reference 5). TasNetworks is continuing to undertake earthing audits at locations that have the potential to present a significant risk to the public e.g. substations within school grounds. Five sites are audited per annum. Where deficiencies are identified remedial work will be undertaken.

There are approximately 10 000 earthing points installed in underground furniture.

7.3.2.3 Pot holing

On identification of a substandard cable installation, an audit is conducted to establish the extent of the substandard installation. Substandard cable installations can be found during various excavation activities or other works, related to cables or near the cables, for different purposes from TasNetworks or any other contractors or customers.

These audits are conducted by potholing and exposing the cables at intervals along the route. Rectification and risk treatment work is then planned based on the outcomes of the audits.

Historically, four to five investigations are completed each year for substandard depths. Each incident generally requires auditing of around 200 m of cable (approximately 15 to 20 potholes).

7.3.2.4 Thermal inspections

Thermal inspections of cable terminations are performed to locate hot spots and overloaded or overheated assets. Thermal inspections are triggered by load monitoring system information and the criticality of the cables in the system.

This program mainly covers thermal imaging of submarine cable poles and some other indoor and outdoor terminations.

7.3.3 Oil-filled cable inspection and monitoring (AIUOS)

Due to the catastrophic consequences of operating oil filled cables when they have suffered a pressure loss (Refer Section 5.1.2), monthly monitoring of pressure gauges is performed on all high voltage oil filled circuits, with some critical cables being monitored with a low-pressure alarm warning system. The alarm circuits are also monitored to ensure they are operational. These alarms are connected to TasNetworks' SCADA system via pilot wires.

In addition, annual testing of the cable sheaths is performed to pre-emptively detect any deterioration of the outer cable layers (corrosion of the outer metallic sheath) that may lead to oil loss. Operational testing of the two oil treatment plants to ensure the smooth running of the plants is also completed quarterly.

All the maintenance activities are performed as per TasNetworks' underground manual DS D UG 2 TasNetworks manual for Low Pressure Oil Filled Cables (reference 7).

7.3.4 Submarine cable inspection and monitoring (Visual) (AIUSU)

Due to the high cost of repair for submarine cables, an annual visual inspection of the cable entry and exit points is performed. This activity checks all signage is in place to deter civil works, fishing or anchoring activities and checks the general condition of the submarine cable termination.

7.4 Non-routine maintenance

7.4.1 Minor and major asset repairs (ARUCA)

Minor and major asset repairs consist of the rectification of faulty assets caused by cable failures, joint and termination failures, third party damages and other defects identified during various inspections. TasNetworks has experienced an increase in expenditure due to an increase in some of the activities as per the description in the following sections.

7.4.2 Asset repair (ARUOS)

The historical spend for undertaking asset repairs on oil filled cables has been quite low, but condition monitoring activities have identified deterioration in some of these cables. Some cables have shown signs of damage to their outer insulation and there are also instances of oil leaking from the cables. The source of the leaks requires further investigation and will result in either an asset repair being undertaken, with the possibly of a section of cable being replaced.

7.5 Replacement

The replacement of underground infrastructure occurs where the condition has deteriorated to the point where the business risk in the areas previously defined (Section 6) is above manageable limits.

The drivers are usually related to a notable safety risk or significant disruption to customer supply. These risks are identified through routine inspection and maintenance activities.

7.5.1 Cast iron potheads (22 kV, 11 kV and LV) (REPOA, REPOB, REPOC)

A cast iron pothead is a cable termination that consists of a cast iron box fitted to a multi-core cable in which the cores pass through porcelain bushings and enable the cable to be connected to the overhead system.

A proactive replacement program was initiated in 2008 due to incidents where the cast iron casing on the pothead termination had cracked, leading to water ingress and failure of the termination. In several instances the failure resulted in the cast iron casing being blown apart. The force behind the explosion is directly proportional to the voltage level. This type of failure poses a safety risk to members of the public and TasNetworks personnel.

The prioritisation for replacement is based on a rating that is derived from the voltage and level of public exposure. The rating for each installation is a cumulative score combining the voltage and level of exposure. The ratings are provided in Table 6.

Table 6: Pothead prioritisation table

Condition	State	Rating
Voltage	22 kV	3
	11 kV	2
	LV	1
Exposure	Within 100 m of schools	5
	Within 15 metres of high pedestrian areas e.g. bus stops	3
	Other urban areas	1
	Remote area	0

The high risk 22 kV potheads located near schools and high pedestrian areas have been removed from the network. There are only five 22kV pot heads remaining on the network. Public exposure to these installations is low.

There are approximately eighty 11kV potheads remaining on the network, with twenty nine being assessed as a 'Medium' risk. The current rate of replacement is approximately twenty per annum.

The number of low voltage pothead terminations on the network is estimated at approximately 120-150. These are being replaced at a rate of 10 per annum.

TasNetworks' strategy is to remove all potheads from its network. All medium and high risk, high voltage potheads will be removed from the distribution network by 2017.

7.5.2 Replace underground cables – High voltage and low voltage (REUGC & REULC)

Currently TasNetworks considers the replacement of cables based on their condition and associated risk if a failure occurs.

Based on current performance levels and low failures, with the exception of CONSAC cable, TasNetworks is not proposing any major cable replacement program. However some provision has been made for the replacement of some high voltage and low voltage cables (less than 1 km per annum). These replacements would occur in response to a cable failure.

TasNetworks has experienced submarine cable failures in 2009 and 2013. As a consequence 700 metres of oil filled cable was replaced and another 1800 metres of submarine cable was abandoned after reconfiguration with newly installed land cables.

7.5.3 Replace LV CONSAC cables (REUCS)

The primary driver of this program is to reduce the public risk in regards to broken neutral and hence of electric shock. With CONSAC cable the outer aluminium sheath is used as the neutral conductor. If this outer sheath is not adequately sealed to prevent moisture ingress n can oxidise. This can eventually cause an open circuit, or broken neutral, which can pose a serious public safety risk due to the potential for electric shock.

Another common point of failure along CONSAC cables is at joints. Bipole joints are a type of LV underground T-joint used in TasNetworks' distribution system from 1971 to 1973. These joints were mainly installed with CONSAC cables. Installation of these joints was discontinued as a result of high failure rates attributed to moisture ingress into the joint over time and is another driver for this program.

TasNetworks implemented a proactive replacement program of CONSAC cables in 2008 after analysis revealed that over 70% of LV cable failures were directly related to CONSAC cables, despite being only 17% of the total LV cable population.

This proactive replacement program targets CONSAC cable replacement in areas where failures had been experienced in the past, as the failures appear to be clustered in geographical areas. It is thought that local jointing practices, soil type and other environmental conditions are contributing to the failures.

TasNetworks' asset records indicate there are approximately 182 km of CONSAC cable in the system. Approximately 30 km of CONSAC cable remains to be replaced within the high failure areas.

The program is coordinated with other capital programs where there is a connection to CONSAC cable e.g. the replacement of ground mounted substations, LV switchgear and wide based streetlight poles.

Where a substation replacement occurs the CONSAC cable is replaced from the substation to the first turret or LV cabinet from the substation. Similarly, where a streetlight is being replaced, the associated CONSAC cable is replaced up to at least the first turret or cabinet.

With an annual cost of approximately $2 million per annum this program is the most significant capital program for the underground network.

7.5.4 Oil-filled cable replacement program

Currently, oil-filled cables are replaced when they fail, are damaged or major repairs are required to address oil leaks. The strategy is to replace the damaged cable with XLPE cables to the nearest appropriate jointing location such as another joint or a termination to the overhead system.

The aim of this strategy is to gradually remove oil-filled cable from the system, removing the environmental risk and eventually reducing the maintenance costs and restoration times.

There is no fixed replacement plan or program currently in place due to the generally good condition of the cables.

The replacement of oil filled cables would provide some marginal reduction in inspection and maintenance of oil filled cables, with the reduction being proportional to length replaced. Although any major reduction in expenditure is possible only after the full length of cable is replaced.

7.5.5 Replace underground furniture (REUGF)

This program has three components:

- Install above ground signage on cable routes
- Replace UGLB or distribution boxes; and
- Replace underground furniture (general).

7.5.5.1 Install above ground signage on cable routes

Above ground cable route signage is installed in situations where the consequence of third party damage to the cable is significant (for example, oil filled cables and submarine cables) and in situations where underground cables may not be expected (such as railway property easements, and bored or ploughed-in cables).

Signage is also installed as a temporary risk treatment measure on cable routes or sections where a cable has been identified at substandard depths. The signage has to be maintained at the site until the rectification work is completed to bring the installation to the acceptable standard.

No funds have been allocated for this in the 2014/2015 financial year. Any issues that arise throughout the year will be prioritised and funded accordingly.

7.5.5.2 Replace UGLB or distribution boxes

There have been several incidents during overload conditions where the compound insulating the terminations in Underground Link Boxes (UGLB) have melted, covering the link mechanism and making it non-operational. There have also been incidents where the link connections in the UGLB fail catastrophically, resulting in a flashover.

Accordingly these assets represent a higher operational risk, which is taken into consideration for replacement projects.

A replacement program was introduced in 2006 to replace all the UGLBs in the system with modern cabinets.

Currently there are twenty units left in the system and TasNetworks is replacing six units per year TasNetworks proposes to continue the program with reduced replacement rate of three units per year for the fourteen remaining units so that complete replacement will have occurred by 2017.

7.5.5.3 Underground furniture replacement (General)

Assets in poor condition are identified and targeted for replacement via inspection programs.

Routine inspections have revealed significant deterioration in some of these assets, particularly the low voltage pillars. Some of these assets have been in service for 40 to 50 years and now present a notable safety and reliability risk due to the deterioration in their condition. In some instances, significant rust within their structures has resulted in a loss of structural integrity, while others have reduced ability to provide protection from the elements due to the deterioration in their external fibreglass covers.

There have also been safety incidents with the older metal service pillars due to a combination of their design and deterioration in their condition.

To manage these emerging risks the rate of asset replacement for these assets has been increased.

7.5.6 Lightning arrestors

In recent years, TasNetworks has experienced substantial damage from lightning strikes. Although the majority of damage has been to pole-mounted transformers, damage has also been sustained to cables and associated ground mounted substations and switchgear. Such events drive early replacement of the asset due to failure. Installation of additional protection in the form of lightning arrestors on every HV cable pole in the future has already been incorporated in TasNetworks’ design and construction standards for underground systems.

TasNetworks had proposed a program to install lightning arrestors on HV cable poles linked to costly assets such as ground mounted substations, but the high cost of implementing this program has made re-evaluation of it necessary. This has resulted in targeting locations where significant assets in high risk areas are unprotected.

The scope has been reduced to minimise the cost of this program, with lighting arrestors only being installed, in isolation, in high risk areas where significant assets are unprotected e.g. submarine cables, otherwise installation will be done in conjunction with other activities.

It is expected that this program will reduce the operational expenditure on the ground mounted and underground networks.

7.5.7 Substandard underground installations

From time to time underground installations have been found with substandard burial depths for cables or cable protection and warning systems.

These are generally due to changes in the installed environment such as changes to road levels after the installation of the assets.

Once identified, appropriate signage is established until further remedy is completed, and replacement is occasionally required where relocation of the asset is not practical.

New signage is established under REUGF and replacement is undertaken under either REUGC or REULC.

7.5.8 Undergrounding of special areas (SIUSA)

On 20 July 1988 as part of the bicentennial celebrations in conjunction with past Local, State and Federal Governments, the Hydro-Electric Commission agreed to contribute to the undergrounding of reticulation in areas of significant heritage, scenic or tourist appeal.

Following agreements with subsequent Governments, TasNetworks has continued with this scheme provided that TasNetworks' contribution was limited to:

- One third of the total cost of each project; and
- The availability of funds for the purpose.

TasNetworks proposes to contribute $125k per year to the undergrounding of reticulation in special areas. The expenditure is based on historical values. Funds for this work will be allocated when TasNetworks is approached for undergrounding in an area by the relevant authority.

Although the main aim of the program is aesthetic value, a very minor reduction in operational expenditure could be expected in proportion to the replaced overhead system by undergrounding.

7.6 Investment evaluation

Where investment is required to achieve compliance with TasNetworks’ business objectives an options analysis is undertaken to determine the most appropriate solution.

Economic analysis is undertaken using TasNetworks’ investment evaluation tool.

7.7 Disposal plan

Various materials pose a risk to human health as well as being a possible environmental hazard. Disposal of these materials are discussed below

7.8 Summary of programs

Table provides a summary of all of the programs described in this management plan.

Table 9: Summary of ground mounted substation programs

Work Program	Work Category	Project/Program
Routine maintenance	Underground system condition Monitoring (AIUCM)	Underground system condition monitoring
	UG cable inspection and monitoring (AIUCT)	Underground cable inspection and monitoring
	Oil-filled cable inspection and monitoring (AIUOS)	Oil-filled cable inspection and monitoring
	Submarine cable inspection and monitoring (AIUSU)	Submarine cables inspection and monitoring (Visual)
Non-routine maintenance	UG system asset repair (ARUCA)	Minor and major asset repairs (excluding oil-filled cables)
	UG system asset repair – Oil-filled cables (ARUOS)	UG System – Asset Repair Oil Filled Cables
Reliability and quality maintained	Preliminary design work (SIPRU)	Preliminary design work - Underground
	Undergrounding in special areas (SIUSA)	Undergrounding in Special Areas
Replacement	Replace cables LV (REUCS)	Replace cable LV
	Replace cables LV CONSAC (REULC)	Replace cables LV CONSAC
	Replace cables HV (REUGC)	Replace cables UG – HV
	Replace UG furniture (REUGF)	Install above ground signage on cable routes
		Replace UGLB or distribution boxes
		Replace underground furniture (general)
Regulatory obligations	Replace terminations – LV cast iron potheads (REPOC)	Replace terminations – LV cast iron potheads
	Replace terminations – 11 kV cast iron potheads (REPOA)	Replace terminations – 11 kV cast iron potheads
	Replace terminations – 22 kV cast iron potheads (REPOB)	Replace terminations – 22 kV cast iron potheads

8 Financial summary

TasNetworks' makes a concerted effort to prepare a considered deliverability strategy based on the planned operational and capital programs of work for distribution network assets. A number of factors contribute to the successful delivery of the program of work. These factors are utilised as inputs to prioritise and optimise the program of work and to ensure sustainable and efficient delivery is maintained. This program of work prioritisation and optimisation can impact delivery of individual work programs in favour of delivery of other programs. Factors considered include:

- Customer-driven work we must address under the National Electricity Customer Framework (NECF).
- Priority defects identified through inspection and routine maintenance activities.
- Identified asset risks as they relate to safety, the environment and the reliability of the electrical system.
- Adverse impacts of severe storms and bushfire events.
- System outage constraints.
- Changes to individual project or program delivery strategy.
- Size and capability of its workforce.
- Support from external contract resources and supplementary service provision.
- Long lead equipment and materials issues.
- Resolution of specific technical and functional requirement issues.
- Complex design/construct projects with long lead times.
- Approvals, land acquisition or wayleaves.
- Access issues.

Specific to management plan for the underground system, these factors have had minimal impact on the delivery of the operational and capital programs of work.

8.1 Proposed OPEX expenditure plan

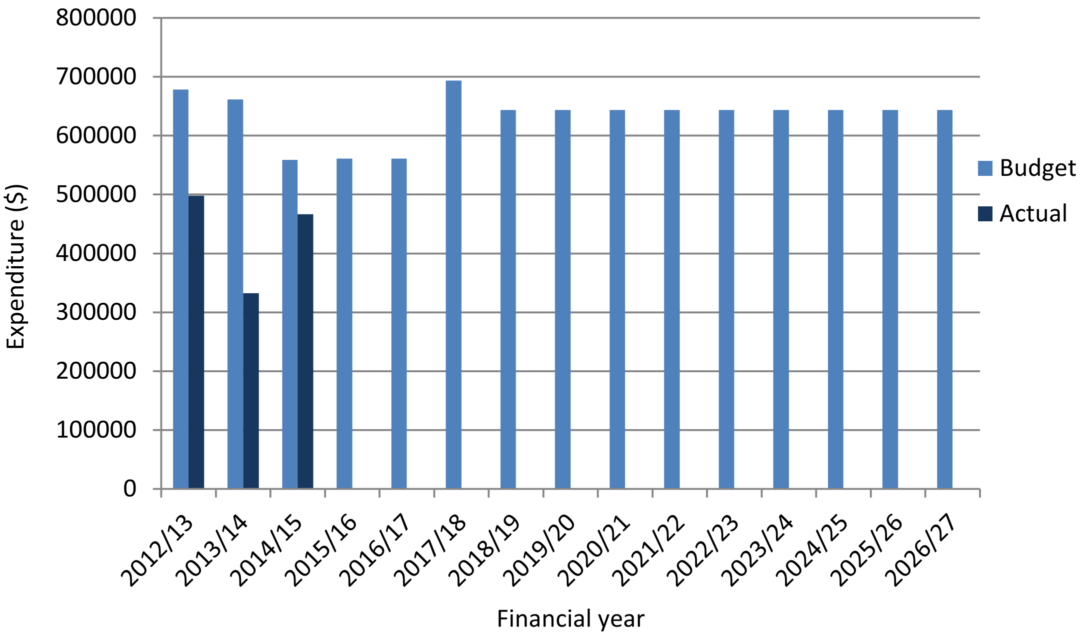
It is proposed to continue the current asset management practices without any significant changes in practice or frequency. The sustained initial increase in repair activities is as a direct consequence of the deteriorating performance of CONSAC cables and other ageing cables. Also, third party damages incidents are on the rise due to increased gas reticulation activities in state.

A marginal increase in asset inspection and monitoring program is attributed to new condition monitoring program and earthing system testing programs.

Table 10: OPEX for period between 2012/13 and 2019/20 financial years

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Budget ($)	678 494	661 340	559 017	561 001	561 001	693 810	693 810	643 810
Actual ($)	497 937	332 226	466 699					

Figure 5: Expenditure profile



8.2 Proposed CAPEX Expenditure Plan

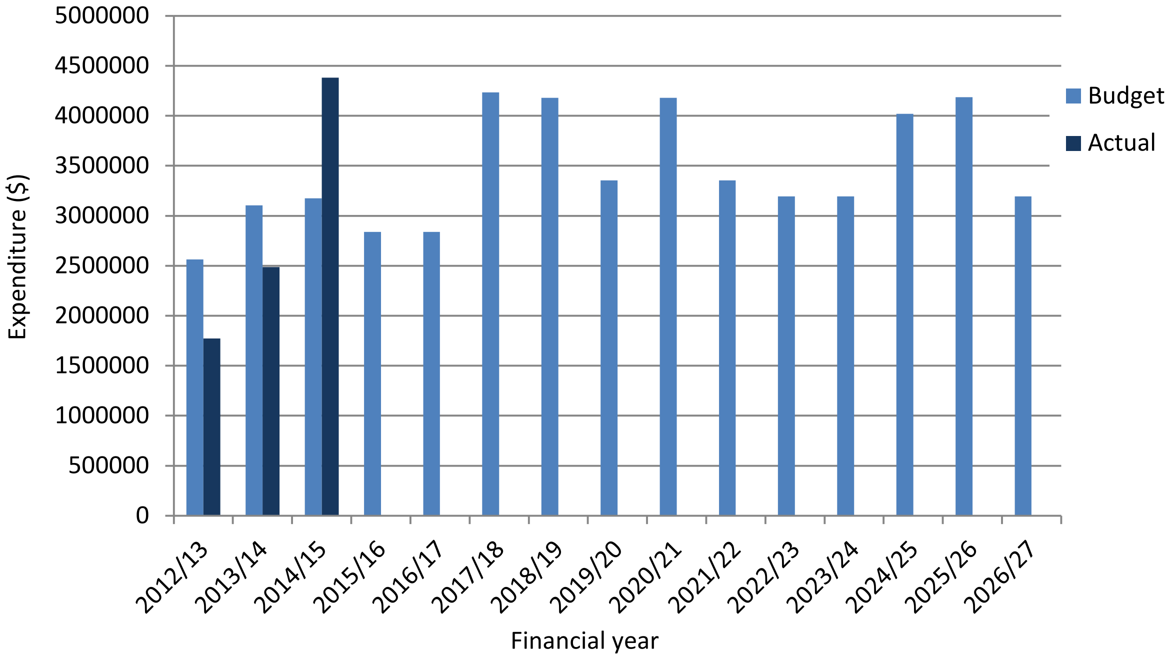
The capital programs and expenditure identified in this management plan are necessary to manage operational and safety risks and maintain network reliability at an acceptable level. All capital expenditure is prioritised expenditure based on current condition data, field failure rates and prudent risk management.

TasNetworks proposes a total capital expenditure of $17.4 million over the next five years, with an average expenditure of $3.48 million per annum. The proposed capital expenditure is based on the programs identified in this management plan

Table 6: CAPEX for period between 2012/13 and 2019/20 financial years

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Budget ($)	2 562 047	3 104 275	3 176 107	2 838 500	2 838 500	4 233 568	4 175 568	3 353 568
Actual ($)	1 774 225	2 485 437	4 380 131					

Figure 6: Forecast expenditure profile



9 Responsibilities

Maintenance and implementation of this management plan is the responsibility of the Asset Strategy Team.

Approval of this management plan is the responsibility of the Asset Strategy and Performance Leader.

10 Related Standards and Documentation

The following documents have been used to either in the development of this management plan, or provide supporting information to it:

1. Strategic Asset Management Plan – R248812
2. Risk Management Framework - R209871
3. AS 2865:2009: Confined spaces
4. Work Health and Safety Act and Regulations 2012
5. AS/NZS 3000: Electrical Installations/ Wiring Rules
6. AS2067: Substation and high voltage installations exceeding 1 kV AC
7. TasNetworks Manual for Low Pressure Oil Filled Cables (DS D UG 02)

11 Appendix A – Summary of Programs and Risk

Description	Work category	Risk level	Driver	Exp. type	Residual risk	12/13 ($)	13/14 ($)	14/15 ($)	15/16 ($)	16/17 ($)	17/18 ($)	18/19 ($)
Underground system condition monitoring	AIUCM	Medium	Safety/ Reliability	Opex	Low	0	0	0	0	50 000	50 000	50 000
Underground cable inspection and monitoring	AIUCT	Medium	Safety/ Reliability	Opex	Low	21 120	11 709	70 565	50 000	70 000	70 000	70 000
Oil-filled cable inspection & monitoring	AIUOS	High	Safety/ Reliability	Opex	Low	0	38 276	46 963	36 000	50 000	50 000	50 000
Submarine cable inspection & monitoring	AIUSU	Medium	Safety/ Reliability	Opex	Low	0	10 763	11 990	25 000	18 810	18 810	18 810
UG - Asset repair minor	ARUCA	High	Safety/ Reliability	Opex	Low	285 993	271 478	337 180	150 000	135 000	135 000	135 000
UG System - Asset repair major	ARUCA	High	Safety/Reliability	Opex	Low				300 000	300 000	300 000	300 000
UG System - Asset repair oil filled cables	ARUOS	High	Safety/ Reliability/ Environment	Opex	Low	0	0	0	0	70 000	70 000	70 000
Replace UG cable - CONSAC	REUCS	High	Safety/ Reliability	Capex	Low	1 011 302	1 598 416	2 616 468	2 023 500	2 200 000	2 200 000	2 200 000
Replace UG cable - HV	REUGC	Medium	Safety/ Reliability	Capex	Low	405 499	182 511	110 651	0	300 000	300 000	300 000
Replace underground furniture	REUGF	Medium	Safety/ Reliability	Capex	Low	147 044	178 441	318 036	215 000	573 567	443 608	443 608
Replace UG cable - LV	REULC	Medium	Safety/ Reliability	Capex	Low	0	0	35 488	50 000	120 000	120 000	120 000
Replace HV potheads	REPOA	High	Safety/ Reliability	Capex	Low	170 619	528 014	1 296 255	450 000	880 000	880 000	880 000
Replace LV potheads	REPOC	Medium	Safety/ Reliability	Capex	Low	37 808	0	3234	100 000	160 000	160 000	160 000