Services replacement program

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

1. Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need for the expenditure and identified credible options that will resolve the need and ensure that Power and Water continues to meet the National Electricity Objectives and maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

The proposed investment identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the condition, compliance and performance issues with overhead services installed across the network.

1.1 Business need

Power and Water has identified an asset performance issue with overhead services[1] installed across the network. There is a large portion of old services and services with other type[2] issues that have reached end of life. The service assets can deteriorate in ways that expose live conductor and can come into contact with adjacent conductive surfaces. This deterioration results in creation of risks and safety hazards to network operations, staff and the public.

The impact on safety is exemplified by two network incidents:

- In 2018, a fault in Alice Springs caused by failed termination and exacerbated by deteriorated insulation resulted in a pole to become energised and a dog to receive an electric shock.
- In 2020 an incident occurred that resulted in a fatality. A detailed investigation found the cause was a deteriorated service where insulation had failed and resulted in the service wire in being in contact with the strap wire, and the strap wire was in direct contact with metallic roof. The person touched the roof and was electrocuted.

As a result of the incident, WorkSafe directed Power and Water to initiate an inspection of all services in the remote community where the incident occurred, inspect a specific type of service (the same type involved in the incident) across the network, and review maintenance strategies for services. Consequently, Power and Water updated its services maintenance plans to include a 5 year cyclic inspection program.

The initial results from that inspection program have been received and used to assess the fleet condition. The inspection results demonstrated that there is an expected backlog of defects, and assets that will deteriorate to become defects, on the network that need to be addressed by Power and Water. Due to known issues with specific types of services, the volume of services requiring replacement is expected to be elevated as standard practice is to replace rather than repair the services with type issues.

Our risk assessment shows that without appropriate mitigation, there will be a continued elevated and increasing level of risk on the network which indicates a fatality would be expected once every 5 to 8 years. This is inconsistent with Power and Water asset objectives and a mitigation program is required.

[1] Overhead service conductors are the connection from a point of attachment on our customer's premises to the low voltage mains conductors.
[2] Type – P1 or P2 defect priority

1.2 Options analysis

To address the identified need, a range of options were identified and assessed. Two credible options were identified as shown in Table 1.

Table 1 Summary of credible options

Option No.	Option name	Description	Recommended
1	Replace on failure	Replace on failure (current practice). This option would involve continuing to replace the services upon failure	No
2	Targeted (risk based) replacement	Proactive replacement of services that have been identified as defective via inspection.	Yes

As part of a holistic assessment, we considered non-network solutions, capex/opex trade-offs and retirement or derating, but found that none of these options addressed the underlying network issues.

A cost benefit analysis was completed for each of the options where the risk reduction, compared to Option 1, was used as the benefit achieved by the option.

1.3 Recommendation

The recommended option is Option 2 - Proactive replacement and repair at an estimated cost of $8.0 million (real 2021/22) to be most prudent and cost effective to meet the identified needs. This option mitigated risk to an appropriate level over an acceptable timeframe given the limitations of understanding where the deteriorated services are located and capacity of the field crews to increase the replacements to the proposed volumes.

The recommended option:

- is aligned to our strategy and asset objectives.
- is deliverable, as evidenced by the initial implementation during five months at the start of FY22, and
- is aligned to customer expectations for maintaining the reliability and safety of the network.

The scope of this option is expected to involve the replacement of 4,000 services across the 2024-29 regulatory period. Table 2 shows a summary of the expenditure requirements.

Table 2 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	1,599.5	1,599.5	1,599.5	1,599.5	1,599.5	7,997
Opex	0	0	0	0	0	0
Total	1,599.5	1,599.5	1,599.5	1,599.5	1,599.5	7,997

2. Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks of overhead services wires to Power and Water and its customers, describes the current mitigation program and its delivery status, highlights the consequence of asset failure, and provides a risk assessment of the inherent risk if no investment is undertaken.

2.1 Asset profile

Overhead service conductors are the connection from a point of attachment on our customer's premises to the low voltage mains conductors. There are two types of services in the network, single phase services operating at 230 V and three phase services operating at 400 V.

To understand issues around services and associated components, a service connection assembly drawing showing various components that can fail or degrade due to ageing are shown in Figure 1.

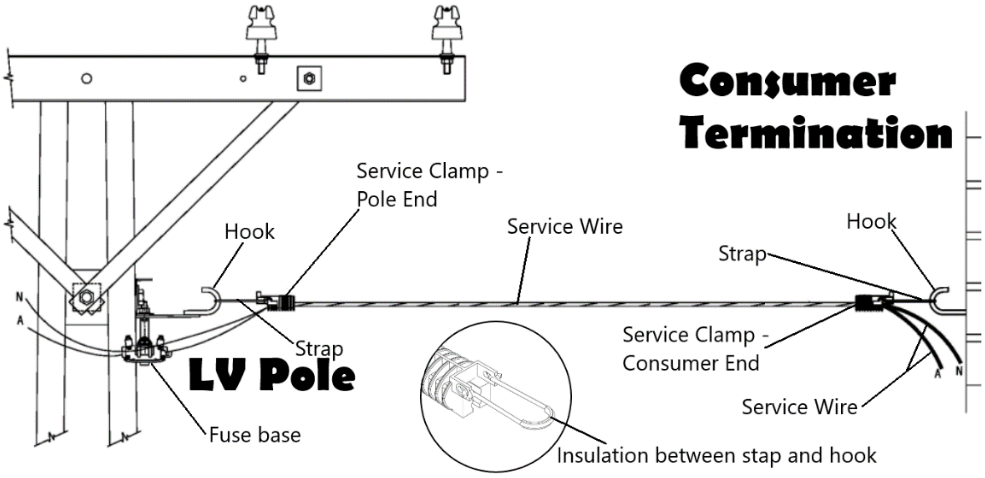

Figure 1 Service Connection Assembly drawing (Power and Water internal drawing)

Power and Water is responsible for maintaining all the different components of service connection up to the service hook on consumer termination side.

Table 3 shows the breakdown of the asset fleet. Services have an average expected serviceable life of 35 years, but this can vary depending on the type of materials used for the sheath and impacts from external objects that can cause damage.

Table 3 Summary of overhead service population

Type	RIN Category	Volumes (units)
Single phase (240V)	< = 11 kV ; Residential ; Simple Type	19,715
Three phase (415V)	< = 11 kV ; Commercial & Industrial ; Simple Type	4,973
Total		**24,688**

The age profile, as extracted from Power and Waters asset information system Maximo, is shown in Figure 2.

The age profile shows 3,255 (16%) services are approximately 36 years old, and 8,523 (35%) that are approximately 47 years old. These asset ages align to a period of significant network growth in the early 1980’s and the reconstruction of the network following Cyclone Tracy (1974), respectively.

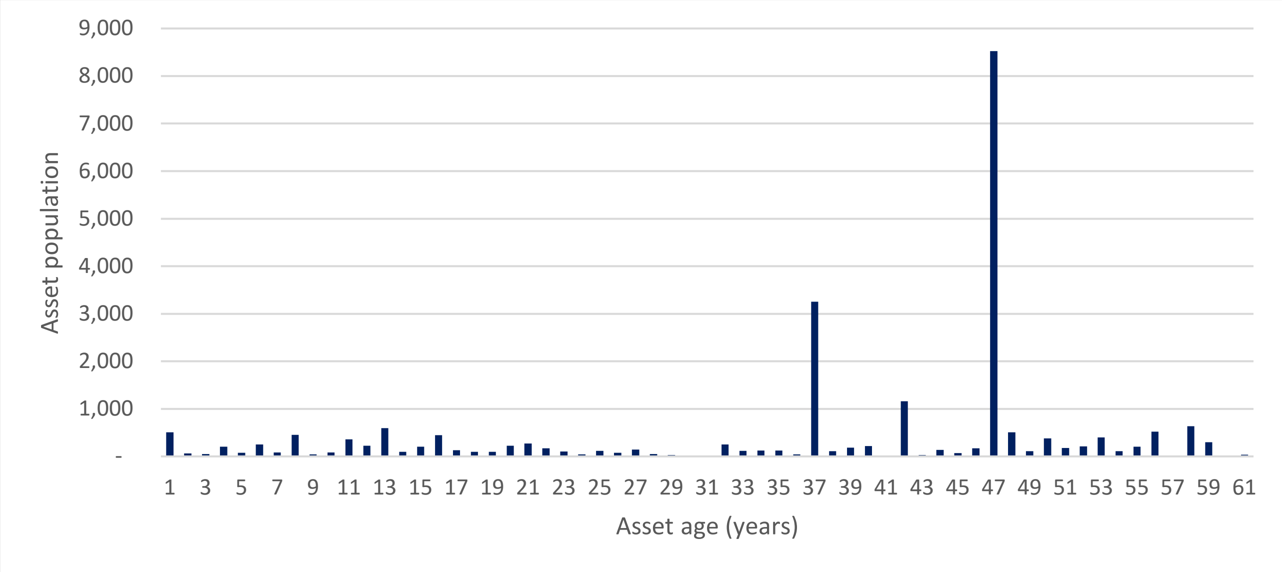

Figure 2 Age profile

Approximately 19,360 or 78% of all service lines are currently at or beyond the expected serviceable life of 35 years. Without intervention, this will increase to 19,990 or 81% by the end of the next regulatory period.

2.2 Historical and current management programs

Historically, service line replacements have been completed under the volumetric replacement program for Pooled Assets (project code NMFCR[3]) and replaced under fault conditions (particularly after tropical storms or cyclones).

While data capturing has improved through the use of technology in the field, there is limited data available regarding the number of service replacements and their locations. The historical expenditure has been isolated to service lines as shown in Figure 3.

[3] NMFCR is the code for the program of works that covers any failure or condition based replacement of volumetric assets (assets with high volumes installed on the network, but individually of relatively low cost and criticality).

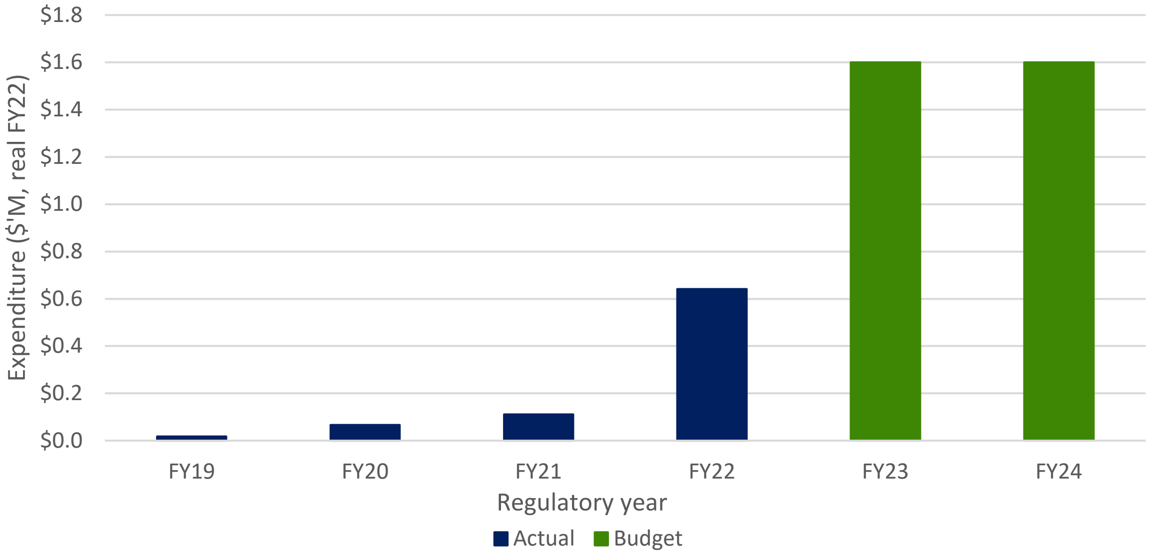

Figure 3 Historical expenditure

The data shows that there was a significant increase in expenditure in FY22 following the inspection and establishment of a planned long term replacement program to manage the asset class following an incident in 2020.

At the time of preparing this business case the YTD expenditure of $640k during FY22 was incurred from January to May (five months) and when annualised is approximately $1.55m. This demonstrates that the estimated expenditure for service line replacement in FY23 and FY24 is reflective of a deliverable program.

Network incidents and mandate to act

In 2018, a fault in Alice Springs caused by a failed termination resulted in a service coming into contact with the pole. The deteriorated insulation exacerbated the failure and resulted in a pole becoming energised and a dog receiving an electric shock.

In 2020, there was a network incident where a failed service line made contact with the metallic roofing of a residential property. A member of the public climbed onto the roof and was electrocuted, resulting in a fatality.

As a result of the 2020 incident, a detailed investigation was conducted by NT Work Safe[4] and identified a combination of factors that resulted in this outcome. Some of these factors include:

- Insulation failure and service wire in contact with strap wire
- Strap wire coming in direct contact with metallic roof

The images for both these scenarios are presented in Appendix C.

As a result of this incident, WorkSafe directed Power and Water to initiate an inspection program for the remote community where the event occurred, undertake inspection of a services installed on the regulated network between 1995 and 1998, and to do a review of maintenance strategies.

[4] https://worksafe.nt.gov.au/forms-and-resources/safety-alerts/damaged,-defective-or-degraded-overhead-electrical-infrastructure

Upon completing the inspections and review, Power and Water found a significant number of defects and revised the asset maintenance plans to include an ongoing cyclic inspection program.

The issues and risks associated with the remaining service replacements are discussed in section 2.5 and options to address these issues prudently and efficiently are analysed and discussed in section 3.

2.3 Asset condition issues and defects

Services are always exposed to the harsh operating environment in the Northern Territory[5] and deteriorate as a result. Some of the primary deterioration drivers and asset issues are described below.

Insulation damage and deterioration

The service conductor insulation deteriorates due to ageing, prolonged exposure to UV radiation (sunlight), and moisture ingress. As a result, conductors may become exposed and increase health and safety hazards for both the public and operational crews working in the vicinity of these assets. Of all the failure modes or defects, insulation damage is the most common cause of failure related to service wires as set out in the recent inspection report[6]. The inspection report identified various issues/defects and assigned criticality ratings based on the condition. Images of insulation damage exposing conductors and insulation damage due to ageing is captured in Appendix C.

Vegetation Encroachment

A quarter (25%) of services inspected under Services inspection program[7] in the Power and Water LV network have issues related to vegetation encroachment. This restricts the access to a customer's point of attachment which hinders the routine inspection and maintenance activities related to service installations.

Vegetation encroachment can lead to physical damage to the service. This damage has the potential to result in creating an electric shock hazard if it touches conductive surfaces in the vicinity of the service or could cause the service to fall and remain as a live conductor on the ground.

This situation will significantly increase the safety risk for both public and operational crews. Images of vegetation encroachment are presented in Appendix C.

Service clamp

Service clamps are used to secure overhead services/conductors onto the pole. Some of the common issues/defects observed with service clamps are deterioration/damage due to ageing, conductor touching the strap, and incorrect/improper termination.

Consequences related to service clamp failure include:

- Insulation damage of the conductor and strap will result in the strap and hook becoming energised and, depending on how the hook is secured, will elevate the risk of an electric shock.
- Improper termination of the strap to the bolt securing the insulator, rather than on the insulator itself, will result in energisation of the metallic bolt and will elevate the risk of an electric shock.

Images of these issues are shown in Appendix C.

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[5] Harsh operating environment includes high humidity, monsoonal rains, storms, cyclones and high ambient temperature.
[6] Service Conductors Inspection Report -20202021.DOCX
[7] Summary report – Service inspections

Point of Attachment to the customers property

A common defect that occurs within the service connection assembly is at the point of attachment (POA). These defects include broken or missing lids for miniature circuit breakers (MCB) and exposed conductor at POA.

With a MCB lid missing, there is a possibility of an external object touching the MCB leading to an electric shock for anyone in the vicinity of the POA or connected conductive surfaces. It may also result in the service becoming disconnected, resulting in loss of supply and potentially a live conductor on the ground that is in a publicly accessible location.

Both these defects can result in safety issues for public and operational crews and an outage for the customer. Examples of these defects are provided in Appendix C.

Asset type

Power and Water is aware of specific types of services that have issues that either cause them to deteriorate more rapidly or have otherwise been identified to be unsafe. This includes services with PVC insulation that is coloured with a stripe. Prolonged exposure to UV light causes the stripe to deteriorate quickly and result in exposed conductors.

When there is a defect identified with these 'type issue' services or their associated assets, standard practice is to replace these services. This is expected to result in a higher replacement requirement as some defects would otherwise be repairable.

2.4 Condition assessments

In late 2021, Power and Water initiated a new inspection program for services as an outcome of the network incident and review of maintenance strategies. The program will inspect all services on a five-year cycle. At the time of writing this Business Case, inspections for 998 services had been completed. The results of these inspection are shown in Table 4.

Actions were priorities based on the degree of deterioration found and have a defined action and time frame for any remediation required:

- Replace as soon as practicable – Not safe to operate as it presents a risk to public safety or imminent failure. Driven by deterioration or incorrect installation. Required to be replaced as soon as practicable.
- Repair or replace within 180 days – Safe to operate but in deteriorated condition or incorrect installation. If left unresolved, a service in this condition is expected to deteriorate within one year to a level where it is no longer safe to operate and must be replaced. Defects included in this category also included incorrect attachment to the service clamp and vegetation encroachment which can be addressed through maintenance.

Table 4 Volume of defects identified during inspection

Action required	Number found	Percentage
Replace as soon as practicable	24	2.4%
Repair or replace within 180 days	400	40.1%
	424	**42.5%**

By applying population sample statistics[8], Power and Water can draw a conclusion about the general condition of the portion of the services fleet that has not yet been inspected, allowing appropriate budgeting for expected remediation works.

Due to the need to undertake the inspection program in an efficient manner, the completed inspections were performed in two suburbs in Darwin and one in Katherine, rather than a random sample across the network. The suburbs inspected contained services that were found to be in the oldest quartile (calculated on weighted average age) of assets in the fleet. The majority of the assets were recorded to be installed in or around 1975.

Analysing the entire services fleet by suburb and age identified that the age profile and weighted average age of the inspected portion was comparable and representative of the services fleet segment of suburbs with assets with a weighted average age of greater than 42 years old.

Power and Water considers the inspection results are sufficiently random for population statistics to be applied to those older suburbs and provides the best information on the state of the asset fleet that we have available for these older assets.

The population statistics show that there is a 95% confidence level[9] that within the group of services aged over 42 years. When applying the inspection results to the population, we consider that:

- 345 service lines are at end of life and require immediate replacement; and
- 5,761 service lines are in a deteriorated condition and will require repair and/or replacement.

In addition to the above-mentioned assets, we used the age profile and survival curve to determine how many assets with ages below 42 years would be expected to be reaching end of life. The combination of the two methods was used to develop the total expected replacement program. This is described further in section 2.6 on risk assessment.

2.5 Consequences

The failure of an overhead service line is considered to have a significant safety risk but only a minor reliability risk. A service line will generally only cause an outage for a single customer so individually these assets do not have a high level of criticality regarding network reliability. However, since the failure of a

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[8] For populations statistics to be applicable, the sample must be random and representative of the population.
[9] The sample size calculation was completed using the online tool https://www.calculator.net/sample-size-calculator.html

service line may result in a live conductor touching conductive surfaces of buildings, or laying on the ground in residential premises, they have a high criticality regarding health and safety.

Health and Safety

Service line conductors connect to the premises of our customers and therefore they are network assets that our customers come into closest proximity to. Hence, when these assets fail there is an increased risk of electric shock or electrocution. There are two key failure modes that increase the risk to the public of electric shock or electrocution:

- Insulation failure that results in a live conductor making contact with a conductive surface
- A service breaking and falling to the ground but remaining attached to the network and therefore remaining live.

As discussed earlier, an incident on the network in 2020 resulted in a fatality due to insulation failure of a service causing electrocution via contact of exposed conductors with a metal roof.

Reliability/Serviceability

Failure of a service will result in the disconnection of the customer to the network and, since there are no opportunities to “switch around” failed overhead services, they will therefore lose power. However, as each service only supplies one customer, the failure of an overhead service will only impact a single individual business or residential customer. The number of annual service failures due to equipment failure (i.e. excluding weather and vegetation) is shown in Figure 4. This indicates that there is volatility in the number of failures, but on average there have been approximately 35 per year for the past five years.

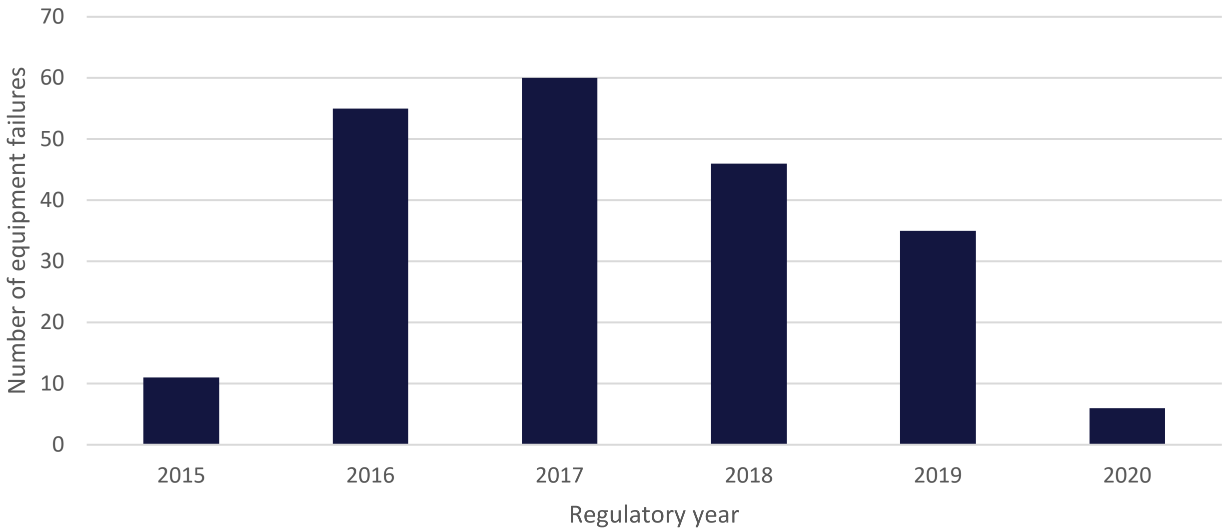

Figure 4 Number of service outages due to asset failure

In 2020, while there were only six asset failures, a deteriorated service that had not failed resulted in a network fatality. Hence, the mode of deterioration and failure is as critical as the number of failures.

2.6 Risk assessment

The risk posed by services due to the identified issues has been quantified by applying Power and Water Risk-Quantification Procedure[10]. This procedure has been developed based on good electricity industry practice and taking into account the recent guidelines and determinations made by the AER, the ISO 31000 Risk Management Standard, and other professional publications.

In the past, due to replacements under fault conditions, particularly as a result of damage caused by storms and cyclones, replacement data was not always captured consistently so there is some uncertainty in the accuracy of the older assets in the age profile where it is more likely they have been replaced without the asset data records being updated.

Power and Water recognises there is some uncertainty in older parts of the age profile. Accordingly, our analysis of network risk posed by the services is based on the following:

- For assets below the age of 42 years, the age profile provides the best knowledge of the asset fleet and we applied survival curve to calculate the expected annual volume of assets reaching end of life.
- For assets older than 42 years, the results of the inspection program provide the most representative of the population. These results were extrapolated across the assets that are not yet inspected and are greater than 42 years old (as discussed in section 2.2.2).

This approach and assumptions are described in Appendix B in more detail.

This assessment has been undertaken based on the business-as-usual (BAU) case, that is, on the basis that Power and Water does not undertake any proactive measures to address the risk and only addresses faults reactively.

Figure 5 shows the increasing level of risk during the current and next regulatory period that would be carried by Power and Water in the absence of any new mitigation measures. The level of risk reduces as our modelling includes the current (BAU) practice of renewal of assets as they fail, and is therefore slowly renewing the fleet, but it takes 20 years for any moderation of the risk to occur.

The dominant components of this increasing level of risk are the economic impacts of safety incidents which are calculated based on the Value of Statistical Life, Gross Disproportionality Factor and associated costs as described in the Risk Quantification Procedure. The consequence on network reliability is not material for this asset class as each service failure only affects a single customer.

We note that while initially $5M of annual risk appears high, we have an aging asset service fleet with verified poor condition and an incident that resulted in a fatality in 2020. Given the majority of defects identified in the recent inspection results related to insulation deterioration (a key contributing factor to the incident), it is not unreasonable to expect another similar incident to occur if nothing is done to address this network issue.

The risk profile equates to the expectation of a fatality once every 8 years, decreasing to once every 5 years by 2045 if there is not mitigation action taken. This level of risk does not align with Power and Water asset objectives.

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[10] CONTROL0932, Risk Quantification Procedure for Investment Decision making

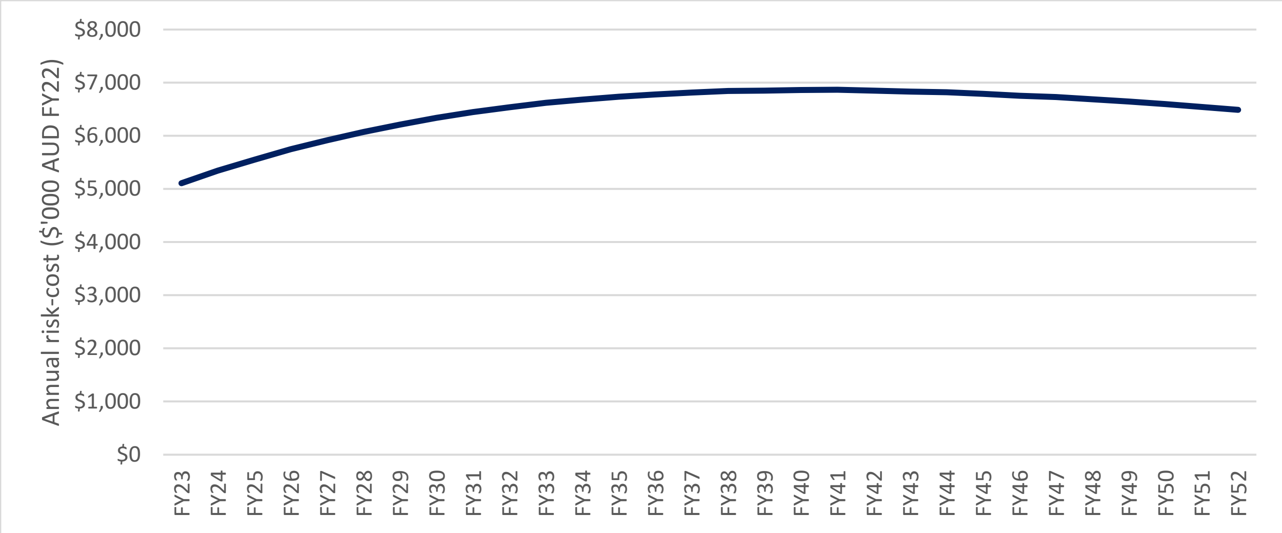


Figure 5 Forecast risk profile

The risk assessment demonstrates that there is an increasing risk across the services fleet covering all regions of the overhead network. The reduction in risk that is achieved by different credible mitigation options, along with the cost of those options and any other incremental changes to expenditure, is used to identify the preferred option in Section 3.

2.7 Summary

As a result of a network incident in 2020 that resulted in a fatality, with the cause determined to be a deteriorated service, WorkSafe mandated that Power and Water initiate the inspection of a specific section of the services fleet, inspect all services in the remote community where the incident occurred, and to review the services maintenance strategies. Consequently, Power and Water updated its services maintenance plans to include a 5 year cyclic inspection program.

The initial results from the inspection program have been received and used to assess the fleet condition. The areas inspected were some of the oldest parts of the network, and the data has been analysed and found to be representative of services aged greater than 42 years. Population statistics based on actual inspection results are the best data we have to base our replacement program upon.

Overall, our analysis has found that approximately 6,106 individual service lines aged above 42 years old are expected to be defective and require repair and/or replacement (with the vast majority requiring replacement) as a result of deterioration.

The risk assessment shows that without appropriate mitigation, the level of risk on the network will remain elevated and continue to increase, with fatality expected once every 5 to 8 years. This is inconsistent with Power and Water asset objectives and a mitigation program is required.

We understand the deterioration identified on the service lines in our network is similar to that identified by other NSPs in Australia, many of which have since undertaken proactive inspection and replacement programs for high-risk service lines in their respective networks.

Section 3 discusses the options that will efficiently manage these risks.

3. Options analysis

This section describes the various options that were analysed to address the increasing risk and the preferred mitigation option. The options are analysed based on their ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified as options that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- Option 1 – Replace on failure. This option would involve continuing to repair or replace services upon failure.
- Option 2 – Targeted replacement. Implement a program of works to replace services in all the regions, by identifying defects during a cyclic inspection and proactively scheduling replacement. Includes addressing the backlog of defects.

Both credible options involve replacing a service with a modern equivalent asset. The different asset management strategies result in a differing risk profiles and investment requirements.

An assessment of the future capacity requirements and any network reconfigurations for efficiency will be undertaken for both options. These two options are described and assessed in detail in the following sub-sections.

Table 5 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2
NPV ($'000, real FY22)	0	36,416
BCR		5.94
Capex ($'000, real FY22)	1,000	7,997
Addresses identified need	●	●
Aligns with Asset Objectives	○	●
Technical Viability	○	●
Deliverability	●	●
Preferred	✗	✓

● Fully addressed the issue ◕ Adequately addressed the issue ◑ Partially addressed the issue ○ Did not address the issue

Note:

- The full program is based on the 30 year assessment period.
- The RP2429 values assume the program is only implemented for the period 2024-29 and assumes investment stops so network risk starts to increase again.
- The capex for Option 1 represents the cost to replace the service failures in excess of what is allowed for in our volumetric (NMFCR program)
- Option 1 NPV and BCR are zero as it is used as the base case for assessing the relative benefits of Option 2.

3.1.1 Option 1 – Replace on failure

This option proposes to only replace services with modern equivalent ones in a reactive manner post failure. This means incurring the cost of the outages and accepting the risk to public and worker safety. In addition, the cost per unit of emergency replacement or repair of services failure is higher than a planned outage and planned replacement program.

The resultant quantified risk-cost of this option is shown in Figure 6 below. This option was found to result in the highest residual risk cost of the two credible options, indicating the poorest network performance.

The model assumes that any assets that fail are replaced, therefore reducing risk in the longer term. Under this option the program would be managed through the volumetric (NMFCR) program[11].

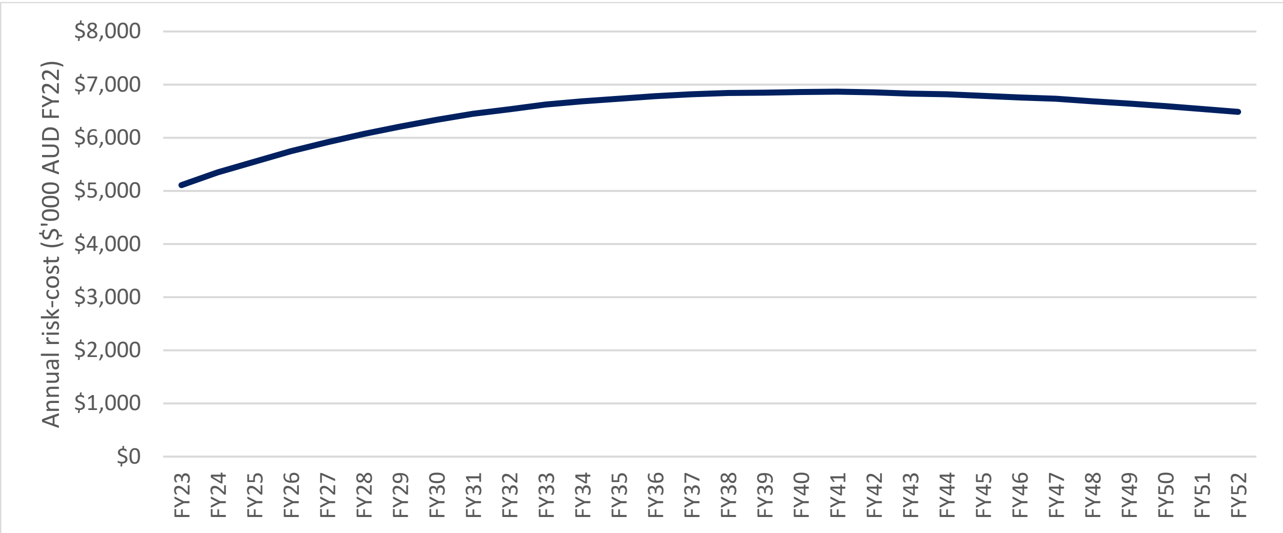


Figure 6 Risk profile achieved through Option 1

While this option is deliverable and technically feasible (it is a reactive activity), it results in deteriorating network performance and increasing safety risk to both the public and workers.

The residual risk of this option is very high, as demonstrated by the recent network incidents. This approach does not directly address the underlying need which is the large volume of services that are known to be in poor condition and exceeding their serviceable life. Therefore, it does not align with the Asset Objectives of maintaining reliability and safety of the network.

[11] Services have been excluded from the Volumetric analysis, hence, if this business case is not approved, the volumetric analysis will need to be updated to include the cost of failed service replacement.

While this is the least cost option, it has the highest risk and does not meet Power and Waters requirements. This option is not recommended.

3.1.2 Option 2 – Proactive replacement program

This option proposes to implement the inspection and replacement program that has been developed as a result of the WorkSafe mandate to review the maintenance strategy and inspect a subsection of the asset fleet. This will involve a cyclic inspection of all service lines on a five yearly basis. When defective services are identified, they will be registered through the standard defect process and scheduled for replacement according to the defect type and its priority.

We expect to replace 800 services per year under this program of works up until the end of 2028-29. This replacement rate is considered prudent as:

- It is based on the program that was completed during the 2021-22 financial year, Power and Water has identified that 800 service line replacements is the maximum that can be delivered based on the resources available and other programs forecast to be undertaken concurrently.
- This replacement rate considers the rate of 'discovery' of defective services during the inspection program and deliverability by the field crews.
- Table 4 shows there are approximately 5,760 service lines expected to currently be at end of life, the replacement of 800 per year (from 2022-23 through to 2028-29) will address the expected volume by the end of the next regulatory period.
- As this is a new program, and the asset class was previously only managed reactively with poorly recorded data, we consider that an initial program set at a level that is moderately higher than the long term sustainable rate, and based on statistical analysis of a sample of inspection data, is appropriate for managing risk given recent network incidents.
- The proposed program was modelled and found to enable Power and Water to manage network risk to an acceptable level within an acceptable timeframe.

In addition to this targeted replacement program, any in service failures will be replaced under the volumetric NMFCR program. The NMFCR program is forecast to replace an estimated 22 services per year, on average, in addition to the proactive replacement program.

We expect that once the risk has been reduced to an acceptable level and the condition of the asset service fleet is fully recorded, subject to further analysis, the average annual replacements will reduce to approximately 600 per year to meet the long-term replacement needs[12] and to ensure ongoing prudent asset management.

As shown in Table 6, the scope of this option is expected to involve the replacement of 4000 services across the 2024-29 regulatory period[13].

[12] An expected serviceable life of 35 years means that on average 2.86% (1/35) of assets – or 705 service lines – would need to be replaced each year to maintain the fleet in a long-term sustainable manner. To be conservative, and to account for the renewal program and different asset types, we have assumed an ongoing rate of 600 units per year for modelling purposes. This will be reassessed to ensure it is a prudent level of replacement and provides the appropriate level of risk reduction.

[13] The service line replacement program will commence in 2022-23 at a rate of 800 service lines per year. It will continue 2023-24 and be implemented under the NMFCR project.

Table 6 Service replacement volumes and expenditure

	FY25	FY26	FY27	FY28	FY29	Total
Volumes replaced (units)	800	800	800	800	800	4,000
Expenditure ($'k, real FY22)	**1,600**	**1,600**	**1,600**	**1,600**	**1,600**	**7,997**

By taking a risk-based approach, Power and Water will be able to replace the services over a longer timeframe, therefore reducing the cost to customers, while maintain network safety and reliability. The resultant residual quantified risk-cost of this option is shown in the following Figure 7.

We note that on a tactical level when scheduling the inspections and replacements, actions can be take to prioritise more critical assets, such as those near schools or shops, which may enable a more rapid reduction of risk than shown in Figure 7.

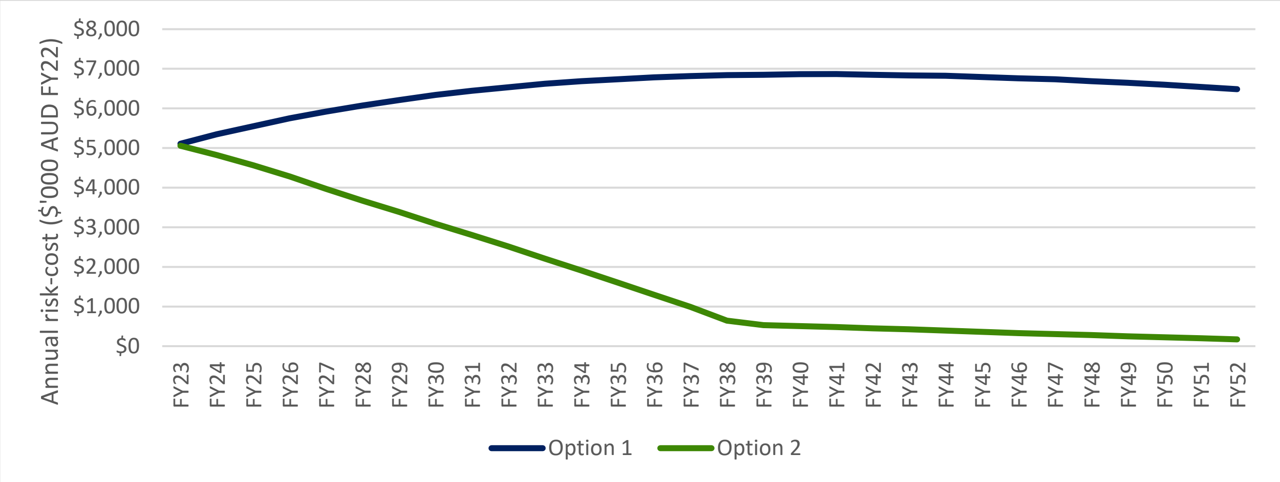


Figure 7 Risk reduction achieved through Option 2

The total capex for this option for the 2024-29 regulatory period is estimated to be $8.0 million with a NPV of $36.4 million and BCR of 5.94.

This option has the following benefits over Option 1:

- It addresses the underlying need which is the large volume of services that have exceeded end of their serviceable life as well as uncertainty in the age and condition of a large portion of the services.
- It will contribute towards achieving the Asset Objective of maintaining safety of the network. As the services in poor condition are removed from the network, and the general condition of the assets is known, network safety will be improved and there will be opportunity to refine the replacement program.
- Reduce cost to customers by undertaking the replacement over a longer timeframe (reduces the present value of the capex) while managing the risk.

Option 2 is the recommended option.

3.2 Non-credible options

The analysis also identified several options that were found to be non-credible. These options are described below.

3.2.1 Retire or de-rate assets to extend life – does not address the need

Total retirement of the assets is not a credible option as the service conductors are required for safe and reliable distribution network operation. De-rating the service conductor will not provide any desired impact as it will curtail customer's maximum demand/load. However, when a service is identified for replacement, assessment is made regarding replaced as part of planned replacement program leading to less expenditure for Power and Water.

3.2.2 Non-Network alternatives – does not address the need

Due to the type and function of these assets, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like (modern equivalent) assets. When a service is identified for replacement, Power and Water undertakes an assessment of whether the size or connection points can be changed to reduce cost or to meet any future demand most efficiently.

3.2.3 Capex/Opex Substitution – does not address the need

Since the driver of this investment is significant deterioration across a fleet of assets caused by age and environmental conditions, it is not feasible to substitute capital expenditure with operational expenditure to resolve the risk. Only capital expenditure to replace a service will resolve the underlying issues.

3.2.4 Undergrounding the services – excessive cost and does not meet the timeframe

The current approach to replacing the services is being achieved at an average cost of approximately $3.4k per service. The cost of undergrounding the service, including installing a LV cable from pole to pillar, installation of a pillar and the service cable from the pillar to the customers connection point (direct bore method) is approximately $28k per service. This does not include obtaining easements or changing the customer's connection asset. This is significantly more expensive and intrusive on our customers. This approach is not considered prudent as a standard practice. In addition, the time required to convert to underground services is significantly longer, meaning the network risk is not managed in a timely manner.

4. Recommendation

The recommended option is Option 2 - Proactive replacement and repair at an estimated cost of $8.0 million (real 2021/22) as the most prudent and cost effective to meet the identified needs.

The unit rates to develop this cost estimate are discussed in Appendix A. The basis of the modelling is described in the Risk Quantification Procedure and Appendix B.

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

4.1 Strategic alignment

The “Power and Water Corporation Strategic Direction” is to meet the changing needs of the business, our customers and is aligned with the market and future economic conditions of the Northern Territory projected out to 2030.

This proposal aligns with Asset Management System Policies, Strategies and Plans that contributes to the D2021/260606 “Power and Water Strategic Direction” as indicated in the table below.

Table 7 Alignment with corporate strategic focus areas

	Strategic direction focus area	Strategic direction priority
1	Customer and the community at the centre	Improve Public Health and Safety
2	Always Safe	Cost Prudency
3	One Power and Water	One Power and Water

4.2 Dependent projects

There are no known projects or other network issues that are dependent on the resolution of this network issue and this issue is not dependant on the completion of any other projects.

4.3 Deliverability

The proactive replacement program was initiated during FY22. During that year, replacement of approximately 320 services for a cost $640k on a year to date basis, with annualised volumes and cost of the rate of delivery achieved through the initial program estimated to be 770 services for a cost of $1.55m. This level of replacement is estimated to be maintained for the remainder of the current regulatory period.

This is a standard program of works that has been implemented historically and it is forecast to continue at volumes consistent with historical practice. Therefore, Power and Water is confident that the scope of works can be delivered based on historical practices and resources available.

4.4 Customer considerations

As required by the AER's Better Resets Handbook[14], in developing this program Power and Water has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this PBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability, and safety of supply[15].

4.5 Expenditure profile

This is the continuation of the Services replacement program which has been operating since 2022 as a defined program.

The forecast expenditure is supported by detailed asset replacement modelling, which has been updated to reflect recent replacement volumes. We expect that this will continue to be an ongoing cyclic replacement program and will continue beyond the end of the next regulatory period.

Table 8 shows a summary of the expenditure requirements for Regulatory Period 2025-29.

Table 8 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	1,599.5	1,599.5	1,599.5	1,599.5	1,599.5	7,997
Opex	0	0	0	0	0	0
Total	**1,599.5**	**1,599.5**	**1,599.5**	**1,599.5**	**1,599.5**	**7,997**

4.6 High-level scope of works

The scope for this project is to replace 4,000 services at a rate of 800 services per year. The forecast is an expected budget for the program based on our best understanding and analysis of the asset fleet.

The actual services requiring replacement will be identified by field crews as the inspection program progresses.

[14] Better Resets Handbook – Towards Customer Centric Network Proposals, Australian Energy Regulator, Dec 2021
[15] Peoples Panel Forum, Darwin, 2 and 3 April 2022

Appendix A. Cost estimation

The unit rates applied in this model are based on analysis of actual historical replacements that were undertaken in Katherine during 2021-22. The analysis considered the materials and labour for a dedicated program of works to calculate the cost per service achieved for that project.

Based on recent project data, the expected cost to replace a service is $1,999 (real FY22) for a single phase service line replacement.

Refer to the Cost estimation methodology and approach report for more details and how this method of coast is consistent with Power and Water's overall approach and methodology.

Appendix B. Modelling approach and assumptions

The model was built using different approaches for the services within different age groups with older than 42 years and other younger than 42 years. We have used the best available data and conservative assumptions to develop this forecast, so we are able to assess the impact on network risk and the net benefits to customers from this proposed program of works.

Method 1: Services younger than 42 years

For the younger services, the standard approach of developing the conditional probability of failure and multiplying it against the age profile was applied. This approach is consistent with the AER's Repex Model and is the standard implementation of the Risk Model that has been developed to assist with applying the Risk Quantification Procedure.

Method 2: Services older than 42 years

For the older services, we had less confidence in the data contained in Maximo as the ages were significantly older than the expected life. We also are aware that there have been replacements due to condition, or damage following storms.

Therefore, for the older services we used the results from the inspection available. The method of calculation is available in the Risk Model. The key assumptions are:

- **Commercial and Residential type services were treated separately**: as they have a different consequence for outages based on the VCR. The same assumptions and method were applied other than the VCR value and energy not served during an outage.
- **The inspection results are representative of the assets older than 42 years**: a comparison of the services in each suburb against the age of those services showed that the three suburbs inspected were heavily weighted towards the older end of the age profile, with weighted average ages above 42 years. Hence, based on this analysis, we consider that the inspections are representative of the assets older than 42 years only, and not the network generally.
- **Population statistics were appropriate**: since the asset are representative, we can use population statistics to extrapolate across the asset fleet for the section of the age profile.
- **Progression from 'no defect' to' deteriorated condition requiring action' (P3)**: we assumed that given the standard life of a service is 35 years, then the rate of progression from not having a defect to being in condition P3 should be in the most conservative case 1 out of 35, or 2.85%. Given the assets are likely in a range of ages, this should be a suitable approximation.
- **Progression from 'deteriorated condition requiring action' (P3) to 'replacement required as soon as practicable' (P2)**: the inspection results found that 24 services were in P2 condition while 400 were classed as P3. This equates to 6.0% (24 divided by 400) of the number of P3 condition assets. It would also imply that the remaining average life of the services is 17 years. This seems to be a conservative number, but supported by the best information we have.
- **Annual failures**: The percentage of services failing each year (the sum of both Method 1 and Method 2) was set to 5% as this resulted in a number of failures that was approximately equal to

the average historical number of service failures due to equipment failure as obtained from the outage records.

- **Energy not served**: was extracted from the outage data and applied to Commercial services. Residential services energy not served was calculated based on the average demand of a customer multiplied by the expected restoration time of 4 hours.
- **For the first 5 years there is limited visibility**: until the network is fully inspected once, the knowledge of the services needing replacement is restricted to a portion of the network. For example, in year 1 only 20% of the network will have been inspected, so while there are 288 services expected to be in poor condition based on statistics, only 58 will have been found by inspectors and can be replaced.

The method then calculated the number of existing P2 that fail and are replaced. If there are more volumes available to be replaced, they are deducted from the P3 backlog (assuming enough of these are found in the first year of inspection). Then the services that transition from no defect to P3, and P3 to P2 are calculated and transferred across.

Additional replacements are set aside for assets calculated in Method 1 that would need replacement. These are used as a balance line as the volumes of the assets in Method 2 available for replacement are reduced.

The assets at end of life, and those that have failed disruptively, are summed into the standard Risk Model to calculate the consequence.

Appendix C. Asset details

The images in Figure 8 below show examples of insulation deterioration that can result in exposed service wires and pose a risk to safety.


Figure 8 Insulation damage exposing conductors

The images in Figure 9 show vegetation encroachment on to service lines. This can result in damage to the insulation, excessive tension damaging the connection points or with the service line breaking and falling to the ground. If the service remains connected to the network, it can result in a live wire on the ground which poses a safety hazard to the public.

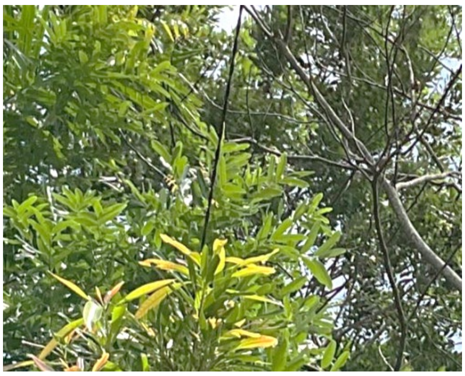



Figure 9 Vegetation Encroachment

The images in Figure 10 below show different types of damage to clamps that attached the service to the network pole. From left to right they show:

- strap deterioration which can result in the strap breaking and the conductor falling to the ground
- conductor touching the strap which can cause it to raise the potential of the connected metallic material and therefore electric shock, or electrocution should somebody touch it
- Improper termination that can result in early asset failure

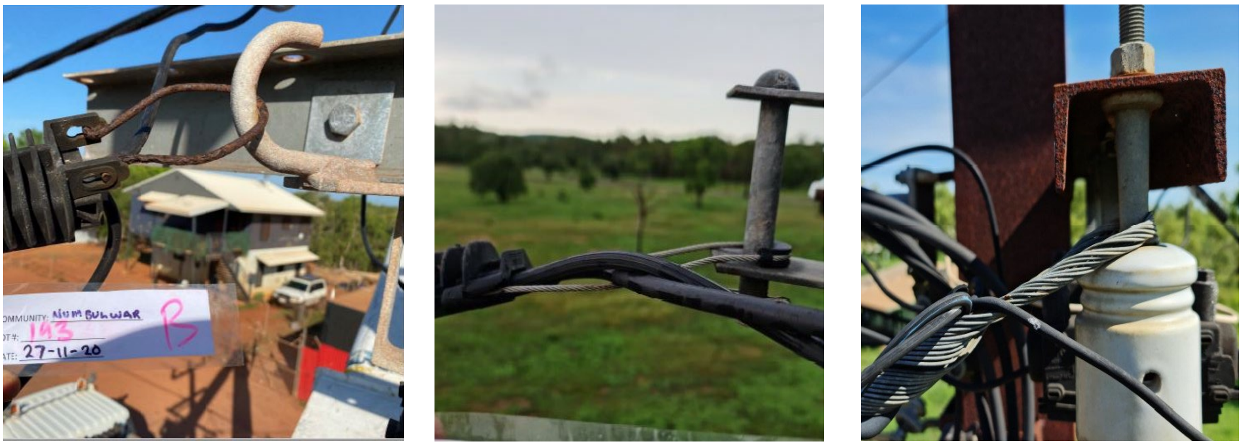
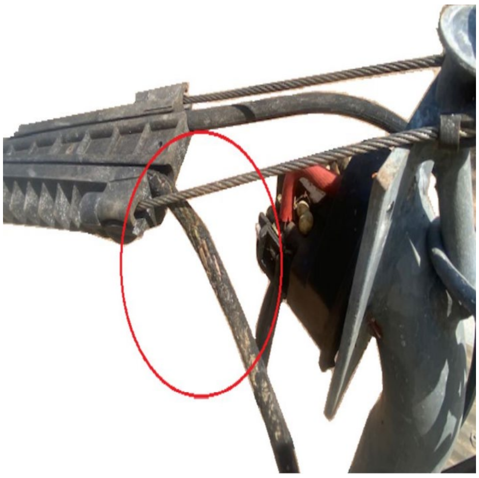


Figure 10 Service clamp defects

The images in Figure 11 show common defect on the customer side point of attachment. These defects can result in the metallic components becoming live and cause electrocution, or failure of the connection and result in the service falling to the ground.

Figure 11 Common defects at Point of Attachment

The images in Figure 12 show another two examples of where insulation failure and incorrect installation of the supporting strap can result in contact with conduction surfaces with the potential to result in electric shock or electrocution.



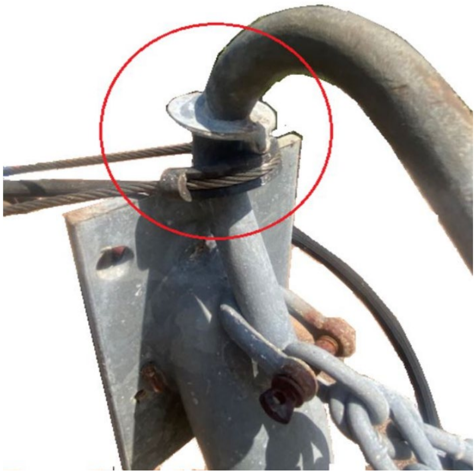


Figure 12 Insulation failure and direct contact between strap wire and metallic roof

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