PowerWater

# Program Business Need Identification

## Power and Water Corporation

**Business Case – Category C**

**PRK31580**

**Pine Creek 132kV Transformer Replacement and Bunding Remediation**

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Proposed:

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Power Networks
Date: 26/2/2018

Djuna Pollard
Executive General Manager
Power Networks
Date: 26/2/2018

# 1 RECOMMENDATION

It is recommended that the General Manager approve the Pine Creek Transformer Replacement and Bunding Remediation project for an estimated cost of $0.45M with a corresponding completion date of July 2020.

In addition it is recommended that the Executive General Manager note that this project is to be included in the next regulatory period and will form part of the submission to the AER.

# 2 PROJECT SUMMARY

| | | | |
|---|---|---|---|
| **Project Title:** | Pine Creek Transformer Replacement and Bunding Remediation | | |
| **Project Number:** | PRK31580 | **SAP Ref:** | NA |
| **Anticipated Delivery Start Date:** | January 2020 | **Anticipated Delivery End Date:** | July 2020 |
| **Business Unit:** | Power Networks | | |
| **Project Owner (GM):** | Djuna Pollard | **Phone No:** | 08 8985 8431 |
| **Contact Officer:** | Stuart Eassie | **Phone No:** | 08 8924 5214 |
| **Date of Submission:** | NA | **File Ref No:** | D2017/468423 |
| **Primary Driver:** | Service Improvement | **Secondary Driver:** | Compliance |

# 3 INVESTMENT NEED

There are three key issues that have been identified at Pine Creek 132kV Zone Substation:

1. Significant deficiencies have been identified on the 132kV/66kV/22kV 30MVA Transformer, in particular oil test results indicate severely degraded paper insulation and internal arcing. Reduced tensile strength in the paper insulation indicates end of life has been reached.
2. Inadequate bunding that is highly likely to result in hydrocarbons escaping and contaminating the ground and adjacent land should there be a major oil spill.
3. There is no water oil separation facility at the substation.
4. No load growth.

Each of these three items is discussed in further detail below.

## 3.1 Transformer

The Pine Creek 132kV/66kV/22kV transformer is used to step down voltage from the DK Transmission Line to supply local load, as well as step up the voltage from the EDL Generator to export load into the network. This transformer is critical for providing system inertia to Crocodile Gold and supplying the approximately 15MVA of local

load. If the DK transmission line suffers an outage, this transformer is required to support Katherine.

The transformer was a second-hand transformer when it was installed in 2008 as a quick replacement. It was required due to a condition assessment of the previous transformer revealing probable internal arcing. The transformer was intended to be a short term fix but has now been there for 9 years and is 51 years old. There are three main issues with the transformer:

- Deteriorated internal paper insulation
- Evidence of internal arcing
- Minor oil leaks

The condition of the internal paper insulation of transformers determines when a transformer has reached the end of its serviceable life. The Degree of Polymerisation (DP) value is measured through trace chemicals in the oil called 'furans'. Low DP values indicate the tensile strength of the paper insulation has reduced to a point where the transformer is susceptible to in-service failure. The use of oil sample testing as an indirect measure of transformer condition is an industry standard approach, and a DP value of 200 is considered the lower limit. Transformers are typically replaced prior to reaching this level. Replacing or filtering oil has the effect of removing the indicator chemicals from the oil so the transformer can appear to be in better condition than it actually is.

At the time of installation, the Pine Creek 132kV transformer was 42 years old and the DP value was 550 on Phase A and C, and 530 on Phase B based on direct paper samples. Since then, the condition has deteriorated through normal operational use.

Linear regression analysis of oil sample testing results was applied to the initial DP value taken from direct paper testing. The regression output was trended forward, and the current DP value is estimated to be approximately 270. The value is consistent with the current age of the transformer of approximately 51years old. The trend is shown in Figure 1 below compared to the lower limit of 200 which is an industry accepted DP level that indicates end of life.

Our analysis indicates that the DP value is likely to reach the 200 limit during 2019, meaning that remedial actions need to be implemented to ensure the reliability and safety of the network can be maintain and the risk to the network by the transformer in poor condition is mitigated.

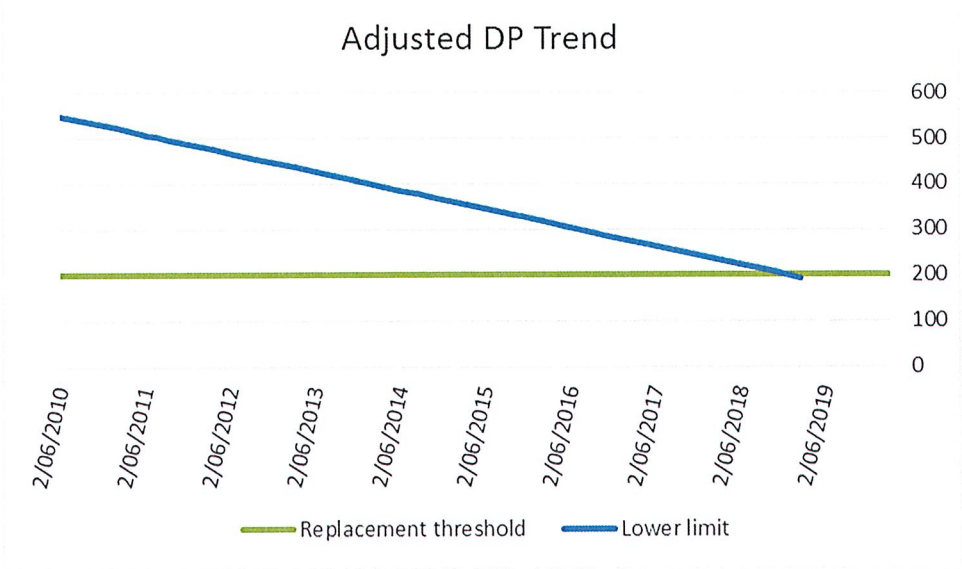


**Figure 1: DP trend**

In addition to the low DP value, Dissolved Gas Analysis identified traces of acetylene gas that is a sign of internal arcing within the transformer. Internal arcing is a major concern as significant arcing can result in transformer failure and occasionally an oil fire.

However, acetylene is a common gas in the tap changer and can leak out and mix with the oil in the main transformer tank. This has two main implications:

- it appears that there is an arc in the main tank
- it can mask actual arcing within the main tank

Further investigation is required to confirm the cause, however, in either case it indicates that there are internal issues with the transformer (ie, arcing or leaking between internal partitions) that need to be addressed.

The transformer also exhibits minor oil leaks which are currently managed through ongoing periodic maintenance.

### 3.2 Bunding

The purpose of bunding is to prevent oil that leaks from a transformer from contaminating the ground.

An investigation into the site, Pine Creek 132kV Zone Substation Environmental Review Report (EN2004/0008), identified a number of deficiencies in the existing bund and other potential hazards on the site:

- Cracks in the brick and mortar construction of the bund
- The bund is not connected to an oil separator tank. Instead it can be manually drained directly into the substation yard
- Six 200L drums of unknown waste, assumed to be old transformer oil, are contained on site but not in a bunded area

The existing transformer does not meet modern standards and it is not known if the base of the bund has been sealed. This is compounded by lack of water oil separation facilities so all hydrocarbons entering the bund are highly likely to eventually contaminate the ground.

### 3.3 Oil water separation

There is no oil water separation device located at the Pine Creek Substation. This does not align with current PWC substation design.

### 3.4 Load growth

The AEMO demand forecast identified that there is no load growth expected at Pine Creek until after 2027 and therefore additional capacity is not required.

## 4 STRATEGIC ALIGNMENT

This project is contributing to the achievement of the Key Strategy (as per the Board's Strategic Directions Paper) of network reliability and environmental sustainability by replacing high value assets at end of life, prior to failure, and ensure appropriate environmental controls are in place to manage foreseeable and credible events.

## 5 TIMING CONSTRAINTS

This project needs to be completed following the 66kV/22kV switchyard upgrade that is planned to be completed by 2019.

This issue needs to be addressed prior to its end of life where there is an increasing risk of failure while in service.

## 6 EXPECTED BENEFITS

| Driver/ Objective | Benefit | Current State | Future State* |
|---|---|---|---|
| Reliability | Improved network reliability and security | Transformer in poor condition at end of life | New transformer installed with more than 40 years serviceable life, DP value >1000 |
| Environmental | Improved environmental outcomes through proper oil containment and treatment | Oil can easily escape the bund and there is no oil treatment on site. | Sealed bund with oil water separation on site |

# 7 REQUIREMENTS

The requirements of this project are to:

- maintain the reliability of Pine Creek ZSS
- ensure the availability of the 132kV Transformer for the Pine Creek generator, and
- comply with environmental requirements and ensure good environmental outcomes for the Pine Creek area.

# 8 OPTIONS

Due to the location of the Pine Creek ZSS and requirement to supply the local load and provide step up transformation for the local generator, the options available are limited.

The following viable options have been identified and considered:

## 8.1 Do nothing

This option proposes not to replace the transformer and instead to continue to manage it through operational means such as oil filtering. This option is not recommended as the transformer has a finite life and the oil testing and regression analysis indicate that it is close to its end of life and expected to reach end of life during the next regulatory period.

Further, this option does not address the environmental issues which are presented by the leaking transformer and sub-standard bunding.

## 8.2 Replace the transformer and repair the bund

This option proposed to replace the existing transformer in 2020 with a suitable transformer that is currently stored as a spare for this site. The bund will be repaired to ensure it is sealed and connected to a water oil separation system that will be installed as part of the 66kV switchyard upgrade that is planned to be completed by 2019.

This option will address the network reliability and environmental issues associated with this substation transformer.

The proposed timing of this option aligns with the forecast deterioration of the DP value.

## 8.3 Decommission the substation

Decommissioning the substation is not a viable option as the Pine Creek generator and local load require this substation to remain in service. There are no other possible connection points that would not need a similar substation to be available.

### 8.4 Demand management/Non-network solutions

There are no Demand Management or Non-Network Solutions that are possible as the generator requires a connection point to the network and the local load required the transformation of the voltage from 132kV to 22kV.

# 9 PROJECT OUTLINE

### 9.1 Project Description

#### 9.1.1 Scope Inclusions

- Prepare the replacement transformer, currently held as spare, for transport to site
- Transfer the transformer to site
- Upgrade the bund to ensure it is properly sealed and install connection to the water oil separation facility
- Install the replacement transformer and complete commissioning and testing
- Clean up site by removing oil drums and other assets not required to be stored on site.
- Protection study to determine any changes in protection settings required for the new transformer and to ensure existing protection relays are fit for purpose

#### 9.1.2 Scope Exclusions

- Installation of a water oil separation unit (Puraceptor). The 66kV yard upgrade expected to be completed in 2019 will install an oil separation unit that is suitably sized for the entire substation, including the 132kV transformer.
- Protection upgrades other than specifically required for the new transformer (if any)
- SCADA, communications or substation LAN installation or upgrades

#### 9.1.3 Assumptions

- Can secure an outage for the required period(s) of time
- Protection systems do not need to be replaced to meet needs of the replacement transformer – ie, no modifications to the protection schemes, just reconnection to the new transformer.
- 1 x 250 kVA diesel generator is sufficient for on-site power during installation and commissioning
- There is sufficient space in the switchyard for working and laydown area

#### 9.1.4 Dependencies

- Completion of the 66kV/22kV switchyard upgrade by the end of 2019 so that there is an oil separation unit installed onsite, sized appropriately for the complete Pine Creek zone substation
- Transformers in storage have not deteriorated and are in suitable condition for use at Pine Creek

## 9.2 Key Stakeholders

| Key Stakeholder | Consulted? (Y/N) |
|---|---|
| Substation Services | Y |
| Test and Protection | Y |
| Major Projects | Y |
| Warehouse | Y |

## 9.3 Capital Cost

The project has an estimated total capital cost of $454k. The main costs elements are:

- Preparation of replacement transformer
- Relocating the transformer from Darwin to Pine Creek
- Onsite generation for duration of works
- Testing and commissioning
- Bunding upgrade and connection to oil water separation
- Disposal of the existing transformer
- Protection study

## 9.4 Ongoing cost impact

Once replaced, the transformer will undergo the standard oil testing and inspection as implemented for all transformers on the PWC network. This will not result in a material change to opex.

## 9.5 Project Milestones

| Project Phase (end) | Investment Planning | Project Development | Commitment | Implementation | Review |
|---|---|---|---|---|---|
| Current Forecast | 01/2018 | 01/2020 | 01/2020 | 05/2020 | 07/2020 |

## 10 RISK MANAGEMENT AND COMPLIANCE

The following table is a summary of the risks have been identified for this project and the corresponding controls.

| Risk | Controls |
|---|---|
| Damage during transport of spare transformer | Define transport conditions in specification.<br>Compliance with manufacturer instructions. |
| Oil spill during removal of transformer and refilling of new transformer | Comply with Safe Work Method Statement for oil handling.<br>Compliance with manufacturers instructions. |

## 11 FINANCIAL IMPACT

The project is included in the 2020 SCI for a value of $454k and is funded by PWC.

Ongoing recurring costs associated with this project have been incorporated into operating budgets.