PowerWater

Power and Water Corporation

Preliminary Business Case – Category B

PRD33003

[redacted] Transformer Replacement

Proposed:

Jim McKay
A/Chief Engineer
Power Networks
Date: 6/ 2/2018

Approved:

Michael Thomson
Chief Executive & Chair
Investment Review Committee
Date: 23/02/2018

Endorsed:

Djuna Pollard
Executive General Manager
Power Networks
Date: 15/2/2018

Refer to email
D2018/72353

Finance
Date: 6/ 02/2018

Refer to email
D2018/60664

PMO QA
Date: 9/ 02/2018

1 RECOMMENDATION

It is recommended that the Chief Executive approve project PRD33003 – [redacted] Transformer Replacement, to replace the existing two transformers with a single transformer and Nomad connection for an estimated capital cost of [redacted] and a corresponding completion date of June, 2022.

Approval is sought for expenditure of up to $0.3M of the total forecast expenditure to undertake the necessary work to proceed to the next approval gateway (Business Case Approval), including:

- Detailed design; and
- Detailed cost estimate by seeking a firm price offer from external contractors through a competitive tender.

The project has a 95% likelihood of being delivered between [redacted]

2 PROJECT SUMMARY

Project Title:	[redacted] Transformer Replacement		
Project No./Ref No:	PRD33003	**SAP Ref:**	
Anticipated Delivery Start Date:	Jul 2020	**Anticipated Delivery End Date:**	Jun 2021
Business Unit:	Power Networks		
Project Owner (GM):	Djuna Pollard	**Phone No:**	8985 8431
Contact Officer:	Peter Kwong	**Phone No:**	8924 5060
Date of Submission:		**File Ref No:**	
Submission Number:		**Priority Score:**	
Primary Driver:	Renewal/Replacement	**Secondary Driver:**	Service Improvement
Project Classification:	Capital Category B		

2.1 Prior Approvals

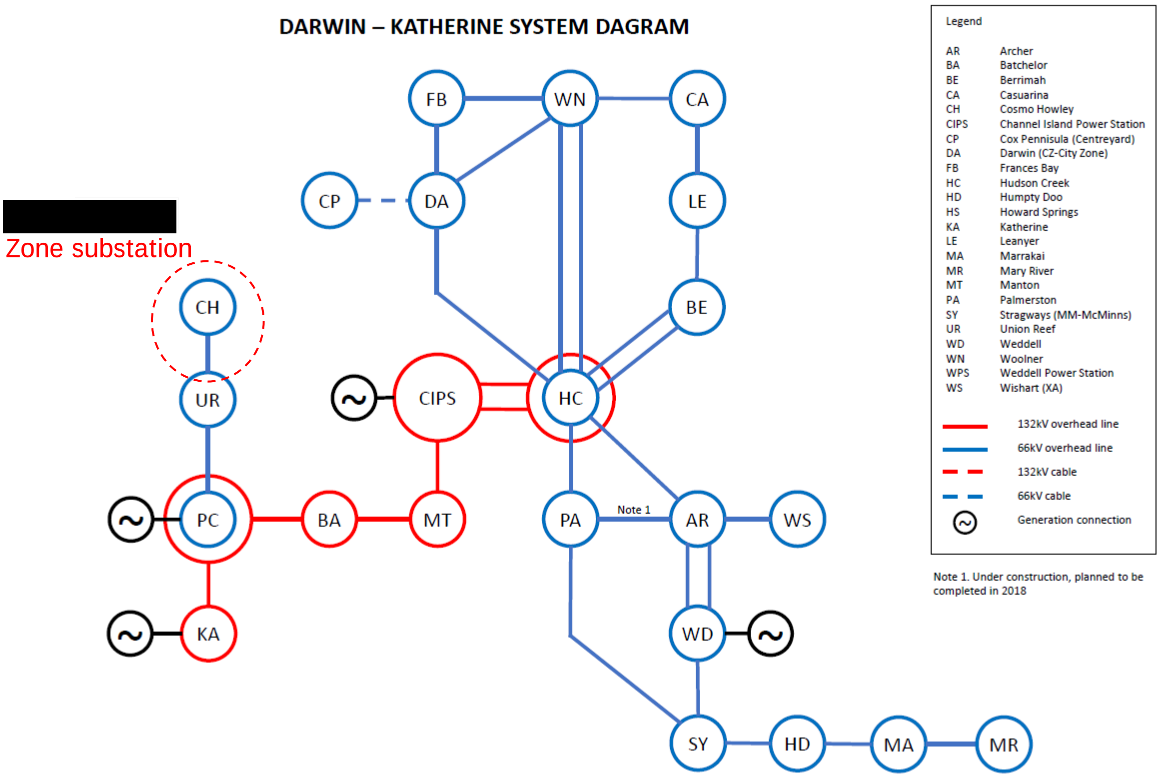
Document Type	Sub Number	Approved By	Date	Capex Value
BNI	10069	Michael Thomson	29/05/2017	[redacted]

3 INVESTMENT NEED

3.1 Background

[redacted] Zone Substation was constructed in the 1980s and it is located about 150km south of Darwin. The zone substation supplies a sole customer, [redacted], who operates the gold mine and camp near the substation.

[redacted]



3.2 Asset details

The [redacted] ZSS consists of two 7.5MVA 66/11kV transformers connected in parallel, 66kV and 11kV switchgear and is supplied via a radial 66kV line of approximately 60km that runs north from Pine Creek.

The majority of assets at [redacted] zone substation have exceeded their design life. For example, a design life of 50 years has been assumed with both transformers already 56 years old.

3.3 Management strategy & investigation outcomes

Recent inspection reports have identified issues with continued operation of the power transformers at the site due to moisture levels in the paper insulation, significantly elevating the risk of failure. The 66kV switchgear is also assessed as being in poor condition and at high risk of failure and the secondary systems are obsolete, unsupported by the manufacturer, increasingly difficult to maintain, and have an increasing defect rate.

These items are discussed further in the following section.

3.4 Current and emerging issues

3.4.1 66kV Switchgear

The existing 66kV CB is scheduled for replacement as part of a separate project in the current regulatory period.

3.4.2 Poor condition power transformers

The two 7.5 MVA transformers at [redacted] are at the end of their economic life. The transformers were manufactured in 1961 and are currently over 56 years old.

Both transformers have had numerous oil leaks repaired at various points on the transformer, parts replaced, and water marks and other deposits removed from bushings.

By 2024, the transformers will be 63 years old. Industry experience is that typical power transformer operating life is 45-50 years, with only a small percentage of transformers operating beyond 60 years.[1]

There have been repeating occurrences with oil leakages in the past with both transformers and recent testing confirmed poor insulation results.[2] Specifically, the testing indicates there is high moisture content in the paper insulation in both transformers, and high furan levels in both transformers, which indicate the paper insulation has low tensile strength. Both of these results increase the risk of transformer failure from insulation breakdown.

PWC has scheduled oil reconditioning (moisture) for Transformer 1 and Transformer 2 during 2016/17, to extend the life of these units. Both transformers have had numerous oil leaks repaired at various points on the transformer, parts replaced and water marks and other deposits removed from bushings.

Whilst further maintenance practices will be undertaken to extend the life of these units, the test results for both transformers indicate the insulation is near its end-of-life. Based on common industry benchmarks, the transformers should be replaced within 3-5 years (i.e. by 2023). Due to the low demand at this site, and corresponding low criticality of this load the timing of replacement is required by the end of this timeframe.

PWC has observed a strong correlation between the ageing of power transformers and its Degree of Polymerisation (DP). Ageing paper and reducing DP reduces the ability of the transformer to withstand transients and essentially will determine end of life for a transformer. DP values indicate the tensile strength of the paper is severely reduced; it would be prudent to plan for end of life & manage exposure to fault risk.

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[1] Power and Water - Power Transformer Asset Management Plan

[2] [redacted] Substation Power Transformer Condition Assessment Report, PWC Ref: D2017/153127

3.4.3 *Obsolete secondary systems*

The existing secondary systems are also scheduled for replacement along with the 66kV circuit breaker in the current regulatory period.

3.4.4 *Balance of plant*

The oil containment systems no longer meet the current Australian Standards and Environmental Protection Agency requirements. Frequent oil leaks from the transformers put the system under increased stress and regular maintenance is required.

The overall condition of the substation is average. No other issues at the site have been identified.

3.5 Peak demand and capacity forecasts

AEMO's demand forecast for [redacted] ZSS[3], projects the total maximum demand growth to be flat by 2024 of 5.2MVA and be well within the substation firm capacity of 7.5MVA. There are no identified demand-driven drivers for this project.

The Network Management Plan (NMP) has confirmed an enduring need for electricity supply to the mining load connected to [redacted] ZSS. There is a contractual agreement between Power and Water and [redacted] to provide supply to the mine site.

3.6 Risk analysis

Figure 2 shows the current rating, inherent rating (in 2024, i.e. if no action is taken in the interim), and the residual (post-treatment) risk ratings associated with the condition of assets in the [redacted] ZSS.

(i) *Current rating:* The Current rating (2017) is assessed to be 'Medium' due to the aggregate safety risk posed to PWC workers by the poor condition primary assets at [redacted] ZSS. The probability of explosive failure of primary plant assets is rated as 'unlikely', but should such an event occur, there consequence could be serious injury to PWC operational personnel (or even a fatality).[4] There would also likely be adverse media attention and temporary disruption to electricity supply.

(ii) *Inherent rating:* If the poor condition assets are not replaced by 2024, the likelihood of explosive failure of primary plant is assessed to increase from 'unlikely' to 'possible'. Given the number and frequency of operational personnel that will need to be on site to address the increasing maintenance (inspection and repair) issues of the increasingly poor condition assets, it is more likely that the

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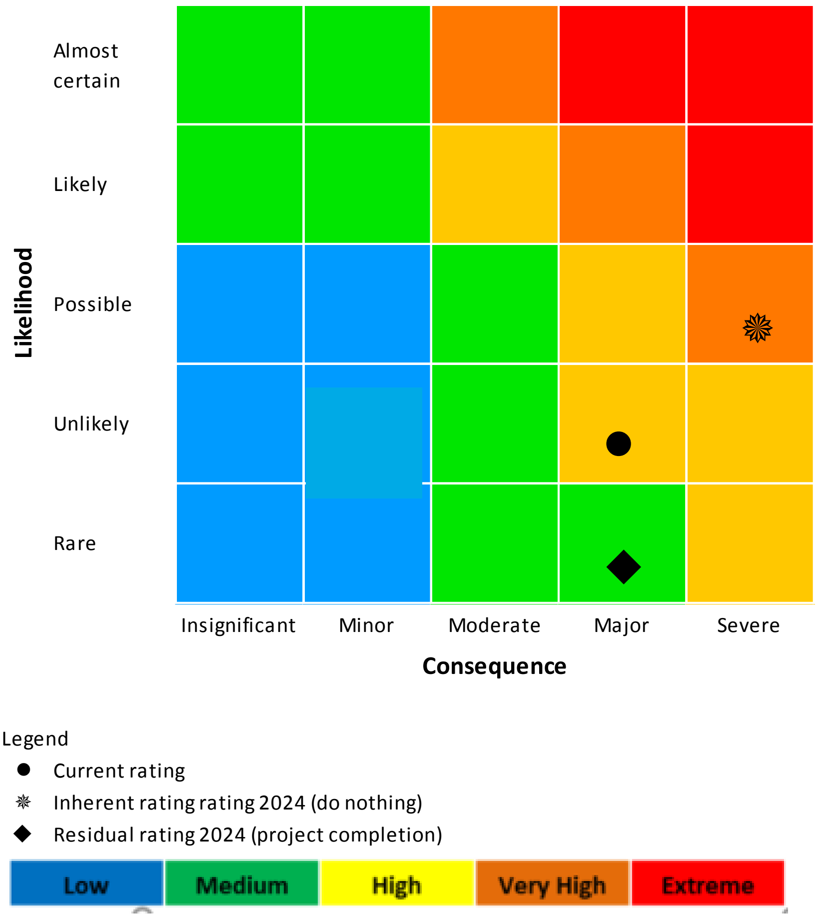
[3] AERReportForPWC_V3

[4] The 66kV circuit breakers, instrument transformers, and power transformer bushings all contain porcelain components which can explode, sending high velocity porcelain shards and oil into the immediate area around the equipment

consequence could be a fatality. There would likely be prolonged adverse media attention and temporary disruption to electricity supply. The inherent risk rating is therefore 'Very High'.

(iii) *Residual rating:* The proposed project will mitigate the poor condition assets through corrective maintenance. Less personnel will need to be on site on average over the course of a year because much less maintenance and repair will be required. The likelihood of explosive failure of primary plant will be reduced to 'rare'. The consequence of explosive failure is likely to be severe injury (or, even less likely, fatality). There would also likely be adverse media attention and temporary disruption to electricity supply. The residual rating is therefore 'Medium'.

Figure 2: [redacted] ZSS risk assessment[5]



It is Power and Water's current practice to take action on risks that have an inherent rating of 'HIGH' or above. The PBC summarises the proposed response to this impending risk.

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[5] Based on Power Network's Risk Assessment Guide

4 STRATEGIC ALIGNMENT

This project aligns with the Corporation's key result areas of operational performance and customer centricity, where the goals are to be an efficient provider of services and delivering on customers' expectations.

This project will allow PWC to safely and reliably meet current and future demands for the [redacted] area."

5 TIMING CONSTRAINTS

The project will need to be completed by June 2021 to reduce the risk of interruptions to the supply to the [redacted] Gold Mine.

[redacted] Zone Substation is essential for the supply of power to the gold mine, as there is no alternate supply. It is difficult to predict the remaining life of the existing transformers as catastrophic failure can be initiated by a transient external event, such as a through fault. However, it is generally agreed that the transformers have reached the end of life and should be replaced.

6 EXPECTED BENEFITS

Driver/Objective	Benefit	Current State	Future State
Safety	Reduced risk of injury (including fatality) from explosive failure of primary plant	Elevated level of personnel safety risk due to poor condition of a high proportion of primary assets	Risk of injury to personnel reduced to acceptable levels
Reliability	Increased reliability and reduced maintenance (inspection and repairs)	Risk of asset failure is very high and increasing maintenance costs	Risk of failure is low for new equipment and reduced maintenance costs

7 REQUIREMENTS

The solution selected must resolve the need to allow PWC supply power to [redacted] camp and mine site during credible contingency events and support reliability targets during unplanned events and planned maintenance activity. It is also preferable to minimise impact on existing operational capabilities at both sites during construction (i.e. maintain system security requirements).

PWC will also require compliance with the following:

- Northern Territory Electricity Reform Act;
- Power and Water's Network Licence as issued by the Utilities Commission, and;

- Network Planning Criteria and Electricity Networks (Third Party Access) Code.

8 OPTIONS

8.1 Options Development

A consultant was engaged to conduct a feasibility options study[6] considering various options for the replacement of [redacted] ZSS including layout drawings and costing information. This study has been drawn upon in the presentation of options below.

8.1.1 Option 1 - Base case (continue to maintain/repair [redacted] ZSS)

This option involves no proactive capital expenditure to replace assets assessed as being in poor condition at [redacted] ZSS.

The advantage of this approach is deferment of capital expenditure to address risks associated with the poor asset condition at [redacted] ZSS.

However, continuing to operate [redacted] ZSS beyond 2021/22 is not considered prudent given the risks to personnel safety from explosive failure of the primary plant assets and the increasing risk of disruption to power supplies in case of unavailability of the transformer circuits. This risk will continue to increase with time as the equipment condition continues to deteriorate and the load at risk continues to grow.

The operational costs will also rise over time due to increasing number of planned and unplanned outages as the equipment reaches the end of operational life.

For the purpose of this assessment, it is likely that the transformers will fail in service and require replacement within a solution similar to Option 3 over the evaluation period. Following failure, the site will have reduced security whilst a transformer is procured. Extended supply outages may occur should both transformers, which are of a similar age and condition fail, as the site is not configured for connection of the Nomad transformer.

Option 1 is not considered to be technically or commercially viable.

8.1.2 Option 2 – Refurbish existing transformers

This option involves removing and refurbishing both transformers by transporting to and from the factory in NSW at an estimated base cost of [redacted]

This would involve complete refurbishment of the transformers, including renewal of the paper insulation via a transformer rewind and replacement of all seals and gaskets in the main tank. The transformers will need to be decommissioned and transported interstate for the work to be completed. To

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[6] [redacted] options report – PWC ref D2018/51041

enable the substation to continue its operation, the refurbishment works will need to be completed sequentially. The only parts of the transformer that can be reused will be the tank and the transformer core.

The proposed scope includes:

- Refurbish both transformers at factory
- Increase size of both transformer bunds
- Replace existing oil/water separator with a new SPEL unit
- Install new duplicate protection for both transformers.

The existing transformer bunds and oil containment system will be upgraded to meet the current requirements specified in the Australian Standards. This would involve increasing the height of the bund walls and replacing the concrete “triple separator” oil containment system with Spel Puraceptor.

The advantage of this option is that it retains the current design philosophy at the site by retaining both transformers.

The disadvantages of this option include:

(i) It has a higher cost base than Option 3 due to the lack of cost savings of refurbishment when compared to purchasing a new transformer, especially considering transport costs to the refurbishment facility. A new transformer will be more efficient and compact in size compared to a refurbished transformer;

(ii) Brownfields redevelopment requires a lot of construction personnel and operational personnel to be in the close vicinity of live assets that are at risk of explosive failure;

(iii) The brownfields construction approach will take considerably longer than a greenfields approach, prolonging the inherent safety and reliability risks; and

(iv) Brownfields redevelopment will require careful outage and commissioning management, and will still result in increased risk of extended supply interruption (i.e. for an unplanned plant/equipment outage whilst the planned outages are in place).

8.1.3 Option 3 – Replace with new 5/7.5MVA transformer and Nomad connection

This option involves replacing existing equipment in the existing switchyard, by replacing the existing transformers and circuits in Transformer Bay 1 with a single 5/7.5MVA transformer and upgrade Transformer Bay 2 for connection of the Nomad modular substation, at an estimated base project cost of [redacted]

The proposed scope includes:

- Procure and install one (1) new 5/7.5MVA power transformer
- Increase size of one transformer bund to comply with AS and PWC standards

- Replace existing oil/water separator with a new SPEL unit
- Rehabilitate second transformer bund
- Install new duplicate protection for new transformer
- Complete minor modifications to allow connection of Nomad modular substation.

A single transformer solution complies with the Network Management Plan for large customers. In addition, modern transformers with improved design and materials have lower electrical losses and greater efficiency.

One of the transformer bunds will be upgraded to the current Australian Standard and the existing oil containment system will be replaced to meet current environmental requirements.

The existing secondary systems are to be replaced with new electronic relays.

The advantage of this option is that it applies the current design standards and modern technologies to this site, and provides a lower cost and less technically complex solution than option 2.

The disadvantages of this option include:

(i) It assumes access to the Nomad substation;

(ii) It reduces the substation supply to single transformer operation. A transformer failure will result in the transformer being isolated and the Nomad being used. It is expected that the interruption will last at least two days to allow for the initial response to the outage, mobilisation and commissioning of the Nomad. The Nomad may be in service for an extended period depending on the severity of the transformer fault;

This may influence the reliability of the PWC network elsewhere, by restricting access to the Nomad substation;

(iii) Brownfields redevelopment requires a lot of construction personnel and operational personnel to be in the close vicinity of live assets that are at risk of explosive failure;

(iv) The brownfields construction approach will take considerably longer than a greenfields approach, prolonging the inherent safety and reliability risks; and

(v) Brownfields redevelopment will require careful outage and commissioning management, and will still result in increased risk of extended supply interruption (i.e. for an unplanned plant/equipment outage whilst the planned outages are in place).

8.1.4 Option 4 – Non-network options / Demand Management

Given the stated condition of the substation assets, deferral of this project using demand management is not considered prudent. Alternative non-network supply options may present a viable option for meeting the supply requirements in the area.

PWC does not currently have a register of available network support services available in the market such as local generation to be provided in proximity of [redacted] ZSS, and no such option is currently known to PWC. This is unlikely to be able to be applied to [redacted] as a direct customer connection.

Option 4 is not considered to be technically viable.

8.2 Comparative cost analysis

PWC is currently developing a probabilistic risk-cost methodology which, when completed will be used to compare options and confirm the economically optimum time for investment.

Table 2 summarises the results of a comparative cost analysis, the details of which are included in Appendix A. Of the technically viable options, Option 3 – Replace with new transformer with Nomad connection has the lowest NPC. Costs shown in the table below are base project costs and do not include the risk-adjusted costs (ie. P_{50}).

Table 2: Summary of comparative capital cost analysis

Option	Capital Base Cost ($M)	Net Present Cost ($M)	Comments
1 – Do nothing	[redacted]	[redacted]	Not technically feasible
2 – Refurbish existing transformers	[redacted]	[redacted]	Ranked 2
3 – Replace with new 5/7.5MVA transformer and Nomad conenction	[redacted]	[redacted]	Ranked 1 - Lowest technically feasible NPC
4 – Demand management	[redacted]	[redacted]	Not technically feasible

8.3 Non-cost attributes

An analysis of the non-cost attributes for each option has been completed using the multi-criteria analysis method. The attributes are selected considering major risks and priorities to achieve Project Objectives. A weighting is allocated to each, totalling 100%. Each attribute is given a score out of 5 (from 1 – Fails to satisfy, to 5 – exceeds requirements); the score is then multiplied by the relevant weighting to give the weighted score that is summarised in the table below.

8.3.1 Evaluation Summary

Project Objectives	Technical & System Risk	Stakeholder Risk	Env. Risk	Commercial

Criteria	Reduced Risk Asset Failure	Maintain System Security	40 Year Design Life	Standard Assets	Constructability	Continuity of Supply	Safety	Community Impact	Approvals	Oil Contamination	Land Clearing	NPV/C
Weighting (%)	10	10	10	5	5	10	10	5	5	5	5	20
Option 1	0.1	0.1	0.1	0.15	0.2	0.1	0.1	0.05	0.2	0.2	0.2	1
Option 2	0.4	0.4	0.4	0.15	0.15	0.3	0.3	0.2	0.15	0.15	0.2	0.6
Option 3	0.4	0.3	0.4	0.15	0.15	0.3	0.3	0.2	0.15	0.2	0.2	0.8

Weighted Scores:

Option 1: Deferral	2.50
Option 2: Refurbish existing transformers	3.40
Option 3: Replace with new transformer	3.55

8.4 Preferred Option

The preferred option (Option 3) is the brownfields replacement of the existing 2 transformers at [redacted] ZSS with a single transformer substation of 5/7.5MVA and Nomad connection consistent with provisions in the NMP for a single customer site.

This option best fulfils the project objectives of safety and reliability at the same time having minimum impact on system security whilst under construction. It also presents an acceptable level of safety risks during construction.

The new Nomad connection will be designed in consideration with the existing switchyard configuration to minimise major alterations to the existing 66kV switchyard.

There is little risk of public opposition to the construction activity associated with this project as it located in a rural area.

The design of the substation will be to the existing PWC Substation Standards and will be similar in layout to current zone substations, for single customer sites including Nomad modular substation connection. This will maximise constructability and reduce design cost risk.

As with other zone substations, the replacement power transformer will be installed with current oil containment systems that will prevent hydrocarbon release.

8.5 Other Considerations

As stated above, installation of a single transformer substation changes the design philosophy at this site. In the event of a single transformer failure, it is estimated that at least 2 days will be required for mobilisation and connection of the Nomad substation during which time alternative provisions need to be made for electricity supplies. This is likely to incur a reliability impact for connected customers and performance of the overall PWC network.

Only one of the two transformers will be in operation at any time. Ideally both the HV and LV isolators should be open if the transformer is not in service to reduce the no-load losses and improve the differential protection sensitivity.

A transformer failure will result in isolating the faulty transformer by opening the HV and LV disconnector switches and energise the standby transformer.

It should be noted that Option 1 (deferral) does not include cost of loss load and the monetarisation of risks, including safety and corporate image. It is also likely the average operational cost will increase significantly in the future due to the increased frequency of failures.

9 PROJECT OUTLINE

9.1 Project Description

This project is to replace the existing 66/11kV transformers at [redacted] Zone Substation. The two existing transformers will be replaced with a single transformer capable of supplying the entire customer load with a hook up point for a portable Nomad substation.

9.1.1 Scope Inclusions

The scope of the project includes:

- Replace existing 66/11kV transformers with one new transformer.
- Convert existing bund and oil separation systems to satisfy the current Australian and PWC standards.
- Modify the second transformer bay to allow a connection to a portable Nomad substation.

9.1.2 Scope Exclusions

- DC and AC supply auxiliary systems.
- Existing 66kV circuit breaker
- Existing protection and SCADA systems.

9.1.3 Assumptions

- The existing DC and 415V supplies capacity at the substation is adequate for expansion works.

- The existing 66kV bulk oil circuit breaker and associated secondary systems are scheduled to be replaced in the 2017/18 financial year.

9.1.4 Dependencies

None identified

9.1.5 Key Stakeholders

There is little risk of public opposition to replace the transformer at [redacted] Mine. This project will ensure a safe, reliable and high quality power supply for the mine.

Name	Title / Business Unit
Internal – Governance Stakeholders	Chief Executive
	Investment Review Committee
	Executive General Manager Power Networks
	Chief Engineer
	Group Manager Service Delivery
Internal – Design Stakeholders	Senior Manager Networks Development and Planning
	Manager Major Projects
	Senior Manager Network Assets
	Manager Protection
External – Authorities	Environmental Protection Authority
	Aboriginal Areas Protection Authority
External - Other	[redacted] Mine
	Ministers
	Utilities Commission
	Australian Energy Regulator

9.2 Capital Cost

A risk adjusted cost estimate (RACE) was conducted on the preferred option based on latest design, scope and cost information.

Based on the analysis, the project has a 90% likelihood of being delivered between [redacted] The contingency attributable to risk is calculated as P95 – P50

= \$0.23M. The calculated P_{50} risk-adjusted cost is the estimated cost of the project.

[redacted]

9.2.1 Base Capital Cost

[redacted]		[redacted]
[redacted]		
	[redacted]	[redacted]
	[redacted]	[redacted]
[redacted]		
	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
[redacted]		
	[redacted]	[redacted]
[redacted]		
	[redacted]	[redacted]

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 1 – Base Capital Cost Estimate

9.2.2 Risk and Contingency

The current estimate has been developed largely based on PWC and consultant estimates considering previous experience with similar works. The contingency amount, calculated as the P95 value minus the expected P50 value, is currently $ 0.23M.

9.3 Estimated Operating Cost Impact

The ongoing operational costs of the new substation are detailed below. It is expected there will be a saving in operating cost due to lower unplanned maintenance associated with the new equipment and one less transformer in the new configuration.

Item	Annual Incremental Cost
Planned Maintenance	9,044
Preventative Maintenance	24,472
Unplanned Maintenance	887
TOTAL	34,403

Table 2 – Estimated Operating Cost Impact for the recommended option

9.4 Project Milestones

Project Phase (end)	Investment Planning	Project Development	Commitment	Implementation	Review
Original Plan (BNI)	07/2017	01/2020	07/2020	06/2022	09/2022
Current Forecast	07/2017	07/2020	09/2020	06/2022	09/2022
Actual Completion	07/2017				

10 RISK MANAGEMENT AND COMPLIANCE

A preliminary risk register has been established to address project risk. This is included in Appendix B. This register will form the basis of the Project Risk Register into the project delivery phase. The register will be regularly reviewed and updated as required to ensure all identified risks are managed as the project progresses.

10.1 Legal Issues

There are no expected legal issues regarding this project.

10.2 Stakeholder and Approval Issues

There are no expected stakeholder and approval issues regarding this project.

10.3 Environment and Sustainability Issues

All replacement or upgrade work will take place entirely within PWC owned zone substations. Decommissioned assets, such as protection relays, will be disposed of appropriately in accordance with good environmental practice.

10.4 Technical and System Issues

The existing 66kV switchyard will be taken out of service with the use of a Nomad modular substation. However, for all construction work adjacent to energised high voltage equipment, PWC has policies and procedures that must be adhered to, such as the Power and Water Access to Apparatus Rules and Access to High Voltage Apparatus Procedure.

Change over from existing to new 66kV switchyards will involve short term line outages to affect the transfer. These outages will be scheduled away from peak periods and in detail to minimise system security risk in close consultation with System Control.

11 PROJECT IMPLEMENTATION

This project is to be managed by the Power Networks' Project Management group. It is planned that the project will be delivered using the "Design and Construct" methodology through an external contractor.

Testing and commissioning will be managed by Power Networks' Test and Protection group.

It is expected that the majority of electrical equipment will be procured through the D&C contract, with detailed specifications from PWC.

11.1.1 Resourcing Requirements (to next gateway)

Resource Type/Role	How Many?	Internal/ External?	Anticipated Start Date	Duration Required	Allocation (% time or # hrs/days/ wks/mths)

Project Manager	1	Internal	Jul 2020	6 months	10%
Planning Engineer	1	Internal	Jul 2020	6 months	10%
Design Engineer	1	External	Jul 2020	6 months	50%

12 FINANCIAL IMPACT

12.1 Funding Arrangements

The capital expenditure for this project will need to be approved by the AER's 2019-24 Network Price Determination, which is recovered through standard control network tariffs.

Based on the most up to date information, the project cost estimate has been revised to [redacted] The revised cost is based on the estimated costs provided in the concept design and additional estimates for internal PWC expenditure.

12.2 Capital Expenditure

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]		[redacted]				[redacted]
[redacted]		[redacted]				[redacted]

12.3 Incremental Operating Expenditure

An operating expenditure of approximately $34,000 per annum is expected for the maintenance of the new transformer and associated equipment. Upon completion of the project, the operation cost of the new transformer will be included in the operational budget and forecasted in regulatory processes.

APPENDIX A

Summary of Financial Analysis

Introduction

The purpose of this Appendix is to provide details of the options analysis for Replace [redacted] Transformers.

Table A1 below outlines the estimated capital expenditure for Options 1, 2 and 3. The operational cost of Option 3 is less than Option 2 as it will only have one transformer, requiring less operational maintenance than the two transformers under Option 2. This is reflected in the operational cash flows below.

Table A1 – Estimated Capital & Operating Expenditure

Option	Capex – Base Costs ($M)	Opex – Base Costs ($000's)
Option 1 – Do nothing	[redacted]	$82 (from 2021/22)
Option 2 – Refurbish existing transformers	[redacted]	$69 (from 2021/22)
Option 3 – Replace with new 5/7.5MVA transformer and Nomad connection	[redacted]	$34 (from 2021/22)

Assumptions

In modelling the options, technical, economic and cost parameters were included. The technical and cost data was provided by Power Networks and the economic data was sourced from Pricing and Economic Analysis (PEA). Base cost capital expenditure was based on the consultant's feasibility study.

In the assumptions, all costs exclude GST or other government charges.

The common variables employed in the Discounted Cash Flow (DCF) model are presented in Table A2 below. These variables are consistent with the 2019-24 Regulatory Proposal to the AER and are considered appropriate for use in the detailed commercial analysis.

Table A2 – Common Variables

Variables	
Nominal Pre-Tax WACC	6.96%
CPI – 2017/18	2.42%
CPI after 2017/18	2.42%
Time Horizon of Project	40 years

Option 1 – Deferral

The analysis for this options does not require any capital expenditure and assumes the average operational costs of $82,022 per annum will continue into the future.

Option 2 – Refurbish existing transformers

The analysis for this option includes capital expenditure of [redacted] in 2020/21. A total of [redacted] is estimated to be the base cost with ongoing operational costs of $68,806 per annum

Option 3 – Replace with new 5/7.5MVA transformer and Nomad connection

The analysis for this option includes capital expenditure of [redacted] in 2020/21. A total of [redacted] is estimated to be the base cost with ongoing operational costs of $34,403 per annum.

Least cost analysis

Based on the DCF analysis undertaken, the least cost option is Option 1 (Do nothing). However, this is not considered to be a viable alternative due to the risk of major outages as a result of equipment failure. The next least cost option is Option 3. This is summarised in Table A3 below.

Table A3 – Net Present Cost of Options

Option	NPC ($M)
Option 1 – Do nothing	[redacted]
Option 2 – Refurbish existing transformers	[redacted]
Option 3 – Replace with new 5/7.5MVA transformer and Nomad connection	[redacted]

Tariff cover

This project capex (2020/21 expenditure) will be submitted as part of the 2019 Regulatory Proposal to the AER. The AER's Final Determination will provide the approved level of net capital expenditure for the 2019-24 period. In so far as the Regulated Networks annual capital expenditure program remains at this level (or lower), Networks will earn a guaranteed rate of return through standard control service charges until the commencement of the next regulatory control period in 2024-25.

APPENDIX B

DETAILED RISK REGISTER

Refer:

PRD33003 Risk Analysis [redacted] Zone Substation

PWC Ref: D2017/475930

APPENDIX C

SUMMARY PROJECT PROGRAM

Task	Baseline			2020				2021				2022			
	Plan Start	*Plan Duration*	*Percent Complete*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Options Study	Jul 17	6 wks	100%												
Concept Design	Jul 17	6 wks	20%												
Planning and Permits	Jul 20	10 wks													
Detailed Design	Aug 20	10 wks													
Procurement	Aug 21	30 wks													
Civil Construction	Oct 21	16 wks													
Electrical Construction	Nov 21	12 wks													
Commissioning	Mar 21	4 wks													
Energisation	Jun 21	2 wks													

APPENDIX D

Single line diagrams

[redacted]

Diagram 1: Existing Single Line Diagram

[redacted]

APPENDIX E

CONDITION ASSESSMENT REPORT

Refer:

[redacted] Substation Power Transformer Condition Assessment

PWC Ref: D2017/153127