Richmond Terminal Station (RTS) Redevelopment - 66kV Line & Secondary Works

Project № UEDO-14-003

EDPR BUSINESS CASE

This document justifies capital expenditure on the United Energy network and forms supporting documentation for the EDPR submission.

REPEX Road Map

1. Asset Replacement – Modelled

a. 6 modelled asset categories

2. Asset Replacement – Modelled & Unmodelled

a. Pole top structures + SCADA/protection

3. Other Repex - Unmodelled

a. ZSS Primary Asset Replacement

(i) CEES - Capacitor Banks + Earth Grid + Neutral Earthing Resistors

(ii) CEES - Buildings

b. Non VBRC Safety Projects

(i) Intelligent Secure Substation Asset Management (ISSAM) – UE PL 2401 e.g.CCTV

c. Operational Technology

(i) OT Safety

- Service Mains Deterioration Field Works – PJ1385
- In Meter Capabilities IMC) – PJ1386
- Light Detection and Ranging (LiDAR) Asset Management – PJ1400
- OT Security – PJ1500
- DNSP Intelligent Network Device – PJ5002

(ii) OT Reliability

- Distribution Fault Anticipation Data Collection and Analytics (DFADCAA) – PJ1599
- Fault Location Identification and Application Development – PJ1600

(iii) OT Other

- Dynamic Rating Monitoring Control Communication (DRMCC) – PJ1413
- Test Harness – PJ1398
- Pilot New and Innovative Technologies – PJ1407

d. Network Reliability Assessment UE PL 2304 – Projects

(i) Automatic Circuit Re-closers (ACRs) and Remote Control Gas Switches (RCGSs)

(ii) Fuse Savers

(iii) Rogue Feeders

(iv) Clashing

(v) Animal Proofing

(vi) Communications Upgrade

e. CEES – Environment

f. CEES – Power Quality Maintained

g. Terminal Station Redevelopment HTS and RTS - UE-DOA-S-17-002 & UEDO-14-003

4. VBRC Projects

a. HV Aerial Bundled Cable Strategic Analysis Plan - UE PL 2053

b. DMA and MTN Zone Substation Rapid Earth Fault Current Limiter (REFCL) Installation

c. Other VBRC projects

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1. EXECUTIVE SUMMARY

1.1 Project Overview

Richmond Terminal Station (RTS) is owned by AusNet Transmission Group and operates at 220kV, 66kV & 22kV and supplies the CitiPower and UE networks. It has five 150MVA (220/66kV) and two 165MVA (220/22kV) transformers and feeds key loads within the Melbourne CBD and surrounding eastern suburbs. Much of the terminal station equipment has reached the end of its economic life and as such AusNet Transmission Group is currently replacing most of the aging assets within RTS to improve security of supply.

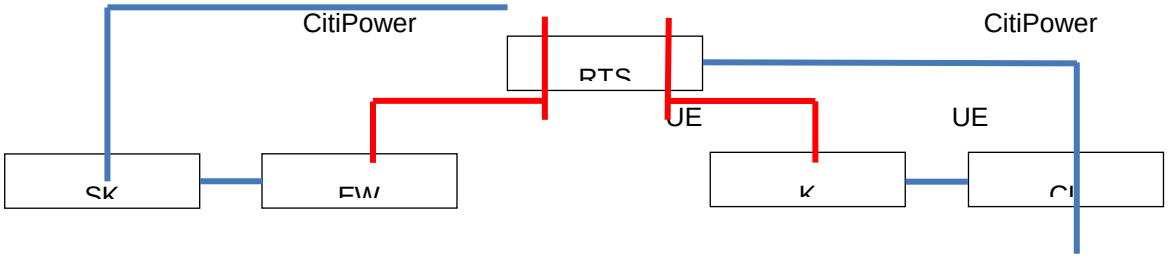
The project assessed in this business case is the proposal to replace the UE owned 66kV EW (Elwood) and K (Gardiner) 66kV line exits at RTS and realign and reconnect the line exits with new underground cables to the new indoor GIS switchboard inside RTS and the existing overhead network. This work shall be coordinated with AusNet Transmission Group's project to rebuild RTS. The project also includes the installation of new fibre optic cabling and protection relays to replace the old equipment and to allow the new protection and control equipment installed at RTS to integrate with remote end relays at EW and K.

The existing RTS 66kV outdoor switchyard is shown in Figure 1 and connects to the two UE owned overhead lines. This outdoor yard will be replaced with an indoor switch-room by AusNet Transmission Group in 2015 and as such the overhead line exits will need to be replaced by UE with underground 66kV cables, to maintain supply via the EW and K 66kV line exits. As part of these works the protection, control and communication systems need to be replaced, requiring substantial fibre optic installation work within UE's service area.

Figure 1: Existing RTS 66kV Switchyard

UE is required to undertake these works to maintain the security and reliability of supply to UE's K (10,878 customers) and EW (15,157 customers) zone substations. Failure to undertake these works will result in UE will be reliant on CitiPower to supply both K and EW zone substations radially on a permanent basis via CitiPower's Camberwell (CL) and St Kilda (SK) zone substations respectively as shown in Figure 2. Such arrangements would result in the 26,035 UE customers supplied from K and EW zone substations experiencing a significant deterioration in the reliability of their electricity supply.

Figure 2: Existing RTS 66kV System Supplying UE

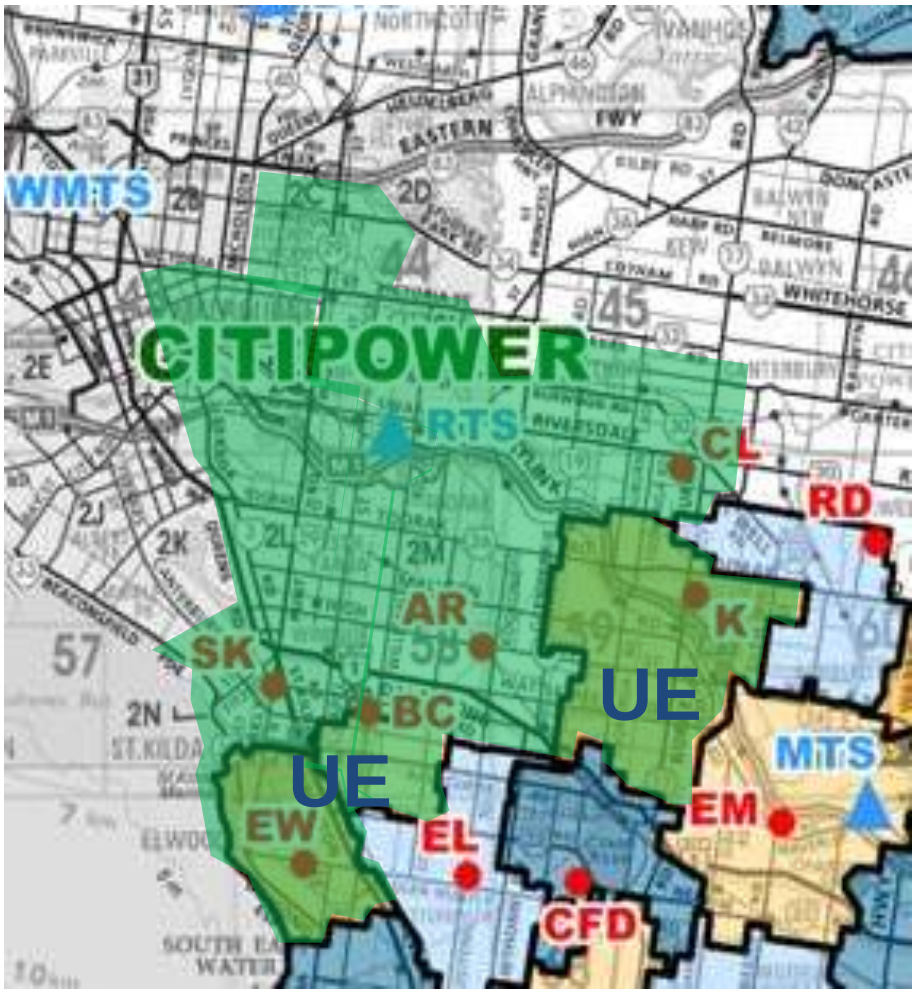


1.2 Project Need

One emerging operational issue associated with the sub-transmission network that supplies EW and K zone substations has been identified, as described below:

- **Security and Reliability of Supply:** As a result of the replacement works on the transmission connection assets at RTS, if UE does not undertake this project to replace its overhead feeder exits ex RTS with underground feeder exits and thus connect its feeders to the new transmission assets (a new 66kV GIS switchboard), then EW and K will need to be operated radially from CitiPower zone substations SK and CL respectively. This is a security of supply issue for both UE and CitiPower as zone substations are not typically designed to operate radially during system normal operations. Radial operation of EW and K from SK and CL will impact reliability performance of all of these zone substations as loss of supply will result for any sub-transmission line outage until the fault is repaired. If the proposed work does not proceed, reliability of supply to the green shaded areas shown below will substantially deteriorate, resulting in long duration outages in the event of a single fault at any time of the year.

Figure 3: Citipower/United Energy Boundaries



In order to address this issue, replacement of the EW and K 66kV overhead line exits with underground cables and the upgrade of the protection, control and communications network servicing these zone substations to interface with RTS has been identified as the preferred option.

1.3 Alternative Options Considered

The following alternative options were considered to address the emerging operational issue at EW and K.

- Option 1: Do nothing. This option involves no incremental capital expenditure, and will necessitate radial operation of UE's sub-transmission network from CitiPower zone substations.
- Option 2 (preferred): Undertake RTS redevelopment 66kV line works to maintain existing network arrangements, and to maintain present levels of supply reliability.

1.3.1. Option 1: Do nothing - Radial operation of the sub-transmission network

This option involves operating the RTS-CL-K-RTS and RTS-SK-EW-RTS sub-transmission loops radially by disconnecting the K and EW connections at RTS and relying on CitiPower to supply the UE zone substations via its 66kV network. This option:

- Involves no incremental capital expenditure;
- Results in the loss of United Energy's 66kV connections to RTS from EW and K zone substations;
- Does not enable UE to maintain present levels of supply security and reliability to the customers supplied from K and EW zone substations;
- Adversely affects the reliability performance of both the UE and CitiPower networks, with long duration outages of tens of thousands of customers in the inner urban areas of Melbourne becoming a frequent occurrence;
- Puts AusNet Transmission Group's main replacement project at RTS at risk of stalling; and
- Assumes CitiPower proceeds with their connection works at RTS.

This is not the least lifecycle cost option for UE. On this basis this option is not preferred.

1.3.2. Option 2 (preferred): RTS Redevelopment 66kV line works to maintain existing supply arrangements

This option involves replacement of the EW and K 66kV overhead line exits with underground cables, to enable connection with the new 66kV indoor GIS switchgear being installed by AusNet Transmission Group to replace the existing outdoor 66kV switchyard. It also involves the upgrade of the protection, control and communications network servicing these zone substations to interface with RTS. This will allow RTS-CL-K-RTS and RTS-SK-EW-RTS to remain in secure loop arrangements. This option:

- Enables UE to maintain present levels of supply security and reliability, and thus addresses the security of supply issues that would arise if the works did not proceed.
- Does not adversely affect the reliability performance of UE and CitiPower's network, compared to the outcomes that Option 1 would deliver.
- Allows AusNet Transmission Group's main project at RTS to proceed as planned.

This is the least lifecycle cost option for UE. For these reasons, this is considered the preferred option.

1.3.3. Technical Summary

Alternative	Option 1- Do nothing - Radial operation of sub-transmission network	Option 2 - 66kV line works to maintain current supply arrangements (Preferred)
Technically viable	Yes	Yes
Addresses security of supply risk; Maintains existing levels of security and reliability of supply to customers	No	Yes
Provides network configuration and operational flexibility in accordance with good electricity industry practice	No	Yes
Integrates as planned with AusNet Transmission Group's RTS rebuild project	No	Yes

1.3.4. Financial Summary

An evaluation of the technically feasible options on a least cost basis for UE over a 20 year lifecycle has been undertaken (excluding costs to CitiPower).

Alternative	Option 1 - Do nothing - Radial operation of sub-transmission network	Option 2 - 66kV line works to maintain current supply arrangements (Preferred)
Gross Capex ($)	0	$6.8M
AusNet contribution	N/A	$3.0M
Net Capex ($)	**N/A**	**$3.8M**
Opex ($)	N/A	N/A
Unserved Energy ($)[1]	$336M	$80M
Outage Costs ($)	$19M	$5M
Total Cost ($)	$355M	$92M
Present value of total cost ($)	$187M	$50M
Ranking	***2***	***1***

Further details of the costs of the options are presented in Appendix B. Appendix C provides a financial evaluation summary.

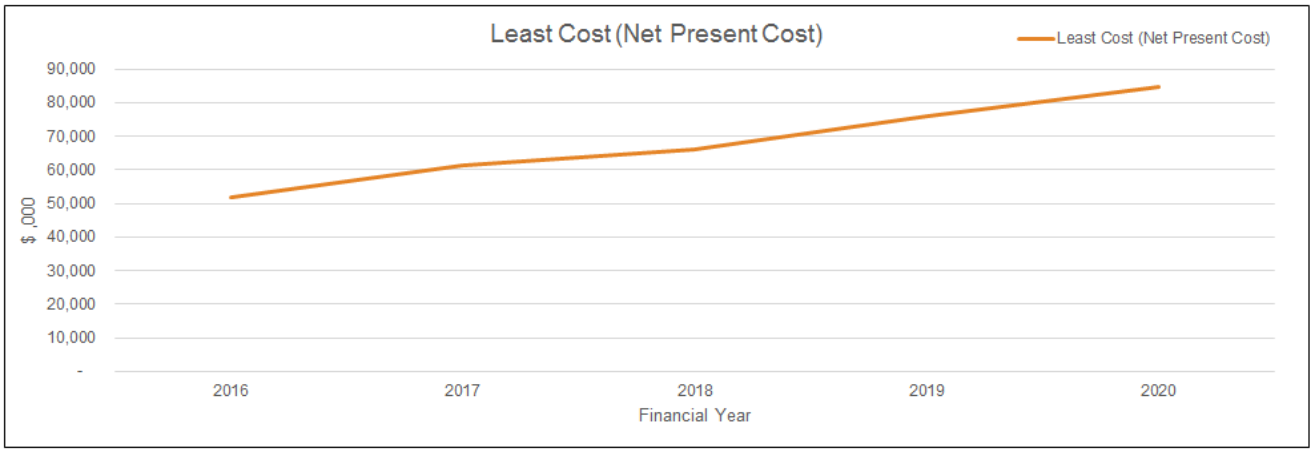
1.4 Optimum Timing

The economic timing of the project has been determined by comparing the annualised cost of Option 1 (do nothing) against the annualised capital cost of the preferred option (Option 2). This is basically a comparison of the annualised cost of expected unserved energy under Option 1 and the annualised cost of Option 2 (which involves capital expenditure to avoid the unserved energy outcomes that arise under Option 1).

The net annual cost of foregoing the preferred option and being exposed to the unserved energy costs under Option 1 is shown in the graph below. It can be seen that in 2016, costs of $50 million can be avoided if Option 2 (the preferred option) is implemented instead of Option 1. The graph also shows that this avoided

[1] This is the expected level of unserved energy incurred from all outages ex EW and K zone substations over 20 years. The difference in unserved energy costs between the two options represents the impacts of sub-transmission outages when operating the network radially rather than in the standard loop configuration.

annual cost - a net benefit of Option 2 - continues to rise over the period to 2020, reflecting the forecast increase in demand, and the increasing level of expected unserved energy over the period. This analysis indicates clearly that the optimal timing of the preferred option (Option 2) is 2016.



On this basis, the economic timing for the preferred option is now.

1.5 Recommendation

The detailed economic assessment indicates that replacing the overhead 66kV line exits at RTS with underground cables and the associated protection, control and communication upgrade is the least lifecycle cost solution to address the emerging issue. Therefore it is recommended to proceed with the preferred option in alignment with the AusNet Transmission Group redevelopment works at RTS.

With a total project cost of $6.8M, it is recommended to proceed with the project with AusNet-supported contribution funding of $3M to allow AusNet Transmission Group's replacement works at RTS to continue. The net replacement capex required for completion of this project is $3.8M.

2. PROJECT FINANCIALS

2.1 AMP Status of Preferred Option

The status of the preferred project is detailed below.

PROJECT COST	
AMP Approved Project?	Yes
Year Budgeted	2014/15 to 2017/18
Required Service Date	Staged: July 2016 / September 2017
Budgeted Total Cost ($A excluding GST)	$6.8M
Business Case Cost ($A excluding GST)	**$6.8M (Note 1)**

Note 1: Approximately $3M of the $6.8 M budgeted cost is a contribution from AusNet Transmission Group. AusNet Transmission Group has agreed to fund the 66kV cabling works component of the project through a contribution, as this reduces the total cost of AusNet Transmission Group's RTS redevelopment project.

2.2 Option 2 RTS Redevelopment – Costs

The major costs of the preferred Option 2 are set out below. Appendix A sets out a high level scope of work.

COSTS (Capex, Opex, Risk, Unserved Energy)	Driver	NPV Cost
Capex (before AusNet contribution)	$6,785,000	$6,785,000
SAIDI Costs (minutes per annum)	3.11	$22,807,000
SAIFI Costs (interruptions per annum)	0.04	$18,660,000
Costs per minute	$56,500	$2,688,000

2.3 Option 1 Radial Operation – Costs

The major costs of Option 1 are set out below.

COSTS (Capex, Opex, Risk, Unserved Energy)	Driver	NPV Cost
Capex	$0	$0
SAIDI Costs (minutes per annum)	18.65	$136,842,000
SAIFI Costs (interruptions per annum)	0.08	$37,320,529
Costs per minute	$56,500	$12,618,463

APPENDIX A – HIGH LEVEL SCOPE OF WORK

A summary of the scope of works for the project is presented below.

66kV Line Works – Replace the overhead line exits with underground cable exits

- Supply and install the cable head pole and terminating structure for the EW and K line exits respectively;
- Selection and supply of EW and K cables (approximately 460 metres route length) and cable terminations, terminating the EW and K cables at both ends to their designated structures (including earthing) and the GIS switchgear;
- Excavation, backfilling, laying, traffic management for the EW cable installation outside Richmond terminal station (including community management and liaising with council);
- Restringing of line K overhead conductor from the new structure inside RTS to the 220kV ROTS tower;

Secondary Works – Retire old pilot wire and supervisory and install modern protection and fibre optics.

- The existing sub-transmission line protection schemes at EW on the RTS 66kV line shall be retired and replaced with new 'X' SEL311L and 'Y' L90 protection relays. Both relays shall be configured so as to protect the EW-RTS 66kV line with (i) line current differential protection (ii) sensitive earth fault protection (non-directional where suitable VTs are not available) and (iii) neutral displacement protection.
- Similarly the existing sub-transmission line protection schemes at K on the RTS 66kV line shall be retired and replaced with new 'X' SEL311L and 'Y' L90 protection relays. Both relays shall be configured so as to protect the K-RTS 66kV line with (i) line current differential protection (ii) sensitive earth fault protection (non-directional where suitable VTs are not available) and (iii) neutral displacement protection.
- This project requires the installation of 96-core fibre optic cables. The fibre work shall be done according to the recommendations of the detailed risk assessment which identified cost savings in the original fibre scope.

APPENDIX B – COST ESTIMATE

The original cost estimate provided by Service Delivery for the project was as follows. This is compared with the revised estimate with identified savings.

Component	$k
Project Management	354
Design	413
66kV feeder works	1,533
Fibre Installation	1,261
Fibre Make Ready	592
ZSS Secondary	283
AusNet/CitiPower scope changes & Indirect Costs	56
Overhead, risk and contingency	2,291
Total Project Cost	6,783

APPENDIX C – FINANCIAL EVALUATION SUMMARY

Project Details

Project Name : RTS Redevelopment

Internal Reference UEDO-14-003

Financial Year in which construction begins 2015

Regulatory Category Demand (Reinforcement)

Project Type Non-Discretionary (customer initiated)

Asset Line Entry

Budget Allocation $2,400

Capital Costs

Capital Costs ($2015)		2015	2016	2017	2018	2019	2020	2021	2022	2023
		$000	$000	$000	$000	$000	$000	$000	$000	$000
	Technical Options									
Reference Case	Status Quo									
Option 1	RTS Redevelopment	479	3,323	1,655	1,059					
Option 2										
Option 3										
Option 4										
Option 5										

Operating Costs ($2015)

"Status Quo" Reference Case

	Unit	2016	2017	2018	2019	2020	2021	2022	2023	2024
Annual Maintenance Costs	($000)	0	0	0	0	0	0	0	0	0

Negative Impact on Revenue (STPIS)	Statistical Limits Band 1	2016	2017	2018	2019	2020	2021	2022	2023	2024
SAIFI sustained	(no. of Interruption)	0.08	0.1	0.1	0.1	0.1	0.1	0.08	0.1	0.1
SAIDI accidental	(minutes)	18.65	18.7	18.7	18.7	18.7	18.7	18.65	18.7	18.7
MAIFI momentary	(no. of Interruption)		0.0	0.0	0.0	0.0	0.0		0.0	0.0
Call centre response	(percentage)		0%	0%	0%	0%	0%		0%	0%

Network Outage Costs		2016	2017	2018	2019	2020	2021	2022	2023	2024
Customer off supply	(minutes)	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65	18.65

Loss of F Factor Benefit		2016	2017	2018	2019	2020	2021	2022	2023	2024
	(No. of fire start NOT avoided)									

Costs		2016	2017	2018	2019	2020	2021	2022	2023	2024
Cost 1	($000)									
Cost 2	($000)									
Cost 3	($000)									
Cost 4	($000)									
Cost 5	($000)									
Risk 1	($000)									
Risk 2	($000)									
Risk 3	($000)									
Risk 4	($000)									
Risk 5	($000)									

Option 1: RTS Redevelopment

		2016	2017	2018	2019	2020	2021	2022	2023	2024
Annual Maintenance Costs	($000)	0	0	0	0	0	0	0	0	0

Negative Impact on Revenue (STPIS)	Statistical Limits Band 1	2016	2017	2018	2019	2020	2021	2022	2023	2024
SAIFI sustained	(no. of Interruption)	0.04	0.0	0.0	0.0	0.0	0.0	0.04	0.0	0.0
SAIDI accidental	(minutes)	3.11	3.1	3.1	3.1	3.1	3.1	3.11	3.1	3.1
MAIFI momentary	(no. of Interruption)		0.0	0.0	0.0	0.0	0.0		0.0	0.0
Call centre response	(percentage)		0%	0%	0%	0%	0%		0%	0%

Network Outage Costs		2016	2017	2018	2019	2020	2021	2022	2023	2024
Customer off supply	(minutes)	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11

Loss of F Factor Benefit		2016	2017	2018	2019	2020	2021	2022	2023	2024
	(No. of fire start NOT avoided)									

Costs		2016	2017	2018	2019	2020	2021	2022	2023	2024
Cost 1	($000)									
Cost 2	($000)									
Cost 3	($000)									
Cost 4	($000)									
Cost 5	($000)									
Risk 1	($000)									
Risk 2	($000)									
Risk 3	($000)									
Risk 4	($000)									
Risk 5	($000)									

Project Details

Project Name : RTS Redevelopment

Asset : United Energy

Year in which project will begin : 2015

Discount Rate : 6.22%

**Business WACC (Pre-tax Nominal WACC)*

Project Type : Non-Discretionary (customer initiated)

Regulatory Asset Category Proportion (Percentage)

Customer Initiated	0%
Demand (Reinforcement)	100%
Reliability & Power Quality Maintained	0%
Reliability & Power Quality Improved	0%
SCADA & Network Control	0%
Environmental, Safety & Legal	0%
Non-Network IT	0%
Non-Network general other	0%
Non-Standard Control	0%

Gas reg categories - to be completed

	0%
	0%
	0%
	0%
	0%
	0%
	0%
	0%
	0%

Economic Assessment

Budget :

Is the project included in the budget?	Yes
If yes, how much is allocated?	$ 2,400.00

Results:

$000

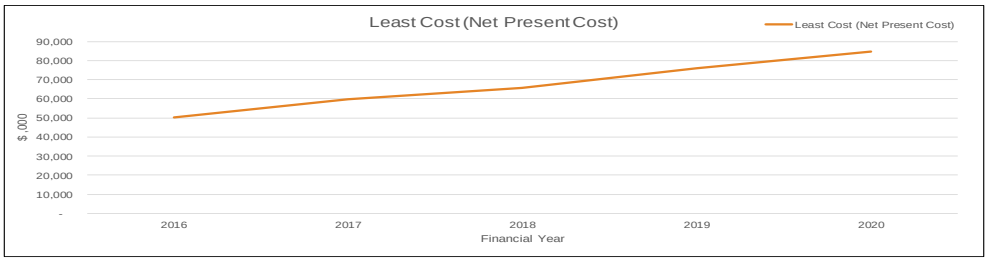
Least Cost Option Option 1: RTS Redevelopment

Least Cost (Present Value) 50,352

Options	"Status Quo" Reference Case	Option 1 RTS Redevelopment	Option 2	Option 3	Option 4	Option 5
Capital Costs	-	6,785.0	-	-	-	-
Annual Maintenance Costs	-	-	-	-	-	-
Negative Impact on Revenue (STPIS)	336,096.9	80,023.1	-	-	-	-
Network Outage Costs	19,174.8	4,877.3	-	-	-	-
Loss of F Factor Benefit	-	-	-	-	-	-
Cost 1	-	-	-	-	-	-
Cost 2	-	-	-	-	-	-
Cost 3	-	-	-	-	-	-
Cost 4	-	-	-	-	-	-
Cost 5	-	-	-	-	-	-
Risks	-	-	-	-	-	-
Total Costs	**355,271.7**	**91,685.4**	**-**	**-**	**-**	**-**
Present Value of Total Costs	**186,780.9**	**50,352.3**				
Project Ranking	***2***	***1***				

Notes:	
Option 1: RTS Redevelopment	
Option 2:	
Option 3:	
Option 4:	
Option 5:	

Timing Analysis - RTS Redevelopment



Sensitivities

Best Case Scenario

Options	"Status Quo" Reference Case	Option 1 RTS Redevelopment	Option 2	Option 3	Option 4	Option 5
Capital Costs	-	6,106.5	-	-	-	-
Opex	319,744.5	76,410.4	-	-	-	-
Total Costs	**319,744.5**	**82,516.9**	**-**	**-**	**-**	**-**

Discount Rate *5.2%*

Present Value of Total Costs	**184,589.8**	**49,364.6**				
Project Ranking	***2***	***1***				

Worst Case Scenario

Options	"Status Quo" Reference Case	Option 1 RTS Redevelopment	Option 2	Option 3	Option 4	Option 5
Capital Costs	-	7,463.5	-	-	-	-
Opex	323,579.5	77,385.8	-	-	-	-
Total Costs	**323,579.5**	**84,849.3**	**-**	**-**	**-**	**-**

Discount Rate *7.2%*

Present Value of Total Costs	**156,000.9**	**43,478.0**				
Project Ranking	***2***	***1***				