Appendix 4.12 HV cables business case

Revised regulatory proposal for the ACT electricity distribution network 2019–24

November 2018

evoenergy

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Executive Summary

Evoenergy, with support from CutlerMerz, further reviewed its proposed high voltage (HV) cable investment program for the 2019-24 regulatory period in response to concerns raised by AER in its draft determination. The objective of the review was to gain an appreciation for AER's concerns and to provide appropriate clarification and validation of the prudency and efficiency of the investment proposal.

AER's focus centred on a proposed step increase in investment identified through its top down challenge and concerns around the associated cost-benefit analysis.

The review found:

- Irregularity in AER's top down challenge. The unit cost applied in AER's model is inconsistent with industry and market expectations, and the calibrated life extension is significantly longer than the industry standard life and the industry average from modelling AER has performed on other networks. The basis for the inconsistency in the unit cost was identified as an anomaly in the regulatory information notice (RIN) data provided to AER.
  Correcting for the unit cost anomaly and applying a life extension comparable with industry provides for a more reasonable and prudent investment challenge. The outcomes of this reasonable and prudent challenge results in AER's model supporting Evoenergy's investment proposal.
- That Evoenergy amended its investment strategy for HV Cables from reactive to condition based, addressing an increasing risk associated with the deteriorating asset base. The amended strategy provides for prudent and cost efficient investments targeting highest risk assets. The condition based strategy results in an initial increased volume and expenditure requirement from historical investments.
- That the cost benefit evaluation process aligns with industry practices and appraises the level of risk mitigated against the proposed investment cost. A validation of the implementation and outcomes confirmed a strong investment case with all the proposed investments mitigating more risk than the investment cost.

The outcomes of the review supports the prudence and cost efficiency of Evoenergy's proposed HV Cable investments.

Evoenergy is requesting the AER to approve the expenditure proposed in our January 2018 submission. This document provides Evoenergy's analysis and supporting information on the proposed HV cable investment for the AER's consideration ahead of their final determination.

1. Introduction

1.1 Background

The AER raised concerns in its draft determination regarding Evoenergy's proposed HV Cable investment program. The AER's concerns are summarised as follows:

- Evoenergy's repex forecast for underground cables are not in line with the AER's modelled results
- Evoenergy is forecasting a significant increase in both replacement expenditure and volumes for underground cables
- Evoenergy has altered its replacement strategy for underground cables
- Evoenergy's underlying cost-benefit analysis includes conservative assumptions, resulting in an overstated repex forecast for underground cables.

1.2 Proposal Review

Evoenergy undertook a review of:

- the AER's application of the repex model to Evoenergy's proposed HV Cable investment program
- Evoenergy's cost-benefit analysis approach and input assumptions

The review involved:

- An assessment of the AER repex model with the aim of gaining an appreciation for the AER's application of the model, the input assumptions and outputs
- Development of a cost/benefit method that can be interrogated in depth to reflect the expenditure on the HV Cable replacement program
- Engagement with the AER to gain input and alignment on the assessment outcomes
- Preparation of this report to document the outcomes and findings

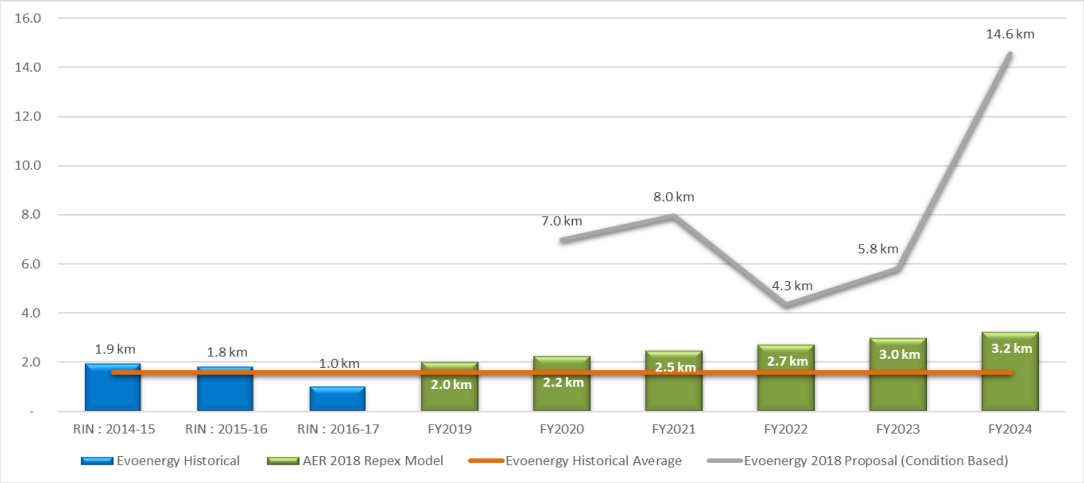
1.3 Proposal Context

Evoenergy changed its strategy for HV Cable investment from a reactive to a condition based approach. This resulted in a step increase in the proposed replacement volumes from historical practices as shown in **Figure 1.** The chart compares historical replacement volumes, the AER forecast, and Evoenergy's condition based forecast.

The AER forecast is based on continuing a business-as-usual investment approach and therefore forecast replacement volumes to reflect historical practices. The AER applies this approach as a challenge to proposed investment forecasts.

Evoenergy has historically managed its investment in the HV Cable network on a reactive basis. Increasing risk as a result of the continued deterioration of the condition of the cables has prompted a need for a targeted investment approach that seeks to manage the risk through planned replacement based on asset condition and risk (i.e. likelihood of failure and consequence of failure).

Figure 1. HV Cable replacement volume adjustment



2. AER Repex model as applied to Evoenergy's HV Cables

AER applied its repex model as part of a top down challenge to identify asset categories where the proposed investments appears to exceed a business-as-usual investment expectation. Fundamentally, the repex model is an aged based model calibrated to recent historic replacement volumes. A step change in investment due to a change in strategy (e.g. from reactive replacement to planned replacement based on condition and risk), has a strong likelihood of being identified as an area for further investigation.

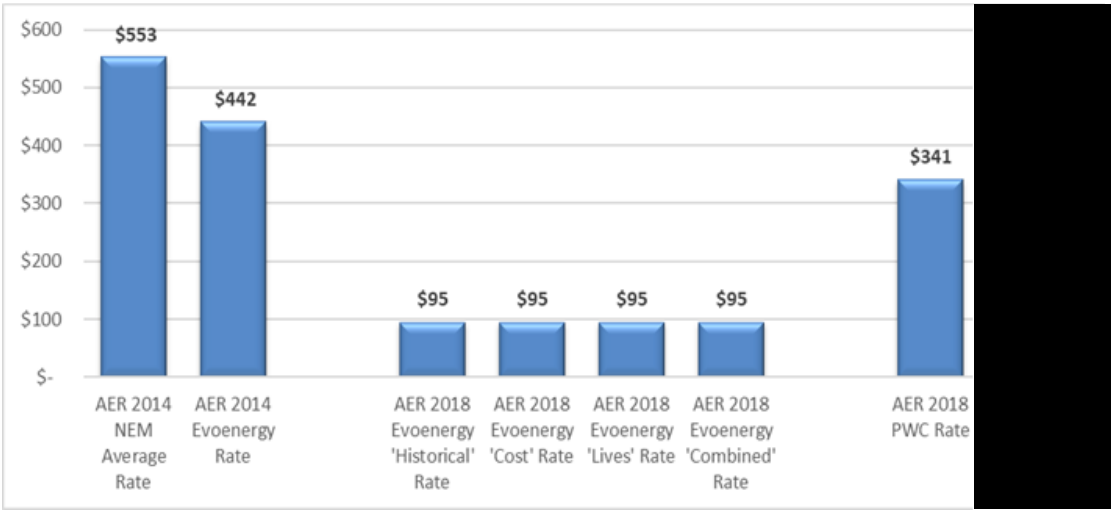
The key inputs to the model are: the asset age profile, historical failure / replacement rates, and the unit cost.

There are two key areas of concern regarding the AER's application of the repex model in developing the alternative expenditure forecast for Evoenergy's HV Cables.

2.1 Unit cost

The unit cost that the AER applied in the model is much lower than what would be considered reasonable for HV Cable replacements. The chart in **Figure 2** shows the HV Cable replacement rate in comparison with the rates applied in the 2014 repex models, the 2018 PWC repex model, and Evoenergy's internal rate. The unit rate selected by the AER materially reduces the expenditure forecast and is not aligned with the expected replacement costs for HV cables.

Figure 2. HV Cable replacement unit cost comparison



The unit cost applied by the AER has been based on Regulatory Information Notice (RIN) data provided by Evoenergy. A review of the RIN submitted over the period 2013-14 to 2016-17 identified an anomaly in the HV Cable data. Expenditures associated with HV Cable replacement projects were incorrectly categorised as augmentation investments as result of their scale, resulting in an under-representation of the replacement cost of HV Cables as demonstrated in **Table 1**.

This anomaly may have led AER to applying the lower than expected unit cost in its assessment of HV Cable replacement expenditures.

Table 1. Category Analysis RIN (section 2.2.1) - 2013/14 to 2016/17

Year	HV cable replacement expenditure ($)	Cable length replaced (km)	Implied unit rate ($/m)
2013-14	$113,260	760	$149
2014-15	$85,274	1,910	$45
2015-16	$328,153	1,790	$183
2016-17	$19,617	1,000	$20
Average	**$136,576**	**1,365**	**$99**

Actual costs incurred on major HV Cable replacement projects over the last five years are provided in **Table 2** and provides a more accurate representation of the unit cost attracted by Evoenergy. The significant increase in the volume of major HV cable replacement projects undertaken by Evoenergy over the next regulatory period is expected to result in a glidepath in efficiency gains driven by a competitive market. This expected efficiency gain is reflected in the unit cost of [redacted] proposed by Evoenergy.

Table 2. HV Cable replacement projects

Replacement Project	Start year	End year	Length (m)	Cost ($)	Unit cost ($/m)
Sternberg Feeder	2016-17	2017-18	6,392	[redacted]	[redacted]
ANU Backup Feeder	2016-17	2017-18	2,400	[redacted]	[redacted]
Yamba Feeder	2013-14	2014/15	2,863	[redacted]	[redacted]
Average				[redacted]	[redacted]

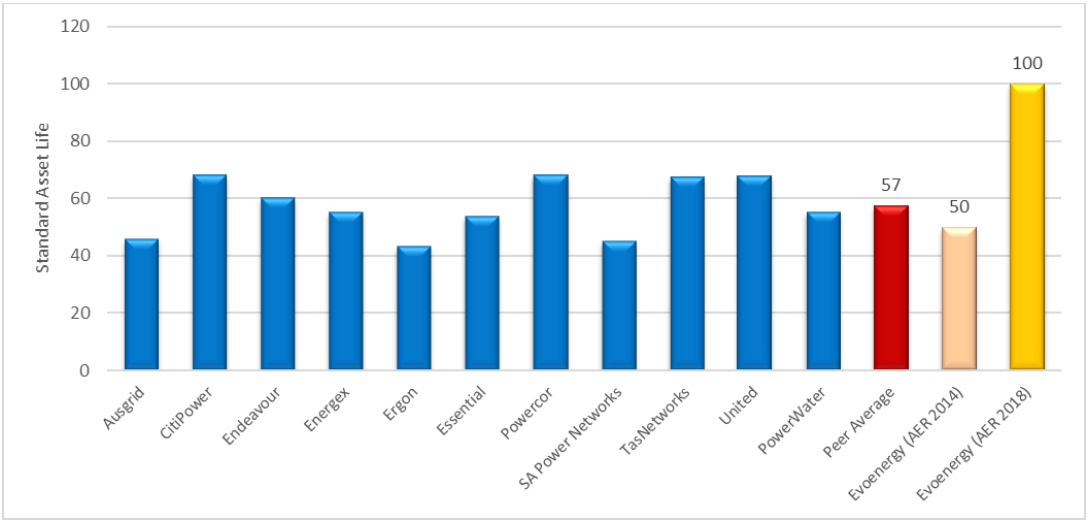
2.2 Calibrated asset life

The second concern is the extended asset life derived in the model. To achieve a business-as-usual scenario, the AER adjust the asset replacement life within the model until the replacement volumes reflect historical replacement rates. Using this approach, the AER determined the asset life for HV cables should be 100 years.

The AER's approach is reasonable when there has been a history of replacement across a large population of assets with a uniform age profile. In the case of Evoenergy's HV cables, there have been relatively few recent replacements across a population of assets with ages skewed towards the end of life. Under this scenario, the repex model methodology of using recent historic replacement volumes as a predictor of future requirements needs to be sense checked before adopting the results.

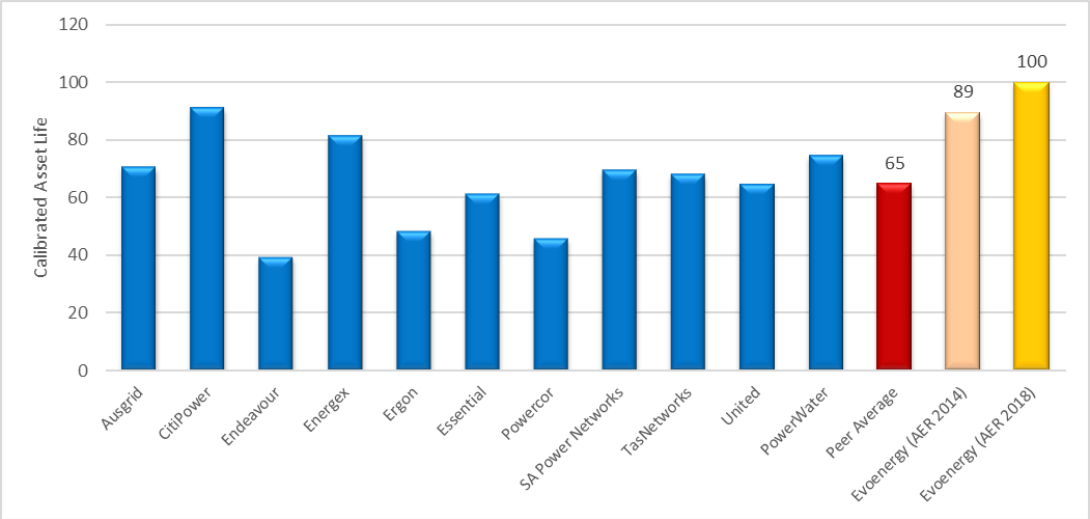
The AER's calibrated asset life exceeds the industry standard life by around 43 years, or 75% as shown in **Figure 3**.

Figure 3. HV Cable standard asset life comparison



Applying the approach results in the AER expecting Evoenergy's HV cables to remain in-service until they reach 100 years of age, significantly higher (35 years, or 54%) than the industry average from the repex modelling the AER has performed on other networks (refer **Figure 4**).

Figure 4. AER - HV Cable calibrated asset life comparison



The reasonableness of extending the asset life to an age far exceeding industry expectation is not considered prudent particularly given the AER commented that *'for most asset groups, Evoenergy compared favourably with other distributors on both unit costs and expected replacement lives.'*

Evoenergy is proposing a condition and risk based investment program aimed at addressing the increasing risk in a prudent and cost efficient way by targeting the replacement of assets with the highest risk.

Back solving for the asset life that would result in the repex model output aligning with Evoenergy's investment forecast indicated that the expected life for Evoenergy's HV Cable asset life would be around 88 years. This represents a 30 year, or 53% life extension from the industry standard life and significantly longer than the industry average from modelling the AER has performed on other networks.

These findings point to the reasonableness of Evoenergy's HV cable forecast expenditure.

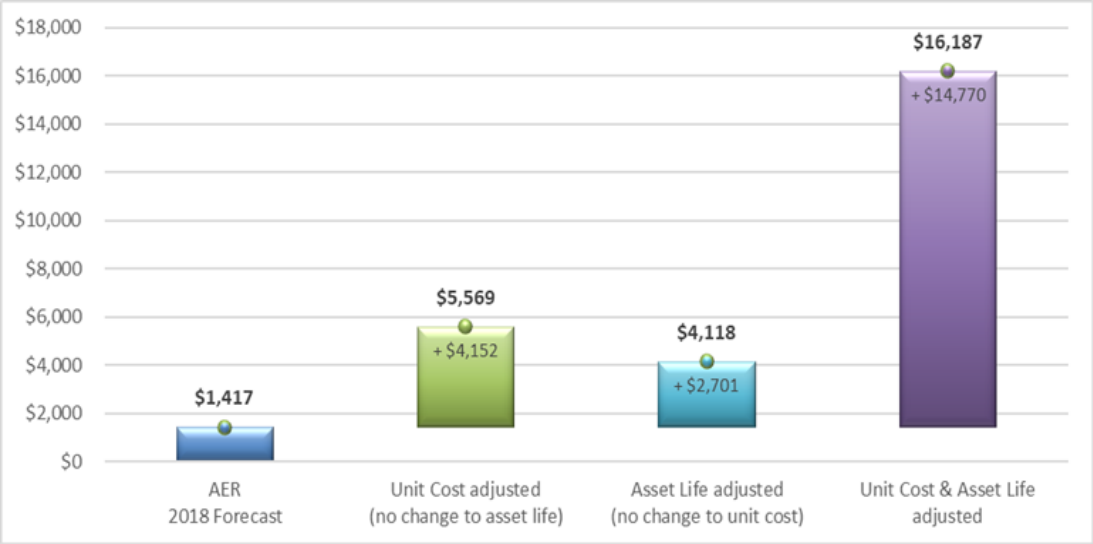
2.3 Adjusted Repex model outcomes

Based on an efficient and reasonable unit cost of [redacted] and adopting a life of 88 years results in a tenfold increase in the investment forecast, and supports Evoenergy's investment proposal of $16.186 million.

The proposed adjustments align the repex model with the AER's comment that *'for most asset groups, Evoenergy compared favourably with other distributors on both unit costs and expected replacement lives.'*

The impact of the proposed adjustment in the unit cost and asset life extension is shown in **Figure 5**.

Figure 5. HV Cable replacement expenditure model forecast adjustments



3. HV Cable Cost–Benefit Analysis

AER raised concerns regarding Evoenergy's cost-benefit approach, in particular regarding some of the input assumptions. A review of approach and input assumptions were undertaken, and the strength of Evoenergy' investments were evaluated by assessing the level of risk that is mitigated by the proposed investments.

This section provides a summary of the findings and outcomes of the review and evaluation.

3.1 Approach

Evoenergy's evaluation process aligns with industry practices and consists of four key areas of assessment:

- Current asset health condition and expected deterioration over time
- The probability of failure associated with each health condition
- The expected cost of failure considering the likelihood and severity of the consequence
- The calculated risk associated with no investment versus the risk after investment

3.1.1 Asset health condition

Considering the number of faults recorded over the last 26 years, the date of these faults, and the age of the cable, the current health of each feeder is determined.

The expected continued deterioration in health condition over time is estimated by applying deterioration curves for the two main cables types, XLPE and Paper. The deterioration curves are calibrated to align with actual failures and failure dates.

3.1.2 Probability of failure (PoF)

The probability of asset failure associated with the asset condition is determined considering three main failure modes: cable mid-section failures, termination and joint failures, end of life failure.

For each of these failure modes a probability of failure is determined based on curve fitting considering data points as defined by actual failure rates and Evoenergy's risk definitions.

The three key PoF data points are defined as follows:

- As new health (100) PoF:
  PoF of 0.0001 based on an unlikely probability of a failure occurring as defined by Evoenergy's Risk Definitions. This initial PoF has been adjusted were appropriate to reflect individual feeder performance. For example, the Tralee feeder, and Isa feeder have experienced multiple unexpected failures even though the feeders were only installed in the last 10 years. The cause of these failures relate to expected substandard installations practices. The initial PoF for these feeders have been adjusted to reflect the current health condition.
- Population average health (73) PoF:
  The average population health score is currently 73 reflecting an above average health condition across the majority of the HV Cable feeders. Failure rates across the population suggest a PoF of around 0.13 per feeder. This PoF represents the outcome of the current reactive asset management strategy where investment is only considered following an asset failure. Based on Evoenergy's proposed condition based investment strategy this PoF is expected to reduce to around 0.061. The reduction in PoF reflects the failures that are expected to be detectable weighted by the probability of the failure being detected prior to occurrence using condition based monitoring techniques. The reduced PoF was applied as the average PoF associated with the current average health of the HV Cable population.
- The end of life health (0) PoF:
  The end of life health score was set at 40% reflecting the average PoF associated with the lowest health feeders.

3.1.3 Cost of Failure (CoF)

The cost of failure has been determined applying Evoenergy's risk framework of likelihood and criticality considering the likelihood of occurrence and expected severity of consequence for each of the risk areas: environmental, health and safety, level of service, economic, and reputation.

3.1.4 Risk calculation

Risk was determined in monetary terms by multiplying the PoF and CoF for each failure mode as applicable to the projected condition of the asset in each year over the regulatory period.

3.2 Application in Riva

3.2.1 Input assumptions

The AER raised a concern regarding the input assumptions to Evoenergy's cost-benefit analysis containing conservative assumptions with particular reference to the use of a higher than expected value for fatality per FTE. Evoenergy applied a value of $10 million whereas the generally accepted industry value is closer to $4.35 million. This difference translate to Evoenergy being willing to invest more heavily than others to reduce the risk of causing the fatality. The ratio of 2.3 that connects the two values is the disproportionality factor that represents Evoenergy's appetite for investing in safety. A

memo prepared by AMCL in 2016 containing general information regarding disproportionate factors (DF) states that:

> *"Guidance from the HSE (UK) notionally suggests that a DF between 2 and 10 can be used, where higher values are used for situations where extensive harm, if the risk event were to happen, is not unreasonable or where there is increasing societal concerns."*

A disproportionate factor of 2.3 as applied by Evoenergy is consistent with the DF's applied by other network businesses for safety related consequences. Notwithstanding the appropriateness of the VSL, it is noted that the safety risk value is not included in the risk quantification conducted by Evoenergy for HV cable risk and therefore, the value quoted is somewhat irrelevant to the case of investment in HV cables.

3.2.2 Risk Quantification

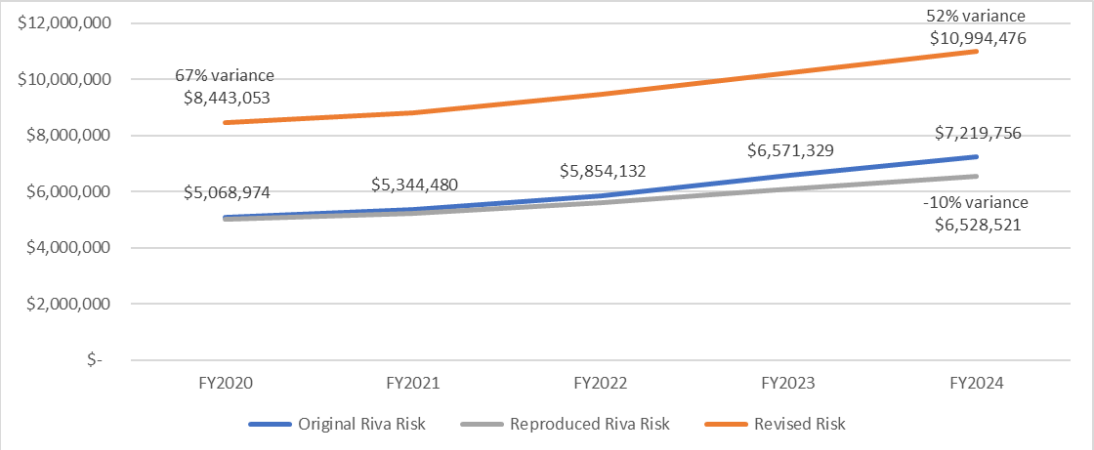
A review of the implementation of the benefits evaluation approach found that Riva closely aligns with the quantification framework set out before.

One minor error was identified in the implementation of the approach. The Riva model failed to include the failure mode for Joints & Terminations in determining the risk. This results in the model understating the level of risk. Despite this minor error, Evoenergy is not proposing to request additional funding in this revised submission.

Representing the whole HV Cable population the outcome of replicating the risk calculations in Excel and including corrections where applicable is summarised in **Figure 6** in comparison with the original risk determined in Riva.

- The Reproduced Riva Risk curve shows the risk calculated based on replicating the PoFs and CoFs. A slight variance of average 5% over the period appears to be as result of a rounding of numbers in Excel.
- The Revised Risk shows the risk when the Joints & Terminations failure mode is included. The annual risk increases with an average 60% across the period FY2020 to FY2024.

Figure 6. Risk quantification review outcomes



The revised risk was applied in the assessment of the strength of the investments proposed over the period FY2020 to FY2024. No additional feeders were identified for investment as result of the increase in risk.

Appendix A, Appendix B, Appendix C, and Appendix D provides the comparative review outcomes for condition, probability of failure, cost of failure, and quantified risk as

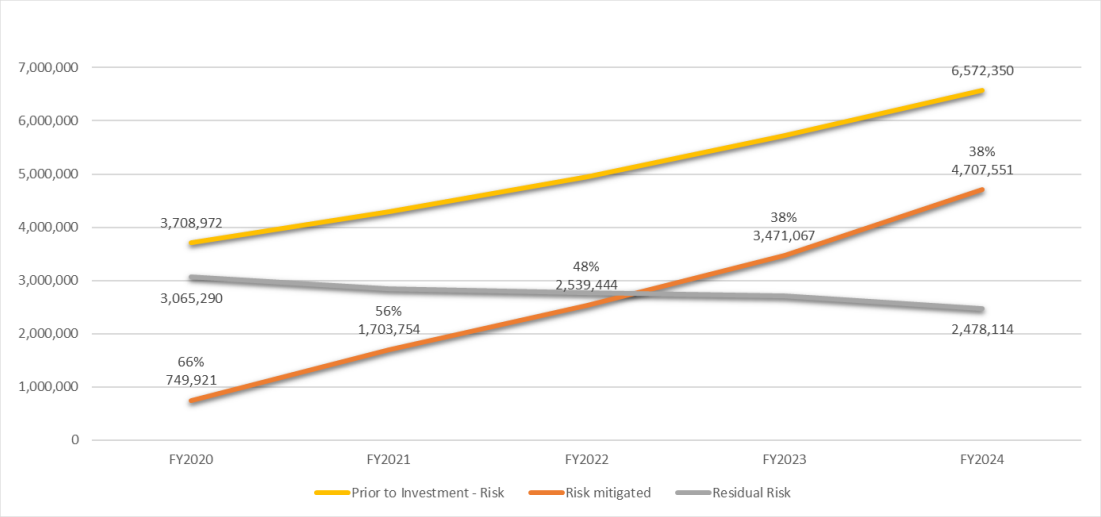
determined for each of the feeders identified for investment during the FY2020 to FY2024 regulatory period.

3.2.3 Mitigated Risk Quantification

A quantification of the risk mitigated was done by using the calculated 'with investment' probability of failure to derive 'no investment' PoF curves. Applying the PoF curves and cost of consequence values the risk without investment and with investment (residual risk) for each of the HV Cable feeders in the investment portfolio were calculated. The difference between the with-investment and without-investment risk profiles provides the risk that are offset (mitigated) as result of the investments. The mitigated risk is shown in **Figure 7** in comparison with the 'no investment' and residual risk.

At the start of the regulatory period around 66% of the risk associated with the portfolio of feeders being invested in, is mitigated. This reduces to around 38% by the end of the regulatory period.

Figure 7. Risk assessment



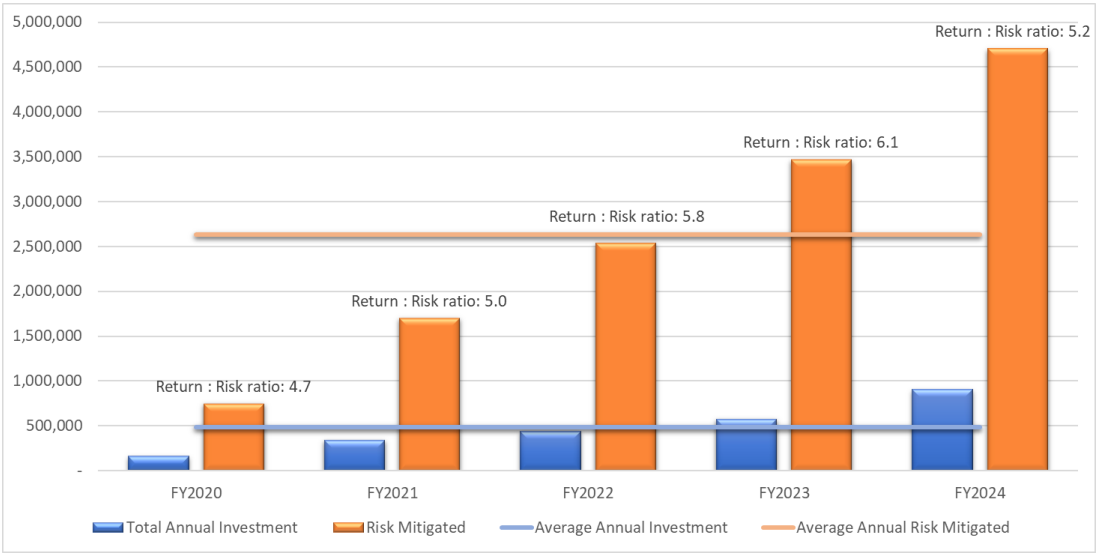
The decline over the period is as a result of the investments focusing on partial replacement to defer the requirement to replace the full length of the assets. Asset replacements result in more risk being mitigated and for a longer period, however at a higher cost to customers.

The capital investment and an asset life of 50 years were used to determine the annual investment cost to Evoenergy. The annual investment cost consists of the amortisation cost associated with the capital investment and return of capital associated with depreciation.

The annual costs arising from the investments have a direct bearing on customer prices and are the appropriate investment cost against which to assess the risk that would be offset. The outcome of the assessment is provided in **Figure 8**. The figure shows the investment cost in comparison with the mitigated risk cost on an annual basis over the regulatory period.

The cost to risk mitigated (benefit) ratio varies year on year between a lower range of 4.7 and an upper range of 6.1 and demonstrates a sound investment program.

Figure 8. Portfolio level Cost-Benefit Analysis outcomes

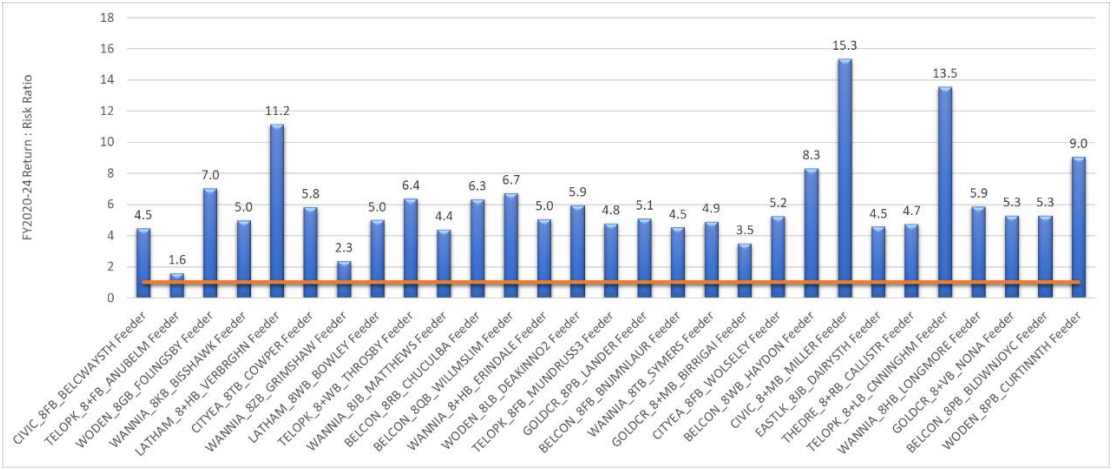


An assessment was also performed at the feeder level to determine whether there are any individual projects that did not present a strong investment case. The outcome of the assessment is provided in **Figure 9** and shows varying cost benefit ratios across the investment feeders varying between 1.1 at the lower range and 14.6 at the upper range.

None of the projects presented a negative cost to benefit ratio. One project presented a lower ratio of 1.6 and involve investment in the replacement of the feeder towards the end of the regulatory period.

With all the investments offsetting more risk than the investment cost, and with the investment portfolio averaging a cost benefit ratio of 5.3 the investments are considered prudent.

Figure 9. Feeder level Cost-Benefit Analysis outcomes



4. Addressing the AER concerns

The review of the AER's key concerns regarding Evoenergy's proposed HV Cable investment program provided the following outcomes:

AER's concern:

Evoenergy's repex forecast for underground cables are not in line with the AER's modelled results

Key Finding:

Applying a reasonable market unit cost as an input to the model and accepting the appropriateness of a prudent life extension, provides for a more reasonable and prudent investment challenge.

Assigning these modelling criteria results in the AER's repex model delivering an investment forecast that is in line with Evoenergy's proposed investment program.

AER's concern:

- Evoenergy is forecasting a significant increase in both repex and replacement volumes for underground cables
- Evoenergy has altered its replacement strategy for underground cables

Key finding:

A business-as-usual investment analysis reveals that Evoenergy has not made significant investments in the HV Cable asset class in recent years. It is somewhat contrived to assume that recent historic replacement rates for large capex investments is representative of future requirements.

Evoenergy amended its investment strategy with the aim of addressing the increasing risk associated with the HV cable asset class by investing in the partial replacement and ultimately in the full replacement of the highest risk assets. A condition based investment strategy provides a targeted and cost efficient investment approach. This has resulted in a step increase in the investment volumes from recent historical replacement rates.

AER concern:

Evoenergy's underlying cost-benefit analysis includes conservative assumptions, resulting in an overstated repex forecast for underground cables.

Key finding:

With particular reference to the value used for 'fatality per FTE': the value used by Evoenergy reflects its appetite for investing in the safety of its employees. The value represents a disproportionality factor of 2.3 that is considered reasonable based on industry guidance. More importantly however, the value of safety is not used for the quantification of risk in Evoenergy's HV cable modelling.

A cost benefit analysis of Evoenergy's proposed HV Cable investment program shows a strong investment case with all the investments mitigating more risk than the investment cost, with an average cost to benefit ratio of 5.3.

Appendix A – Health Condition Score

HV Cable Feeder	Riva Condition Scores: Including Investment Adjustments							Reproduced Condition Scores: Excluding Investment Adjustments						
	Condition [2018]	Condition (2019)	Condition (2020)	Condition (2021)	Condition (2022)	Condition (2023)	Condition (2024)	Condition [2018]	Condition (2019)	Condition (2020)	Condition (2021)	Condition (2022)	Condition (2023)	Condition (2024)
CIVIC_8FB_BELCWAYSTH	55	51	47	42	67	64	60	55	51	46	40	34	33	32
CIVIC_8QB_ANUNO12345	56	53	48	44	39	34	58	56	56	51	46	41	34	34
WANNIA_8QB_HEMMINGS	65	61	57	52	47	41	65	65	62	59	54	49	43	36
TELOPK_8+FB_ANUBELM	30	25	19	13	7	100	100	30	27	24	20	15	11	6
WODEN_8GB_FOLINGSBY	40	34	58	54	49	44	38	40	36	30	22	13	13	13
WANNIA_8KB_BISSHAWK	49	44	69	65	61	57	53	49	46	40	33	26	18	18
LATHAM_8+HB_VERBRGHN	46	41	35	60	57	53	49	46	42	36	35	34	34	33
TELOPK_8MB_BOWEN	61	58	54	51	46	42	67	61	60	56	51	45	45	44
CITYEA_8TB_COWPER	52	48	45	41	67	65	62	52	51	48	45	41	39	35
CITYEA_8EB_FERDINAND	57	54	50	47	43	39	64	57	57	55	53	52	50	48
WANNIA_8ZB_GRIMSHAW	60	56	51	46	70	66	62	60	59	54	50	44	37	31
LATHAM_8WB_BOWLEY	58	54	49	44	38	62	58	58	58	53	48	42	36	29
TELOPK_8+WB_THROSBY	49	45	41	36	61	58	55	49	48	46	45	43	41	39
WANNIA_8JB_MATTHEWS	52	47	41	65	61	57	52	52	49	43	36	29	22	13
BELCON_8RB_CHUCULBA	44	38	63	59	56	51	47	44	43	37	30	22	22	21
BELCON_8QB_WILLMSLIM	45	40	65	61	57	53	48	45	41	34	27	19	19	18
WANNIA_8+HB_ERINDALE	47	41	65	61	57	52	47	47	45	38	32	24	16	7
WODEN_8LB_DEAKINNO2	35	30	25	49	45	40	36	35	34	32	30	29	26	24
TELOPK_8FB_MUNDRUSS3	45	39	32	55	51	45	39	45	43	37	30	22	14	4
GOLDCR_8PB_LANDER	50	45	69	66	63	59	54	50	47	41	34	27	19	10
GOLDCR_8NB_ANTHNYRLF	51	46	40	33	26	18	100	51	50	44	37	31	23	14
BELCON_8FB_BNJMNLAUR	55	51	46	41	66	62	58	55	52	46	41	34	27	19
WANNIA_8TB_SYMERS	48	43	39	33	58	54	50	48	43	36	36	35	35	34
GOLDCR_8+MB_BIRRIGAI	59	56	51	47	42	67	64	59	56	50	45	40	33	25
LATHAM_8QB_SEAL	54	50	47	43	39	34	60	54	52	49	46	44	40	38
CITYEA_8FB_WOLSELEY	49	45	41	66	64	61	57	49	49	48	46	44	43	41
BELCON_8WB_HAYDON	41	35	57	53	47	41	35	41	34	28	20	11	1	1
CIVIC_8+MB_MILLER	37	33	27	52	48	44	40	37	35	33	30	26	23	19
EASTLK_8JB_DAIRYSTH	58	55	50	46	41	66	63	58	55	50	45	39	32	32

Appendix B – Probability of Failure (PoF)

HV Cable Feeder	Riva PoF: Including Investment Adjustments							Revised PoF: Including Investment Adjustments						
	PoF [2018]	PoF (2019)	PoF (2020)	PoF (2021)	PoF (2022)	PoF (2023)	PoF (2024)	Revised PoF [2018]	Revised PoF (2019)	Revised PoF (2020)	Revised PoF (2021)	Revised PoF (2022)	Revised PoF (2023)	Revised PoF (2024)
CIVIC_8FB_BELCWAYSTH	4.08%	4.67%	5.42%	6.35%	2.78%	3.08%	3.42%	12.14%	13.76%	15.53%	17.96%	8.09%	8.99%	10.31%
CIVIC_8QB_ANUNO12345	3.90%	4.43%	5.08%	5.88%	6.88%	8.15%	3.72%	11.76%	12.93%	15.07%	16.96%	19.54%	22.39%	11.02%
WANNIA_8QB_HEMMINGS	2.91%	3.31%	3.82%	4.47%	5.31%	6.42%	2.90%	8.68%	9.97%	11.38%	13.34%	15.53%	18.48%	8.68%
TELOPK_8+FB_ANUBELM	9.15%	10.72%	12.65%	15.04%	17.99%	0.66%	0.66%	24.88%	28.24%	32.69%	37.61%	43.03%	1.80%	1.80%
WODEN_8GB_FOLINGSBY	6.61%	8.05%	3.72%	4.29%	5.00%	5.92%	7.09%	19.00%	22.39%	11.02%	12.53%	14.63%	16.96%	20.09%
WANNIA_8KB_BISSHAWK	4.94%	5.83%	2.61%	2.94%	3.34%	3.85%	4.43%	14.63%	16.96%	7.52%	8.68%	9.97%	11.38%	12.93%
LATHAM_8+HB_VERBRGHN	5.59%	6.55%	7.74%	3.46%	3.89%	4.41%	5.05%	16.00%	18.48%	21.80%	10.31%	11.38%	12.93%	14.63%
TELOPK_8MB_BOWEN	3.36%	3.74%	4.20%	4.75%	5.42%	6.25%	2.73%	9.97%	11.02%	12.53%	13.76%	16.00%	17.96%	8.09%
CITYEA_8TB_COWPER	4.55%	5.08%	5.71%	6.46%	2.76%	2.99%	3.26%	13.34%	15.07%	16.47%	18.48%	8.09%	8.68%	9.63%
CITYEA_8EB_FERDINAND	3.83%	4.26%	4.76%	5.36%	6.09%	6.97%	3.03%	11.38%	12.53%	14.19%	15.53%	17.45%	19.54%	8.99%
WANNIA_8ZB_GRIMSHAW	3.47%	4.00%	4.68%	5.55%	2.50%	2.81%	3.20%	10.31%	11.76%	13.76%	16.00%	7.25%	8.38%	9.63%
LATHAM_8WB_BOWLEY	3.70%	4.26%	4.97%	5.88%	7.05%	3.24%	3.69%	11.02%	12.53%	14.63%	16.96%	20.09%	9.63%	11.02%
TELOPK_8+WB_THROSBY	4.95%	5.63%	6.47%	7.50%	3.32%	3.66%	4.07%	14.63%	16.47%	18.48%	21.22%	9.97%	11.02%	12.14%
WANNIA_8JB_MATTHEWS	4.49%	5.34%	6.45%	2.92%	3.32%	3.83%	4.49%	13.34%	15.53%	18.48%	8.68%	9.97%	11.38%	13.34%
BELCON_8RB_CHUCULBA	5.88%	7.02%	3.15%	3.54%	4.02%	4.62%	5.37%	16.96%	20.09%	9.31%	10.66%	11.76%	13.76%	15.53%
BELCON_8QB_WILLMSLIM	5.62%	6.62%	2.97%	3.34%	3.80%	4.37%	5.09%	16.47%	19.00%	8.68%	9.97%	11.38%	12.93%	15.07%
WANNIA_8+HB_ERINDALE	5.37%	6.47%	2.92%	3.33%	3.84%	4.49%	5.33%	15.53%	18.48%	8.68%	9.97%	11.38%	13.34%	15.53%
WODEN_8LB_DEAKINNO2	7.76%	9.09%	10.74%	5.03%	5.74%	6.60%	7.67%	21.80%	24.88%	28.24%	14.63%	16.47%	19.00%	21.22%
TELOPK_8FB_MUNDRUSS3	5.74%	6.92%	8.48%	4.05%	4.74%	5.64%	6.80%	16.47%	19.54%	23.61%	12.14%	13.76%	16.47%	19.54%
GOLDCR_8PB_LANDER	4.79%	5.67%	2.55%	2.84%	3.20%	3.64%	4.19%	14.19%	16.47%	7.52%	8.38%	9.31%	10.66%	12.53%
GOLDCR_8NB_ANTHNYRLF	4.70%	5.58%	6.73%	8.25%	10.27%	12.98%	0.66%	13.76%	16.00%	19.00%	23.00%	27.55%	33.48%	1.80%
BELCON_8FB_BNJMNLAUR	4.08%	4.70%	5.46%	6.44%	2.89%	3.25%	3.69%	12.14%	13.76%	16.00%	18.48%	8.38%	9.63%	11.02%
WANNIA_8TB_SYMERS	5.18%	5.99%	7.01%	8.28%	3.77%	4.28%	4.90%	15.07%	17.45%	19.54%	23.00%	11.02%	12.53%	14.19%
GOLDCR_8+MB_BIRRIGAI	3.54%	4.02%	4.62%	5.36%	6.30%	2.77%	3.09%	10.66%	11.76%	13.76%	15.53%	17.96%	8.09%	8.99%
LATHAM_8QB_SEAL	4.26%	4.76%	5.36%	6.07%	6.94%	7.98%	3.52%	12.53%	14.19%	15.53%	17.45%	19.54%	22.39%	10.31%
CITYEA_8FB_WOLSELEY	4.95%	5.63%	6.47%	2.81%	3.08%	3.40%	3.79%	14.63%	16.47%	18.48%	8.38%	8.99%	9.97%	11.38%
BELCON_8WB_HAYDON	6.45%	7.93%	3.79%	4.44%	5.29%	6.40%	7.87%	18.48%	21.80%	11.38%	12.93%	15.53%	18.48%	21.80%
CIVIC_8+MB_MILLER	7.25%	8.46%	9.94%	4.52%	5.10%	5.80%	6.65%	20.65%	23.00%	26.86%	13.34%	15.07%	16.96%	19.00%
EASTLK_8JB_DAIRYSTH	3.66%	4.15%	4.75%	5.51%	6.46%	2.83%	3.13%	11.02%	12.14%	14.19%	16.00%	18.48%	8.38%	9.31%

Appendix C – Cost of Failure (CoF)

	Cost of Failure		
HV Cable Feeder	Joints & Terminations	Cable mid-section	End of Life
CIVIC_8FB_BELCWAYSTH	$454,653	$444,651	$3,715,013
CIVIC_8QB_ANUNO12345	$359,504	$349,502	$8,171,888
WANNIA_8QB_HEMMINGS	$222,587	$212,585	$4,528,538
TELOPK_8+FB_ANUBELM	$249,733	$239,731	$4,820,588
WODEN_8GB_FOLINGSBY	$292,825	$282,823	$3,122,775
WANNIA_8KB_BISSHAWK	$615,165	$605,163	$6,124,500
LATHAM_8+HB_VERBRGHN	$545,813	$535,811	$2,030,288
TELOPK_8MB_BOWEN	$199,130	$189,128	$4,314,600
CITYEA_8TB_COWPER	$460,615	$450,613	$2,807,700
CITYEA_8EB_FERDINAND	$455,854	$445,852	$2,804,438
WANNIA_8ZB_GRIMSHAW	$310,741	$300,739	$6,688,088
LATHAM_8WB_BOWLEY	$521,100	$511,098	$3,547,238
TELOPK_8+WB_THROSBY	$348,172	$338,170	$2,095,800
WANNIA_8JB_MATTHEWS	$420,428	$410,426	$4,947,263
BELCON_8RB_CHUCULBA	$343,584	$333,582	$4,052,925
BELCON_8QB_WILLMSLIM	$628,106	$618,104	$4,446,450
WANNIA_8+HB_ERINDALE	$234,432	$224,430	$3,462,750
WODEN_8LB_DEAKINNO2	$128,001	$117,999	$2,115,825
TELOPK_8FB_MUNDRUSS3	$144,706	$134,704	$2,966,325
GOLDCR_8PB_LANDER	$591,833	$581,831	$5,531,100
GOLDCR_8NB_ANTHNYRLF	$705,728	$695,726	$6,854,513
BELCON_8FB_BNJMNLAUR	$542,110	$532,108	$4,356,900
WANNIA_8TB_SYMERS	$176,157	$166,155	$2,203,463
GOLDCR_8+MB_BIRRIGAI	$515,778	$505,776	$4,806,675
LATHAM_8QB_SEAL	$470,350	$460,348	$2,319,038
CITYEA_8FB_WOLSELEY	$384,569	$374,567	$2,952,075
BELCON_8WB_HAYDON	$468,158	$458,156	$3,100,500
CIVIC_8+MB_MILLER	$514,100	$504,098	$1,267,725
EASTLK_8JB_DAIRYSTH	$452,767	$442,765	$2,893,163

Appendix D – Quantified Risk

HV Cable Feeder	Riva Risk: Including Investment Adjustments							Revised Risk: Including Investment Adjustments						
	Riva Risk [2018]	Riva Risk (2019)	Riva Risk (2020)	Riva Risk (2021)	Riva Risk (2022)	Riva Risk (2023)	Riva Risk (2024)	Revised Risk [2018]	Revised Risk (2019)	Revised Risk (2020)	Revised Risk (2021)	Revised Risk (2022)	Revised Risk (2023)	Revised Risk (2024)
CIVIC_8FB_BELCWAYSTH	$44,769	$53,079	$64,488	$80,148	$30,009	$32,913	$36,732	$81,626	$92,529	$104,427	$120,777	$54,380	$60,470	$69,320
CIVIC_8QB_ANUNO12345	$73,884	$87,016	$105,231	$130,512	$165,461	$213,618	$69,636	$103,329	$113,664	$132,487	$149,059	$171,775	$196,834	$96,822
WANNIA_8QB_HEMMINGS	$30,286	$34,372	$40,429	$49,495	$63,081	$83,372	$30,259	$43,438	$49,863	$56,935	$66,740	$77,687	$92,435	$43,438
TELOPK_8+FB_ANUBELM	$152,303	$192,521	$244,972	$313,168	$401,694	$1,411	$1,431	$191,568	$217,506	$251,773	$289,652	$331,339	$13,835	$13,835
WODEN_8GB_FOLINGSBY	$66,797	$88,726	$31,127	$36,931	$45,208	$57,046	$73,924	$103,954	$122,490	$60,252	$68,541	$80,001	$92,759	$109,895
WANNIA_8KB_BISSHAWK	$89,059	$111,896	$44,154	$48,948	$55,596	$65,032	$77,281	$149,656	$173,522	$76,950	$88,849	$101,991	$116,455	$132,318
LATHAM_8+HB_VERBRGHN	$49,388	$59,982	$74,080	$28,509	$32,300	$37,218	$43,658	$105,704	$122,104	$144,067	$68,121	$75,209	$85,453	$96,650
TELOPK_8MB_BOWEN	$32,938	$37,166	$42,917	$50,732	$61,361	$75,796	$27,038	$46,092	$50,936	$57,943	$63,629	$73,967	$83,054	$37,395
CITYEA_8TB_COWPER	$42,862	$49,238	$57,327	$67,610	$25,072	$26,999	$29,380	$83,213	$94,014	$102,741	$115,251	$50,441	$54,160	$60,095
CITYEA_8EB_FERDINAND	$34,828	$39,373	$45,176	$52,636	$62,221	$74,573	$27,165	$69,257	$76,252	$86,339	$94,501	$106,215	$118,921	$54,722
WANNIA_8ZB_GRIMSHAW	$53,006	$62,761	$77,214	$98,626	$39,286	$43,154	$48,706	$74,376	$84,816	$99,278	$115,409	$52,291	$60,471	$69,514
LATHAM_8WB_BOWLEY	$40,777	$48,085	$58,328	$72,765	$93,105	$35,393	$40,626	$78,968	$89,831	$104,852	$121,572	$144,031	$69,070	$78,968
TELOPK_8+WB_THROSBY	$35,616	$42,145	$50,664	$61,793	$22,384	$24,878	$28,071	$69,588	$78,372	$87,915	$100,964	$47,425	$52,409	$57,755
WANNIA_8JB_MATTHEWS	$60,751	$76,731	$100,285	$37,392	$42,479	$49,852	$60,673	$98,396	$114,536	$136,279	$64,041	$73,515	$83,940	$98,396
BELCON_8RB_CHUCULBA	$71,899	$92,692	$32,874	$37,201	$43,194	$51,578	$63,324	$109,907	$130,210	$60,336	$69,073	$76,188	$89,179	$100,647
BELCON_8QB_WILLMSLIM	$84,865	$105,934	$40,157	$45,134	$51,932	$61,310	$74,355	$153,970	$177,644	$81,164	$93,170	$106,383	$120,874	$140,891
WANNIA_8+HB_ERINDALE	$51,539	$67,578	$24,751	$28,113	$33,022	$40,267	$50,993	$74,903	$89,123	$41,881	$48,076	$54,894	$64,348	$74,903
WODEN_8LB_DEAKINNO2	$52,912	$66,978	$85,629	$27,958	$33,781	$41,559	$51,949	$71,540	$81,631	$92,684	$47,994	$54,053	$62,364	$69,633
TELOPK_8FB_MUNDRUSS3	$46,036	$60,956	$82,834	$28,359	$34,989	$44,816	$59,332	$61,047	$72,426	$87,508	$44,987	$50,996	$61,047	$72,426
GOLDCR_8PB_LANDER	$78,529	$98,734	$39,801	$43,640	$48,839	$56,069	$66,303	$134,859	$156,566	$71,480	$79,664	$88,488	$101,301	$119,102
GOLDCR_8NB_ANTHNYRLF	$93,945	$118,509	$154,246	$206,190	$281,424	$390,130	$4,344	$157,532	$183,128	$217,576	$263,281	$315,368	$383,304	$20,568
BELCON_8FB_BNJMNLAUR	$52,977	$63,040	$76,982	$96,372	$36,592	$41,005	$47,074	$96,794	$109,723	$127,551	$147,340	$66,832	$76,827	$87,835
WANNIA_8TB_SYMERS	$32,111	$39,477	$49,518	$63,184	$21,288	$24,844	$29,740	$49,386	$57,189	$64,031	$75,349	$36,091	$41,056	$46,488
GOLDCR_8+MB_BIRRIGAI	$47,249	$54,732	$65,080	$79,429	$99,350	$37,104	$40,986	$84,477	$93,179	$109,067	$123,092	$142,364	$64,100	$71,278
LATHAM_8QB_SEAL	$35,681	$40,773	$47,230	$55,463	$65,950	$79,341	$28,781	$74,474	$84,326	$92,297	$103,738	$116,148	$133,093	$61,268
CITYEA_8FB_WOLSELEY	$46,229	$54,968	$66,443	$24,554	$26,759	$29,589	$33,259	$83,852	$94,436	$105,935	$48,051	$51,555	$57,145	$65,250
BELCON_8WB_HAYDON	$72,566	$96,289	$36,958	$44,604	$55,670	$71,781	$95,258	$129,141	$152,370	$79,543	$90,378	$108,536	$129,141	$152,370
CIVIC_8+MB_MILLER	$51,554	$61,801	$74,866	$29,982	$34,310	$39,732	$46,552	$120,772	$134,498	$157,096	$78,025	$88,153	$99,180	$111,149
EASTLK_8JB_DAIRYSTH	$33,559	$38,806	$45,885	$55,498	$68,567	$25,945	$28,517	$67,208	$74,063	$86,568	$97,597	$112,739	$51,138	$56,802