SINCLAIR KNIGHT MERZ
SKM

Coleambally IRRIGATION

Coleambally Irrigation Cooperative Limited

MEERA Analysis

- FINAL REPORT
- December 2011

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Contents

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1. Executive Summary

Coleambally Irrigation Cooperative Limited (CICL) has engaged Sinclair Knight Merz to provide a Modern Engineering Equivalent Replacement Asset (MEERA) valuation of infrastructure assets within the Coleambally irrigation system. The MEERA assessment determined the total valuation of the assets, the Optimised Depreciated Replacement Cost (ORDC) and the annuity required. A summary of the results is provided below.

- **Table 1-1 Summary of Results**

Valuation	Total
Replacement Cost of Assets in 2007 (with CPI)	$109m
Replacement Cost of Assets in 2011	$141m
Optimised Depreciated Replacement Cost	$75m
Annuity Required (3% Base Case)	$1,315,427

The base case results assumed 100% design life with asset replacement occurring at the end of the design life. As many assets are now beyond their theoretical design life, an additional five years is added to the design life beyond the current start date. All model scenarios are based on the asset register as at 24 October 2011 and assume the calculated annuity is available from year one. It is also assumed that $20 m is currently available in the Coleambally Irrigation Mutual Cooperative Limited renewals account. The renewals annuity calculated is based on 2011 dollars and it is expected that this would increase from year to year based on CPI increases or a construction index that reflects the assets to be replaced.

Table 1-2 provides the base case annuity under differing rates of return. The rates of return are post-tax real returns.

- **Table 1-2 Base case annuity modelling**

Rate of return (real, post-tax)	3%	4%	5%
100 year	$1,315,427	$993,787	$648,532
200 year	$1,380,742	$1,026,650	$664,221

A number of scenarios were modelled to assess the impact of changes to replacement cost or change in the design life. The scenarios are provided in Table 1-3. For each modelled scenario the design life was further adjusted by randomly varying the design life by +/-15%. By randomly varying the renewal profile of each asset a more likely asset replacement schedule is represented. The variation for a particular asset was randomly generated and 1,000 simulations were completed to obtain results. The simulations provide a distribution of results, of which the 50th and 95th percentile are presented.

Table 1-3 Modelled scenarios

Modelled scenario	Replacement Cost	Design life	Design life variation
1 (Base case)	100%	100%	-
2	100%	100%	15%
3	125%	100%	15%
4	100%	80%	15%
5	125%	80%	15%

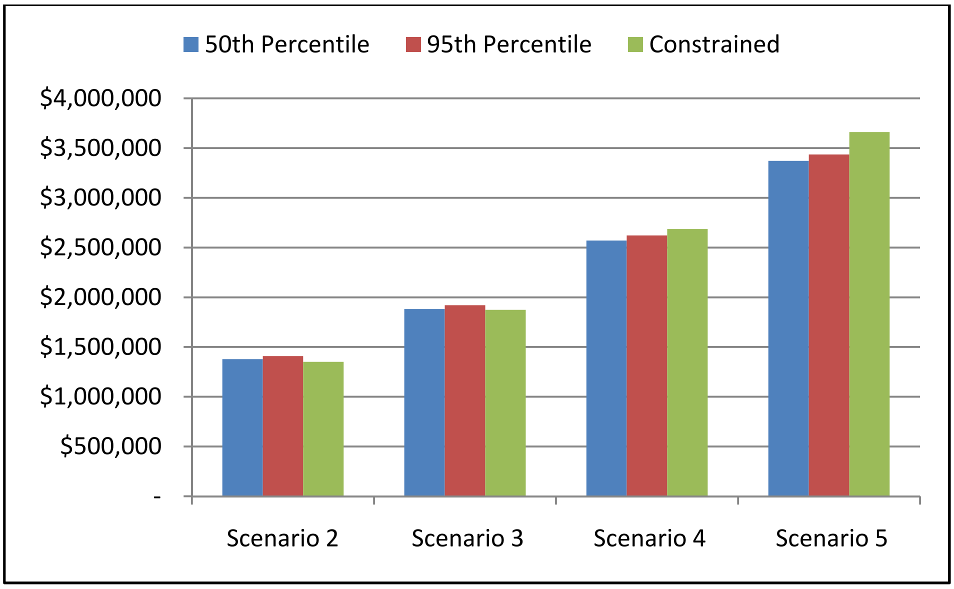
For each scenario, outputs are provided for the 50th and 95th percentiles and also an annuity that ensures the balance does not drop below zero. This is a 'constrained' result, which minimises the annuity whilst ensuring the balance remains above zero. This output was generated using non-linear programming. All of the scenarios use a 3% real rate of return.

The results of the modelling are provided in Table 1-4 and Figure 1-1.

Table 1-4 Renewals modelling results

Scenario	50th percentile	95th percentile	Constrained
2	$1,378,238	$1,409,421	$1,350,329
3	$1,881,297	$1,920,443	$1,873,334
4	$2,570,406	$2,621,541	$2,686,245
5	$3,371,096	$3,435,213	$3,661,875

Figure 1-1 Annuity results



The following conclusions can be made from the above results:

- An increase in replacement cost of 25% increases the constrained renewals annuity by 39% while a reduction in design life of 20% increases the annuity by 99%. The combination of increased replacements costs and reduced design life increases the annuity by 171%.
- Increasing the forward look period from 100 to 200 years does not significantly influence the analysis.
- The analysis indicates the importance of both the design life and replacement cost in the total annuity.

2. Background

Coleambally Irrigation Cooperative Limited (CICL) has engaged Sinclair Knight Merz to provide a Modern Engineering Equivalent Replacement Asset (MEERA) valuation of infrastructure assets within the Coleambally irrigation system. MEERA valuations incorporate both the greenfield and brownfield replacement value of an asset and consideration of the current demand for a particular asset.

The use of these valuations will assist the planning and financial provision for asset renewal.

During the process of Coleambally Irrigation privatisation, and the period subsequent, several asset valuations were completed. A summary of these reports is presented below in Table 2-1.

Table 2-1 Previous Asset Valuation Reports for Coleambally Irrigation

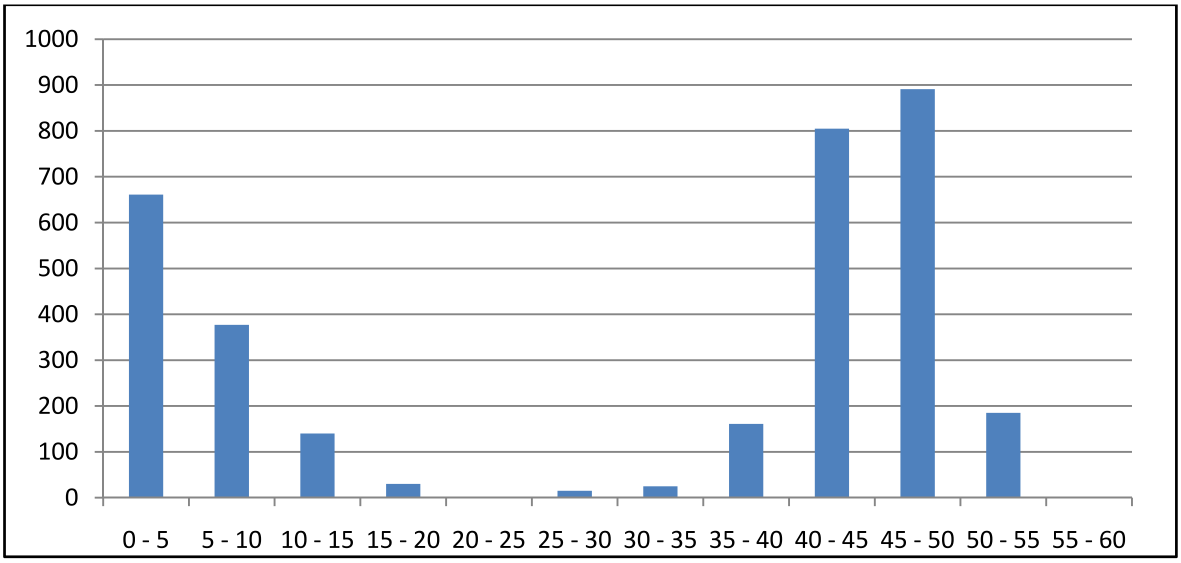
Date	Completed By	Objective	Assets Evaluated
September 1993	Hydrotechnology	▪ Review of asset management ▪ Structure condition assessment	▪ 50 structures sampled ▪ Condition rating applied to asset set ▪ Samples of channel seepage
September 1995	Kinhill	▪ Review of asset management ▪ Incl. channel seepage remediation	
April 1997	Sinclair Knight Merz	▪ Asset valuation ▪ Incl. cost savings of co-constructing bridges and regulators	▪ 38 combined regulator/road crossing structures
August 1997	CMPS&F Environmental	▪ Channel inspection & asset valuation	▪ Channels
2002	Sinclair Knight Merz	▪ MEERA analysis	▪ All assets
2008	Sinclair Knight Merz	▪ MEERA analysis	▪ All assets

3. Infrastructure Portfolio

Construction commenced in the Coleambally Irrigation Area in the late 1950's, with the first assets commissioned during 1958. Development of the irrigation scheme then continued over the next 15 years. As at 24/10/11, the asset register identified 3,317 infrastructure assets which remain the responsibility for Coleambally Irrigation Mutual Cooperative Limited (CIMCL) to renew and replace.

Many of the existing assets are those originally constructed, represented by the fact that approximately 85% of assets are older than 40 years (Figure 3-1).

- **Figure 3-1 Asset Age Profile Count**



The increase in the "0 – 5 year" category, against the overall trend, is evidence that some assets with lower design lives (30-50 years) are now requiring replacement and that some modernisation works have taken place. Past asset valuations have generally indicated that the majority of asset lives lie somewhere between 50 years and 100 years, consequently it is forecast that the 'first round' of significant replacement works has commenced, and this will continue over the next 50 years.

When replacing assets, it is critical to look at the forecast demands on the system so that efficient expenditure is achieved, and asset redundancy and over investment in assets is avoided. The extent of irrigation in the Coleambally region originally planned was much greater than what has been constructed to date. Similarly, the framework for irrigation infrastructure provision has also changed significantly. While initially designed, constructed and managed by government authorities, the Coleambally irrigation area is now operated within a dual co-operative structure.

In determining asset replacement strategies, CIMCL will need to review the level of service provided by the channel and drainage systems. This is particularly important considering current trends in agricultural diversification irrigation infrastructure modernisation and reductions in water availability for irrigation. The technology strategies, for example remote monitoring and automation of operational activities, will also need to be reviewed regularly.

Policy reviews undertaken at regular intervals will assist in determining what represents the current set of ‘Modern Engineering Equivalent Replacement Assets’ (MEERA) of the existing system.

4. MEERA methodology

The objective of applying MEERA analysis to the Coleambally Irrigation system is to estimate the Optimised Depreciated Replacement Cost (ODRC). This is a measure of the cost required to replicate the system, applying modern technology and meeting the current demands on the system.

Examples of the application criteria are:

- The substitution of remotely operated gates on regulators for existing drop bars and mechanical gates;
- Substitution of infrastructure that has decreased hydraulic capacity as current demand is less than the original design.

The ODRC methodology requires:

- Preparing a detailed asset register;
- Determining the Modern Equivalent Asset (MEA) for existing assets;
- Calculating the Replacement Cost (RC) using Modern Equivalent Asset values;
- An assessment of depreciation (DRC);
- System optimisation; and
- Subsequent estimation of the Optimised Depreciated Replacement Cost (ODRC)

4.1. Detailed asset register

The asset register has been provided by CICL.

4.2. Determining replacement assets and costs

For each of the existing assets, a Modern Equivalent Asset (MEA) must be allocated. The allocated asset must have similar capacity and useful life, equivalent reliability, and meet statutory requirements of the existing assets. The value of fixed assets is estimated using the Replacement Costs (RC) of Modern Equivalent Assets (MEA) that would be installed today in order to provide the same level of service as the current assets. A series of maximum replacement asset values and lives was developed in consultation with CICL.

4.3. Estimating the depreciated replacement costs

Asset replacement costs should be depreciated when the existing asset's remaining service life is less than the total life (TL) that would normally be expected from a new asset. The depreciation effectively recognises the limited Remaining Life (RL).

The Depreciated Replacement Value Cost (DRC) is calculated as follows:

DRC = UDV x RL/TL

where: UDV = Un-depreciated Value (ie replacement cost (RC))

RL = Remaining Life

TL = Total Life (begins on commissioning)

The current asset register has the commissioning year for each asset, with previous asset reviews identifying the total life of assets in various classifications.

4.4. Optimising the system and demand

The system optimisation analysis undertaken for the 2001 MEERA analysis is used as the basis of the capacity calculations.

5. Inspections

As part of the MEERA assessment, a sample of structures was inspected on 19 and 20 July 2011. The purpose was to gain an appreciation of the type of structures, their condition, and maintenance issues, in particular "concrete cancer" associated with precast concrete from the 1960's, to assist in determining the remaining life of the structures. The inspections are summarised in Appendix A and are based solely on a visual assessment. An Asset Condition Rating (ACR) using the system used by Goulburn-Murray Water has been applied to these structures. The details are included in Appendix B.

The bridges were mainly constructed using precast 1 m wide inverted U beams with a cast-in-situ concrete overlay slab. The condition rating has been applied to the key part or critical part of the structure, ie bridge beams, or the central (original) culverts in the case where road culverts have been extended.

5.1. Concrete Condition

A number of sites showed concrete "cancer" or spalling. This was most evident on road bridges on the soffit (underside) of the main beams on combined regulating structures. This is to be expected as the beams flex and concrete is in tension allowing micro cracks to occur. Air and moisture from flow turbulence spray or high humidity enters the cracks, which along with the calcium chloride in the concrete, results in corrosion of the embedded steel reinforcement causing it to expand and spall the cover concrete. CICL has undertaken repairs at affected sites to prevent further deterioration of the concrete. The defects are not extensive and will have been affected by construction practices and variations in the cover to the reinforcement, concrete mix and quality on the day of manufacture.

- **Figure 5-1 Asset IF0268 Road bridge/regulator**

There was no obvious spalling on precast regulator piers. This may be due to the piers only being subject to compression forces. Also bridges over drainage channels did not have concrete spalling, which may be due to the dry ambient conditions.

These observations suggest the life of bridges over channels, especially road culvert/regulator structures, will be less than for bridges over drains.

5.2. Other Issues

A number of issues also arose whilst inspecting the structures.

The first issue relates to access onto regulators. Whilst the regulators have been mechanised with Rubicon Flume Gates and operate remotely or automatically, there is still a need for operators and maintenance staff to access the work platform and control equipment. The key issue is excessively high steps or awkward access to the platform as shown in Figure 5-2. These should be upgraded to comply with Occupational Health and Safety Act and Regulations.

- **Figure 5-2 Regulator 4 (Site IF0101) showing difficult access to the walkway**

Another safety issue is with regulators attached or part of road structures where there is a risk to operator safety and comfort, especially with high speed traffic. There is also a potential risk to Flume Gates from wide farm machinery. It is suggested that CICL consider the relocation of the regulator when replacement is required. Other infrastructure upgrade programs such as the Northern Victoria Irrigation Renewal Program (NVIRP) are separating the relatively few combined road culvert/regulators primarily for safety reasons.

The separation of regulating structures nominally 20 m upstream from road bridges will also result in drier ambient conditions under bridges which is expected to extend the bridge life.

5.3. Life of Assets

A critical element of the MEERA assessment is the remaining life of the assets. From a review of previous assessments and recent inspections some adjustments to the asset life should be made. The original asset life in the 1993 report for major structures was based on:

- asset value above $100,000, life 100 years
- asset value below $100,000, life 60 years

This approach is somewhat simplistic as it does not take into account service conditions and the large difference in asset life is not considered warranted.

The actual life of structures is dependent on many factors including:

- Design criteria
- Materials
- Construction techniques (precast versus cast-in-situ)
- Construction quality
- Service conditions (channel, drain, climate, vehicle/live loading ,frequency of loading, soil stability)
- Maintenance activities

For the mainly reinforced concrete structures, provided that the minor defects that arise are repaired so that the structural integrity is maintained, then the design life should be achieved and possibly exceeded.

Structures are usually replaced when the cost of repairs become uneconomic or the risk of imminent failure would be unacceptable to CICL.

It is expected that some structures will need replacement before the end of their design life due to external factors, such as requirements from the Road Authorities where there is a need for wider road structures for increased road traffic and public safety. This has already occurred for several road culverts and bridges on Kidman Way.

Based on the above, the following design life for different assets is proposed for the MEERA. The methodology used has been to assess the relative life for different asset types based on their service conditions. The major regulators on the Main Canal are very substantial structures and are expected to have a life of 100 years, though the bridge decking is expected to have a lesser life as discussed in previous sections. The proposed life is somewhat subjective but provides a more likely design life before replacement works are required.

■ **Table 5-1 Proposed Design Life**

Structure Type Code	Description	Current Design Life	Proposed Design Life	Comments
502	Access bridge (drain)	100	100	
502	Access bridge (channel)	100	90	
591	Road bridge (drain)	100	90	
591	Road bridge (channel)	100	80	
503	Road Culvert	100	90	
504	Access Culvert	100	90	
505	Road bridge & regulator	100	Major Regulator 100 Minor Regulator 80 Bridge 70	Replace as separate assets
506	Access bridge & regulator	100	80	
507	Road culvert & regulator	100	80	Replace as separate assets
508	Access culvert & regulator	100	80	
509	Regulator	100	Major Regulator 100 Minor Regulator 80	
510	Dethridge outlet	60	60	
511	Pipe outlet	40	80	
512	Drainage Inlet	40	80	
517	Flume	50	80	
518	Subway	50	80	
519	Walkway (Galv. Steel)	30	50	
523	Maintenance culvert	50	80	
524	Escape	50	80	
525	Other structures	50	50	
526	Flow Meter -S&G	20	20	
526	Flow Meter - other	20	50	Replaced with Flume Gate Meter
528	Pump Saddle Meter	20	20	
531	Actuators	40	40	
532	Tilting Door	40	40	
535	Ultrasonic Meter	20	50	Replaced with Flume Gate Meter
537	Flume Gates – Meter		50	Average of Flume Gate and Concrete flume
537	Flume Gates - Regulator gate		30	
538	Magflow Meters	30	50	Replaced with Flume Gate Meter

Structure Type Code	Description	Current Design Life	Proposed Design Life	Comments
539	Guardrail		80	

During the inspection it was noted that some structures have been modified. For example, many road culverts were extended with new pipes each end as part of the modernisation with Flume Gates. This may create errors with asset condition assessments in the future, as the central part of the structure is not visible without the use of cameras. For this assessment, the asset life is based on the central (older) part of the culvert.

Some of the major combined road bridge and regulators on the Main Canal have mixed asset conditions. The bridge beams have deteriorated due the concrete type and ingress of moisture whilst the underlying regulator foundation and walls were in very good condition. In these cases, it is expected that the bridge beams will be replaced on the original abutments and piers, which appear to be quite sound and the life of the asset should reach that given in the previous table.

6. Asset Replacement Costs

The estimated replacement cost for different asset classes has been based on the existing works. The replacement structures will have the same or current optimised flow capacity and be the Modern Equivalent Asset (MEA). For example, bridges in channels or drains with flows less than 400 ML/d can be more cost effectively replaced with pipe culvert structures and precast concrete flumes for small channel regulators.

The cost for each type of asset was reviewed from previous MEERA studies and updated where appropriate using works estimates based on first principles. For major structures on the Main Canal, design drawings were obtained and concrete quantities with typical construction rates were used to determine the cost. Where actual CICL constructed costs were available, these were used to refine or validate the estimates. The works costs allow for removal of the existing asset. As in previous studies, structures are grouped into a number of flow categories, which then provides average costs for similar sized structures. A detailed summary of the replacement costs can be found in Appendix C.

Replacement works on State Highways currently require the construction of side tracks. Recent experience with two culverts on Kidman Way (IF0276 and IF2966) shows that the additional cost for the road culvert extension under the side track, to construct, seal and remove the side track, and traffic management added substantially to the basic works cost. For future work sites it is assumed that the road culvert will not need extension under the side track, which will reduce the total cost. A cost of $300,000 per site has been allowed in the estimates on all future State Highway road structures. The only other road requiring a side track is Morundah Road. On other roads, it is assumed the road can be temporarily closed for the works duration with traffic management costs included in the estimate.

The replacement costs now directly include allowances for design, CICL administration recovery and contingencies. These costs can vary depending on the scope of the works and the following percentages of the capital costs were adopted:

- Design (5 to 10%) - 7.5%
- Contingencies (5 to 15%) - 10%
- CICL administration recovery - 7.5 %

A description of the basis for the cost estimates for each asset type is shown in Table 6-1.

▪ Table 6-1 Asset cost estimates

Asset code	Description	Replacement Works
502	Access bridge	Flows < 400 ML/d replaced as culvert Flows > 400 ML/d, replaced as bridge
503	Road culvert	Two types: ▪ In-line road culverts ▪ Farm supply road culverts Allowance included for side track for RTA roads and Morundah Road. For other roads assume road temporarily closed.
504	Access culvert	Two types: ▪ In-line access culverts ▪ Farm supply access culverts
591	Road bridges	Flows < 400 ML/d replaced as culvert Flows > 400 ML/d, replaced as bridge Allowance included for side track for RTA roads and Morundah Road. For other roads assume road temporarily closed.
505 and 595	Road bridge & regulator	505 - Regulator cost component, 595 - Bridge cost component
506 and 506B	Access bridge & regulator	506 - Regulator cost component, 506B - Bridge cost component
507	Road culvert & regulator	Combined cost of culvert and regulator, actual may be two structures for OH&S reasons
508	Access culvert & regulator	Combined cost of culvert and regulator, actual may be two structures
509	Regulators	Assumed replaced with new precast flume immediately upstream of existing for relocation/replacement of Flume gates. Major regulators - cost based on original concrete design Costs for civil works only
511	Pipe Outlet	Assume 300 mm RC pipe
512 & 513	Drainage inlet (pipe)	Costs based on HDPE pipe currently used by CICL
515	Pump (other)	Updated costs from 2008
517	Flume	Updated costs from 2008
518	Subways	Costs based on first principles estimates
519	Walkways	Typical cost adopted.
523	Maintenance culverts	Updated costs from 2008
524	Escape	Assumed replacement works are the same as an Access culvert & regulator
526	Flow meter	Typical cost adopted for Flume Gate meters

Asset code	Description	Replacement Works
531	Actuators	Updated actual costs
532	Tilting Door	Updated actual costs
535	Ultrasonic flow meter	Typical cost adopted for Flume Gate meters
537	Flume Gate	Updated actual costs
538	Mag Flow Meter	Typical cost adopted for Flume Gate meters
539	Guardrails	Typical cost adopted.

The costs for each asset class are shown in Table 6-2. The costs for regulator gates and other mechanical equipment is not part of the MEERA scope.

- **Table 6-2 Cost Summary**

			Capacity Range						
Asset Code	Asset type	Farm supply	0-50ML/d	51-150ML/d	151-400ML/d	401-1000ML/d	1001-3000ML/d	3001-6000ML/d	>6000ML/d
		600 Dia	900 dia	1350 dia	2x 1500 dia				
			1 bay	2 bay	3 bay				
502	Access bridge		$ 50,000	$ 70,000	$ 100,000	$ 220,000	$ 300,000		$ 600,000
503	Road culvert	$ 45,000	$ 90,000	$ 120,000	$ 170,000	$ 300,000			
504	Access culvert	$ 20,000	$ 50,000	$ 70,000	$ 100,000	$ 220,000	$ 300,000		$ 600,000
591	Road bridge		$ 90,000	$ 120,000	$ 170,000	$ 300,000	$ 400,000		$ 700,000
505	Road bridge & regulator (regulator cost)		$ 50,000	$ 70,000	$ 90,000		$ 600,000	$ 1,200,000	$ 2,100,000
593	Road culvert (gov)		$ 90,000	$ 120,000	$ 170,000				
595	Road bridge & regulator (bridge cost)		$ 90,000	$ 120,000	$ 170,000	$ 300,000	$ 170,000	$ 200,000	$ 250,000
506	Access bridge & regulator (regulator cost)		$ 50,000	$ 70,000	$ 90,000				
506B	Access bridge & regulator (bridge cost)		$ 50,000	$ 70,000	$ 100,000				
507	Road culvert & regulator		$ 140,000	$ 145,000	$ 210,000				
508	Access culvert & regulator		$ 100,000	$ 110,000	$ 140,000				
509	Regulator		$ 50,000	$ 70,000	$ 90,000				
510	Dethridge outlet			*Not in scope*					
511	Pipe outlet		$ 6,000	$ 6,000	$ 6,000				
512	Drainage inlet (pipe)	$ 2,000							
513	Drainage inlet	$ 2,000							
515	Pump (other)			$ 500,000					
517	Flume			$ 5,000					
518	Subway (drains only)		$ 35,000	$ 50,000	$ 120,000				
519	Walkway			$ 10,000					
520	Levee			*Not in scope*					
522	Fence Stop			*Not in scope*					
523	Maintenance culvert	$ 15,000							
524	Escape		$ 50,000	$ 100,000					
525	Other structures			*Various*					
526	Flow meter	S&G Meters $1,000		*Flume Gate meters $31,000*					
527	SCADA installation			*Not in scope*					
528	Pump saddle meters			$ 21,000					
529	Radio installation			*Not in scope*					
531	Actuators			*Various*					
532	Tilting door			*Various*					
534	SCADA building			$ 60,000					
535	Ultrasonic flow meter			$ 31,000					
536	Weather station			$ 5,000					
537	Flume gates	Flume meter $35,000 (Average for 15 and 30ML/d)				Regulator gate $25,000			
538	Mag Flow meters			$ 31,000					
539	Guardrails			$ 50,000					
597	Road culvert (REG)		$ 120,000	$ 145,000	$ 260,000				
632	Tilting Doors			$ 90,000					

6.1. Exclusions and responsibilities of CICL

CICL and CIMCL have determined that the replacement of the Rubicon supplied gate part will be an operating expense of CICL as it is a shorter life than the concrete flume emplacement. The batteries, motors, seals, cables will be replaced as a maintenance expense. This applies to the FlumeGateR (Regulators) and the FlumeGateM (meter outlet).

The earthen assets, “530 Retention Basin”, “520 Levee” and the Channels and Drains are not included as it is assumed that with a regular and ongoing maintenance program they will have an indefinite life. Fences are not included as they are not recorded on the asset database and are repaired during normal maintenance. “533 Piezometers” is not included in the analysis as there is no practical way of inspecting the PVC pipe for condition and they are replaced as a maintenance expense if they fail.

The Dethridge Outlets are being replaced by the FlumeGates which are not being funded by CIMCL therefore the replacement of Dethridge Outlets (S Type 510) are excluded from the analysis.

7. Outcomes from Valuation Process

7.1. Asset register

Key outputs from the MEERA valuation process are:

- A detailed asset register that contains key information from the optimisation and valuation process, and a review of the accuracy of this information;
- The estimated replacement value of infrastructure assets; and
- Comment on the projected asset replacement schedule and the renewals annuity requirement.

7.2. MEERA valuation

Detailed infrastructure valuation using the MEERA methodology has been completed. The infrastructure components included in the valuation:

- Are based on the set of replacement assets required to service current levels of demand, as opposed to current design capacity.
- Exclude assets owned by landholders and local government.
- Exclude Dethridge outlets as these have all been replaced with FlumeGate™ meters
- Exclude fencing and piezometer costs as these assets are not included in the asset register
- Exclude earthen assets (channels, drains, levees etc) as these are assumed to have an indefinite life provided regular maintenance is undertaken.

The valuation has been completed using July 2011 dollars and the value of the assets includes construction as well as 15% for design and construction management, and 10% contingency. The asset valuation includes the replacement of channel and drain structures to current standards and CIL policy. The results are presented in Table 7-1.

Table 7-1 Valuation of Assets

Valuation	Total
Replacement cost of assets in 2007[1]	$97,006,154
Replacement cost of assets in 2011	$141,486,000
Optimised Depreciated Replacement Cost (ODRC)	$74,781,417
ODRC as % of Replacement Cost of Optimised Assets	53%

The following conclusions can be made on the replacement value of Coleambally Irrigation assets:

[1] The costs were determined in 2008 correct to July 2007.

1) The total replacement cost of assets increased by 45% from 2007 to 2011. The increase is due to the increase in general costs (CPI) over four years, the application of detailed estimates for the major structures, and specific inclusion of overhead costs.
2) Based on theoretical assumptions of design life the assets have approximately 53% of their replacement value remaining.
3) Weighted by replacement cost, the average remaining life for existing assets is 37 years.
4) Of the infrastructure assets, over 90% of the asset replacement value is attributed to regulators, culverts, bridges, flume gates, drainage inlets and pipe outlets. The asset types in terms of infrastructure replacement cost are presented in Table 7-2.
5) Because of their relative importance in terms of total infrastructure replacement value, road culverts, bridges and regulators should continue to be the focus of condition-based assessment. If the expected remaining life, or replacement value changes significantly from that assumed in this valuation process, the impacts on the renewals annuity are likely to be significant.

■ Table 7-2 Breakdown of Channel Infrastructure Asset Replacement

Asset Type	Count of Asset Type Code	Total Replacement Value (SKM 2011)	Percentage
502			
Access Bridge	51	$7,410,000	5.2%
503			
Road Culvert	249	$21,430,000	15.1%
504			
Access Culvert	112	$3,430,000	2.4%
505			
Road Bridge & Regulator	20	$10,700,000	7.6%
506			
Access Bridge & Regulator	12	$6,700,000	4.7%
507			
Road Culvert & Regulator	9	$1,490,000	1.1%
508			
Access Culvert & Regulator	72	$8,020,000	5.7%
509			
Regulator	182	$16,570,000	11.7%
511			
Pipe Outlet	53	$398,000	0.3%
512			
Drainage Inlet (Pipe)	1060	$2,756,000	1.9%
513			
Drainage Inlet (Other)	35	$70,000	0.0%
515			
Pump (Other)	2	$1,000,000	0.7%
517			
Flume	6	$115,000	0.1%
518			
Subw ay (drains only)	23	$910,000	0.6%
519			
Walkw ay	107	$1,070,000	0.8%
523			
Maintenance Culvert	24	$390,000	0.3%
524			
Escape	36	$2,950,000	2.1%
525			
Other Structures	11	$400,000	0.3%
539			
Guardrails	47	$1,750,000	1.2%
591			
Road Bridge	68	$17,060,000	12.1%
593			
Road Culvert (gov)	3	$350,000	0.2%
595			
Road Bridge (Reg)	19	$3,335,000	2.4%
597			
Road Culvert (Reg)	12	$1,755,000	1.2%
506B			
Access Bridge & Regulator*	13	$1,350,000	1.0%
526			
Flow meter	206	$2,486,000	1.8%
528			
Pump Saddle Meters	24	$504,000	0.4%
531			
Actuators	20	$1,066,000	0.8%
532			
Tilting Doors	6	$526,000	0.4%
535			
Ultrasonic Flow meters	52	$1,612,000	1.1%
537			
Flume Gates	768	$23,300,000	16.5%
538			
Mag Flow meters	13	$403,000	0.3%
632			
Tilting Doors*	2	$180,000	0.1%
Grand Total	**3317**	**$141,486,000**	**100.0%**

7.3. Renewals Profile and Forecast Account Balance

The main output of the analysis is the calculation of an annuity that enables assets to be replaced as they reach the end of their useful life. The annuity is calculated using the following formula:

Annuity = NPV x $r/(1-(1+r)^{-n})$ where:

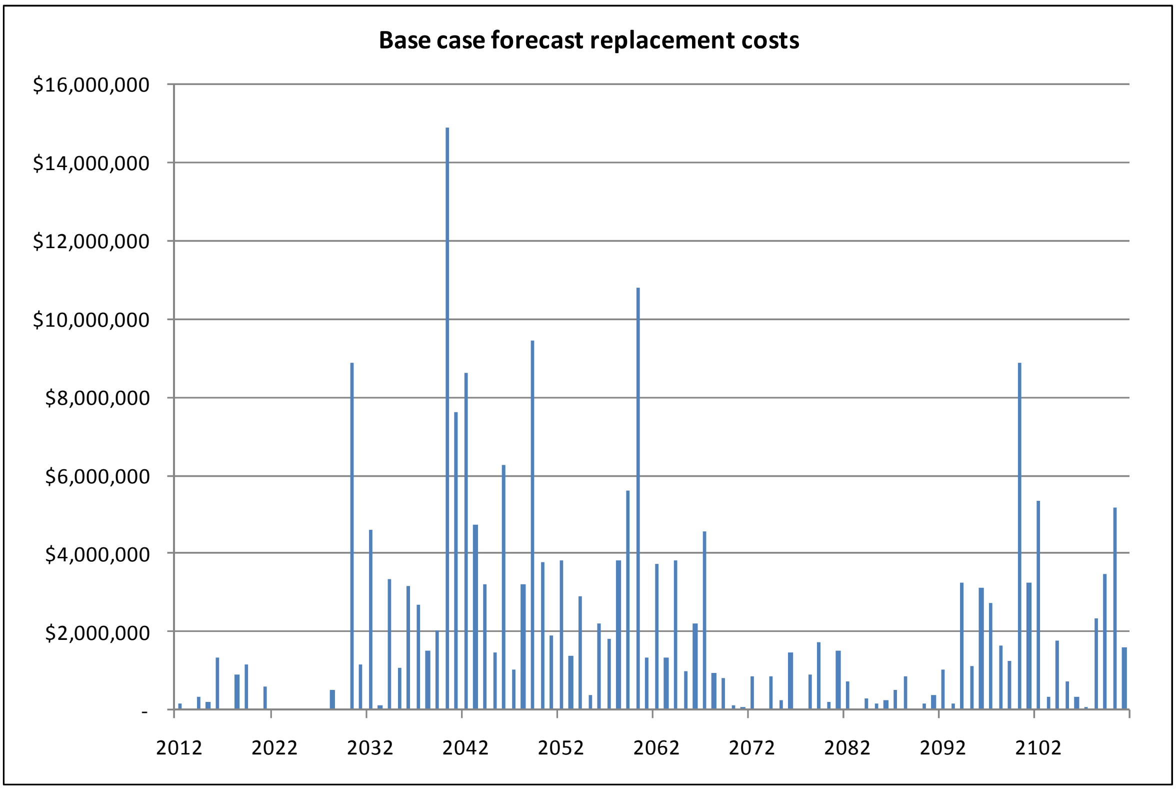
r = the rate of return

n = number of years

NPV = the net present value of the series of expenditures.

The "year constructed" field and "design life" fields from the asset register are used to establish the asset renewal profile. A profile that assumes all assets have a 100% design life (the base case) is provided in Figure 7-1.

▪ **Figure 7-1 Asset Renewal Profile – 100% Design Life**



As many assets are now beyond their theoretical design life, an additional five years is added to their design life beyond the current start date. All model scenarios are based on the asset register as at 24 October 2011 and assume the calculated annuity is available from year one. It is also assumed that $20 m is currently available in CIMCL renewals account. The renewals annuity calculated is based on 2011 dollars and it is expected that this would increase from year to year based on CPI increases for the assets to be replaced.

The following table provides the base case annuity under differing rates of return. The rates of return are post-tax real returns.

- **Figure 7-2 Base case annuity modelling**

Rate of return (real, post-tax)	3%	4%	5%
100 year	$1,315,427	$993,787	$648,532
200 year	$1,380,742	$1,026,650	$664,221

To represent a more likely asset replacement schedule, the renewal profile was adjusted to allow design life to vary randomly by +/- 15%. The variation for a particular asset was randomly generated and 1,000 simulations were completed to obtain results. The simulations provide a distribution of results, with the 50th and 95th percentile presented below in Table 7-4. A number of scenarios were also modelled which assess the impact of changes to replacement cost or change in the design life. The scenarios are provided in Table 7-3.

- **Table 7-3 Modelled scenarios**

Modelled scenario	Replacement Cost	Design life	Design life variation
1 (Base case)	100%	100%	-
2	100%	100%	15%
3	125%	100%	15%
4	100%	80%	15%
5	125%	80%	15%

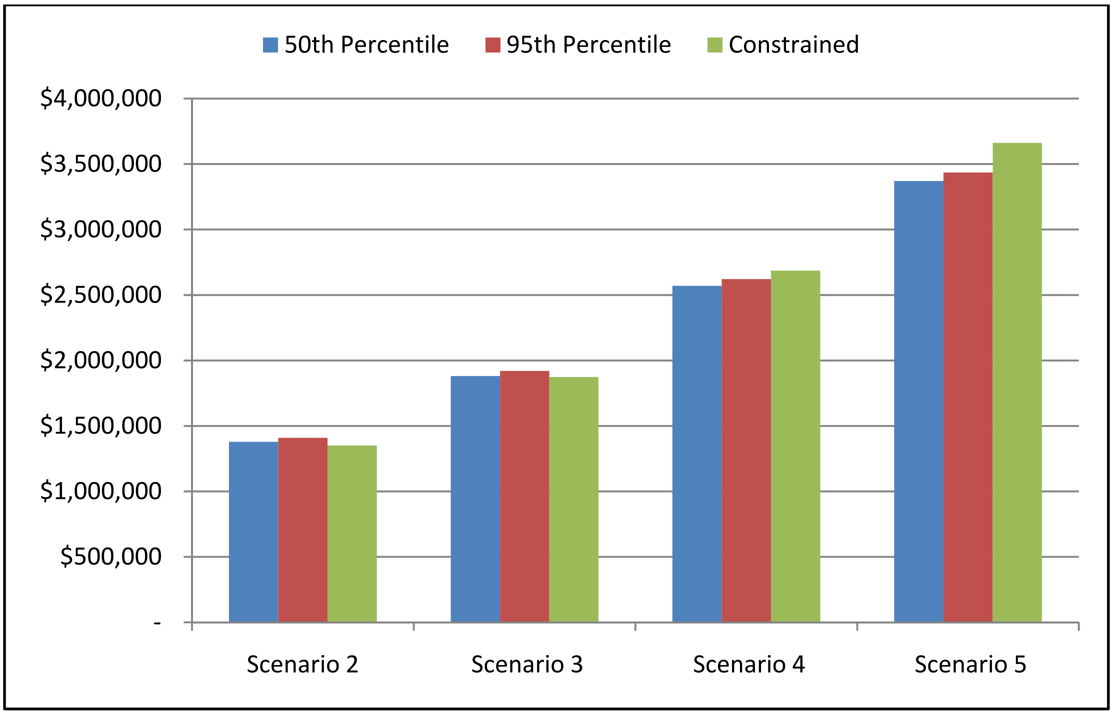
For each scenario a number of outputs are provided: the 50th and 95th percentiles and also an annuity that ensures the balance does not drop below zero. This is a 'constrained' result, which minimises the annuity but ensuring the balance remains above zero. This output was generated using non-linear programming. All of the scenarios use a 3% real rate of return.

The results of the modelling are provided in Figure 7-3 and Table 7-4.

Table 7-4 Renewals modelling results

Scenario	50th percentile	95th percentile	Constrained
2	$1,378,238	$1,409,421	$1,350,329
3	$1,881,297	$1,920,443	$1,873,334
4	$2,570,406	$2,621,541	$2,686,245
5	$3,371,096	$3,435,213	$3,661,875

Figure 7-3 Annuity results

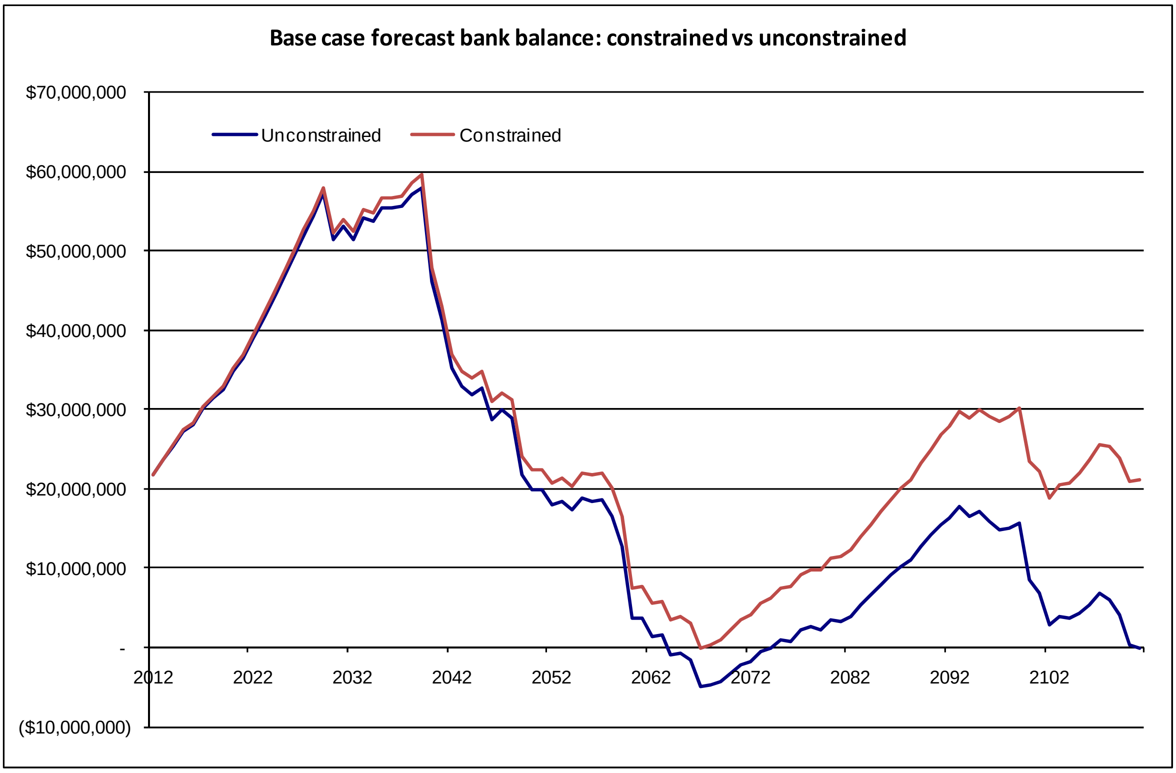


The following conclusions can be made from the above results:

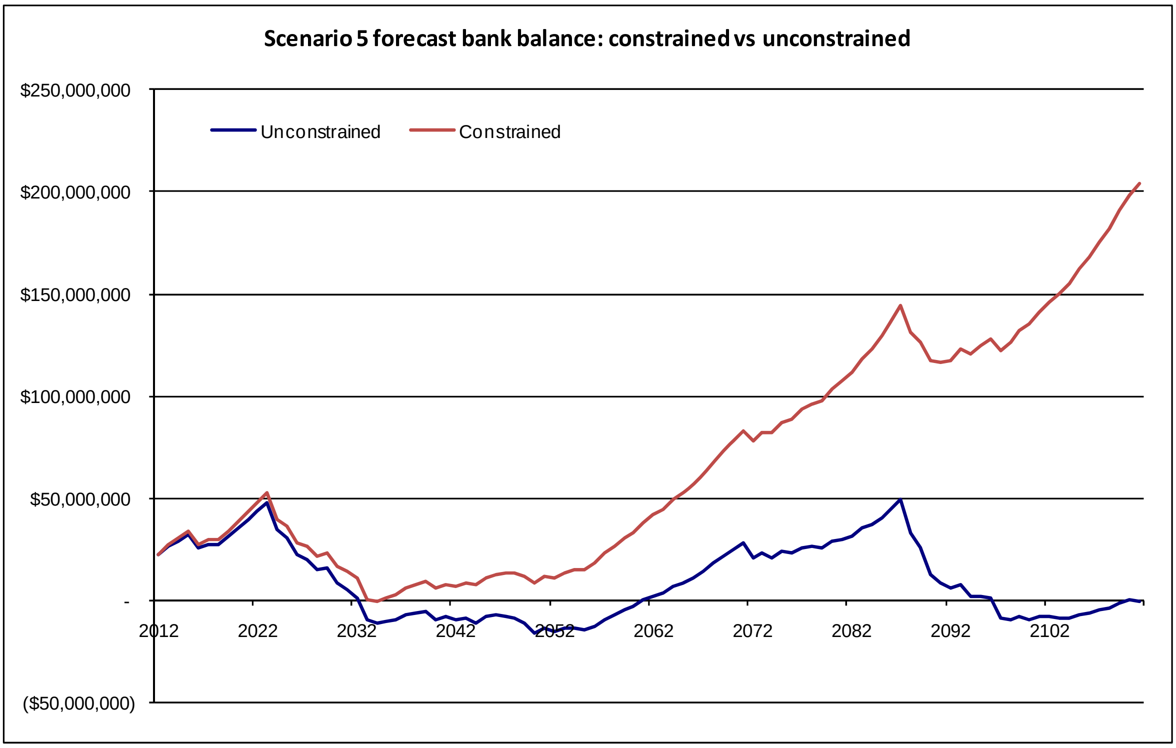
1) An increase in replacement cost of 25% increases the constrained renewals annuity by 39% while a reduction in design life of 20% increases the annuity by 99%. The combination of increased replacements costs and reduced design increases the annuity by 171%.
2) Increasing the forward look period from 100 to 200 years does not significantly influence the analysis.
3) The analysis indicates the importance of both the design life and replacement cost in the total annuity.

Figure 7-4 and Figure 7-5 show the impact of the constrained modelling and what is driving the increase in the annuity when either the design life falls or the replacement cost increases. In the base case, the annuity would see the bank balance fall below zero at around 2065. The constrained result ensures the bank balance remains above zero which sees a slightly increased annuity. Under Scenario 5, where the design life is reduced and replacement cost increased, the bank balance falls below zero much earlier, around 2030. To avoid this, the required annuity is much greater. This does however result in a significant bank balance at the end of the 100 year modelling period. The graphs for all the Scenarios are provided in Appendix D for comparison. Appendix E provides the simulation outputs.

- **Figure 7-4 Comparison of base case unconstrained and constrained results**



- **Figure 7-5 Comparison of Scenario 5 unconstrained and constrained results**



8. Summary Findings

The MEERA valuation of the Coleambally irrigation system has determined the total valuation of the assets, the Optimised Depreciated Replacement Cost (ORDC) and the annuity required. A summary of the results is provided below:

- **Table 8-1 Summary of Results**

Valuation	Total
Replacement Cost of Assets in 2007 (with CPI)	$109m
Replacement Cost of Assets in 2011	$141m
Optimised Depreciated Replacement Cost	$75m
Annuity Required (3% Base Case)	$1,315,427

9. Future valuations

The MEERA valuation relies heavily on the adoption of design lives. These design lives are the theoretical asset lives not based on condition assessment data. Given the sensitivity of the results to changes in design life, it is important to understand the actual design performance of key assets and how these compare to the theoretical design life. Preferably a program of condition assessments could be undertaken in the period between MEERA assessments.

To allow for a transparent and cost effective MEERA analysis, it is important to maintain a complete and up to date asset database that contains data on construction date, capacity (where applicable) and design life.

A number of assets contain components that have different design lives, for example the flume gates contain both concrete and steel components. To increase the accuracy of the results the asset database could separate the different components that have differing design lives.

As the existing assets have recently been optimised, a fresh look at the channel and drain capacity optimisation would only be required if there is a major infrastructure reconfiguration before the next MEERA analysis.

Appendix A Inspection Summary

Asset	Type	Condition	Issues	ACR
IF0256	Road bridge/regulator (Jimmy Cull Road)	Road deck minor cracking Abutment - good Beams – not accessible	Regulator too close to main road – OHS risks	3
IF0258	Road bridge (Bencubbin Avenue)	Abutment - good		3
IF0259	Escape	Surface cement lost		3
IF0172	Boona 9 Offtake/road culvert	Good condition	Culvert extended - mixed age structure End structure reused indicating original structure was good quality and still has significant remaining life.	3
IF0261	Occupation bridge /regulator	Abutment walls good, previously rendered	2m wide U beams, no overlay deck Previously had radial gates	3
IF0268	Road bridge/regulator (Channel Nine Road)	Concrete spalling on soffit	2m wide U beams, no overlay deck Previously had radial gates	3
IF0340	Road bridge over drain	Good condition		3
IF1076	Regulator 15	Good condition		3
IF1076001	Flume Gate	New condition		1
IF3836	Farm outlet 81 /road crossing	Good condition	Culvert extended - mixed age structure	3
IF1073	Regulator 14	Good condition		
IF1073001	Flume Gate	New condition		1
IF	Farm outlet 80 /road crossing	Good condition		
IF1079	Outlet 82	New condition		1
	Escape	Old but no significant defects		3
New	Road culvert (Kidman Way)	New		1
IF0280	Regulator 12	Good condition		3
IF0122	Road culvert (Bull Road)	Good condition		3
IF0299	Road culvert (Steele Road)	Good condition		3
IF0301	Regulator 16	Good condition		3
IF0321	Escape	Good condition		3
IF0299	Road bridge (DC500, Bull Road)	Good condition Right abutment -		3

Asset	Type	Condition	Issues	ACR
		crack about 5 mm wide, stable		
IF0112	Road bridge (channel)	Good condition	Soffit submerged by 50 mm	3
IF0101	Regulator 4 (4 bay)	Flume gates	Originally radial gates OHS issues with access	3
IF0098	Road bridge (channel)	Spalling of soffit		3
IF0094	Regulator 3 /road bridge (Kidman Way)	Abutments – good Underside of deck not accessible Northern road approach settling	Regulator too close to major road – OHS risks	3
IF1696	Road culvert (DC560) (Argoon Road)	Very good condition		3
IF1695	Drainage inlet	Good condition		3
IF2780	Regulator 1 /road bridge (Morundah Road)	Some exposed rebar in deck Upstream head wall – no visible defects Underside of deck not accessible	Regulator too close to main road – OHS risks	3
IF2792	Regulator 3 /road bridge (Prickley Road)	Some cracking of road deck		3
IF1052	Regulator (1 bay)	Good condition		3
	DAY 2			
IF0445	Regulator 1	Good condition		3
	Farm offtake (Flume Gate)/ road crossing	Good condition		3
IF0448	Access culvert/regulator	New extension for regulator Pipe access culvert – good condition		3
IF0452	Regulator (3 bay)	Good condition		3
IF0456	Access bridge	Very good condition	Soffit submerged by 25mm	3
IF452004	Access walkway (steel)	Steel truss partly corroded as below supply level. Right abutment washed out.	Replace structure	5
IF3165 IF2189	Road bridge and regulator (Main Canal, Morundah Road)	Previous spalling had been repaired /stabilised. Fresh spalling observed. Abutment and floor – very good Gates due to be sand blasted and re-coated in situ		3
IF3352	Bridge (Main Canal, Kay Hull Bridge, Sturt	New condition		1

Asset	Type	Condition	Issues	ACR
	Highway)	Left side, first pile group, 1 pile damaged at corner near supply level		
	Access bridge/regulator	Not assessed		
IF3167 IF2532	Road bridge /Tubbo offtake (4 gates)	Bridge deck- some surface defects Bridge beams – minor patching done to soffit mid span Precast central piers – good condition		3
IF0815	Road culvert (Main Canal Road)	Extended each end		3
IF0842	Regulator	Good condition		3
IF0848	Regulator 3	Good condition	OHS issues with access onto regulator	3
IF0850	Walkway (steel)	Very good condition		2
IF0856	Road culvert (Donald Ross Road)	Good condition	Extended culvert with reused end structure	3
IF3515	Farm Flume Gate	New condition		1
IF0858	Escape	Good condition		3
IF0873	Road culvert (Donald Ross Road)	Good condition	Extension proposed	3

Appendix B Asset Condition Rating

B.1 Structures

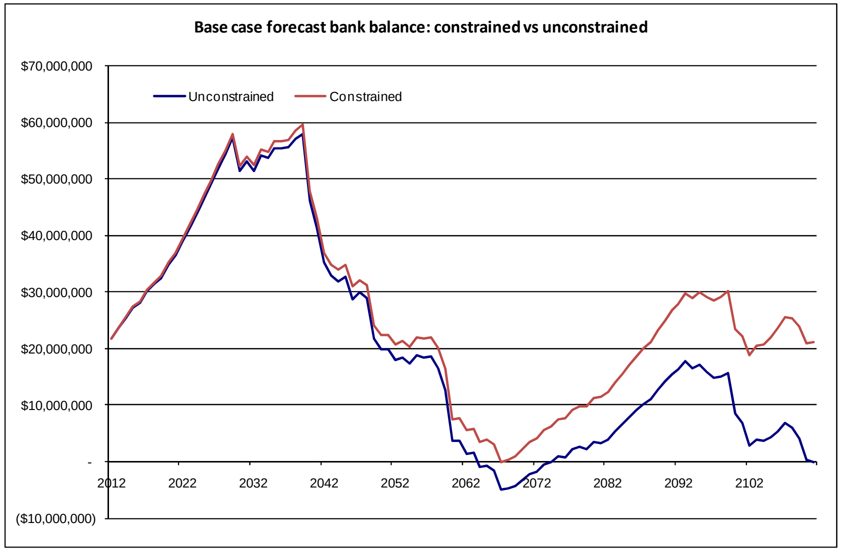
	Asset Condition Rating					
Criteria	**1**	**2**	**3**	**4**	**5**	**6**
Appearance	Recently constructed Excellent condition	Very good condition Some wear and tear	Moderate wear and tear Surface (cosmetic) cracking	Significant structural cracking Some visible spalling (loss of aggregate) Undermining of headwalls, apron Headwalls tilted/broken Aprons broken off	Severe structural cracking Severe undermining Structure damaged, near collapse	Structure in total collapse Essential components collapsed and unserviceable
Age	<15 years	15-30 years	30-45 years	45+ years		
Frequency of Concern	Nil	less than 1 in 5 years	1 per year	3 per year	6+ per year	Too late
Maintenance Emergency (refurbishment to stop undermining – repair of headwalls, aprons	Nil	Nil	Unlikely	Possible	1 per year	Too late
Maintenance – reactionary (minor structural repair, eg filling of cracks)	Nil	Unlikely	1 in 5 years	1 per year	Too late	Too late
Operation Restriction	None	None	None	Possible difficult operation of component parts	Reduced Load Capacity (for culverts and bridges) Non-operation of component parts imminent	Non-operational Unserviceable

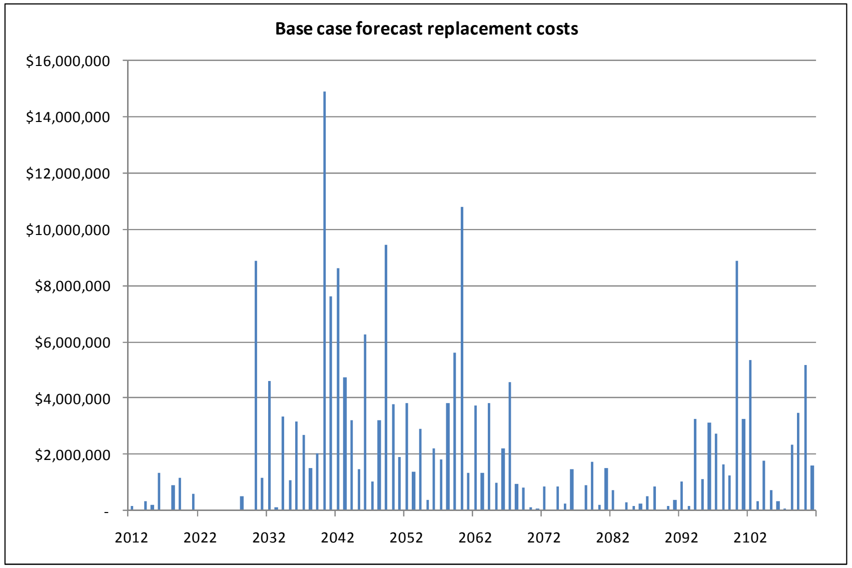
Note: New component parts may have been added to a much older structure, eg raised headwalls on culverts, new lifting gear, lay-down doors bolted onto regulators and offtakes. Underlying structure is to be assessed.

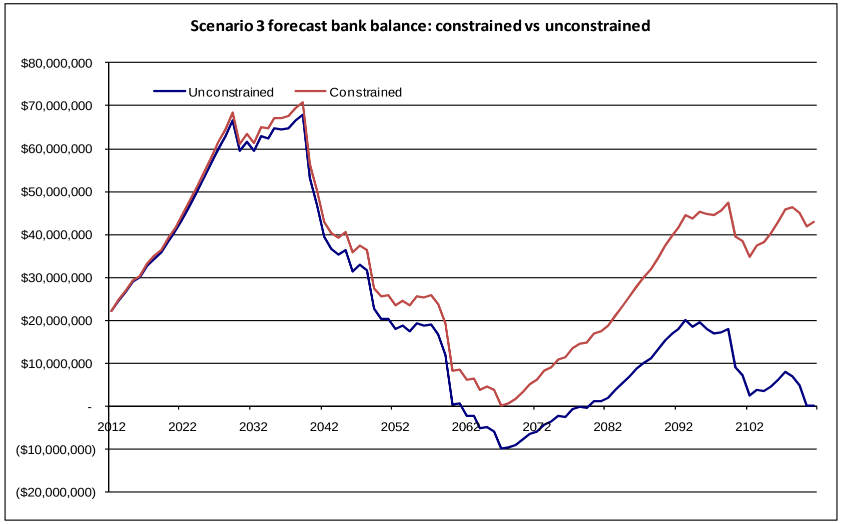
Appendix C Replacement costs

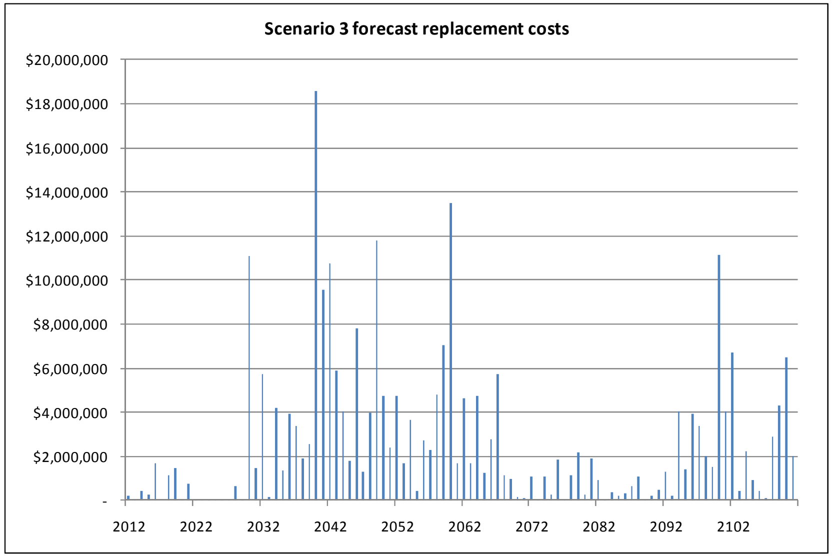
Row Labels	501-1500 ML/d Average $	Count	HL_Sheet_Main_2 Average $	Count	151-500 ML/d Average $	Count	>6000 ML/d Average $	Count	0-50 ML/d Average $	Count	1501-3000 ML/d Average $	Count	3001-6000 ML/d Average $	Count	Total Average $	Total Count
502																
90																
Access Bridge	$220,000	1	$50,000	2	$100,000	2	$600,000	3							$290,000	8
100																
Access Bridge	$252,000	5	$70,000	3	$103,429	35									$118,372	43
503																
80																
Road Culvert	$108,750	12	$75,613	106	$69,531	32			$98,333	90	$78,750	4	$45,000	2	$84,553	246
100																
Road Culvert			$420,000	1					$105,000	2					$210,000	3
504																
100																
Access Culvert	$23,333	9	$28,846	26	$20,000	14			$34,762	63					$30,625	112
505																
70																
Road Bridge & Regulator	$300,000	3	$70,000	1	$103,333	9	$2,500,000	1			$600,000	3	$1,500,000	3	$535,000	20
506																
80																
Access Bridge & Regulator	$250,000	2	$62,000	5	$130,000	3									$120,000	10
100																
Access Bridge & Regulator							$2,750,000	2							$2,750,000	2
507																
80																
Road Culvert & Regulator			$170,000	6	$210,000	1			$90,000	1					$165,000	8
100																
Road Culvert & Regulator									$170,000	1					$170,000	1
508																
80																
Access Culvert & Regulator			$118,889	27	$162,000	5			$100,000	40					$111,389	72
509																
80																
Regulator	$266,667	9	$50,000	100	$110,000	27			$50,000	42	$400,000	2	$1,650,000	2	$91,044	182
511																
80																
Pipe Outlet	$6,000	2	$6,000	3	$6,000	10	$15,000	2	$6,000	28	$20,000	3	$10,000	5	$7,509	53
512																
80																
Drainage Inlet (Pipe)	$2,212	99	$2,000	180	$3,443	422			$2,017	359					$2,600	1060
513																
80																
Drainage Inlet (Other)			$2,000	4					$2,000	31					$2,000	35
515																
30																
Pump (Other)			$500,000	1					$500,000	1					$500,000	2
517																
80																
Flume			$5,000	2					$26,250	4					$19,167	6
518																
80																
Subway (drains only)	$120,000	1	$23,125	8	$77,500	2	$150,000	1	$27,273	11					$39,565	23
519																
50																
Walkway	$10,000	8	$10,000	25	$10,000	16			$10,000	56	$10,000	2			$10,000	107
523																
80																
Maintenance Culvert	$15,000	3	$17,143	7	$15,000	2			$16,250	12					$16,250	24
524																
80																
Escape	$50,000	1	$50,000	1	$87,500	4			$85,185	27	$50,000	2	$100,000	1	$81,944	36
525																
50																
Other Structures	$26,250	4			$34,583	6			$87,500	1					$36,364	11
539																
80																
Guardrails									$37,234	47					$37,234	47
591																
80																
Road Bridge	$300,000	4	$120,000	2	$228,889	9	$700,000	1			$800,000	1			$294,118	17
90																
Road Bridge	$300,000	9	$93,333	9	$182,000	25			$213,333	3					$189,783	46
100																
Road Bridge			$470,000	1	$470,000	2	$1,500,000	1	$420,000	1					$666,000	5
593																
80																
Road Culvert (gov)			$170,000	1					$90,000	2					$116,667	3
595																
70																
Road Bridge (Reg)	$186,667	3			$153,750	8	$250,000	1			$170,000	3	$253,333	3	$183,889	18
100																
Road Bridge (Reg)									$25,000	1					$25,000	1
597																
80																
Road Culvert (Reg)	$45,000	1	$147,778	9	$260,000	1			$120,000	1					$146,250	12
506B																
80																
Access Bridge & Regulator*	$100,000	3	$70,000	5	$100,000	3	$200,000	2							$103,846	13
526																
20																
Flow meter	$31,000	6	$31,000	26	$31,000	10			$6,776	161	$31,000	1	$31,000	2	$12,068	206
528																
20																
Pump Saddle Meters					$21,000	24									$21,000	24
531																
40																
Actuators	$40,000	2			$50,000	1	$45,000	4			$39,250	4	$66,556	9	$53,300	20
532																
40																
Tilting Doors					$24,000	1			$71,000	2	$170,000	1	$95,000	2	$87,667	6
535																
20																
Ultrasonic Flow meters	$31,000	2	$31,000	14	$31,000	24	$31,000	1	$31,000	8	$31,000	1	$31,000	2	$31,000	52
537																
30																
Flume Gates	$25,000	18	$25,000	46	$26,389	36			$25,295	271					$25,350	371
50																
Flume Gates	$35,000	6	$35,000	12	$35,000	3			$35,000	376					$35,000	397
538																
30																
Mag Flow meters									$31,000	13					$31,000	13
632																
40																
Tilting Doors*									$90,000	2					$90,000	2
Grand Total	**$62,061**	**213**	**$42,363**	**633**	**$35,383**	**737**	**$686,368**	**19**	**$28,863**	**1657**	**$177,556**	**27**	**$313,323**	**31**	**$42,655**	**3317**

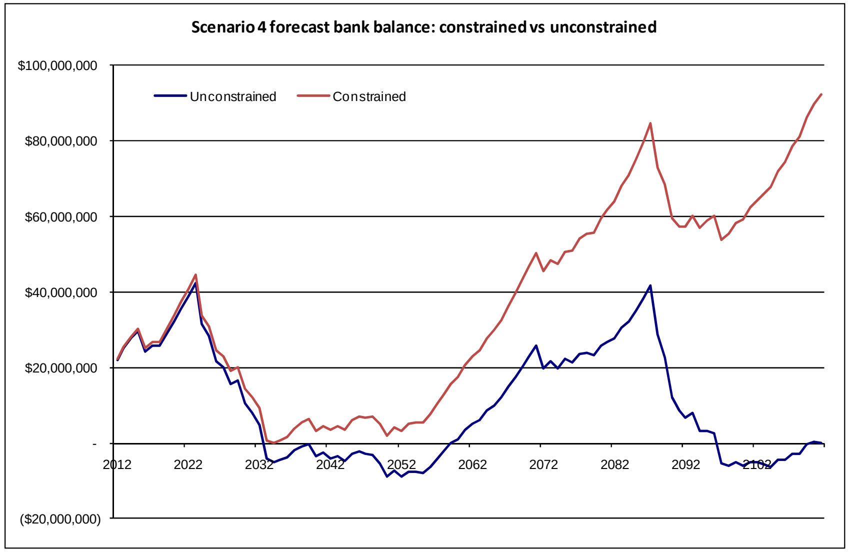
Appendix D Renewals Annuity Modelling Results

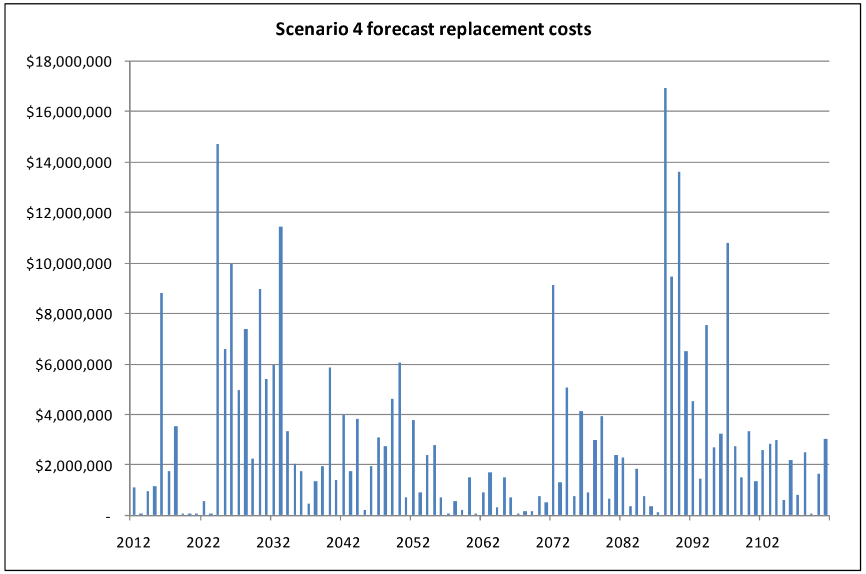


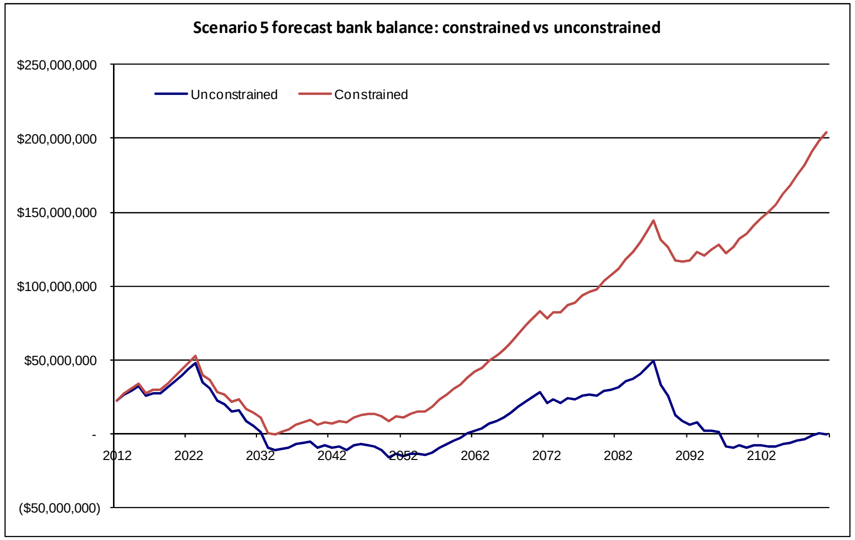


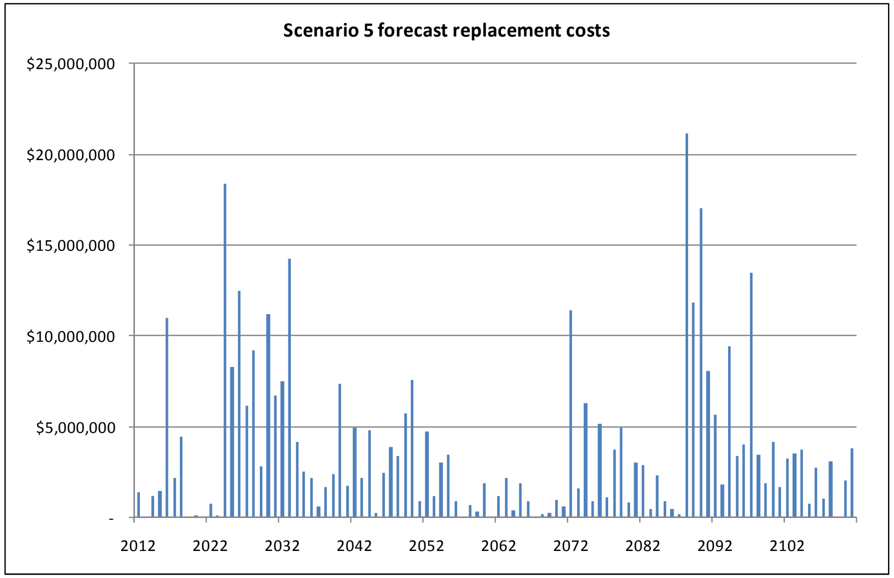





Scenario 4 forecast bank balance: constrained vs unconstrained
Unconstrained
Constrained
$100,000,000
$80,000,000
$60,000,000
$40,000,000
$20,000,000
-
($20,000,000)
2012
2022
2032
2042
2052
2062
2072
2082
2092
2102

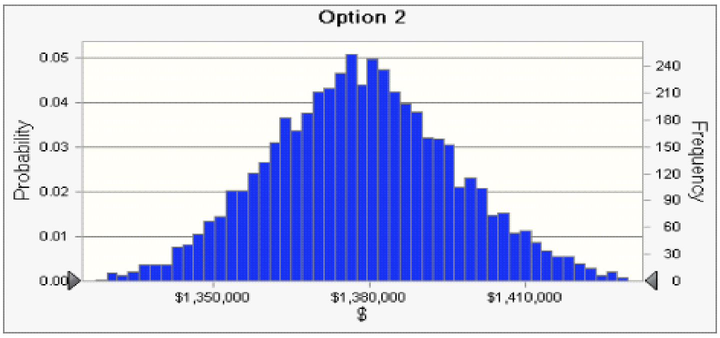

Scenario 4 forecast replacement costs
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
-
2012
2022
2032
2042
2052
2062
2072
2082
2092
2102


Scenario 5 forecast bank balance: constrained vs unconstrained
Unconstrained
Constrained
$250,000,000
$200,000,000
$150,000,000
$100,000,000
$50,000,000
-
($50,000,000)
2012
2022
2032
2042
2052
2062
2072
2082
2092
2102

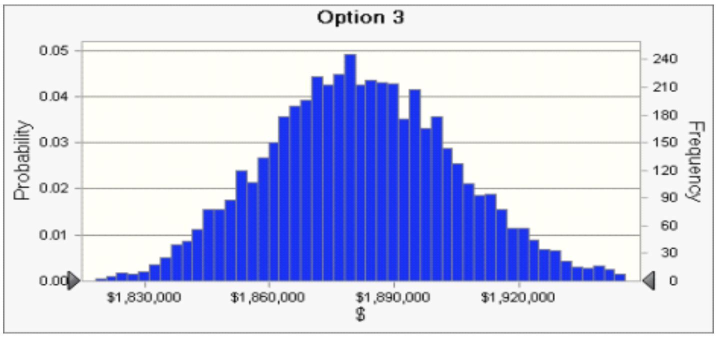

Scenario 5 forecast replacement costs
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
-
2012
2022
2032
2042
2052
2062
2072
2082
2092
2102

Appendix E Monte Carlo simulation outputs

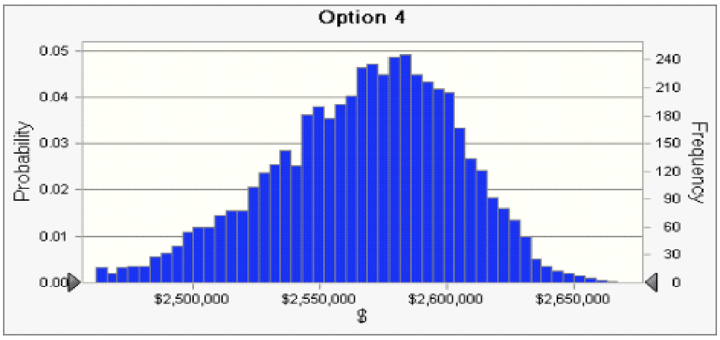
Forecasts



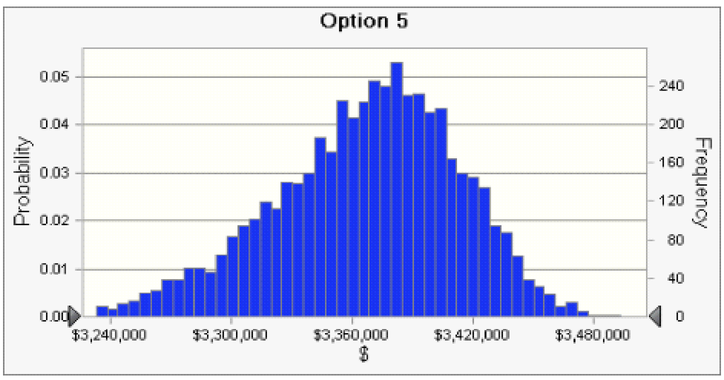
Percentiles:	Forecast values
5%	$1,349,167
10%	$1,355,502
20%	$1,363,214
30%	$1,369,002
40%	$1,373,973
50%	$1,378,238
60%	$1,382,632
70%	$1,387,588
80%	$1,393,576
90%	$1,401,871
95%	$1,409,421
99%	$1,422,681



Percentiles:	Forecast values
5%	$1,845,178
10%	$1,852,721
20%	$1,862,748
30%	$1,869,598
40%	$1,875,550
50%	$1,881,297
60%	$1,887,317
70%	$1,893,748
80%	$1,900,878
90%	$1,911,720
95%	$1,920,443
99%	$1,937,643



Percentiles:	Forecast values
5%	$2,498,378
10%	$2,515,223
20%	$2,535,395
30%	$2,549,178
40%	$2,560,591
50%	$2,570,406
60%	$2,579,906
70%	$2,588,650
80%	$2,598,609
90%	$2,611,350
95%	$2,621,541
99%	$2,638,884



Percentiles:	Forecast values
5%	$3,279,165
10%	$3,302,379
20%	$3,327,508
30%	$3,344,940
40%	$3,358,810
50%	$3,371,096
60%	$3,382,539
70%	$3,393,745
80%	$3,405,921
90%	$3,423,406
95%	$3,435,213
99%	$3,456,838