Appendix F

Risk Review of Capital Works Program

EVANS & PECK

think through the future

ElectraNet

Risk Review of Capital Works Program

May 2007

EXECUTIVE SUMMARY

This report analyses the cost impact of the risks associated with ElectraNet's capital works program for the 5-year regulatory period from 1 July 2008 to 30 June 2013.

An analysis of ElectraNet's project estimates and out turn costs over the current regulatory period shows that ElectraNet has historically underestimated projects by on average 22%. Electranet has recognised this level of inaccuracy, and has introduced new estimation processes. Notwithstanding the new estimation processes, there are still residual risks and opportunities that need to be considered.

The outcomes of risk analysis are usually expressed as probabilities that the actual out turn cost will not exceed a certain amount. The 50% probability that the out turn cost will be under a defined dollar value (known as P50) is often used to establish a target cost estimate in contracting. The 80% probability that the final cost will be under a defined dollar value (known as P80) is commonly used in industry to establish a budget estimate.

In our experience, for a project portfolio of this nature, a P80 would normally be used for a budget figure. However, for the purposes of this analysis, the conservative "target cost" P50 has been used. The P50 figure means that there is equal probability that the costs will be above or below the identified P50 value.

The results of Evans & Peck's analysis indicate that the risk-adjusted cost of ElectraNet's capital works program, in 2007/08 dollars, has a 50% probability (P50) of not exceeding the "base case" estimates by 5.2%. The build up from the base case estimate is summarised in the following table:

	P50		**P80**	
Cost component ($2007/08)	**($ million)**	**(% of base estimate)**	**($ million)**	**(% of base estimate)**
Base Estimate	700.0		700.0	
Risk Adjustment (P50)	36.6	5.2%	49.1	7.0%
Total	**736.6**		**749.1**	

This risk-adjusted cost does not include any allowance for the annual escalation of input costs – forecast escalation is outside of the scope of this paper and is addressed in separate reports by Evans & Peck and BIS Shrapnel.

The forecast range of out turn costs for ElectraNet's portfolio are shown graphically overleaf.

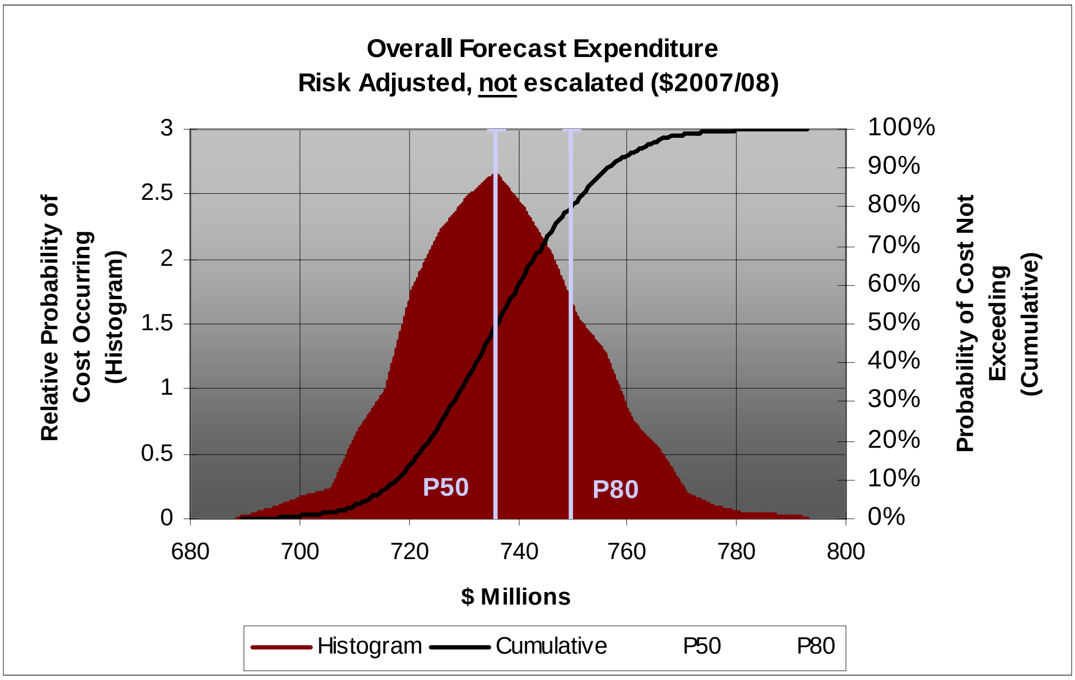

Figure 1 Forecast Expenditure Range – Risk Adjusted

The risk adjustment of 5.2% for ElectraNet's capital works program is at or below the lower bound of typical industry experience, and is considered to be a low estimate of the likely capital works expenditure for the 2008/09 – 2012/13 regulatory period.

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1 INTRODUCTION

ElectraNet engaged Evans & Peck to assess and quantify the risks and opportunities associated with the delivery of the 2008-2013 Capital Works Program, for the purposes of providing a risk-adjusted portfolio cost to the Australian Energy Regulator.

The development of major capital works projects involves complex transactions with considerable uncertainty. While risk management measures can reduce risk, they cannot and do not fully remove risk.

The long duration of ElectraNet's capital works projects from scope and cost estimation through to completion and commissioning, combined with the exposure of these projects to outside influences, means that at any point in time up until all costs have been expended, the forecast cost at completion will be a range, rather than a single number. This uncertainty is directly related to the risk profile of each project, which is related to the way that risk is managed on that project.

In statistical terms, the future cost of a project is *stochastic* in nature, not *deterministic.*

There are two primary areas of capital project uncertainty – timing and cost.

ElectraNet has addressed the uncertainty of project timing with a scenario-based approach, weighting scenarios based on their probability of occurrence. (The scenario-based approach uses 18 scenarios, reflecting uncertainty in items such as economic growth. Each scenario has projects occurring at different times, if they occur at all). The Australian Energy Regulator, in its Draft Determination for Powerlink, dated 8 December 2006, has favourably considered the probabilistic determination of scenarios in this manner.

This paper addresses cost uncertainty through the construction of a risk model. Risk profiles are assigned to each project, assessing the likely range of potential cost outcomes of a particular project. The likely range of potential cost outcomes for the total portfolio of projects contained in ElectraNet's regulatory submission is determined using a Monte Carlo analysis of the individual projects.

Decisions on risk appetite in industry are based on the purpose of the estimate, and the company's individual appetite for risk. Typically we identify and define the following risk classifications:

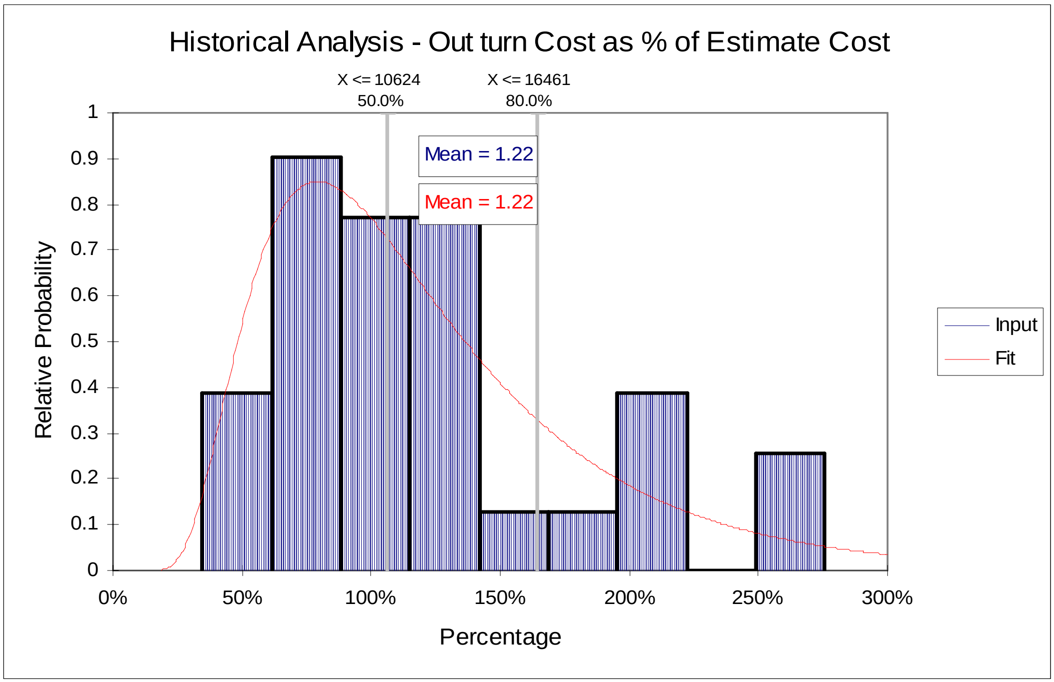
- P10 **-** Best Case / Stretch Target
- P50 **-** Most Likely / Target Cost
- P80 - Budget Requirement
- P100 **-** Worst Case / Residual Risk Exposure / Insurance

For the purposes of this report, the final cost outcome is the P50 resulting from the range of likely costs for the delivered capital works program. The P50 figure means that there is equal likelihood that the delivered capital works program will exceed the estimated cost, or that the program will be delivered for less than the estimated cost.

2 HISTORICAL INFORMATION

A comparison of the out-turn cost against the budget cost of 29 historical ElectraNet projects revealed the "best-fit" distributions below. These 29 projects represent almost 20% of the 166 projects identified in the current regulatory period. These projects represent $179 million of the $409 million, which is over 40% of the forecast capital expenditure value of the current regulatory period. Where projects for the current period are yet to be completed, current cost-to-completion estimates are used as the final cost for comparison purposes.

The projects selected for comparison represented like-for-like comparisons of scope definition and scope outcome. The estimated and out turn costs were de-escalated to a common 2002-03 baseline cost using actual CPI values, to enable a common cost comparison.



It will be noted that the best-fit curve is not specifically a PERT distribution. On a range of statistical measures, the best fit is an Inverse Gaussian characteristic. It is similar in form to the PERT distribution and asymmetric, and is continuous to infinity. In completing this analysis we have restricted the useable range of the log-logistic distribution to be consistent with historic outcomes.

It can be seen from the graph that the mean difference between ElectraNet's historical estimated and out turn project costs is 22% - that is, ElectraNet have historically underestimated project costs by 22%.

This compares with the risk-adjusted mean forecast outturn cost of the 2008/09 – 2012/13 Regulatory Period which is 5.2% higher than the estimated cost.

It is our view – based on discussions with ElectraNet staff – that ElectraNet has improved, and can continue to improve its outturn cost to budget cost ratio. However, forecasting future costs will always include an element of risk. Even with best practice budgeting and project management, some risk premium is still applicable.

3 ASSESSMENT OF RISKS

The long duration and exposure of capital works projects to outside influences means that at any point in time up until all costs have been expended, the forecast cost of the projects will be a range, rather than a single number. The uncertainty is directly related to the risk profile of a project.

The risk profile of a project will depend on the measures that are in place to manage risk, including optimising the ability to capitalise on opportunities. Therefore, to measure the potential overall cost of a project, it is necessary to understand:

- the potential risks and opportunities;
- how these are managed;
- potential financial exposure (ie. residual risk) after risk management; and
- the potential cost implications of the residual risk.

ElectraNet's cost estimates are built up from the following components:

1. The "base case" estimate, as estimated by ElectraNet
2. The results of the Risk Model, using Monte Carlo risk analysis to determine the portfolio risk adjustment due to:
   - The "inherent risks" contained in ElectraNet's project portfolio (refer to Section 3.3.1)
   - The "contingent risks" contained in ElectraNet's project portfolio (refer to Section 3.3.2)
3. Escalation, converted to $2007/08.

3.1 WHY USE RISK ANALYSIS

Traditionally project and portfolio managers have made best estimates of future project costs, and applied a contingency to each project to allow for unforeseen cost increases. Applying contingencies at a project level can give rise to an excessive contingency amount at a portfolio level – this is discussed further in the Definitions.

The US Department of Energy recognises the need to address the uncertainty associated with estimates, with an entire directive devoted to contingency, which it defines as:

"costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of the contingency will depend on the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project."

While contingency allowances and risk analysis have the same end goal – to provide an accurate allowance for costs likely to be incurred – risk analysis is a more sophisticated and accurate tool which recognises both risks <u>and</u> opportunities.

In particular, the assessment of specific risks and opportunities, combined with the application of computational techniques such as Monte Carlo simulation, provides an accurate and robust methodology for assessing the likely cost outcome of a project or portfolio of projects.

3.2 QUALITATIVE RISK ASSESSMENT

The first step in quantifying the cost impact is to assess the risks and risk management measures that exist on the project. This is called qualitative risk assessment. The basic process involves identifying the risks and opportunities, assessing them generally in terms of likelihood and consequence, identifying the treatment measures that are in place for the risks and opportunities, and where necessary, developing and implementing appropriate risk treatment measures.

3.3 QUANTITATIVE RISK ASSESSMENT

The outputs of the qualitative process become the inputs to the quantitative process as illustrated in Figure 2 below.

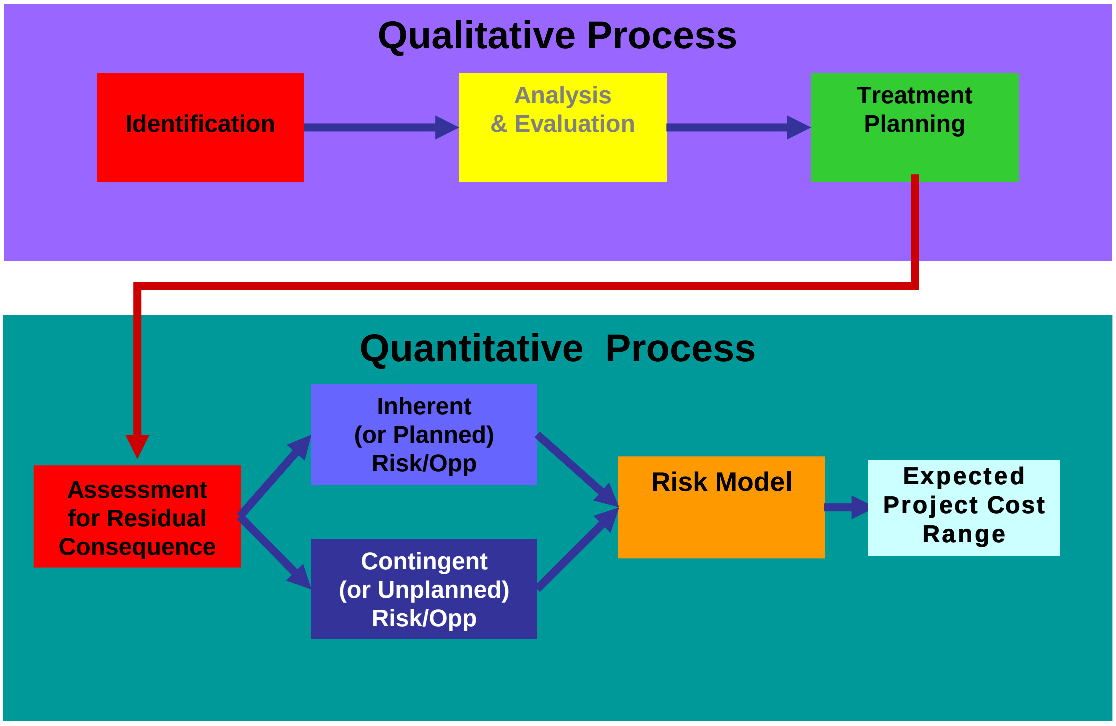


Figure 2 – Relationship between Qualitative and Quantitative Risk Assessment

Figure 2 above shows two types of potential sources of cost uncertainty – inherent risk and contingent risk. These are described further below.

3.3.1 Inherent Risks

Inherent (or planned) risks and opportunities represent the uncertainty in the pricing of the known scope of work, and are due to uncertainty in the scope of work, quantities or unit cost rates for items in the base estimate. This is especially so where assumptions have been made in regard the scope, size or type of material required for the project.

Inherent risks include:

- uncertainty in the scope of work;
- uncertainty, or potential variations, in quantities and unit rates/metrics proposed in the base estimate;
- variance in construction method;

The inherent risks relevant to ElectraNet's Regulatory Reset are discussed in Section 4.5 and in Appendix 1.

3.3.2 Contingent Risks

Contingent risks are risk events that may occur during the life of the project, or across the portfolio, that may differ from what has been assumed in the original pricing.

Contingent risks include:

- occurrence of an unplanned or unforeseen event such as a catastrophic natural event or a major safety incident;
- change to planned assumptions;
- stakeholder issues (operators, community);
- delayed access to site;
- Industrial Relations issues external to the project.

Contingent risks relevant to ElectraNet's Regulatory Submission are listed in Section 4.7 and Appendix 3.

3.3.3 Risk Analysis

The analysis of a project risk profile to develop a model for potential project and portfolio costs involves using statistical techniques and computational power. The most effective and well recognised of these techniques is Monte Carlo simulation, where very large numbers of potential combinations of risk and opportunity outcomes are randomly sampled within a defined probability distribution.

For a portfolio of capital works, Monte Carlo simulation involves:

1. including the range of potential cost outcomes for each item of known scope (“inherent risk”), based around the project cost estimates;
2. including the probability of occurrence of each identified risk event and the probable range of costs (“contingent risks”); and
3. simulating potential combinations of the costs of all of these to develop a likely range of costs for the overall project portfolio.

4 RISK MODELLING

4.1 PROJECT COST INPUTS

ElectraNet's project estimates are a single cost estimate for each project, built up from individual cost components. Since these estimates represent ElectraNet's best estimate of the project cost, the estimates represent the most likely (or modal) project cost outcome.

While using the most up to date cost components from previous projects will improve the likelihood of forecasting the most likely project cost, this technique does not remove the uncertainty of future cost forecasting.

A quantitative risk assessment workshop, facilitated by Evans & Peck, was conducted with ElectraNet management, planning engineers, project delivery managers, and cost estimators in November 2006. This workshop determined the range and variability of various project costs, aggregated into risk categories, and the boundaries of these risk categories. These assessments represent ElectraNet's considered professional opinion of the likely range of project cost outcomes.

Following the risk workshop, ElectraNet revised the upper end of the risk profiles downwards, taking a more conservative (optimistic) approach to estimating risk.

In addition, an individual risk assessment was carried out for the single largest project to be conducted during the next regulatory reset period, the Adelaide CBD Reinforcement Project, to provide greater understanding of the risks associated with this project.

4.2 DETERMINATION OF PROBABILITY DISTRIBUTIONS

There are three methods of determining appropriate probability distributions for an individual project, of decreasing accuracy:

1. Risk analysis for the specific project followed by quantification of residual risk.
2. analysis of data from similar, previous projects
3. judgement of appropriate ranges.

Method 1 above involves the detailed analysis of the risks and opportunities for individual projects. The risks are first identified, risk treatments are considered, and any residual risk is quantified. The quantified residual risk profile is added to the base project estimate, to give a risk-adjusted project cost profile. This method is the preferred risk assessment methodology where time and resource constraints permit, as it is the most detailed and robust of the three methodologies.

Method 2 involves the analysis of historical data from similar projects, to determine the historical range of outturn costs against estimates. This range represents the risk profile of the historical projects (typically as a percentage of the project estimate cost), which can then be assigned to the current projects under assessment. This method is not as robust as method one, as it does not account for any efficiencies or improvements made since the time of the historical projects. Similarly, this method does not allow for unforeseen issues which may result in increased risk.

Method 3, judging the appropriate risk profiles, is a "rule-of-thumb" method which relies on the expertise of the person making the assessment. While not as accurate as Method 1 or Method 2, it can be a practical and relatively accurate method of assessing the out turn cost where time or resources are constrained.

4.2.1 Application to Adelaide CBD Reinforcement Project

Method 1, a detailed analysis of the individual risks, has been used for the Adelaide CBD Reinforcement Project. A detailed analysis was carried out for this project as it represents approximately 20% of the estimated capital expenditure over the regulatory period, and the realisation of any risks and opportunities associated with this project would have a significant impact on the overall regulatory period capital expenditure.

4.2.2 Application to other ElectraNet Capital Projects

A modified version of Method 1 was used to practically and efficiently assess the risks for the large number of remaining projects in ElectraNet's capital works portfolio. The modification was to group the cost components for each project into risk categories, and assess the risk profile of each of these risk categories. Determination of the risk categories and the associated risk profiles was made at a risk workshop conducted with ElectraNet's planning engineers, project delivery managers, and cost estimators, facilitated by Evans & Peck.

The risk profiles determined for each risk category were applied to the relevant cost amount for each project, building up project-specific risk profiles.

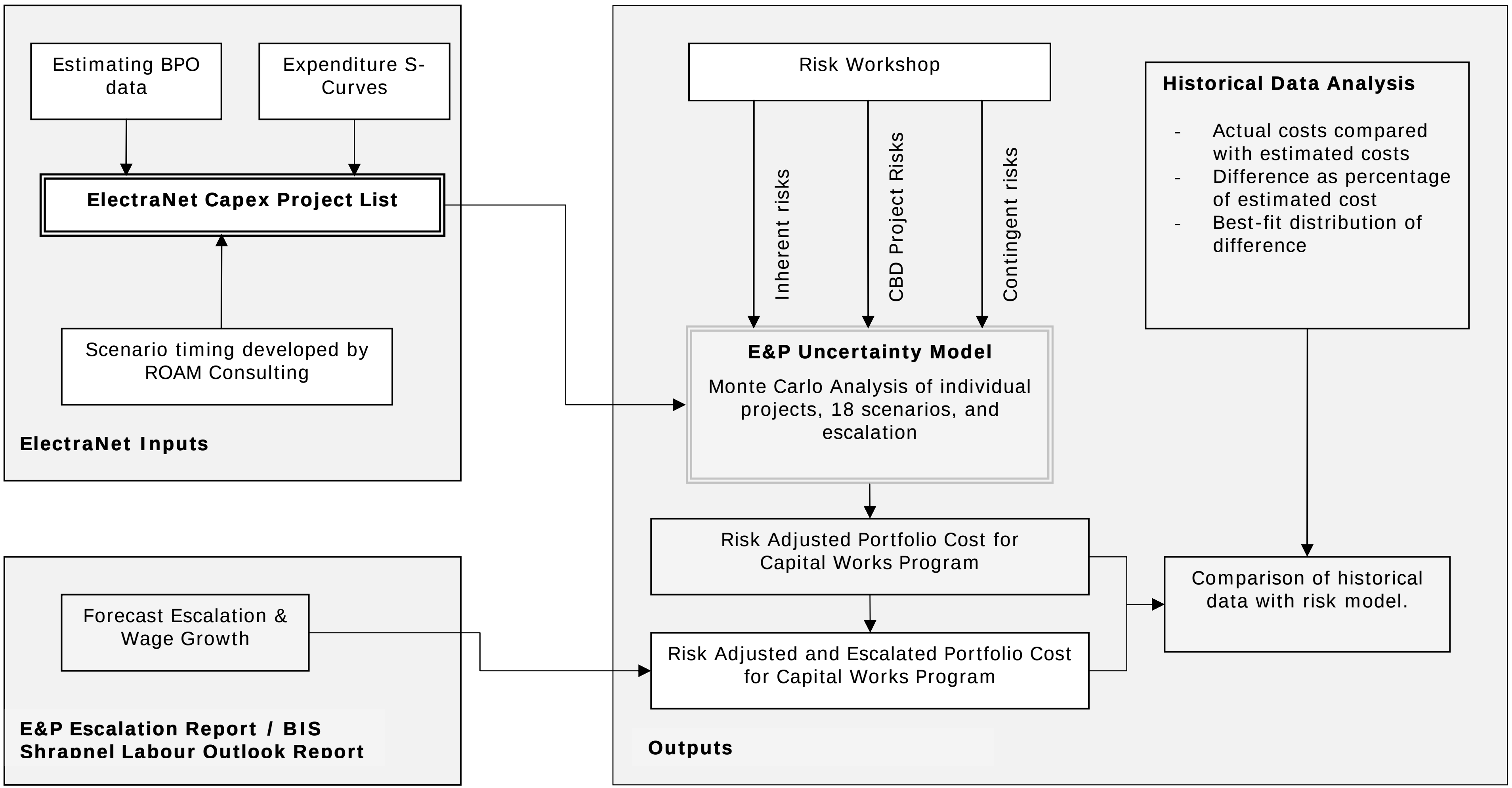
The risk categories are further discussed in Section 4.5 below.

4.2.3 Comparison of Detailed Risk Determination with Historical Data

Method 2, analysis of data from previous projects, is used as a comparative tool to compare the risk-adjusted portfolio cost to the outcomes of historical projects. The outcome of this comparison is detailed in Section 5 below.

4.3 STRUCTURE OF RISK MODEL

The diagram overleaf provides a graphical overview of the inputs and outputs of the risk model.


Estimating BPO data
Expenditure S-Curves
ElectraNet Capex Project List
Scenario timing developed by ROAM Consulting
ElectraNet Inputs
Forecast Escalation & Wage Growth
E&P Escalation Report / BIS Shrapnel Labour Outlook Report
Risk Workshop
Inherent risks
CBD Project Risks
Contingent risks
E&P Uncertainty Model
Monte Carlo Analysis of individual projects, 18 scenarios, and escalation
Historical Data Analysis
- Actual costs compared with estimated costs
- Difference as percentage of estimated cost
- Best-fit distribution of difference
Risk Adjusted Portfolio Cost for Capital Works Program
Risk Adjusted and Escalated Portfolio Cost for Capital Works Program
Comparison of historical data with risk model.
Outputs

4.4 BASE ESTIMATES

ElectraNet use two primary levels of project costing estimates. These are different for projects at different lifecycle stages, with associated different degrees of estimating accuracy. The two primary levels of estimates are as follows:

- Concept Estimates (Level A and Level 1 Estimates):

  These are high-level estimates, where the numbers of items of key plant are estimated, and the costs of these key plant items are based on Base Planning Objects. The size and location of the project may not be known when these estimates are developed. The estimates prepared for ElectraNet's Revenue Proposal are primarily Level A estimates, while Level 1 estimates are prepared as part of the normal project development process, based on preliminary scoping.

  Both Level A and Level 1 estimates are associated with the project concept phase, and the associated uncertainty in the estimates is very high.

- Detailed Estimates (Level 2 Estimates):

  Level 2 estimates are detailed estimates where the project is fully scoped, and the quantities and location of the project are known to some level of detail. Level 2 estimates are prepared for project approval, with a somewhat lower uncertainty than a Level A/Level 1 estimate. Base Planning Objects are not used in the compilation of Level 2 Estimates.

The uncertainty associated with the project risk categories was assessed separately for Level A/Level 1 estimates, and for Level 2 cost estimates.

4.5 RISK CATEGORIES – INHERENT RISKS

As described in Section 3.3.1, inherent risks represent the uncertainty in the costing for the known scope of work.

To enable the inherent risks of a large number of projects to be efficiently assessed, the individual cost components of all of the projects have been aggregated into risk categories. A workshop was held to determine the risk categories and associated risk profiles. This workshop was conducted with ElectraNet's planning engineers, project delivery managers, and cost estimators, facilitated by Evans & Peck. The inherent risk categories and risk profiles determined by this workshop are provided in Appendix 1.

A separate risk assessment has been conducted for the Adelaide CBD Reinforcement project, due to the high proportion of the overall capital expenditure that this project represents. The inherent risks described in this section do not apply to Adelaide CBD Reinforcement project.

ElectraNet determined an estimated cost for each capital works project, built up from a number of cost components. The cost components for each project were grouped into the inherent risk categories, and the risk profile for each inherent risk category assigned to the relevant aggregated project cost component.

ElectraNet has advised that the project cost estimates do not include any contingency. The risk profile of the project cost components (aggregated into risk categories) captures the range of expected cost outcomes for each project, and so contingency amounts are not required.

By applying the risk profiles to the estimated costs for each project risk category, the risk analysis explicitly weights projects according to their relative contribution to the overall capital works portfolio.

A Monte Carlo simulation was run across the entire capital works portfolio to determine the overall portfolio risk profile.

It is almost certain that one or more of the items in the risk categories will cause a measure of cost overrun on each project, relative to an estimate that includes no risk allowance.

Evans & Peck is familiar with numerous project outcomes that have been in the range of 80 per cent of forecast cost to 250 per cent (net of escalation) of forecast cost. Historical analysis of ElectraNet's project estimating indicates that the mean out turn cost of projects is 22% higher than estimated.

4.6 ADELAIDE CBD REINFORCEMENT PROJECT RISK

ElectraNet's Adelaide CBD Reinforcement Project accounts for approximately 20% of the estimated capital expenditure, and has been the subject of a separate risk assessment. The individual risks associated with the Adelaide CBD Reinforcement Project are listed in Appendix 2.

The risk for this project is included in the scenario risks in the Risk Model.

4.7 CONTINGENT RISK

As discussed in Section 3.3.2, contingent risks include items that may arise if the underlying assumptions that form the basis of the base estimate do not prove to be valid or constant, or if an unforeseen event occurs.

Contingent risks associated with the delivery of the capital works program have been assessed separately to the 'planned' risks which are incorporated in the Scenario Risk and CBD Reinforcement Project Risk assessments.

The contingent risks relevant to ElectraNet's capital works projects are detailed in Appendix 3.

4.8 ESCALATION RISK

Forecast escalation is outside the scope of this paper, and is addressed in separate reports by Evans & Peck and BIS Shrapnel. The variability of forecast escalation is not captured in the risk model.

4.9 RUNNING THE RISK MODEL

The risks determined and previously described (inherent risks, contingent risks, and Adelaide CBD Reinforcement project risks) were analysed using a probabilistic risk analysis. This was conducted using @RISK modelling software, using a Monte Carlo simulation to analyse the various risk profiles.

5 INDEPENDENT ESTIMATE COMPARISON

To verify its own estimating techniques, ElectraNet obtained independent cost estimates from two independent estimators. Maunsell Australia provided independent estimates for five substation and lines projects, and Worley Parsons provided independent estimates for an additional three projects.

A comparison of ElectraNet's most-likely cost estimates for the five projects with Maunsell's most-likely estimates revealed that Maunsell's estimates differed between 10% lower to 16% higher than ElectraNet's estimates. For four of the five projects Maunsell estimated a higher cost than ElectraNet. The weighted average difference was 15% higher than ElectraNet's estimates.

A comparison of ElectraNet's most-likely cost estimates for the three projects with Worley Parson's most-likely estimates revealed that Worley Parson's estimates differed between 5% lower to 14% higher than ElectraNet's estimates. For two of the three projects Worley Parsons estimated a higher cost than ElectraNet. Due to the high weighting of one of the projects (due to its higher cost) where the independent estimate was lower than ElectraNet's, the overall weighted average difference was 2.0% lower than ElectraNet's estimates.

The weighted average for the most likely cost estimates of all eight independently assessed projects is 10.6% higher than ElectraNet's own estimates. This difference is within "normal" expectations for estimates of this type, reflecting the uncertainty involved with estimating costs. This cost comparison highlights that ElectraNet's forecasting process is not artificially biased to the high end, and further justifies the need for a structured approach to risk inclusion.

6 OUTCOMES

The estimated expenditure and risk profile of each project was combined using a Monte Carlo based software package (@RISK) to determine the risk-adjusted distribution of the total Capital Works Expenditure.

The Monte Carlo based risk analysis of ElectraNet's forecast expenditure assesses the likelihood of the final cost of an individual project changing from the estimated cost. The uncertainty of if, and when, a project is carried out, is addressed in ElectraNet's creation and weighting of some 18 different project scenarios.

The model establishes a cost profile for each of the 18 scenarios, and provides an overall risk-adjusted outturn cost based on their relative probability of occurrence.

The range of possible outcomes can be represented as a histogram or as a cumulative distribution of the probability of the cost being less than a given amount. The cumulative distribution allows the probability of the cost being less than a given amount to be interpreted directly from the graphs. Conversely for any chosen probability, the appropriate cost value can also be interpreted directly from the curves.

The results of Evans & Peck's analysis indicate that the risk-adjusted cost of ElectraNet's capital works program, in 2007-08 dollars, has a 50% probability (P50) of being less than $736.6 million. Risk analysis results in the P50 cost of the risk-adjusted portfolio cost 5.2% higher than the non risk-adjusted "base case" estimates. The breakdown of the cost components is summarised in the following table:

	P50		**P80**	
Cost component ($2007/08)	**($ million)**	**(% of base estimate)**	**($ million)**	**(% of base estimate)**
Base Estimate	700.0		700.0	
Risk Adjustment (P50)	36.6	5.2%	49.1	7.0%
Total	**736.6**		**749.1**	

The results of the analysis are shown graphically overleaf.

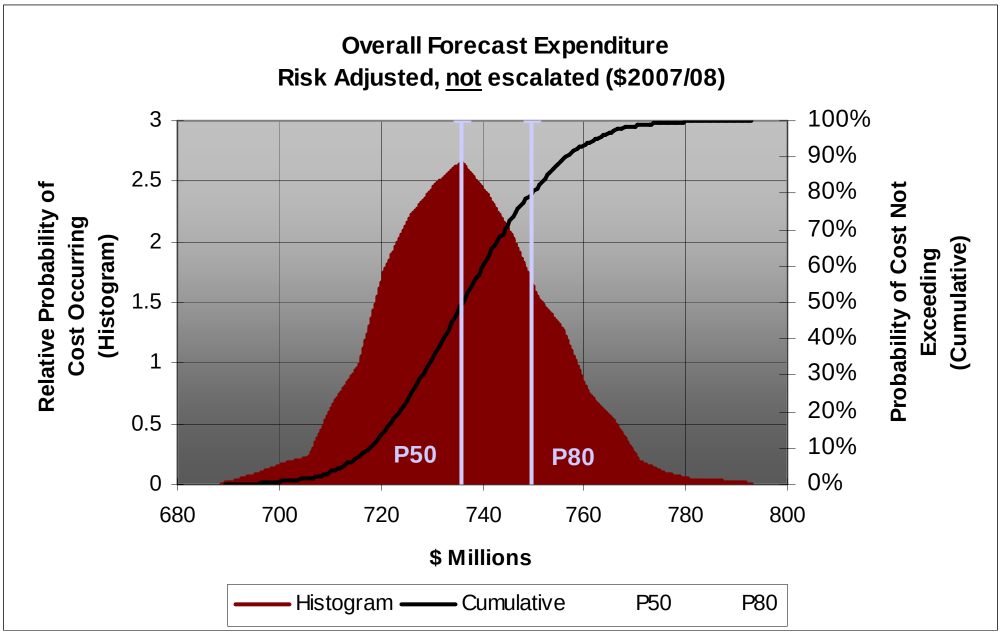


Figure 3 Forecast Expenditure Range – Risk Adjusted

The risk adjustment of 5.2% for ElectraNet's capital works program is at or below the lower bound of typical industry experience, and is considered to be a low estimate of the likely capital works expenditure for the 2008/09 – 2012/13 regulatory period.

7 CONCLUSION

Major project development involves considerable uncertainty. Evans & Peck's analysis of ElectraNet's project estimates and out turn costs over the current regulatory period demonstrates that ElectraNet has historically underestimated projects by 22%.

Based on discussions with ElectraNet, it is Evans & Peck's view that ElectraNet has improved its estimating processes, and that the differential between out turn costs and estimates has narrowed and will continue to narrow over time. However, no amount of improvement will eliminate future risks, and forecast costs will continue to carry an element of risk and uncertainty, with the result that out turn costs will continue to be higher than estimates.

A rigorous and detailed risk assessment and modelling exercise has determined that the P50 out turn cost of ElectraNet's capital works project portfolio, including risk adjustments, is expected to be 5.2% higher than the non-risk adjusted "base case" estimate. This is lower than industry experience would typically suggest, and shows that ElectraNet has been conservative (ie. optimistic) in estimating the amount of risk that is contained in its portfolio. By being conservative in estimating the amount of risk in its portfolio, ElectraNet has produced a conservative (low) cost of delivering it's portfolio of projects.

To achieve a P50 outcome, with an equal probability of a cost over-run or a cost under-run, the 5.2% risk adjustment needs to be added to the "base" capital works expenditure forecast.

Appendix 1:
Risks – Inherent Risk Categories

Risk Categories – Risk Profiles

The inherent risk categories determined in the risk workshop are shown in the table below, along with expected boundaries of the cost ranges of these categories.

Risk Category / Asset Classes	Level A / Level 1 Estimates			Level 2		
	% of Baseline Cost			% of Baseline Cost		
	Min	Most Likely	Max	Min	Most Likely	Max
Preliminaries	80%	100%	130%	90%	100%	115%
Overhead Lines	95%	100%	130%	95%	100%	120%
Underground Cables (internal to substations)	80%	100%	150%	90%	100%	120%
Easements & Land Acquisition	50%	100%	150%	80%	100%	180%
Civils	95%	105%	130%	95%	100%	115%
Site Establishment	80%	100%	120%	90%	100%	110%
Buildings	90%	100%	110%	95%	100%	105%
Switchgear	90%	100%	115%	95%	100%	105%
Power transformers	95%	100%	110%	95%	100%	105%
Primary Plant Ancillaries	90%	100%	115%	90%	100%	110%
Reactive Plant	95%	100%	110%	95%	100%	105%
Secondary Systems	90%	100%	135%	90%	100%	120%
Telecoms & IT	85%	100%	120%	90%	100%	115%
Approvals	90%	100%	110%	90%	100%	110%
Decommissioning/Demolition	75%	100%	125%	80%	100%	120%
Inventory and Spares	90%	100%	110%	95%	100%	105%
Security System (Concept 4000)	90%	100%	110%	90%	100%	110%
Minor projects (<$2million)	80%	100%	120%	85%	100%	115%

Risk Categories - Explanations

Preliminaries

Uncertainty in this category includes variances in:

- volume of design input required
- project management costs, including staffing levels and associated salary and contract costs (separate to escalation)
- some planning approval and approval condition risk

Overhead Lines

Uncertainty in this category includes variances in:

- total line length, due to terrain complexity and deviations around sensitive areas
- number of poles, footings and crossarms
- ratio of strain to suspension structures
- lines crossings over or under the base planning object assumption of 0.5 crossings per kilometre of line length
- soil variations affecting footing design and cost
- urban/rural differences
- adverse environmental conditions
- design risk
- construction completion risk
- limited skilled resources
- changes in legal requirements – for example, cultural and heritage, environmental, workplace health and safety

Underground Cables (internal to substations)

Uncertainty in this category includes variances in:

- short length cables (minimum order quantity)
- brown fields issues - directional boring compared with trenching
- high level of design risk
- construction completion risk
- difficult access conditions in live sites

Easement and Land Acquisition

Uncertainty in this category includes:

- individual land price variations, separate to average escalation
- variations in route, since route typically not fully established prior to approval

Civils

Uncertainty in this category includes:

- variances in soil type, different from the typical soil type assumed in the Base Planning Objects
- variances in topology, different from the level ground assumed in the Base Planning Objects, potentially requiring cut and fill
- geotechnical risk – no geotechnical studies are conducted for level A/level 1 estimates
- risk that sub-contractors will require additional funds (variations) in order to complete construction works

Site Establishment

This category includes demountable buildings, earthworks, site infrastructure, establishment of secondary systems for the common services building (HMI, common multiplexer etc).

- Uncertainty in this category includes variances in staging and outage costs.

Buildings

Buildings have limited uncertainty, so are priced with a narrow and symmetrical risk profile.

Switchgear

Standard switchgear equipment is supplied under three year contracts, which effectively hedge against foreign exchange risk for the period of the contract. Uncertainty in this category includes variances in:

- environmental risk
- difficult access conditions in live sites

Power Transformers

Uncertainty in this category includes variances in:

- purchase price subject to market forces and manufacturing capacity
- difficult access conditions in live sites
- individual site variations

Primary Plant Ancillaries

This category includes items such as transformer firewalls, transformer footings, substation equipment relocation, and oil separation plant.

Uncertainty in this category includes variances in:

- difficult to adequately size and scope requirements for oil separation plant (which is a large component of this category)
- purchase price subject to market forces
- primary plant ancillary items can be easy to leave out of scope
- environmental risk
- planning risk
- difficult access conditions in live sites
- individual site variations

Reactive Plant

This plant is usually “turn-key” fixed price contracts, with a stable scope of work, however uncertainty in this category includes variances in:

- purchase price subject to market forces and manufacturing capacity, over and above escalation
- difficult access conditions in live sites

Secondary Systems

Secondary systems are designed to a common standard “template”. Uncertainties arise with:

- difficulties in interfacing with old equipment in brown fields substations, and also existing protection equipment outside green fields substation
- individual site variations

Telecommunications and Information Technology

Uncertainty in this category includes variances in:

- generic estimates
- installation by Telco providers
- technology changes - technology can be difficult to assess as part of the evaluation cycles
- difficult to scope.

Decommissioning and Demolition

Uncertainty in this category includes:

- potential for asbestos in existing buildings, PCBs in equipment
- equipment may some have residual value (eg. scrap)
- risk that demolition requirements are not fully understood at start of project
- environmental risk
- individual site variations

Inventory and Spares

Uncertainty in this category includes variances in:

- purchase price subject to market forces

Security System

Uncertainty in this category includes variances in:

- brown fields sites
- individual site variations
- cost will be limited to the extent that the project will be scaled back to keep within this cost range

Minor Projects (less than $2 million)

This basket of smaller projects has an uncertainty allowance, recognising that estimates may not be carried out to the same level of accuracy as the larger projects.

Appendix 2:
Risks - Adelaide CBD Reinforcement Project

Description	Likelihood of occurrence (%)	Residual Risk ($) Probability Min (P10)	Most Likely	Max (P90)	Comments / Reasons for Risk
Technical					
Cable type and capacity undefined	20%	$ 200,000	$1,000,000	$2,000,000	Cable rating may change from 700MVA to 900MVA
Ratio of cable to overhead line undefined	50%	$5,000,000	$7,500,000	$10,000,000	Planning limitations may require more (expensive) underground than overhead
Type, size, and location of substation undetermined (AIS/GIS) - will also affect constructability	10%	$1,000,000	$2,000,000	$5,000,000	Based on potential substation layout changes
No plant specifications for GIS (equipment required unknown)	50%	$1,000,000	$1,500,000	$3,000,000	Equipment specifications not yet determined
Equipment layout yet to be determined (interface equipment unknown)	50%	$1,000,000	$1,500,000	$2,000,000	Equipment arrangement not yet finalised
Future requirements of project uncertain (substation layout)	10%	$ -	$ -	$1,000,000	Planning requirements known
Connection to ETSA (scope) undefined	20%	$ -	$ -	$1,000,000	ETSA requirements known
Geotech unknown (variability in underground soil types, fault line crossings)	50%	-$2,000,000	$ -	$1,000,000	Estimate allows a + 50% for unknown route conditions
Interface risks with service authorities (for example rail and road authorities)	50%	$2,000,000	$3,000,000	$5,000,000	Estimate allows a + 50% for unknown route conditions
Location and interface with existing services and utilities undefined.	50%	-$5,000,000	$ -	$3,000,000	Estimate allows a + 50% for unknown route conditions
Environmental					
Route undefined	20%	$ 100,000	$ 200,000	$ 500,000	Kilburn route not as environmentally sensitive as Magill
Overhead section subject to community consultation - potential delay	50%	$ 100,000	$ 200,000	$ 300,000	Majority of overhead is in industrial areas, however community comment likely
Cultural heritage issues unknown	20%	$ 100,000	$ 200,000	$ 300,000	Majority of overhead is in industrial areas, metro already disturbed likelihood of heritage issues low.
Wetlands and parklands flora and fauna unknown	40%	$ 100,000	$ 200,000	$ 500,000	Likelihood that Kilburn-Para line section may trigger EPBC referral

Areas of significance & existing right-of-ways/easements may increase cable route length	20%	$ 500,000	$1,000,000	$5,000,000	Right of way may change max 1km due to route variations.
Inclement weather affecting construction - (rain) will affect trenching operations, Summer heat reducing productivity	60%	$ 250,000	$ 500,000	$1,000,000	No stand down cost, but overhead mgt cost during times of no work. Major impact on overhead section.
Difficulties and delays in obtaining easements and (compulsory) land acquisitions.	25%	$ 250,000	$ 500,000	$1,000,000	Admin and legal cost to manage this work.
Parallel laying of additional services (eg. Telco)	25%	$ 500,000	$2,000,000	$3,000,000	Earthing and screening of other services yet to be identified
External					
Obtaining suitably experienced (specialised) contractors for laying large cable, and GIS substation	20%	$3,000,000	$4,000,000	$5,000,000	Maybe re-work of contractors poor workmanship
Contractor interface strategy (including industrial relations and global contractors)	40%	$3,000,000	$4,000,000	$5,000,000	Unknown international risks - govt, political unrest, econies
Obtaining specialised plant (in particular, cable laying and GIS - if used)	30%	$ -	$1,000,000	$2,000,000	Reasonable access to most supplies of equipment
Foreign exchange fluctuations	50%	$1,000,000	$2,000,000	$3,000,000	$30M of imported equipment at say 10% fluctuation in forex.
Traffic management during construction	30%	$ 200,000	$ 500,000	$1,000,000	potential unknown traffic implications
Delays in procurement and delivery of key equipment	20%	$ 100,000	$ 500,000	$2,000,000	Equipment to be ordered early hence risk reduced
Delays in planning approval for substation and overhead section of line	40%	$ 250,000	$ 500,000	$1,000,000	Admin and legal cost to manage this work.
Identification and obtaining support from key stakeholders (eg. Councils & EIPC)	20%	$ 250,000	$ 500,000	$1,000,000	Admin and legal cost to manage this work.
Delays in obtaining environment & planning approvals, & compliance with conditions associated with approvals	40%	$ 250,000	$ 500,000	$1,000,000	Admin and legal cost to manage this work.
Risk that regulatory conditions will change (eg ERIG/COAG review of National Electricity Planner)	10%	$ 250,000	$ 500,000	$1,000,000	Admin and legal cost to manage this work.
Organisational					
Limited availability of skilled internal resources & retention of these resources	50%	$ 500,000	$ 600,000	$1,000,000	Projects like BHP already causing delays, will have to buy in extra consultants
Loss of key personnel	50%	$ 50,000	$ 100,000	$ 100,000	Staff turnover in ElectraNet high

Implementation of communication protocols (internal and external)	20%	$ 200,000	$ 500,000	$1,000,000	The communication plan is well designed, but exceptional circumstances may require changes
Project Planning					
Design & construction finished by 2011	30%	$2,000,000	$2,000,000	$2,000,000	Loss of suply to city and SIM, public relations issues, compensation
Integration with existing telco network	10%	$ 500,000	$1,000,000	$1,000,000	Telco will be new, planned, limited integration
Operations					
Cancellation of Planned Outages	20%	$ 250,000	$ 250,000	$ 250,000	Limited outages required, can be planned in advance
Delays to obtaining required system outages, and restrictions to outage timings - including electricity, rail, gas lines etc.	80%	$1,500,000	$ 2,000,000	$2,000,000	Control over other outages by eg rail & gas is difficult
Failure to adequately scope and design for maintenance requirements	10%	$1,000,000	$ 1,000,000	$1,000,000	A&O input will be required into the technical specifications
Poorly defined spares and services agreements (for new type of equipment)	30%	$1,000,000	$ 2,000,000	$2,000,000	Inexperience of plant may lead to poor spare selection
Fully defined training requirements for new technologies	20%	$ 300,000	$ 500,000	$ 500,000	Specialist training may only be identified once plant is ordered.

Appendix 3:
Risks - Contingent

			Percentages			
Item	**Annual Consequence**	**Likelihood**	**Min (P10)**	**ML (P50)**	**Max (P90)**	**Comments**
Standards / Design						
Design delays impact project progress	$ 1,000,000	25%	75%	100%	150%	The average capex per year over the regulatory period is approximately $150m. Design is assumed to be 7.5% of this cost, with the consequence of delayed design assessed to be 10% of the design cost ($150m * 7.5% * 10% = $1m).
Political / community						
Change in legislation	$ 1,000,000	5%	50%	100%	200%	Additional expenditure due to changes in legislative requirements. Assessed to represent 1% of annual project expenditure.
Community relationship issues	$ 750,000	15%	25%	100%	150%	Additional expenditure to alleviate community relationship issues relating to project implementation, construction, or location. Assessed to represent 0.5% of annual project expenditure.
ElectraNet						
Small projects left out of scenarios	$ 250,000	20%	50%	100%	150%	Consequence of inadvertantly leaving small projects out of 18 scenarios. Large projects left out/excluded from the scenarios are not considered, as they are captured as contingent projects under the regulatory process.
Additional spares may be required over and above maintenance replacement.	$ 250,000	10%	75%	100%	150%	Consequence of replacing spares over and above planned maintenance requirement – for example a blown transformer. This also represents the probability that new technology and equipment will require additional spares.
Risk of interface risk with existing/legacy systems underestimated	$ 250,000	40%	75%	100%	150%	Consequence of underestimating interface requirements with existing systems (brownfields installations). Assessed to be a high likelihood but a relatively small consequence.
Loss of key personnel (ElectraNet and Contractor)	$ 100,000	10%	75%	100%	150%	ElectraNet has a real turnover of personnel at 10%.
Planning and Environment						
Additional EIS processes	$ 1,000,000	5%	75%	100%	150%	Risk that additional EIS processes are required for the larger projects.

			Percentages			
Item	**Annual Consequence**	**Likelihood**	**Min (P10)**	**ML (P50)**	**Max (P90)**	**Comments**
Conditions of approvals altered	$ 1,000,000	5%	75%	100%	150%	Risk that existing approval conditions/expected approval conditions are altered.
Additional bushfire design requirements	$ 500,000	5%	75%	100%	150%	Risk that continuous improvement of best practice requirements for bushfire resistant designs result in cost increase.
Bushfires delay project	$ 200,000	5%	75%	100%	150%	Risk that bushfires delay projects. Consequence assessed as 1% of annual project expenditure.
Environmental incident in one project	$ 200,000	30%	50%	100%	200%	Risk that an environment incident on one or more projects will require mitigation.
Encountering endangered species	$ 200,000	100%	50%	100%	200%	Risk that unexpected endangered species are encountered requiring modification, or causing delay, to the project design and/or construction.
Heritage/Aboriginal findings	$ 200,000	15%	50%	100%	200%	Risk that finding heritage or Aboriginal items will require modifications, or cause delay, to project construction.
Delivery						
Contaminated site (soil)	$ 1,000,000	5%	50%	100%	200%	Separate to latent conditions, this contingency allows for unexpected contamination of soil due to previous land use.
Contaminated equipment (eg. PCBs in oil)	$ 100,000	25%	50%	100%	200%	Risk that unforeseen contamination of equipment causes additional disposal requirements with brownfields projects.
Delayed deliveries in imported & major equipment items	$ 1,000,000	15%	75%	100%	150%	Risk that delays in imported major equipment items will cause project delays. The average capex per year over the regulatory period is approximately $150m. Procurement of major materials approximately 25% of this cost, with the consequence of delayed delivery assessed to be 3% of the procurement cost ($150m * 25% * 3% = $1m).
Relationship issues with new contractor	$ 50,000	100%	50%	100%	200%	Risk that relationship with current or new contractor causes when current partnering relationship is renegotiated (prior to the reset period).
Encountering unexpected latent site conditions	$ 500,000	80%	75%	100%	150%	Encountering unexpected latent conditions, such as unknown services, or harder or less stable soil. This has a high likelihood, as no geotechnical studies are conducted at the estimating stage.
System constraints on planned outages	$ 100,000	30%	75%	100%	150%	Delays or deferrals of planned outages, due to system constraints, impacting project construction. This risk is relevant

			Percentages			
Item	**Annual Consequence**	**Likelihood**	**Min (P10)**	**ML (P50)**	**Max (P90)**	**Comments**
						to all system related projects.
Industrial Relations issues	$ 200,000	2%	50%	100%	150%	Risk that despite mitigation measures, industrial relations will cause delays to one or more projects.
Contractual / commercial						
Contractor interface	$ 250,000	2%	50%	100%	200%	Risk that interface between ElectraNet and partner contractor, or the contractor and a sub-contractor, will cause delays or variations in project costs. Approximately 60% of the $150M annual capex would be procurement of partner contractor services, with an estimated 5% of contractual variations, 6% of which are attributable to interface issues between ElectraNet and it's partners ($150m * 60% * 5% * 6%).
Contractor insolvency/nonperformance	$ 250,000	5%	50%	100%	200%	Risk that partner contractor, or a sub-contractor, will become insolvent or otherwise fail to perform in accordance with expectations.
Foreign exchange rates	$ 375,000	10%	50%	100%	150%	Risk that foreign exchange movements will be outside the expected ranges. The average capex per year over the regulatory period is approximately $150m. Procurement of major materials is approximately 25% of this cost, with an allowance made for a 10% unfavourable drop in the foreign exchange rate. The consequence of further unfavourable shifts is assessed at 10% error of this amount ($150m * 25% * 10% * 10% = $375,000).
Safety						
Inclement Weather - more than normal	$ 800,000	40%	50%	100%	150%	Risk that more instances of inclement weather than normal impact on the project delivery.

Appendix 4:
Risk Definitions

Risk Item	Definition
Minimum	The minimum value that could reasonably be expected to occur. Used as an input to the risk distribution.
Maximum	The maximum value that could reasonably be expected to occur. Used as an input to the risk distribution.
Mean	The mean value of the risk distribution.
Monte Carlo Simulation	A simulation technique whereby a very large number of random samples are taken and a range of results is obtained. For risk analysis, this involves randomly sampling all of the input distributions and calculating a result to give one simulated result, then re-sampling all of the distributions repeatedly to build up a range of simulated outcomes (the output risk distribution). The random nature of each sample for the Monte Carlo simulation in this report means that there will be a cross-section of project costs from within the defined risk profiles, with some sampled costs being at the higher end of the risk profile, while others will be from the lower end. By assigning no correlation between the risks, the random sampling of this technique treats the different risks as diversifiable.
Most Likely	The most likely value that could reasonably be expected to occur. Used as an input to the risk distribution.
Mode	The most likely value of the risk distribution.
Risk Distribution	The input distribution determined by the minimum, most likely, and maximum values. Also the output distribution determined by the risk simulation model.
P50	The probability that 50% of the time, the out turn cost will not exceed the P50 amount. Typically used as a “most likely” or target cost estimate.
P80	The probability that 80% of the time, the out turn cost will not exceed the P80 amount. Typically used as a budget estimate.
Pert	There are a number of uncertainty distributions that can be applied to the range of expected cost outcomes. The PERT distribution was chosen for the risks in this report. The PERT distribution was created in the late 1950’s by the US Navy to provide insight as to the likely time to complete major capital projects, and is also applicable to the likely cost to complete these projects. The minimum value in a PERT distribution is the minimum value that could be reasonably expected to occur, with the maximum value providing the upper bound of the range of values which could be reasonably expected to occur. The most likely value in the PERT distribution is the value which has the highest probability of occurrence (ie. the value that is most likely to occur). For the purposes of this analysis, the base estimate for each project is considered to be the value which is most likely to occur. The PERT distribution emphasizes the "most likely" value over the

	minimum and maximum estimates and constructs a smooth curve that places progressively more emphasis on values near the most likely value, in favour of values at the extremes. In practice, this means that the expected outcome is weighted toward the most likely value. Even if it is not exactly accurate (as estimates seldom are), there is an expectation that the resulting value will be close to that estimate. This means that the PERT distribution is implicitly conservative (i.e. optimistic) in determining the likely final cost outcome. This implicit conservatism provides the appropriate driver to ensure that prudent project management and control is essential to mitigate cost overrun, and is therefore an appropriate distribution to apply to ElectraNet's regulatory situation.
Portfolio Effect	A portfolio of projects such as ElectraNet's capital works program will have a combined level of risk which is less than the arithmetic sums of the risks for the component projects. For example, the probability of five projects, assuming no correlation between projects, being completed at a cost in the top 35% of the estimated range is: 35% x 35% x 35% x 35% x 35% = 0.5%. This is much less than the 35% likelihood that a single project will be completed in the top 35% of the estimated range. The corollary of this is that a portfolio manager can have a lower overall "contingency provision" that is smaller than the arithmetic sum of the contingencies required for individual projects, while still having sufficient contingency for each project. The concept of using a risk distribution for each project supersedes the requirement for a prudent business owner to allow for contingency, as the risk distribution considers the likely range of cost outcomes for a particular project. The impact of the portfolio effect on capital expenditure over the regulatory period can be calculated by the use of Monte Carlo simulation techniques. By conducting repeated random samples of each project, and adding these samples together, the expected risk distribution of the final capital works cost can be established.