

**BIRMINGHAM CITY  
COUNCIL**

A452 Chester Road Improvements

Quantified Risk Assessment

August 2011



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## **1.0 INTRODUCTION**

- 1.1 Faithful+Gould have been commissioned by Birmingham City Council to undertake an update of the Quantified Risk Assessment associated with the A452 Chester Road Improvements project. The following is an explanation of the QRA process with the results being found in Appendix A.

## **2.0 PART ONE**

- 2.1 In order to adjust the base cost for the risks associated with the cost of the scheme, a Quantified Risk Assessment (QRA) has been undertaken for this scheme. It is based on the DfT prescribed four step process including:
- a) Risk identification
  - b) Assessing the impacts of risk to determine possible outcomes
  - c) Estimating the likelihood of the possible outcomes occurring; and
  - d) Deriving the probability distribution and expected value of the costs of the scheme
- 2.2 The first three steps have been incorporated into the overall process by developing a Risk Register which has then run through a Monte Carlo Assessment. The following sections discuss this in greater details.

### **RISK REGISTER**

- 2.3 The key elements of the risk management process is the preparation of a risk register which gives an overview of risks facing a scheme at a particular stage of development. The Risk Register lists any identified risks that are likely to affect the delivery and operation of the scheme.
- 2.4 The risk register for the scheme has identified all potential risks under the main classification of Design, Construction, Finance, Commissioning and Operations. It also identifies the possible impact of the identified risk on the final cost of the scheme and/or the timescale for completion. The risk register has also identified the way the risk is proposed to be managed including who owns the identified risk and where possible, to who is the risk transferred. This is based on the professional experience of specialist consultants who have relevant expertise in facilitating a risk identification exercise in consultation with BCC.
- 2.5 Having identified risks the risk register has assessed the impact of each risk, or combination of risks, should they be realised. This quantitative assessment is based on the cost outcomes of the risk considering both the upper and lower extremes of the possible range, taking into account any reasonable constraints. To assess this empirical evidence is used wherever possible along with the professional experience of specialist consultants.
- 2.6 Having identified the risks and having assessed the potential range of cost outcomes, the likelihood of occurrence for each of the possible outcomes was assessed. This was based on experience of past events, taking account of any foreseeable changes or developments.

## 2.0 QUANTIFIED RISK ASSESSMENT (Continued)

### QUANTITATIVE COST RISK ANALYSIS

- 2.7 Following the risk identification exercise a Monte Carlo type Quantitative Cost Risk Analysis (QCRA) model was constructed to give a full understanding of the risk exposure during the project.
- 2.8 QCRA is an analytical simulation technique used to determine the combined outcome of risk and uncertainty. Costs are uncertain and deterministic values will never be 100% correct. QCRA explicitly recognises the uncertainty that surrounds the input variables and models the situation.
- 2.9 In decision making, probability acts as a substitute for certainty, so the output is frequently represented as a cumulative probability curve, which provides the full range of confidence levels in the potential cost impact.
- 2.10 The impact assessment for each risk was in the form of a 3 point estimate. That is the minimum, most likely and maximum impacts that each specific risk will have on the project cost should it occur.
- 2.11 The QCRA was undertaken using @RISK software. Once the software has been run the results are plotted in an S Curve graph from which the percentiles can be read off to produce the P Levels. For example for the 80 percentile (£401,899), it is probable that there is an 80% risk that the contingency required for the project would fall at or below said amount.

### RISK ADJUSTED COST ESTIMATES

- 2.12 The mean of the results is the value in the middle of the range of results obtained from the QCRA. As shown in the results, in this case £315,727 is the mean risk modelled for the scheme. It is this value which has been included in the estimates for risk and to derive the risk adjusted costs.
- 2.13 The risk adjusted costs has therefore been estimated at £9.2m. Total costs including the adjustment for risk is as summarised in the table below.

Summary of Risk Adjusted Costs

Element	Estimate (£)
Land Purchase	165,000
Statutory Utilities	3,002,179
Works Contract including works related contingency @10% of works costs	4,752,054
Professional Fees-Preparation	581,568
Professional Fees-Supervision	387,711
Risk (Mean)	315,727
Total	9,204,239

### 3.0 APPENDICES

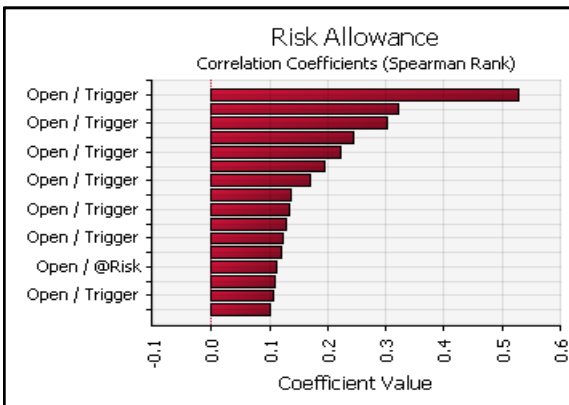
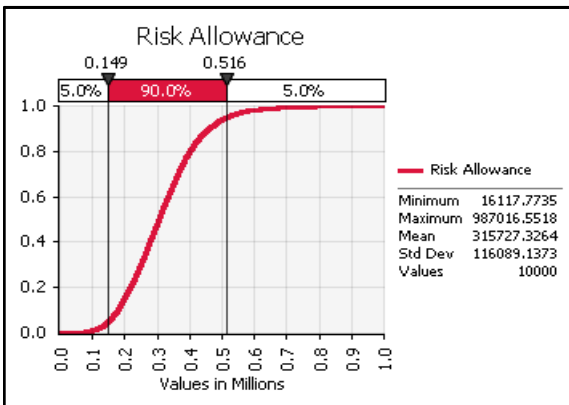
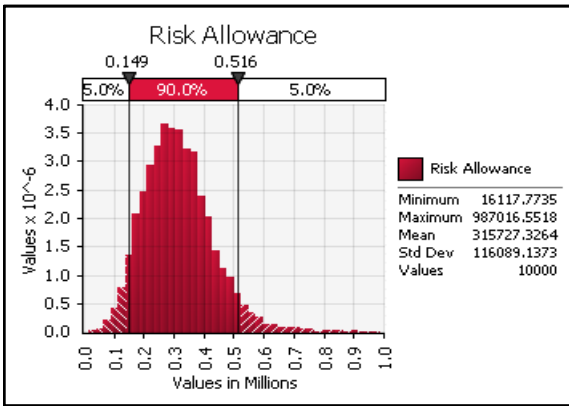
APPENDIX A - QRCA RESULTS

## **Appendix A QRCA Results**

# @RISK Output Report for Risk Allowance

Performed By: vija1684

Date: 18 August 2011 17:44:26



## Simulation Summary Information

Workbook Name	QRA Chester Rd Risk Register 160811 (Risk Copy) MM Amended.xls
Number of Simulations	1
Number of Iterations	10000
Number of Inputs	179
Number of Outputs	4
Sampling Type	Latin Hypercube
Simulation Start Time	8/18/11 17:43:20
Simulation Duration	00:00:28
Random # Generator	Mersenne Twister
Random Seed	504669276

## Summary Statistics for Risk Allowance

Statistics	Value	Percentile	Value
Minimum	£16,118	5%	£149,363
Maximum	£987,017	10%	£178,223
Mean	£315,727	15%	£198,759
Std Dev	£116,089	20%	£217,669
Variance	13476687809	25%	£234,547
Skewness	0.818582827	30%	£250,533
Kurtosis	4.70028442	35%	£264,548
Median	£306,010	40%	£277,888
Mode	£268,430	45%	£291,463
Left X	£149,363	50%	£306,010
Left P	5%	55%	£319,417
Right X	£515,795	60%	£333,864
Right P	95%	65%	£350,054
Diff X	£366,432	70%	£364,673
Diff P	90%	75%	£381,323
#Errors	0	80%	£401,899
Filter Min	Off	85%	£426,524
Filter Max	Off	90%	£462,254
#Filtered	0	95%	£515,795

## Regression and Rank Information for Risk Allowa

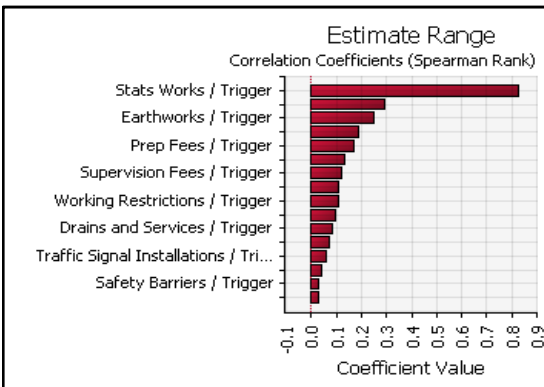
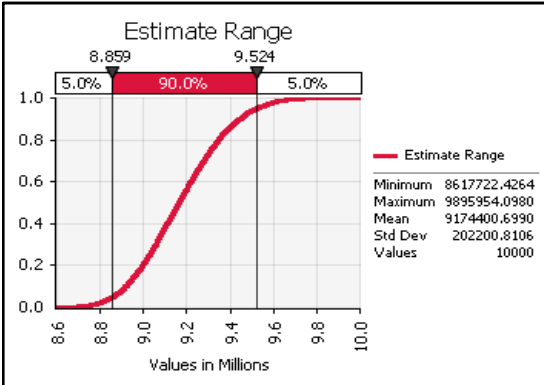
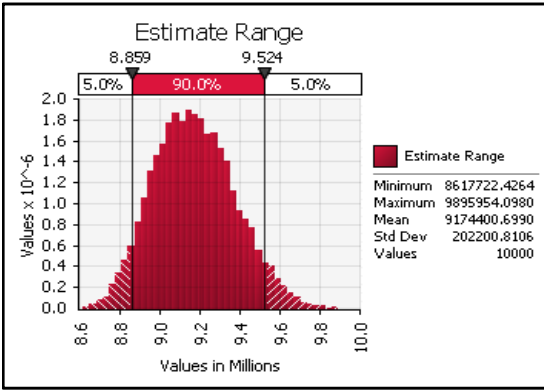
Rank	Name	Regr	Corr
1	Open / Trigger	0.465	0.529
2	Open / Trigger	0.426	0.301
3	Open / Trigger	0.310	0.323
4	Open / Trigger	0.229	0.245
5	Open / Trigger	0.202	0.222
6	Open / Trigger	0.175	0.194
7	Open / Trigger	0.160	0.171
8	Open / Trigger	0.142	0.120
9	Open / Trigger	0.139	0.130
10	Open / Trigger	0.126	0.111
11	Open / Trigger	0.123	0.136
12	Open / Trigger	0.118	0.135
13	Open / @Risk	0.110	0.106
14	Open / Trigger	0.107	0.109



# @RISK Output Report for Estimate Range

Performed By: vija1684

Date: 18 August 2011 17:44:25



## Simulation Summary Information

Workbook Name	QRA Chester Rd Risk Register 160811 (Risk Copy) MM Amended.xls
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Random # Generator	Mersenne Twister
Random Seed	504669276

## Summary Statistics for Estimate Range

Statistics	Value	Percentile	Value
Minimum	£8,617,722	5%	£8,858,523
Maximum	£9,895,954	10%	£8,917,587
Mean	£9,174,401	15%	£8,959,740
Std Dev	£202,201	20%	£8,996,258
Variance	40885167804	25%	£9,028,151
Skewness	0.222708662	30%	£9,057,856
Kurtosis	2.743441777	35%	£9,083,456
Median	£9,165,028	40%	£9,110,825
Mode	£9,060,437	45%	£9,137,967
Left X	£8,858,523	50%	£9,165,028
Left P	5%	55%	£9,192,410
Right X	£9,523,974	60%	£9,220,245
Right P	95%	65%	£9,248,991
Diff X	£665,451	70%	£9,279,376
Diff P	90%	75%	£9,311,563
#Errors	0	80%	£9,347,117
Filter Min	Off	85%	£9,389,468
Filter Max	Off	90%	£9,445,457
#Filtered	0	95%	£9,523,974

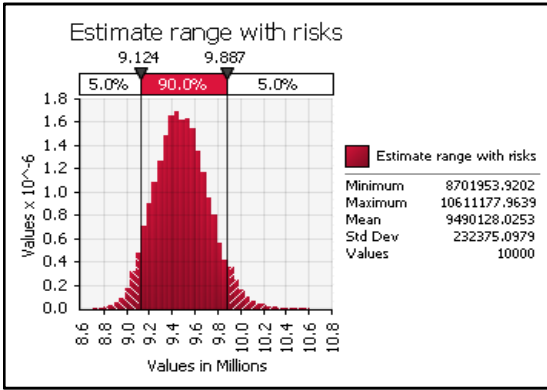
## Regression and Rank Information for Estima

Rank	Name	Regr	Corr
1	Stats Works / Trigg	0.821	0.828
2	Prelims/TM (33%	0.297	0.292
3	Earthworks / Trigg	0.255	0.248
4	Carriageway / Trigg	0.188	0.169
5	Prep Fees / Trigg	0.184	0.186
6	Contingency (10%	0.140	0.131
7	Supervision Fees	0.112	0.106
8	Misc Works (10%	0.106	0.119
9	Working Restricti	0.097	0.096
10	Kerbs Footways /	0.090	0.110
11	Drains and Servid	0.080	0.083
12	Lighting / Trigg	0.072	0.070
13	Traffic Signal Inst	0.067	0.060
14	Land / Trigger	0.043	0.031

# @RISK Output Report for Estimate range with risks

Performed By: vija1684

Date: 18 August 2011 17:44:29

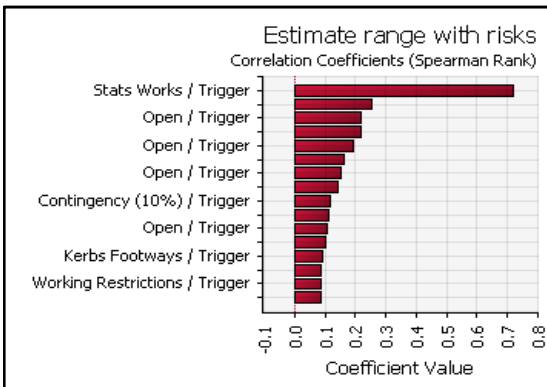
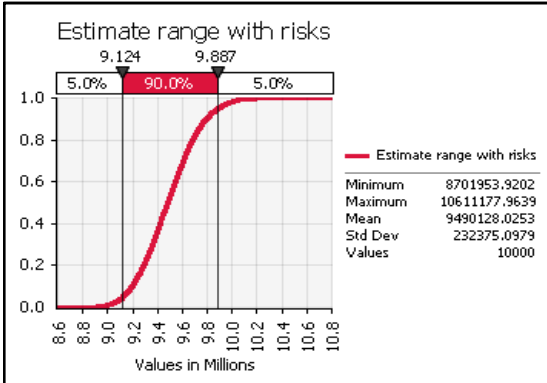


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Random # Generator	Mersenne Twister
Random Seed	504669276

## Summary Statistics for Estimate range with risks

Statistics	Value	Percentile	Value
Minimum	£8,701,954	5%	£9,123,790
Maximum	£10,611,178	10%	£9,194,875
Mean	£9,490,128	15%	£9,246,446
Std Dev	£232,375	20%	£9,288,986
Variance	53998186108	25%	£9,327,353
Skewness	0.211453417	30%	£9,362,529
Kurtosis	2.993474264	35%	£9,392,517
Median	£9,482,275	40%	£9,422,236
Mode	£9,430,159	45%	£9,451,741
Left X	£9,123,790	50%	£9,482,275
Left P	5%	55%	£9,513,099
Right X	£9,886,571	60%	£9,543,501
Right P	95%	65%	£9,576,192
Diff X	£762,781	70%	£9,607,745
Diff P	90%	75%	£9,642,536
#Errors	0	80%	£9,684,137
Filter Min	Off	85%	£9,732,971
Filter Max	Off	90%	£9,790,878
#Filtered	0	95%	£9,886,571



## Regression and Rank Information for Estimate range with risks

Rank	Name	Regr	Corr
1	Stats Works / Trigger	0.712	0.719
2	Prelims/TM (33%)	0.254	0.255
3	Open / Trigger	0.231	0.220
4	Earthworks / Trigger	0.221	0.217
5	Open / Trigger	0.212	0.191
6	Carriageway / Trigger	0.163	0.144
7	Open / Trigger	0.158	0.161
8	Prep Fees / Trigger	0.155	0.152
9	Contingency (10%)	0.125	0.118
10	Open / Trigger	0.114	0.107
11	Open / Trigger	0.101	0.112
12	Supervision Fees	0.098	0.089
13	Kerbs Footways / Trigger	0.094	0.101
14	Misc Works (10%)	0.087	0.087

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