

Memorandum

To John McCarthy

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From s 9(2)(a)

Office Hamilton Office

Date 24 May 2019

File

Subject Baypark to Bayfair Link (Bay Link) project. MGI Underpass – Cost Estimate/Verification

1 Overview:

WSP|OPUS was requested by the NZ Transport Agency to provide a cost estimate/verification for the construction of a new underpass connecting Matapihi Road and Bayfair Shopping Centre as part of the Baypark to Bayfair Link (Bay Link) project. The existing underpass was due to be closed permanently as part of the Bay Link project. The main purpose of the new underpass is to provide an alternative and safer option for people walking or cycling to cross State Highway 2. Instead of crossing at ground level through the centre of the new Bayfair roundabout using the pedestrian crossings at the traffic lights, pedestrians and cyclists will now be able to use the new underpass once completed.

CPB Contractors have been awarded the contract to build the second, and final, phase of the project, which also includes two flyovers. The new underpass will be constructed alongside the old underpass and once the new underpass is operational the old underpass will be infilled to accommodate the weight of the new Bayfair flyover approach ramps.

The Cost Estimate and associated risk profile was based on the following information provided by CPB contractors and Beca consultants:

- 50% Design Drawings;
- Pricing package information sheets (Drainage, Structural, Roading, Urban Design and Geotechnical); and
- Schedule of Quantities (SoQ).

Despite the limited information provided, the Schedule of Quantities supplied by CPB was adopted and consistently used to calculate the base cost across all pricing packages.

Uncertainty in the final design and construction programme for the project, will also result in uncertainty in the total estimate value. Therefore, in the absence of a detailed design and construction programme, the following list of assumptions were used to inform this estimate and risk profile:

- Construction duration – 12 months;
- Exclusion of any programme delays (time variable costs) associated with the repair or replacement of the Chorus Fibre Cable;
- Contractor inefficiencies;
- Client instructions that could significantly extend/delay the programme;
- Potential Contractor Claims and Variations;
- No significant objections from stakeholders including Tauranga Airport;
- Natural lightwells to the main structure excluded;

- No significant geotechnical slope movements; and
- Design Assumptions as listed in each of the Pricing Packages provided.

As part of the cost estimate and verification process that was conducted on the Schedule of Quantities (SoQ), the following queries require further clarification:

- Drainage 8.37: SoQ = 1,224. Verification calculation is 1,328;
- Drainage item 2.03 listed as 1.5 to 3.0m deep. Drawing shows 3.0-4.5m deep;
- We have accepted the area of temporary sheet piling due to lack of information. The scheduled quantity appears to be appropriate as a base; and
- Gantry G04 is scheduled. The drawings show a second, G05. Clarification is required as to which, if any, of G04 and/or G05 are required in this SoQ.

Due to the level of design conducted to date, items were identified as missing from the schedule. These have been included in our estimate. Items include:

- Environmental Compliance costs;
- Allocation for temporary traffic diversions:
 - Pavement;
 - Drainage;
 - Lighting; and
 - Removal of aforementioned items.
- Transitions of concrete barriers: We have priced TL5 to Thrie Beam transitions, Thrie to TL3 transitions and leading and trailing ends as appropriate. Alternatively TAU-11 crash cushion instead of transition to leading terminal (at six times the price);
- Non return valves in the pumping station; and
- Telemetry in the pumping station.

It should be noted the following costs have been excluded:

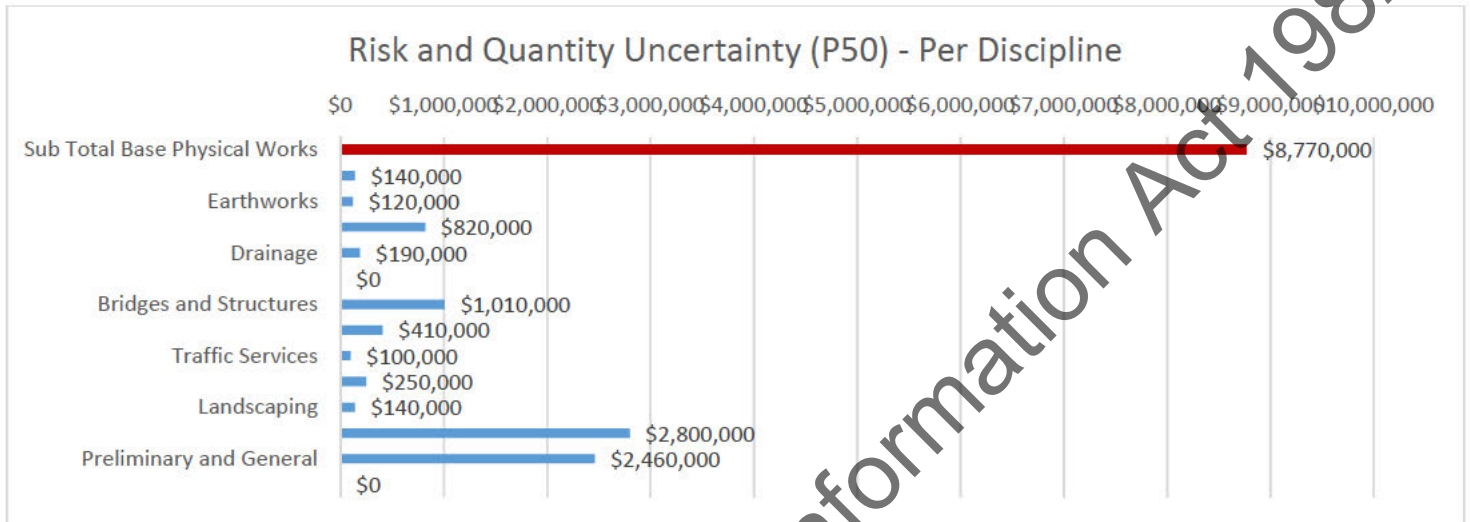
- Client related costs
- Consultancy Fees
- Design Fees
- Consent Monitoring Fees
- Property acquisition costs

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2 Risks, issues and uncertainty:

Confining the risk assessment to matters outside the base estimate is unrealistic and not best practice. Therefore, the risk analysis was divided into the following subcategories, which cumulatively represent the risk profile and total risk-based contingency for the project:

- Rate and Quantity Uncertainty in base estimates; and
- Residual risks.

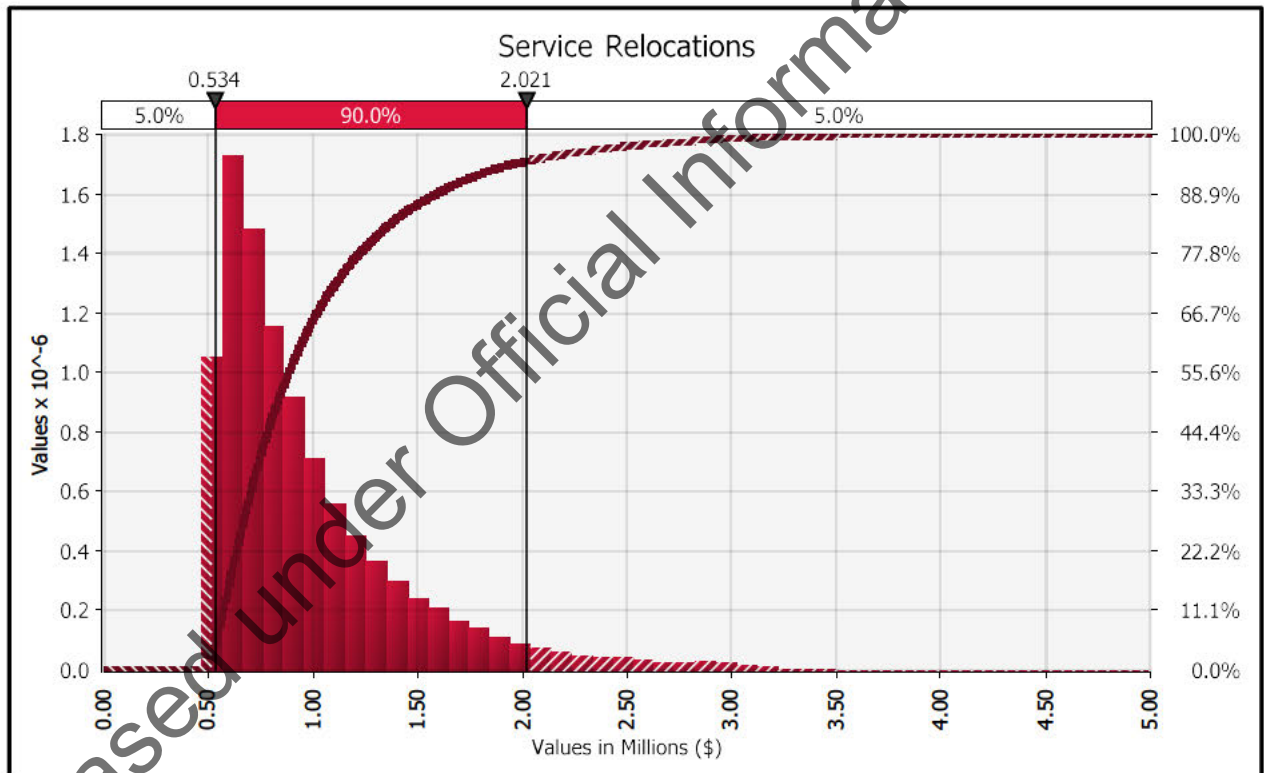


Note: The minor difference in the 'Sub Total Base Physical Works' totals for the above two charts are due to the rounding of values during the different calculation stages

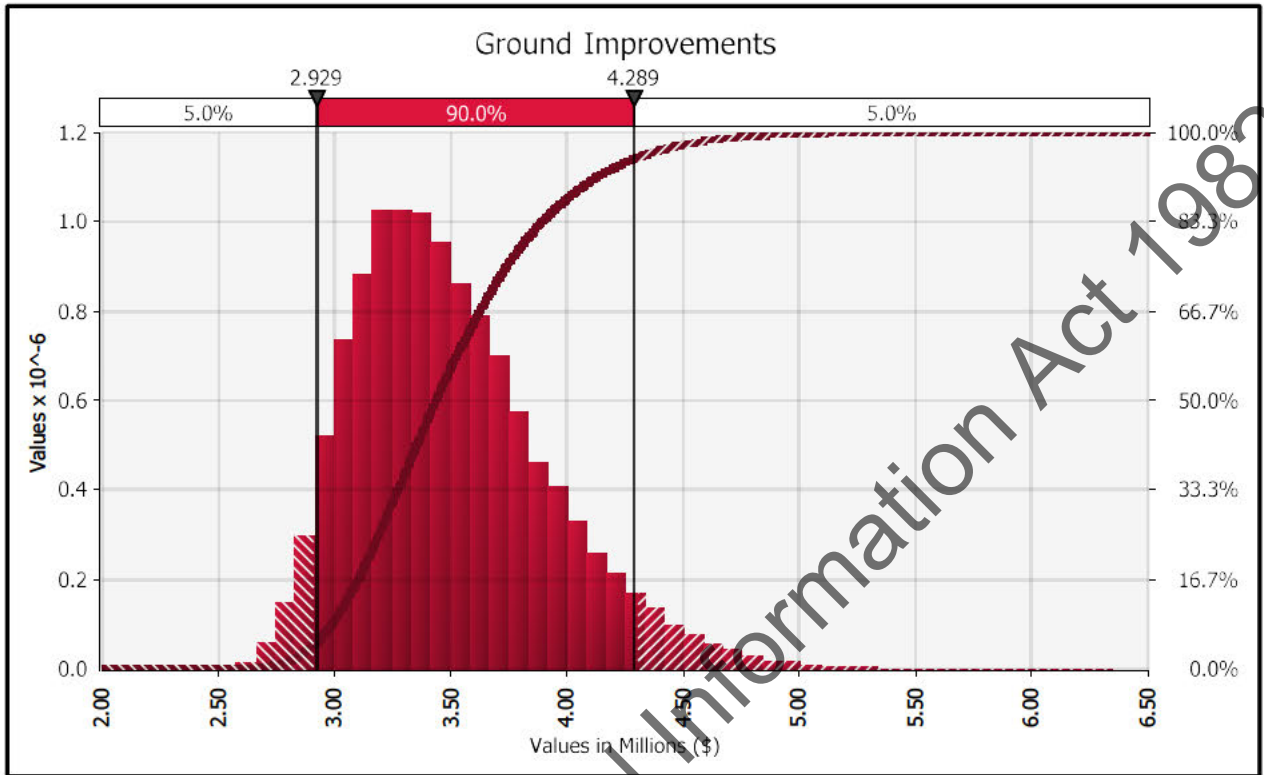
2.1 Rate and Quantity Uncertainty

From our detailed analysis, the items with the biggest variances compared to base cost can be summarized as follows. These estimates are reflective of the limited information, level of design detail completed to date, limited survey information, potential departures and Design Assumptions listed in the Pricing Packages Information sheets provided and associated with each of the individual elements of work.

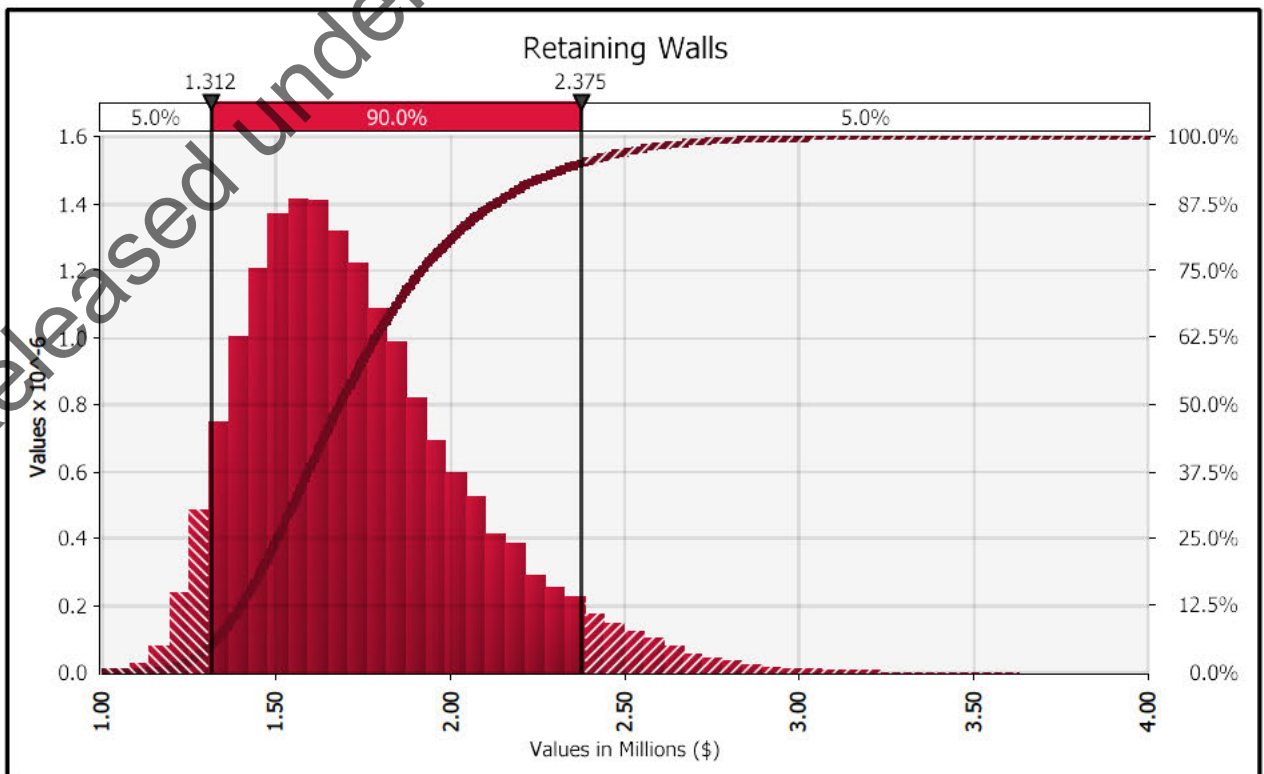
- Services:
 - Fibre
 - *Diversion of 1200 pair fibre line*
 - Water Mains
 - *Pipe sizes: are they 200mm or 700mm watermains, temporary and permanent diversions*
 - Underground Power
 - *Too many joints could require a complete replacement cable*



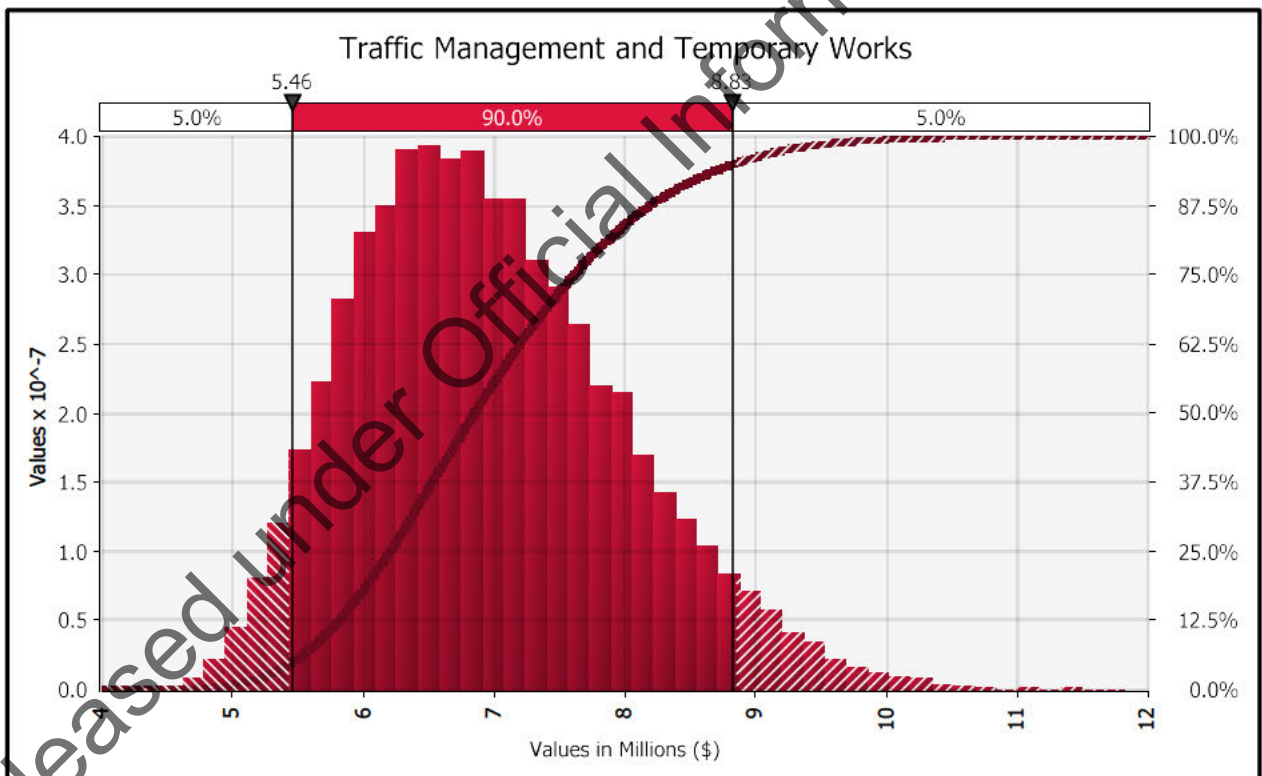
- Ground Improvements
 - Stone columns
 - *Ground conditions require deeper columns.*



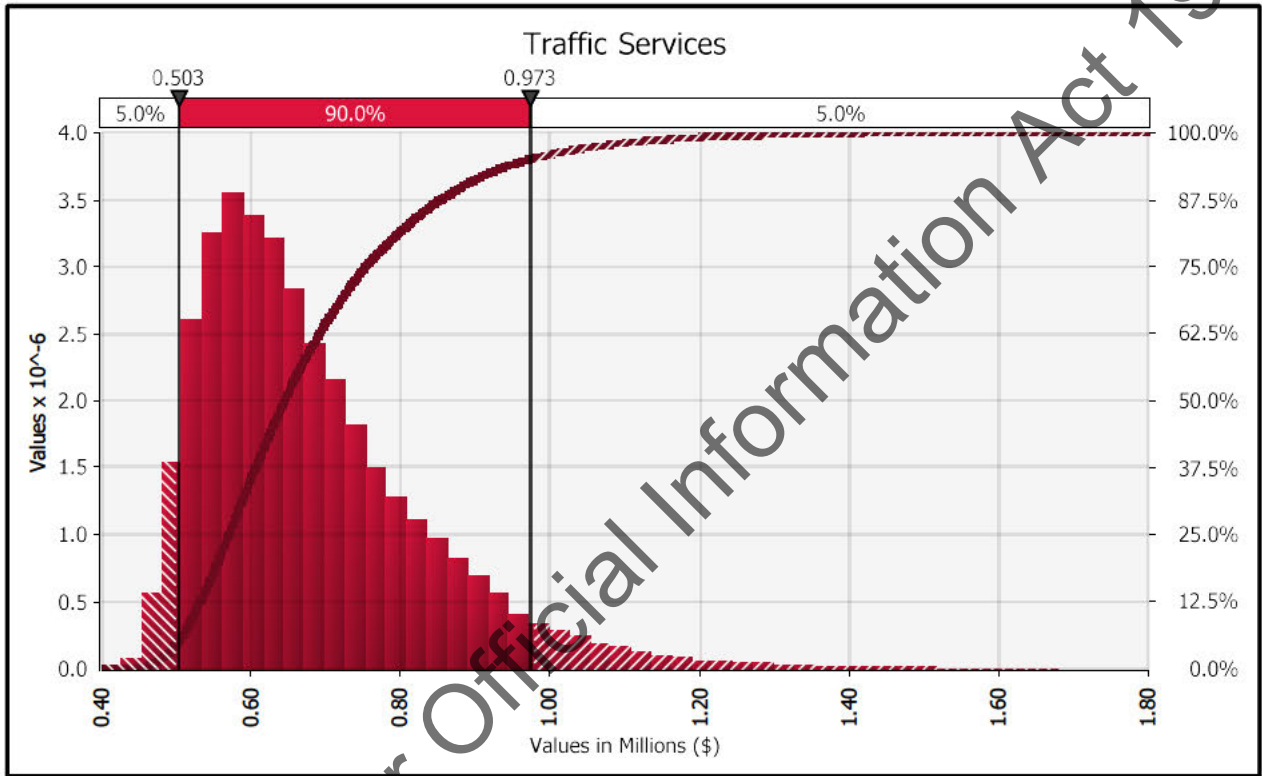
- Retaining Walls
 - Permanent sheet piling
 - *Height restrictions may cause more time intensive installation process (initial trenching, use of excavators to conduct initial driving etc.)*



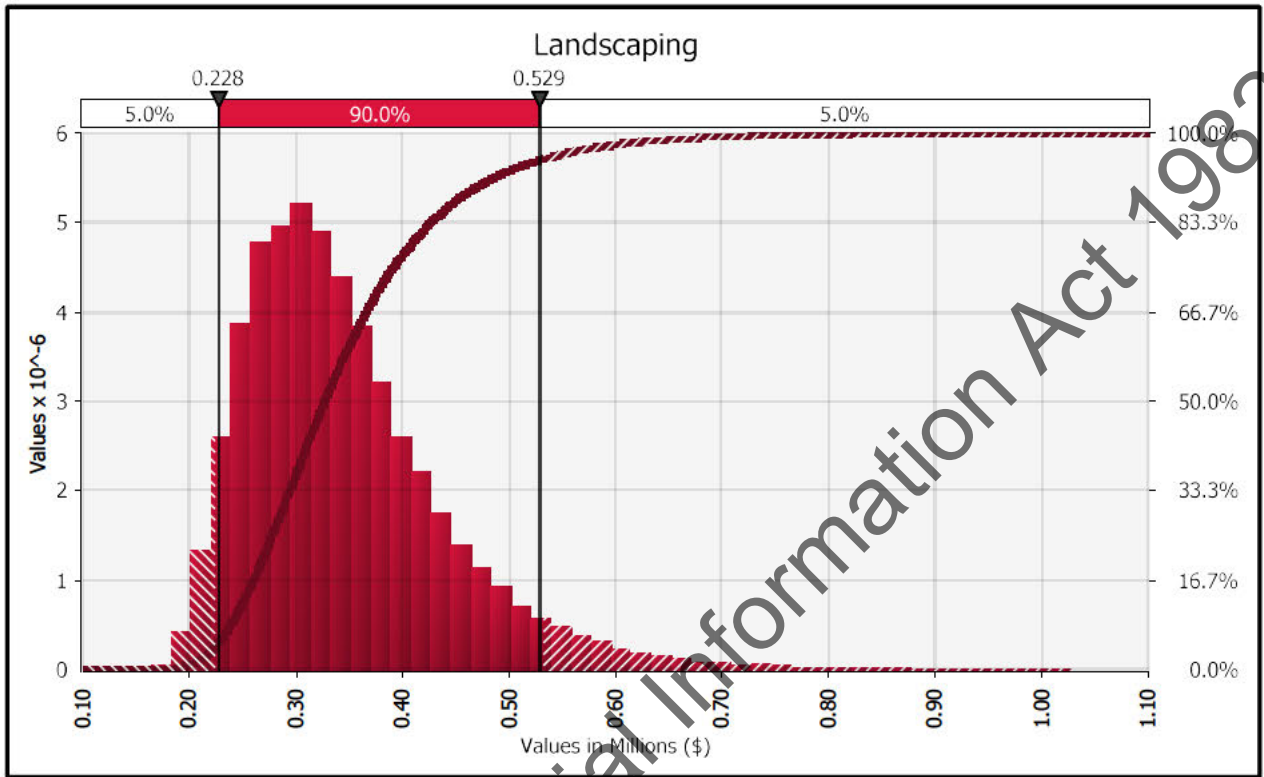
- Traffic Management and Temporary Works
 - Temporary Works
 - Only temporary works listed in the schedule as well as minor items identified as missing in the schedule have been priced. Construction methodology needs to be determined to ascertain the true cost associated with this element of the works for example but not limited to: The exact mechanism and process to connect the existing underpass with the new underpass for pedestrian transition during construction. The uncertainty associated with the value of required temporary works are estimated to be millions of dollars.
 - Sheet pile quantities, constructability and phasing uncertain.
 - Temporary Traffic Management
 - Programme sequencing and change in regulations and standards to be confirmed.
 - Temporary pavement, drainage and lighting
 - Sequencing details to be confirmed, depth of excavations



- Traffic Services:
 - G04 and G05 gantries
 - Clarification required as to whether both gantries are required as part of the underpass project or whether they are only related to the main B2B construction works.
 - Lighting options
 - Details for the underpass and ramps, especially around the hand rails to be confirmed.



- Landscaping and Urban Design
 - Retaining wall relief patterning
 - Clarification on exactly what is required i.e. painted / blasted pattern vs custom moulds.



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2.2 Residual Risks - Qualitative Assessment

The qualitative risk review with associated risk register was based on the following risk breakdown structure:

- Constructability;
- Costing;
- Design Development;
- Health and Safety;
- Production;
- Regulatory delays;
- Remedial works;
- Stakeholders/3rd parties;
- Temporary works;
- Utilities; and
- Vibration/Noise/Pollution.

Risk Matrix

		THREAT					
		Insignificant	Minor	Moderate	Severe	Extreme	Risk Spread
L i k e l i h o o d	Almost certain				1		5 Critical
	Likely		2	1	1		4 High
	Possible			1	5		3 Medium
	Unlikely		2	4	5		2 Low
	Rare				1		1
		1	2	3	4	5	

From a qualitative risk perspective, it is evident that there is a significant amount of uncertainty associated with the following items:

- Underground utilities;
- Design Development across all packages;
- Temporary works; and
- Inefficient phasing of works.

2.3 Quantitative Assessment (Residual Risks)

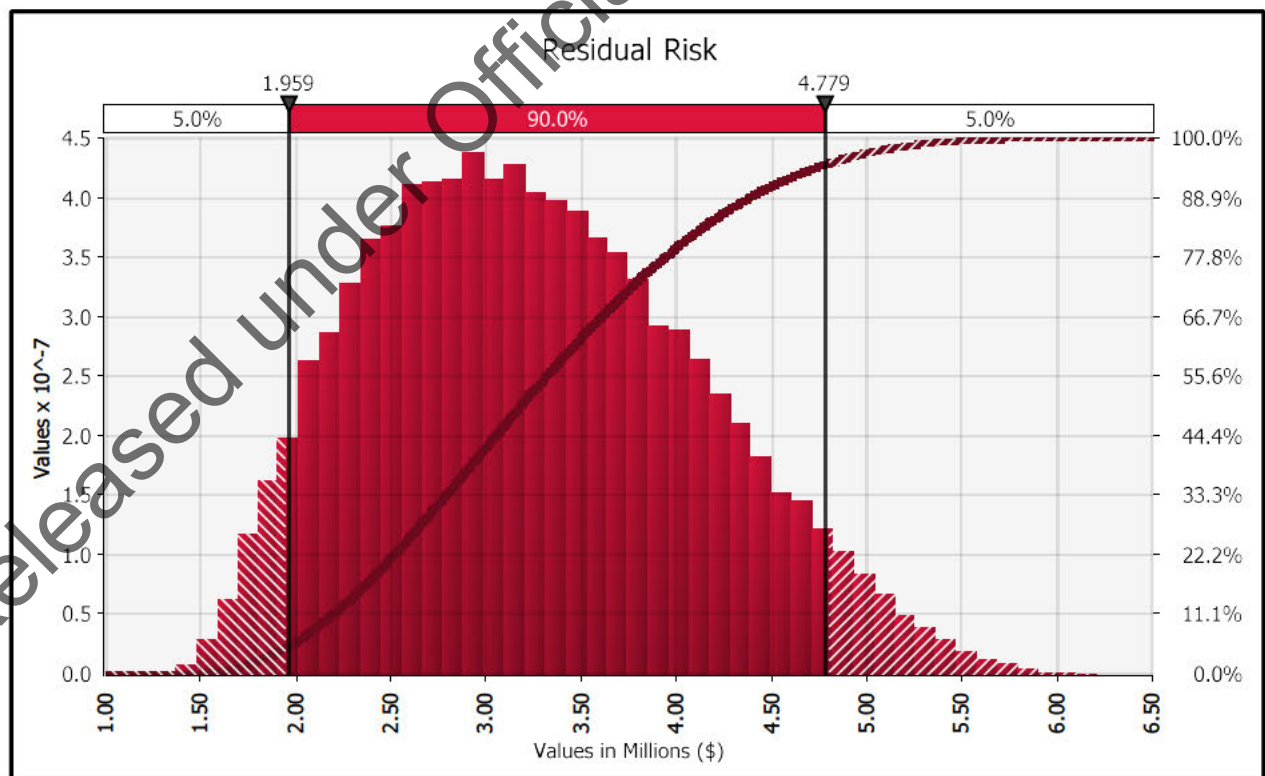
2.3.1 Schedule Delays – Time Variable Cost

A typical quantitative schedule and cost risk analysis (QCSRA) assesses uncertainty from both a direct and time variable cost perspective. Time variable delays are more complex to assess, due to the inherent correlation between time and time related costs associated with cost items such as labour, plant, equipment and overall time related overhead costs by both the contractor, client and client consultants. To fully understand and assess the time variable delay, it is critical to understand the impact of such a potential delay on the critical path of the schedule.

This is furthermore complicated by schedule logic, activity linkages, the number of activities and constraints embedded in the schedule that require specialist schedule risk assessment software such as Primavera Risk Analysis or Acumen Fuse. These software solutions carry out detailed schedule integrity checks to ensure the schedules are robust from a technical scheduling perspective, before carrying out a detailed uncertainty and opportunity analysis as identified by the project team.

Without a project schedule from CPB, time related risks can only be assessed at a high level to establish concurrency of events and therefore ignores the cumulative impact that time related risks and uncertainty could potentially have on the construction of the underpass. We therefore recommend that time related risks and opportunities are assessed in the context of concurrency, as this could undoubtedly lead to double counting and overestimation of costs.

Inevitably this may lead to over or underestimation of time related risks on the project. This is problematic from a cost and risk estimating perspective, as time related risks are typically more 'expensive' or higher value cost items. Based on the limited schedule information available the quantitative results as captured in the project risk register can be summarised as follows:

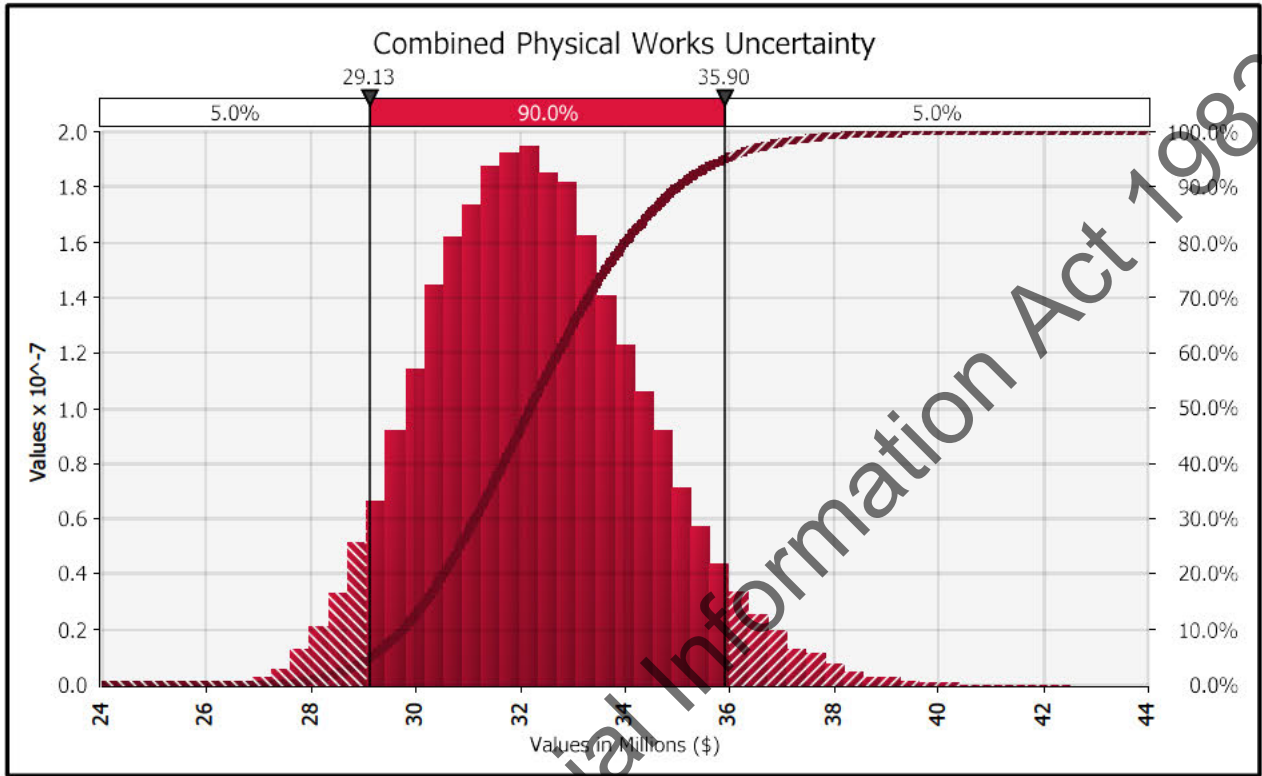


A cumulative delay of circa 3 months has been identified as part of the quantitative schedule risk analysis. This would result in additional time variable costs for contractor P&Gs, consultant and client costs.

2.3.2 Direct Cost Impacts

Direct costs are relatively easy to assess and ignores time variable cost elements such as client, contractor and consultant costs associated with risks and issues.

Based on the risks identified in the risk register the analysis produced the following results:



It is clear from the analysis that the limited information resulted in large cost uncertainty in the project.

3 Percentile Values - P5/P50/P95

3.1.1 Base/Rate and Quantity Uncertainty/Residual Risks

The base estimate is our estimate produced before project risk is considered. This provision will be integrated with a wider consideration of risk as mentioned above to understand the uncertainty in the total cost.

Quantified impacts are added to the baseline costs to estimate a new, risk-adjusted, final cost. Impacts are quantified with probability distributions that, in turn, produce probability distributions of results.

Description	Base Estimate	5th %	50th %	95th %
Total Project Cost	\$23,436,050	\$32,100,000	\$35,460,000	\$39,420,000

4 Recommended 'Way Forward'

To further reduce current project cost estimation uncertainty, it is our recommendation that the following supplementary analysis, workshops and information be provided:

- Risk and construction workshops;
 - Including Temporary works requirements
- Consider acceleration of design;
- Schedule Risk Analysis (Primavera Risk Analysis) on the P6 schedule
- P6 Schedule
- Detailed Utility/service information and surveys;

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5 Project Cost Summary

Project Estimate			PE1		
Project name: Bayfair to Baypark Underpass			Pre-Implementation Estimate		
Item	Description	Base Estimate	Contingency	Funding Risk	
A	Nett Project Property Cost	0	0	0	
	Project Development Phase				
	- Consultancy Fees				
	- Client Managed Costs				
B	Total Project Development				
	Pre-Implementation Phase				
	- Consultancy Fees				
	- Client Managed Costs				
C	Total Pre-implementation	0		0	
	Implementation Phase				
	Implementation Fees				
1.1	- Consultancy Fees				
1.2	- Client Managed Costs				
1.3	- Consent Monitoring Fees				
	Sub Total Base Implementation Fees	0	0	0	
	Physical Works				
1	Environmental Compliance	250,000			
2	Earthworks	719,727			
3	Ground Improvements	2,623,972			
4	Drainage	914,737			
5	Pavement and Surfacing	0			
6	Bridges and Structures	6,039,841			
7	Retaining Walls	1,286,901			
8	Traffic Services	555,822			
9	Service Relocations	590,000			
10	Landscaping	191,462			
11	Traffic Management and Temporary Works	4,066,329			
12	Preliminary and General	6,197,261			
13	Extraordinary Construction Costs	0			
	Sub Total Base Physical Works	23,436,050	3,190,000	3,960,000	
D	Total construction	23,436,050	3,190,000	3,960,000	
E	Project base estimate (A+C+D)	23,436,050			
F	Contingency (Assessed/Analysed)	(A+C+D)	3,190,000		
G	Project expected estimate (E+F)		35,460,000		
	Nett Project Property Cost Expected Estimate		0		
	Project Development Phase Expected Estimate		0		
	Pre-implementation Phase Expected Estimate		0		
	Implementation Phase Expected Estimate		26,626,050		
H	Funding risk (Assessed/Analysed)		(A+C+D)	3,960,000	
I	95th percentile Project Estimate		(G+H)	39,420,000	
	Project property cost 95th percentile estimate			0	
	Investigation and reporting 95th percentile estimate			0	
	Design and project documentation 95th percentile estimate			0	
	Construction 95th percentile estimate				
	Date of estimate	22/05/2019	Cost Index (Qtr/Year)	01/19	
	Estimate prepared by	Simon Drummond	Signed		
	Estimate internal peer review by	Robin Garrett	Signed		
	Estimate external peer review by		Signed		
	Estimate accepted by the NZTA		Signed		

Note: (1) These estimates are exclusive of escalation and GST.

6 Project Risk Register

Risk description:						
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Con "If the then f conse
21	Threat	Structural	Constructability	Inability to find a suitable supplier to pre-cast and supply the 400mm thick concrete walls for the underpass	Quality and constructability concerns	- Redes in-situ c
2	Threat	Structures	Design development / optimisation	<p>Design development / optimisations to structures package:</p> <ol style="list-style-type: none"> 1. Footbridge currently unable to accommodate dead load of 400 dia. bundled cables (weight and headroom) 2. Bayfair end retaining wall extension beyond boundary 3. Movement joints demand might influence water tightness 4. Post tensioning stress design exceeded 5. Ground anchors at approach ramps for buoyancy effects 6. Slope displacement effects on structure have not been assessed as adequate for 50% design stage (high risk) 7. Fill material behind box or ramp might not met settlement requirements 	- Drainage design based on assumptions (50%)	<ol style="list-style-type: none"> 1. Footb increas 2. Rede potenti cost 3. Rede potenti cost 4. Rede potenti cost 5. Rede potenti cost 6. Rede potenti cost 7. Rede potenti cost

Risk description:							Risk profile assuming generally accepted controls and principles are in place for applicable design / construction stage design:						
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Consequences "If the event occurs, there will be the following consequence(s)..."	Risk Owner	Likelihood (%)	Cost Impact	Schedule Impact	Reputational Impact	Score	Assumptions applied to risk quantification / qualitative ranking
1	Threat	Utilities	Utilities	Potential unidentified / unforeseen utility constraints: - Fibre (1,200 fibre main trunk) - Telecom - Gas - Power - Water - Storm water - Railway	- Global assumption that all utilities can be moved / protected to accommodate the overall design during construction.	- Significant construction delays / sequencing - Additional design changes	Contractor	3. Medium (55%)	4. High	5. Very High	4. High	15	Direct Cost: - Additional plant and labour Schedule delay: - Implementation of additional works - Contractor P&G's
4	Threat	Geotechnical	Design development / optimisation	Design development / optimisations to structures package: - Changes to retaining wall geometry - Design development / optimisations to ground improvement package	- Status of design (50%) - Design based on assumptions	- Additional ground improvements	Contractor	4. High (85%)	3. Medium	3. Medium	2. Low	12	Direct cost: - Materials and labour - Additional design / design optimisation costs Schedule Delay: - Implementation of additional work - Contractor P&G's
6	Threat	Constructability	Temporary works	Inability to define scope of works and associated cost for temporary works: - Excavation in loose sand (sheet piling and dewatering) - Formworks	- Undefined temporary works requirements - No allowance for any temporary works - Constructability / sequencing of works - Safety	- Construction delays / sequencing - Constructability constraints	Contractor	3. Medium (55%)	4. High	3. Medium	2. Low	12	Direct Cost: - Additional design / design optimisation costs Schedule Delay: - Implementation of additional work - Contractor P&G's
7	Threat	Constructability	Vibration / noise / pollution	Potential damage to adjacent properties from vibration	- Cut off wall installation along boundary - Stone column installation	- Damage claims - Reputation	Contractor	3. Medium (55%)	3. Medium	3. Medium	4. High	12	Direct Cost: - Potential excess payment following insurance claim Schedule delay: - Implementation of remedial works - Contractor P&G's
8	Threat	Constructability	Vibration / noise / pollution	Contaminated soil / water run-off during construction	- Contaminants identified in surveys - Potential inadequate temporary and / or permanent drainage	- Regulatory issues - Additional cost for preventative measure during construction	Contractor	3. Medium (55%)	3. Medium	3. Medium	4. High	12	Direct Cost: - Removal, treatment or replacement with new soil/material Schedule delay: - Implementation of remedial work - Contractor P&G's

Risk description:								Risk profile assuming generally accepted controls and principles are in place for applicable design / construction stage design:					
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Consequences "If the event occurs, there will be the following consequence(s)..."	Risk Owner	Likelihood (%)	Cost Impact	Schedule Impact	Reputational Impact	Score	Assumptions applied to risk quantification / qualitative ranking
10	Threat	Constructability	Production	Potential inefficient phasing of works	- Design not advanced adequately to fully understand complete scope and sequencing of works	- Construction delays / sequencing - Constructability constraints	Contractor	3. Medium (55%)	3. Medium	4. High	3. Medium	12	Direct Cost: - Labour and material to accommodate potential changes to construction methodology and sequencing of works Schedule delay - Implementation of any potential construction methodology or sequencing changes - Contractor P&G's
9	Threat	Drainage	Design development / optimisation	Design development / optimisations to drainage package - Confirmation of 3.8m RL as designed groundwater level outstanding - Groundwater collection / discharge from areas above 3.8m RL needs further refinement - Potential rainfall scenarios more than 50-year ARI	- Drainage design based on assumptions (50%)	- Redesign	Contractor	3. Medium (55%)	3. Medium	3. Medium	2. Low	9	Direct Cost: - Additional design / design optimisation costs Schedule delay: - Implementation of additional work - Contractor P&G's
3	Threat	Health and Safety Project Wide	Health and Safety	Project specific health and safety risks	- Working on steep slopes (plant, equipment and material) - Flooding - Working in clay - Interface with railway - Working at night - Interface with online traffic - Interface with live utilities (power / gas / water)	- Potential for accident, incident, loss of life	Contractor	2. Low (30%)	4. High	4. High	4. High	8	Direct Cost: - Labour and material Schedule Delay: - Combination of Contactor P&G's and Client cost (\$10k/w) - Safety stand-down, investigation or similar

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Risk description:								Risk profile assuming generally accepted controls and principles are in place for applicable design / construction stage design:					
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Consequences "If the event occurs, there will be the following consequence(s)..."	Risk Owner	Likelihood (%)	Cost Impact	Schedule Impact	Reputational Impact	Score	Assumptions applied to risk quantification / qualitative ranking
5	Threat	Stakeholder Interface	Stakeholders / 3rd parties	Poor management / interface with stakeholders: - Bayfair Mall - Omano golf course - NZTA - Adjacent residential, retail and commercial properties - Utilities - Pedestrians and any other road users - Airport - Interface with other construction projects in close proximity - Local council - Regulatory bodies (HSEQ) - Local community - Political interest	- Poor understanding of stakeholders requirements and expectations - Stakeholder identification not comprehensive	- Construction delays / sequencing - Constructability constraints - Reputation / relationships	Contractor / Client	2. Low (30%)	3. Medium	3. Medium	4. High	8	Direct Cost: - Allowance made for any potential additional issues or requirements not budgeted for Schedule delay: - Implementation of unforeseen work - Contractor P&G's
11	Threat	Geotechnical	Design development / optimisation	Ground settlement is greater than predicted - Further design and investigatory works to be undertaken - Additional fill and remedial works during construction	- Currently based on assumptions	- Redesign to pavements and /or footpaths	Contractor	2. Low (30%)	4. High	4. High	2. Low	8	Direct Cost: - Additional design / design optimisation costs - Cost of additional investigations and production of reports by specialists
13	Threat	Urban Design	Design development / optimisation	Design development / optimisations to lighting design package	- Currently based on absolute minimum requirements / compliance	- Redesign	Contractor	4. High (85%)	2. Low	2. Low	2. Low	8	Direct Cost: - Additional design / design optimisation costs - Labour and light fittings Schedule Delay: - Implementation of the work - Contractor P&G's
14	Threat	Urban Design	Design development / optimisation	Design development / optimisations to cycleway integration with Bayfair Mall	- Currently based on assumptions	- Redesign	Contractor	4. High (85%)	2. Low	2. Low	2. Low	8	Direct Cost: - Labour and materials Schedule Delay: - Implementation of the work - Contractor P&G's
21	Threat	Constructability	Production	Potential construction logistics constraints including interface with online traffic and general construction traffic management	- Reliability of concrete supply - Access and egress to work phases	- Additional cost - Potential claims - Safety - Reputation	Contractor	2. Low (30%)	3. Medium	4. High	2. Low	8	Schedule delay: - Implementation of the work - Contractor P&G's

Risk description:								Risk profile assuming generally accepted controls and principles are in place for applicable design / construction stage design:					
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Consequences "If the event occurs, there will be the following consequence(s)..."	Risk Owner	Likelihood (%)	Cost Impact	Schedule Impact	Reputational Impact	Score	Assumptions applied to risk quantification / qualitative ranking
22	Threat	Geotechnical	Remedial Works	Ground settlement is greater than predicted and requires additional fill materials	- Ground conditions and / geotech dissimilar than anticipated	- Remedial works and associated costs	Contractor	2. Low (30%)	4. High	4. High	2. Low	8	Direct Cost: - Labour and material Schedule Delay: - Implementation of the work and import of material to site - Contractor P&G's
15	Threat	Regulatory	Regulatory delays	Departure approval delay or rejection - Geotech design (Reduction of 5m additional ground improvement) - Urban design (Use of designation boundary, P39 specification, ULDF) - Road design (Barrier length reductions)	- Council resistance	- Redesign	Contractor	2. Low (30%)	3. Medium	3. Medium	2. Low	6	Direct Cost: - Labour and material Schedule delay: - Implementation of the work - Contractor P&G's
16	Threat	Regulatory	Regulatory refusals	Potential refusal / delay to approval of underpass departure	- Non compliance to agency standards and regulations - Unpragmatic design approach	- Redesign	Contractor	2. Low (30%)	3. Medium	3. Medium	3. Medium	6	Direct Cost: - Labour and material Schedule delay: - Implementation of the work - Contractor P&G's
17	Threat	Drainage	Utilities	Unforeseen clashes with drainage and existing underground utilities	- Poor design coordination with services - Potential inaccurate survey drawings	- Significant construction delays / sequencing - Additional design changes - Safety	Contractor	2. Low (30%)	3. Medium	3. Medium	2. Low	6	Direct Cost: - Additional plant and labour Schedule delay: - Implementation of additional works - Contractor P&G's
20	Threat	Drainage	Production	Potential construction inefficiencies associated with the installation of new drainage storm water pipe through golf course (675mm dia.)	- Construction limited to night time working increases safety risks, methodology, and double handling	- Additional cost - Potential claims	Contractor	2. Low (30%)	3. Medium	3. Medium	2. Low	6	Schedule delay: - Implementation of the work - Contractor P&G's
12	Threat	Design Project Wide	Design development / optimisation	Change in alignment of underpass / ramps / path / structural retaining walls / stair locations	- Regulatory (NZTA / Tauranga Airport) - Client initiated	- Significant construction delays / sequencing - Additional Design development / optimisations - Reputational damage	Contractor	1. Very Low (5%)	4. High	4. High	4. High	4	Direct Cost: - Labour and material Schedule Delays - Implementation of the works - Contractor P&G's

Risk description:								Risk profile assuming generally accepted controls and principles are in place for applicable design / construction stage design:					
ID	Type	Risk Category	Risk Title	Risk "There is a risk"	Cause "caused by"	Consequences "If the event occurs, there will be the following consequence(s)..."	Risk Owner	Likelihood (%)	Cost Impact	Schedule Impact	Reputational Impact	Score	Assumptions applied to risk quantification / qualitative ranking
18	Threat	Drainage	Costing	Drainage pricing not properly / adequately defined	- Based on a 'previous' estimate / design	- Additional cost	Contractor	2. Low (30%)	2. Low	2. Low	2. Low	4	Direct Cost: - Plant, labour and materials Schedule Delay: - Implementation of work - Contractor P&G's
19	Threat	Geotechnical	Design development / optimisation	Design development / optimisations to retaining wall displacement criteria	- Currently based on assumptions	- Redesign	Contractor	2. Low (30%)	2. Low	2. Low	2. Low	4	Direct Cost: - Plant, labour and materials Schedule Delay: - Implementation of work - Contractor P&G's

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