



Risk and Uncertainty in Construction

An Overview

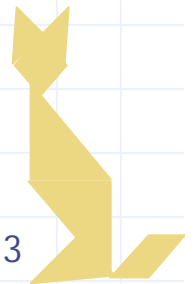
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Outline

- ◆ Risk Concepts
- ◆ Risk Management Techniques
- ◆ Sample Application

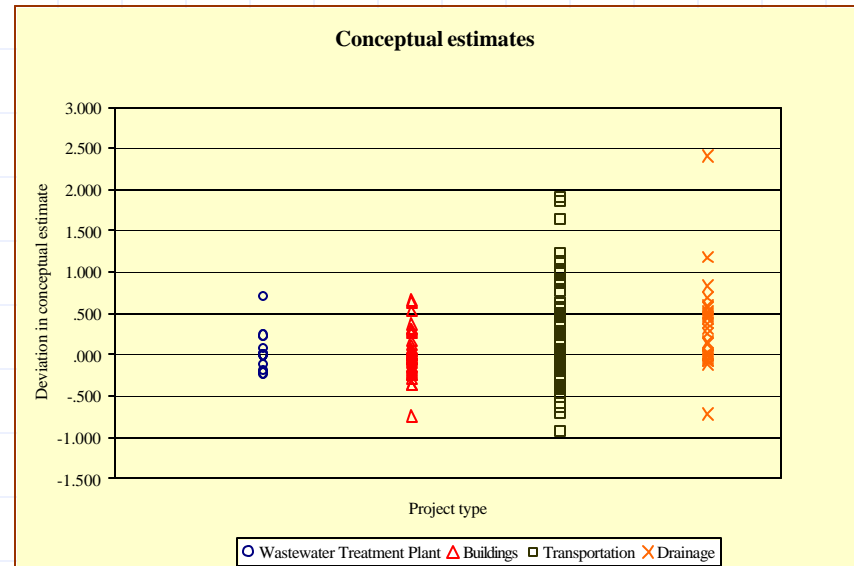
Concepts

- Risk: The possibility of suffering loss (or harm) and the impact that loss has on the involved party. Risk can be characterized in terms of its Severity where
 - ◆ Severity = Likelihood of Occurrence x Magnitude of the Impact
- Opportunity: The possibility of realizing a favorable outcome and the impact this outcome has on the involved party. Opportunity is positive risk and can be identified and managed in a similar way.
- Uncertainty: "The gap between the information required to estimate an outcome and the information already possessed by the decision maker." (CII 1989)
- Risk Analysis: The process of identifying risk factors and the quantification of those factors (estimating likelihood and magnitude of impacts).
- Risk Mitigation: The process of developing a plan to respond or deal with risk on a project.



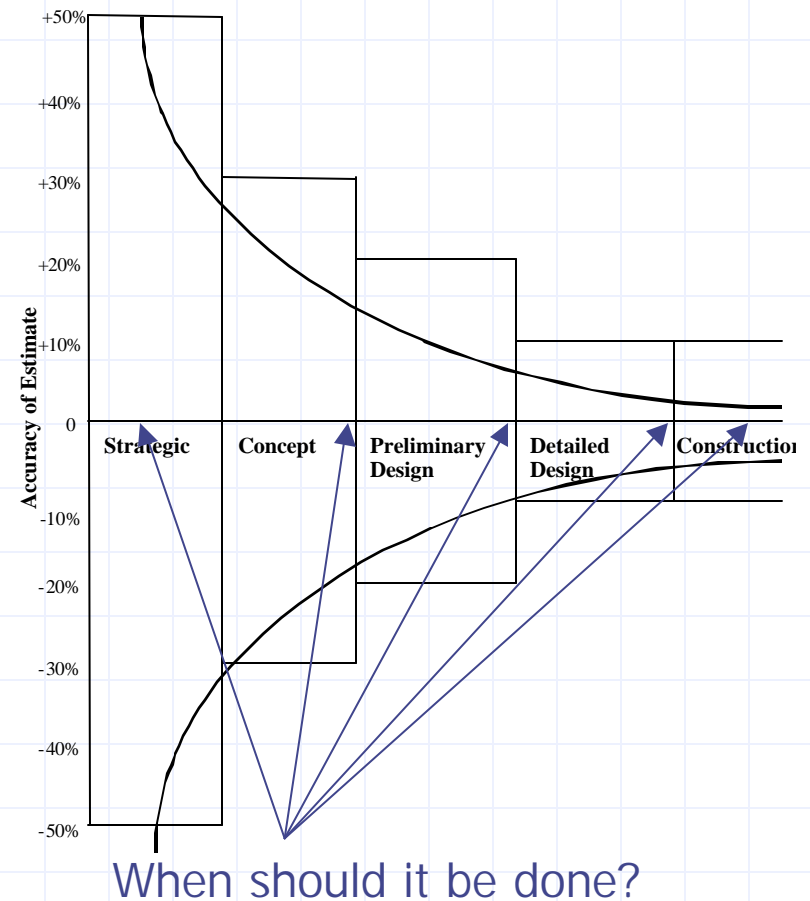
Why do you need risk analysis

- Minimize management by crisis
- Minimize surprises and problems
- Increase probability of project success
- Better handle on true costs and schedules by properly estimating contingencies...



So what is risk analysis & management?

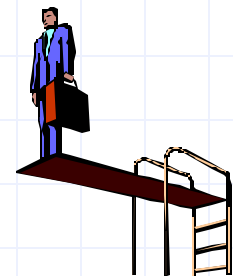
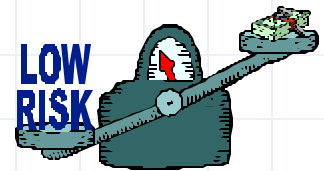
- ◆ An orderly way of studying and analyzing the project. More than simply designing it...
- ◆ Clear understanding of the project objectives, all alternatives, and all issues that need to be considered during the design and construction...
- ◆ A comprehensive understanding of all stakeholder issues, a probing of internal experts and review of similar projects...



Characteristics of risk events

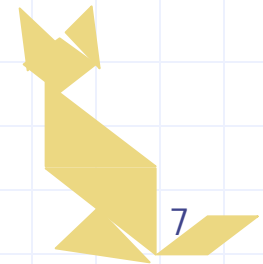
◆ Risk is generally:

- “Magnitude dependent”.
 - ◆ The greater the payoff, the more the risk is acceptable...
- “Value based”.
 - ◆ Everyone sees risks differently. Everyone has a different tolerance level for risk...
- “Time dependent”.
 - ◆ Risk is a future event, time affects its perception. What is seen today as a risk may not be tomorrow...



More Characteristics

- For risk to be an issue, the event and/or its outcome must be associated with a certain degree of uncertainty (the possibility).
- In practice it is virtually impossible to avoid all risks.
- Risks can be reduced and sometimes transferred (e.g. through contracts, financial agreements, concessions, insurance policies).



Process of Risk Management

- ◆ Generally involves the following steps:
 - Preparation for risk analysis
 - Risk Identification
 - Risk Analysis
 - Risk Response
 - Risk Control
 - Close down

Risk Identification

◆ Risk Factor Definition:

- Identify every possible event or issue that may cause harm to the project (from the organizations view point).
- Risk factors can be stated in the form:
 - ◆ “..... may happen during the execution of which may impact”, or
 - ◆ “ If occurs, then an impact to will be realized.”
 - e.g. “If the lay-down area is not optimized then productivity will be too low.”
 - e.g. “segmental liners may not be available prior to construction thus delaying project”

◆ So, how do we do this?

- ◆ A number of approaches can be used including:
 - Standard Checklists
 - Comparison to other projects
 - Expert Interviews
 - Facilitated brainstorming sessions
 - Delphi Technique

Risk Analysis

◆ Tools used:

- Decision trees
- Expected value (severity, contingency)
- Questionnaires
- Life Cycle Cost Analysis
- Financial measures
- Computer simulation
 - ◆ Range estimating
 - ◆ Schedule analysis

◆ Qualitative

- Using a subjective assessment of “low, Medium, High”... or color code the various risk factors.

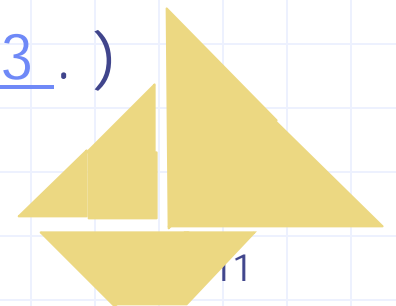
◆ Quantitative

- Assign probabilities or likelihood to the various factors and a value for the impact then identify severity for each factor.

An approach for conducting risk management

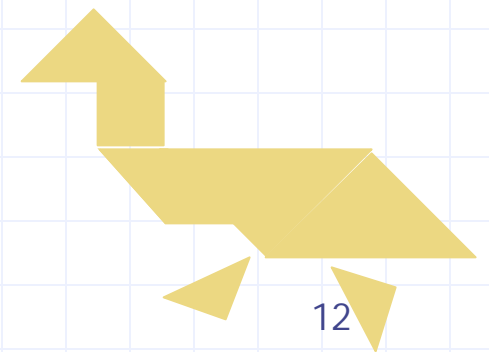
Evaluate risk factors as follows:

- ◆ Assess each factor and its impact if it occurs
- ◆ Determine the likelihood of the factor being encountered (e.g. [Table 1.](#))
- ◆ Determine the magnitude of the impact if the factor is encountered (e.g. [Table 2.](#))
- ◆ Determine the overall impact of the factor by multiplying likelihood (ii) by magnitude (iii).
- ◆ Interpret the score of (iv) (e.g. [Table 3.](#))



Sample Applications

- ◆ Risk Analysis for projects in Edmonton –Risk Identification, and quantification, and Contingency derivation...
- ◆ Range estimating to quantify uncertainty with estimate



Risk Response

- ◆ Decide on the actions to be taken in response to residual risks (where the overall impact exceeds the risk threshold . Actions can include:
 - ◆ Reduce uncertainty by obtaining more information. (This generally leads to a re-evaluation of the likelihood or impact.)
 - ◆ Eliminate or avoid the risk factor through means such as a partial or complete re-design, a different strategy or method etc.
 - ◆ Transfer the risk element by contracting out affect work.
 - ◆ Insure against the occurrence of the factor (generally difficult in self insured organizations such as the City).
 - ◆ Abort the project if the risk is intolerable and no other means can be undertaken to mitigate its damages.
- Plan response to residual risks
- Communicate mitigating strategy and response plan to risk review team.

Risk Management

- ◆ Develop and implement a risk strategy through integration with mainstream management.
- ◆ Manage the agreed risk mitigation initiatives.
- ◆ Revise plan periodically (e.g. at each phase of the project life-cycle) to reflect changes in conditions, information or as a result of the undertaken response.
- ◆ Report changes.



Sample risk management plan

- ◆ Like any other plan, should outline what is to be done, who is responsible for it, when to do it and other pertinent information. Use of [programs](#) may help.
- ◆ Examples are wide varied, can be straight forward or fairly integrated with the overall project management process. [See sample](#)

Close Down

- ◆ Assess investment outcome
 - Consider results of investment against original objectives
 - Compare risk impacts with those anticipated
- ◆ Review Risk Analysis Process
 - Assess effectiveness of process and its application
 - Draw lessons for future investments
 - Propose improvements to process
 - Communicate results

Table 1: Likelihood

<i>Descriptor</i>	<i>Explanation</i>	<i>Probability</i>	<i>Value</i>
Highly Likely	Almost certain that it will happen	Values are set by the corporation and used for all projects	
Likely	more than 50-50 chance		
Somewhat likely	less than 50-50 chance		
Unlikely	small likelihood but could well happen		
Very unlikely	not expected to happen		
Extremely unlikely	just possible but would be very surprising		



Table 2. Magnitude

<i>Descriptor</i>	<i>Explanation</i>	<i>Dollar impact</i>	<i>Value to use</i>
Disastrous	The impact is totally unacceptable to the organization.		
Severe	Serious threat.		
Substantial	Considerably affects cost		Values are set by the corporation and used for all projects
Moderate	Moderately effects costs		
Marginal	Small effect on costs		
Negligible	Trivial effect on costs		

Table 3: Consequence

Total severity score	Category	Response
	Intolerable	Must eliminate or transfer risk
	Critical/ Undesirable	Avoid or transfer risk
	Serious	Attempt to avoid or transfer, be proactive in managing risk.
	Important	Accept manage proactively
	Acceptable	Accept and manage risk
	Negligible	Can be ignored but should be managed

Range Estimating Algorithm

1. Divide the project into manageable components (e.g. line items or work packages).
2. Identify the uncertain components (those that effect the bottom line.)
3. For each of the uncertain components estimate the variability using a statistical distribution (e.g. triangular).
4. Generate random numbers and transform them to the appropriate distribution
5. Find the project cost on this iteration as the sum of all components (including those that do not vary).
6. Repeat steps 1-5 a large number of times
7. When done construct the cumulative distribution function and calculate all relevant statistics to perform risk analysis

Sample Range Estimating Application for Tunneling

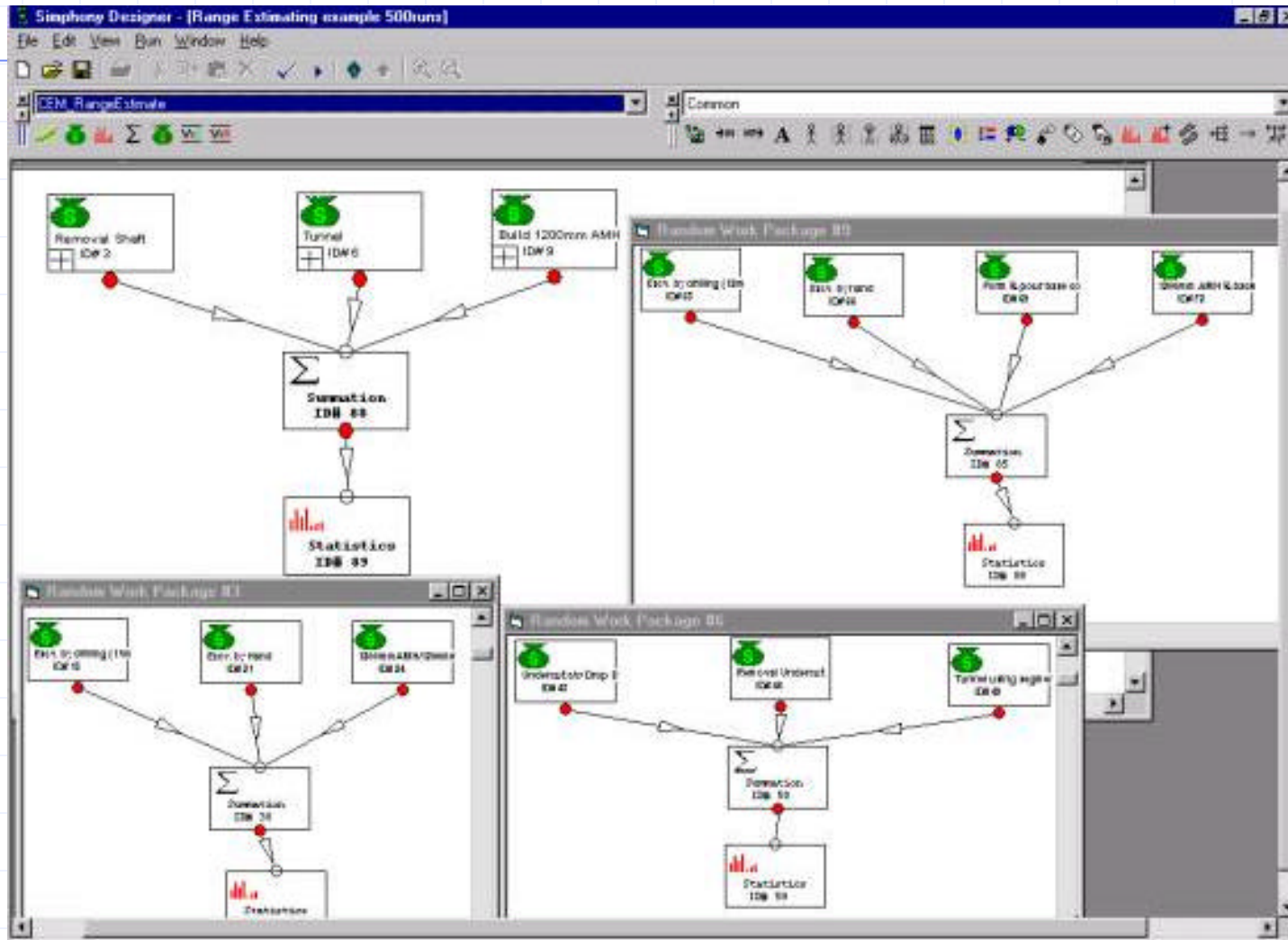
- ◆ Estimators prepared the estimate breakdown and preliminary estimate
- ◆ Program Manager decides to perform a range estimate to
 - ◆ determine the probability of achieving this estimate
 - ◆ derive a value to use for project contingency

Sample Range Estimating Application for Tunneling

Item (1)	Description (2)	Unit (3)	Quantity (4)	Unit Cost			Mean (8)
				Optimistic (5)	Most likely (6)	Pessimistic (7)	
2	Removal Shaft						
21	Excavate by Drilling (11m)	Each	1	15000	30000	45000	30000
22	Excavate by Hand	Vert m	18	3000	4300	7500	4933.333
25	Form & Pour Drop Structure (included in Tunnel)	Each	1	0			0
26	Build 1200 mm AMH/1300 mm DMH & Backfill	Vert m	23	1600	2300	3500	2466.667
3	Tunnel						
31	Build Undercut c/w Drop Structure	Each	1	437369			437369
32	Build Removal Undercut	Each	1	47425			47425
33	Tunnel using segments	Lin m	2298	1200	1500	3000	1900
4	Build 1200 mm AMH (4 locations)						
41	Excavate by drilling (12m)	Each	4	5500	11000	16500	11000
42	Excavate by Hand	Vert m	79.8	2100	3000	4500	3200
45	Form & Pour Base Connection	Each	4	21959			21959
46	Build 1200mm AMH & Backfill Shaft	Vert m	114	700	1000	1300	1000

Range for Unit costs

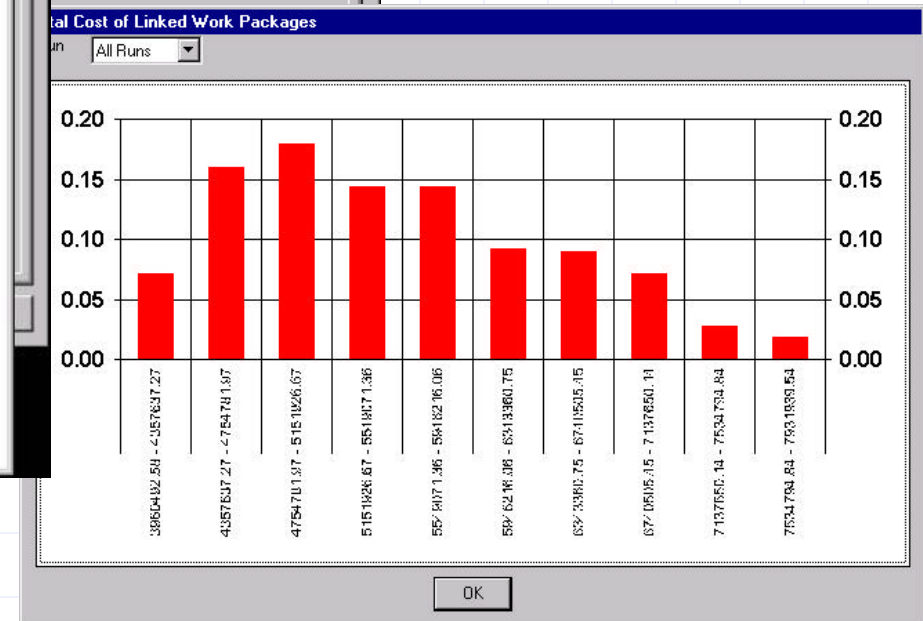
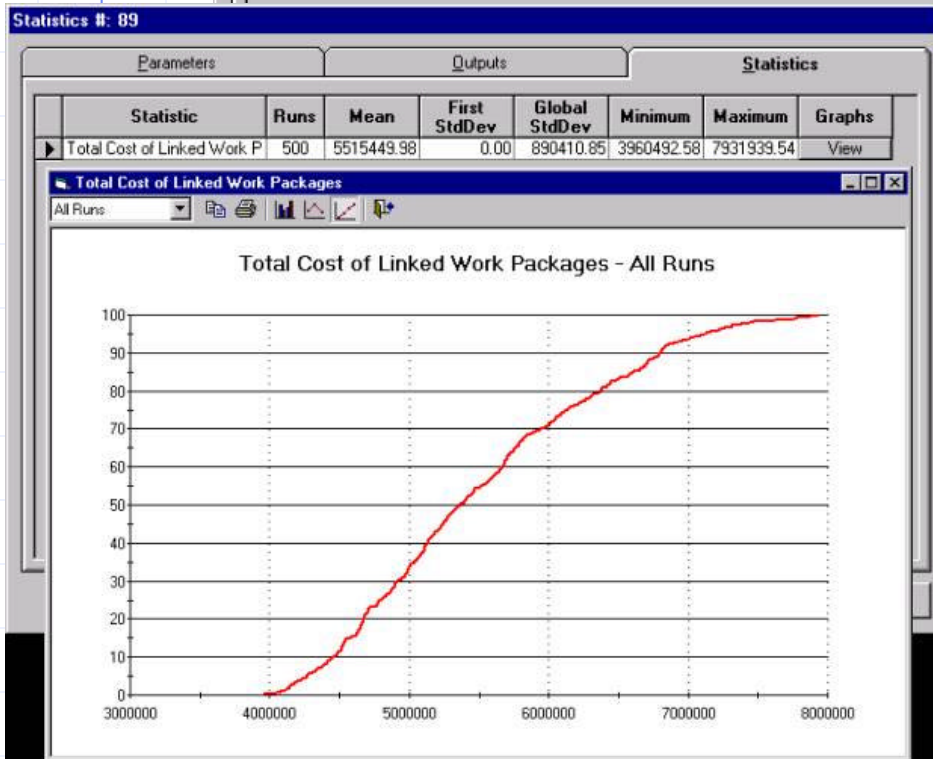
Symphony Range Estimating Template



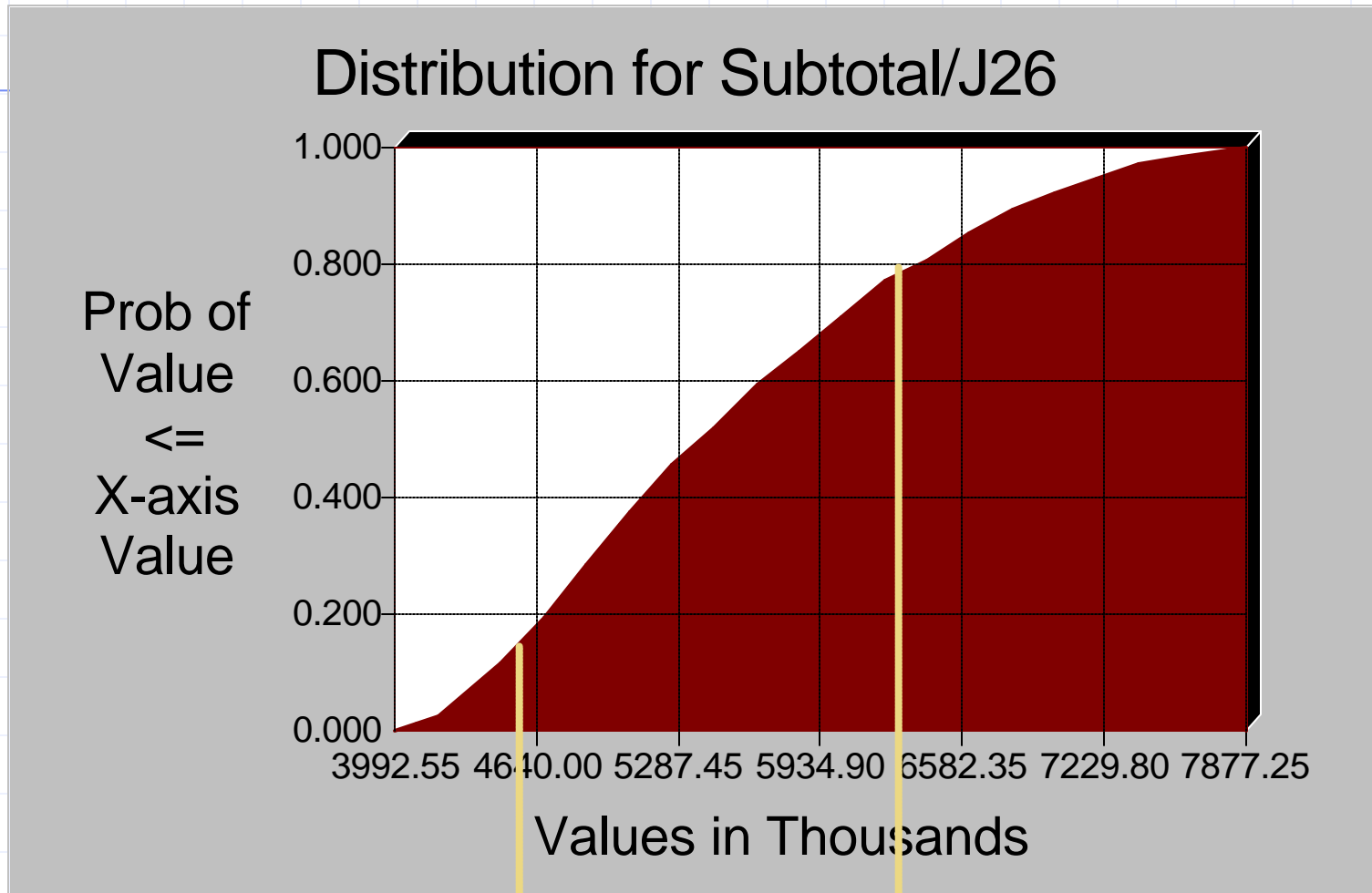
Output Statistics – Range Estimating

Statistics Collector #90

Parameters		Outputs				Statistics			
Statistic	N	Mean	First StdDev	Global StdDev	Minimum	Maximum	Hist	TG	CDF
Total Cost of Linked Work P	500	5515449.98	0.00	890410.85	3960492.58	7931939.54	Y	Y	Y



Cumulative Density Function (CDF) for the tunnel range estimate



If Cost = \$ 4,700,217 then
probability of cost underrun = 20%

If Cost = \$ 6,373,368 then
probability of cost underrun = 80%

Microsoft Access

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Risk_Control_Main

Risk Description				Recommended Action	
Uncertainty associated with land acquisition				Early negotiations with land owners in conceptual design stage Negotiate agreement in practice with all parties. Early buy-in from stakeholders. Communicate with landowners throughout the process Timely purchase or expropriation.	
Severity	Likelihood	Magnitude	Risk Significant?	Action Taken	
150.00	15.00	10.00	No		
Calculated Action: From Average			ID		
Acceptable - Accept and manage					
Alternative And It's Tasks And Assignments					
Alternative					
1					
Task Description		Hours	% Completed	Assignee Name	
Conduct one-on-one meetings with all affected stakeholders in the concept planning study to get early buy in from stakeholders and to obtain agreement in principle.		0	0%	Streets Engineering Branch	
Ensure required property is purchased or expropriated before finalizing detailed design phase.		0	Required date of completion	Each Department as it passes	
*		0	9 /15/00	TPB -Systems planning section	
			Followup Date	Frank Vanderlaan	
			9 /15/00	Mike Marlow	
			Date Completed	Michael Chibuk	
				Reports To	
				Hassan Shaheen	

Record: 8 of 40

Form View

Start | Internet Explorer | Outlook | Word | Access | Calculator | Excel | Risk... | RA... | Swi... | Ri... | 1:31 PM

