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Capital Projects

Project Risk Management – Leading Practices

January 2016

Agenda

Introductions

Challenges of Large Capital Projects

Building a Risk Intelligent Enterprise – Best Practices

Appendix – Monte Carlo Simulation Example

Introductions

John Stone, PE, CCP

Deloitte Advisory

1700 Market Street
Philadelphia, PA 19103
Telephone: 215-316-6559
E-mail: jostone@deloitte.com

John is a Specialist Master in the Capital Projects Consulting practice in the Philadelphia office of Deloitte Advisory.

He is a registered professional engineer and certified cost professional with over 20 years of dispute resolution, project advisory, and risk experience spanning a wide range of domestic and international engineering and construction projects. He has significant experience in construction disputes, estimations, project management, risk assessments, project controls, procurement, construction cost assessments, on-site claims management, and construction field experience. Furthermore, he has been involved in the construction, as well as construction disputes, audits and risk assessments, of industrial and power plants for projects in Canada, Central Europe, the Caribbean, Brazil, the Middle East, and the United States. John has also been a subject matter expert and assisted internal audit teams in numerous construction cost assessments, fraud investigations, control, and risk assessments for a number of domestic and international clients.

Challenges of Large Capital Projects

Root Causes

Root causes of many breakdowns are within the owner's control

- Inadequate risk planning and monitoring
- Lack of clear governance structure and accountability
- Poorly developed project team
- Insufficient resources
- Limited controls for avoiding cost and schedule overruns
- Inadequate project reporting
- Inadequate contract planning/ undefined contracting strategies
- Inability to accurately estimate and measure productivity
- Late scope changes
- Insufficient change and issue management processes
- Poor communication

Polling Question #1

During your experience in executing capital projects, what risk keeps you up at night?

1. Schedule delay
2. Cost overruns
3. Resources
4. Procurement
5. Other

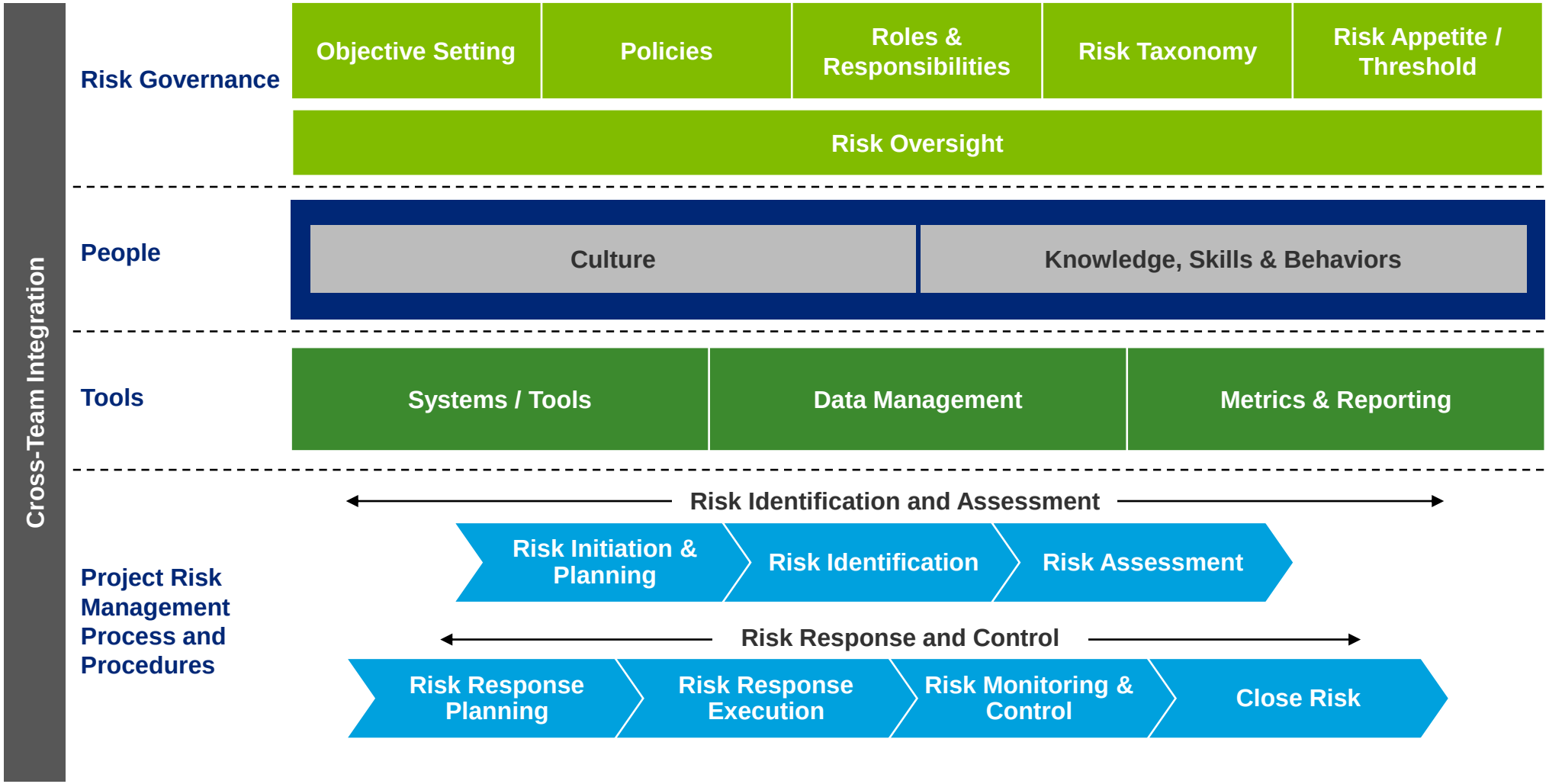
The Construction Industry Institute Top 107 Project Risks

1. Acquisition of necessary easements
2. Adequacy of labor force
3. Ambiguous acceptance criteria
4. Archaeological discoveries
5. Availability of materials
6. Back charge provisions
7. Bonding capacity
8. Broad transfer of ownership of intellectual property to owner/contractor
9. Cumulative impact of change orders
10. Change management
11. Civic/community activism
12. Consequential damages
13. Constructability/operability/maintainability analysis
14. Contracting/Compensation Method: GMP/Lump Sum/ Cost Plus/Unit Pricing
15. Contractor skills and experience (type and size)
16. Control of scope growth
17. Coordination with other on-site contractors
18. Cost compensation for change orders
19. Cost escalation
20. Currency fluctuations
21. Delegation/allocation of design responsibility
22. Delivery sequence of long lead items
23. Design responsibility
24. Differing site conditions
25. Dispute provisions
26. Drawings not coordinated
27. Economic feasibility analysis (cost/benefit)
28. Environmental liability
29. Errors and omissions
30. Estimating
31. Express warranties
32. Financial capacity of contractor
33. Financial capacity of owner (funding of the project)
34. Financial capacity of subcontractor
35. Force majeure
36. Geo-technical data
37. Hazardous materials plan
38. Identification of underground site features (utilities, old building foundations, etc.)
39. Implied warranties
40. Incentives/disincentives clauses (safety incentives, rewards in general)
41. Indemnity (including gross negligence, sole negligence, and willful misconduct)
42. Inflation
43. Insufficient contractor insurance
44. Insufficient owner insurance
45. Insurance allocation
46. Integrated schedule management
47. Interest rate changes
48. Labor strike/jurisdictional disputes
49. Lack of appropriate involvement of design professional during construction
50. Lack of clearly defined safety guidelines and responsibilities
51. Lack of coordination/communication program among owner and design/construction teams
52. Lapsed insurance coverage
53. Latent defects
54. Legislative changes
55. Level of public support
56. Limits of liability
57. Liquidated damages
58. Local codes and standards
59. Local taxes
60. Most-favored-customer pricing provisions
61. New or unfamiliar technology
62. No damages for delay
63. Notice requirements
64. Overlapping insurance coverage
65. Owner-furnished equipment delivery
66. Owner-furnished equipment performance
67. Owner inspection requirements
68. Owner-mandated subcontractors/vendors
69. Owner operations and maintenance
70. Owner organizational structure
71. Owner skills and experience
72. Payment provisions (percent complete, milestones, deliverables)
73. Pay when paid clause
74. Permitting obligation
75. Pollution liability
76. Poor subcontractor performance
77. Post-award changes or reinterpretation of laws
78. Quality of workmanship
79. Regulatory permitting and mitigations
80. Reliance of subcontractors versus self-performing
81. RFI process
82. Risk of physical loss or damage to the work as pertains to builder's risk
83. Schedule acceleration
84. Scope definition
85. Shop drawing approval process
86. Site layout
87. Site security
88. Site selection
89. Standard of care (engineering and construction)
90. Subcontractor default
91. Subcontractor safety training
92. Sufficient transportation facilities
93. Supplier performance
94. Tax regulation change
95. Termination rights
96. Third-party performance/errors litigation risk (subcontractor/supplier performance)
97. Time compensation for change orders
98. Trade coordination
99. Uncertain labor productivity
100. Unknown conditions
101. Unrealistic performance schedules
102. Unsafe construction site
103. Using standard trade practices as solutions for design shortcomings
104. Waiver of claims
105. Waiver of liens
106. Waiver of subrogation
107. Warranty work

Building a Risk Intelligent Enterprise

Best Practices

Project Risk Management Framework



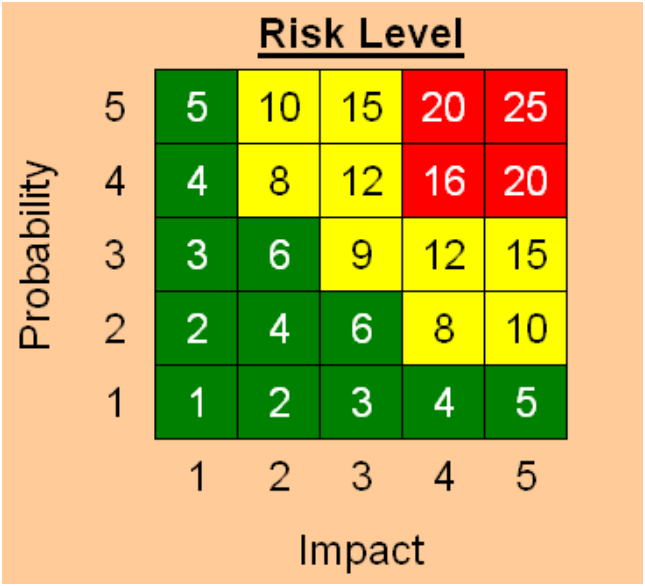
ERM vs. Project Risk

Makes risks more visible to management, stakeholders, and the Board of Directors so that management decisions can be evaluated and challenged.

	Red	Yellow	Green
Corporate	$100+ M	*$50-100M*	<$50M
Segment	$30+ M	$10-30M	<$10M
Function	$10+ M	$3-10M	<$3M

Projects mitigate company risks and are therefore, also included in the ERM tool.

- **Monthly reporting:** An overall project risk indicator (red, yellow, or green) shall be reported monthly. The risk indicators will be determined based on the severity of the risks measured in terms of the potential impact (in a dollar equivalent) from the project risk register.



Risk Management Program

Bridging the Gap

The Risk Management process is directed toward achieving the following goals:

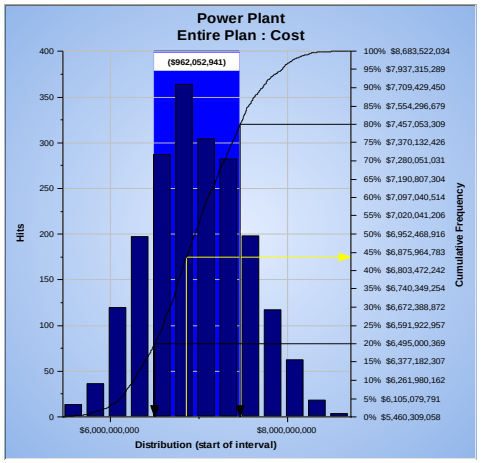
- Streamline and standardize the identification, analysis and mitigation of significant risks to program success
- Identify risks with the greatest potential to impact project cost, schedule and performance criteria
- Allocate resources efficiently and in a cost-effective manner to mitigate the highest priority risks early in the planning process
- Promote risk management as an ongoing project control imperative that focuses on defining the project risk profile as it evolves throughout performance

Risk Identification → **Risk Assessment** → **Risk Response** → **Monitor & Control**

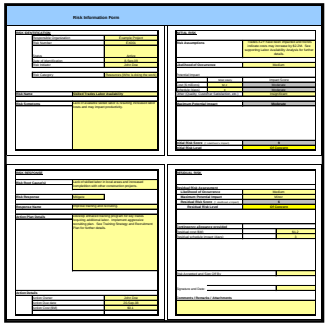
- Implement a standardized methodology for identifying, prioritizing and managing project risks
  - Procedures and Guidelines
  - Roles and Responsibilities
  - Risk Tolerances
  - Process and Tools

- Approach to Risk Assessment
  - Qualitative
  - Quantitative

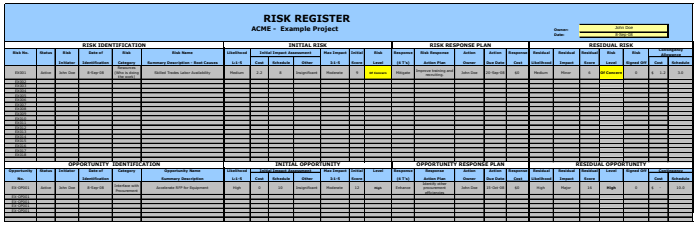
Monte Carlo Analyses



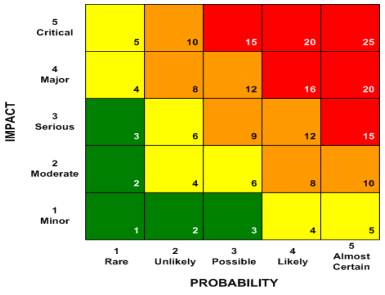
Risk Evaluation Forms



Risk Register



Risk Matrix

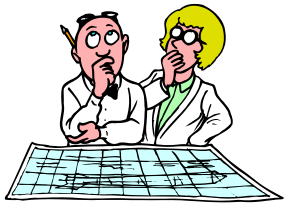


Path Forward…

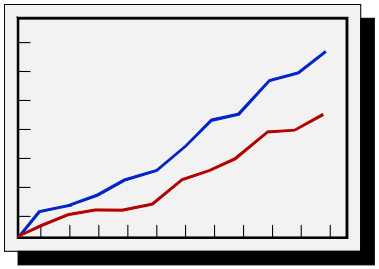
Avoidance

Transference

Mitigation



Acceptance



- **Risk re-assessment**
- **Risk audits**
- **Variance and trend analysis**
- **Earned value analysis**
- **Status meetings**

Bridging the Gap

Clearly defined governance structure with accountability for all necessary risk classes assigned accordingly

Deloitte POV on Project Risk

Major capital projects tend to have extremely complex stakeholder structures with multiple relationships that come into play. Risk intelligent project officers ensure governance is enabled through three lines of defense:

- First line: Accountability for risk is secured through a clearly articulated risk breakdown structure that outlines all necessary risk classes, individual roles and specific responsibilities;
- Second line: Risk oversight and tone setting is provided by a central governing body which receives timely and accurate risk information upon which to make informed decisions;
- Third line: Independent and objective reviews are conducted to validate risk data and controls.

Governance structure must be aligned with the contracting strategy and organizational structure.

Portfolio and ERM Integration

Governing bodies (board, steering committee, audit committee, ERM, etc.) all have appropriate transparency and insight into the project's risk management practices.

- Ensure that appropriate, consistent systems and processes are in place to manage risk proactively as well as provide timely risk information that may be escalated as necessary;
- Examine the current risk structure across the portfolio. How are risks being managed? Are risk silos being bridged?
- Ensure risks remain visible to those beyond the risk owners — the broader stakeholder group needs to be engaged.

Out of sight means out of mind

Stage Gate Approach

Project Critical Decision Process Matrix

	CDO: Approve Business Case Feasibility Statement	CD1: Approve Submission of Proposal	CD2: Approve Performance Baseline	CD3: Approve Execution Readiness	CD4: Approve Acceptance and Turnover Activities	CD5: Approve Transition Completion	CD6: Approve Final Project Closeout
PHASE	**INITIATE**	**DEVELOP**	**DEFINE**	**PREPARE**	**EXECUTE**	**TURNOVER**	**CLOSEOUT**
Level of Development	Assess Business Case Feasibility	Develop Conceptual Design/Bid	Define Performance Baseline	Detailed Design and Prepare for Execution	Execute / Construction Work	Acceptance and Turnover	Completion of Contractual Obligations
Critical Decision Criteria — Governance / CD Approver	*Major Capital Projects* ☐ Board of Directors *Sustaining Capital* ☐ Owners Committee	*Major Capital Projects* ☐ Board of Directors *Sustaining Capital* ☐ Critical Decision Approval Committee	*Major Capital Projects* ☐ Board of Directors *Sustaining Capital* ☐ Critical Decision Approval Committee	*Major Capital Projects* ☐ Board of Directors *Sustaining Capital* ☐ Critical Decision Approval Committee	*Major Capital Projects* ☐ Critical Decision Approval Committee ~~☐ Board of Directors~~ ~~*Sustaining Capital*~~ ☐ Critical Decision Approval Committee	*Major Capital Projects* Critical Decision Approval Committee ☐ Board of Directors *Sustaining Capital* ☐ Critical Decision Approval Committee	*Major Capital Projects* ☐ Owners Committee *Sustaining Capital* ☐ Critical Decision Approval Committee ☐ Owners Committee
CD Package	☐ CD-0 Template ☐ Synchronization Matrix/Decision Support Tool	☐ CD-1 Template ☐ PMP (Initial) ☐ Project Charter (Initial) ☐ Design Basis Memorandum	☐ CD-2 Template ☐ PMP (Updated) by Discipline ☐ Performance Baseline	☐ CD-3 Template ☐ PMP (Final) ☐ Commissioning Plan (Initial) ☐ Performance Baseline	☐ CD-4 Template ☐ Transition/Closeout Plan (Initial) ☐ Commission Plan (Final) ☐ Certificate of Substantial Completion	☐ CD -5 Template ☐ Final Operational Acceptance	☐ CD-6 Template ☐ Project Completion Report ☐ Close of AFE
Key Deliverables	☐ Synchronization Matrix/Decision Support Template ☐ Business Case ☐ Preliminary Scope Statement (Initial) ☐ Start / Stop Schedule ☐ Class 5 AACE Estimate ☐ L1 Milestone Schedule ☐ CD Plan/Phase Plan (Initial) ☐ Phase Funding Requirement ☐ Identification of Consultant/ Vendor/ Engineering Contract(s) (if required) ☐ Project Director/Manager Identified	☐ Contract & Procurement Strategy (Initial) ☐ Business Proposal / Bid ☐ Authorization for Expenditure ☐ Project Charter (Initial) ☐ Refined Scope Statement (Updated) ☐ Decision Support Tool/Synchronization Matrix (Initial) ☐ Project Work Breakdown Structure (Initial) ☐ L2 Project Management/Control Schedule ☐ Class 4/3 AACE Estimate ☐ CD Plan/Phase Plan (Updated) ☐ Project Management Plan (Initial) ☐ Scope Management Plan (Initial) ☐ Schedule Management Plan (Initial) ☐ Costs Management Plan (Initial) ☐ Quality Management Plan (Initial) ☐ Engineering Management Plan (Initial) ☐ Procurement Management Plan (Initial) ☐ Health, Safety, and Environmental Management Plan (Initial) ☐ Organization Chart (Initial) ☐ Staffing Management Plan (Initial) ☐ Long Lead Items and Contract(s) – Identified ☐ Contracts initiated ☐ Regulatory Requirements (Initial) ☐ Project Specific Procedures (Initial) ☐ Lessons Learned Report ☐ Conceptual Design Report ☐ Design Basis Memorandum (Preliminary Engineering) ☐ Engineering to Support Class 4/3 Estimate ☐ Preliminary P&IDs ☐ PFDs ☐ Equipment lists ☐ Geotechnical ☐ Preliminary Site Plan ☐ Process Design Guide ☐ Preliminary Building layouts ☐ Preliminary Control Systems Philosophy ☐ Process Descriptions ☐ 30% Model Reviews (Large/Mega projects) ☐ Phase gate review ☐ Independent Peer Review (IPR) Recommendation (If required)	☐ Performance Baseline (Initial) ☐ Project Charter (Final) ☐ PMP (Updated) – by Discipline ☐ Scope Management Plan (Final) ☐ Schedule Management Plan (Updated) ☐ Costs Management Plan (Updated) ☐ Change Management Plan (Updated) ☐ Quality Management Plan (Updated) ☐ Staffing Management Plan (Updated) ☐ Communications Management Plan (Updated) ☐ Risk Management Plan (Updated) ☐ Procurement Management Plan (Updated) ☐ Engineering Management Plan (Updated) ☐ Construction Management Plan (Initial) ☐ Safety Management Plan (Updated) ☐ Environmental Management Plan (Updated) ☐ Process Improvement Plan (Updated) ☐ Project Finance Plan (Final) ☐ Training Plan (Initial) ☐ L3 Resource Loaded Schedule ☐ Synchronization Matrix (Final) ☐ Project WBS (Final) ☐ Class 2 Estimate ☐ L3 Work Package Schedule ☐ Organization Chart – Key Positions Identified/Filled (Updated) ☐ Procurement Measure - 100% of long lead item PO's; Procurement 20% ☐ CD Plan/Phase Plan (Updated) ☐ Regulatory Requirements (Updated) ☐ Lessons Learned ☐ Engineering to Support Class 2 Estimate (IFD): ☐ P&ID's IFD ☐ PFD's IFD ☐ Basis of Design – Final ☐ Piping Layouts ☐ Control Systems ☐ Line List –IFD ☐ Tie-in list – IFD ☐ Electrical Single Line – IFD ☐ Process Descriptions - Final ☐ Project Procedures – Final ☐ Major Equipment Bids evaluated – ready for purchase ☐ Systems Functions & Requirements Document (Initial) ☐ Geotechnical Report – Final ☐ Site plan - Final ☐ Engineering Work Packages – 50% Complete ☐ Value Management/Engineering Report ☐ Independent Peer Review (IPR) Recommendation (If required) ☐ 60% Model Reviews (Large/Mega projects) ☐ P&ID Review ☐ Phase Gate Review ☐ Bid ability/Constructability/Modularization Review ☐ Operability and Safety Review (Hazop)	☐ PMP (Final) ☐ Schedule Management Plan (Final) ☐ Costs Management Plan (Final) ☐ Change Management Plan (Final) ☐ Quality Management Plan (Final) ☐ Staffing Management Plan (Final) ☐ Communications Management Plan (Final) ☐ Risk Management Plan (Final) ☐ Procurement Management Plan (Final) ☐ Safety Management Plan (Final) ☐ Engineering Management Plan (Final) ☐ Environmental Management Plan (Final) ☐ Process Improvement Plan (Final) ☐ Construction Management Plan (Final) ☐ Turnover Plan (Initial) ☐ Commissioning Plan (Initial) ☐ Performance Baseline (Final) ☐ Class 2 and/or Class 1 Estimate ☐ Organization Chart (Final) ☐ Execution Performance Baseline (Final) ☐ L4 Activity Schedule for Construction/Fabrication (resource loaded) ☐ Construction Work Packages 100% Complete ☐ Contracts in Place – Signed Contracts ☐ Procurement Measure - 100% POs placed ☐ CD Plan/Phase Plan (Updated) ☐ Regulatory Requirements (Updated) ☐ Lessons Learned ☐ Engineering to Support Class 1 Estimate (IFC): ☐ P&ID's - IFC ☐ PFD's - IFC ☐ Piping Layouts - IFC ☐ Control Systems architecture ☐ Line List – IFC ☐ Tie-in list – IFC ☐ Electrical Single Line – IFC ☐ Cable layouts and wiring diagrams - IFC ☐ I/O lists – IFC ☐ Isometrics - IFC ☐ Engineering Work Packages – 100% Complete ☐ System Functions & Requirements Document (Final) ☐ Independent Peer Review (IPR) Recommendation (If required) ☐ 90% Model Reviews (Large/Mega projects) ☐ Construction Execution Readiness Review/Phase Gate Review ☐ Constructability/Bid-ability/ Modularization Review ☐ Operability and Safety (Hazop) Review	☐ Transition/Closeout Plan (Final) ☐ Certificate of Substantial Completion ☐ Commissioning Plan (Final) ☐ CD Plan/Phase Plan (Updated) ☐ CD Discussion & Guidance ☐ Fabrication – Construction Substantially Complete ☐ Compliance Assurance ☐ Lessons Learned ☐ CD Plan/Phase Plan (Updated) ☐ Regulatory Requirements (Updated) ☐ L4 Activity Schedule for Commissioning ☐ Construction Completion Review	☐ Project Transition to Operations Report ☐ Final Operational Acceptance ☐ Transfer of Care, Custody and Control ☐ CD Discussion & Guidance ☐ Integrated System Commissioning Complete ☐ Regulatory Approvals Obtained ☐ Start Up and Performance Testing ☐ Lessons Learned ☐ Final Project Documentation ☐ CD Plan/Phase Plan (Final) ☐ Handover Review	☐ Preparation & Issue of Project Completion Report ☐ Close of AFE ☐ Settlement of All Outstanding Financial and Contractual Obligations, Claims, Issues & Disputes ☐ Process improvement (Lessons Learned) Report Issued ☐ Post Expenditure Review

Legend:
Project Management Deliverables
Engineering Deliverables
Reviews

In a risk intelligent project, stage gate specific project assurances activities are required in order to determine whether the project may proceed

Deloitte POV

Top project management teams develop an early view of what risk based activities are required per phase and stage gate in order to provide assurance that the project is ready to proceed through each gate.

The project assurance plan is used to formulate a risk-based operational excellence program for the entire end-to-end project lifecycle.

Ineffective stage gate risk assurance and related decision making often results in carry over legacy issues which burden the project for the remainder of its lifecycle.

Stage-gate project assurance activities

- Discipline specific risk studies (e.g. engineering, procurement, construction, etc.)
- Class specific risk studies (e.g. regulatory, security, political, resources, etc.)
- Resource, cost and schedule peer reviews
- Contingency analysis
- Vendor qualification analyses
- Internal control audits
- Independent project assurance
- Operational readiness reviews

In a risk intelligent project, material-risk classes, as well as all associated controls, are independently tested and validated

Deloitte POV

In many major capital projects, internal resources are stretched and struggle to consistently deliver the necessary performance and control assessments.

Project officers may fear they are not getting the full story from their project teams and that bad news may not arrive in time to address the risks.

Without independent project assurance, project officers will find themselves in a position where they are relying on those who manage the risks to report on the risks.

Stage-gate project assurance activities

- Timely access to specialized expertise
- Greater integrity and higher quality
- Neutral and un-biased opinions
- Additional resourcing options
- Broader exposure to industry best practices

Appendix

Quantitative (Monte Carlo) Risk Analysis

Quantitative risk analysis enables the client to identify and mitigate “high impact” risks inherent in traditional cost estimates and schedule projections

- Traditional cost estimating and CPM scheduling does not account for risk or uncertainty
- Monte Carlo simulation and scenario analysis accounts for both risk and uncertainty related to cost estimates and project schedules
  - Cost and schedule confidence: Monte Carlo simulation and scenario analysis will help to evaluate the range of expected costs or schedule completion dates as well as the confidence levels associated with achieving certain cost or schedule objectives

Risk Assessment Process

Simulation (Monte Carlo) Process

- Establish the model structure
- Define the inputs
  - Conduct risk workshops and assess relevant support
- Run the simulation
  - During each iteration, the model selects cost or durations for each item and risk event based on the probability distributions established
  - The simulation model may be run thousands of times while various statistics are collected
  - Results will converge to a level of confidence
    - Additional simulations will not have a significant impact on the results already collected
- Key outputs include:
  - Histograms showing the anticipated costs or schedule completion dates and their associated confidence levels
  - Statistics showing key drivers of risk and uncertainty
- Perform scenario analyses as necessary

Risk Uncertainty vs. Risk Events

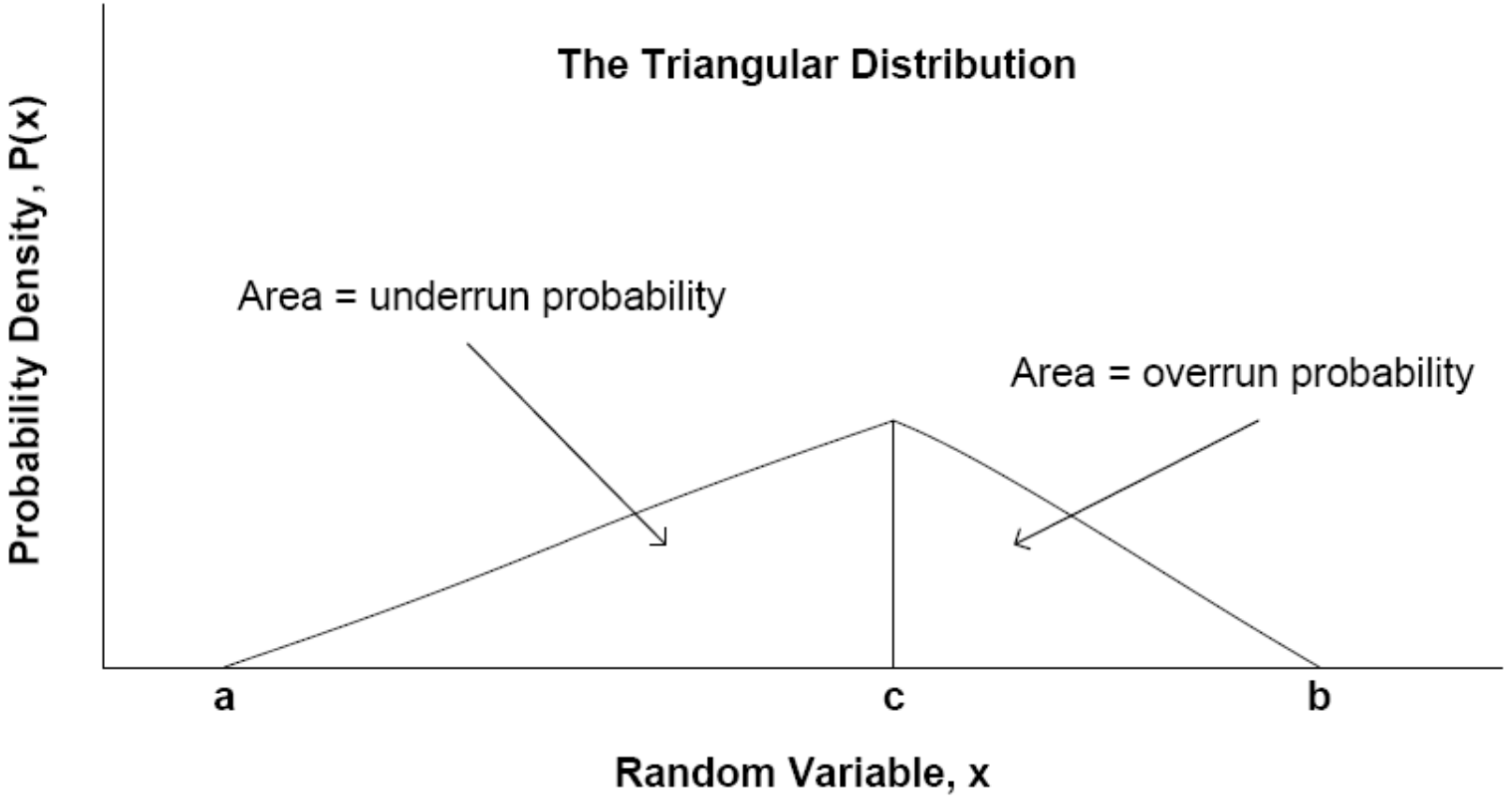
- Risk uncertainty
  - Inherent uncertainty
- Risk events
  - Event may or may not occur (unknown site conditions)
  - External to cost items and schedule tasks
  - May impact several cost items or the duration of one or more tasks within a schedule
  - Modeled using two inputs: Probability of Existence and Impact

Defining Risk Inputs

Choosing the appropriate curves

- Typical distributions for construction activities
  - Right-skewed distributions: greater tendency (probability) of extending durations
- Utilize historical data to develop risk inputs
  - Each project has unique circumstances and challenges
  - May need to modify or adjust historical data
- Leverage industry knowledge
  - Educated assumptions

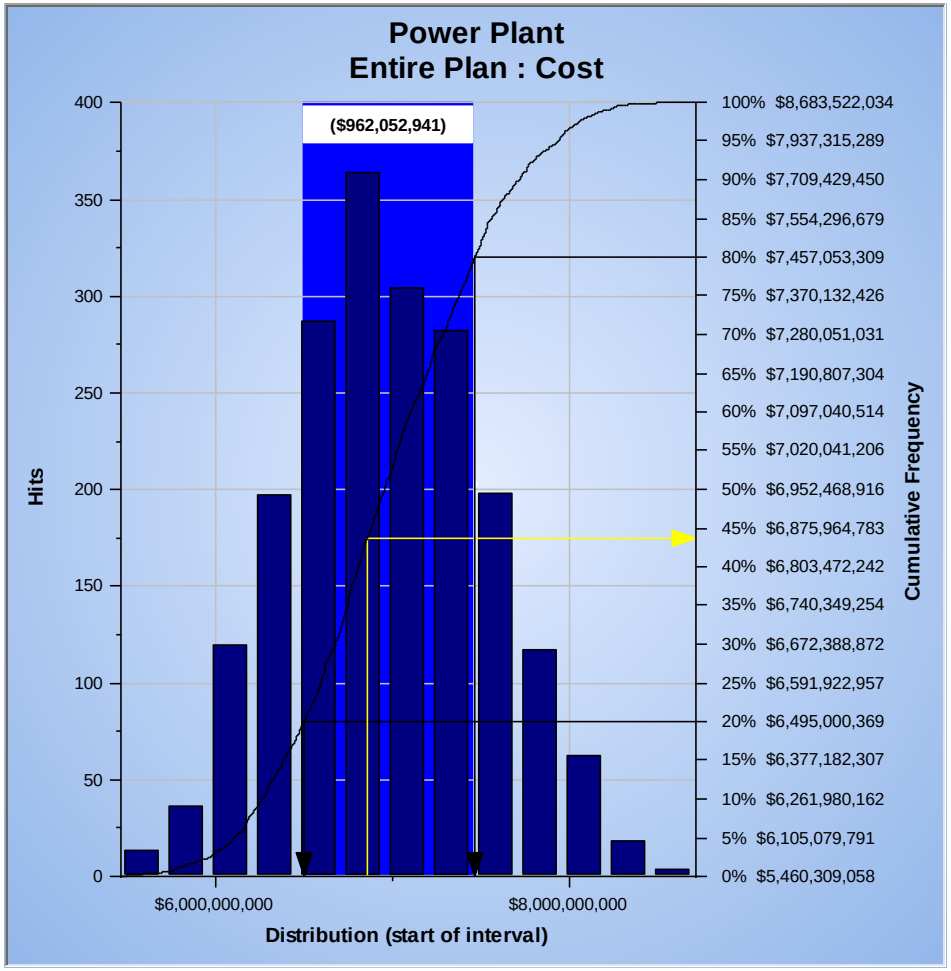
Triangle Distribution



Inputs: minimum, most likely, maximum

Quantitative Risk Analysis – Cost Confidence

Quantitative cost estimate analysis provides the means to quantify and evaluate cost estimate confidence



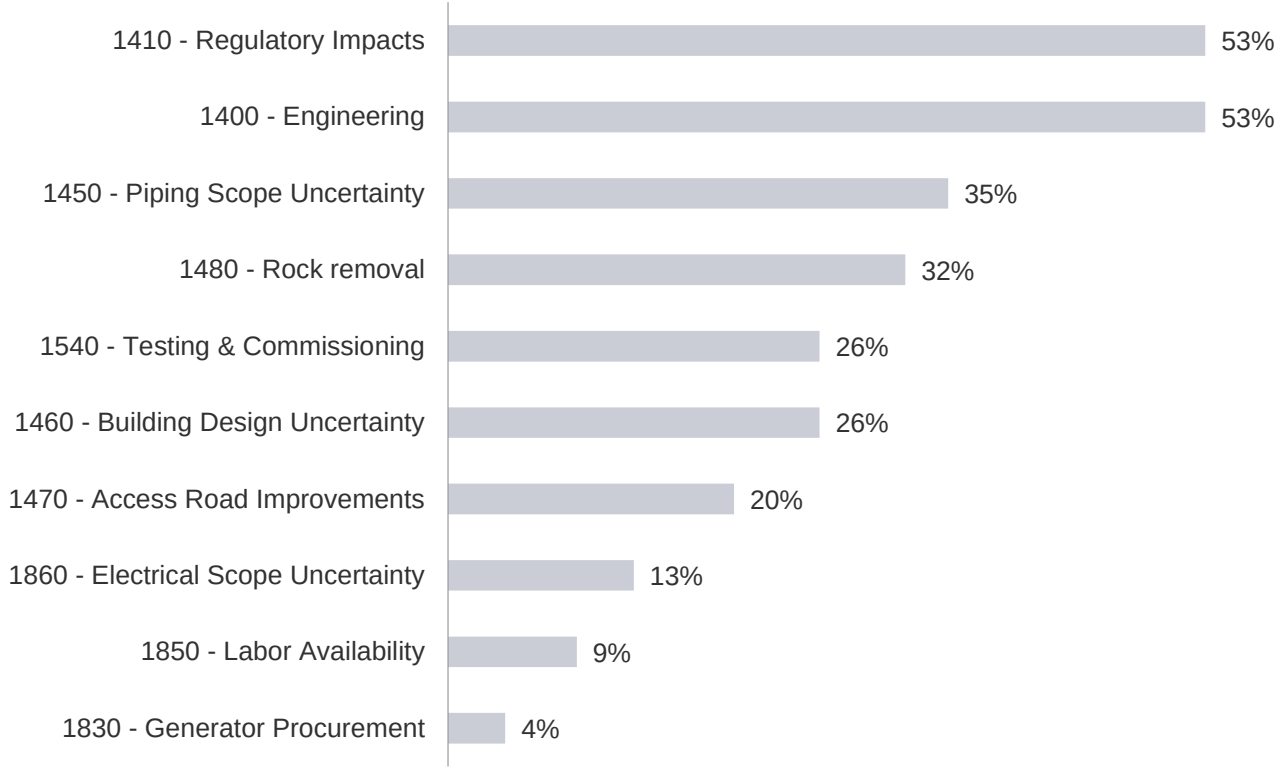
Monte Carlo Cost Analysis Histogram

Quantitative Risk Analysis – Cost Sensitivity

Evaluated component costs likely to have the greatest impact on overall project cost and develop mitigation strategies to proactively address risks

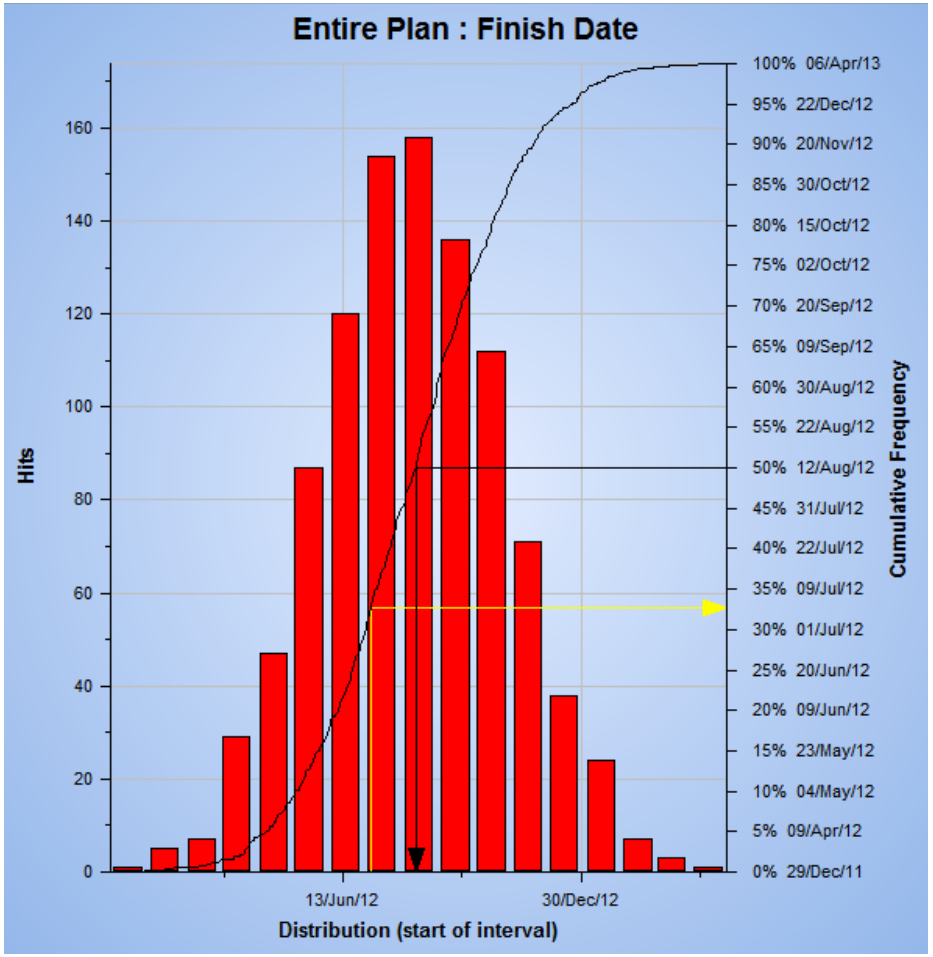
- The tornado chart depicts the impact of high risk cost items in relation to the overall cost

Cost Sensitivity Tornado Chart



Quantitative Risk Analysis – Schedule Confidence

Quantitative schedule analysis provides the means to quantify schedule confidence



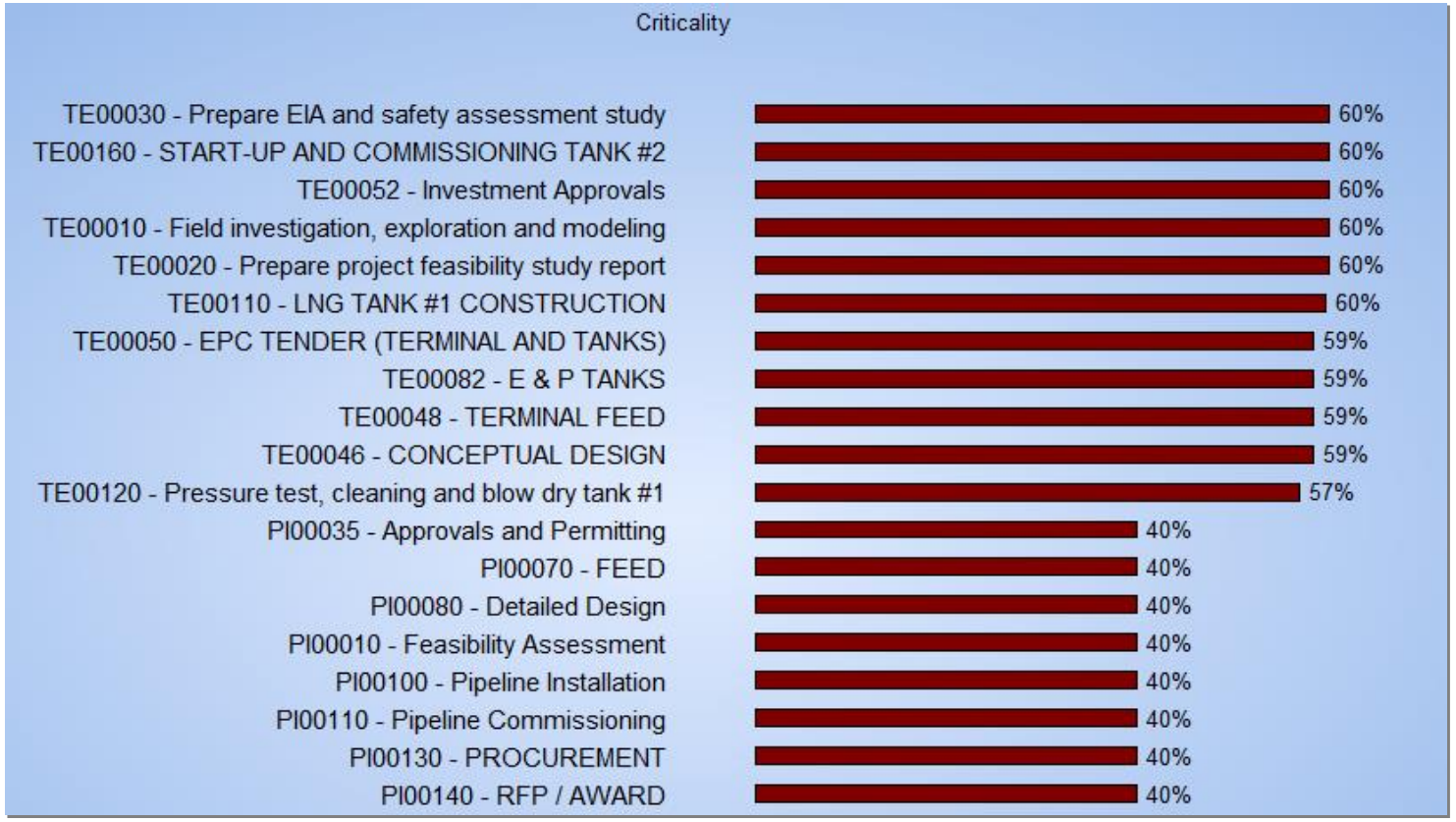
Monte Carlo Schedule Analysis Histogram

Quantitative Risk Analysis – Schedule Criticality

Evaluate probable critical path, assess controlling tasks, and identify any potential logic flaws

- The criticality chart depicts the percentage of time each task appears on the critical path during the simulation analysis

Schedule Criticality Tornado Chart



Identified Risk Elements

Planning & Design	Procurement	Construction	Project Controls
Project Drivers	Procurement Procedures	Physical Site Constraints	Schedule Controls
Permits	Engineering	Labor Productivity	Cost Controls
Regulatory Approvals	Inventory Control	Site Coordination	Invoice Processing
ROW/Land Acquisition	Long-Lead Items	Site Staffing	Material & Equipment
Labor Availability			
Governance Structure			
Public Relations			

Planning Phase Risks & Mitigation Strategies

	Risk Issue	Proposed Mitigation Strategies	Existing Controls
Project Drivers	Project completion by 20XX	• Engage scheduling engineer to test baseline schedule, monitor weekly updates, and conduct trend and forecast analyses • Drive management decisions based on progress	• Contractor maintains master project schedule • Owner to monitor Contractor performance against schedule • Owner seeking approval for project controls positions
Permits	Identify all permit needs, timely commence application process, and complete engineering	• Comprehensive master permit list • Division of Responsibility • Monitor on master schedule	• Contractor has permit risk • Schedule reflects permit requirements • Weekly progress meetings with permitting and engineering teams
Regulatory Approvals	Obtain CPCN in each state or resort to NIETC process	Drive approval process through public relations and communications efforts	• Communications plan in place • Public relations firm retained • External Affairs retains local consultants
ROW/Land Acquisition	Conduct acquisition activities in timely and sequential manner, and with adequate funding controls	• Integrate with procurement and construction • Secure material staging areas early • Develop system for commitment & transfer of funds	• Acquisition plans are in process and will be part of Execution Plan • Condemnation may be used when CPCN issued • Funding process and controls under development

Planning Phase Risks and Mitigation Strategies

	Risk Issue	Proposed Mitigation Strategies	Existing Controls
Labor Availability	• Quantity and quality of craft labor • Overtime and productivity • Management and engineering resources	• Labor plan to identify alternate sources of craft labor • Incentives for retaining supervisory and engineering staff	• Contractor to conduct craft labor survey and develop project labor plan • Engineering divided among several firms • Contractor has commitment of contractor with sufficient resources • Owner compensation package designed to retain staff
Governance Structure	Designed to drive sound management decisions and support prudency reviews	Routine assessment of Owner and Contractor compliance with systems and processes	Three control points include Contractor as CM, project oversight team (including project controls), and Steering Committees (contractual and internal).
Public Relations	Effect of public opinion on regulatory approvals, ROW/land acquisition and route selection, and construction schedule	Monitor organized activity Develop focused media and PR campaigns Conduct training	• PR firm has been engaged • Communications plan in place • Various training has been completed

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