Introduction to Risk-Based Project Management

- Afternoon Session -

Session Lead:
Marian L. Rule, PE, *TranSystems*
Co-Lead:
Will Willson, F.R.I.C.S. A.V.S., *Gardiner & Theobald, Inc NY*

Highway Projects, Conventional/ Higher Speed Rail Projects & High Speed Rail

Presented by

Marian Rule, PE, *TranSystems*

Will Willson, F.R.I.C.S. A.V.S., *Gardiner & Theobald, Inc NY*

Highways vs Railroads

- **Fundamental differences and unique needs for:**
  - Road/highway program work
  - Conventional / higher speed rail work (operating track; could have at-grade or grade separated crossings; interface with freight / other passenger services)
  - High-speed rail work (could still be proximate to conventional rail corridors or highways; primarily/fully grade-separated; security; different environmental impacts; electrification; safety; security)

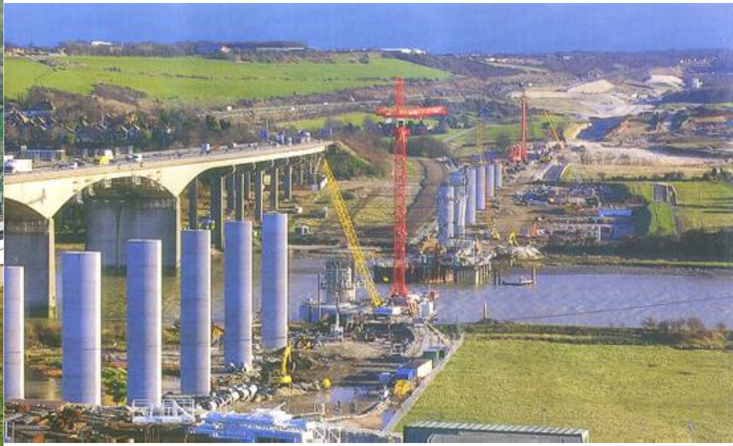
Highways vs Railroads

Highways vs Railroads

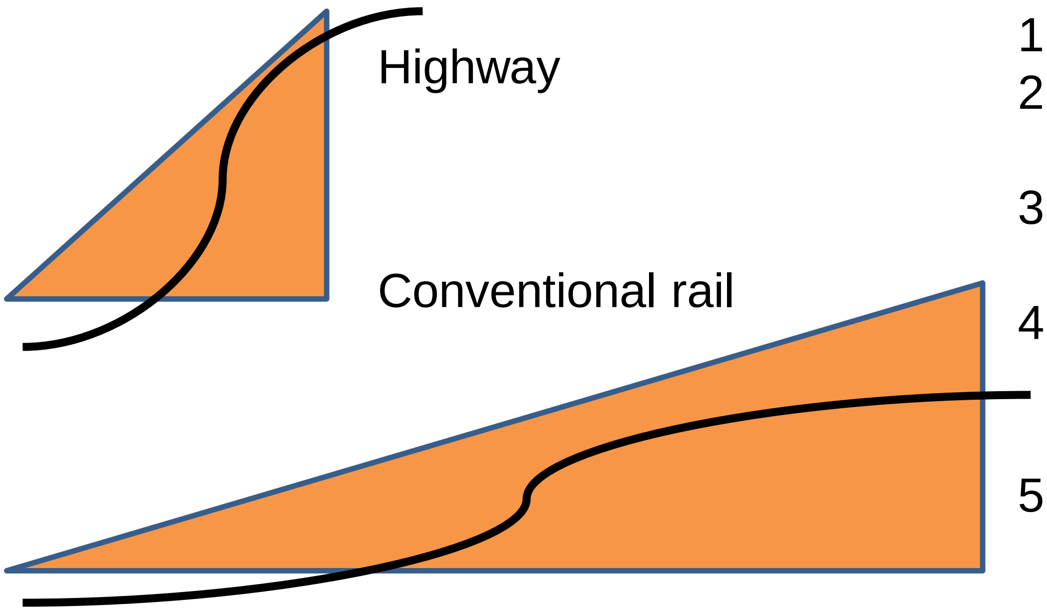
Highways vs Railroads

Highways vs Railroads

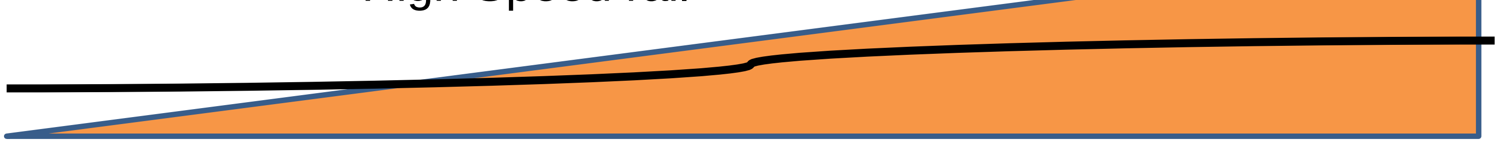
Highways vs Railroads



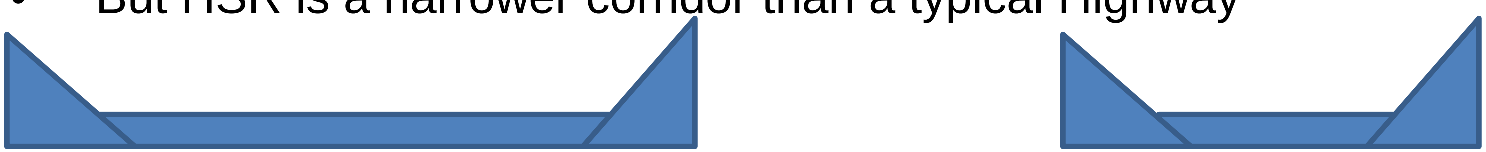
Highways vs Railroads



1. Gradients - mass haul challenges
2. Structure Approaches - constrained far back
3. Utility conflicts more difficult to avoid
4. Ground obstructions / poor ground requires solutions rather than avoidance
5. Grade separation - long approaches



- But HSR is a narrower corridor than a typical Highway



Highways vs Railways

Risks	Highway Improvements	New Highway	Conventional Rail Upgrades	New Light Rail	New High Speed Rail
Maintenance of traffic more challenging than anticipated	✓	✓		✓	
Mass haul impacted by phasing increases imported fill / disposal costs		✓			✓
Relocation of Protected Species delays construction		✓	✓	✓	✓
Utilty relocations delay access	✓	✓	✓	✓	✓
Working adjacent to existing tracks may be delayed because of flagger shortages			✓	✓	
Alterations to signals dependant upon availability of railroad staff			✓	✓	
Speed restrictions next to existing tracks reduces productivity			✓	✓	
Interfaces with existing railroads at terminus may result in specification enhancements to locomotives					✓
Significant increase in ROW to avoid bad ground may result in SEIS					✓
Interoperablility may result in unforseen technical costs and delays					✓

Example: Grade Separation Project

Risks	Highway Constraining	Risk impacting success	Railroad constraining
Relocate Utilties		✓	
ROW acquisitions [for bridge wing walls]		✓	
Ground conditItions [piles, underpass excavations]		✓	
Settlement to Track		✓	
Beam Manufacture / timely delivery		✓	
Contractor performance		✓	
Work in railroad 'work windows'			✓
Work requiring train speed restrictions			✓
Work requiring railroad flaggers			✓
Signal Interfaces / connections after civil work shift			✓
Political commitment to open Road in XX days	✓		

Developing the Master Schedule and Adding Schedule Risk

Presented by

Will Willson, F.R.I.C.S. A.V.S.

Gardiner & Theobald, Inc NY

Schedule Structure

Master Project Schedule

Funding, Procurement, ROW, Permits, 3rd Party Agreements & Environmental

Design Schedule

Start-up & Pre-revenue Operations Schedule

Construction Schedule

Underlying WBS: Level 1

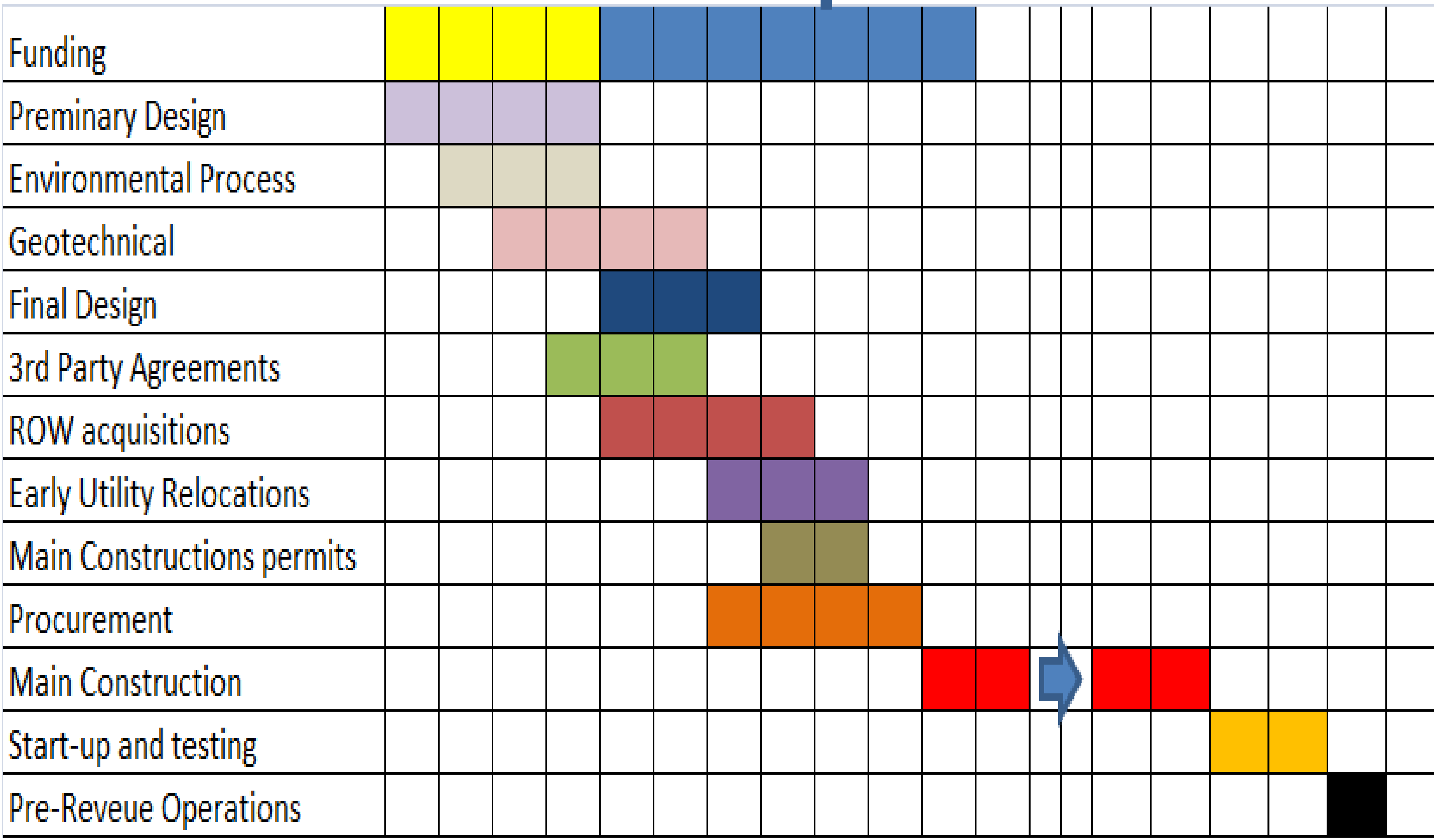
Level 1

- Funding
- Preliminary Design
- Environmental process
- Geotechnical
- Final Design
- 3rd Party Agreements
- ROW acquisitions
- Early Utility Relocations
- Main Construction Permits
- Procurement
- Main Construction
- Start-up and Testing
- Pre Revenue Operations

Should not change throughout project

On large projects may expand into major geographic or contract areas

Ideal Level 1 Roll-Up



Underlying WBS: Level 2

Level 2

- Main Construction

- Geographic Area
- Design Area
- Operational Area
- Major component

↓

- Contract works packages [major]

WBS Level 2 typically changes as Contract Package Plan is matured

Estimate must also transition whilst maintaining SCC tractability

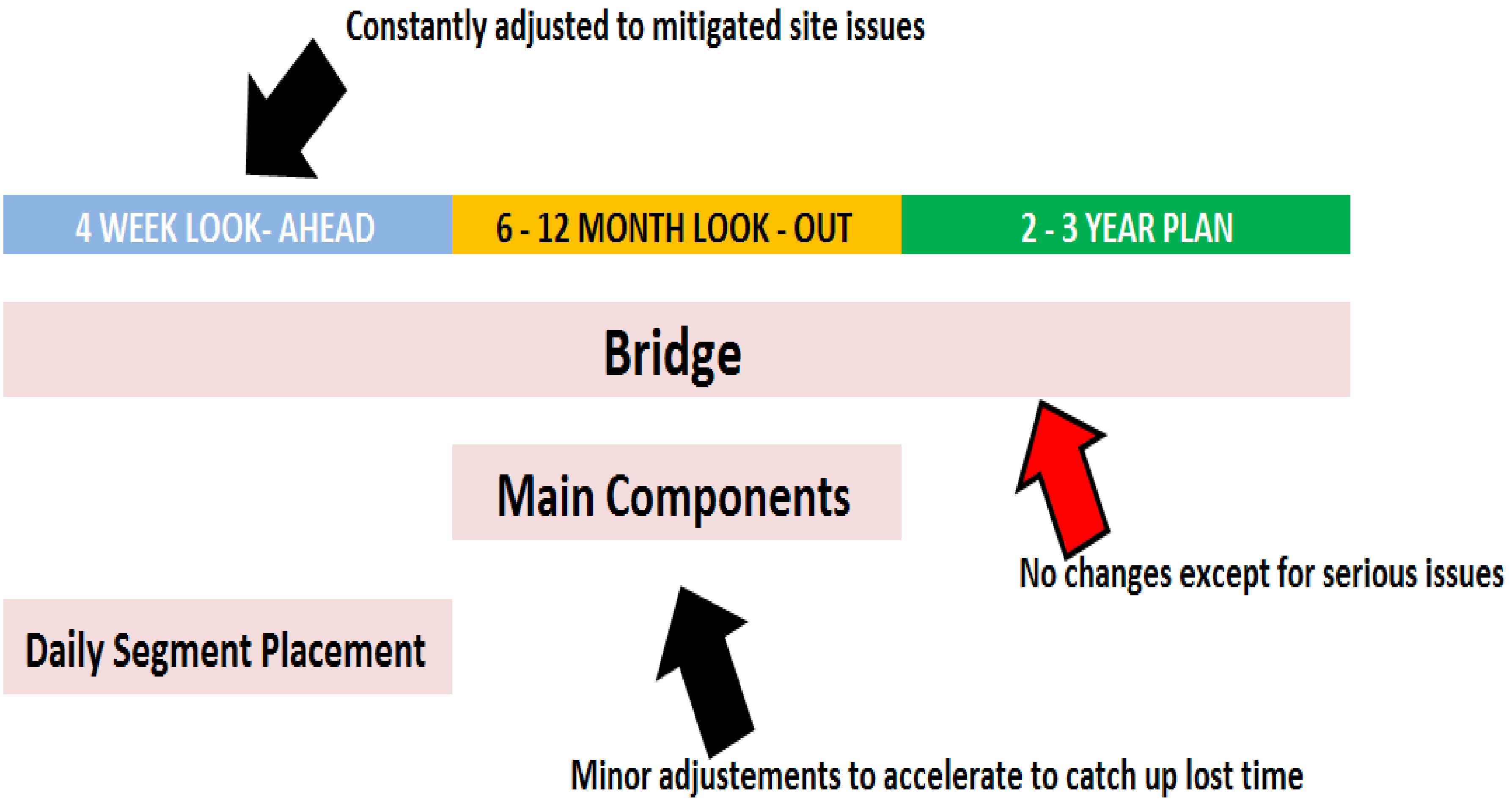
Underlying WBS: Level 3

Level 3

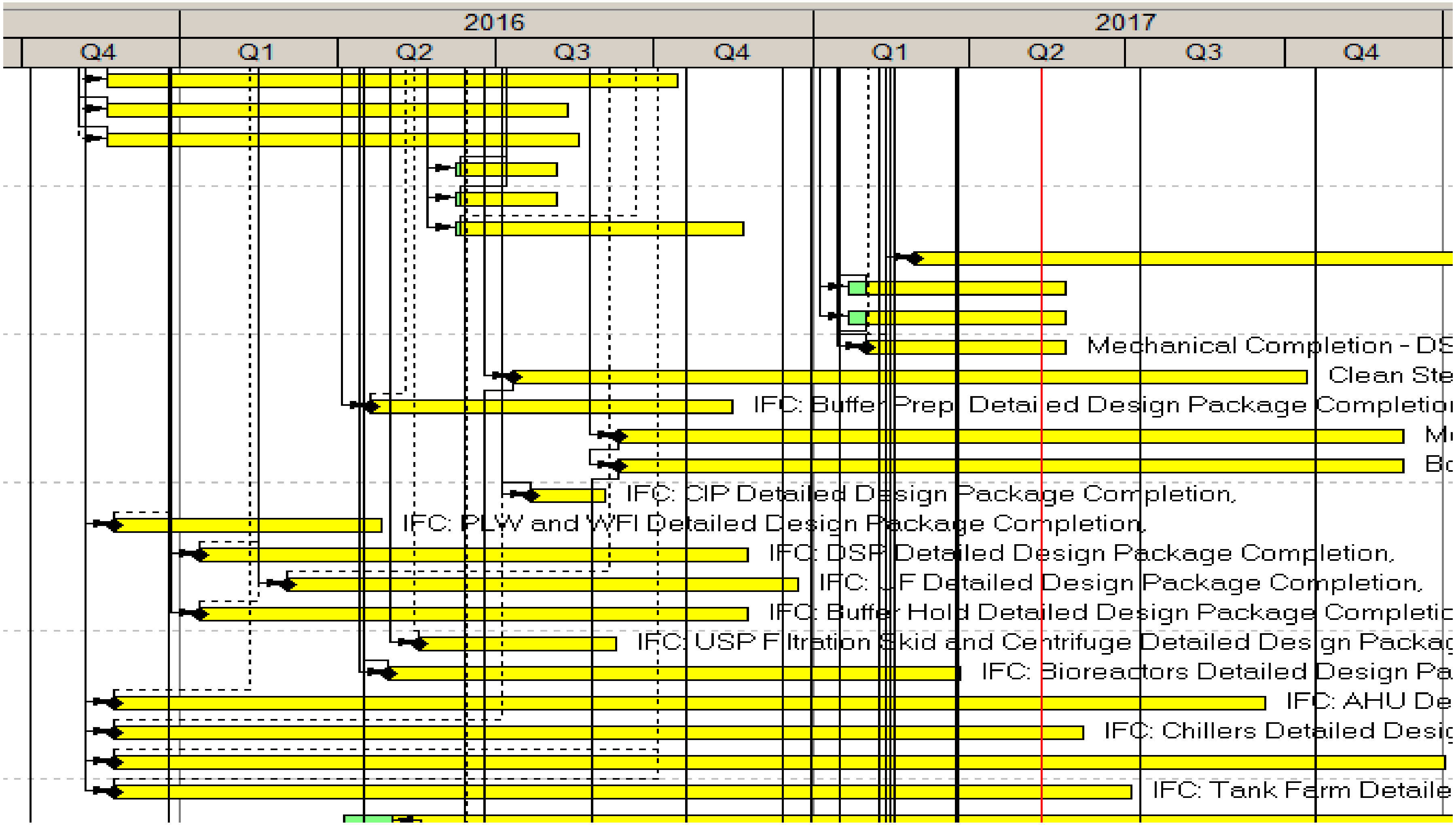
- Key advance works (e.g. Major Utility relocations, Directional drills under obstructions)
- Individual tunnels
- Individual Bridges
- Viaducts
- Track
- Systems installations
- Individual Stations
- 3rd Party interface projects
- Parking lots
- Start up

} Should not change throughout project

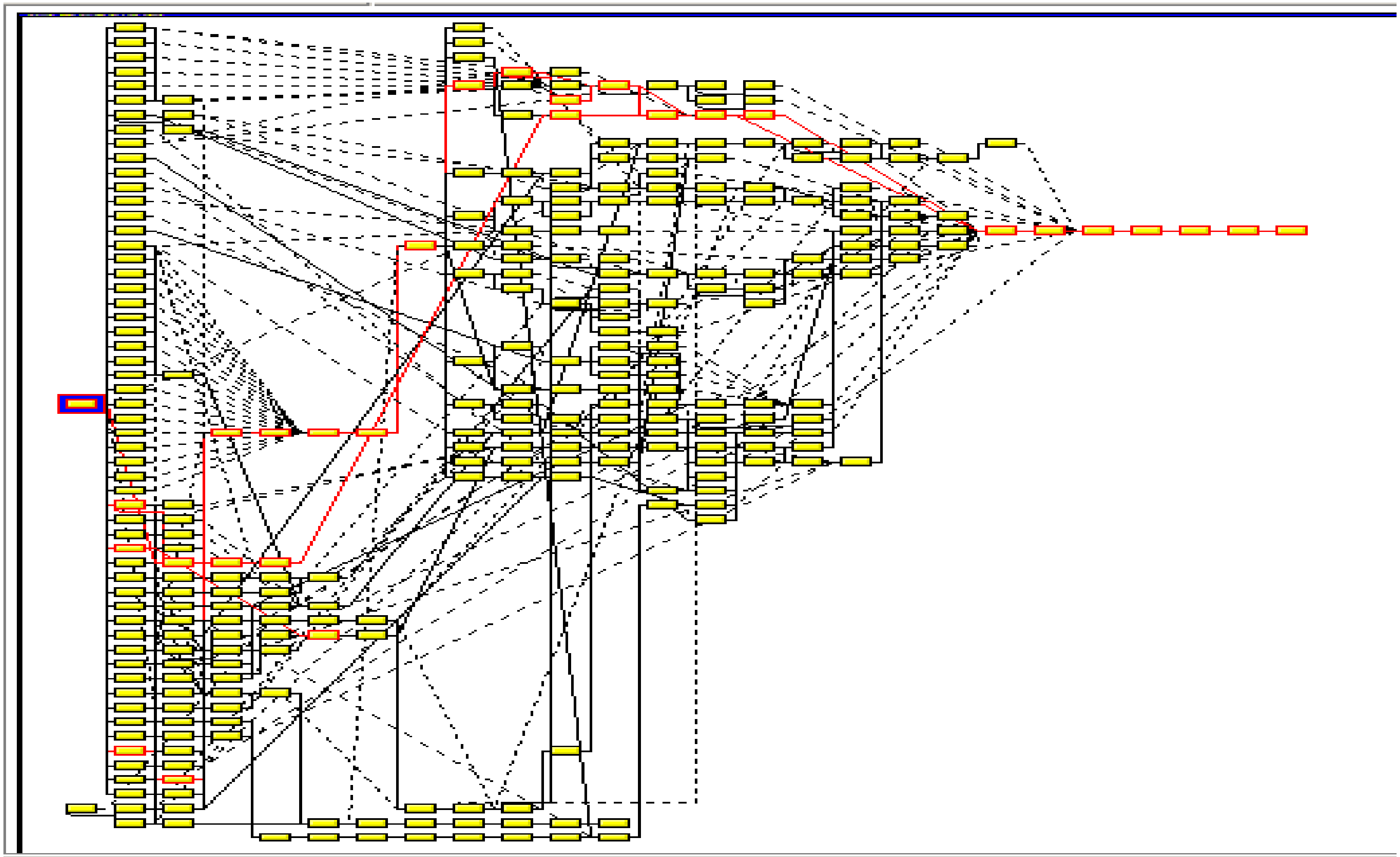
How Much Detail in a Master Schedule?



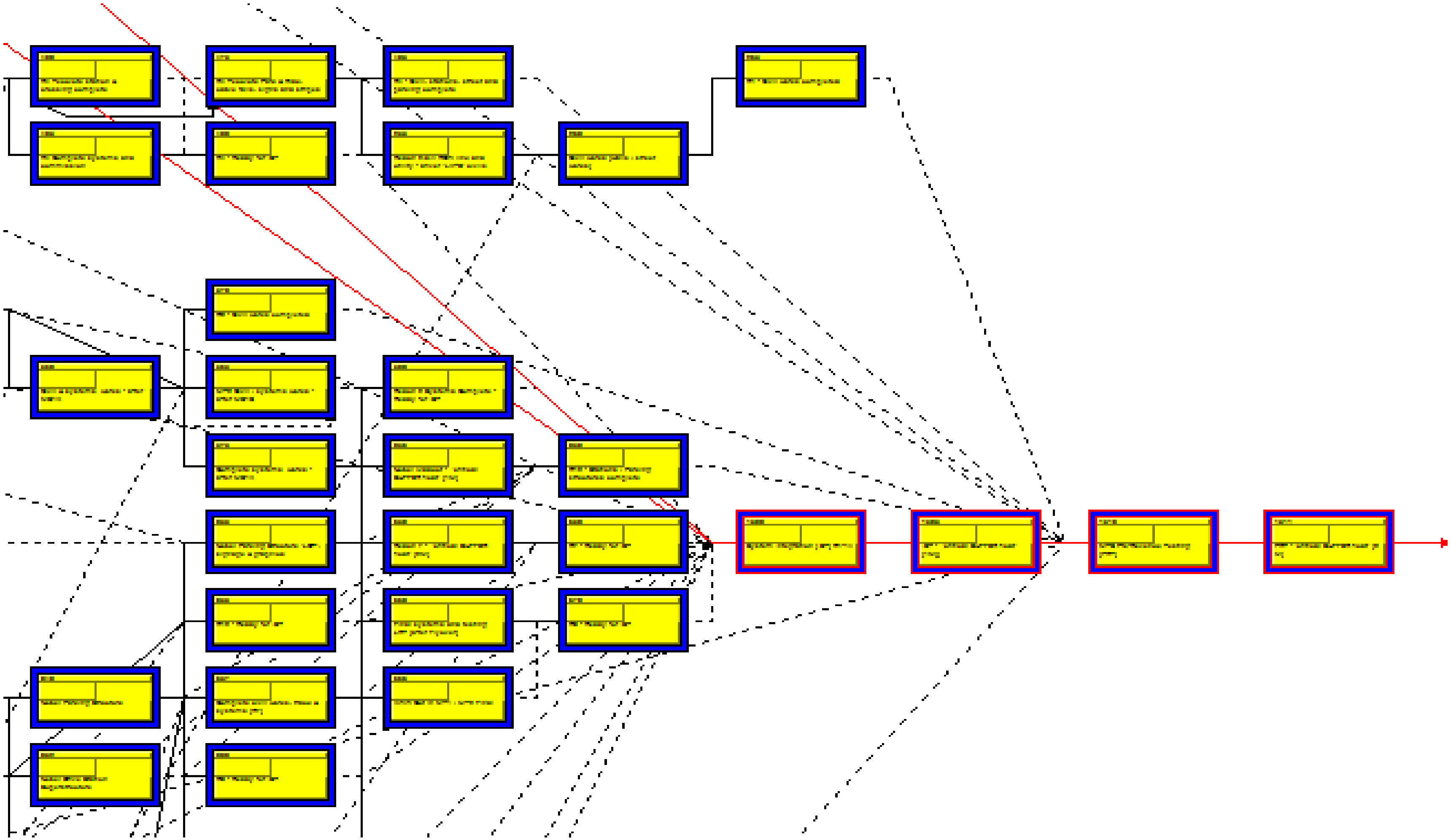
Developing a Master Schedule



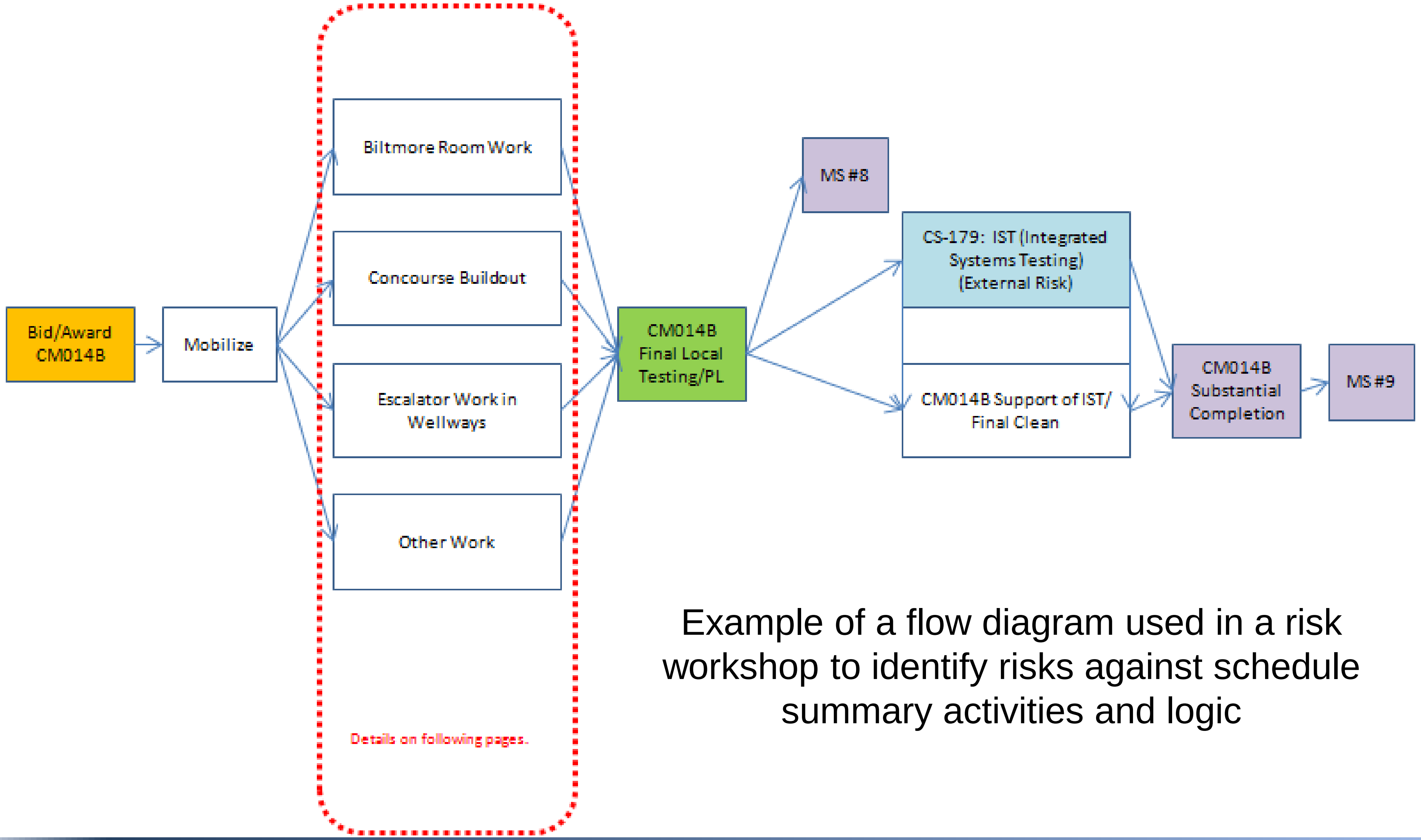
Developing a Master Schedule



Developing a Master Schedule



How Much Detail in a Master Schedule?



Example of a flow diagram used in a risk workshop to identify risks against schedule summary activities and logic

Developing a Master Schedule

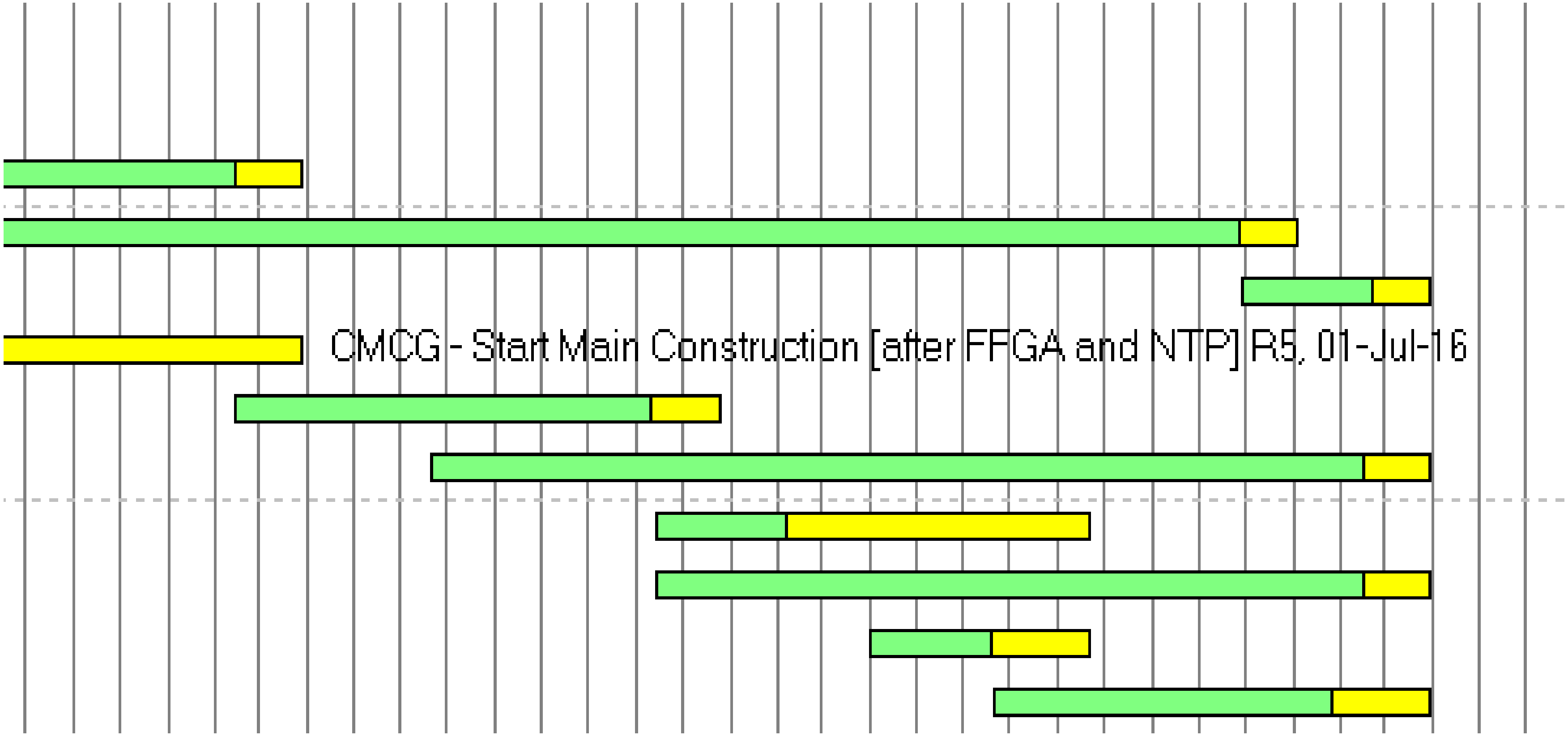
Use the Grantee's Master Schedule or Develop an Independent Master Schedule?

- Is master schedule complete & cover all scope?
- Is it up to date?
- Is it too detailed to follow?
- Is it too detailed to update?
- Does it have a 'basis of schedule'?
- Does it have 'cash attached'?
- Does it follow the KISS principle?

Oversight requires:

- A summary view
- A baseline that can be tracked against
- An ability to quickly conduct periodic updates via site visit / discussion without spending days analyzing the 'weeds'

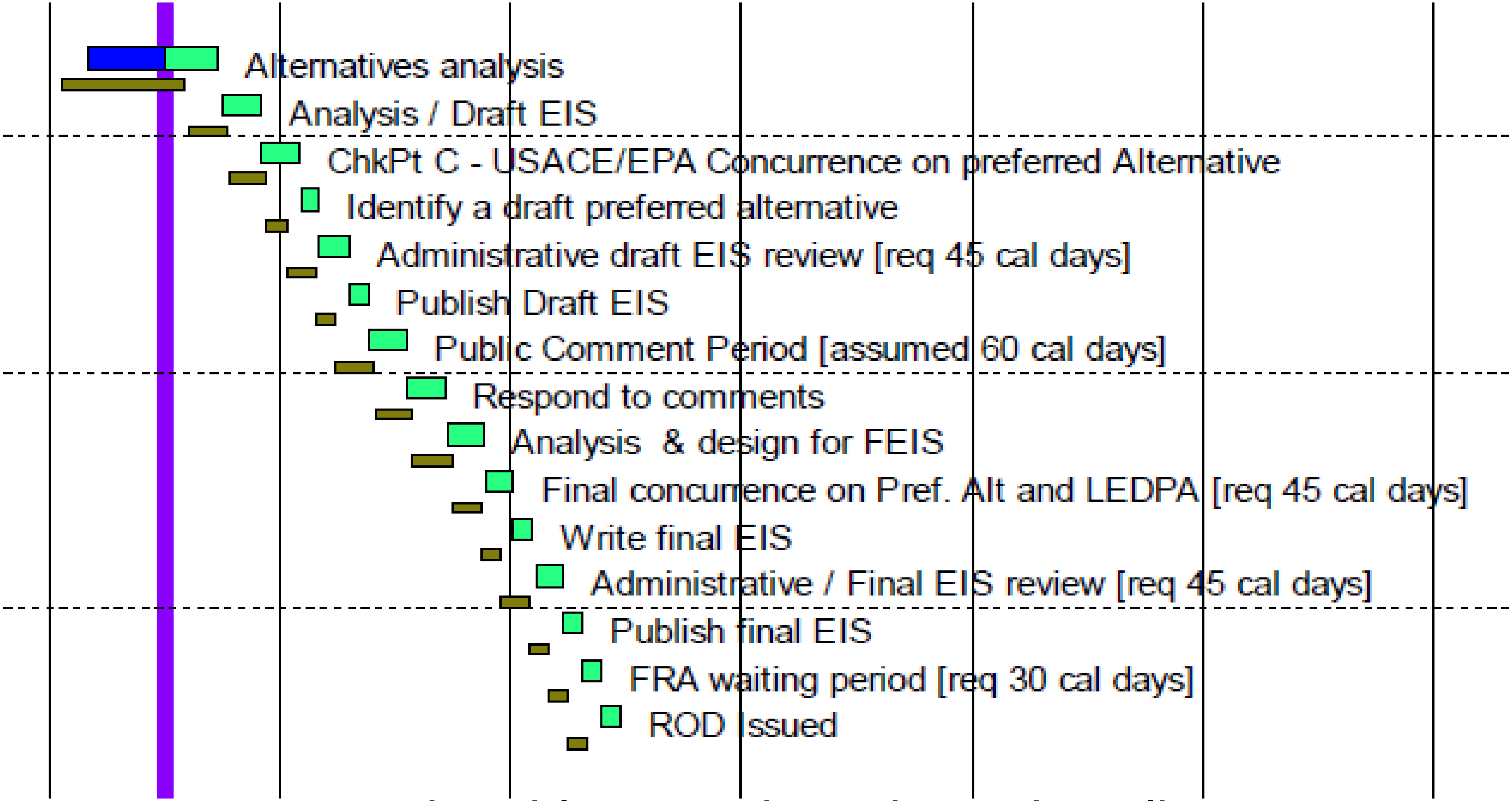
Developing a Master Schedule



Must be able to see Float

Has to be a ‘closed network’

Developing a Master Schedule



Must be able to track against a baseline

Risk Schedule

Why develop a separate risk schedule – why not use the project's schedule?

- Master schedule likely too detailed
- Master schedule often uses 'convenient logic':
  - Mandatory starts / Late Starts / Negative lags / Start to Finish [backward logic] / Roll-up constraints [deterministic]
  - Risks than happen at same time very difficult to model in a large schedule
  - Time required to 'model' and update
  - Turns quickly into a 'black box'

Risk Schedule

Benefits of developing an independent schedule:

- Validates project schedule (key element of ‘oversight’ is validation)
- Forces the risk analyst to think & question logic / constraints
- Acts as a communication tool
- Simplifies discussions on risks / simplifies schedule key elements
- Best way to ‘learn’ the project
- Likely requires the merging of separate schedules
  - ROW
  - 3rd Party Agreements
  - Rail activation Plan / Start-up
  - Design
  - Construction

Risk Schedule

Realistic but optimistic schedule recognizing:

- Target 25% contingency at Entry into Engineering (Entry to Engineering → Revenue Operations Date) on critical / near critical path
- Schedule logic does not easily go ‘backwards’
- Imposed date constraints means no optimism before that date
- Must have constraining calendars or ‘risks’ must allow for ‘step jumps’ (not that easy to ‘guess’ or ‘defend’)
- Grantee Master Project Schedule may not need calendars if it’s designed to ‘avoid constraints’
- Start with a simple logic Flow chart
- Activities need to be able to ‘hang risks’
- Need to mimic critical path and float
- Needs to have all components …not just critical path

Need to see “Visible Schedule Contingency”

Size of Contingency

Depends on the risks

Constraint Illustration

Bridge Footings in River Bed | "wet season" No Work | Complete Bridge

DELAY

Bridge Footings in River Bed

"wet season" No Work | Bridge Footings in River Bed | Complete Bridge

Constraint Illustration

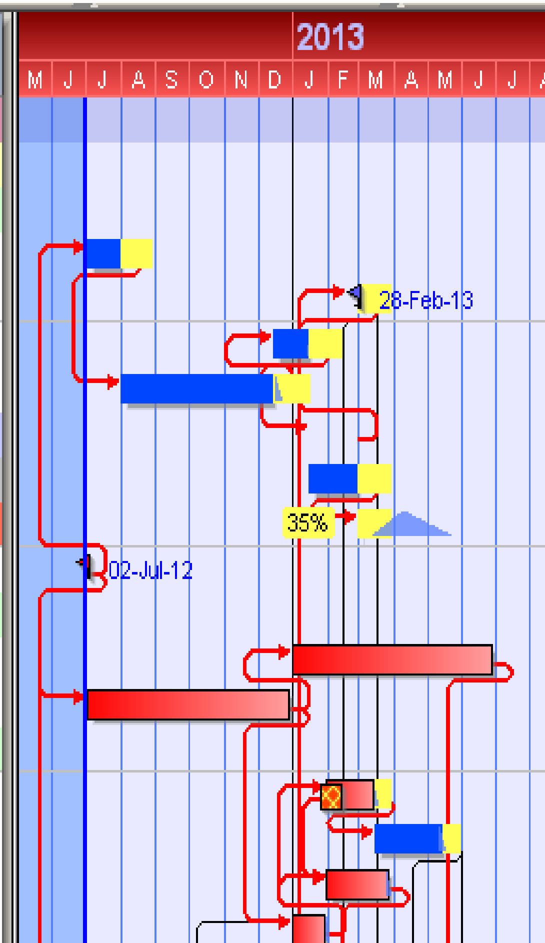
Bridge Footings in River Bed | Fish Season — No Work | Complete Bridge

DELAY → Bridge Footings in River Bed → Fish Season

Fish Season — No Work | Bridge Footings in River Bed | Complete Bridge

Sample Risk Schedule

ID	Description	Remaining Duration	Start	Finish	es	Minimum Duration	Most Likely	Maximum Duration
A	PRELIMINARY ENGINEERING & E...	365	02-Jul-12	01-Jul-13				
A.A	WHOLE ALIGNMENT	362	02-Jul-12	28-Jun-13				
A.A.AB	Environmental Statement	242	02-Jul-12	28-Feb-13				
130	Draft FEIS Document	20	02-Jul-12	30-Jul-12		19	20	21
140	EA Record of Decision [ROD]	0	28-Feb-13					
15	FEIS public comments	20	14-Dec-12	14-Jan-13		19	20	21
150	Final FEIS Document	96	31-Jul-12	13-Dec-12		96	101	106
160	Obtain ROD	32	15-Jan-13	27-Feb-13	Nc			
160: B	Obtain ROD	32	15-Jan-13	27-Feb-13		31	32	33
160:11	ROD delayed - late docuementati...	0	28-Feb-13	27-Feb-13		10	44	88
5	Start schedule [PE Risk Assessm...	0	02-Jul-12					
A.A.AC	Preliminary Engineering	362	02-Jul-12	28-Jun-13				
180	Complete Preliminary Engineering	128	31-Dec-12	28-Jun-13	Nc	127	128	129
30	Preliminary Engineering [for EFD ...	126	02-Jul-12	28-Dec-12	In	125	126	127
A.A.AD	Entry into Final Design process	135	31-Dec-12	14-May-13				
100	Complete Schedule / Estimate ref...	30	31-Jan-13	13-Mar-13		30	33	36
110	Financial Plan update for EFD	44	14-Mar-13	14-May-13		40	44	48
60	Red Line Risk Assessment for EFD	40	31-Jan-13	27-Mar-13		36	40	44
90	PE Documents for EFD	22	31-Dec-12	30-Jan-13		22	24	26



Schedule activities [summary]

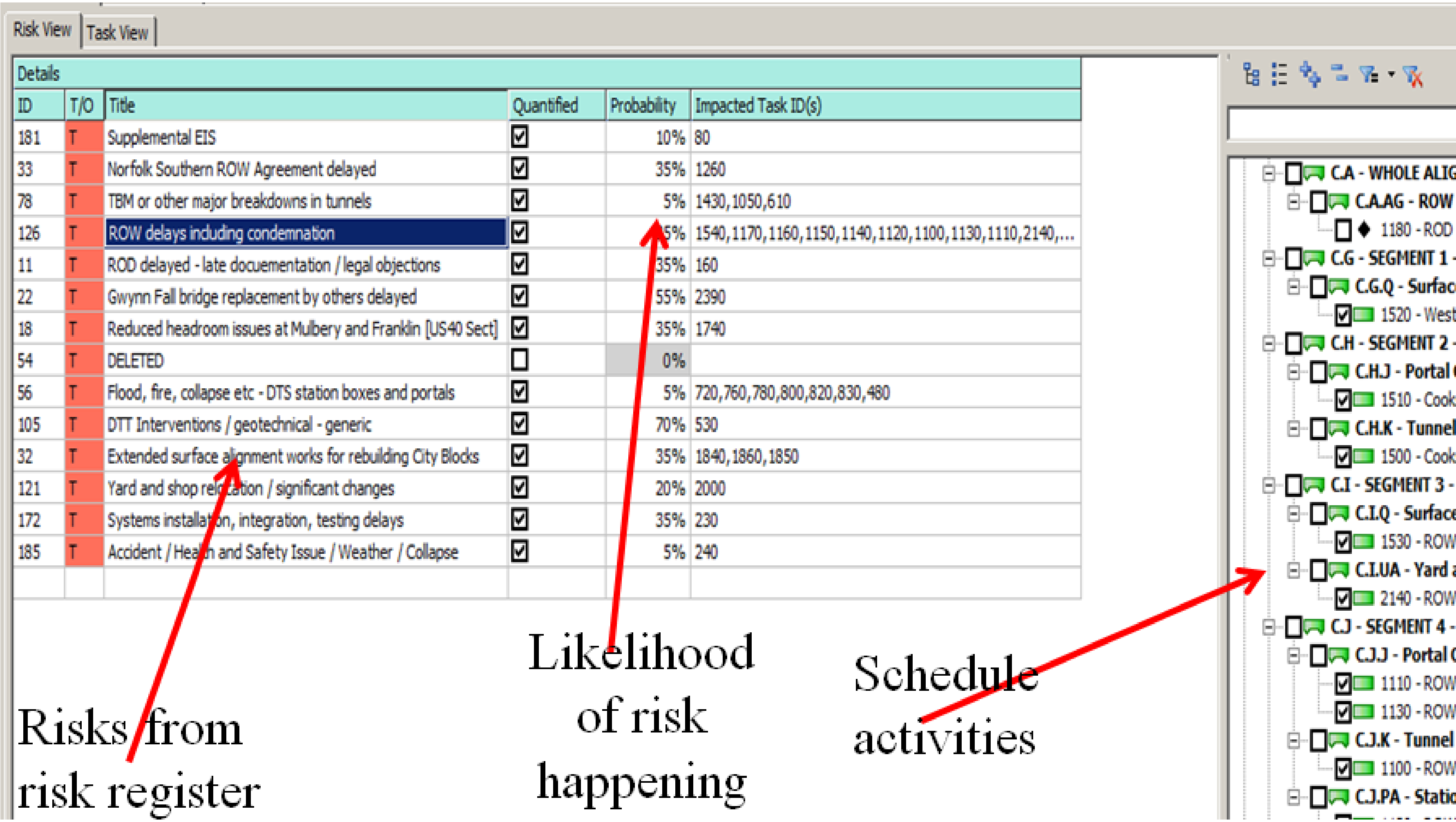
Planned duration

Discrete risk ‘event’

% Likelihood of risk occurring

Range of uncertainty

Mapping Risks to Schedule



Details

ID	T/O	Title	Quantified	Probability	Impacted Task ID(s)
181	T	Supplemental EIS	☑	10%	80
33	T	Norfolk Southern ROW Agreement delayed	☑	35%	1260
78	T	TBM or other major breakdowns in tunnels	☑	5%	1430,1050,610
126	T	ROW delays including condemnation	☑	[illegible]5%	1540,1170,1160,1150,1140,1120,1100,1130,1110,2140,...
11	T	ROD delayed - late docuementation / legal objections	☑	35%	160
22	T	Gwynn Fall bridge replacement by others delayed	☑	55%	2390
18	T	Reduced headroom issues at Mulbery and Franklin [US40 Sect]	☑	35%	1740
54	T	DELETED	☐	0%	
56	T	Flood, fire, collapse etc - DTS station boxes and portals	☑	5%	720,760,780,800,820,830,480
105	T	DTT Interventions / geotechnical - generic	☑	70%	530
32	T	Extended surface alignment works for rebuilding City Blocks	☑	35%	1840,1860,1850
121	T	Yard and shop relocation / significant changes	☑	20%	2000
172	T	Systems installation, integration, testing delays	☑	35%	230
185	T	Accident / Health and Safety Issue / Weather / Collapse	☑	5%	240

A schedule used for risk analysis should ‘model the risks’

The Risk Schedule Structure

- No point in adding detail if no ‘risk against it’
- Many risks impact schedule at the same time so activities need to be able to recognize this
- Critical logic and constraints (that impact risk) must be incorporated

Developing a Risk Register

Presented by

John Holak, *Urban Engineers, Inc.*

The Importance of Core Documents

- Risk is fundamentally the possibility of change to the project's expectations
- Project expectations are captured in the plans, estimate, and schedule for the project
  - Before moving into the risk review, these important project elements must be accurate and in sync
  - All assumptions should be documented
- If these elements are flawed or incomplete, risk assessment may be undermined before it even begins

Project Status Evaluation

- Grantee should conduct internal meetings at each major design and construction milestone
- Major assumptions or unknowns should be recorded as risks
- Fundamental project documents must be provided to complete the project status evaluation
    - Program documents
    - Project agreements
    - Design documentation
    - Cost estimates, with contingencies exposed
    - Schedule, with contingencies exposed

What is a Risk Register?

- A list or database of risk issues or events that could impact the scope or success of completing a project within the planned schedule and budget (Cost Estimate)

- Collaboratively developed in “brainstorming” sessions with internal and external project stakeholders

Risk Identification

- Formal risk identification meetings are held to develop a listing of risks
- Project management and technical experts are in attendance
- Outside experts bring objectivity
- An independent facilitator helps remove bias
- Involving the FRA or MTAC generally speeds up the risk review and builds trust in the process

Identifying Risks

Internal Risks Caused by the actions of the project team (e.g., what if the designers don't choose the best option for a bridge abutment?)	**External Risks** Caused beyond the control of the project team (e.g., what if unforeseen hazardous materials are discovered in a cut?)
Identified Risks	Identified Risks
Unidentified or Unknowable Risks	Unidentified or Unknowable Risks

Categorizing Risks

- It is very helpful to categorize each risk according to these four types:
  - Requirements
  - Design
  - Market
  - Construction
- These classifications mirror the typical evolution cycle of most projects
- After the Risk Register is developed, it is helpful, while risks are discussed, to capture potential mitigation activities

Assessing Risks

- Factoring is a simple method for initially discovering which risks need the most attention

- FACTORING
  - **Probability (P)** – chance of occurrence
  - **Magnitude (M)** – value
  - These 2 factors determine the **Expected Value (E)** of a risk event

$$E = P*M$$

Risk Factoring

Risk Register							
		Identification	Assessment				
	SCC Code	Risk and Outcome	Probability (1-3)	Cost Magnitude (1-3)	Schedule Magnitude (1-3)	Expected Value Cost Score	Expected Value Schedule Score
1							
2							
3							
4							
5							

1 = "Low" Probability or Magnitude
2 = "Medium" Probability or Magnitude
3 = "High" Probability or Magnitude

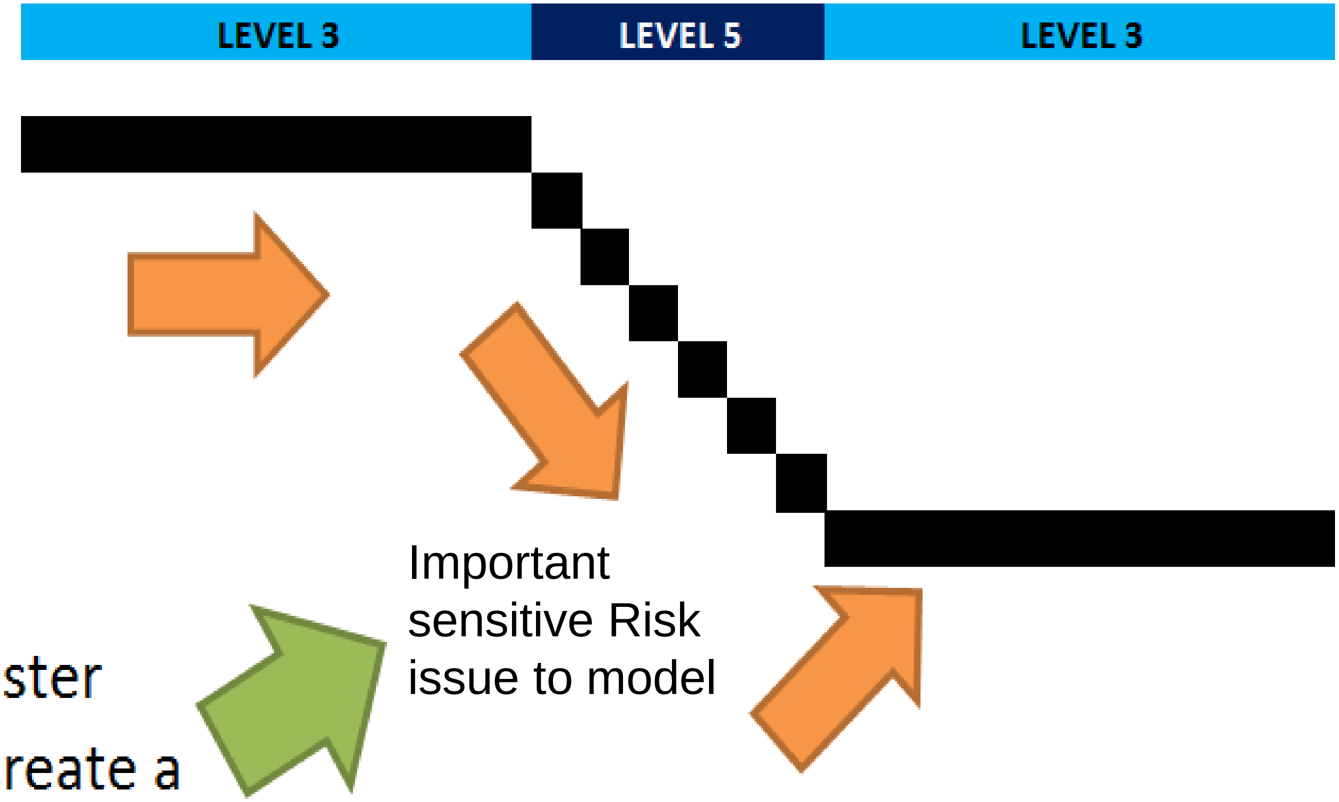
Case Study:
After the Risk Register

Presented by

Will Willson, F.R.I.C.S. A.V.S.

Gardiner & Theobald, Inc NY

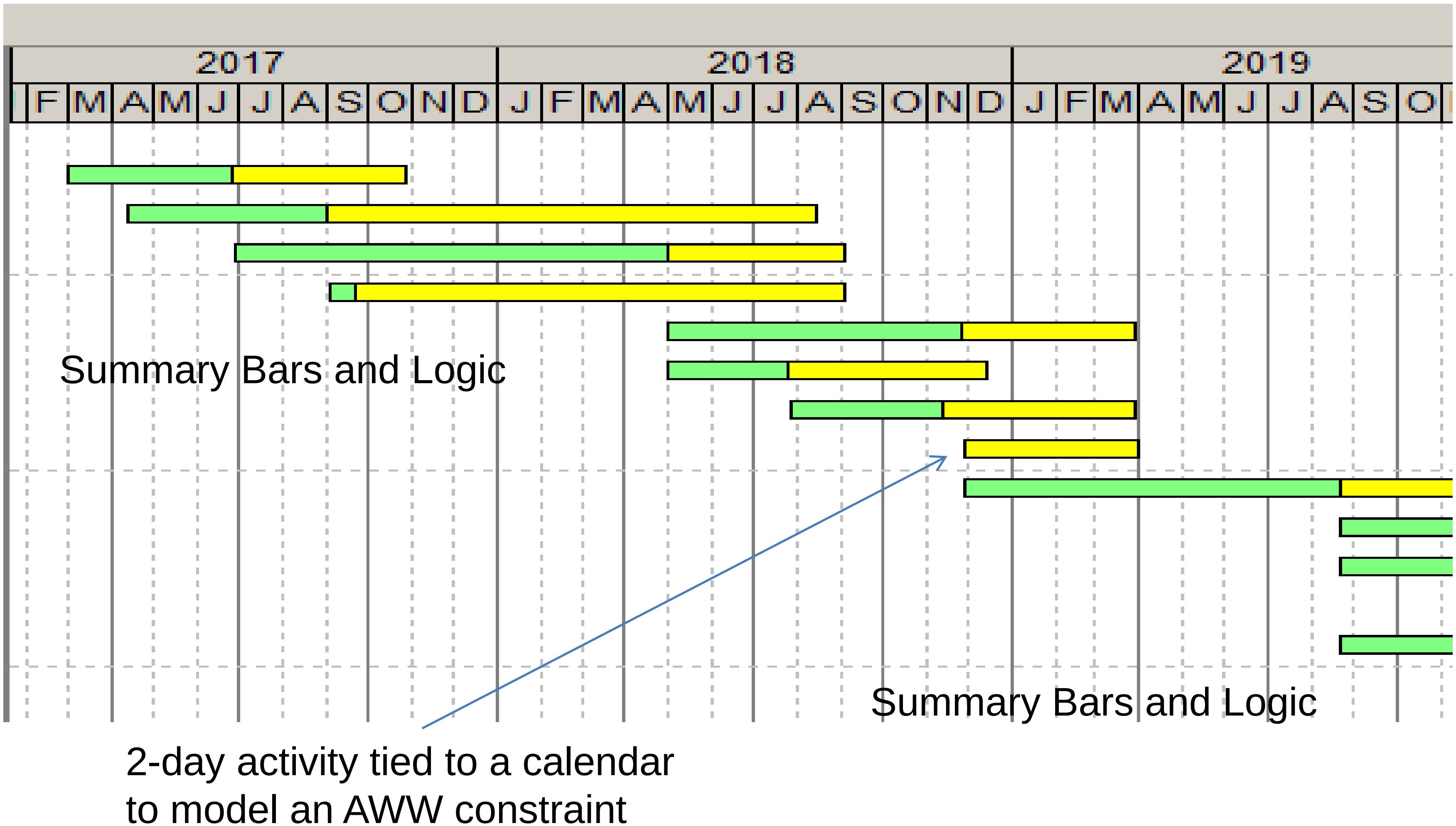
Constraints on a Railroad Project



Risk Register needed to create a 'risk schedule'

Constraints on a Railroad Project

Example of a risk schedule diving in and then out to model a critical constraint issue



Constraints on a Railroad Project

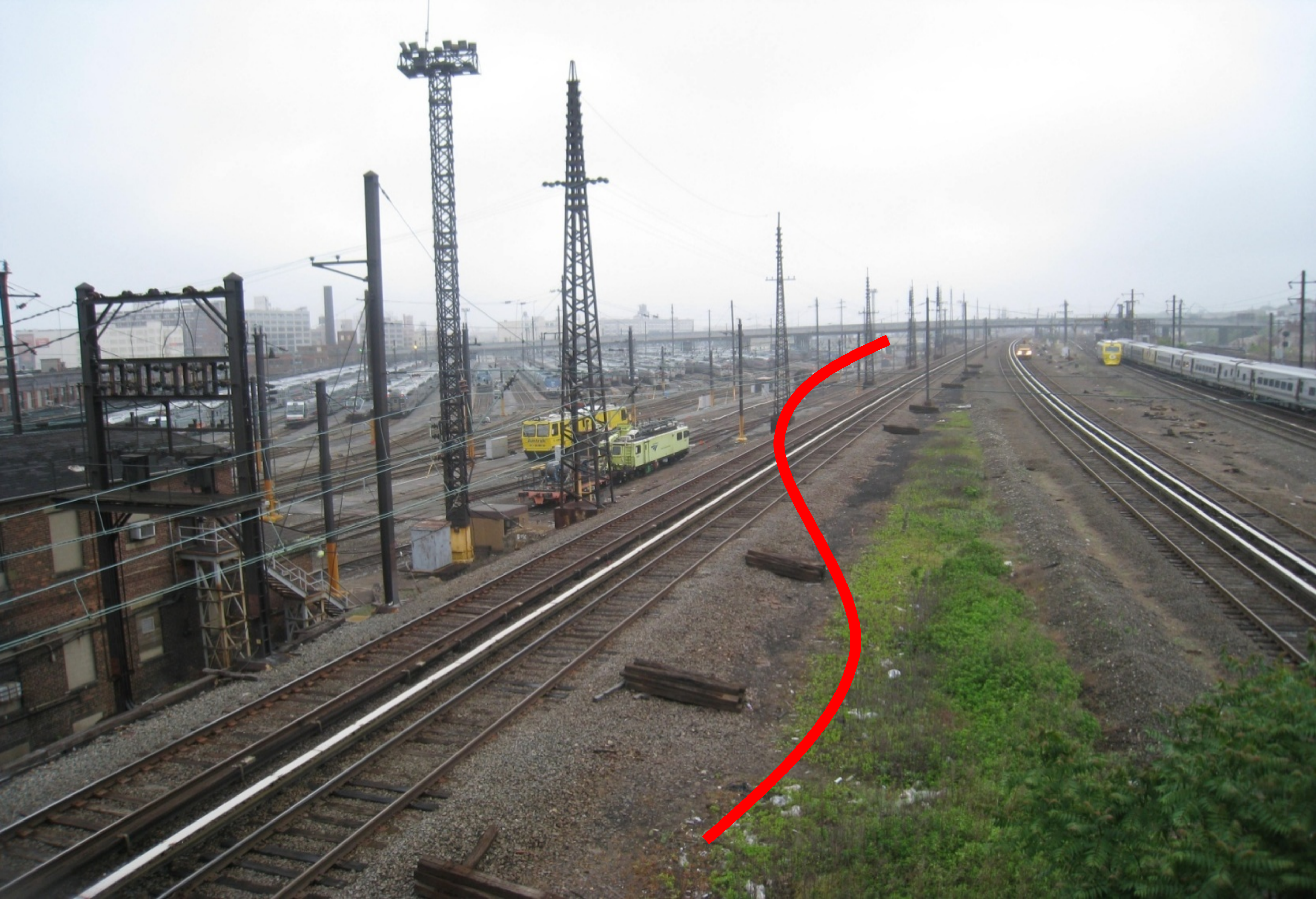
Illustrating that impact risks (cost and time) related to interfacing with the railroads (passenger and/or freight) include:

1. Operational constraints and the realization that stopping / diverting or slowing a train is not "free".
2. Railroad resources are limited and in high demand.
3. Need for flaggers when working adjacent to existing operating railroad - the railroad provides the flaggers (not an unlimited resource and not free).
4. Signal/Communications have to be disconnected / re-connected by the railroad (constrained resource).
5. Windows for major line closures (limited time windows and also seasonal limitations).
6. Not only can your project miss a "track closure window", other projects beyond your control could result in "your window" becoming not available.
7. It takes time to disconnect signals and power and time to test and reconnect signals and power ...this all comes off your 'possession window' ...and there is risk in these operations.

ROAD DIVERSIONS

SHOO FLYS

SHOO FLYS



Mitigations, Contingencies, and Management

Presented by

John Holak, *Urban Engineers, Inc.*

Risk Response

- Once risk events/issues are identified, assessed, and prioritized on a Risk Register
  - Important to develop a structured management plan or response to reduce probability of occurrence or potential impacts to the project
- Four typical Risk Responses:
  - Avoid
  - Transfer
  - Reduce
  - Absorb/Retain

Four Typical Risk Responses

1. Avoidance
   - Pursue a different project or project element
2. Transfer
   - By contract or agreement with the performing parties
   - Consider efficient and equitable allocation of risk
3. Reduce
   - Modifying either the **probability (P)** or **magnitude (M)**, or both, reduces the **expected value (E)** of the risk
4. Retain/absorb
   - Recognize a risk event, but take no action (minimal consequence)
   - Retain it and protect against it
     - Where risks are unavoidable
     - Establish contingencies that can absorb realized risks
     - Develop a “Plan B” in case risks become realized

Primary Mitigations

- A qualitative means to reduce the probability or potential impact of risks
- Define specific and proactive measures or actions to be taken
  - Memorialize timeline to effectively implement action plan
  - Memorialize action plan owner
  - Follow up with periodic Risk Management meetings

Contingency

- A means to address risk events/issues by creating quantifiable risk protection
- Project budgets and schedules should always include amounts to buffer against likely risk-based growth
- Many studies (TCRP and AACE) provide trends on contingency recommendations at various stages of project evolution
  - These should be enhanced through the risk profile of the project and recent industry experience

Secondary Mitigations

- Another quantifiable means to address potential cost or schedule creep on a project when contingencies become insufficient
- Many projects experience unexpected and significant cost challenges as the project proceeds
- Development of plans to recover cost or schedule overruns using redesign techniques where contingency is insufficient
- Alternate design solutions should be considered in worst-case scenarios, but must avoid loss of system functionality and are usually only available during the design phases

Risk and Contingency Management Plan

- Following discussions on mitigations, contingencies, and secondary mitigations, it is highly recommended to memorialize all risk process and steps – a **Risk and Contingency Management Plan**
- Contingency drawdown curves for use of cost or schedule contingencies or implementation of secondary mitigations by authorized staff should be recorded
- Appoint a Risk Manager who will periodically revisit Risk Register, mitigation plans, and contingency levels
- Ensure the support of senior or executive management

Mitigation and Contingency Case Study:

Eastside Access Project MTA of New York, NY

Mitigations – Lessons Learned

Presented by

John Holak, *Urban Engineers*

Project Overview

- ESA will connect Long Island Rail Road (LIRR) trains to Grand Central Station in mid-Manhattan
- Significant tunneling into dense existing infrastructure
- Involves significant interaction with existing Amtrak & LIRR operating service
- Current budget ~ $10.2 billion
- Current Revenue Service Date – February 2021

Mitigations
Lessons Learned

- LL: Expect the unexpected particularly when working around active operating railroads or vehicular traffic
  - Mitigation: Plan, plan, and plan…
- LL: Going underground presents a host of unforeseen issues such as utility interferences, contaminated soils, poor soil conditions, unanticipated structures
  - Mitigation: Increase the number of core borings & underground tests in an expanded area during early engineering

Mitigations
Lessons Learned

- LL: Anticipate staff attrition
  - Mitigation: Develop Succession/Attritions Plans
- LL: Lack of defined organizational processes, procedures, responsibilities, and authority levels can lead to confusion, redundancy, and inefficiencies in project management
  - Mitigation: Have a well-defined Project Management Plan (PMP) that is periodically updated

Mitigations Lessons Learned

- LL: Anticipate operational/extended stakeholder interference that may impact schedules
  - Mitigations:
    - Form Memorandums of Agreement or Understanding (MOA/MOU) with extended stakeholders
    - Minimize need to use Force Account personnel
    - Use fences or barriers to isolate construction zones
    - Refrain from affecting regularly service schedules
    - Maximize work during daylight hours
    - Consider using proactive site design measures (e.g. retaining walls, concrete slabs, etc.)

Mitigations
Lessons Learned

- LL: Use realistic and conservative budgets and schedule projections
  - Mitigations:
    - For complex projects involving multiple stakeholders, underground construction work, operational interference, and coordination of multiple contractors - use conservative estimates for contractor markup, escalation, and schedule activities
    - Expand contingency levels particularly early in project design

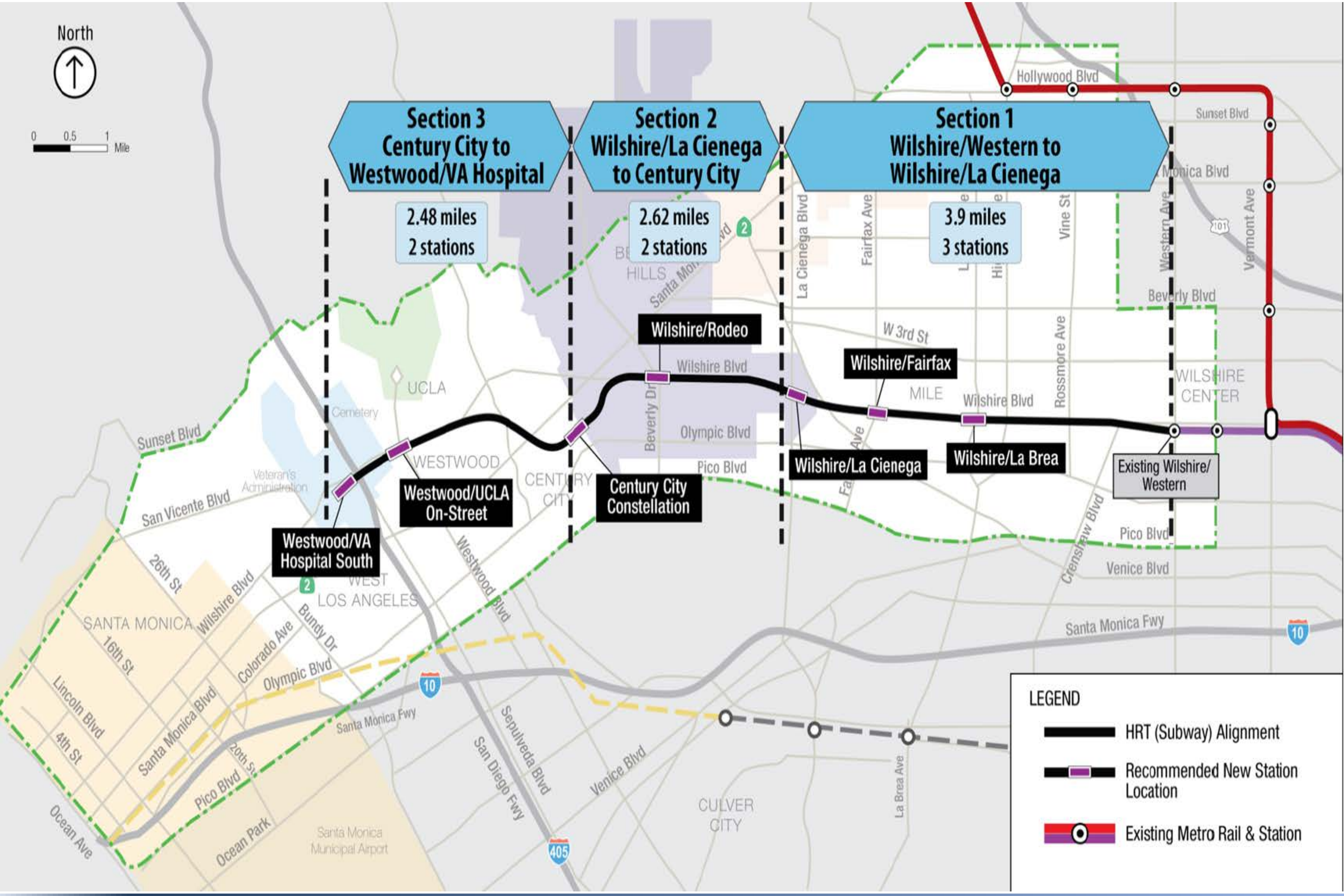
Mitigations
Lessons Learned

- LL: Use conservative procurement cycle schedule allotments
  - Mitigations:
    - Consider alternative Project Delivery Methods by using a educated analysis of plusses and minuses
    - Involve procurement personnel (Officers) in project planning
    - Consider use of industry forums for contractors to offer questions and make suggestions
    - Bundle or segregate contracts after educated analysis
    - If using a Best Value procurement, allow sufficient time for potential discussions, negotiations, BAFO's

Mitigation and Contingency Case Study: Westside Purple Line Extension

Presented by

Thomas E. Mitchell, PE, *Urban Engineers, Inc.*


North
0 0.5 1 Mile
Section 3
Century City to
Westwood/VA Hospital
2.48 miles
2 stations
Section 2
Wilshire/La Cienega
to Century City
2.62 miles
2 stations
Section 1
Wilshire/Western to
Wilshire/La Cienega
3.9 miles
3 stations
Wilshire/Rodeo
Wilshire/Fairfax
Wilshire/La Cienega
Wilshire/La Brea
Existing Wilshire/
Western
Westwood/UCLA
On-Street
Century City
Constellation
Westwood/VA
Hospital South
UCLA
WESTWOOD
CENTURY CITY
BEVERLY HILLS
MIRACLE MILE
WILSHIRE CENTER
WEST LOS ANGELES
SANTA MONICA
CULVER CITY
Santa Monica Municipal Airport
Veteran's Administration
Cemetery
Hollywood Blvd
Sunset Blvd
Santa Monica Blvd
Beverly Blvd
W 3rd St
Wilshire Blvd
Olympic Blvd
Pico Blvd
Venice Blvd
Santa Monica Fwy
San Vicente Blvd
San Diego Fwy
Sepulveda Blvd
Westwood Blvd
Bundy Dr
Colorado Ave
Lincoln Blvd
Ocean Ave
Ocean Park
26th St
16th St
4th St
20th St
La Cienega Blvd
Fairfax Ave
Vine St
Rossmore Ave
Western Ave
Vermont Ave
Crenshaw Blvd
La Brea Ave
Beverly Dr
LEGEND
HRT (Subway) Alignment
Recommended New Station Location
Existing Metro Rail & Station

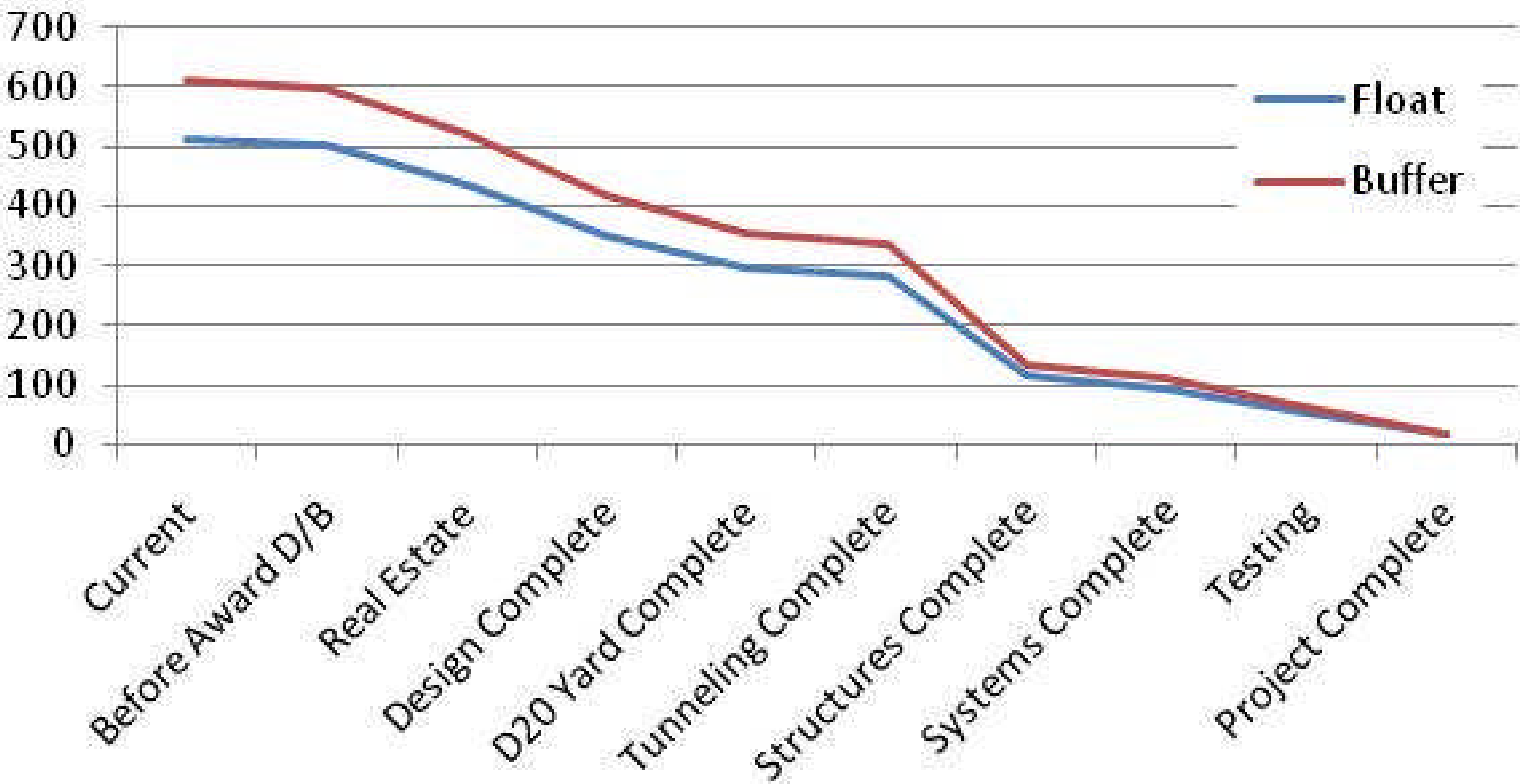
Initial Scope Definition (2010)

- **Nine Mile Project (LPA 9.3 miles) – Key Challenges:**
  - Wilshire Blvd.
  - La Brea Tar Pits
  - Beverly Hills
  - Active Fault Zones
  - UCLA
- **Twin Bore running tunnels**
- **Eight New Stations**

Scope Definition (2013)

- **Section 1 - 3.9 Mile Project – Key Challenges:**
  - AUR Contracts
  - Real Estate
    - 19 Parcels
    - Over 100 relocations
  - Traffic – Congested corridor
- **Twin Bore running tunnels**
- **Three New Stations**

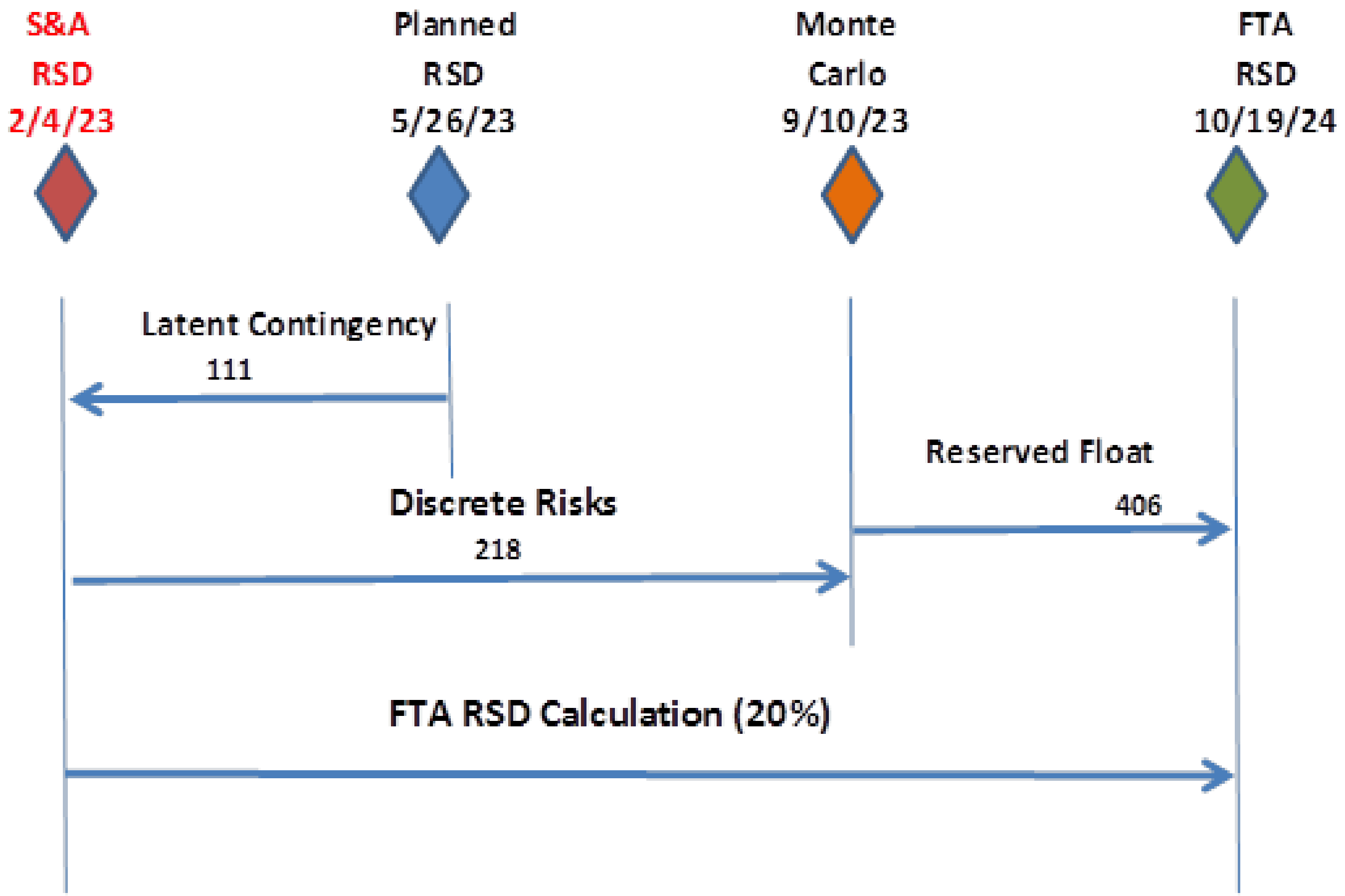
WSE Section 1 Schedule Contingency Drawdown Curve



Section 1 Key Schedule Metrics

• Entry into Final Design:	July 23, 2014
• S & A RSD:	February 4, 2023
• Elapsed Time:	3,118 calendar days
• 20% of 3,118:	624 days or 20.8 months
• FTA Revenue Service Date	October 2024

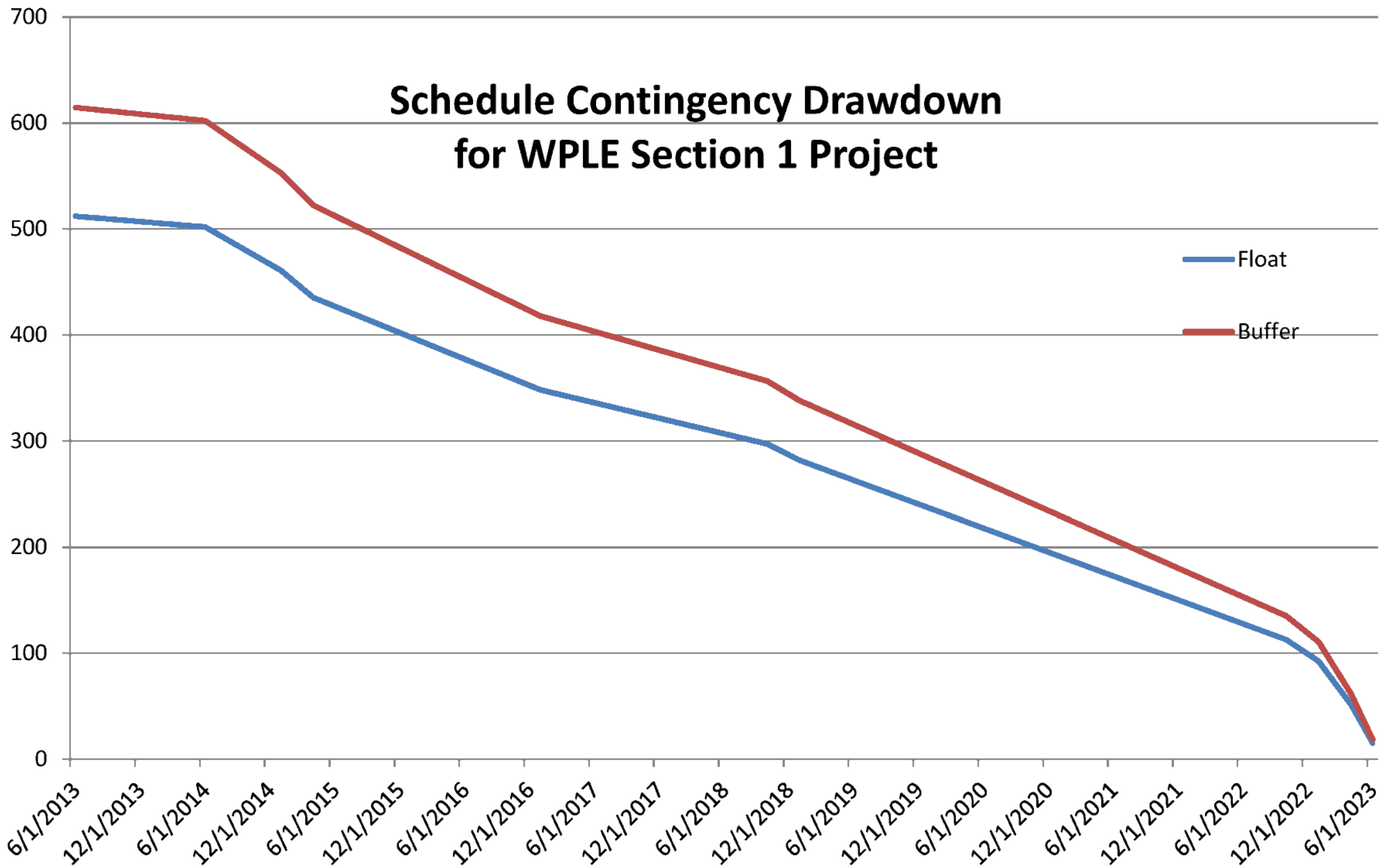
Calculated Schedule Contingency



Risk Assessment Process - Schedules

- **Stripped and Adjusted Budget/Schedule**
- **Add Risks to Budget/Schedule**
- **Determine what Contingency is Needed to cover risks**
- **Conceptualize Mitigation Plans**

Schedule Contingency Drawdown



Q&A and Close

Moderator:

Susan M. Herre, AIA, AICP, *FRA*

Thank you!

For further information, please contact:

Susan Herre, *FRA*
Susan.Herre@DOT.gov

Bill Thomsen, *Urban Engineers*
WTThomsen@UrbanEngineers.com

John Lehman, *Hill International*
JohnLehman@Hill Intl.com

Marian Rule, *TranSystems*
MLRule@TranSystems.com

John Holak, *Urban Engineers*
JHolak@UrbanEngineers.com

Will Willson, *Gardiner & Theobald*
W.Willson@GardinerUSA.com

Thomas Mitchell, *Urban Engineers*
TEMitchell@UrbanEngineers.com