INDEPENDENT PROJECT ANALYSIS

Pacesetter Evaluation of the Muskrat Falls Generation Project and Island Link Transmission Project

Presented to Nalcor Energy

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September 2010

FINAL

Confidentiality Statement

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Objectives of this Pacesetter Presentation

- **Provide feedback on Muskrat Falls Generation Project and Island Link Transmission Project (Muskrat Falls and Island Link Projects) status at end of Front-End Loading (FEL) 2**
  - **Determine if FEL 2 is really closed**
  - **Highlight key activities to be completed during FEL 3 to finalize definition and thereby minimize risk**
  - **Identify gaps that may preclude project excellence**
- **Determine and identify areas of risk**
- ***Present recommendations for risk reduction and performance improvement***

Key Message

- **Muskrat Falls and Island Link Projects are better prepared than a typical megaproject at end of FEL 2**
  - **Clear objectives**
  - **Well-developed project team in place**
  - **Closed scope and optimal project definition**
- **However, key risks present challenges going forward**
  - **Team misalignment on several key project elements**
  - **FEL 3/detailed engineering overlap increases risk of late changes and cost growth**
- **Project team must resolve these issues as it enters FEL 3 to improve its chances for success**

Agenda

- ***Project Background***
- **IPA Process and Methodology**
- **Project Practices**
- **Project Outcomes**
- **Relevant Research**
- **Conclusions and Recommendations**

Business and Project Objectives

- **Business objective: provide renewable, clean, electrical energy through project that focuses on**
  - **Commitment to safety and environment**
  - **Sound business case**
  - **Stakeholder alignment**
  - **Predictable outcomes**
- **Project objective: develop 824-MW powerhouse and associated infrastructure at Muskrat Falls (on Lower Churchill River) and 900MW HVdc Transmission Link from Labrador to the Island of Newfoundland**
  - **Current cost estimate is C$4.9 billion**
  - **Full-funds authorization planned October 2011 with steady-state operations by May 2017**
  - **Costs have higher priority over schedule**

Project Scope

- **Design and install hydroelectric generation facility, transmission links, and support structures**
  - **Two roller compacted concrete overflow dam, river diversion, reservoir preparation, access roads, and other infrastructure**
  - **824-MW power generation via four 206-MW turbine / generator units**
  - **345-kV HVac transmission interconnection from Muskrat Falls to Churchill Falls**
  - **Island Link +/-320-kV HVdc transmission connection from Muskrat Falls to Soldier's Pond (over 1,050 km of overhead Transmission Line)**
  - **HVac to HVdc converter stations, shore electrodes, and 30 km of cable crossing at Strait of Belle Isle**
  - **Island system upgrades**

Brief History

- Nalcor Energy has been developing plans to build powerhouse at Gull Island and Muskrat Falls on Lower Churchill River
- Earlier focus was on larger Gull Island Facility (Phase I) with Muskrat Falls (Phase II) to follow in few years
- Due to delays in achieving market access for Gull Island facility, Nalcor decided to pursue Muskrat Falls site first
- This IPA analysis is a standalone evaluation of Muskrat Falls Project with the 900MW Island Link

Technology

- **Project mainly using off-the-shelf technology**
- **Kaplan turbines at 206 MW each are 20 MW larger than largest turbine currently in operations worldwide**
  - **Team taking steps to reduce any technical risks**
  - **Modeling with turbine vendors planned to further reduce technical risks**
- **Some equipment and construction techniques may be new to company but are proven across Industry**

Execution Approach (1)

- **FEL being performed by owner**
  - **Large owner team (about 88 Full Time Equivalent (FTE)) assigned to the project**
  - **Experienced in megaprojects, hydro power, and transmission projects**
  - **Several studies performed (last few are being wrapped up) on technology, execution approaches, and other areas**
- **Engineering, procurement, and construction management (EPCm) will be awarded by reimbursable contract**
  - **Key packages identified and contracting approach approved by key stakeholders**

Execution Approach (2)

- Detailed engineering to be performed in St. John's, NewFoundland and Labrador, and will start in early FEL 3
  - Most of FEL 3 overlaps with detailed engineering
  - Owner oversight to increase up to ~150 FTE
- Construction to be done using mixed contracting approach; use of incentives not finalized
- Project to be executed in labor-short area
  - Execution overlaps other large projects in region
  - Harsh weather conditions

Stakeholder Management

- **Project involves several external stakeholders:**
  - **Several aboriginal groups from province of Newfoundland & Labrador, and Quebec; claiming aboriginal usage rights within project area land**
  - **Local community in Muskrat Falls, affected by project**
  - **News media, various NGOs, environmental organizations, etc.**
- **Several of these groups could delay project progress**
- **Project team managing all stakeholders with significant and substantive support from local political figures**

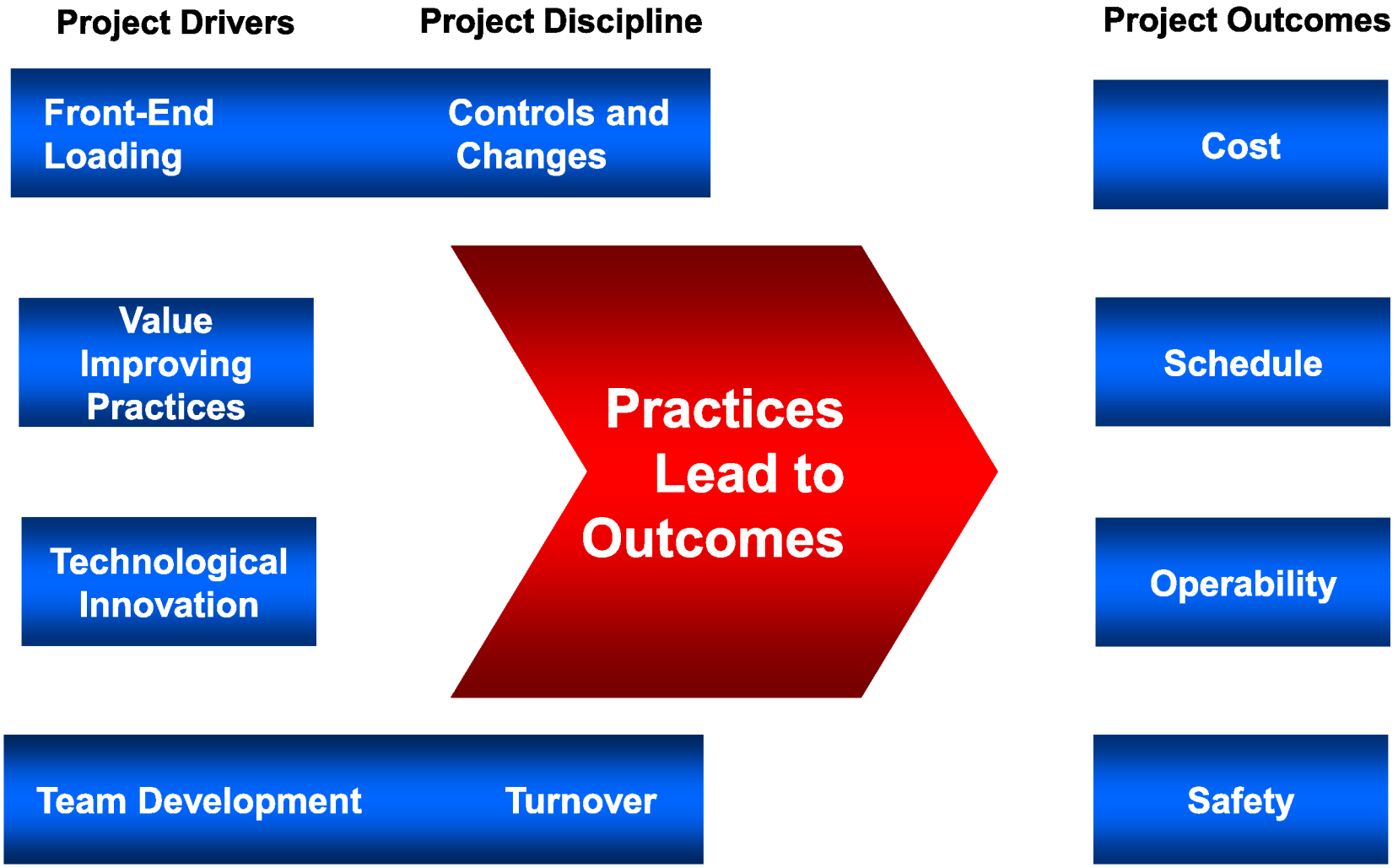
Agenda

- Project Background
- *IPA Process and Methodology*
- Project Practices
- Project Outcomes
- Relevant Research
- Conclusions and Recommendations

IPA's Project Analysis Process

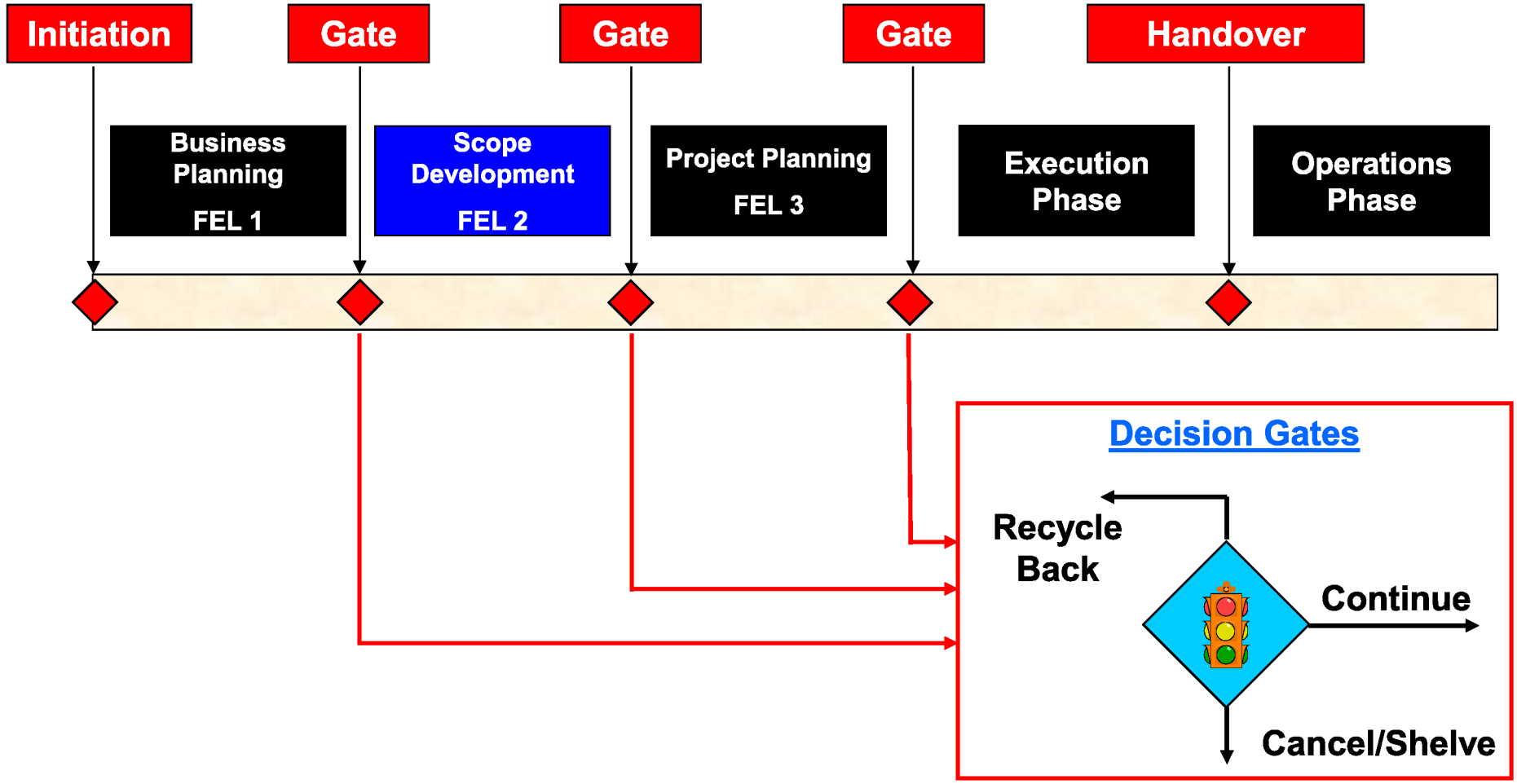
- Interviewed Muskrat Falls Project team members (August 31 to September 3, 2010)
  - Complete IPA benchmarking workbooks
  - Review project documentation
- Identify similar industry projects as comparison basis
- Analyze project, including running models
- Apply relevant IPA research
- Complete preliminary review of analysis
- Prepare deliverable for client
- Complete edit and review of deliverable
- Present findings to client; issue Draft deliverable
- Seek feedback from client
- Issue Final deliverable

Capital Effectiveness: Project Practices Drive Project Outcomes



Three Phases of Front-End Loading

Muskrat Falls and Island Link Projects are at End of FEL 2



Why Is FEL 2 the Most Important Phase?

- **Starting FEL 3 without completing FEL 2 is the root cause of several problems endemic to Industry**
  - **Projects that get delayed, recycled, or cancelled during FEL 3**
  - **Projects that do not meet the business need after they are put into operation**
  - **Projects that reach *Best Practical* FEL, but do not have competitive outcomes**

Goals for FEL 2

- **Goals for FEL 2**
  - **Align project objectives with business objectives**
  - **Develop a reliable cost estimate to judge the robustness of the business case**
  - **Set competitive cost and schedule targets**
- **Key Practices**
  - **Clearly defined business and project objectives**
  - **Integrated team during FEL 2**
  - **Completing engineering definition**

Basis of Comparison

- **Inherent project characteristics influence outcomes to varying degrees, including:**
  - **Project size**
  - **Location**
  - **New technology**
  - **Technical complexity**
  - **Degree of revamp**
- **IPA does not analyze project outcomes in this evaluation**
- **However, we share relevant research findings from IPA studies**

Defining a Megaproject

- A project can be considered a megaproject if it meets one or more of the following criteria:
  - Project cost is greater than $1 billion
  - Project has potential to change its environment:
    - > Regulatory environment
    - > Local labor markets
    - > Local political environment
    - > Financial environment
    - > Physical environment
  - Project represents major step-out of complexity or size for the company

Muskrat Falls and Island Link Projects meets all these criteria

Unique Characteristics of Megaprojects (1)

- ✓ Require huge physical and financial resources
- ✓ Stretch available resources to the limit
- ✓ Built in areas with hostile climates and inadequate basic infrastructure
- ✓ Built in areas where the culture is alien to those responsible for project management
- ✓ Have a high profile within sponsoring firms/agencies and in the politics of the host countries

Muskrat Falls and Island Link Projects' characteristics are similar to megaprojects in IPA's database.

Unique Characteristics of Megaprojects (2)

- ✓ Have long schedules that result in more team member turnover than typical projects
- ✓ Comprise several functional areas with separate project managers, schedules, and budgets
- ✓ Include several major contractors, each with distinct contracting strategies
- ✓ Have complicated communication matrices between functional areas, contractors, business, local government, etc.

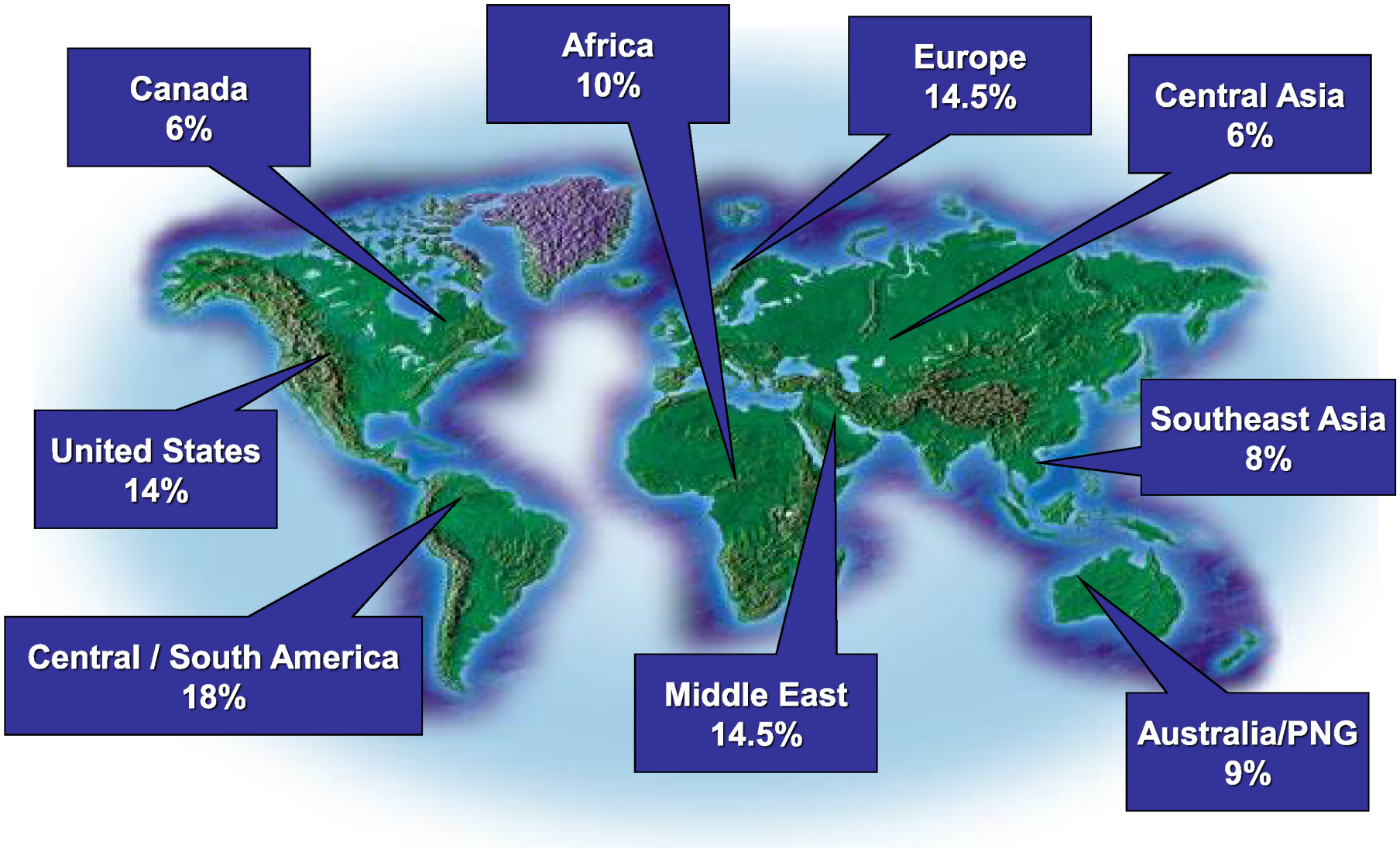
Muskrat Falls and Island Link Projects' characteristics are similar to megaprojects in IPA's database

Comparison Dataset Characteristics

- **Megaprojects dataset used to share findings**

Size of Overall Megaproject Database	**316 Projects**
Average Project Cost ***(2009 US$)***	**2.9 Billion**
Range of Project Costs (2009 US$)	***$960 Million to $16 Billion***
Average Authorization Date	**2003**
Number of Companies Represented	**80**
Percentage of Projects w/ New Technology	**15%**
Percentage of Joint Venture Projects	**64%**

Geographic Distribution of Megaprojects Dataset

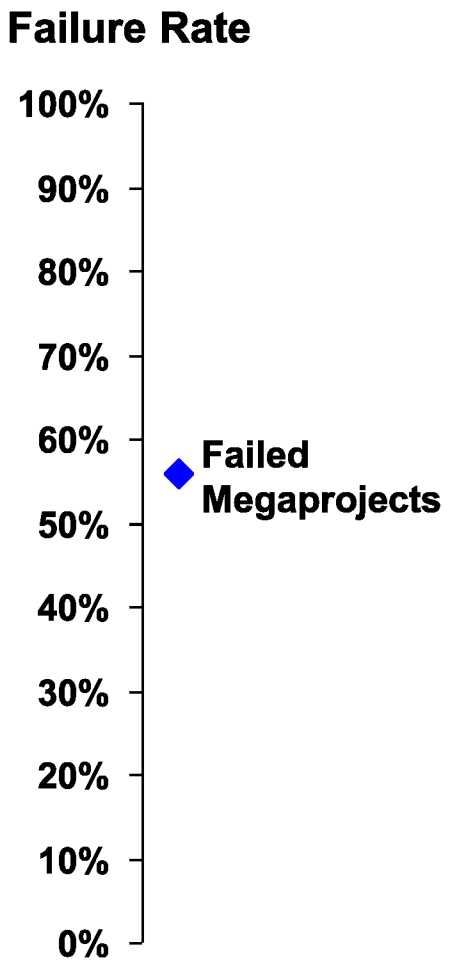


Megaproject Success and Failure

- **We deem a project to be a failure if one or more of the following occurred:**

Costs grew	25% +
Schedule Slipped	25% +
Overspent *(Absolute Measure)*	25% +
Severe and Continuing Operational Problems *(1 year or more)*	Yes

- **Of the projects that failed (56 percent):**
  - 42 percent failed on one criterion
  - 32 percent failed on two criteria
  - 21 percent failed on three criteria
  - 5 percent failed on all criteria



Relevant IPA Research

- Analysis draws data and findings from applicable special studies performed by IPA over last 20 years
- Some relevant findings indicate:
  - Greenfield projects experience an average of 26 percent cost growth from FEL 2 to FEL 3
  - Integrated teams are key predictor of megaproject success
  - Cost reduction exercise is most common source of late changes in FEL 3
  - Executing a project in labor-short environment costs more and results are less predictable

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- IPA Process and Methodology
- *Project Practices*
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Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- ***Clearly defined business objectives and project objectives***
- Project teams with adequate representation from key stakeholders, especially business (integrated team)
- Reaching closure on project scope at end of FEL 2

Clarity of Business Objectives

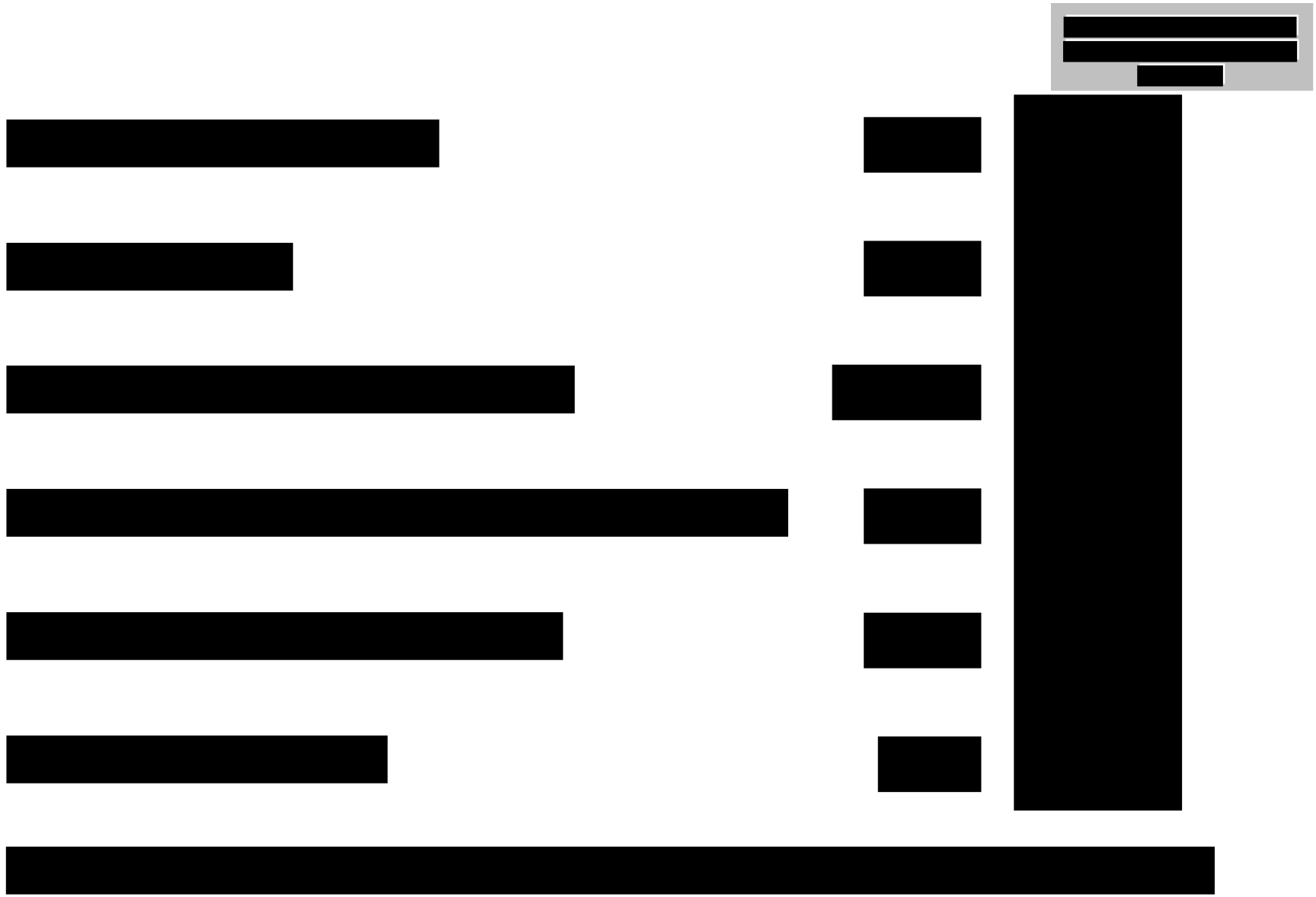
Muskrat Falls Project has clear business objectives and project objectives but risks, though manageable, exists

Risk to Clearly Defined Objectives	Issue for the project?
Turnover of project manager or business manager	No
Design changes in execution	No
Project a lower priority to the business	No

Risks to Business Objectives

- **No Project Manager turnover yet, but increased probability due to long cycle time**
  - **Typically PM is assigned to another project: team dynamics are broken; contractors have problems adjusting to new point of contact; decisions are revisited**
- **Risk of design changes are high during execution**
  - **Nalcor Energy and project team has performed several studies leading up to FEL 2 and remaining few are being wrapped up**
  - **Some team members indicated that they may look at additional options during FEL 3 and engineering; Project Management team reinforced that scope was closed**
  - **Overlap of FEL and engineering introduces additional risks**

Key Team Member Turnover Affects Cost, Schedule, and Operability



Risks to Business Objectives

- No Project Manager turnover yet, but increased probability due to long cycle time of the project
  - Typically PM is assigned to another project: team dynamics are broken; contractors have problems adjusting to new point of contact; decisions are revisited
- **Risk of design changes are high during execution**
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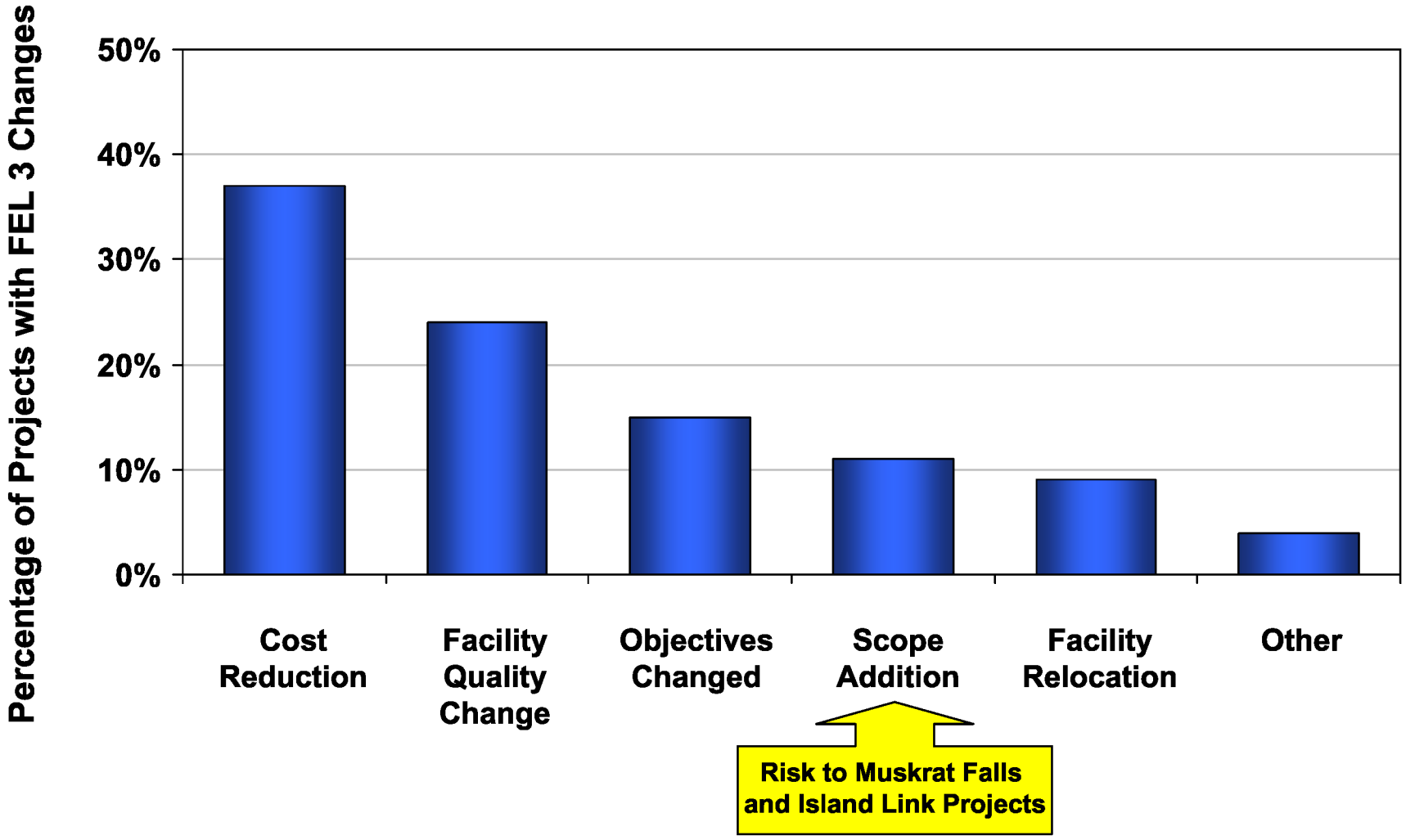
Most Common Sources of FEL 3 Change



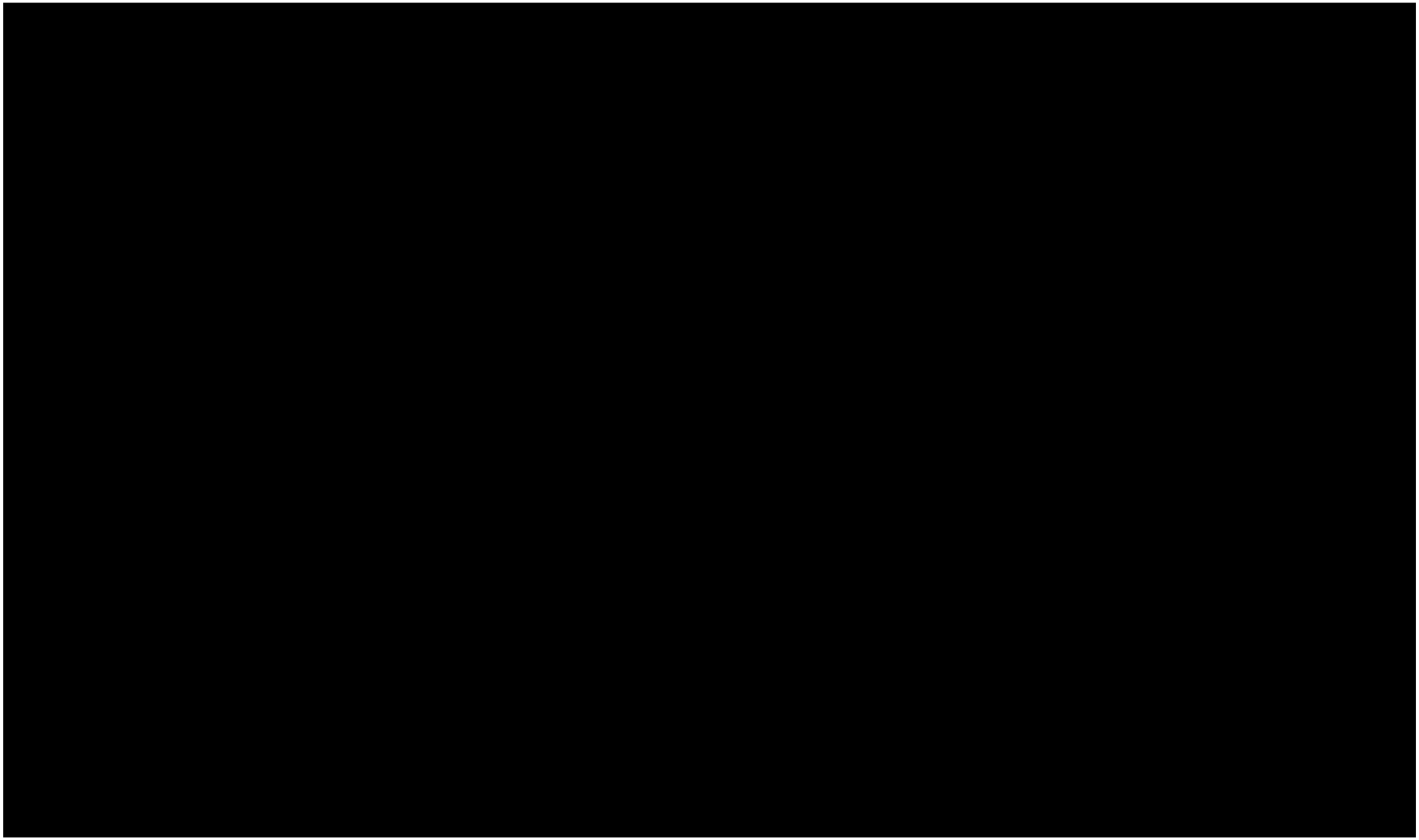
The Effects of Major Changes in FEL 3

Major Changes in FEL 3
Increase Occurrence of Changes in Execution

	NO CHANGE IN FEL 3	CHANGE IN FEL 3
Major Change During Engineering		
Major Change During Construction		
Major Change During Start-Up		

Factors That Discourage FEL 3 Change

Several Already Addressed on Muskrat Falls and Island Link Projects



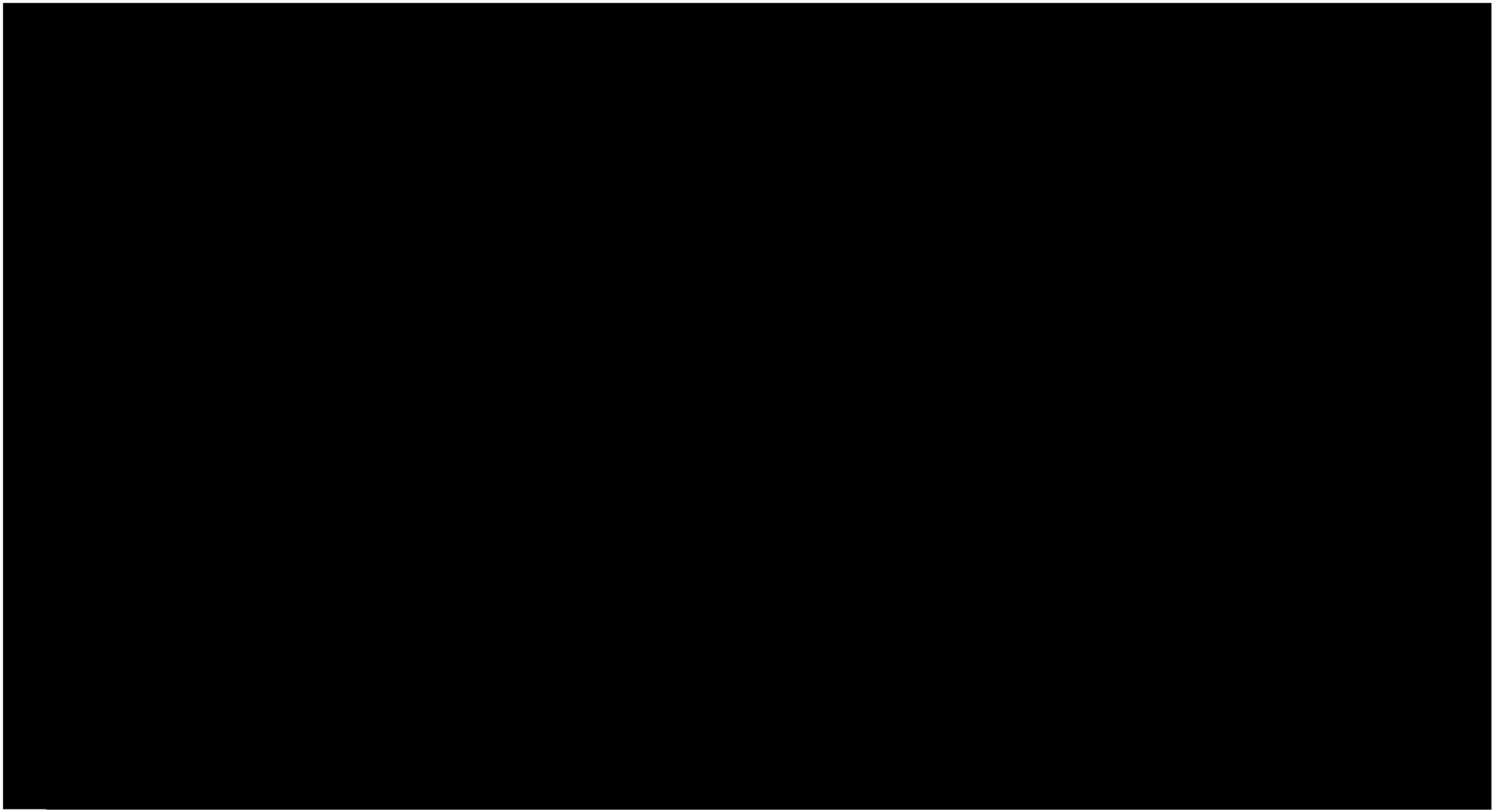
What Is the Right Response to Change in FEL 3?

Response Options for FEL 3 Changes:

- Soldier on after trending the estimate.
- Do a complete re-estimation of the project with the changes incorporated.
- Substantially extend FEL 3 to try to incorporate the changes in the FEL package.
- Recycle the project to the appropriate point in FEL 2.

What do we actually choose?

The Effects of Our Choices



If faced with Change in FEL 3, recycling project to FEL 2 is the most cost effective option; costs are the primary driver for the Muskrat Falls and Island Link Projects

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- Clearly defined business objectives and project objectives
- ***Project teams with adequate representation from key stakeholders, especially business (integrated team)***
- Reaching closure on project scope at end of FEL 2

Components of Team Development Index (TDI)

Project Objectives

Team Composition

Roles & Responsibilities

Project Implementation Process

Muskrat Falls and Island Link Projects TDI Is *Good (1)*
Project Team is Integrated

- **Business and project objectives are clearly defined and communicated**

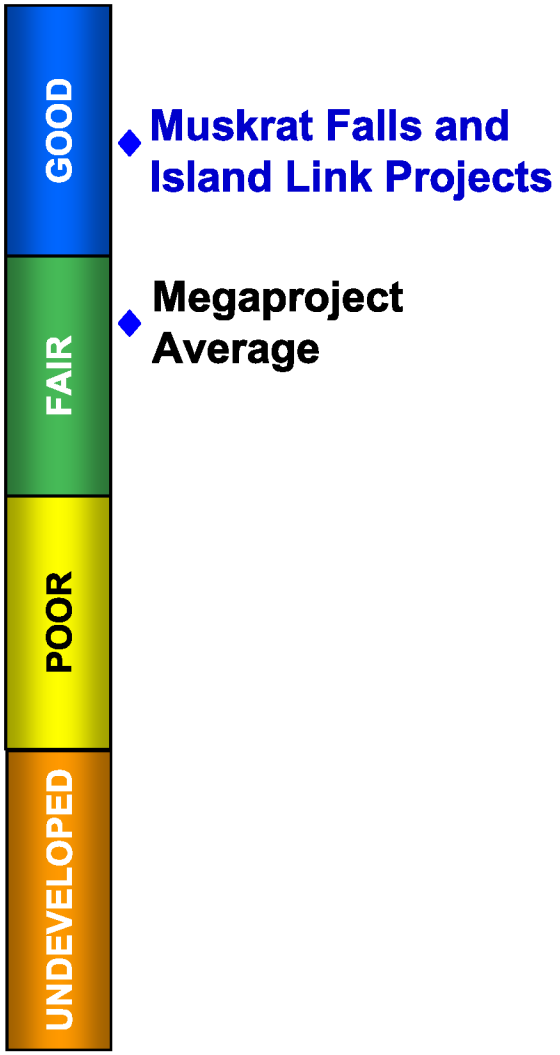
  Clearly defined business and project objectives, but some team members have doubts (details in Team Functionality section)

  Good alignment between project drivers and Nalcor's overall objectives

- **Project team is fully integrated**

  Experienced megaproject team comprises 1/3 owner staff (remainder are consultants); some members filling multiple functions

  FTE ramp-up from ~88 to ~ 150 expected in early FEL 3



Muskrat Falls and Island Link Projects TDI Is *Good (2)*
Better Than Comparison Group

- **Roles and responsibilities are defined, and risks have been assessed**

  Project team has defined and established roles and responsibilities (R&R)

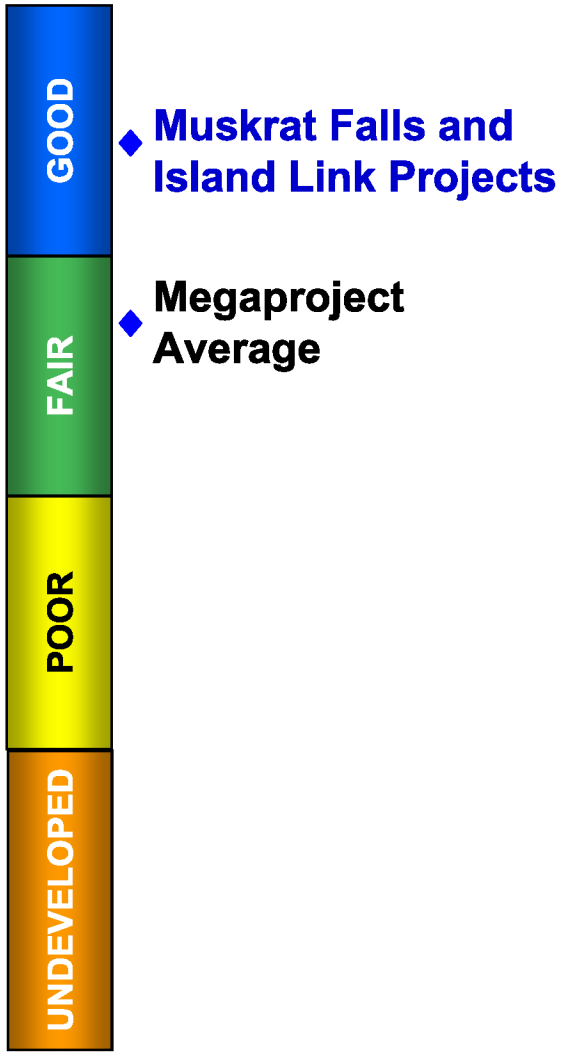
  Comprehensive risk register updated regularly, external consultants hired to analyze project risks

- **Standard work process is in place**

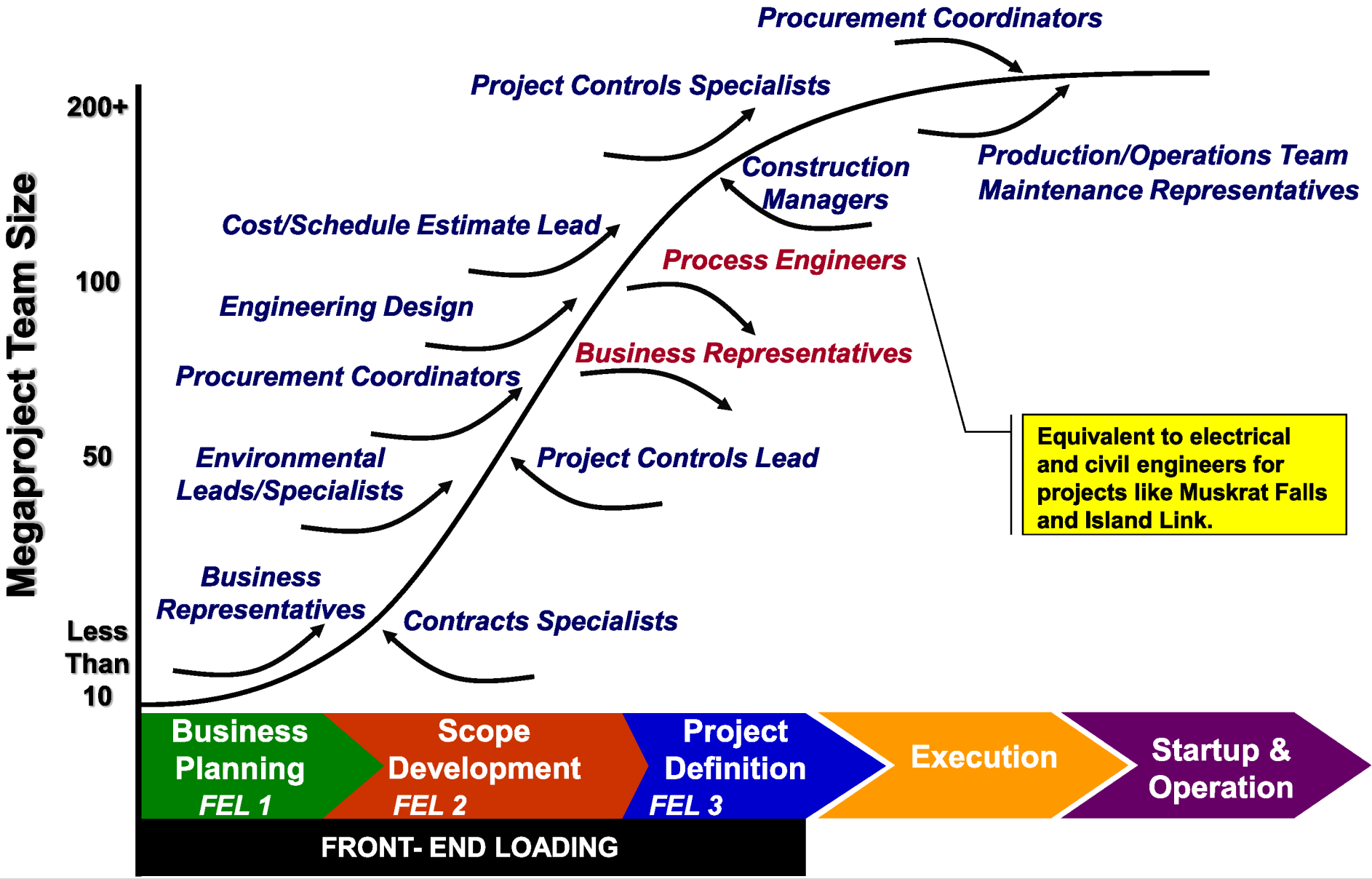
  Project following Nalcor's Gateway work process, which was modified; more changes planned for first-time implementation on a megaproject

  Training ongoing for team members and planned for contractors

  Gate approvals are deliverable-based



The Project Team Changes Its Size and Composition as the Project Progresses



More Lead Process Engineer Involvement in FEL 3 Results in More Changes

Increased involvement of process engineers (i.e. civil and electrical engineers on projects like Muskrat Falls and Island Link) increases the likelihood of "tweaking of scope", "application of latest technology", "performing studies", etc. which eventually leads to costly changes

Megaprojects With Integrated Teams Are More Successful

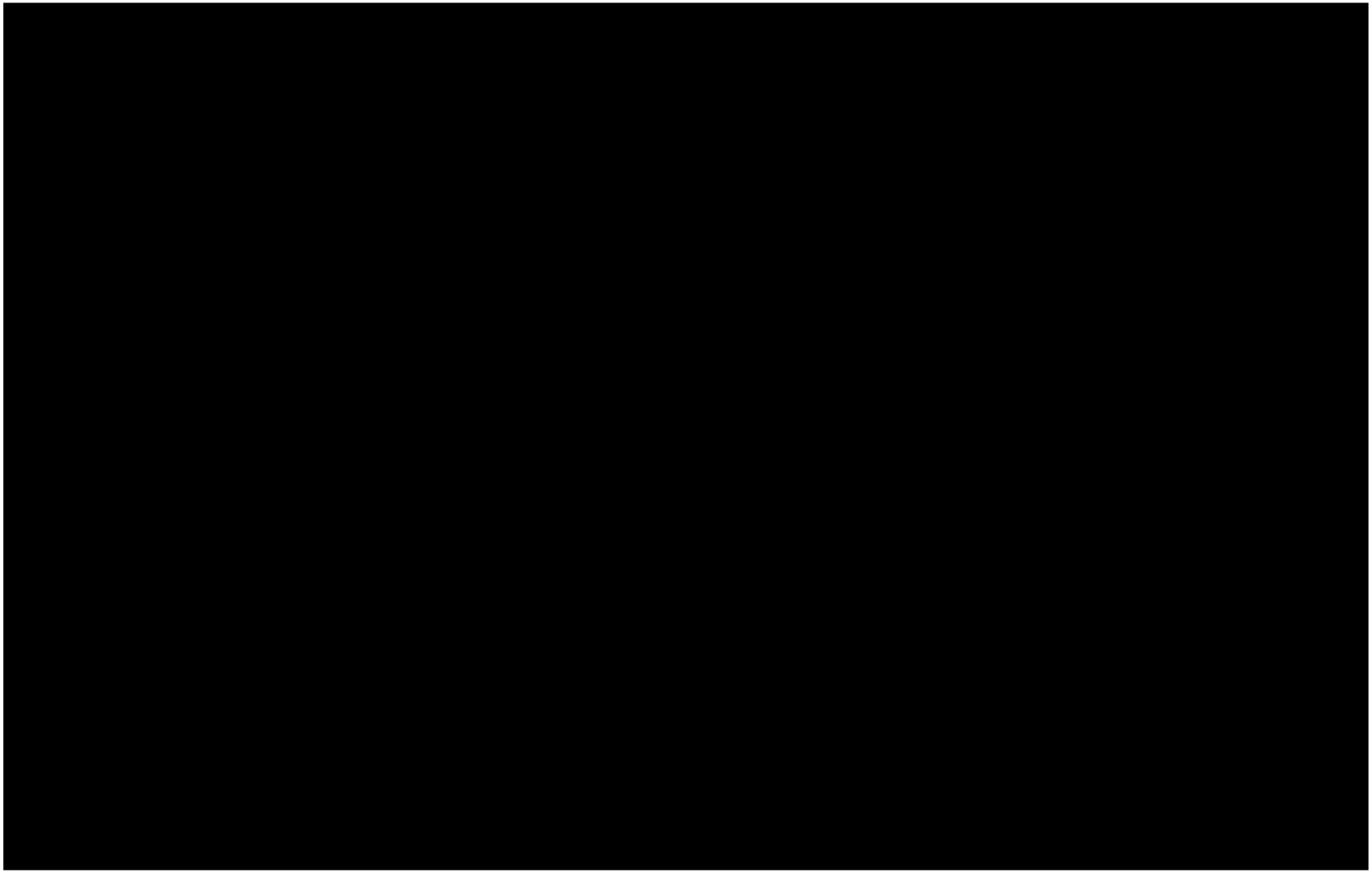
Muskrat Falls and Island Link Projects has an integrated team

High Level of Owner Involvement

What does it mean for the owner to be highly involved?

- ✓ Steps are taken to integrate the owner team with the contractor team
- ✓ Strong owner project controls are in place
- ✓ Early development of interface management plans

High Owner Involvement Improves Megaproject Cost Performance



Muskrat Falls and Island Link Projects has highly involved owner team

Value Chain for Capital Projects

Business Strategists

Business Objectives

Project Group & Feasibility Manager

Project Management Process

Process Engineers & Core Project Team

Project Objectives

Key Stakeholders Involved

Stakeholders Aligned

Feas. Study Project Team

Right Technology

Contractors Involved

Risks Understood

Scope Agreed To

Execution Strategy in Place

If any link is unsound, the project will most likely fail

The team responsible for the project believes it is ready for execution

Team Functionality Measures Team's *Perception* of These Four Elements

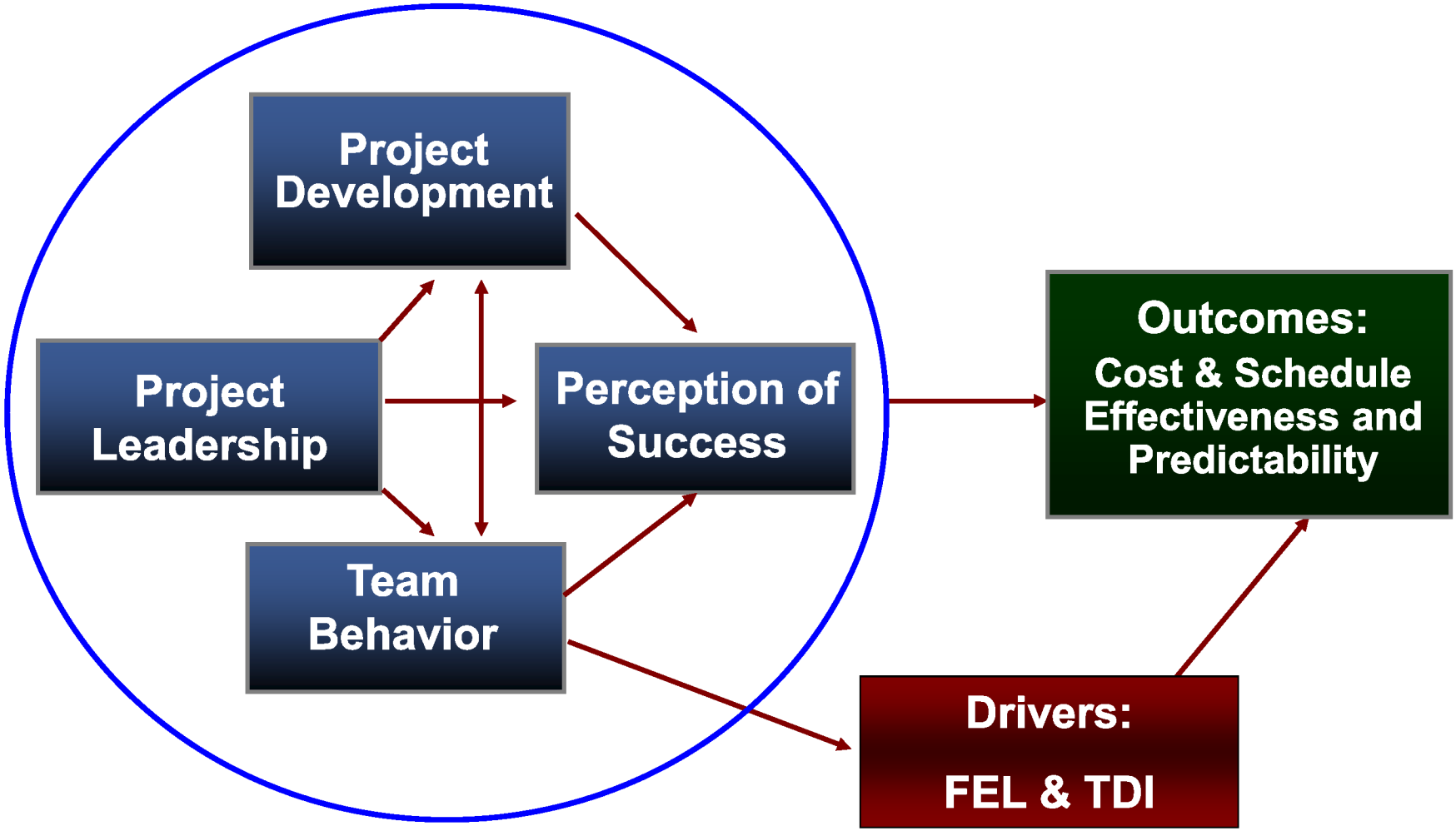
Leadership

Project Development

Team Behavior

Project Success

Team Functionality Drives Project Outcomes Both Directly and Indirectly

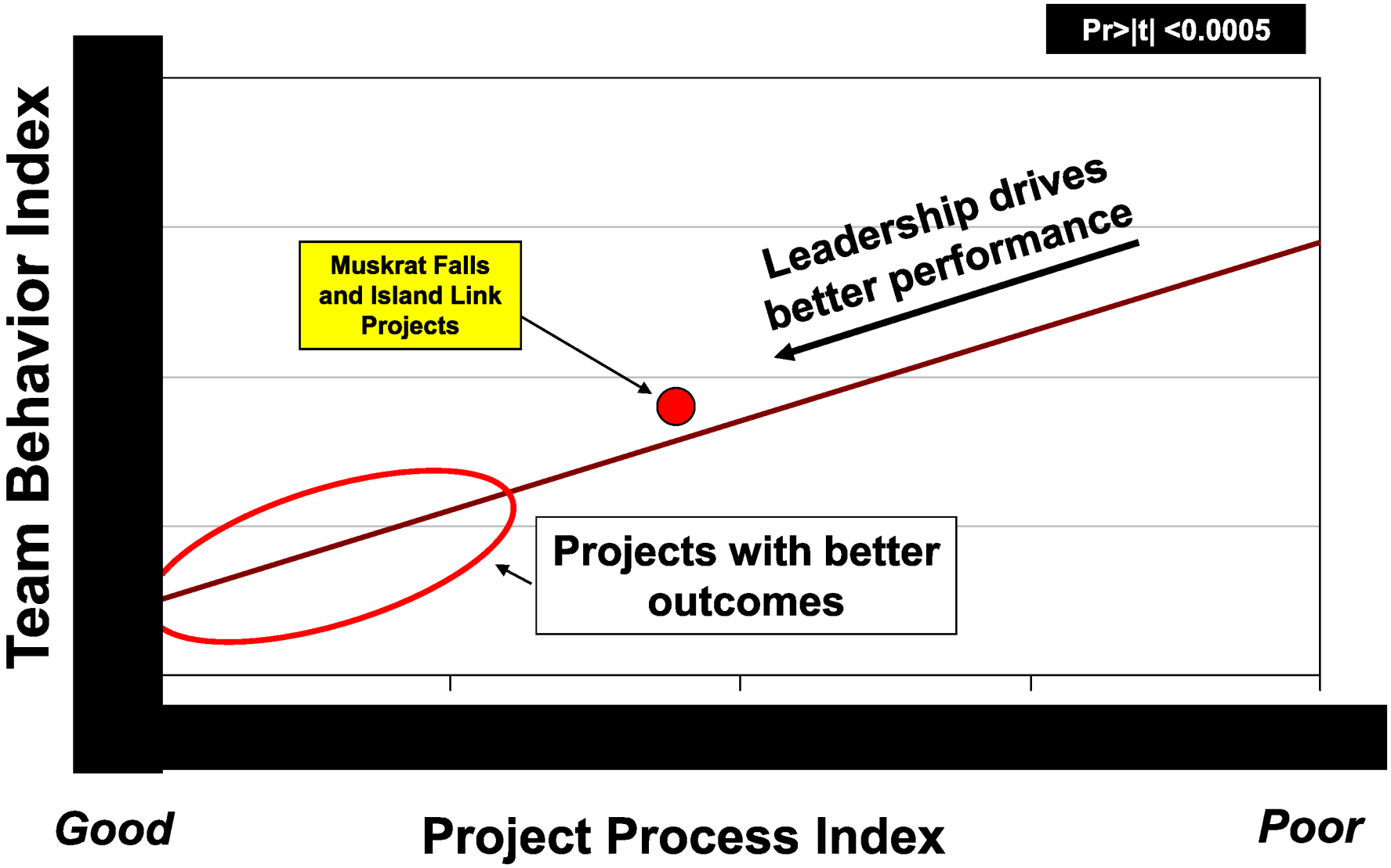


Elements of Team Functionality

Muskrat Falls and Island Link Projects Team Functionality Survey

- 28 out of 24 completed surveys were returned from project team
- Team Functionality Indices are calculated from responses from each member and then averaged for each team
- Team Behavior Index is average of six Likert Scale questions, including:

The Driver Is Project Leadership

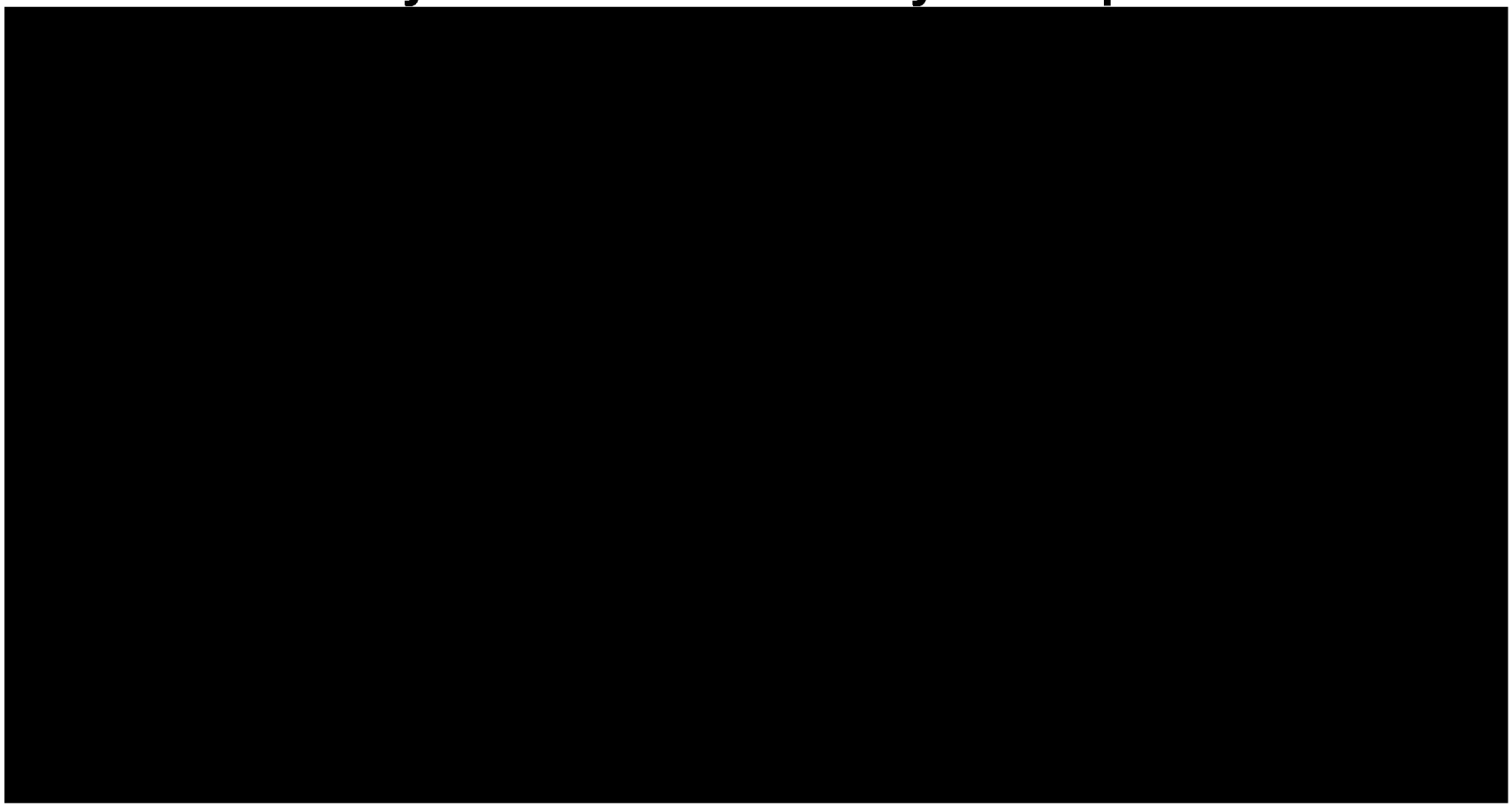


Observations from Team Surveys

- To better understand gaps discovered in surveys, IPA shares some questions that got lowest responses
- Graphics on next few slides pertain to specific question, however, the ratings are based on several questions and proprietary formulas
  - Graphics shows response from Muskrat Falls and Island Link Projects
  - Goal for Muskrat Falls and Island Link Projects

Observations Related to Clarity of Project Objectives

As shown below, team members believe business/project objectives have changed since scope has changed, hence they need additional clarity on scope



Observations Related to Decision Making

Team members believe they have input on key decisions but as shown below the key decisions are not made in timely manner

Observations Related to Team Communications

Team members believe they cannot express different opinions and as shown below some feel they are not part of team

Observations Related to Team Alignment

Team members believe their roles and responsibilities are unclear and as shown below project lacks alignment on implementation approach

Observations Related to Team Behavior

Team members believe they are highly motivated to make project a success but as shown below performance is affected by personal conflict

Observations Related to Project Process

Team members believe they don't have clear understanding of project implementation process

Observations Related to Project Integration

Team members believe they don't have good support from interfacing departments and as shown below project strategy lacks alignment

Observations Related to Project Leadership

Team members believe project leaders lack clear vision on how project should be implemented

Muskrat Falls and Island Link Projects have Opportunity to Improve Team's Effectiveness During FEL 3 By Addressing Highlighted Gaps

Leadership	Project Development	Team Behavior	Project Success

Observations from Team Assessments

- **Team Development Index and Team Functionality Surveys indicate a mixed response, and potentially some unresolved issues facing the Muskrat Falls and Island Link Projects team**
  - **Project objectives appear to be clear on the surface but several team members believe they need additional clarity**
  - **Team members are clear about their own R&R but unclear about each others' R&R**
  - **Several team members need better understanding of the Gateway Process**
  - **Open communication is hampered**
  - **Execution strategy is developed but it appears additional clarity is needed on the strategy**
  - **Low inter-departmental support**

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

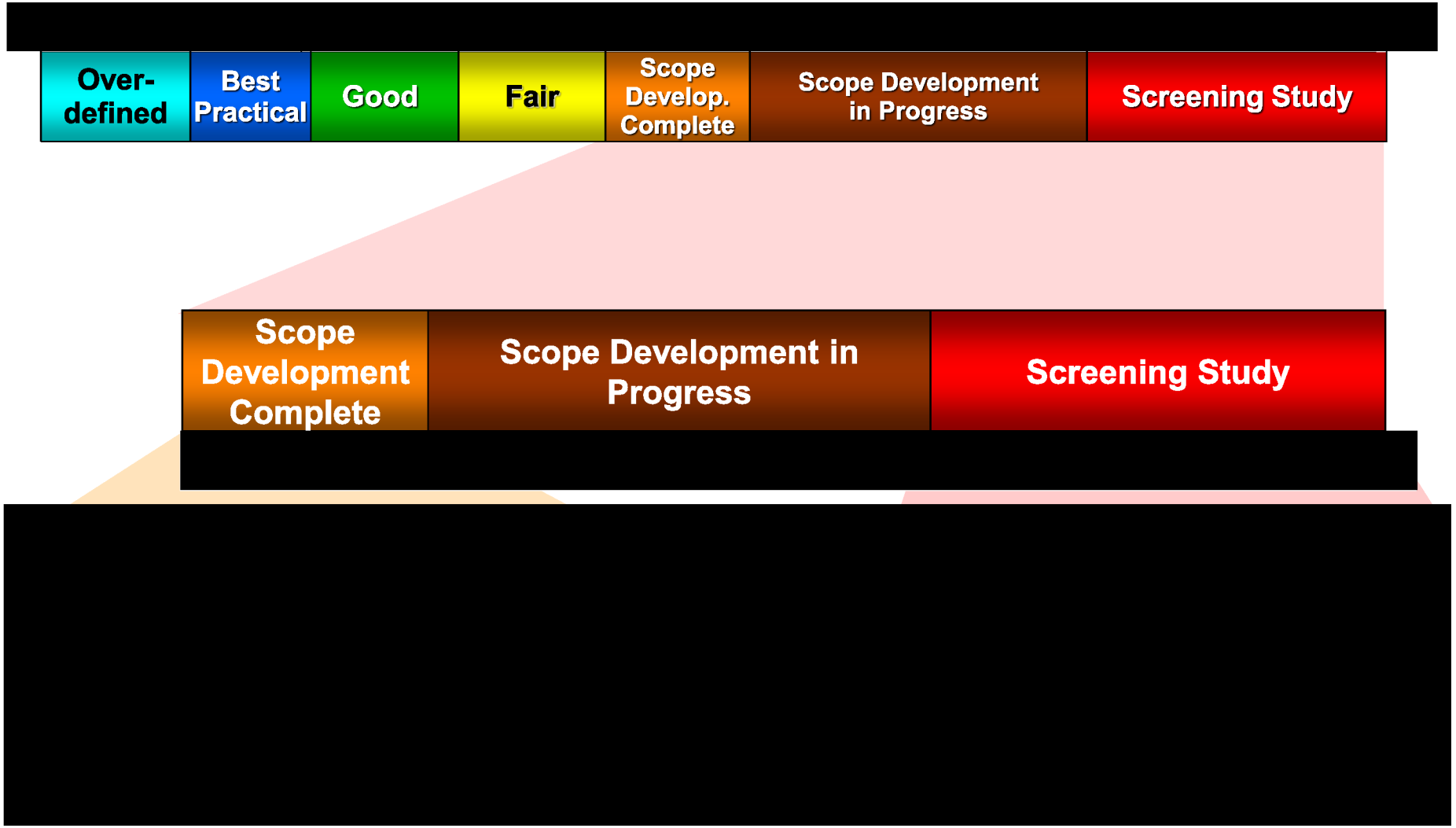
- Clearly defined business objectives and project objectives
- Project teams with adequate representation from key stakeholders, especially business (integrated team)
- ***Reaching closure on project scope at end of FEL 2***

FEL Index

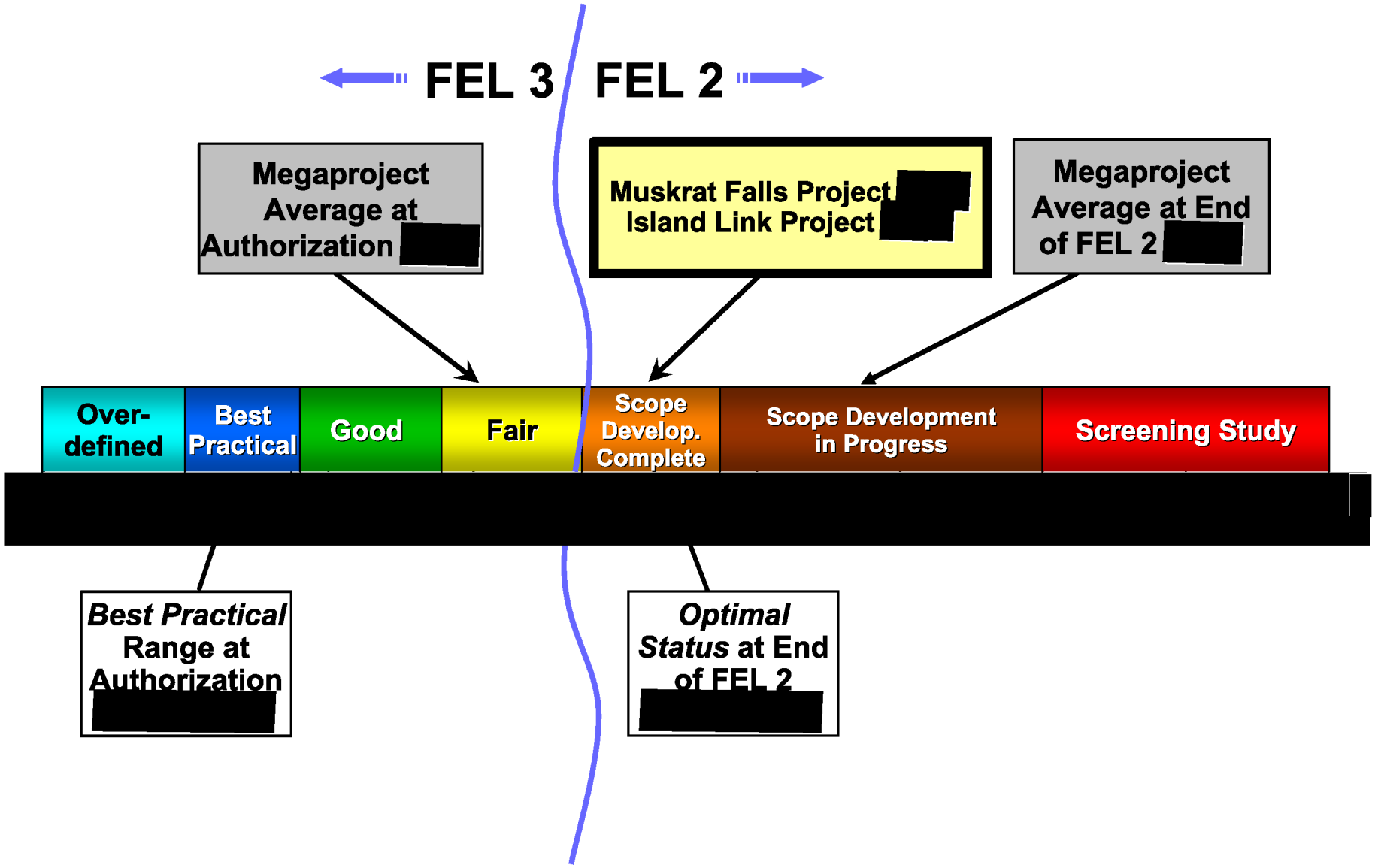
Components of Pacesetter (FEL 2)

Site Factors + **Engineering Definition** + **Project Execution Strategy** ➡ **Pacesetter FEL**

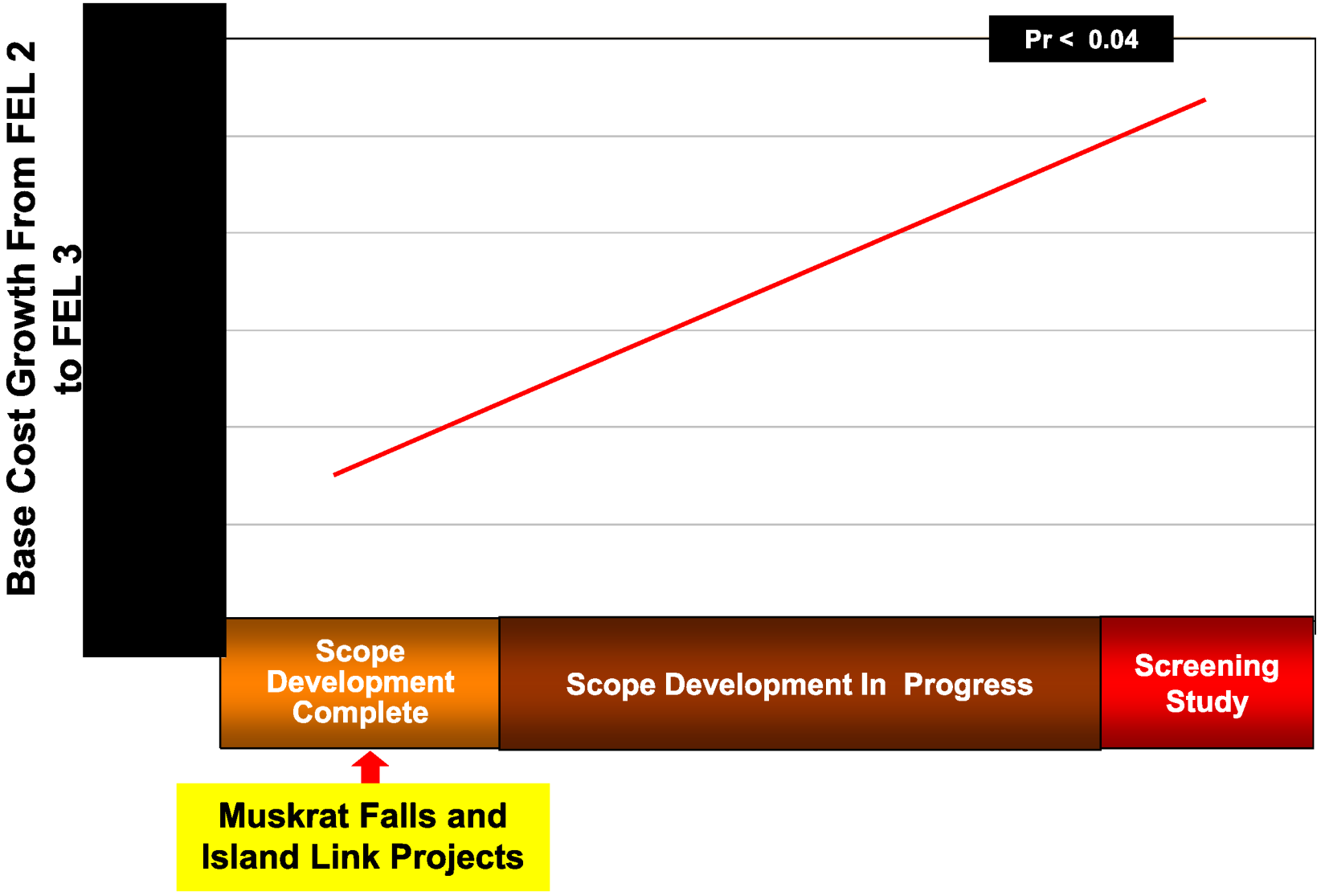
FEL Index to Measure Status at End of FEL 2



FEL Status of Muskrat Falls and Island Link Projects at End of FEL 2



Completing Scope Development Minimizes FEL 2 Cost Growth

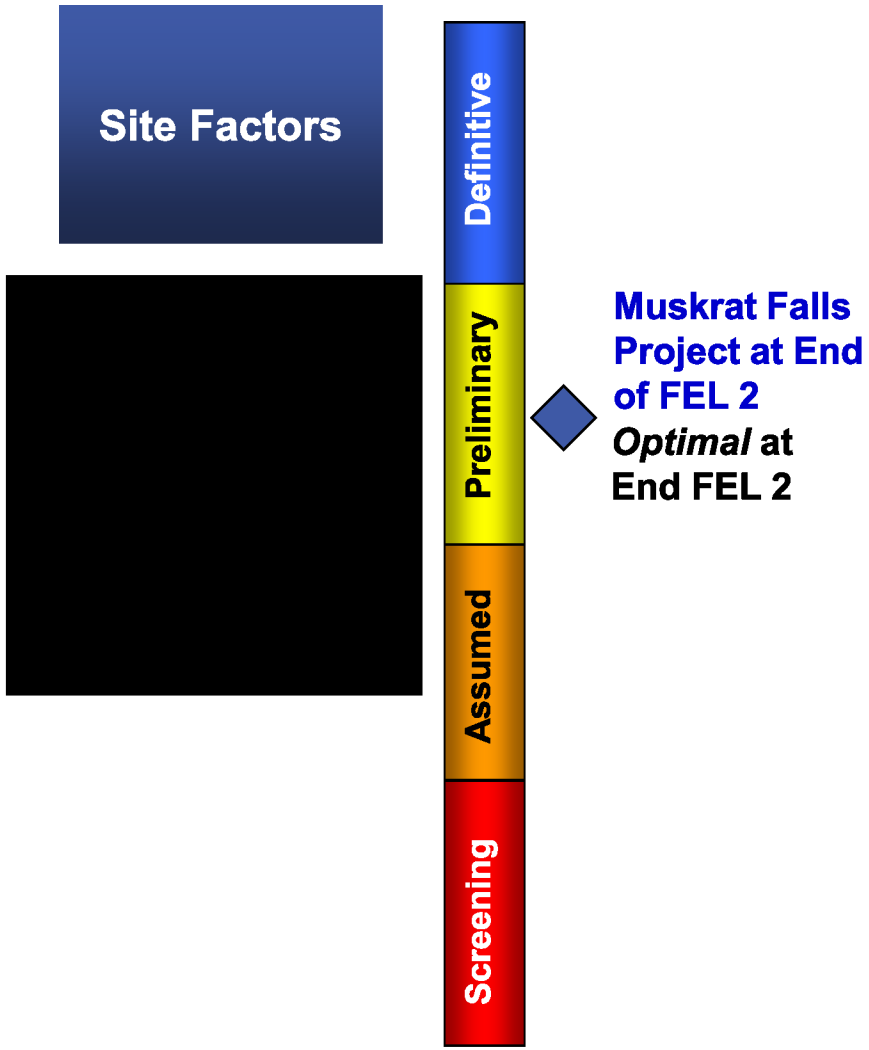


FEL Status

Muskrat Falls Project at End of FEL 2

FEL Component	Muskrat Falls Project	*Optimal Status* at End of FEL 2	*Best Practical* at Authorization
Plot Plans	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Soil/Hydrology Information	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Health and Safety Plans	*Factored* (3)	*Preliminary* (2)	*Definitive (1)*
Environmental Requirements	*Preliminary* (2)	*Factored* (3)	*Preliminary* (2)
Engineering Status	*Limited Study* (3)	*Limited Study* (3)	*Advanced Study* (2)
Project Execution Planning	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Composite FEL Index	[redacted]	[redacted]	[redacted]

Site Factors Are *Preliminary*



- Preliminary plot plan includes equipment layout in powerhouse, switchyard, and other areas
- Soil borings done at several locations; LIDAR surveys done for terrain conditions
- Key environmental permit, Environmental Assessment for Generation facility applied (*Best Practical* for FEL 3)
- Preliminary Hazards Identification (HAZID) review planned in FEL 3
- Overall, Site Factors are *Optimal* at late FEL 2

Site Factors – Going Forward
Achieving Best Practical at FEL 3

Site Factors

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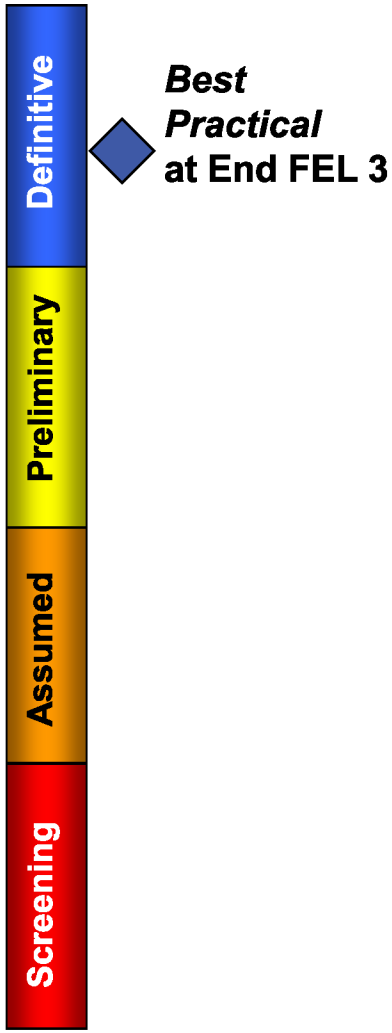

- Plots plans for all areas must be frozen with approval by operations and maintenance
- Team must take borings at specific foundation locations and incorporate results into FEL 3 deliverables
- Required environmental permit must be applied for
- Detailed HAZOP (on near final design documents) review with findings incorporated into design and cost estimate

Engineering Status Is *Screening Study*

Engineering Definition

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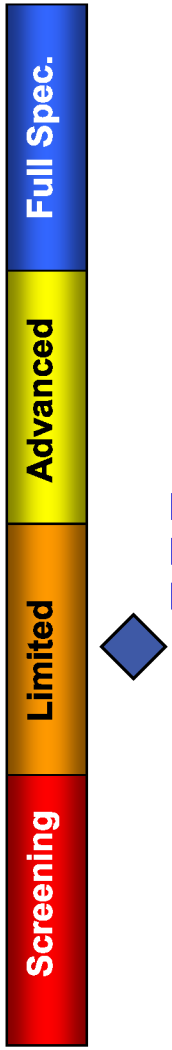


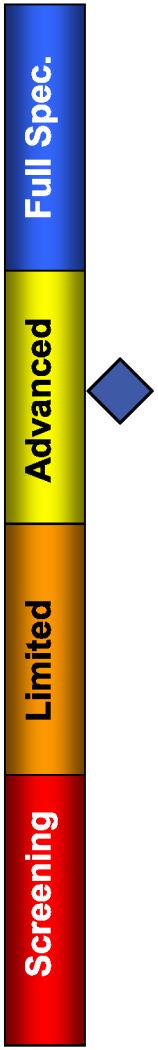
- Basic design and scope complete and approved
- Equipment list and sizing for large pieces of equipment are firm
- Electrical one-line drawing is firm
- Cost estimate is +30/-15 percent
- Labor surveys performed
- Engineering Status is *Optimal* at end of FEL 2
- Ongoing studies are being wrapped up; risk to basic design if team pursue new studies

Engineering Status – Going Forward

Achieving Best Practical at FEL 3

Engineering Definition

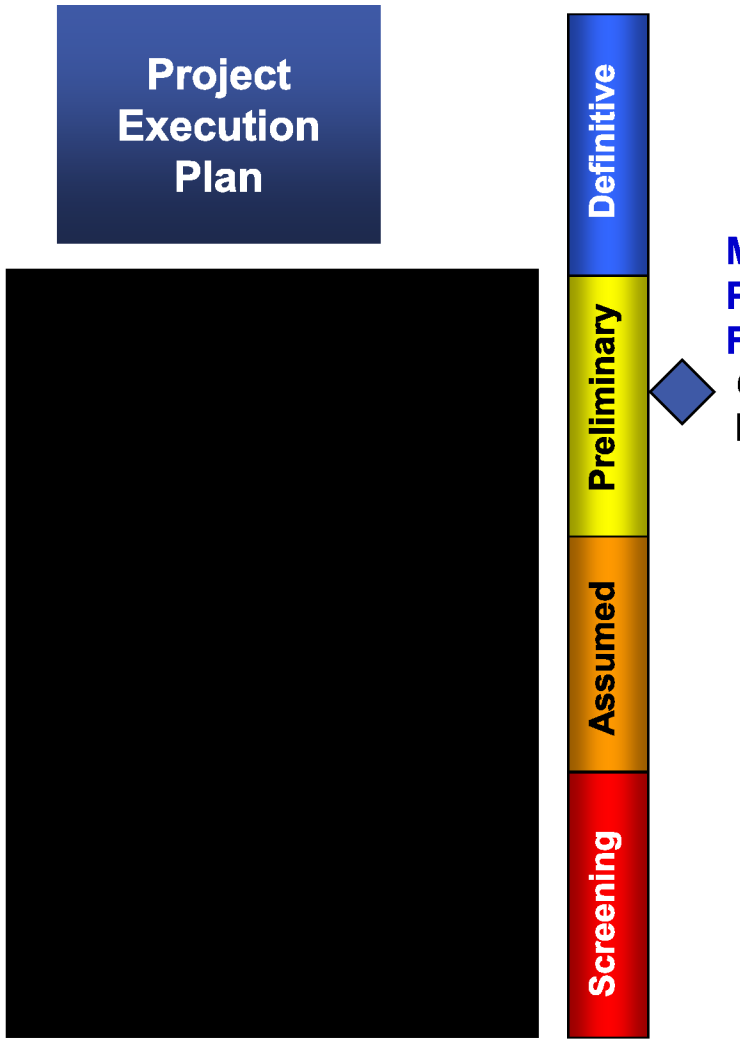
[redacted]



***Best Practical* at End FEL 3**

- **Finalized key design documents, including electrical single-line drawings, process control strategy, equipment specifications, and other design related deliverables**
- **Scope and design reviewed and signed off by stakeholders**
- **Control authorization estimate (+/-10 percent) in place**

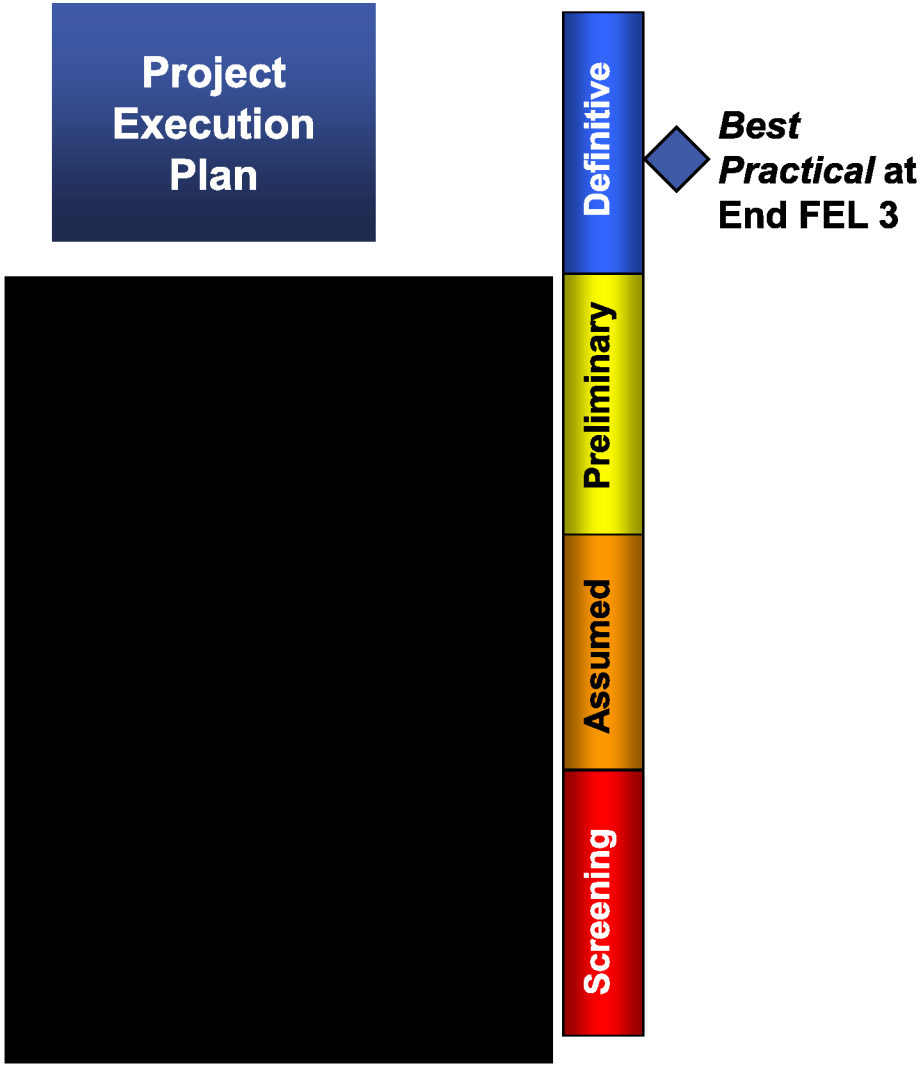
Project Execution Planning Is *Preliminary*



- Preliminary contracting strategy in place, key packages identified
- Integrated team in place
- Level II control-grade schedule, supported by details for engineering, procurement, and construction
- Key procurement packages identified
- Preliminary startup and commissioning plan available
- Ready for Operations philosophy developed
- Detailed manpower plan developed
- QA plans under development
- PEP is *Optimal* at end of FEL 2

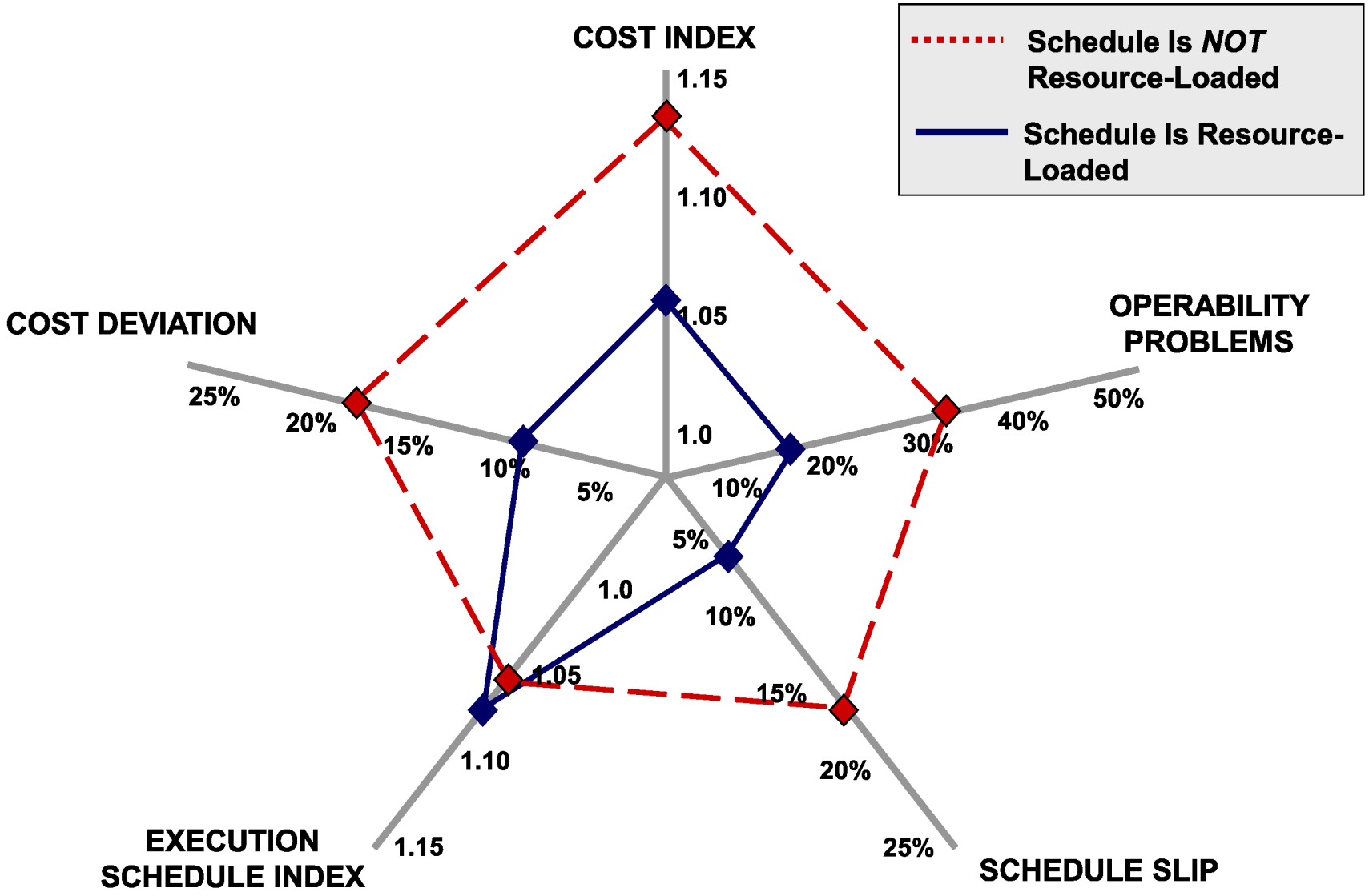
Project Execution Planning – Going Forward

Achieving Best Practical at FEL 3



- Define and finalize extent of modularization
- Finalize contracting strategy
- Finalize execution plans (including turnover sequencing and startup)
- Develop detailed and integrated schedule that incorporates equipment delivery dates, resource loading, turnover and commissioning sequences for startup
- Often, key difference in PEP level is driven by having resource-loaded schedule

Value of Resource-Loaded Megaproject Schedules



FEL Status

Island Link Project at End of FEL 2

FEL Component	Island Link Project	*Optimal Status* at End of FEL 2	*Best Practical* at Authorization
Route Definition	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Terrain Conditions	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Health and Safety Plans	*Factored* (3)	*Preliminary* (2)	*Definitive (1)*
Environmental Requirements	*Preliminary* (2)	*Factored* (3)	*Preliminary* (2)
Rights of Ways	*Preliminary* (2)	*Factored* (3)	*Preliminary* (2)
Community Issues	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Engineering Status	*Limited Study* (3)	*Limited Study* (3)	*Advanced Study* (2)
Project Execution Planning	*Preliminary* (2)	*Preliminary* (2)	*Definitive (1)*
Composite FEL Index	[redacted]	[redacted]	[redacted]

Site Factors: Island Link Project

- **Site Factors are *Preliminary*, which is *Optimal* for FEL 2**
  - **Route definitions, terrain conditions, environmental status, rights of way (ROW), and community issues are *Preliminary***
  - **Health and safety status is *Factored* as project team plans to perform HAZID in FEL 3**
- **During FEL 3, project team must**
  - **Finalize transmission routes**
  - **Complete route surveys, 70 percent already complete**
  - **Acquire ROW**
  - **Continue to manage community issues**
  - **Perform a detailed hazards analysis**

Engineering Status: Island Link Project

- **Engineering Status is *Limited Study*, which is *Optimal* for FEL 2**
  - **Basis of design developed and signed off**
  - **Detailed labor surveys have been performed**
  - **Cost estimate is +30/-15 percent**
- **During FEL 3, team must**
  - **Finalize key design related deliverables**
  - **Acquire approval from key stakeholders**
  - **Develop control-grade authorization estimate (+/-10 percent)**

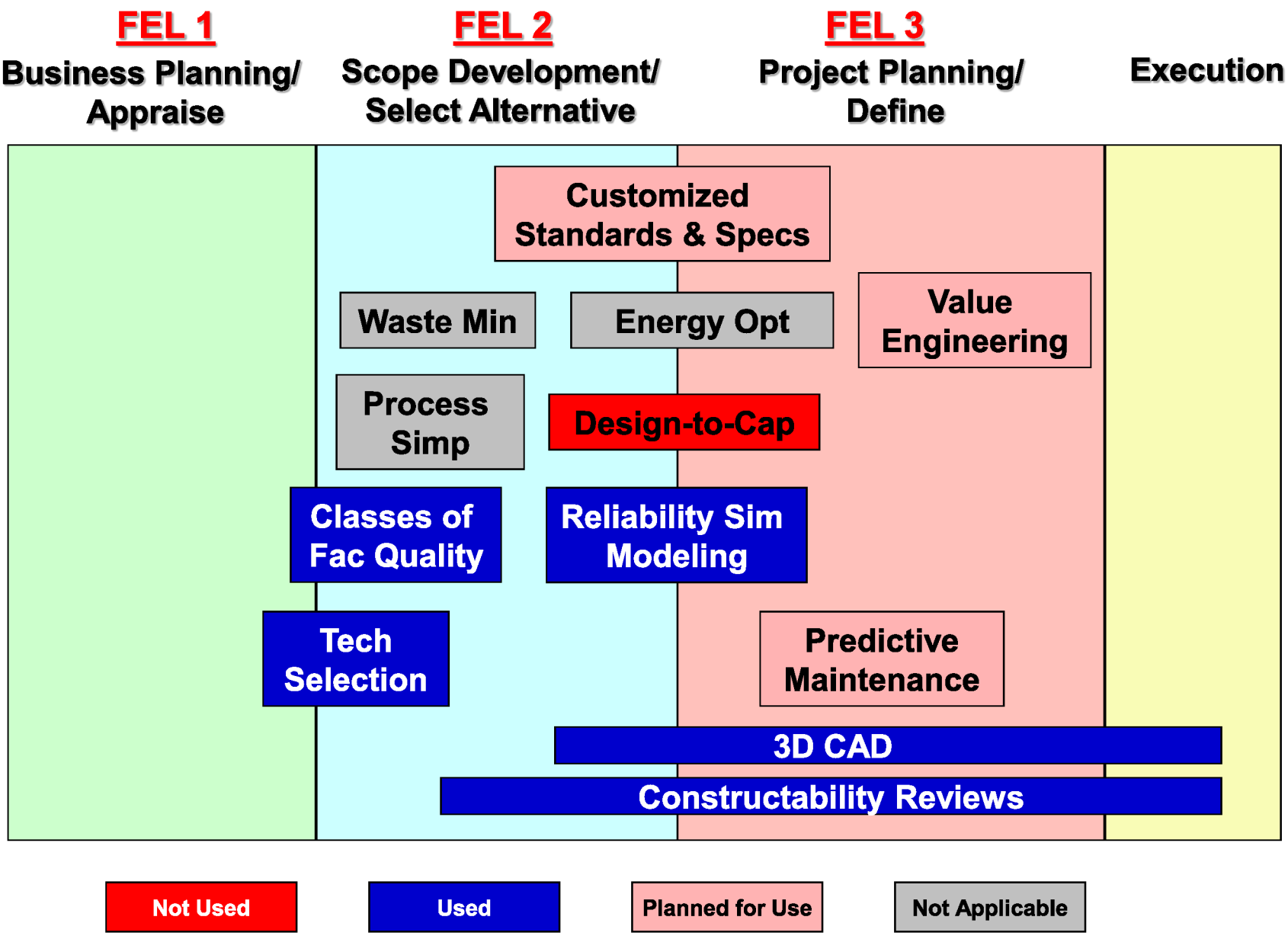
Project Execution Planning: Island Link Project

- **Project Execution Planning is *Preliminary*, which is *Optimal* for FEL 2**
  - **Preliminary contracting strategy defined**
  - **An integrated team in place**
  - **Detailed level II schedule in place**
  - **Execution plan includes all key elements**
- **During FEL 3, team must**
  - **Finalize contracting strategy and execution plans**
  - **Further develop and resource load project schedule**

Defining Value Improving Practices

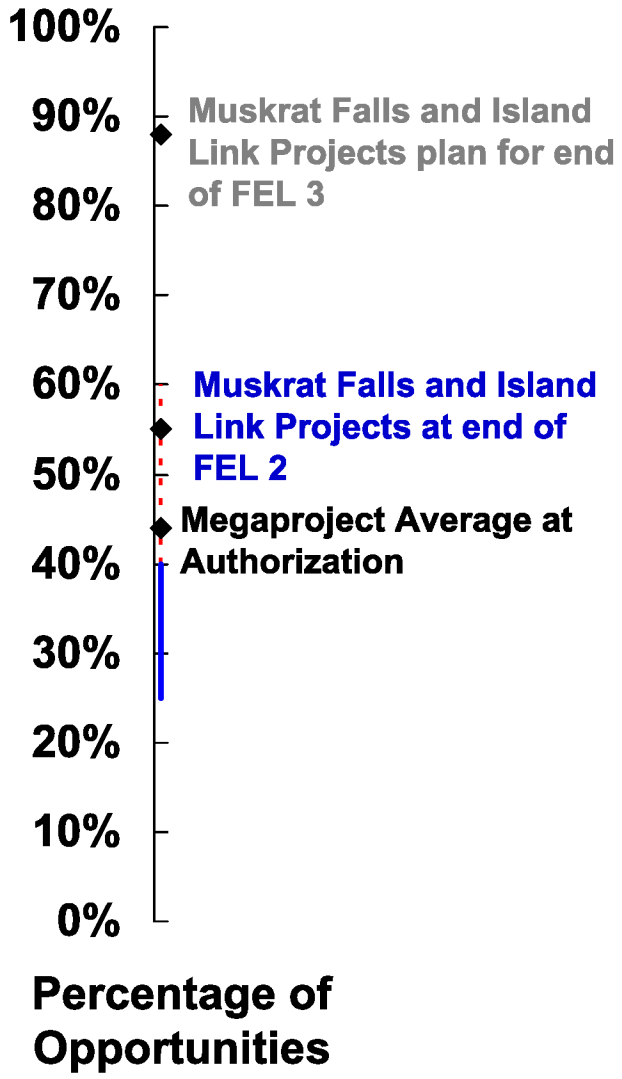
- VIPs are out of the ordinary practices used to improve cost, schedule, and/or reliability of projects:
- Used primarily during FEL
- Formal, documented practices involving repeatable work process with measurable results
- Usually facilitated by specialists from outside of project team
- 9 VIPs were applicable to Muskrat Falls and Island Link Projects

VIPs and Their Timing



Use of VIPs for Muskrat Falls and Island Link Projects

Several VIPs Used



Red dashed line represents optimal use range by authorization

Blue solid line represents optimal use by start of FEL 3

VIPs Observations for Muskrat Falls and Island Link Projects

- Optimal VIPs use (55 percent) driven by key factors:
  - Experienced project team
  - Work process that requires use of good practices
  - Diverse, large scope provides opportunity for application
- Application of VIPs used are new for company and team
- 88 percent VIPs planned in FEL 3 with three more VIPs:
  - Customized Standards and Specifications, Value Engineering, and Predictive Maintenance
- IPA research shows a "point of diminishing returns" when projects use over 60 percent of applicable VIPs

Agenda

- Project Background
- IPA Process and Methodology
- Project Practices
- *Planned Outcomes*
- Relevant Research
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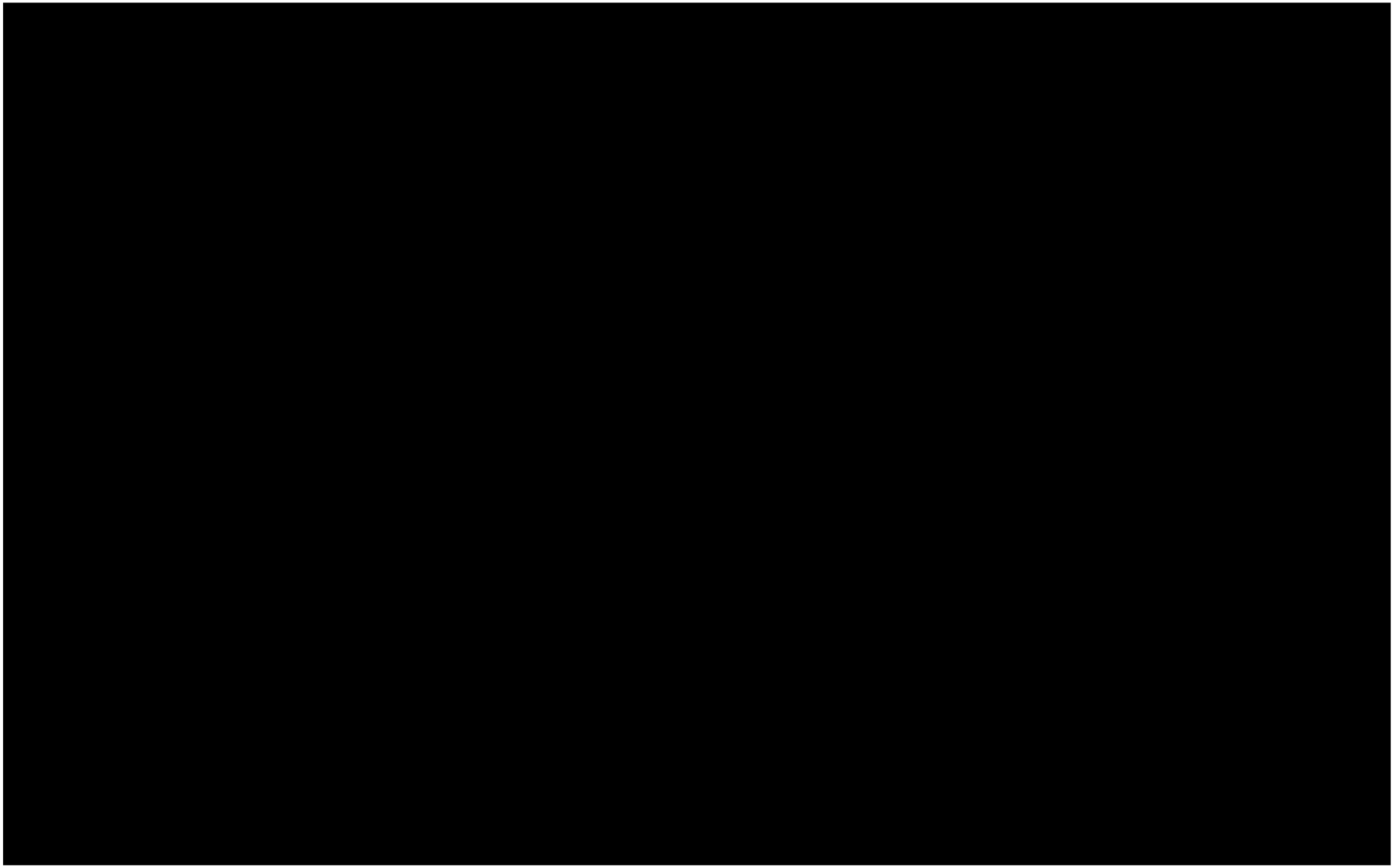
Muskrat Falls and Island Link Projects Estimated Costs (in C$ millions)

Cost Categories	Muskrat Falls Project	Island Link Project	TOTAL
Project Definition	-	-	-
Detailed Engineering	100.7	180.0	**280.6**
Construction Management	114.9	50.6	**165.6**
Project Management	305.0	170.6	**475.6**
Major Equipment	317.5	381.9	**699.3**
Bulk Materials	890.5	361.9	**1252.3**
Construction Labor	654.4	385.9	**1040.3**
Lump-Sum Contracts	-	-	-
Other Construction-Related	-	-	-
Contingency	286.0	184.0	**470.0**
Escalation	380.6	205.4	**586.0**
Total Design and Construction	**3049.5**	**1920.2**	**4969.7**
Special	-	-	-
Startup	-	-	-
Project Total	**3053.7**	**1921.3**	**4969.7**

Note: IPA analysis uses only total design and construction costs, not total project costs, in benchmarking comparisons, because startup and special costs vary widely from project to project

How Does IPA Normalize Costs?

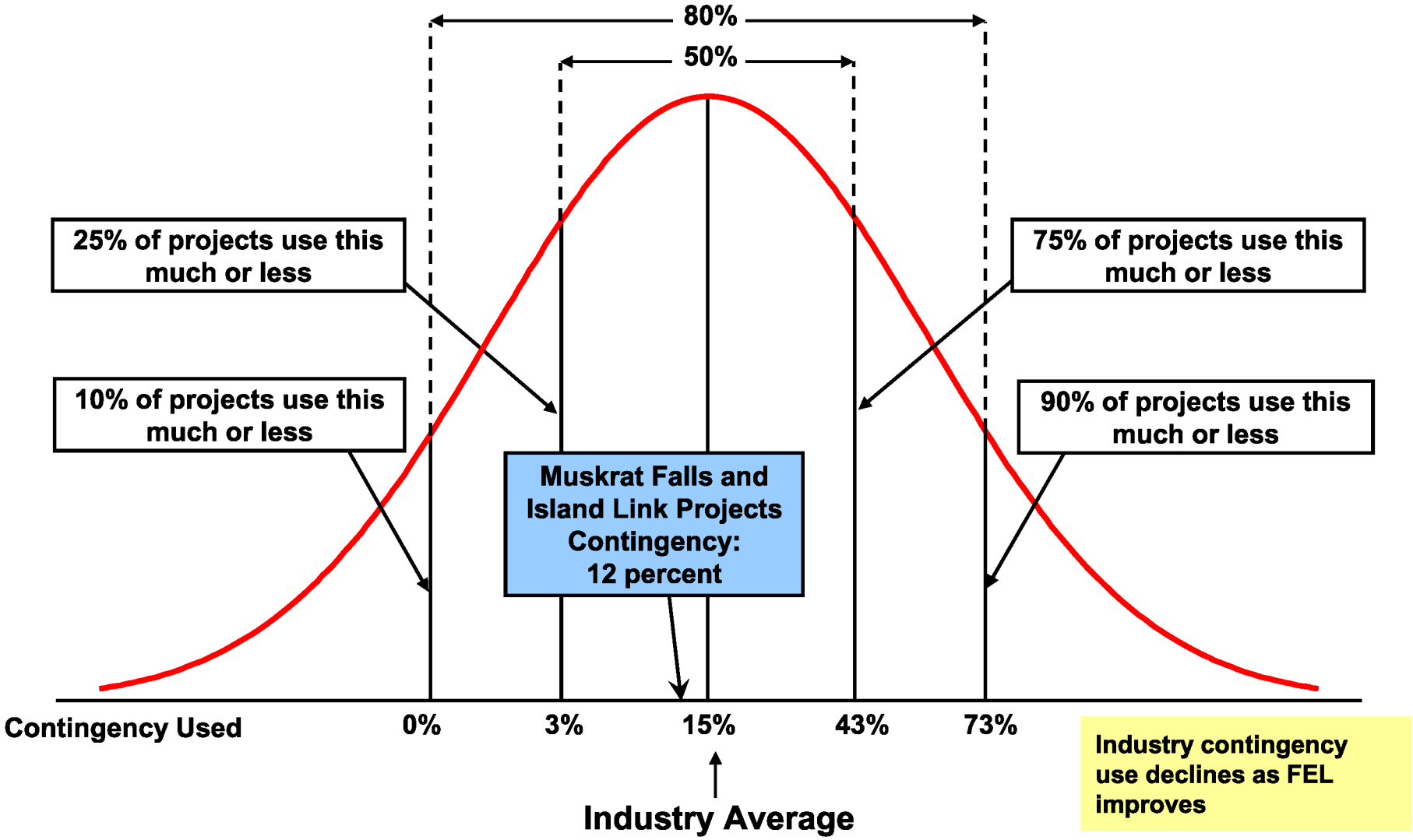
Three Steps



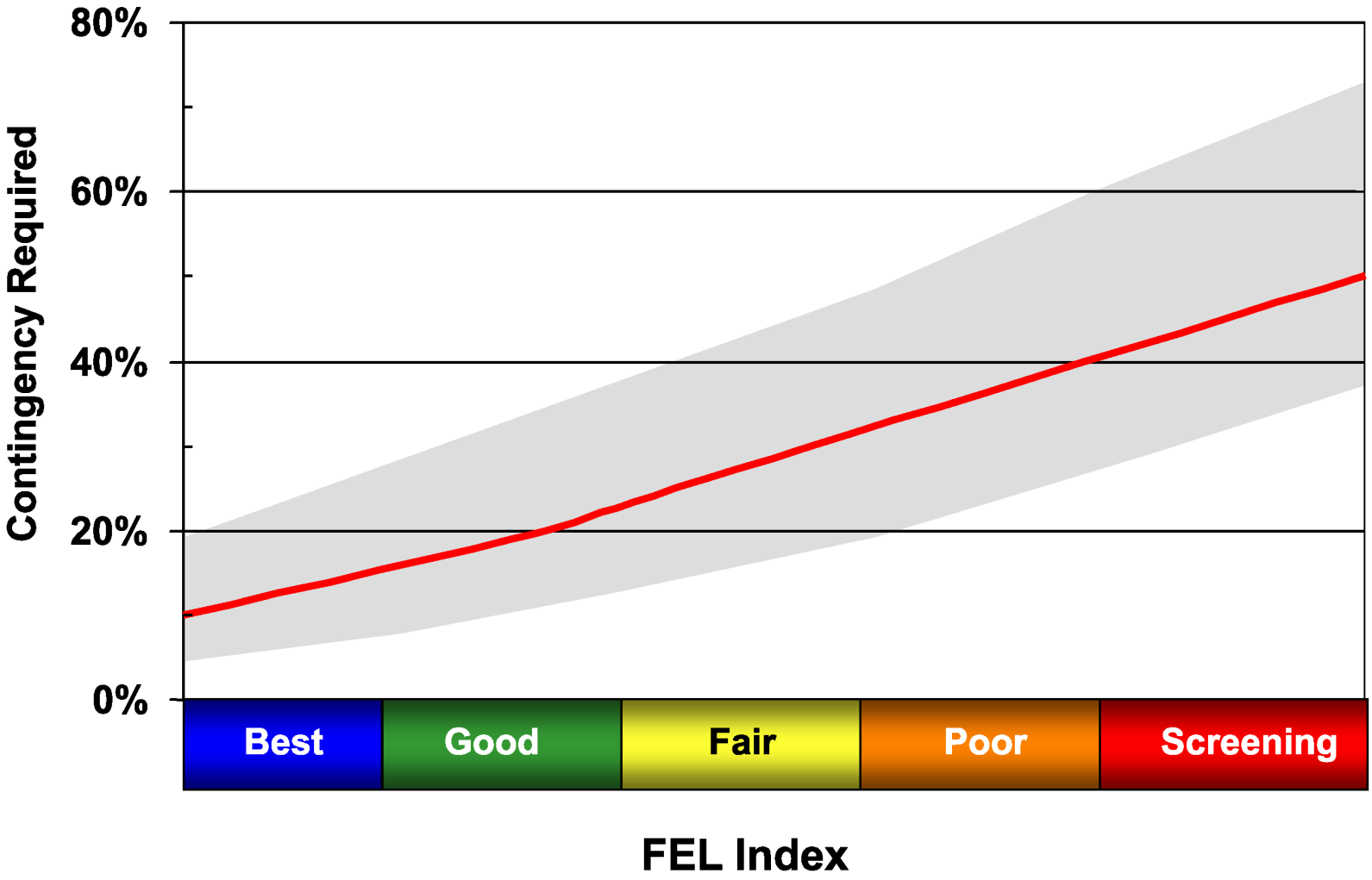
What Is Contingency?

- Money added to estimate to provide for uncertainties
- Normally selected so that estimate, including contingency, is most likely cost
- Not intended to provide for changes to project scope and unforeseeable circumstances beyond management's control
- Normally expressed as percentage of base capital cost
- For Muskrat Falls and Island Link Projects' contingency benchmark
  - IPA analyzed actual contingency used by large megaprojects with similar project definition, use of technology, and other characteristics

Historical Contingency Use on Megaprojects with FEL Similar to Muskrat Falls Project



Contingency Is Related to FEL



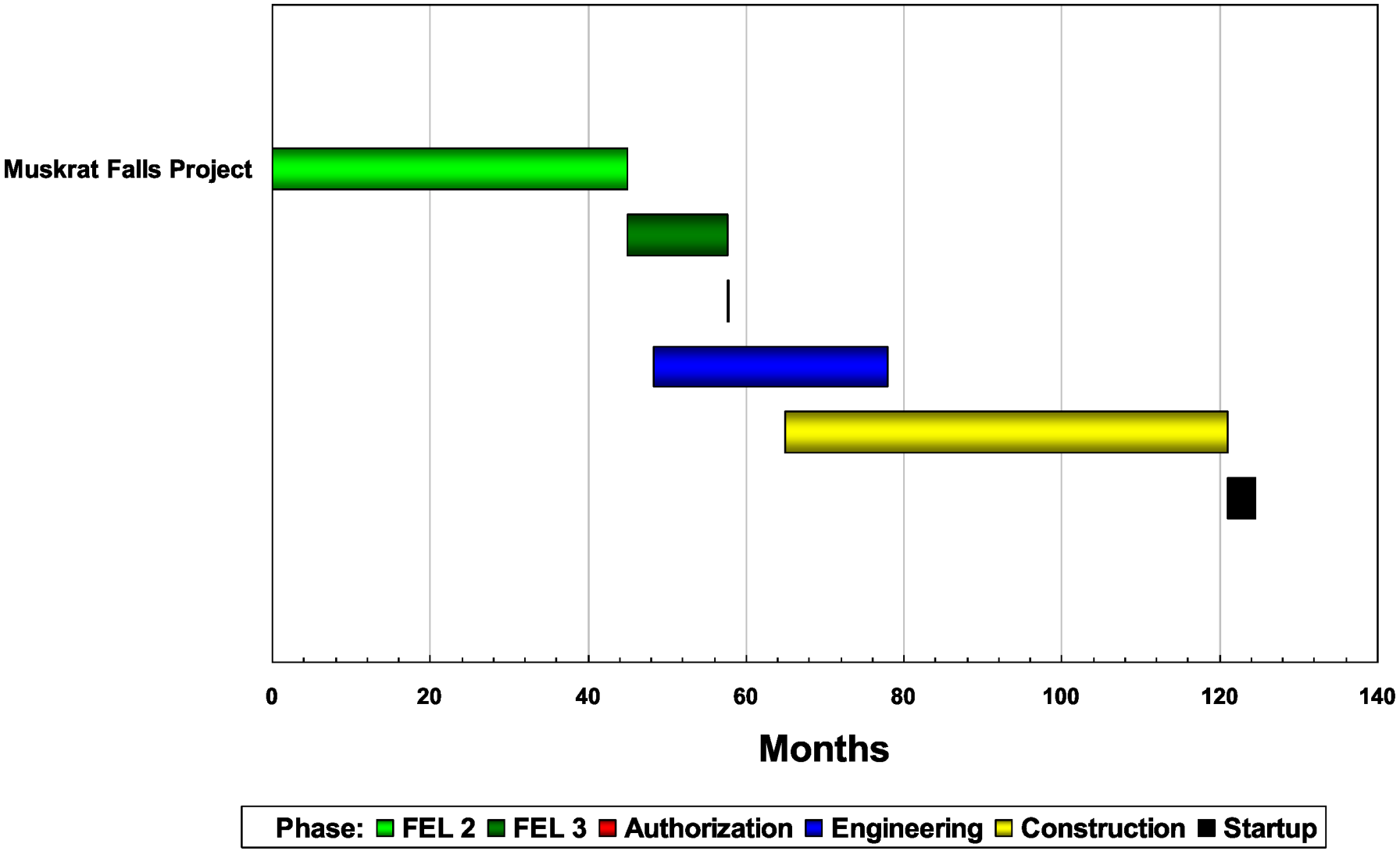
Planned Muskrat Falls and Island Link Projects Schedule

Phase	Start	Finish	Duration (months)
Project Definition	1 Jan 2007	21 Oct 2011	57.7
FEL 2	1 Jan 2007	30 Sep 2010	45.0
FEL 3	30 Sep 2010	21 Oct 2011	12.7
Authorization	21 Oct 2011	22 Oct 2011	0.1
Detailed Engineering	12 Jan 2011	30 Jun 2013	29.6
Procurement	28 Feb 2012	31 Jul 2015	41.1
Construction[1]	1 Jun 2012	31 Jan 2017	56.1
Execution Duration[2]	12 Jan 2011	31 Jan 2017	72.7
Startup[3]	19 Feb 2017	18 May 2017	3.5
Cycle Time[4]	1 Jan 2007	18 May 2017	124.6

[1] Construction starts with first foundations and ends with mechanical completion
[2] Execution is detailed engineering and construction
[3] Startup duration is the time between mechanical completion and routine operation
[4] Cycle time is FEL 2 through startup

Cycle Time Analysis

Overlap of FEL 3 and Engineering is a Major Concern on Muskrat Falls and Island Link Projects



Risks Related to Overlap

- **Muskrat Falls and Island Link Projects had long FEL 2 duration due work being performed alongside Gull Island Project**
  - **Project used 45 months for FEL 2**
  - **Plans to take about 13 months for FEL 3**
  - **For Industry, FEL 2 and FEL 3 durations are generally identical**
- **IPA research indicates, high overlap of FEL with engineering leads to cost growth, reduces engineering productivity, and results in costly changes**

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Other Issues Facing Muskrat Falls and Island Link Projects

- **Megaprojects like Muskrat Falls and Island Link Projects face multiple issues during their Cycle Time**

- **In this section, IPA shares some of the key findings that are applicable to issues facing the project, specifically**
  - **Need to build infrastructure in remote areas**
  - **Managing local communities**
  - **Addressing local content requirements**
  - **Risk premiums for working under harsh weather conditions**
  - **Planning when labor market is thin**
  - **Need for interface management**

Mitigating Risks With Infrastructure Requirements

- Successful projects adequately define and plan for required infrastructure
- Infrastructure scope is integrated into overall schedule and coordinated with other scope areas
- Some projects successfully develop an infrastructure package separate from megaproject and start package before megaproject
  - This beneficial approach provides site access before contractors mobilize labor and materials to project site
  - Team is certain that infrastructure work is done before it is needed

Muskrat Falls and Island Link Projects infrastructure include labor camps, roads, power supply, telecommunication, etc. and are included in the scope, cost estimate, and schedule

Importance of Megaproject Community Relations

- Solid community relations are essential for government cooperation and support
- Being proactive in community development results in good public relations for the company
- Building supporting project infrastructure and community relations go hand-in-hand with other intertwined issues
- Well-developed community relationships set a foundation and can reduce other project problems:
  - Local content issues
  - Labor productivity/availability
  - Delays from host government problems

Muskrat Falls and Island Link Projects' team consists of several members responsible for communicating and managing community relations.

Project-Specific Risks
Onerous Local Content Requirements

- Local government has high expectations for team to maximize local content, but provides no defined requirements or specific guidelines
- Local content requirements are difficult to achieve
  - For example, most labor hours are required to be done in-country) given a thin, local skilled labor pool
- High premiums exist for in-country fabrication
- Onerous local content requirements can affect bid on projects (average premium +38 percent)

Muskrat Falls and Island Link Projects is planning to perform all engineering at St. John's, gaining alignment with stakeholders on trade-offs (cost and schedule) will be crucial; some commitments already made

Project-Specific Risks
Harsh Physical Environment / Climate

- **Difficult climates can result in restricted weather windows for construction and importation of materials**
- **Harsh environments refer to the following:**
  - **Extreme cold regions (Examples: Northern Alberta and Iceland)**
  - **Intense heat/desert regions (Examples: Middle East countries)**
  - **Severe rainy seasons (Example: West Africa)**
- **Harsh physical environment/climate can affect bid on projects (average premium +27 percent)**

Muskrat Falls and Island Link Projects will be executed in a remote region, and extreme cold conditions during winter affecting labor productivity and construction sequencing

Project-Specific Risks
High Potential for Labor Shortages

- **This applies to skilled construction/fabrication labor and qualified construction supervision personnel**
- **Concurrent large projects in a region can lead to scarce, expensive labor and high competition for specialized resources**
- **Degree of remoteness and lack of industrial infrastructure challenges project to attract sufficient skilled labor**
- **High potential for labor shortages can affect bid on projects (average premium +16 percent)**

Muskrat Falls and Island Link Projects will be executed in parallel with several other megaprojects in the region, project will compete for scarce resources

Labor Shortages Hurt Megaproject Cost Performance

What Really Matters in a Labor-Short Environment

1. Plan for a labor shortage during FEL by understanding the local labor environment and gathering input from key team members.

2. Team dynamics, including integration, defined roles and responsibilities, and clear understanding of objectives, are critical in handling labor shortages.

3. Adequately plan for overtime requirements and the skill level availability.

4. Fast-tracking a project in a labor short environment and slipping project schedules drive cost up.

Labor shortage is a risk that can be mitigated with adequate planning, an understanding of the local labor environment, and good project definition.

Interface Management

- Owner develops and executes interface management plan (for both internal and external interfaces)
- Develop interface management plans early:
  - Organization chart should show interfaces between functions and between organizations
  - Define communication protocols to facilitate personnel and functional interactions
  - Support and align design activities among all contractors
  - Clearly define team members' roles and responsibilities
  - Outline conflict resolution process
- Ideally, every subproject team should have full-time interface manager to communicate with other teams

Muskrat Falls and Island Link Projects' team shows signs of misalignment which will restrict teams ability to provide clear directions to contractors

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Muskrat Falls Project is Ready for FEL 3
Remaining Risks Needs to be Addressed

KEY FEL 2 PRACTICES

- ✓ **Clearly defined business objectives and project objectives**
- ✓ **Project teams with adequate representation from key stakeholders, especially business (integrated team)**
- ✓ **Reaching closure on project scope at end of FEL 2**

Conclusions

- **Muskrat Falls and Island Link Projects drivers are better than typical megaproject drivers at the end of FEL 2, but project faces risks of late changes and cost growth**

- **Experienced, highly involved and robust team in place, but team is not fully aligned on several issues and doubts project's success**

- **As owner ramps-up the team and EPCm contractors mobilize in next few months, lingering team issues will magnify risks and potentially erode benefits of Best Practices applied thus far**

Recommendations (1)

- **Prior to ramping up for FEL 3, develop specific steps to address and resolve gaps identified under Team Functionality:**
  - **Clarify project scope and its relation to project/business objectives**
  - **Improve timeliness on key decisions and gain alignment on project implementation approach**
  - **Allow team members to express their opinions and clarify each others' roles and responsibilities**
  - **Reduce and resolve occurrences of personal conflicts**
  - **Adequately train staff in project implementation process**
  - **Ensure inter-departmental supports**
  - **Provide clear vision on how project will be implemented**

Recommendations (2)

- Develop detail interface management plans that provide clear directions to contractors
- To mitigate risk of late changes, implement and strictly adhere to strong change management process and gain closure on ongoing studies
- Develop transition plans to minimize negative affects of turnovers, which are likely to occur on long projects

Recommendations (3)

- Ensure infrastructure scope is fully integrated into overall schedule and coordinated with project scope
- Adequately plan for labor shortages, which are likely to occur, and follow through on the plan to resource load project schedule
- Gain alignment with stakeholders on trade-offs related to performing of detailed engineering locally
- Follow plan to ramp up and maintain active owner involvement throughout project

Questions?

For additional information, contact

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