

**ePMO**

**ADVANCING TxDOT  
PROJECT  
MANAGEMENT AND  
PROJECT DELIVERY**



Risk-Based Construction Cost  
Estimating

# **REFERENCE GUIDE**



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## PREFACE

### BACKGROUND

In a comprehensive, agency-wide effort to improve and revitalize itself through the Texas Department of Transportation (TxDOT) Modernization Project, TxDOT is examining ways to create consistent, accurate, and well-documented project cost estimates and risk management practices at the various project development phases (i.e., planning and programming, preliminary design, and design) for roadway and bridge construction projects. TxDOT contracted with the Texas A&M Transportation Institute (TTI) to assist with these efforts. These improvement efforts follow a phased approach:

- **Phase I:** Identify TxDOT's current processes and practices regarding cost estimating and risk management, compare those processes and practices to recognized best practices, and make recommendations for improvements.
- **Phase II:** Develop reference materials and tools to assist TxDOT in adopting the recommended best practices for construction cost estimating and project risk management; develop workshops to validate the reference materials and tools with trial districts.
- **Future Phases:** Distribute the reference materials and tools agency-wide with appropriate guidance; expose all districts to the reference materials and tools through a series of workshops and/or training opportunities.

Phase I of the improvement process occurred late 2011 through early 2013 culminating in a report noting three primary areas where TxDOT should focus their initial efforts to improve construction cost estimating and risks management: (1) scope and estimate documentation; (2) risk determination and contingency setting; and (3) estimate review and approval. It should be recognized that during the interviews with several districts, researchers noted that TxDOT is performing many of the best practices identified in the national research; however, those practices were often used informally and performed inconsistently from one district to the next.

Phase II of the improvement effort is currently underway. This “Risk-Based Construction Cost Estimating Reference Guide” (Reference Guide) captures and communicates the practices and processes TxDOT will advance to improve their project delivery. A series of workshops with select districts aided in the development and validation of the Reference Guide.

### BEST PRACTICES GUIDANCE

To aid the endeavor of identifying areas where performance gaps may exist between current TxDOT practices and recognized best practices, national research and experiences from other state departments of transportation (DOTs) to serve as guidance for TxDOT. The primary references include the following:

- [Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction](#). National Cooperative Highway Research Program (NCHRP) Report 574 (2007).
- [Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs](#). NCHRP Report 658 (2010).
- [Practical Guide to Cost Estimating](#). American Association of State Highway and Transportation Officials (2013).
- [Cost Estimation and Cost Management Technical Reference Manual](#). Minnesota Department of Transportation (2008).

The NCHRP 574 report and the Minnesota Department of Transportation (MnDOT) Cost Estimation and Cost Management Technical Reference Manual were the core references used as guidelines for best practices. The NCHRP 574 report is a series of strategies derived from substantial data collection and testing with DOTs around the country. The MnDOT manual amplified the findings of the NCHRP 574 report by creating a how-to guide for implementing the best practices identified within the research at the national level. The AASHTO “Practical Guide to Cost Estimating” follows the framework of the NCHRP 574 and 658 reports, yet provides a recommended structure that is similar to the MnDOT manual yet more generic so that it can be applied to any state DOT.

## **ABOUT THIS REFERENCE GUIDE**

TxDOT initiated the Cost Estimation Process Improvement Initiative to address the many challenges and difficulties associated with estimating project costs and managing costs during the pre-construction phases of project development. This Reference Guide provides instruction for the creation and management of construction cost estimates and risk assessments for design-build-build roadway and bridge projects that are smaller than FHWA designated Major Projects (<\$500,000,000). Although there is no absolute “right way” to prepare an estimate, this Reference Guide provides a framework of recognized and accepted processes and tools that each TxDOT district can adapt and use as appropriate for their situation.

The Reference Guide was developed to:

- Achieve accuracy, accountability, and consistency in cost estimation, risk management, and cost management efforts during the Planning and Programming, Preliminary Design, and Design phases of project development.
- Acknowledge that uncertainty and risk exist in all projects and how to account for and present the impact of those uncertainties and risks within a cost estimate.
- Define a process framework relating to cost estimating, risk assessment, and cost estimate management that can be consistently applied to ensure that TxDOT is thorough and transparent in the development of roadway and bridge projects.
- Follow a framework based on national research and recommended best practices from other state departments of transportation.
- Include discussions and tools to address projects of different complexity/rigor levels.

- Serve as a companion to the *Major Project Cost Estimating and Risk Assessment (CERA)* Manual, using the same concepts and terminology, however, presented with discussions and tools relevant to the more typical TxDOT project sizes and the design-build approach.

## **Intended Audience of This Reference Guide**

Although primarily geared toward Project Managers and Estimators during all phases of project development, anyone involved in TxDOT's project development activities should also be familiar with this Reference Guide. The Reference Guide is written to address the needs of mid-level engineers and designers within TxDOT, i.e., someone more knowledgeable than beginning engineers and designers but not as experienced as more tenured senior engineers and designers. Part III of this document does, however, contain a Quick Reference Guide to provide a concise, summarized version of the recommended practices for those who want a condensed version of the guidance presented.

## **Purpose of This Reference Guide**

The Reference Guide will:

- Establish a systematic and consistent approach to cost estimating, risk assessment, and cost management as highway projects become more complex, face intense challenges increased scrutiny, and higher expectations.
- Institutionalize practices that can withstand greater visibility among legislators, public officials, national and local transportation agency representatives, and citizens, as transportation project costs increase while funds remain limited.



# INTRODUCTION

## OVERVIEW

This chapter introduces the key terms and overviews the risk-based estimating framework that is explained in detail in subsequent chapters.

### Chapter Organization

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## KEY TERMS AND DEFINITIONS

Many terms are used throughout the Reference Guide. Specific key terms are defined below with a more extensive glossary located in ([Appendix A. Glossary](#)).

**Base Estimate:** The most likely project cost estimate in any phase at any time, which normally includes all estimated known project costs, but does not include Project Contingency.

**Baseline Cost Estimate:** The most likely estimated construction cost including Project Contingency, which constitutes the approved project budget against which project costs are managed.

**Basis of Estimate (or Estimate Basis):** A documentation of the project scope and requirements for each cost estimate, including items such as drawings that are available (defining percent engineering and design completion), project design parameters, project complexity, unique project location characteristics, and other inputs required to prepare the cost estimate.

**Cost Management:** The process of managing the cost estimate through reviews and approvals, communicating estimates, monitoring scope and project conditions, evaluating the impact of changes, and making estimate adjustments as appropriate.

**Estimator:** The person responsible for predicting the cost of a project for a defined scope, to be completed at a defined location and point of time in the future. Cost Estimators assist in the economic evaluation of potential projects by supporting the development of project budgets, project resource requirements, and value engineering. They also support project control by providing input to the cost baseline. Estimators collect and analyze data on all of the factors that can affect project costs such as: materials, equipment, labor, location, duration of the project, and other project requirements.

**Project Contingency:** An estimate of costs associated with identified risks, the sum of which is added to the Base Estimate.

**Project Cost Control:** The process of controlling deviations from the estimated project costs and monitoring the risks and contingencies associated with changes.

**Project Manager:** The individual responsible for the execution and completion of a project which involves managing a team comprised of TxDOT employees &/or consultants.

**Risk:** An uncertain event or condition that, if it occurs, has a negative or positive effect on a project's objectives such as schedule and cost.

**Risk-Based Estimating:** A predictive process for approximating all project costs, including consideration of risks and uncertainties.

**Total Construction Cost Estimate:** The sum of the project's Base Estimate and the project's contingency, in any phase at any time.

## RISK-BASED ESTIMATING FRAMEWORK

The framework for the cost estimating process presented in this Reference Guide provides a structured and systematic approach for determining anticipated project costs. Figure 1 presents a flowchart of the five stages as well as the steps associated with each stage. The stages and steps are also presented Table 1 along with their general inputs and outputs. Note that in the flowchart and table:

- The descriptions are generic and applicable to the risk-based cost estimating process across each development phase.
- These steps convey the idea of a structured approach to cost estimation.
- The operational manner in which the steps are performed will vary depending on project development phase. (The level of completeness in the project scope and refinement of project design will drive these variations.)

# RISK-BASED COST ESTIMATE PROCESS

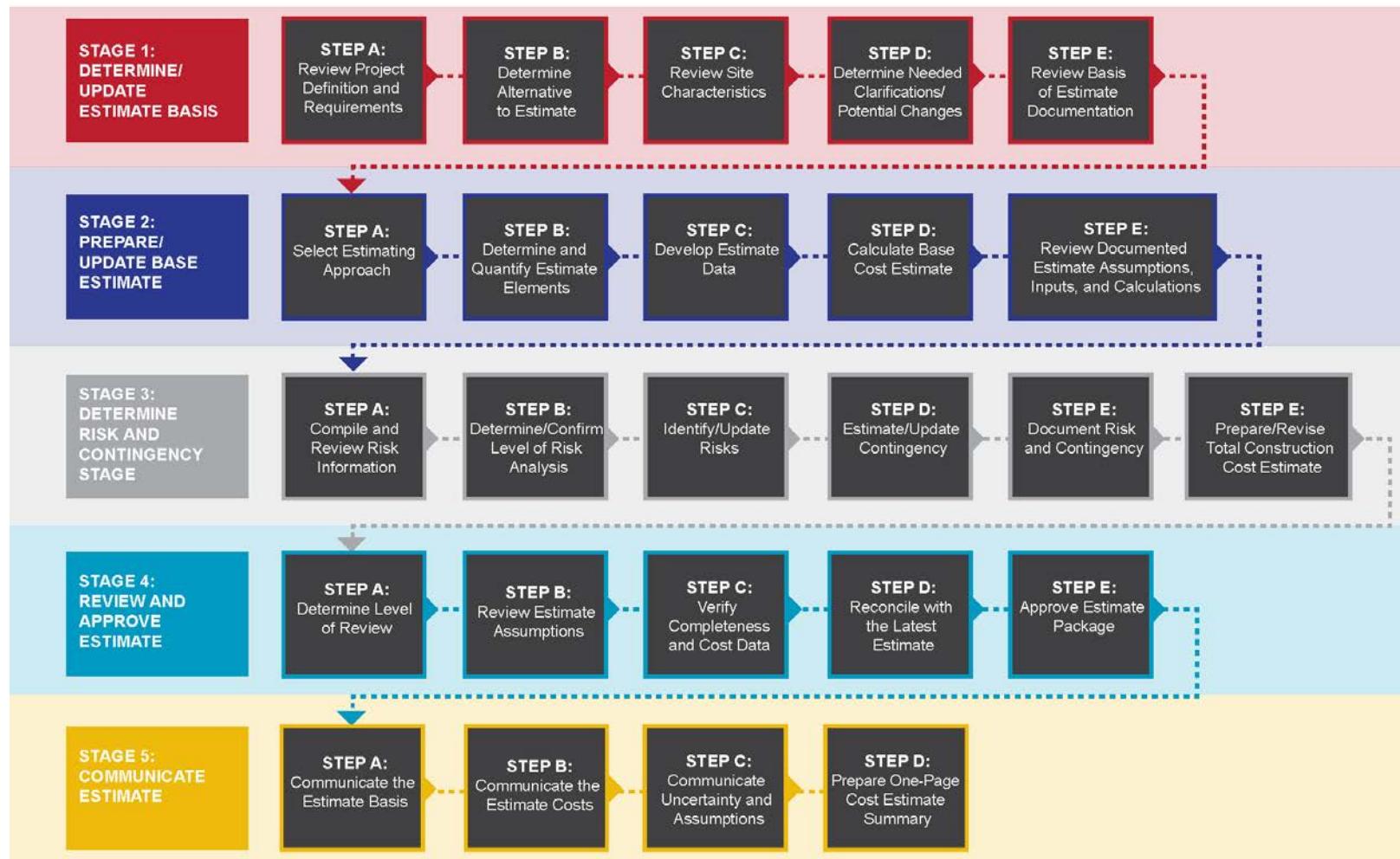


Figure 1. Flowchart of the Risk-Based Estimating Framework.

**Table 1. Risk-Based Estimation Framework.**

Stage	Purpose	Inputs	Basic Process	Outputs
1. <u>Determine/ Update Estimate Basis</u>	Use proper inputs and sources that will serve as an accurate Basis of the Estimate and its updates.	<ul style="list-style-type: none"> <li>● Project information:           <ul style="list-style-type: none"> <li>○ Project concept definition.</li> <li>○ Project location.</li> <li>○ Project type.</li> <li>○ Rigor level.</li> <li>○ Project characteristics and scope.</li> </ul> </li> <li>● Non-project specific inputs:           <ul style="list-style-type: none"> <li>○ Market conditions.</li> <li>○ Inflation rates.</li> </ul> </li> </ul>	<ol style="list-style-type: none"> <li>A. Review project definition and requirements.</li> <li>B. Determine alternative to estimate.</li> <li>C. Review site characteristics.</li> <li>D. Determine needed clarifications/potential changes.</li> <li>E. Review basis of estimate documentation.</li> </ol>	<ul style="list-style-type: none"> <li>● Complete Project Estimate File.</li> </ul>
2. <u>Prepare/ Update Base Estimate</u>	Develop and update the base cost estimate.	<ul style="list-style-type: none"> <li>● Phase Specific Estimate Basis.</li> <li>● Project Characteristics.</li> <li>● Historical Bids.</li> <li>● Functional Area Input.</li> <li>● Basis of Estimate</li> </ul>	<ol style="list-style-type: none"> <li>A. Select estimating approach.</li> <li>B. Determine and quantify estimate elements.</li> <li>C. Develop estimate data.</li> <li>D. Calculate base cost estimate.</li> <li>E. Review documented estimate assumptions, inputs, and calculations.</li> </ol>	<ul style="list-style-type: none"> <li>● Base estimate.</li> <li>● Updated Project Estimate File.</li> </ul>
3. <u>Determine Risk and Contingency</u>	Characterize the estimate uncertainty and develop contingency amount.	<ul style="list-style-type: none"> <li>● Base Estimate.</li> <li>● Project Estimate File.</li> <li>● Project Complexity Evaluation.</li> </ul>	<ol style="list-style-type: none"> <li>A. Compile and review risk information.</li> <li>B. Determine/confirm level of risk analysis.</li> <li>C. Identify/update risks.</li> <li>D. Estimate/update contingency.</li> <li>E. Document risk and contingency.</li> <li>F. Prepare/revise Total Construction Cost estimate.</li> </ol>	<ul style="list-style-type: none"> <li>● Total Construction Cost Estimate.</li> </ul>
4. <u>Review and Approve Estimate</u>	Ensure that the estimate is as complete and accurate as possible.	<ul style="list-style-type: none"> <li>● Total Construction Cost Estimate.</li> <li>● Project Estimate File</li> </ul>	<ol style="list-style-type: none"> <li>A. Determine level of review.</li> <li>B. Review estimate assumptions.</li> <li>C. Verify completeness and cost data.</li> <li>D. Reconcile with latest estimate.</li> <li>E. Approve estimate package.</li> </ol>	<ul style="list-style-type: none"> <li>● Approved estimate.</li> <li>● Updated Project Estimate File.</li> </ul>
5. <u>Communicate the Estimate</u>	Develop a communication package that conveys key project information to internal and external project stakeholders.	<ul style="list-style-type: none"> <li>● Approved estimate.</li> <li>● Updated Project Estimate File.</li> </ul>	<ol style="list-style-type: none"> <li>A. Communicate the estimate basis.</li> <li>B. Communicate estimate costs.</li> <li>C. Communicate uncertainty and assumptions.</li> <li>D. Prepare one-page cost estimate summary.</li> </ol>	<ul style="list-style-type: none"> <li>● One-Page Cost Estimate Summary.</li> <li>● Updates to DCIS, ROWIS, P6, etc.</li> </ul>

## **GUIDE ORGANIZATION**

The risk-based estimating framework is presented in five chapters, with each chapter addressing a specific stage. The appendices provide additional information and tools that aid in risk-based estimating. The organizations of the Reference Guide is shown in Table 2

**Table 2. Organization of the Reference Guide**

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### **Part I**

The first section of the Reference Guide presents the concepts of cost estimating, risk management, and cost management then ties these concepts to the TxDOT project development process.

## **Part II**

The risk-based cost estimating framework is presented in Part II of the Reference Guide. Each stage of the framework is broken into the steps required for the particular stage. Each step has an explanation, guidance, and a flowchart that shows the specific processes related to the three project development phases. To aid the user, the chapters for the risk-based estimating framework are structured in a similar manner using icons and color coding for easy referencing. Table 3 defines the icons used in the Reference Guide while Table 4 presents the color codes that designate the project phases.

**Table 3. The Icons and Headings Used in the Reference Guide.**

Icon	Heading	Description
	Roles	Describes who is responsible and what they need to know.
	Why	Explains why that step is needed.
	Guidance	Gives guidance, tips, and reminders that aid in that step.
	Process	Lists each point of action necessary for that step.
	Tools	Lists tools that will aid that step.

**Table 4. Color Codes Associated with Project Phases.**



## **Part III**

The Quick Reference Guide is basically a compilation of executive summaries for each of the five stages of the risk-based estimating stages that can be used as a standalone aid for senior engineers, designers, and Estimator, or as a condensed orientation for other staff to become more familiar with the concepts and procedures of the Reference Guide.

## **Appendices**

At the end of the Reference Guide, several resources are assembled into a series of appendices that readers can refer to and use when implementing the stages and steps associated with the risk-based cost estimating framework. The Reference Guide includes the following appendices.

## Appendix A. Glossary

Using common terminology improves the adoption and implementation of the concepts and processes across TxDOT. Appendix A includes terms specific to the risk-based estimating framework. Additional terms and their official agency definitions are located in the TxDOT Glossary.

## Appendix B. RACI Diagrams

A RACI Diagram is a matrix that aids in visually portraying the roles and responsibilities of a person or party involved with a particular aspect of a project. (RACI is an acronym derived from the roles assigned to participants: responsible, accountable, consulted, or informed.) The RACI matrices are provided to aid each district in determining who should have what responsibilities during the risk-based estimating stages.

## Appendix C. Tools

The various stages and steps of the risk-based estimating framework have processes to complete as the construction estimate is developed and managed. To facilitate these processes, tools are suggested throughout the Reference Guide. Each tool is present and described in this appendix.



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## PART I – APPROACH AND CONCEPTS

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# COST ESTIMATING AND THE TXDOT PROJECT DEVELOPMENT PROCESS

## OVERVIEW

Cost estimates are made at various times during the development of solutions to identified transportation needs and deficiencies. These estimates support funding and program decisions.

The estimation approach that is used at these various times must conform to the information available when the estimate is prepared. For example, when only concept information is available, then conceptual estimation practice methods are used to determine planning-level cost projections.

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## COST ESTIMATING

Cost estimation management is practiced as projects are identified and developed. Cost estimation management methods will also vary depending on the level of project scope definition and cost details provided in the estimates.

An understanding of the phased progression to developing a solution for a transportation need is critical to the strategies, methods, and tools that can be used for cost estimation practice and cost estimation management. The terms used to describe the development phases can vary slightly, or even significantly, from agency to agency. Table 5 shows the development phases and their descriptions as presented in this guide and defined by TxDOT. This guide does not cover the advertise-and-bid and construction phases.

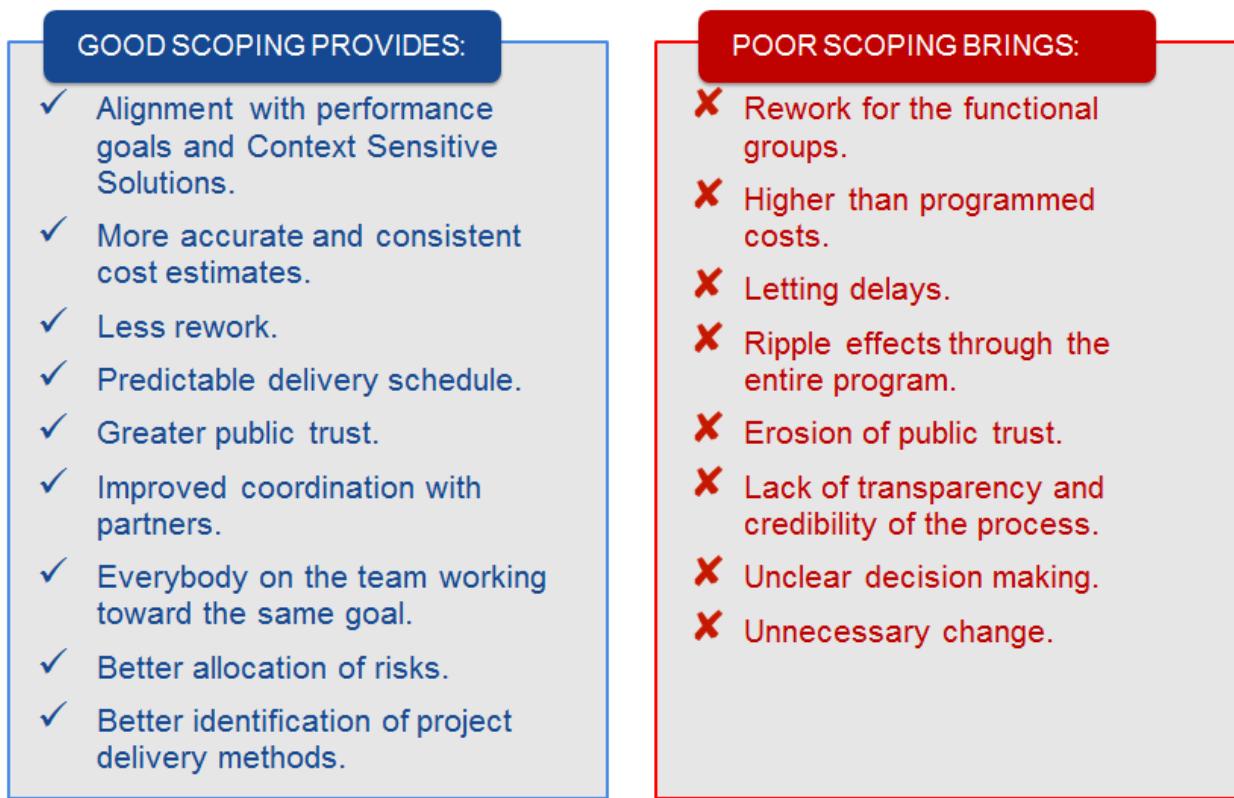
**Table 5. Project Development Phases and Their Activities.**

<b>Project Development Phase</b>	<b>Typical Activities</b>
<b>Planning &amp; Programming</b>	Determine purpose and need, determine whether it's an improvement or requirement study, consider environmental factors, facilitate public involvement/participation, and consider interagency conditions.
<b>Preliminary Design</b>	Conduct environmental analysis, conduct schematic development, hold public hearings, determine right-of-way impact, determine project economic feasibility, obtain funding authorization, develop right-of-way documentation, perform hydraulics studies, obtain environmental clearance, determine design criteria and parameters, survey utility locations and drainage, make preliminary plans such as alternative selections, assign geometry, and create bridge layouts.
<b>Design (PS&amp;E)</b>	Acquire right-of-way; develop plans, specifications, and estimates (PS&E); and finalize pavement and bridge design, traffic control plans, utility drawings, drainage design, and cost estimates.
<b>Letting</b>	Prepare contract documents, advertise for bid, hold a pre-bid conference, and receive and analyze bids.
<b>Construction</b>	Determine the lowest responsive bidder; initiate contract; mobilize; conduct inspection and materials testing; administer contract; control traffic; and construct bridge, pavement, and drainage.

*Note: Definitions and typical activities adapted from the “TxDOT Project Development Manual.”*

## SCOPE

Scope is the definition of the project. Scope encompasses the elements, characteristics, and parameters of a project and work that must be accomplished to deliver a product with the specified requirements, features, and functions. Figure 2 shows the benefits of good scoping and the pitfalls that a poorly scoped project can bring.



**Figure 2. Scoping Benefits and Pitfalls.**

## PROJECT MATURITY

Project maturity is how well developed the scope is or the amount of design development. The more mature a project is, the more defined the scope is.

Project maturity communicates more precisely the current development stage of a given project. Figure 3 presents the code structure that will be used to denote the various stages with the life cycle of most projects. Smaller projects will quickly move from one stage or phase to the next while larger projects might take years to move from one phase to the next.

## TxDOT Project Maturity Levels

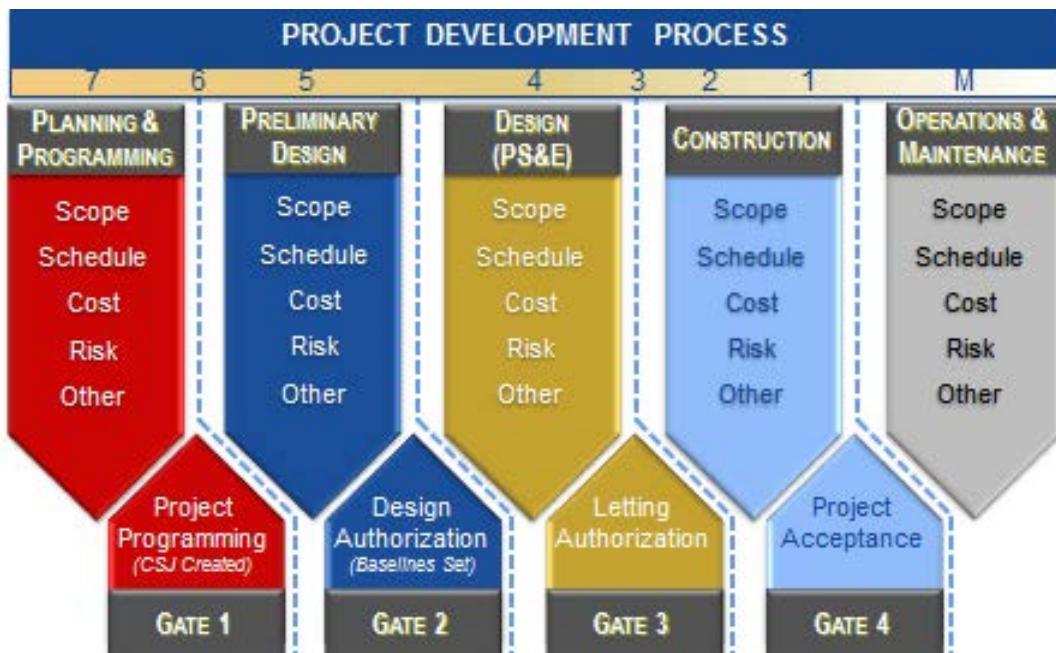
Project Maturity (DCIS Field)	Project Maturity Level/Phase of Overall Project	Project Maturity Timeframe (in Relation to Letting and Typical Values by Project)
7	Planning	25 to 10 years before
6	Programming	10 to 5 years before
5	Preliminary Design (0-30%)	5 to 1 years before
4	Design (30-60%)	3 to 1 years before
3	Final Design (60-100%)	1 to 0 years before
2	Advertise and Bid (Letting)	0 years before
1	Construction	0 to 5 years after
M	Operations and Maintenance	Varies after

Reference: Project Health Management Information System(PHMIS)-Project Data Gathering 2012

**Figure 3. Project Maturity Codes.**

To successfully address transportation needs and deficiencies, TxDOT must have reliable risk-based estimating frameworks that support the spectrum of costing from early conceptual alternatives through to definitive project PS&E.

Figure 4 illustrates the relationship between project maturity rating and the traditional project development phases.



**Figure 4. Project Maturity as the Project Develops.**

## ESTIMATE CLASS

TxDOT's Project Health Management Information System (PHMIS) includes inputs for "cost drivers" that make up the total project cost: Construction, Environmental, Right-of-Way, Utilities, Design and Construction Engineering and Inspection (CE&I). An input for "estimate class" is provided for each of the cost drivers; however, these have not all been implemented statewide. Estimate class communicates the maturity and level of effort in the development of the cost driver estimate. Each cost driver for each project is assigned an estimate class, which provides information on the methodology used in creating the estimate and the accuracy of the cost estimate. Figure 5 shows the code structure denoting the various classes of estimate maturity for each cost driver as defined in PHMIS.

A Class E estimate would be performed very early in the cost driver work at very minimal cost and most likely, just be based on a cost per mile calculated from a recent and/or similar project. A Class A estimate would be a detailed estimate incorporating any actual contract values or expenditures for the cost driver, using a bottom-up methodology. If there are multiple control-section-jobs (CSJs) with conflicting estimate class codes, PHMIS advises using the lowest rating (e.g., E instead of C).

Estimate Class					
Estimate Class Rating	Definition & Maturity (% Complete of Cost Driver Work)	Conceptual Step of Cost Driver Task Definition	End Usage (Typical Purpose of Estimate)	Typical TxDOT Methodology	Preparation Effort
E	0% to 2%	Determine Scope	Screening or Feasibility	Per Mile Cost or Similar Projects	Very Low (.005% of Cost)
D	1% to 15%	Identify Tasks	Concept Study or Feasibility	Per Mile Costs or Similar Projects	Low (.01% to .02% of Cost)
C	10% to 40%	Identifying Tasks not Previously and Identified Completing Tasks	Budget Authorization or Control	Unit Prices Applied to Estimated Major Tasks/Items/Hours	Medium (.015% to .05% of Cost)
B	30% to 70%	Completing and Few Tasks	Control or Bid Tender	Unit Prices Applied to all Estimated Tasks/Items/ Hours	High (.025% to .1% of Cost)
A	50% to 100%	Finalizing all Tasks	Check Estimate or Bid/Tender	Unit Price applied to Tasks/Items/Hours of Work	Very High (.05% to .5% of Cost)

Reference: Project Health Management Information System(PHMIS)-Project Data Gathering 2012

**Figure 5. Estimate Class.**

## RIGOR

TxDOT has developed a tiered scale for projects whereby the approach and requirements for certain project management practices are determined by these project tiers. This scale is referred to as a project's rigor.

## Rigor Levels

The [TxDOT Primavera \(P6v8\) Baseline Policy dated May 22, 2013](#) provides a tiered project classification table defining a project's "rigor". Rigor takes into account a project's scope, cost, risk factors, and other project characteristics to categorize projects into one of three classifications: 1) High, 2) Medium, and 3) Low.

This guide presents the minimum cost estimate development requirements for each rigor level. The project team may choose to utilize tools associated with a higher rigor than required if they feel it would be beneficial due to any special circumstances surrounding the project. Factors to consider when determining the level of estimating tools to be used include, but are not limited to, the following:

- Type of project.
- Location of the project and the communities it serves.
- Duration of the project.
- Stakeholders of the project.

## COMBINING PROJECT MATURITY, ESTIMATE CLASS, AND RIGOR LEVEL

Table 6 captures the relationship of project maturity, rigor level, and estimate class for construction projects. In general, it can be anticipated that the estimate class for lower rigor projects will be higher than that of high rigor projects for any particular project maturity level. In other words, estimates for lower rigor projects can generally be expected to be more detailed earlier in the development process. This is due to the fact that bid items and quantities for low rigor projects are easier to predict than that of high rigor projects. Regardless of rigor level, the Estimator should update DCIS and other TxDOT systems when the project maturity level changes and/or when the estimate class changes.

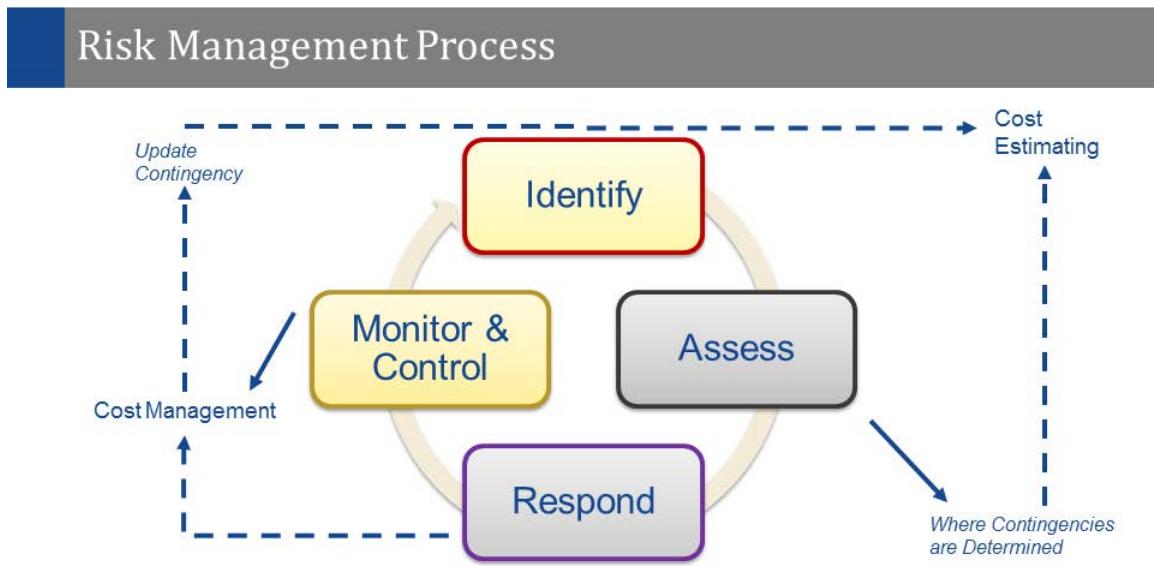
**Table 6. Relationship between Project Maturity and Estimate Class.**

Traditional Project Phase	Project Maturity Rating	Project Scale		
		Low Rigor	Medium Rigor	High Rigor
<b>Planning &amp; Programming</b>	<b>7</b>	E	E	E
	<b>6</b>	E-C	E-C	E-D
<b>Preliminary Design</b>	<b>5</b>	E-C	E-C	E-C
	<b>4</b>	D-B	D-B	D-C
<b>Design</b>	<b>3</b>	C-A	C-A	C-A
	<b>2</b>	A	A	A
<b>Letting</b>	<b>1</b>	A	A	A
<b>Construction</b>				

# RISK MANAGEMENT

## OVERVIEW

Risk management describes a sequence of analysis and management activities (see Figure 6) focused on creating a project-specific response to the inherent risks of developing a transportation project.



**Figure 6. Risk Management Process.**

## Chapter Organization

Topic	See Page
Risk	21
Risk Management Process	22
The Effect of Risk Management	27
Risk Management Roles and Responsibilities	27

## RISK

Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives. There is some degree of risk on every project, regardless of project size or complexity. Identifying potential project risks usually starts by reviewing the estimating assumptions made by the project Estimator and by the design team.

If not properly identified and treated throughout project development, risk can play a major role in causing inaccurate cost estimates, which are key in budgeting and funding projects. So every risk must be analyzed and, if necessary, have a contingency included in the Total Construction Cost Estimate.

As the project progresses through the project development phases, identified risks will be realized, resolved, or better defined based on updated project information. Additionally, new risks may be identified. The project team should actively manage the risks and update the contingency estimate throughout the project development phase.

### **Characteristics of Risk**

Every risk has the following attributes:

- Has not yet occurred. Risk is always in the future. If it has occurred, it is a certainty, not a risk. If a risk is realized, it is considered an issue.
- Has a cause. Something causes the event or condition to become a reality. Examples of causes include assumptions, project constraints, requirements, and other conditions.
- Has a probability or likelihood of occurring. This probability is greater than 0 percent and less than 100 percent.
- Is tied to a specific event or condition.
- Has an outcome that results in an impact, negative or positive.

To see more terms related to risk and their definitions, see Appendix A. Glossary.

## **RISK MANAGEMENT PROCESS**

The overall risk management process is repetitive and cyclical. The four fundamental risk management steps shown in Figure 6 can be applied throughout the project life cycle as risks are resolved or added. It is recommended that, at a minimum, formal updates to the risk process be performed as the project moves from one phase of project development to another; and informal updates be performed continuously throughout the project life. Formal updates would involve the project team collaboratively reviewing and updating the risk documentation. Informal updates would include the continual monitoring of project risk documentation and updating with new risks as they are identified, and retiring or modifying existing risks as new information is obtained through the project development process.

TxDOT has elected to use a project's rigor classification to help determine to what extent and what tools should be employed to assist with the risk management process. The differentiation of level of risk management by rigor classification is discussed in Part II of this Reference Guide.

### **Risk Identification**

Identifying potential risks is the first step to being able to manage them and account for them within the cost estimate. Design assumptions typically serve as a starting point for risk identification when creating a contingency estimate. Stage 3 of the Reference Guide goes into specifics in terms of the processes and tools associated with risk identification. As indicated in

Stage 3, it is necessary that each risk be defined to an appropriate level of detail and non-overlapping with other potential risks (see Table 7) so that the individual's cause and effect can be determined (see Table 8).

**Table 7. Challenges to Risk Identification.**

Challenge	Principles	How to Avoid
<b>Defining the risk with an appropriate level of detail.</b>	<ul style="list-style-type: none"> <li>• Risks should be comprehensive and non-overlapping.</li> <li>• Issues defined too vaguely are hard to assess.</li> <li>• Defining too many separate, detailed risks can lead to overlapping among issues or missing larger issues.</li> </ul>	To the extent possible, define risks to be independent of each other to eliminate overlap among risks through their descriptions.
<b>Separating a risk from its cause and/or effect.</b>	<ul style="list-style-type: none"> <li>• A risk may have one or more causes and, if it occurs, one or more effects.</li> <li>• Causes themselves are not uncertain since they are facts or requirements, so they are not the main focus of the risk management process; however, they are good to know when determining the response plan to a particular risk.</li> <li>• Effects are contingent events, unplanned potential future variations that will not occur unless risks happen.</li> <li>• As effects do not yet exist, and they may never exist, they cannot be managed directly through the risk management process.</li> </ul>	Use a description with required elements to provide a three-part structured risk statement: “As a result of <definite cause>, <uncertain event> may occur, which would lead to <effect on objective(s)>.”

**Table 8. Causes, Risks, and Effects.**

What	Definition	Examples
<b>Causes</b>	Definite events or sets of circumstances that exist in the project or its environment, and which give rise to uncertainty.	<ul style="list-style-type: none"><li>• The need to use an unproven new technology.</li><li>• The lack of skilled personnel.</li><li>• The fact that the organization has never done a similar project before.</li><li>• The lack of pertinent project information such as geotechnical, survey, or design development.</li></ul>
<b>Effects</b>	Unplanned variations from project objectives, either positive or negative, which would arise as a result of risks occurring.	<ul style="list-style-type: none"><li>• Early milestone completion.</li><li>• Exceeding the authorized budget.</li><li>• Failing to meet agreed quality targets.</li></ul>
<b>Genuine risks</b>	Uncertainties that, if they occur, affect the project objectives either negatively (threats) or positively (opportunities).	<ul style="list-style-type: none"><li>• The possibility that planned completion targets might not be met.</li><li>• Escalation rates might fluctuate.</li><li>• The chance that requirements may be misunderstood.</li><li>• Geological conditions more favorable than assumed.</li></ul>

### Risk Assessment and Analysis

Once a risk is identified, it is necessary to determine the probability of it actually occurring, and the impact to the project if it does occur. Risk analysis determines contingency values to place in the cost estimate to account for these possible impacts. Assigning values for probability and impact relies on the expertise and professional judgment of experienced participants. Again, Stage 3 of the Reference Guide discusses the risk analysis in greater detail for each project development phase.

There are two approaches to risk assessment: qualitative and quantitative. Qualitative analysis is a relative measure of risk using descriptive categories such as low, medium, high; or on a scale from 1 to 10. This type of analysis is typically used to rank – or prioritize – risks relative to one another. Quantitative analyses uses estimated percentage probabilities and dollar amounts (or time amounts when analyzing schedule risks) to develop a specific contingency amount to carry in the estimate to account for each risk.

### Risk Response

The objective of this step is to explore response strategies for the identified risks. The process identifies and assigns parties to take responsibility for each risk response. It ensures that each risk requiring a response has an owner. Appropriate responses identified by TxDOT are shown in Table 9.

**Table 9. Potential Risk Responses**

Risk Response	Definition
<b>Threat and Opportunity Response Options</b>	
<b>Accept</b>	Indicates that the project team has decided not to change the project plan to deal with a risk, or is unable to identify any other suitable response strategy. It should be noted, that mitigation or transference is not necessary for all risk threats, particularly those with minimal potential impacts. Judgment must be used as to whether a more rigorous (and potentially costly) response should be implemented.
<b>Share</b>	Allocates a <u>portion</u> of ownership of a risk <u>threat</u> to another party who is best able to minimize the impact and/or probability of the risk; or, allocates <u>all or a portion</u> of ownership of a risk <u>opportunity</u> to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does occur. TxDOT and 3rd party share the benefits of the opportunity.
<b>Threat Response Options</b>	
<b>Mitigate</b>	Seeks to reduce the probability and/or impact of a risk threat to below an acceptable threshold.
<b>Transfer</b>	Allocates <u>all</u> ownership of a risk threat to another party who is best able to minimize the impact and/or probability of the risk.
<b>Avoid</b>	Involves changing the project plan to eliminate the risk threat or to protect the project objectives from its impact.
<b>Opportunity Response Options</b>	
<b>Enhance</b>	Seeks to modify the “size” of a risk opportunity by increasing its probability and/or impact thereby maximizing benefits realized for the project.
<b>Exploit</b>	Seeks to eliminate the uncertainty associated with a particular upside risk by making the risk opportunity definitely happen - can be considered a more rigorous response than "enhance".

The list of risks is used as the basis for the solicitation of mitigation and planning options from key managers and experts. The project management staff will determine who owns the risk and is responsible for ensuring that it is managed effectively. The risk management plan and/or risk register should clearly identify who is responsible for monitoring, managing, reporting on, and resolving each individual risk. For most projects – particularly medium and high rigor projects, ownership of risks should be dispersed amongst the project team so that all the work doesn't fall on one or two people. Ownership should be assigned to the party best able to address and monitor the risk.

Once each risk has an owner, developing a response plan for the risk follows these steps:

1. For risks that are not “accepted”, use the remaining response choices defined in Table 9, to identify options for reducing the probability or impacts of each negative risk (or enhancing the probability or impacts for opportunities) before they occur. Involve experts available to the project as necessary.
2. Evaluate each option for potential reduction in the risk and cost of implementing the option.
3. Select the best option for the project.
4. Assign a Risk Owner to execute the selected response action. The Risk Owner is the lead and may assign specific tasks to other resources to have the response implemented and documented.
5. Determine whether a contingency plan is necessary. A contingency plan defines the actions that will be taken if the response plan fails and the risk occurs; and allows the project team to take more immediate action to help reduce the negative impact to the project. While not all risks will warrant the development of a contingency plan, special consideration should be given for larger threats since these will have a significant impact on the project if they do occur.

## Risk Monitoring

The objectives of risk monitoring and control are to:

- Systematically track the identified risks.
- Identify any new risks.
- Effectively manage the contingency reserve.
- Capture lessons learned for future risk assessment and allocation efforts.

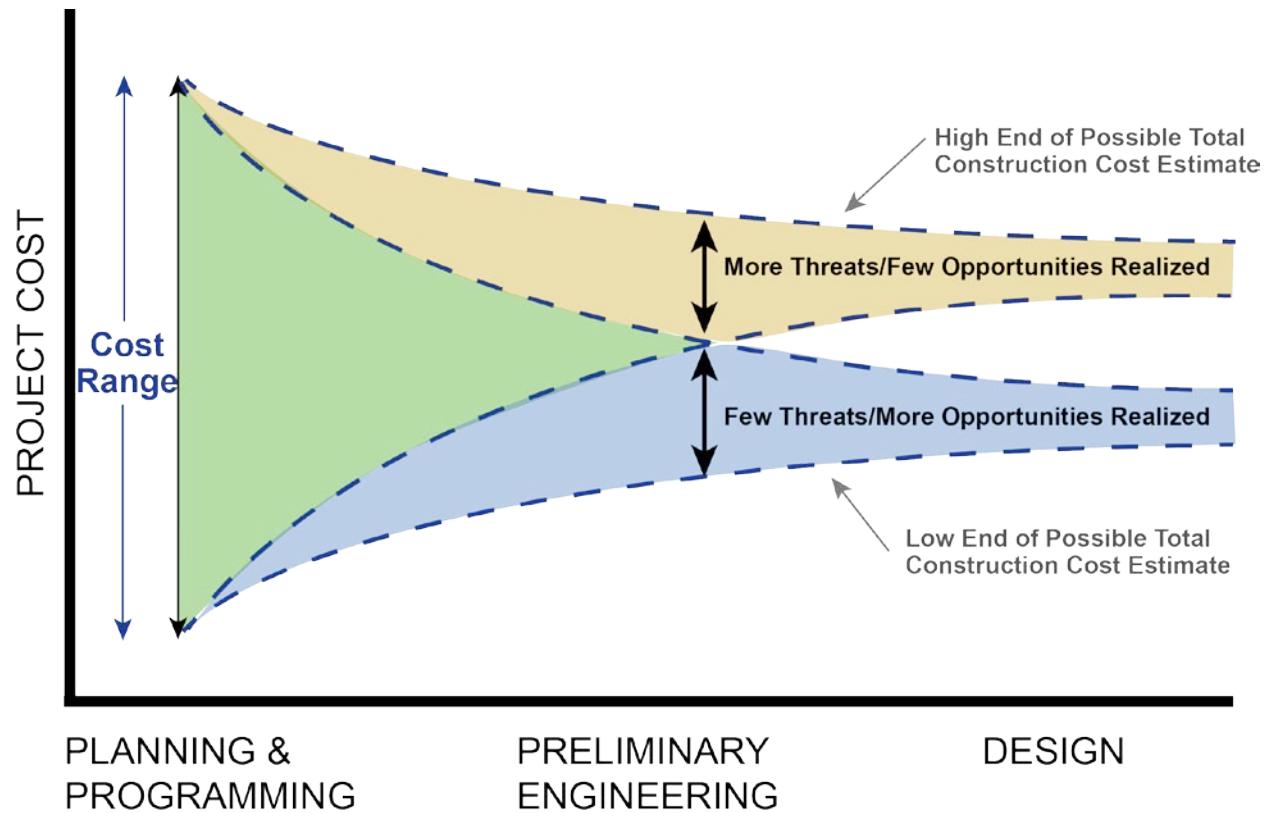
The key inputs to risk monitoring and control are the Risk Management Plan and Risk Register. These tools provide a framework for managing risks through a formalized monitoring and control process. In general, a good risk monitoring and control plan should follow these principles:

- Risk monitoring and control should be a continuous and repetitive activity during all phases of project development.
- Risk management should be considered an investment of time upfront in order to avoid problems in the future. The time spent on monitoring and controlling risks should be commensurate with the size and complexity of the project and its associated risks. For each project, develop a unique risk monitoring and control process that is not overly burdensome or creates undue paperwork.
- A successful risk monitoring and updating process will systematically track risks, support the identification of new risks, and effectively manage the contingency reserve.
- Risk monitoring and control may involve recommending:
  - Alternative risk responses.
  - Implementing a contingency plan.
  - Taking corrective actions.
  - Changing the project objectives.

## THE EFFECT OF RISK MANAGEMENT

If the problems or uncertainties included in the early stages of a cost estimate do materialize, then a higher range of the cost estimate will be expected. In contrast, when risk management and other cost control processes are used effectively, a lower range of expected costs will result.

Figure 7 depicts how identifying, quantifying, and managing risks can impact the cost of project. If risks were not properly identified and managed throughout the design process, the cost to deliver the project will typically be higher. Likewise, opportunities that are ignored prevent the ability to take advantage of circumstances that could have lowered the overall cost of the project.



**Figure 7. Impact of Risk Management on Project Cost.**

## RISK MANAGEMENT ROLES AND RESPONSIBILITIES

At some level, all Stakeholders influence the Risk Management process. However, not all Stakeholders will be involved in Risk Management Planning. The Project Manager is the person who is ultimately responsible for delivering the project. However, the Project Manager should seek advice and input from the Project Team and other Stakeholders when developing the plan, particularly for larger projects. While the team should seek to address risks at the lowest level possible, not all risks can effectively be addressed at the project team level and some may need to be escalated to the District or even Department Leadership level.

The Project Team is responsible for:

- Bringing knowledge and experience to Risk Management.
- Ensuring the plan is followed.
- Helping with the planning process.
- Executing and carrying out the details of the plan.
- Monitoring, managing, reporting on, and resolving risks for which they are assigned ownership.

One method of emphasizing that the entire project team is responsible for risk management is to make risk a standard discussion item during project meetings. Risk owners should report on any changes in a risk's anticipated impact and/or probability and if a risk's response plan is progressing or is ineffective. Placing risk on the meeting agenda also allows team members the opportunity to mention new risks that should be added to the risk register and managed accordingly.

## RISK-BASED ESTIMATING

### OVERVIEW

A cost estimate that directly addresses uncertainty and risk is at the core of a comprehensive risk management program. This chapter addresses the relationship between risk and cost and how they work together in risk-based estimating.

#### Chapter Organization

Topic	See Page
Risk-Based Estimating	29
Estimating Risk and Setting Contingency	32

### RISK-BASED ESTIMATING

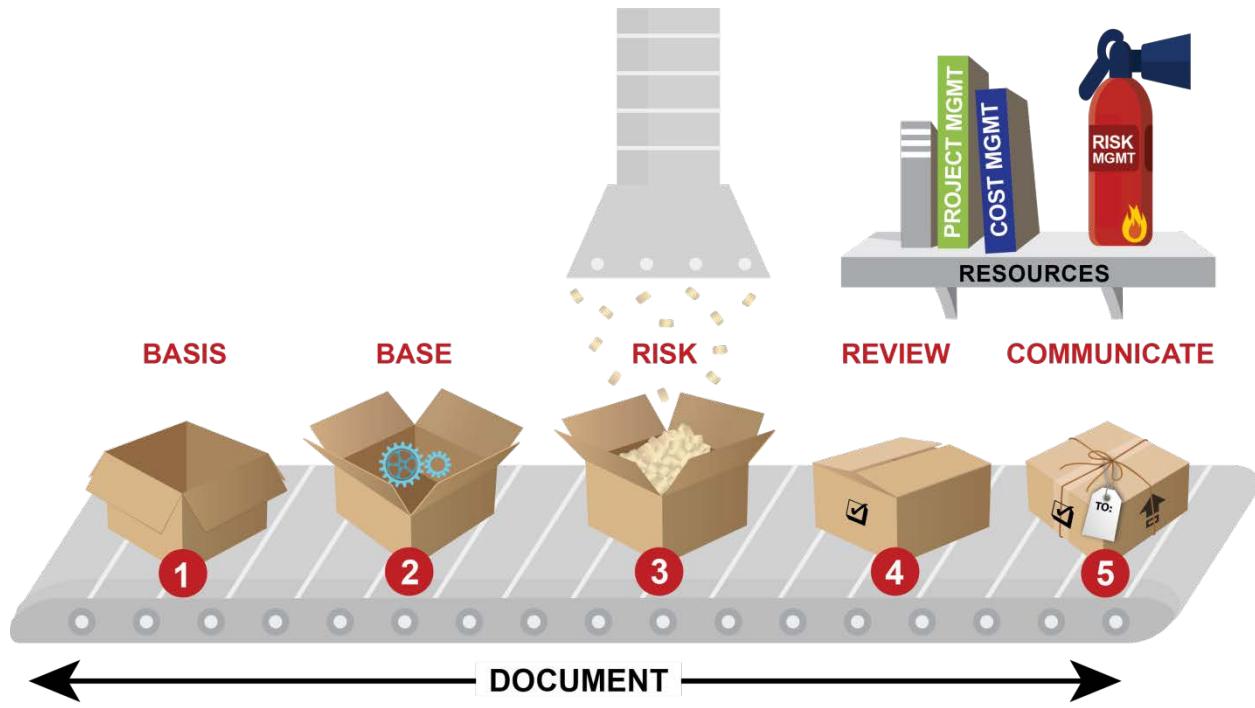
Risk-based cost estimation considers uncertainties and related risks early and often in the project development process. Management uses identified risks and uncertainties to structure procedures that mitigate, eliminate, or account for the possible variation in the outcomes.

Risk-based cost estimating methods and tools must relate and adapt to the various phases of project development. When estimating costs, particularly on large and complex projects, this becomes even more profound. A summary table of tools by project phase is included in Table 177 of Appendix C.

Figure 8 shows a graphical representation of the risk-based estimating framework detailed in this guide:

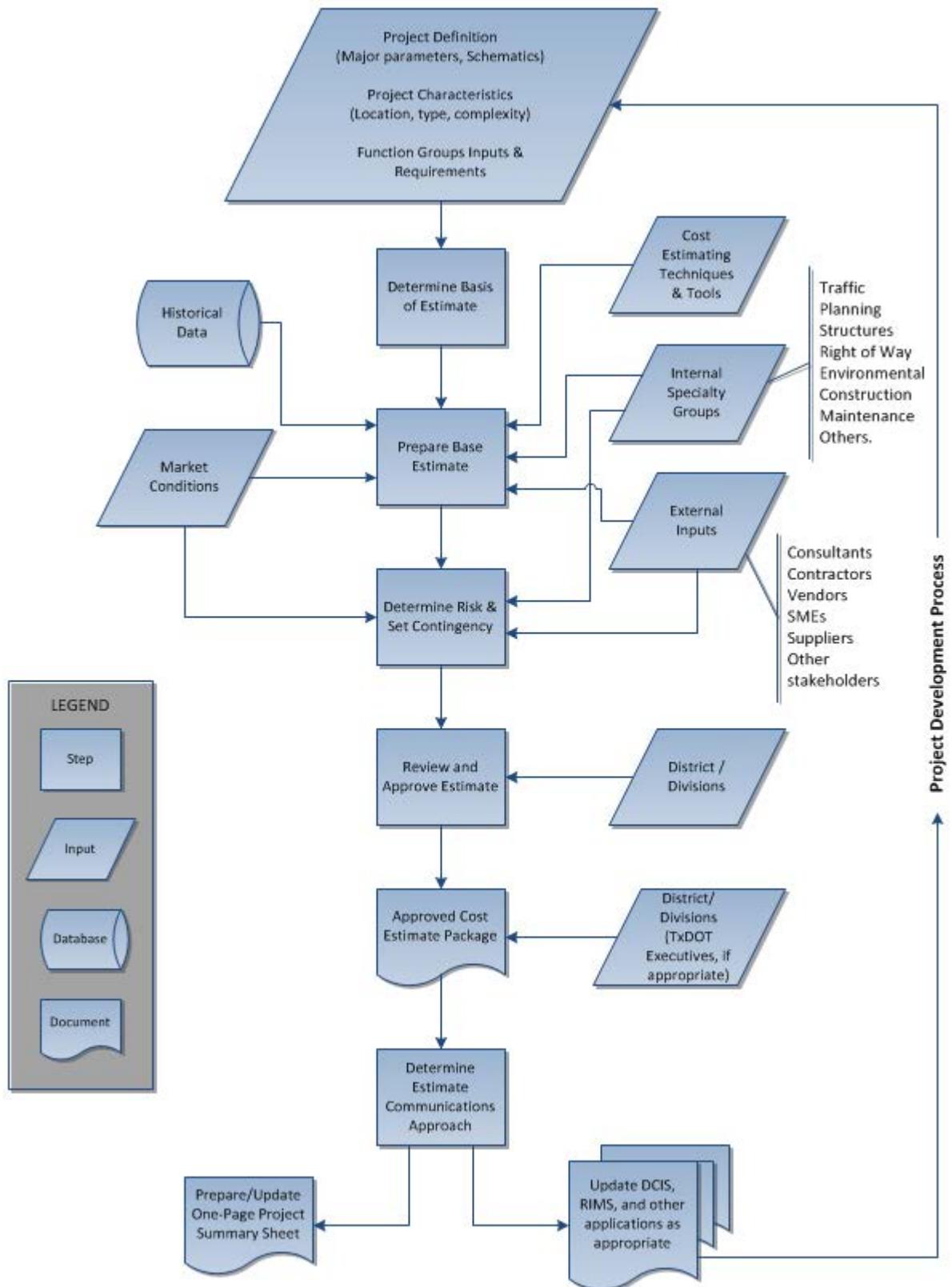
- **Stage 1:** The box represents the “basis of estimate”. The basis of estimate defines the boundaries of the project, i.e., the size of the object that will go inside the box. Just like the estimate basis, the box also has to consider other factors that may impact successful delivery of its contents such as how the item will be delivered.
- **Stage 2:** The known items that go into the box – in this case, a widget -- illustrates the concept of the “Base Estimate” that is comprised of the known items within the estimate.
- **Stage 3:** Because there are uncertainties and other variability in a project, contingency is determined and added to the estimate which is the equivalent of adding packing materials to the box to account for the unknowns.
- **Stage 4:** Once the box is packed – just like an estimate that is completed, it is reviewed to ensure it contains the appropriate elements and it is ready to be presented.
- **Stage 5:** Finally, the package is tagged with the necessary information to communicate to others what is in the package with the appropriate instructions. Similarly, the estimate

must be packaged so that it conveys what is in the estimate, what assumptions might have been made, and any uncertainties that are being accounted for within the estimate.



**Figure 8. Risk-Based Estimating Framework.**

To continue the illustration, an estimate -- just like the hypothetical package -- requires documentation throughout its life and other resources and processes such as project management, cost management, and risk management are employed to ensure the anticipated outcome. Figure 9 represents a flowchart of the risk-based estimating process described within this Reference Guide.



**Figure 9. Risk-Based Cost Estimating Process.**

## **Why Risk-Based Estimating**

A risk-based cost estimate identifies critical cost containment issues and helps to effectively inform the design team about risks as projects move through the development phases.

A cost estimate that directly addresses uncertainty and risk is at the core of a comprehensive risk management program. Risk management must be viewed as a comprehensive management process, not as simply a tool or set of tools for cost estimating.

## **Benefits of Risk-Based Estimating**

Systematically incorporating risk early into the cost estimate improves the planning-level cost projections. The intended benefits of risk-based estimating are:

- Improved delivery of projects and program management.
- Better use of available resources.
- Greater credibility with the public and other stakeholders.
- Increased satisfaction as a result of more efficiently and effectively meeting public needs.

## **Risk-Based Estimating Fits TxDOT's Plans**

In November 2011, TxDOT established an initiative to improve construction cost estimating. The approved project charter for this initiative is included in appendices. The scope of that initiative was to...

*“Develop best practices and business rules for determining the estimated construction cost of transportation projects....over the history of the project life cycle.”*

Specific objectives of the initiative were to:

- Increase transparency through appropriate document creation and maintenance.
- Improve accountability for the development and approval of estimate.
- Improve the accuracy of estimates.
- Improve the documentation of assumptions and risks associated with estimate.

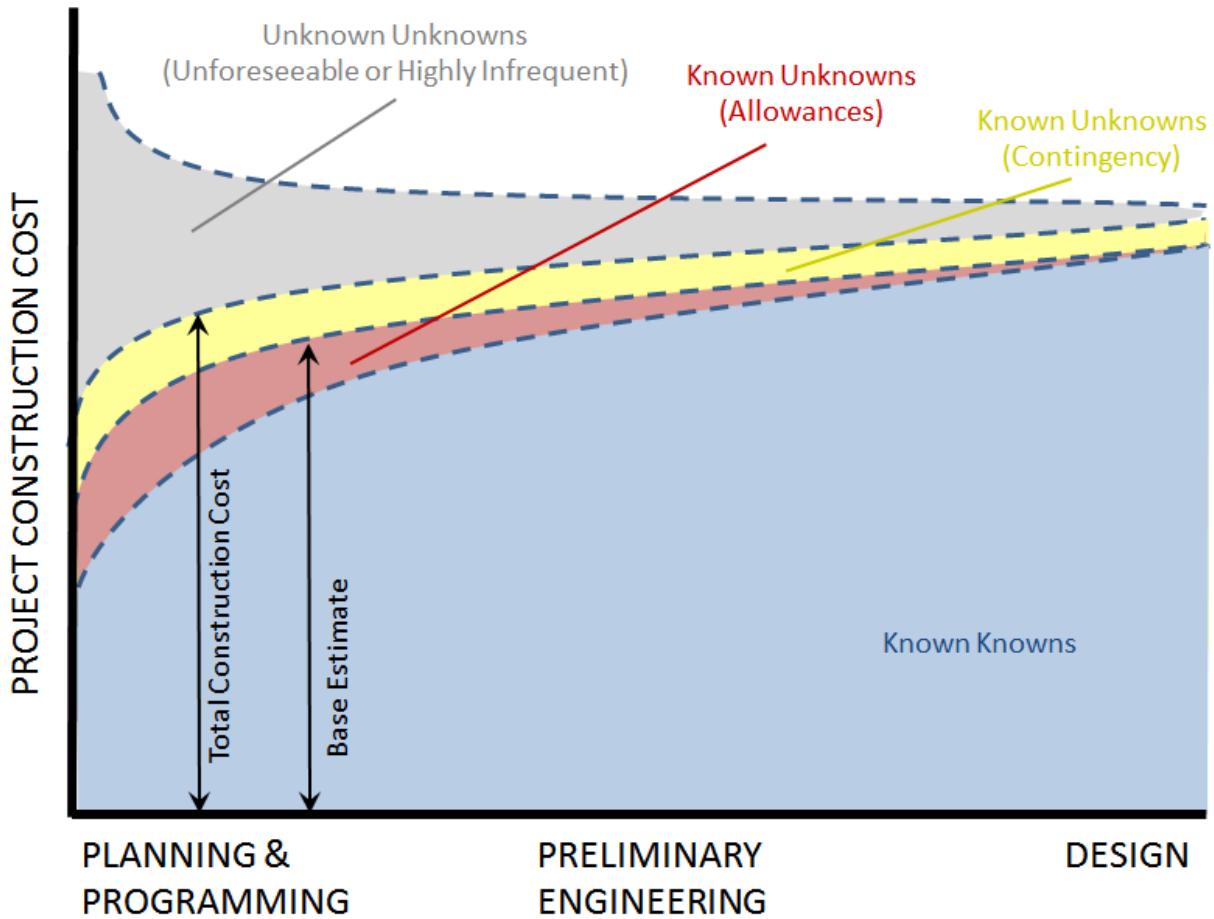
The concepts of risk-based cost estimating and the framework presented in this Reference Guide support and can help TxDOT achieve those objectives if fully practiced.

## **ESTIMATING RISK AND SETTING CONTINGENCY**

Until the final engineer’s estimate just prior to letting, an estimate is compiled with various levels of known and unknown information. Table 10 summarizes the types of information that are present during estimating. As a project moves through the development process, the proportion of “knowns” to “unknowns” changes so that, ideally, the project goes to letting with practically no unknown details (other than unit price variability) and no unaddressed risks as illustrated in Figure 10.

**Table 10. Cost Estimate Information Types.**

Information Types	Principles
<b>Known/ Knowns</b>	Estimators should prepare their estimates considering what is defined in the project scope or drawings and apply the appropriate estimating method to determine the Base Estimate costs. For some known work items, it may not be possible to break down the cost to bid items and quantities until the design has matured. These known items, however, can be accounted for in the Base Estimate through an allowance that serves as a placeholder until the design advances with detailed information. For example, placing an allowance in the estimate for “drainage items” because it is known to be needed but the design of the drainage system has not been designed.
<b>Known/ Unknowns</b>	<p>Known Unknowns are items that are known to be required on the project, but at a particular project development stage are not yet drawn on the plans and not yet quantifiable. typically fall within two categories:</p> <ul style="list-style-type: none"><li>• general uncertainties such as the variability in unit prices and quantities for bid items, or an allowance for drainage when the drainage plan has not be determined or designed; and</li><li>• uncertain events – risks – that the project team attempts to identify and quantify.</li></ul> <p>Allowances are used to account for the first categoriy of known unknowns.</p> <p>Contingency is needed in an estimate to account for the second type of known unknowns. Risk management practices and tools can assist in the calculation of appropriate contingencies to account for these costs. Note: documentation of assumptions and methods for identifying and accounting for known unknowns within an estimate is critical to ensure that risk – and associated contingency – is not double-counted. For example, if a risk is associated with lack of geotechnical information which may impact the pavement design, this could be captured in either the bid item quantity variability or as a discrete risk. Either way is acceptable, however the risk should not be double counted which would lead to essentially doubling the contingency allocated for that item.</p>
<b>Unknown/ Unknowns</b>	These are costs that an Estimator typically will not account for in an estimate because they are unforeseeable or happen so infrequently that they would make the project estimate unrealistically high.



**Figure 10. Evolution of Project Information.**

Because there are unknowns and uncertainty in the project, especially in the Planning and Programming Phase and Preliminary Design Phase, it is difficult to pinpoint a specific cost to place within the estimate. Through experience and input from others, the Estimator should be able to indicate a probable cost knowing that it could actually be lower or higher. Because of this variability, it is more prudent to develop an estimate that can represent a probable range of costs until more design specificity can narrow (or eliminate) the cost variability.

### Accounting for Discrete Risks within the Cost Estimate

By their very nature, risks have a probability of occurring and if they do occur, will impact the project in a positive or negative way. For example, in early planning it may be assumed that the reconstruction of a roadway will include a flexible pavement and the initial estimate includes the appropriate items, quantities, and cost for that pavement design. Further studies and analysis, however, may indicate that a rigid pavement might be a better choice but it is too early to confirm. The engineer and Estimator now have a project risk that the pavement design changes from what is accounted for within the estimate. And since a rigid pavement would be more costly to construct, this risk poses a threat to the cost of the project. (If the reverse situation was true, i.e., a rigid pavement was initially assumed but there is a chance the final design calls for a

flexible pavement, then this uncertainty would represent a risk than can be an opportunity for cost savings.)

In both situations, risk as a threat or risk as an opportunity, there exists the need to capture those circumstances within the estimate. Otherwise, if the risk becomes reality, the estimate inaccurately portrayed what the eventual project could cost. A Project Contingency is used to capture the cost impacts associated with risks.

### **Accounting for Variability and Uncertainty within the Cost Estimate**

Variability can exist in both known and unknown elements of an estimate. For example, the price of hot mix may be fluctuating and it is difficult to determine the specific unit price to include in the estimate. Or a risk (such as contaminated soil) is possible, but the potential quantity is not identified. In these examples, variability would exist in the Base Estimate—because the design and relevant bid items are known but the price is in question, and variability would be in the contingency because the contaminated soil is an uncertainty with a range of possible outcomes.

### **Contingency**

Contingency funds are incorporated into a cost estimate to account for the risks associated with the project. Contingency is meant to protect the project against cost increases that may arise when risks become reality, not to cover overruns, inflation, or allow for scope creep.

### **Estimate Ranges**

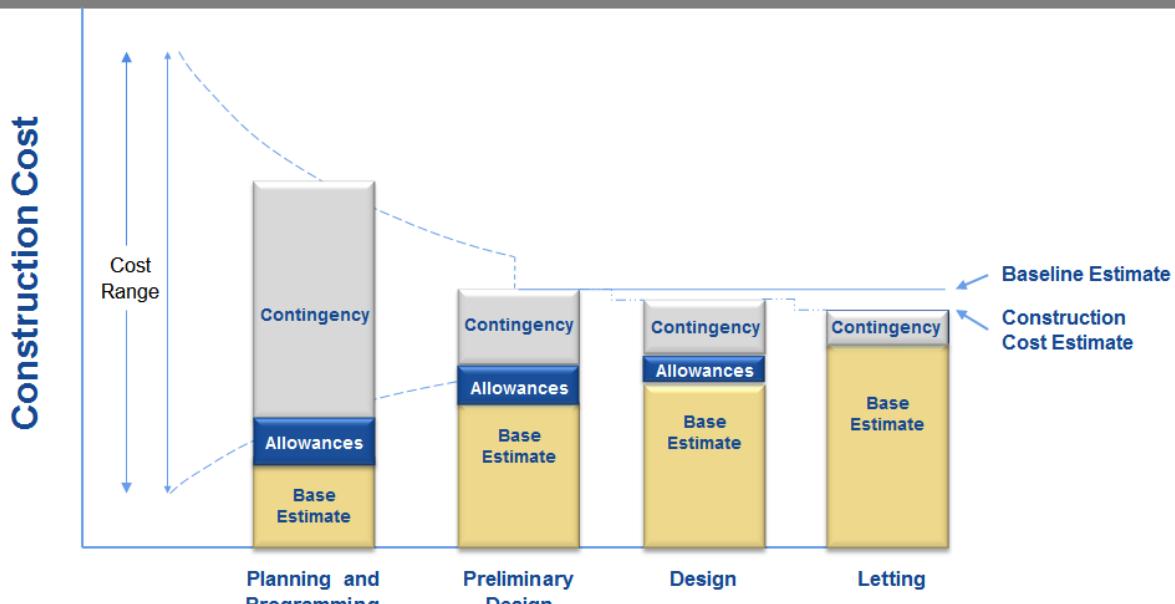
When asked “how much will this project cost,” any number given really only represents one estimate result based on multiple assumptions. These assumptions contain many variables that are not all controllable or quantifiable until the design matures. Between these unknowns, uncertainties (or risks), and variability, it is difficult to say with absolute confidence what precisely a project will cost. Developing and communicating a range of cost in which the actual cost will most likely fall, accounts for and conveys that the estimate is accounting for unknowns, uncertainties, and variability inherent to any project.

Showing an estimate as a range of values:

- Creates a better understanding of estimate precision by showing risk and uncertainty as compared to a single-point estimate.
- Represents the most probable range of project costs, not merely the absolute possible minimum or maximum costs.
- Educates and communicates to interested parties outside of the project team that unknowns and uncertainties still exist within the project and to what degree they exist.

Figure 11 combines the concept of accounting for the Base Estimate and contingencies separately throughout project development as well as the ideal that an estimate can fall within a range of values due to unknowns, risks, and variability. Notice how contingency reduces as the design matures because assumptions are resolved, risks are being managed, and fewer unknowns remain in the project.

## Maturity of Construction Cost Estimate



**Figure 11. Refinement of Cost Estimate during Project Development.**

Figure 11 also illustrates two basic characteristics of risk-based estimating:

- An estimate at any given point is made up of a Base Estimate component and a contingency component. As the project progresses in development, the contingency amount is expected to decrease because the project information is refined. Often the Base Estimate increases as some of the Project Contingency is realized and included as part of the Base Estimate.
- A range estimate transitions to a baseline estimate when moving from the Preliminary Design to the Design phases. It is at the end of the Preliminary Design phase that the baseline estimate is set and Cost Management to that baseline begins.

Figure 11 can also be summarized according to each pre-construction development phase:

- *Use of Cost Ranges at the Planning and Programming Phase* – Planning and Programming phase estimates, particularly on a more complex/major project should be communicated through a range. As depicted in the cost estimate column at the Planning and Programming Phase, the contingency can be very large. In fact, the contingency can potentially be larger than the Base Estimate if very little is known about the project's definition.
- *Application of a Baseline Cost Estimate at the end of the Preliminary Design Phase* – The estimate at the end of the Preliminary Design phase is frequently used to establish a Baseline Cost Estimate. The Baseline Cost Estimate is made up of both a Base Estimate plus a Project Contingency.

- *Contingency Resolution throughout the Design Phase* – As the project matures from Planning and Programming through Design, the Project Contingency is lowered and the Base Estimate amount increases. The percentage of the contingency to the Base Estimate is a function of the project complexity and the level of project definition.



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## PART II – RISK-BASED ESTIMATING FRAMEWORK

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**STAGE 1. DETERMINE/UPDATE ESTIMATE BASIS**

Risk-Based Estimating

**STAGE****1****The Framework****5 Stages****1** Determine/Update Basis of Estimate**2** Prepare/Update Base Estimate**3** Determine Risk and Set Contingency**4** Review and Approve Estimate**5** Communicate Estimate**OVERVIEW**

Stage 1 has five steps that provide a natural progression to determine and update the Basis of Estimate at the three stages of the Project Development Process.

**Chapter Organization**

This chapter contains the following topics.

Topic	See Page
Quick Reference Guide	43
Step A. Review Project Definition and Requirements	47
Step B. Determine Alternative to Estimate	52
Step C. Review Site Characteristics	56
Step D. Determine Needed Clarifications/Potential Changes	61
Step E. Review Basis of Estimate Documentation	65

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

### Remember

- The activities are often performed concurrently and repeated as an estimate is prepared.
- A clear definition of the basis of the estimates is essential for preparing an accurate cost estimate.

Stage 1. Determine and Update Estimate Basis			
Purpose	Steps	Outputs	Tools
Use proper inputs and sources that will serve as an accurate basis of the estimate and its updates.	A. <a href="#">Review project definition and requirements.</a> B. <a href="#">Determine alternative to estimate.</a> C. <a href="#">Review site characteristics.</a> D. <a href="#">Determine needed clarifications/potential changes.</a> E. <a href="#">Review Basis of Estimate documentation.</a>	Project Estimate File	<ul style="list-style-type: none"><li>• <a href="#">Project Estimate File</a></li><li>• <a href="#">Design Summary Report</a></li><li>• <a href="#">Annual Scope and Estimate Documentation Form</a></li><li>• <a href="#">Advance Planning Risk Analysis</a></li></ul>

### How to Use This Chapter

For each step in Stage 1, the following information is provided:

- Important information across the three pre-construction phases of project development.
- The roles and responsibilities of the step.
- Why the step is needed.
- Guidance relevant to all three phases.
- Specifics to the Planning and Programming phase.
- Specifics to the Preliminary Design phase.
- Specifics to the Design phase.

## Stage 1: Determine/Update Basis of Estimate

### Quick Reference Guide

#### Risk-Based Estimating

# STAGE

# 1

## The Framework

5 Stages

- 1 **Determine/Update Basis of Estimate**
- 2 **Prepare/Update Base Estimate**
- 3 **Determine Risk and Set Contingency**
- 4 **Review and Approve Estimate**
- 5 **Communicate Estimate**

**Purpose:** Identify and use proper inputs and information sources that will serve as an accurate basis of the project estimates and its future updates.

STEP	PURPOSE
A. Review project definition and requirements.	Collect and review relevant project information to gain knowledge of the project in order to identify the proper items and inputs that will serve as an accurate basis of the estimate and its updates.
B. Determine alternative to estimate.	When a project has more than one solution to meet the purpose and need of the project, prioritize the alternative to estimate first.
C. Review site characteristics.	Helps the Estimator gain knowledge, insight, and a better understanding of the project site characteristics and their impact on cost and risk.
D. Determine needed clarifications/potential changes.	Assess the completeness of the key inputs to the cost estimation process and request additional information; notify Project Manager of potential changes.
E. Review Basis of Estimate documentation.	Summarize information used for the estimate for reviews and future reference for other cost estimates that will be prepared.

#### Key Reminders

- Document and communicate any changes to the estimate basis from previous estimates.
- Every project, regardless of size or complexity, needs an up-to-date Project Estimate File.
- Getting input from others avoids unnecessary or inaccurate assumptions.

#### Tools

- [Project Estimate File](#)
- [Design Summary Report](#)
- [Annual Scope and Estimate Documentation Form](#)
- [Advance Planning Risk Analysis](#)

## Stage 1: Determine/Update Basis of Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Review project definition and requirements.</u>	<ul style="list-style-type: none"> <li>Reviewing the documents and changes to the documents helps the Estimator understand the scope of the project and assess the completeness and quality of the available inputs to the cost estimating process.</li> </ul>	<ol style="list-style-type: none"> <li>Review project requirement described by the concept definition at the time of estimate.</li> <li>Identify key project categories and parameters.</li> <li>Determine if more than one alternative should be considered for the project.</li> <li>Consider project complexity (i.e., taking into account project uniqueness and differences).</li> <li>Plan how the estimate will be prepared, what information and data are needed, and which functional groups or Divisions need to provide input.</li> </ol>	<ol style="list-style-type: none"> <li>Review all project requirements covered in Design Summary Report.</li> <li>Review available drawings (e.g., proposed schematic and proposed typical section).</li> <li>Understand key project design parameters.</li> <li>Determine if multiple estimates (one for each of the proposed alternatives) are required.</li> <li>Consider project complexity (i.e., taking into account project uniqueness and differences).</li> <li>Account for estimating activities in project schedule including necessary inputs from other functional groups.</li> </ol>
<u>B. Determine alternative to estimate.</u>	<ul style="list-style-type: none"> <li>When preparing cost estimates for the purpose of comparing alternatives, each estimate should be developed using the same procedure.</li> <li>The cost estimate for each alternative must have a documented Basis of Estimate, list of assumptions, and a list of considered risks for which the contingency is derived.</li> <li>If one alternative is to be the base case to which other alternatives will be compared, the base alternative estimate should be developed first.</li> </ul>	<ol style="list-style-type: none"> <li>Determine the alternative to estimate first.</li> <li>Prioritize the remaining alternatives for estimating.</li> </ol>	<ol style="list-style-type: none"> <li>Determine the alternative to estimate first.</li> <li>Prioritize the remaining alternatives for estimating.</li> <li>Document when and why an alternative was no longer considered and estimates where no longer developed.</li> </ol> <p><i>Not applicable for this phase</i></p>

## Stage 1: Determine/Update Basis of Estimate

	Planning & Programming	Preliminary Design	Design
<b>C. Review site characteristics.</b>	<ul style="list-style-type: none"> <li>A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos.</li> <li>Relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.</li> <li>It is also helpful to visit the site even if the project is not very complex and considered typical.</li> <li>For unusual or complex projects, it is recommended that the Estimator visit the site at least one time in each of the development phases especially if the project takes several years to develop.</li> </ul>	<ol style="list-style-type: none"> <li>Review project objectives and requirements.</li> <li>Review video log (if available) and aerial photos (e.g., Google Earth™) of site location.</li> <li>Visit site and walk project.</li> <li>Review site characteristics in view of concept definition (especially if alternatives are being considered to ensure there are no missing cost categories).</li> <li>Consider potential constructability issues that may have major impacts on estimated project costs.</li> </ol>	<ol style="list-style-type: none"> <li>Review project objectives and requirements as well as planning/design work completed to date.</li> <li>Visit site and walk project.</li> <li>Review video log and aerial photos of site location.</li> <li>Consider impact of site characteristics on project costs (material storage, batch plant, staging, etc.).</li> <li>Document constructability issues and related issues that may impact estimated project costs.</li> </ol>
<b>D. Determine needed clarifications/potential changes.</b>	<ul style="list-style-type: none"> <li>Request for clarifications is a means of communication. Efficient communication between the Project Manager, the Estimator, and functional groups improves the accuracy of the cost estimates.</li> <li>Documentation of requests for clarifications and the responses should be maintained in the Project Estimate File.</li> <li>Clarification requests should reduce as successive cost estimates are prepared.</li> <li>A potential change can alter the project definition, schedule, and/or estimate.</li> </ul>	<ol style="list-style-type: none"> <li>Develop lists of questions for functional groups and/or Divisions regarding their area of the project.</li> <li>Develop list of questions regarding project requirements and potential impacts of major construction constraints.</li> <li>Request clarification regarding project requirements or construction impacts.</li> <li>Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.</li> <li>Notify the Project Manager of the changes and request direction regarding the change.</li> </ol>	<ol style="list-style-type: none"> <li>Develop lists of questions for functional groups and/or Divisions regarding their area of the project.</li> <li>Develop list of questions regarding project requirements and impacts of constructability issues on cost estimate categories and elements.</li> <li>Request clarification regarding project definition or construction impacts.</li> <li>Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.</li> <li>Notify the Project Manager of the changes and request direction regarding the change.</li> </ol>
<b>E. Review Basis of Estimate documentation.</b>	<ul style="list-style-type: none"> <li>Documentation of project requirements is critical when updating the base cost estimate, risks, and contingency.</li> <li>A standard Project Estimate File format should be followed. The Project Estimate File provides uniformity in the documentation, which helps other Estimators to understand the project definition basis clearly.</li> </ul>	<ol style="list-style-type: none"> <li>Prepare file of Basis of Estimate to include all documents and information used to prepare planning-level estimates.</li> </ol>	<ol style="list-style-type: none"> <li>Prepare estimating file with documentation of Basis of Estimate to include:             <ol style="list-style-type: none"> <li>All Scoping Worksheets.</li> <li>Schematic or other preliminary drawings.</li> <li>Design criteria.</li> <li>Other specific project requirements.</li> </ol> </li> </ol>

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

### Preview of Stage 1 Procedure

Table 11 provides an overview of the basic procedure, its purpose, who does it, and when in the Project Development Process it should be done.

**Table 11. Stage 1 Procedure.**

STEP	PURPOSE	WHO DOES IT?	WHEN?
<a href="#"><u>A. Review project definition and requirements.</u></a>	Collect and review relevant project information to gain knowledge of the project in order to identify the proper items and inputs that will serve as an accurate basis of the estimate and its updates.	Estimator (with input from design disciplines)	• All phases.
<a href="#"><u>B. Determine alternative to estimate.</u></a>	When a project has more than one solution to meet the purpose and need of the project, prioritize the alternative to estimate first.	Project Manager Estimator	• Planning and Programming. • Preliminary Design.
<a href="#"><u>C. Review site characteristics.</u></a>	Helps the Estimator gain knowledge, insight, and a better understanding of the project site characteristics and their impact on cost and risk.	Estimator (with input from project team)	• All phases.
<a href="#"><u>D. Determine needed clarifications/potential changes.</u></a>	Assess the completeness of the key inputs to the cost estimation process and request additional information; notify Project Manager of potential changes.	Project Manager Estimator	• All phases.
<a href="#"><u>E. Review Basis of Estimate documentation.</u></a>	Summarize information used for the estimate for reviews and future reference for other cost estimates that will be prepared.	Estimator	• All phases.

Each phase builds on the previous phase's information. Planning and Programming inputs are listed in red, followed by Preliminary Design additions in blue, followed by Design additions in grey. Items listed for the Planning and Programming Phase are also used in the Preliminary Design and Design Phases. Items listed for the Preliminary Design Phase are also used in the Design Phase. At the end of Stage 1, the Project Estimate File and current Design Summary Report are the key outputs.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review project definition and requirements.

### STEP A. REVIEW PROJECT DEFINITION AND REQUIREMENTS

This step identifies and reviews proper inputs and sources that will serve as an accurate basis of the estimate and its updates.



The Estimator should gather key cost estimate inputs and their sources.



This information serves as the basis of the estimate.



**Guidance for All Phases**

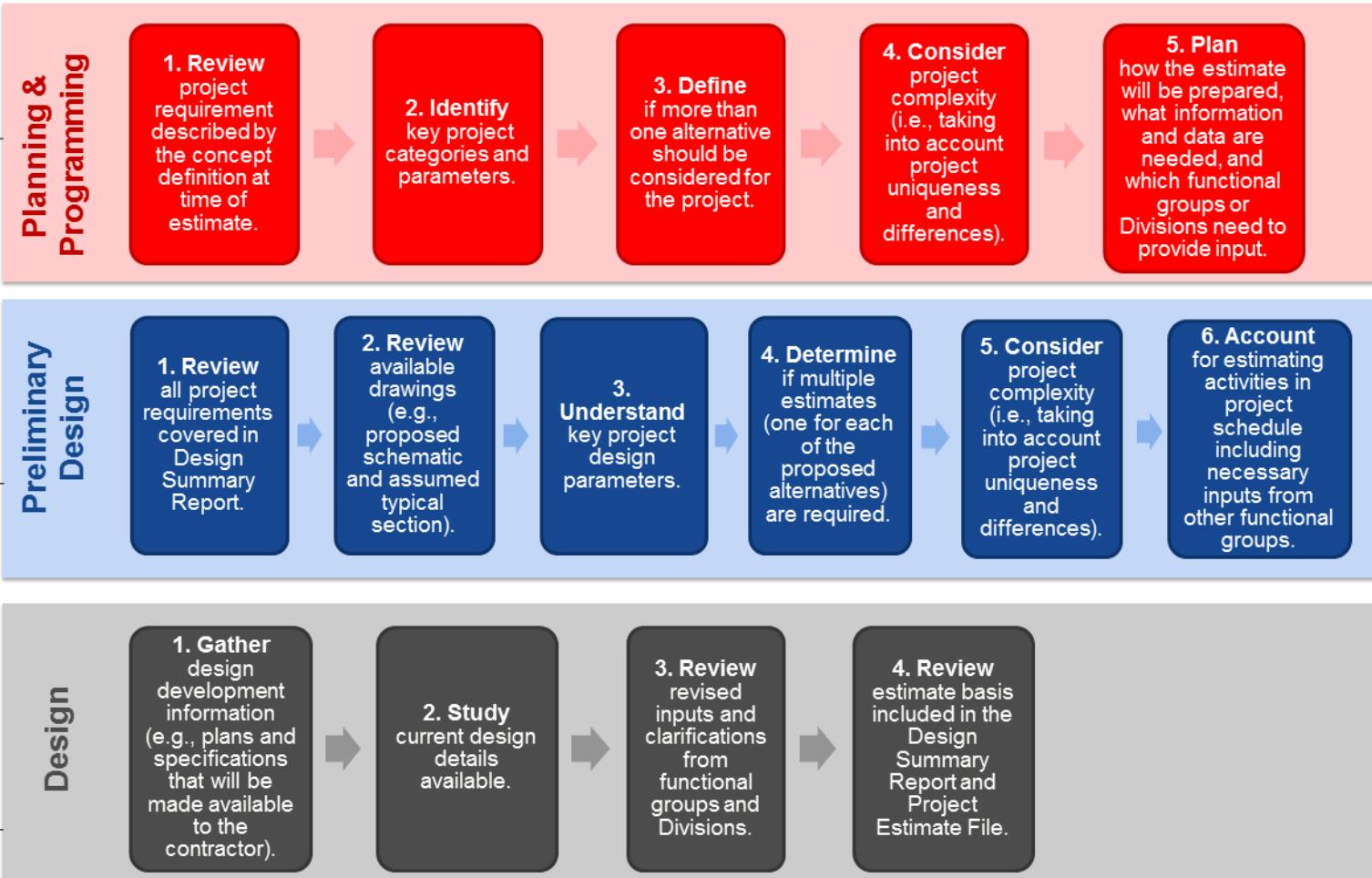
Reviewing the documents and changes to the documents helps the Estimator understand the scope of the project and assess the completeness and quality of the available inputs to the cost estimate process.

## Process Flowchart

### Stage 1 Determine/Update Estimate Basis Step A Review Project Definition and Requirements

8†

### STAGE 1/STEP A



## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review project definition and requirements.

### Specifics to the Planning and Programming Phase

#### *Process*

1. Review project requirement described by the concept definition at the time of estimate.
2. Identify key project categories and parameters.
3. Determine if more than one alternative should be considered for the project.
4. Consider project complexity (i.e., taking into account project uniqueness and differences).
5. Plan how the estimate will be prepared, what information and data are needed, and which functional groups or Divisions need to provide input.

#### *Tools*

- [Project Estimate File](#)
- [Design Summary Report](#)
- [Advance Planning Risk Analysis](#)

#### *Guidance*

- The Estimator should carefully review the project description and Design Summary Report, if started, to understand the project's purpose and concept.
- Conversations with the District's Transportation Planning and Development staff, Design staff, and the Area Engineer, if applicable, add further details and clarity to the project's description.
- TxDOT's Advance Planning Risk Analysis is a helpful tool to assess the completeness of project scope definition. At this step the rigor level of the project should be determined.
- Consider developing a list of key cost categories based on the project concept.
- Understanding what is in the concept definition and what is still unknown is critical to preparing a reasonable conceptual estimate for planning and programming purposes.

### Specifics to the Preliminary Design Phase

#### *Process*

1. Review all project requirements covered in Design Summary Report
2. Review available drawings (e.g., proposed schematic and proposed typical section).
3. Understand key project design parameters.
4. Determine if multiple estimates (one for each of the proposed alternatives) are required.
5. Consider project complexity (i.e., taking into account project uniqueness and differences).
6. Account for estimating activities in project schedule including necessary inputs from other functional groups.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review project definition and requirements.



- [Project Estimate File](#)
- [Advance Planning Risk Analysis](#)
- [Design Summary Report](#)
- [Annual Scope and Estimate Documentation Form](#)



*Guidance*

- The Estimator should make sure to identify these items:
  - Divisions and functional groups involved in project development.
  - Project proposed schematics and design basis.
  - Alternatives of the project and the preferred alternative.
  - Project complexity.
  - Incorporate cost estimate development activities and inputs required from functional groups and Divisions into the Project Schedule.
- For a more comprehensive list of Preliminary Design submissions consult Chapter 2 of [TxDOT Project Development Process Manual](#).
- Use TxDOT's Advance Planning Risk Analysis tool to assess the completeness of project definition.

### Specifics to the Design Phase



*Process*

1. Gather current design information (e.g., plans and specifications that will be made available to the contractor).
2. Study current design details available.
3. Review revised inputs and clarifications from functional groups and Divisions.
4. Review Basis of Estimate included in the Design Summary Report and Project Estimate File.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)



*Guidance*

- Review the outputs of the Design process as design develops to determine if the Basis of Estimate has changed.
- The Estimator should identify the areas where changes or modifications to the Baseline Cost Estimate may be necessary.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review project definition and requirements.

- The Project Estimate File and Annual Scope and Estimate Form is the basis for identifying areas in the current estimate where updates will be required due to the increased level of design information.
- Periodic updates of the cost estimate are made each year or more often, depending on district management needs. These updates form the basis for modifications to the Baseline Cost Estimate.
- With the increased project definition that occurs during the Design Phase, the involvement of specialty functional groups and Divisions will also increase. Successful estimate updates require timely input from these groups.
- The Design Summary Report should guide the updating of estimates, as this document indicates the major impacts on construction costs.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine alternative to estimate.

### STEP B. DETERMINE ALTERNATIVE TO ESTIMATE

Some projects—particularly larger or more complex projects—may have multiple solutions being considered that require analysis prior to selecting the preferred alternative. If more than one alternative is evaluated, each alternative should be reviewed and a cost estimate developed to support the decision-making process.



The Estimator must determine, with input from the Project Manager, which alternative should be estimated first and the priority sequence for estimating the remaining alternatives.



For projects that are in the early years of the planning, it is common to examine more than one approach and solution for meeting a project's requirements. These alternatives could, for example, account for specific site restrictions, various stakeholder desires, or funding limitations. Evaluating more than one alternative, including the construction cost estimate of each, is critical to deciding the preferred alternative.

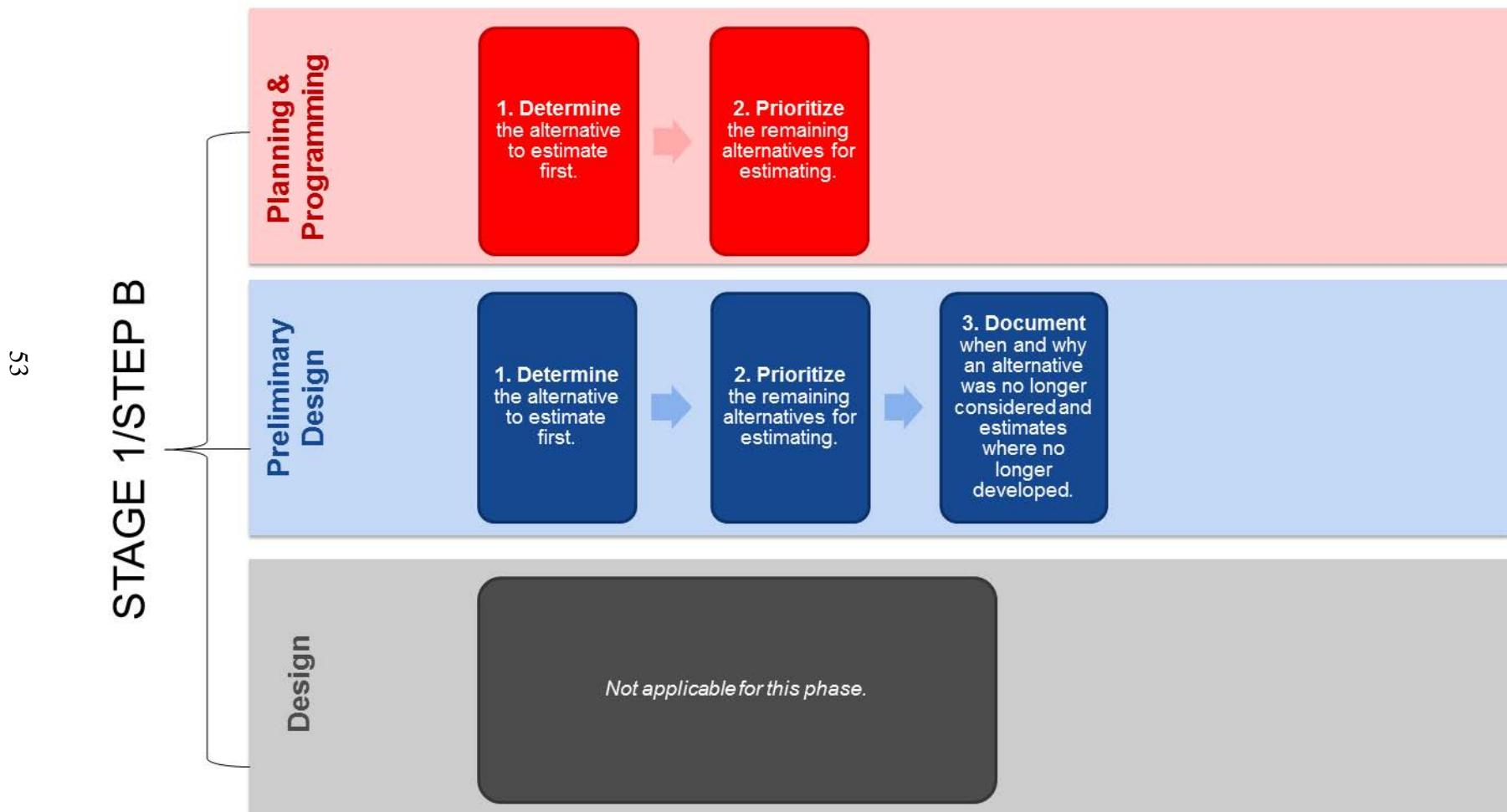


#### Guidance for All Phases

- When preparing cost estimates for the purpose of comparing alternatives, each estimate should be developed using the same procedure.
- The cost estimate for each alternative must have a documented Basis of Estimate, list of assumptions, and a list of considered risks for which the contingency is derived. This information should be consistent with the level of information available at the time of each estimate.
- If one alternative is to be the base case to which other alternatives will be compared, the base alternative estimate should be developed first.

## Process Flowchart

**Stage 1 Determine/Update Estimate Basis Step B Determine Alternative to Estimate**



## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine alternative to estimate.

### Specifics to the Planning and Programming Phase



1. Determine the alternative to estimate first.
2. Prioritize the remaining alternatives for estimating.



- [Project Estimate File.](#)



- As much as possible, the same estimating approach and techniques should be used for each alternative.
- The alternatives not considered should be documented explaining why those alternatives were not analyzed.

### Specifics to the Preliminary Design Phase



1. Determine the alternative to estimate first.
2. Prioritize the remaining alternatives for estimating.
3. Document when and why an alternative was no longer considered and estimates where no longer developed.



- [Project Estimate File.](#)



- The risk and contingency analysis should reflect the differences due to the unique uncertainty relevant to each alternative.

### Specifics to the Design Phase



N/A



N/A

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine alternative to estimate.



### *Guidance*

- By the time a project has entered the Design Phase, the preferred alternative is selected and future estimates will be for this single project definition.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine alternative to estimate.

### STEP C. REVIEW SITE CHARACTERISTICS

This step helps the Estimator gain knowledge, insight, and a better understanding of the project site characteristics and their impact on cost and risk.



The Estimator should have an ample knowledge about project site characteristics, their relationship to the project's concept definition, and their potential impact on cost.



Site characteristics may have major impacts on project's cost. Site characteristics to consider include, for example, access to the site, constructability considerations, proximity to materials and resources, physical limitations and restrictions, and safety requirements.

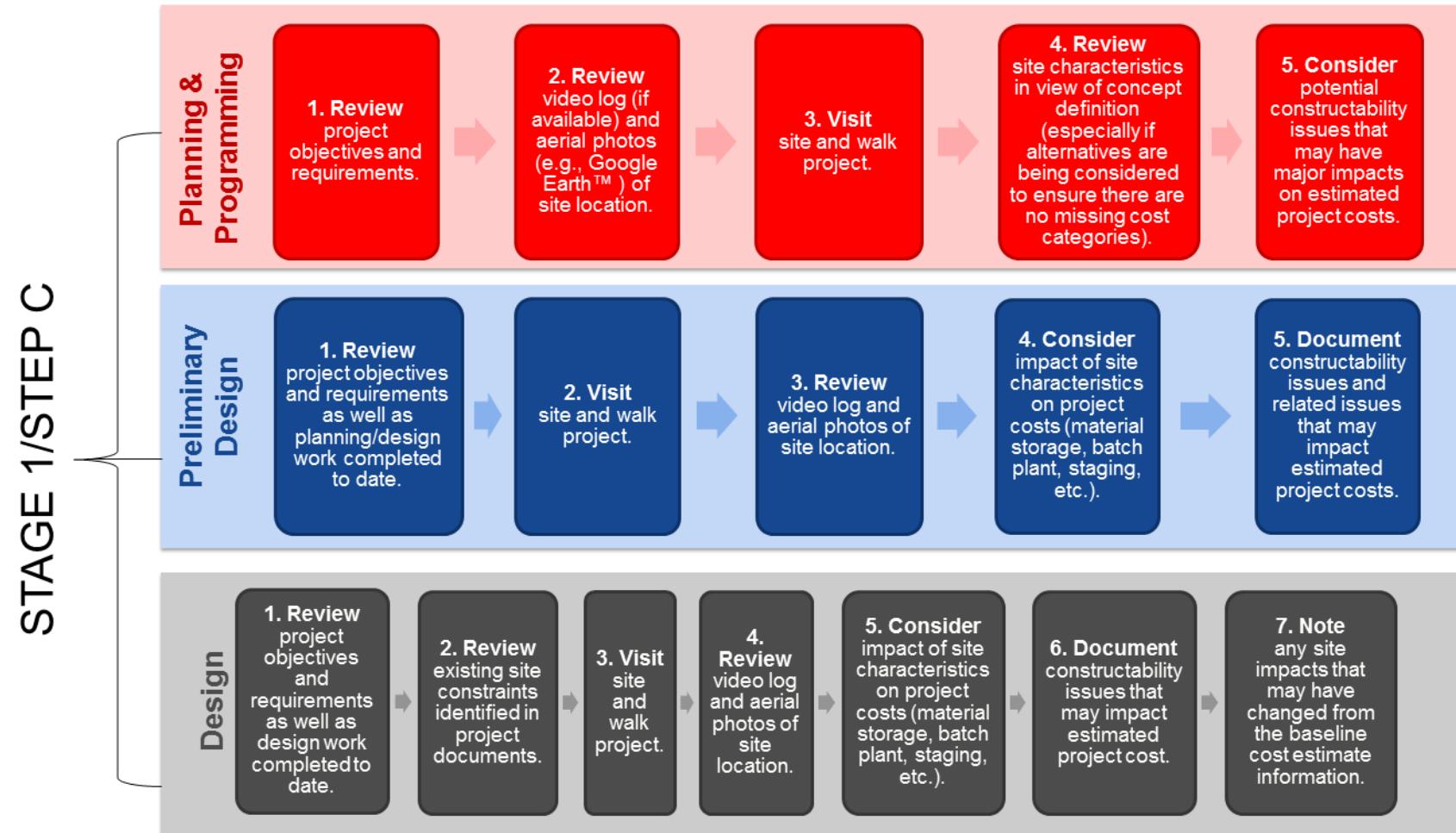


#### Guidance for All Phases

- A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos.
- Relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.
- Since Estimators often have a large workload and are governed by time restrictions, they understandably cannot make a site visit for every project (or at every phase); however, the Estimator should fully weigh the benefits and drawbacks before making that decision.
- For unusual or complex projects, it is recommended that the Estimator visit the site at least one time in each of the development phases especially if the project takes several years to develop.
- It is also helpful to visit the site even if the project is not very complex and considered typical.
- Information collected that impacts the estimate should be included in the Project Estimate File as documentation of features, assumptions, and risk; this documentation aids in identifying any changes in site conditions that may have occurred over time.
- Construction and maintenance staff can help evaluate the potential impact of staging, material storage, hauling of materials, location of batch plants, and other constructability related issues. Their input becomes more relevant as preliminary drawings are prepared relative to traffic control strategies and construction staging.

## Process Flowchart

### Stage 1 Determine/Update Estimate Basis Step C Review Site Characteristics



## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review site characteristics.

### Specifics to the Planning and Programming Phase



1. Review project objectives and requirements.
2. Review video log (if available) and aerial photos (e.g., Google Earth™) of site location.
3. Visit site and walk project.
4. Review site characteristics in view of concept definition (especially if alternatives are being considered to ensure there are no missing cost categories).
5. Consider potential constructability issues that may have major impacts on estimated project costs.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)



- The Estimator should review the Design Summary Report to understand the attributes of the project site.
- The Estimator should prepare questions to guide the site walk-through.
- The Estimator should make notes as to potential impacts of the site characteristics on the project cost groups and/or categories.
- When using aerial photos including online maps such as Google Earth™, note the date as to when the photos were taken and accessed. These photos may be updated multiple times if a project resides in the Planning and Programming Phase for several years.
- A digital camera should be carried on every site visit. Archive the photos by location and date.

### Specifics to the Preliminary Design Phase



1. Review project objectives and requirements as well as planning/design work completed to date.
2. Visit site and walk project.
3. Review video log and aerial photos of site location.
4. Consider impact of site characteristics on project costs (material storage, batch plant, staging, etc.).
5. Document constructability issues and related issues that may impact estimated project costs.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review site characteristics.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)



### Guidance

- Review notes and photos from previous site visits to determine if changes of any consequence have occurred.
- If a project resides in the Preliminary Design Phase for many years, it is easy to assume nothing has changed since the previous site visit and estimate update. That assumption is typically not true in metropolitan and urban areas; even rural project sites can see changes over time.

### Specifics to the Design Phase



### Process

1. Review project objectives and requirements as well as design work completed to date.
2. Review existing site constraints identified in project documents.
3. Visit site and walk project.
4. Review video log and aerial photos of site location.
5. Consider impact of site characteristics on project costs (material storage, batch plant, staging, etc.).
6. Document constructability issues that may impact estimated project cost.
7. Note any site impacts that may have changed from the Baseline Cost Estimate information.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)



### Guidance

- The Estimator should carefully review the previously gathered site information to ensure clarity and thoroughness of the information.
- If the Estimator has not visited the project before, he should walk the project site at this phase.
- If visiting the site is not possible, at a minimum the Estimator should review video logs or aerial photos.
- The Estimator should make notes regarding changes or modifications to previously identified impacts related to the project's site characteristics.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review site characteristics.

- Visit the site with construction and maintenance staff to obtain their perspective on site characteristics and potential impacts on the project. Staff in these areas of responsibility can clarify project definition issues as these issues relate to the site, especially as design details mature during project development.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine needed clarifications/potential changes.

### STEP D. DETERMINE NEEDED CLARIFICATIONS/POTENTIAL CHANGES

This step assesses the completeness of the key inputs to the cost estimation process.

#### Roles

- The Estimator identifies and lists areas where more clarification is needed (e.g., regarding specific project requirements or impacts of project site characteristics on construction) and how these impacts influence project costs.
- In addition, the Estimator notes changes that have occurred or are likely to occur in the project definition or planning/design documents since the previous estimate.
- The Project Manager reviews the needed clarifications and initiates these requests.
- The Project Manager reviews and evaluates potential changes to the project definition.

#### Why

This step assesses the completeness of the key inputs to the cost estimation process and confirms that all information is available regarding the project requirements, especially where potential changes are identified. Timely identification and management of project definition changes is the cornerstone of effective Cost Management during the pre-construction phases of project.

#### Guidance for All Phases

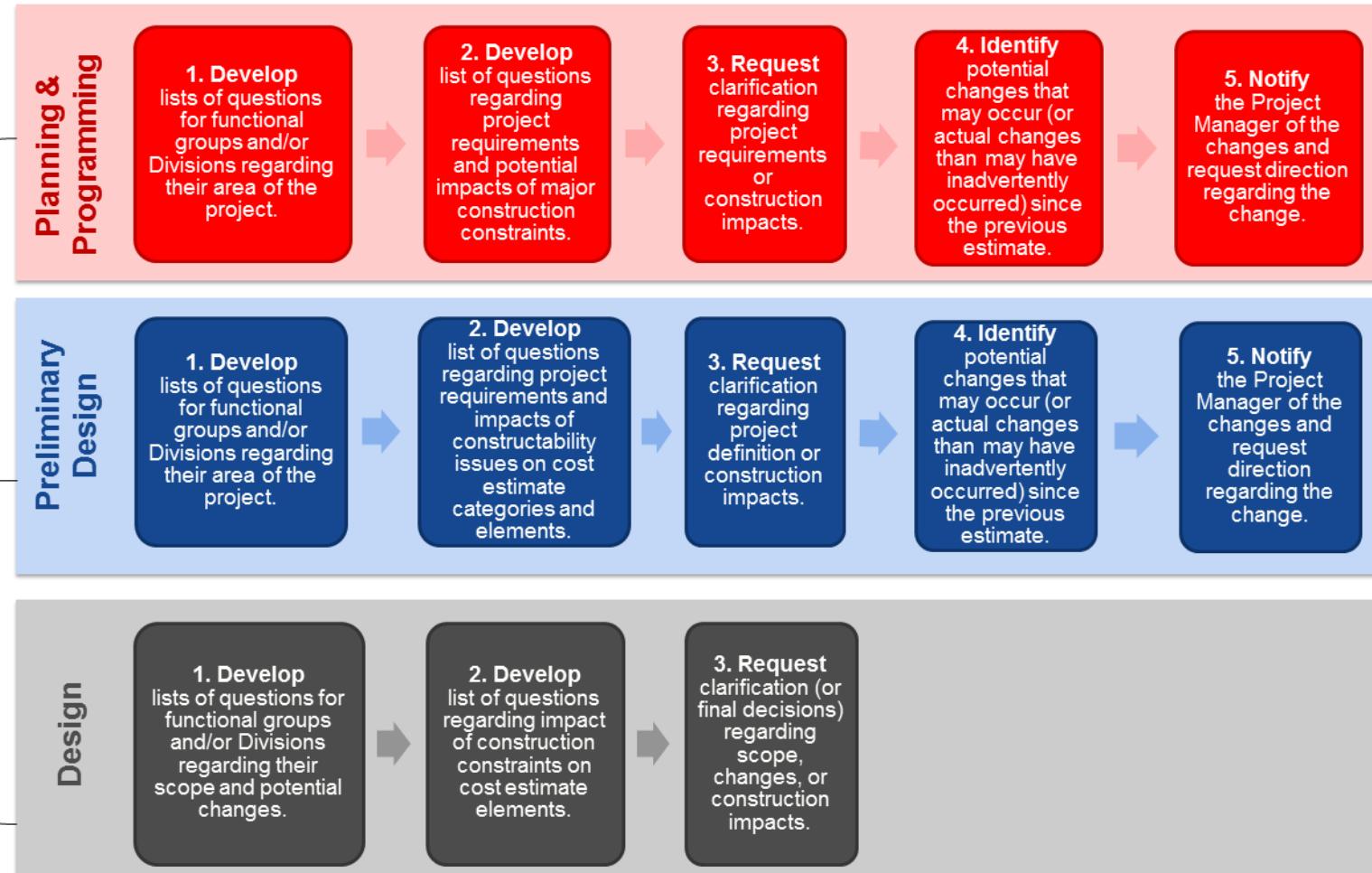
- Check for the availability of complete data related to project requirements and site characteristics. Then, if necessary, request any additional information that will help in completing an estimate. This request may focus on clarifying existing documentation of the project requirements or inquiring about new documents and data.
- The Advance Planning Risk Analysis (APRA) tool developed under TxDOT research project 0-5478 offers a method to measure project scope definition for completeness and identify potential risks early in the project.
- Request for clarifications is a means of communication. Efficient communication between the Project Manager, the Estimator, and functional groups improves the accuracy of the cost estimates.
- The request of clarification can be made in several ways. A meeting with all functional groups and appropriate Divisions may be necessary for complex projects.
- Face-to-face discussion is often the best way to clarify project definition and construction-related issues.
- Documentation of requests for clarifications and the responses should be maintained in the Project Estimate File.
- Clarification requests should reduce as successive cost estimates are prepared.
- A potential change can alter the project definition, schedule, and/or estimate.
- A change must remain consistent with a project's need and requirements.
- The documentation of a potential change does not imply the change is accepted, merely that the change is acknowledged and subject to further evaluation.

## Process Flowchart

**Stage 1 Determine/Update Estimate Basis Step D Determine Needed Clarifications/Potential Changes**

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### STAGE 1/STEP D



## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine needed clarifications/potential changes.

### Specifics to the Planning and Programming Phase

#### *Process*

1. Develop lists of questions for functional groups and/or Divisions regarding their area of the project.
2. Develop list of questions regarding project requirements and potential impacts of major construction constraints.
3. Request clarification regarding project requirements or construction impacts.
4. Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.
5. Notify the Project Manager of the changes and request direction regarding the change.

#### *Tools*

- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)

#### *Guidance*

- The Estimator submits questions to the appropriate groups and documents responses to aid in the development of the Basis of Estimate.
- During the Planning and Programming Phase, some questions may not have a definitive answer due to lack of design details, e.g., pavement design and drainage design. The Estimator should at least ask what assumptions should be made at the time in order to determine an Basis of Estimate.
- Some potential changes may need to be considered as unique alternatives for further evaluations before a decision to accept or reject the change is made.

### Specifics to the Preliminary Design Phase

#### *Process*

1. Develop lists of questions for functional groups and/or Divisions regarding their area of the project.
2. Develop list of questions regarding project requirements and impacts of constructability issues on cost estimate categories and elements.
3. Request clarification regarding project definition or construction impacts.
4. Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.
5. Notify the Project Manager of the changes and request direction regarding the change.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Determine needed clarifications/potential changes.

### Tools

- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)

### Guidance

- The Estimator submits questions to the appropriate groups and documents responses to determine if they are consistent with the Basis of Estimate or if changes should be made to the Basis of Estimate and the estimate itself.
- Again, it may not be possible to obtain explicit answers to all questions generated by the Estimator during the Preliminary Design Phase. At the very least, however, the Estimator should determine if the current assumptions contained in the Basis of Estimate are still valid.
- The sources of changes at this phase typically are the result of design development (e.g., revised surveys or geological studies) or added/modified project scope.

## Specifics to the Design Phase

### Process

1. Develop lists of questions for functional groups and/or Divisions regarding their scope and potential changes.
2. Develop list of questions regarding impact of construction constraints on cost estimate elements.
3. Request clarification (or final decisions) regarding scope, changes, or construction impacts.

### Tools

- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)

### Guidance

- Throughout the Design Phase, the Estimator should resolve all outstanding questions so that the Basis of Estimate is complete and assumptions either confirmed or changed.
- If the Estimator is not able to obtain responses to questions as the project nears design completion and the Basis of Estimate still carries some assumptions, the Estimator should document and elevate the issue(s) to the Project Manager or lead designer so that the Basis of Estimate becomes more definitive.
- The timely consideration of changes, their evaluation, and decision to accept or reject the change is critical in maintaining the delivery of the PS&E package during this phase.

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review basis of estimate documentation.

### STEP E. REVIEW BASIS OF ESTIMATE DOCUMENTATION

This step summarizes information used to prepare the Base Estimate, to facilitate estimate reviews, and as reference for future cost estimates that will be prepared on the project.



The Estimator initiates/updates the Project Estimate File.



This step is:

- A key to achieving cost estimate consistency.
- Necessary as the first input for [Stage 2 – Prepare/Update Base Estimate](#).
- Critical when reviewing the estimate, obtaining management approval, and reconciling differences between the updated cost estimate and the Baseline Cost Estimate.
- Critical when changes occur in costs due to changing project requirements as the project design is developed and completed.



#### Guidance for All Phases

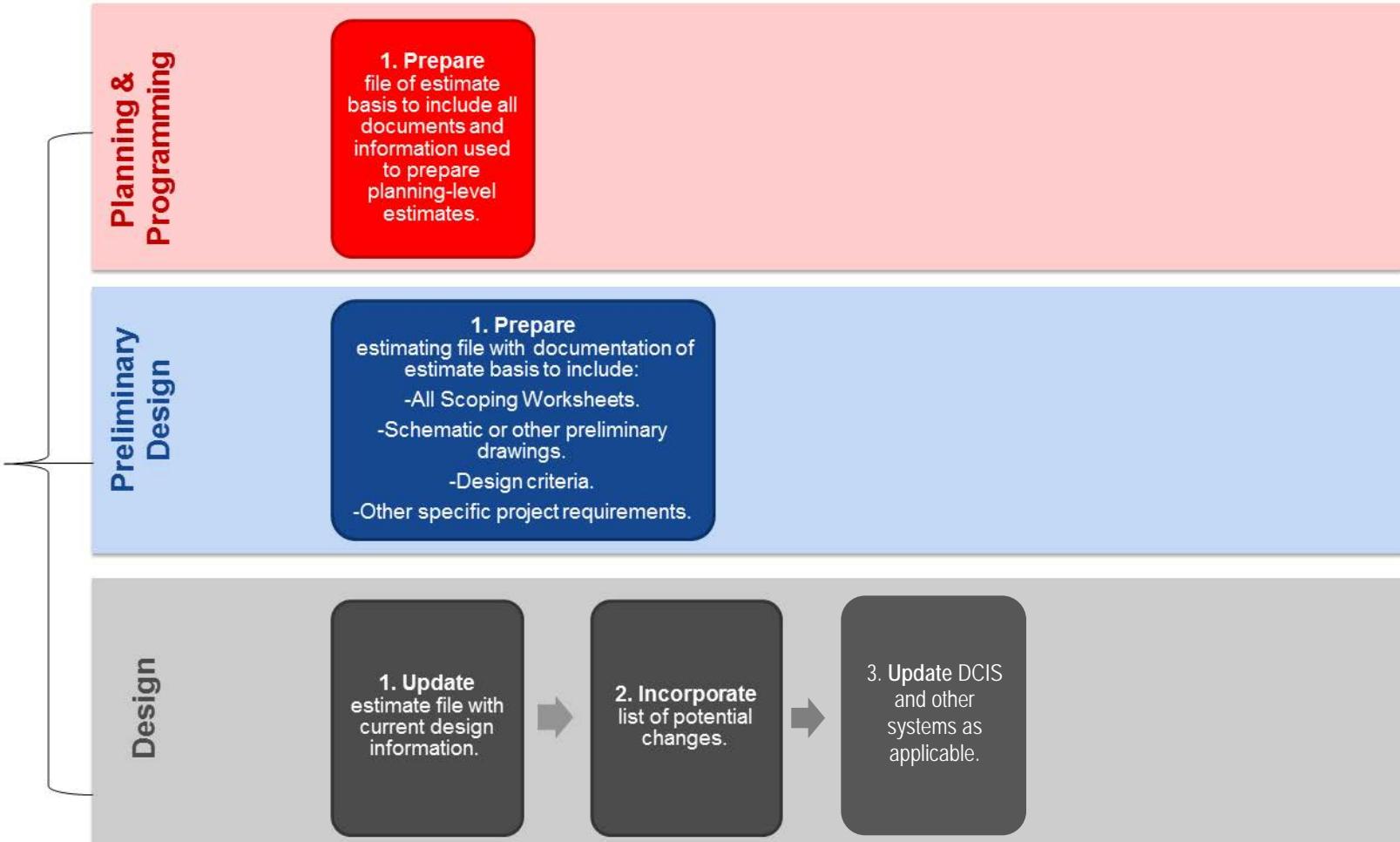
- Time to prepare the Basis of Estimate documentation is necessary and should be included in the Project Schedule.
- Documentation of project requirements is critical when updating the base cost estimate, risks, and contingency.
- A standard Project Estimate File format should be followed. The Project Estimate File provides uniformity in the documentation, which helps other Estimators to understand the project definition basis clearly.
- It is important to document the Basis of Estimate for all projects, not just those that are complex.
- The level of documentation is likely to increase for projects that are considered high rigor. The Project Estimate File may have more sections to cover the various functional group's and Divisions' inputs that describe the Basis of Estimate.

## Process Flowchart

### Stage 1 Determine/Update Estimate Basis Step E Review Basis of Estimate Documentation

99

#### STAGE 1/STEP E



## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review basis of estimate documentation.

### Specifics to the Planning and Programming Phase



1. Prepare file of Basis of Estimate to include all documents and information used to prepare planning-level estimates.



- [Project Estimate File](#)



- The Estimator initiates a Project Estimate File starting with sections on project requirements that are used as a basis for preparing Planning cost estimates.
- The Estimator should ensure that any sketches, specific design parameters, and other design components are included in the information and data compiled to support the Basis of Estimate.
- Although easier, just placing documents and notes in a single folder (either in a notebook, filing cabinet, or electronically) can be confusing and frustrating when others on the project team need to locate information regarding the Basis of Estimate. Following a standard structure in the Project Estimate File makes organizing and finding information efficient for the entire project team.
- Previous projects of similar size and scope can serve as an example as to what items should be included in the Project Estimate File.

### Specifics to the Preliminary Design Phase



1. Prepare estimating file with documentation of Basis of Estimate to include:

- All Scoping Worksheets.
- Schematic or other preliminary drawings.
- Design criteria.
- Other specific project requirements.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)

## Stage 1. Determine/Update Estimate Basis

A

B

C

D

E

Review basis of estimate documentation.



### Guidance

- The Estimator updates and expands the Project Estimate File using current information from the Design Summary Report, Annual Scope and Estimate Documentation Form, and other documents as appropriate.
- As the Project Estimate File expands with new and more information, it may be helpful to create a quick summary page for each section to make locating information quicker.

### Specifics to the Design Phase



1. Update estimate file with current design information.
2. Incorporate list of potential changes.
3. Update DCIS and other systems as applicable.



- [Design Summary Report](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Documentation Form](#)



- The Estimator updates the Project Estimate File with sections on current project requirements that are used as a basis for updating the cost estimate.
- The Basis of Estimate, as incorporated into the Project Estimate File, should be in a form that can be easily checked, understood, verified, and corrected, especially where changes in costs have occurred.
- The documents in the file should include all the available information about the actual and potential changes, including the changes themselves, the reason for the changes, and any clarification related to specific changes provided by the functional groups, Divisions, or other sources such as local stakeholders.

## STAGE 2. PREPARE/UPDATE BASE ESTIMATE

Risk-Based Estimating

# STAGE

# 2

## The Framework

5 Stages



### OVERVIEW

Stage 2 has five steps that provide a natural progression of effort to prepare/update a Base Estimate at the three phases of the Project Development Process. This stage prepares the most likely cost estimate without contingency.

### Chapter Organization

This chapter contains the following topics.

Topic	See Page
Quick Reference Guide	72
Step A. Select Estimating Approach	76
Step B. Determine and Quantify Estimate Elements	81
Step C. Develop Estimate Data	87
Step D. Calculate Base Cost Estimate	93
Step E. Review Documented Estimate Assumptions, Inputs, and Calculations	99

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

### Remember

- These steps are often performed concurrently and repeated as each cost component is identified, quantified, and priced.
- The categories (e.g., excavation, pavement, and drainage) and their elements and/or line items may be estimated using different techniques, depending on the level of project definition and the type and complexity of the project.
- The number of components estimated may also vary depending on project complexity.
- Lack of specific information on the project leaves the Estimator to make many assumptions, basing large portions of the estimate on previous projects using conceptual estimating approaches such a cost per mile.
- Because of the length of time between the planning estimate and letting, it is impossible to perfectly predict inflation, market impacts, or even project definition changes over the lifespan of a project, particularly if it takes many years before they project goes to contract. Assumptions and decisions on these items should be based on the best available information at the time and professional judgment.
- The Base Estimate should not contain any cushion or “fluff” in the quantities or cost, but should be a reflection of the Estimator’s most likely estimate for the known items, including allowances, at any given time.

### About the Project Estimate File

- The output of this stage is an updated Project Estimate File and the Base Estimate.
- This Base Estimate plus Project Contingency (see Stage 3), which constitutes the Total Construction Cost Estimate, will serve as the Baseline Cost Estimate when it is approved by District management to be the baseline.
- The package contains all pertinent project definition requirements, assumptions, and historical bids used to prepare a Base Estimate, as well as cost summaries and cost details for the Base Estimate.
- The Total Construction Cost Estimate helps TxDOT prioritize projects and determine the projects that can be completed within the funding constraints over 4-, 10-, and 20-year planning horizons.

## Stage 2. Prepare/Update Base Estimate

A	B	C	D	E
Purpose	Steps	Outputs	Tools	
Develop and update the base cost estimate.	A. <a href="#">Select estimating approach.</a> B. <a href="#">Determine and quantify estimate elements.</a> C. <a href="#">Develop estimate data.</a> D. <a href="#">Calculate base cost estimate.</a> E. <a href="#">Review documented estimate assumptions, inputs, and calculations.</a>	Base Estimate.  Updated Project Estimate File.	<ul style="list-style-type: none"> <li>• <a href="#">Typical Sections on a Per Mile Basis.</a></li> <li>• <a href="#">Similar Projects.</a></li> <li>• <a href="#">Historical Bids.</a></li> <li>• <a href="#">Parametric Estimating.</a></li> <li>• <a href="#">Project Estimate File.</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template.</a></li> </ul>	

### How to Use This Chapter

For each step in Stage 2, the following information is provided:

- Important information across the three pre-construction phases of project development.
- The roles and responsibilities of the step.
- Why the step is needed.
- Guidance relevant to all three phases.
- Specifics to the Planning and Programming phase.
- Specifics to the Preliminary Design phase.
- Specifics to the Design phase.

## Stage 2: Prepare/Update Base Estimate

### Quick Reference Guide

#### Risk-Based Estimating

# STAGE

# 2

## The Framework

### 5 Stages

- 1 Determine/Update Basis of Estimate
- 2 Prepare/Update Base Estimate
- 3 Determine Risk and Set Contingency
- 4 Review and Approve Estimate
- 5 Communicate Estimate

**Purpose:** Develop and update the base cost estimate.

STEP	PURPOSE
A. Select estimating approach.	Decide which tool(s) are used for preparing a quality and accurate estimate.
B. Determine and quantify estimate elements.	Determine the categories and quantities consistent with the estimating tool(s) used.
C. Develop estimate data.	Develop/update the appropriate cost data for each category.
D. Calculate base cost estimate.	Calculate cost data for each estimate element and combine and summarize in a spreadsheet.
E. Review documented estimate assumptions, inputs, and calculations.	State the decisions and assumptions used in the estimate for communication to management in a structured format. Accumulate and organize all details, summaries, and assumptions made in completing the estimate.

#### Key Reminders

- Document all assumptions and changes.
- Based on the maturing of project design and/or the amount of time that has passed since the previous estimate, a completely new estimate may be warranted.
- Have someone else review the estimate for completeness and accuracy.

#### Tools

- [Typical Sections on a per Mile Basis.](#)
- [Similar Projects.](#)
- [Historical Bids.](#)
- [Parametric Estimating.](#)
- [Project Estimate File.](#)
- [Cost Estimate Spreadsheet Template.](#)

## Stage 2: Prepare/Update Base Estimate

	Planning & Programming	Preliminary Design	Design
<p><b>A. Select estimating approach.</b></p> <ul style="list-style-type: none"> <li>• Certain tools require specific information or that the required data is in a particular format; understanding what information is available often dictates what estimating approach is selected.</li> <li>• At times, an Estimator is asked to provide an initial estimate in short notice with little project information. Such situations can limit the Estimator to using a cost per mile based on a similar project.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review types of information contained in the Planning and Programming Estimate Basis (from Stage 1).</li> <li>2. Determine those tools that fit the level of project definition, complexity, and likely availability of historical bids.</li> <li>3. Consider time constraints for estimate preparation.</li> <li>4. Decide on best estimate tool(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. Review types of information contained in the Project Estimate File.</li> <li>2. Review available tools in tool appendix.</li> <li>3. Determine those tools that fit the level of project definition and complexity.</li> <li>4. Consider time restraints for estimate preparation.</li> <li>5. Decide on best estimate tool(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. Use historical bid-based estimating approach.</li> <li>2. Review level of design information available.</li> <li>3. Determine if other tools might be necessary for certain project elements due to level of detail available.</li> <li>4. Select other tools that are appropriate, if needed.</li> </ol>
<p><b>B. Determine and quantify estimate elements.</b></p> <ul style="list-style-type: none"> <li>• Calculations of quantities should be documented, including all backup calculations and assumptions made when determining quantities.</li> <li>• Special care should be taken while operating electronic spreadsheets or other computer based estimating tools. While they are quite helpful in performing calculations and are an expedient way to update an estimate, it is easy to make a small typing error or miscalculation in a cell that raises or lowers the estimate by an order of magnitude. Always double check entries and use reasonableness checks where possible.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine project components, categories, and elements covered in the estimate.</li> <li>2. Determine quantity measure required and/or other requirements based on tools selected and level of project definition.</li> <li>3. Quantify appropriate components, categories, and elements.</li> <li>4. Document method for deriving quantities.</li> <li>5. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine elements/items per category consistent with project definition and project requirements (refer to the Project Estimate File).</li> <li>2. Determine quantity measure required (e.g., miles, lane miles, square foot, or cubic yard) and/or other requirements based on tools selected.</li> <li>3. Quantify appropriate items based on typical sections, profiles, and other preliminary design documents.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review design categories, elements, and items covered in the Baseline Cost Estimate to ensure those same categories, elements, and items are included in the current estimate.</li> <li>2. Update detailed elements and items consistent with current project definition and project requirements.</li> <li>3. Review existing and determine new quantity measures required and/or other requirements based on tools.</li> <li>4. Quantify new elements and items and/or revise existing quantities.</li> <li>5. Document methods for deriving quantities.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>
<p><b>C. Develop estimate data.</b></p> <ul style="list-style-type: none"> <li>• A spreadsheet template or specific estimating software are excellent tools for ensuring all categories of project cost have been considered and accounted for in the estimate.</li> <li>• Adding notes within a spreadsheet can be a quick way to document assumptions, adjustments, source, and other items related price data.</li> <li>• Adjusting historical bids to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul routes and distance, work zone staging, and any market volatility.</li> <li>• Refer to the American Association of State Highway Transportation Officials (AASHTO) "Practical Guide to Cost Estimating" (2013) for consideration when adjusting and setting unit costs for local conditions.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine unit costs for elements and major items.</li> <li>2. Develop cost approach for other categories: percentages, parametric, etc.</li> <li>3. Adjust costs to reflect potential market conditions, project complexity, and age of historical bids.</li> <li>4. Estimate costs of other Total Construction Cost Estimate Categories not covered in items 1 through 3.</li> <li>5. Document assumptions.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine unit costs for elements and major items.</li> <li>2. Develop cost approach (e.g., percentages or allowances) for other items.</li> <li>3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids.</li> <li>4. Estimate costs of other construction-related project features not covered in items 1 through 3 (e.g., safety, SWPPP maintenance, and police/safety officer for traffic control).</li> <li>5. Document assumptions for any adjustments made to the cost data.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Review and revise unit costs for elements and items.</li> <li>2. Update cost approach on all elements and items, if necessary.</li> <li>3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids to current day dollars.</li> <li>4. Document how and why the adjustments were made.</li> <li>5. Make modifications requested through estimate review (Stage 4).</li> </ol>

## Stage 2: Prepare/Update Base Estimate

Planning & Programming	Preliminary Design	Design
<ul style="list-style-type: none"> <li>• Cost estimates provided by functional groups and/or Divisions should also be included.</li> <li>• The cohesiveness of the resulting base cost estimate is imperative. While merging work from different functional groups and/or Divisions into a single, integrated estimate may be difficult, it must be integrated for the comprehension of reviewers and management approval.</li> <li>• Contingency should not be included in any category cost/item estimates. These will be determined and included in the estimate during Stage 3.</li> </ul>	<ol style="list-style-type: none"> <li>1. Input historical estimate data into estimating system (e.g., spreadsheet) in the appropriate cost estimate category.</li> <li>2. Ensure all categories are covered.</li> <li>3. Incorporate functional group and/or Division estimates as appropriate.</li> <li>4. Subtotal major cost categories and elements for quick reference and to aid with reviews.</li> </ol>	<ol style="list-style-type: none"> <li>1. Prepare updated cost estimating representing the Base Estimate.</li> <li>2. Input historical estimate data into the selected estimating system (i.e., spreadsheet) in the appropriate work category, element, and items with the calculated quantity.</li> <li>3. Ensure all work elements and major items are covered as determined by the Basis of Estimate determined in Stage 1.</li> <li>4. Incorporate functional groups' and/or Divisions' construction estimates, if necessary.</li> <li>5. Subtotal major cost elements into categories, groups, etc.</li> </ol>
<p><b>D. Calculate base cost estimate.</b></p> <ul style="list-style-type: none"> <li>• Documentation should include Basis of Estimate, assumptions, and calculations. The Project Estimate File should be created to assemble and update these items in a single location.</li> <li>• As more details, items, notes, and documents are placed in the Project Estimate File, it may be helpful to create short summary sheets for each section to facilitate rapid location of information.</li> <li>• Force accounts assumed and the calculations used to determine their costs should be explicitly documented.</li> <li>• Documenting how a cost estimate was developed (e.g., estimating technique, source of cost data, adjustments to cost data, and other assumptions) allows others to trace the Estimator's work through the process. Traceability allows others to review and validate the estimate. Traceability also provides the mechanism to assess cost impact when the planning estimate updates are made.</li> </ul>	<ol style="list-style-type: none"> <li>1. Organize back-up quantity calculations.</li> <li>2. Identify sources of historical bids and document adjustments to data (if applicable).</li> <li>3. Summarize estimate approaches used to prepare costs for each category.</li> <li>4. Document all estimate assumptions related to work categories.</li> <li>5. Incorporate cost estimates from functional groups and/or Divisions including back up calculations and assumptions.</li> <li>6. Document general Basis of Estimate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Organize back-up quantity calculations especially if the estimating approach has changed.</li> <li>2. Identify sources of historical bids and document adjustments for specific project conditions.</li> <li>3. Summarize estimate approaches used to prepare costs for each element.</li> <li>4. Document all estimate assumptions related to elements.</li> <li>5. Incorporate cost estimates from functional groups and/or Divisions including back-up calculations and assumptions.</li> <li>6. Update the Basis of Estimate as appropriate and as approved.</li> </ol>

**E. Review documented estimate assumptions, inputs, and calculations.**

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

### Preview of Stage 2 Procedure

Table 12 provides an overview of the basic procedure, its purpose, who does it, and when in the Project Development Process it should be done.

**Table 12. Stage 2 Procedure.**

STEP	PURPOSE	WHO DOES IT?	WHEN?
A. <a href="#"><u>Select estimating approach.</u></a>	Decide which tool(s) are used for preparing a quality and accurate estimate.	Estimator	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
B. <a href="#"><u>Determine and quantify estimate elements.</u></a>	Determine the categories and quantities consistent with the estimating tool(s) used.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Designer</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
C. <a href="#"><u>Develop estimate data.</u></a>	Develop/update the appropriate cost data for each category.	Estimator	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
D. <a href="#"><u>Calculate base cost estimate.</u></a>	Calculate cost data for each estimate element and combine and summarize in a spreadsheet.	Estimator	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
E. <a href="#"><u>Review documented estimate assumptions, inputs, and calculations.</u></a>	State the decisions and assumptions used in the estimate for communication to management in a structured format. Accumulate and organize all details, summaries, and assumptions made in completing the estimate.	Estimator	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>

### Stage 2 Inputs and Sources of Information

Each phase builds on the previous phase's information. Planning and Programming inputs are listed in red, followed by Preliminary Design additions in blue, followed by Design additions in grey. Items listed for the Planning and Programming Phase are also used in the Preliminary Design and Design Phases. Items listed for the Preliminary Design Phase are also used in the Design Phase. At the end of Stage 2, the Project Estimate File is updated.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Select estimating approach.

### STEP A. SELECT ESTIMATING APPROACH

This step decides which tool(s) are used for preparing a quality and accurate estimate.



The Estimator should be aware of the project definition, size, complexity, and level of design maturity when selecting the appropriate estimating approach.



Different estimating approaches require different amounts of data and various amounts of time to prepare the estimate. The effort associated with the approach selected for preparing an estimate should be proportional to the level of design maturity and size of the project. An extremely preliminary, initial estimate might simply be based on a cost per mile with other features and elements added. While an estimate based on actual bid items and quantities once the project has entered the Design Phase is more appropriate.

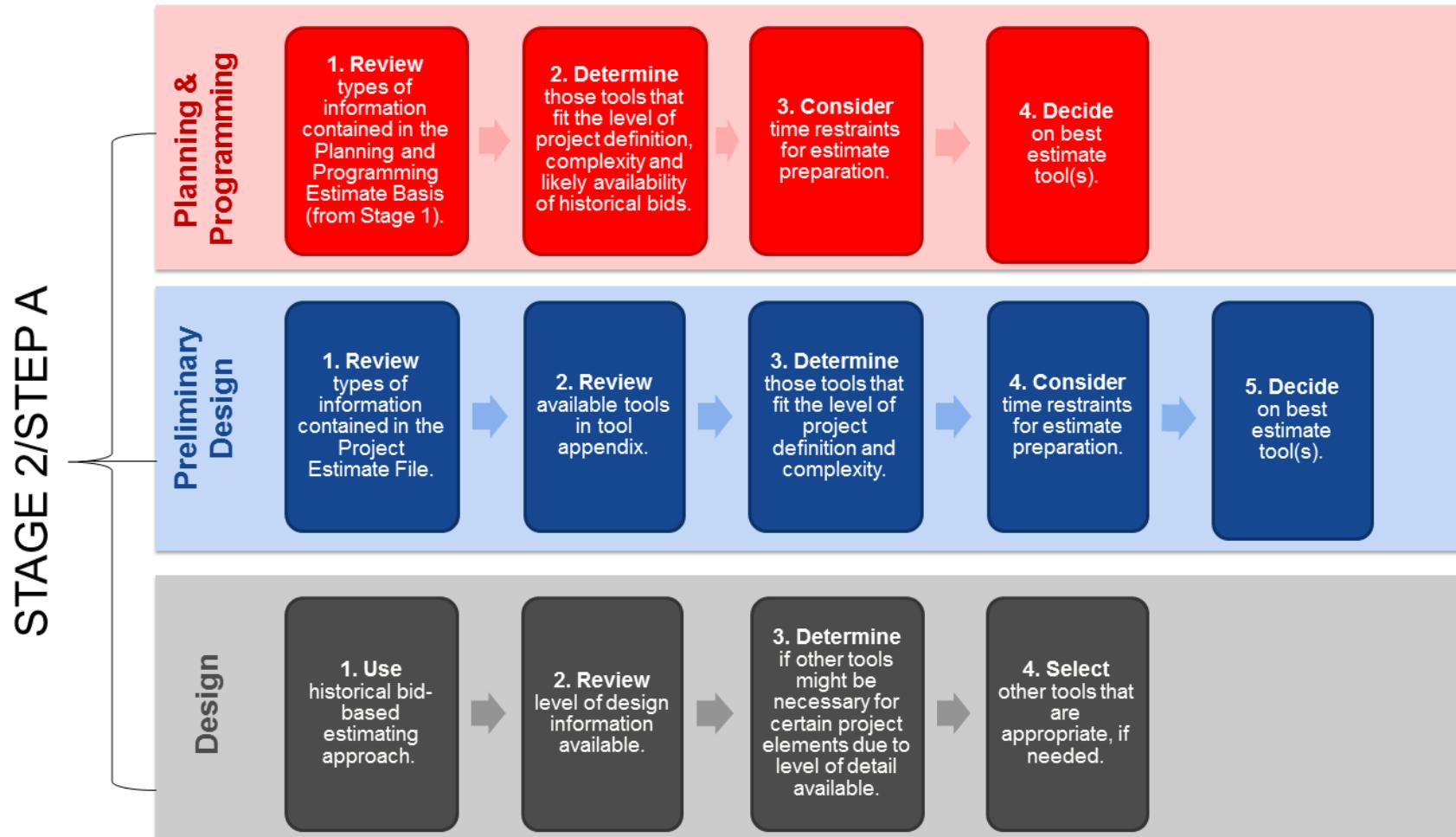


#### Guidance for All Phases

- While costs based on similar projects, historical bids, parametric methods, and even spreadsheets all have their place in an Estimator's toolbox, each project is unique and necessitates due consideration in deciding the most appropriate estimation approach.
- If an inappropriate estimating approach is selected, then a false sense of accuracy may result.
- Time, information available, and the desired level of accuracy are all considerations when developing an estimate. The Estimator should weigh each of these factors when deciding on the appropriate estimating approach.
- Certain tools require specific information or that the required data is in a particular format; understanding what information is available often dictates what estimating approach is selected.
- At times, an Estimator is asked to provide an initial estimate in short notice with little project information. Such situations can limit the Estimator to using a cost per mile based on a similar project.

## Process Flowchart

### Stage 2 Prepare/Update Base Estimate Step A Select Estimating Approach



## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Select estimating approach.

### Specifics to the Planning and Programming Phase



1. Review types of information contained in the Project Estimate File (from [Stage 1](#)).
2. Determine those tools that fit the level of project definition, complexity, and likely availability of historical bids.
3. Consider time constraints for estimate preparation.
4. Decide on best estimate tool(s).



- [Cost Estimate Spreadsheet Template](#)
- [Typical Sections on a Per Mile Basis](#)
- [Parametric Estimating](#)
- [Similar Projects](#)



- Different Estimators will have their preferred estimating approach.
- Since this estimate is in the Planning and Programming Phase, it can be useful to select more than one estimating approach (e.g., cost per mile and similar projects) to see how the results compare as a quick check.
- In the Planning and Programming Phase, the level of project definition is a main factor in deciding what tools are selected.
- Due to the lack of project definition in this phase, methods involving specific bid items probably are not possible unless it is a highly typical project that occurs frequently for the district.
- Conceptual estimating approaches use dollars-per-mile from past projects or dollars-per-mile based on typical sections.
- Parametric estimating methods (e.g., estimating the cost of a bridge based on square feet of bridge deck) can be useful, provided pricing from similar projects is available.

### Specifics to the Preliminary Design Phase



1. Review types of information contained in the Project Estimate File.
2. Review available tools in tool appendix.
3. Determine those tools that fit the level of project definition and complexity.
4. Consider time restraints for estimate preparation.
5. Decide on best estimate tool(s).

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Select estimating approach.



- [Historical Bids](#)
- [Cost Estimate Spreadsheet Template](#)
- [Typical Sections on a Per Mile Basis](#)
- [Similar Projects](#)
- [Parametric Estimating.](#)



### Guidance

- TxDOT Estimators often prefer to migrate their estimating approach to actual bid items with quantities as soon as possible in the project development process.
- Use historical bid based estimating for 20 percent of work elements that represent 80 percent of the cost, and then use historical percentages to estimate the remaining 20 percent of the costs (Pareto Principle).
- When a project is very similar to a previous project recently bid or constructed, use the previous project as a basis for preparing the estimate on the current project, adjusting only for differences in quantities and unit costs.
- Project estimation approaches should be selected on the basis of:
  - Level of project definition and design maturity.
  - Historic data available.
  - Project characteristics.

## Specifics to the Design Phase



### Process

1. Use historical bid-based estimating approach.
2. Review level of design information available.
3. Determine if other tools might be necessary for certain project elements due to level of detail available.
4. Select other tools that are appropriate, if needed.



- [Historical Bids](#)
- [Cost Estimate Spreadsheet Template](#)
- [Typical Sections on a Per Mile Basis](#)
- [Similar Projects](#)
- [Parametric Estimating.](#)

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Select estimating approach.



- When the Estimator moves from a parametric approach to a detail bid-based approach, ensure all design elements are included in the new estimate. For example, if a cost per mile using a typical section was initially used, make sure all elements included (and not included) in that typical section such as drainage are detailed in the bid-based estimate.
- If a project design element such as drainage is not completely detailed, the Estimator should consult with the appropriate functional group or Division to determine an allowance to place in the estimate until that element is more fully detailed.
- In the Design Phase, much more is known about the project definition than when the Base Estimate was completed during Preliminary Design.
- While an earlier estimate may heavily rely on a mixture of bid-based, percentages, and parametric estimating approaches, the updated cost estimate during the Design Phase is almost entirely constructed using bid-based estimating since most of the design quantities will be known at this time.
- If an allowance is placed in an estimate for a to-be-designed element, ensure the allowance is an appropriate amount and not treated as an opportunity to hide contingency within the Base Estimate. A discussion of how contingency is determined and allocated is discussed in [Stage 3](#).

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Determine and quantify estimate elements.

### STEP B. DETERMINE AND QUANTIFY ESTIMATE ELEMENTS

This step determines the categories and quantities consistent with the estimating tool(s) used.



#### Roles

- The Estimator or designer determines the appropriate quantity measure and calculates quantities for the appropriate components.
- If their area of expertise is required for the project, the functional groups and/or Divisions provide documentation of calculations and assumptions associated with the calculations to be incorporated into the estimate.



#### Why

Quantifying estimate categories, elements, and major items produces more detailed and accurate estimates. Also, it allows for more transparent and beneficial reconciliation of estimate data from previous phases.

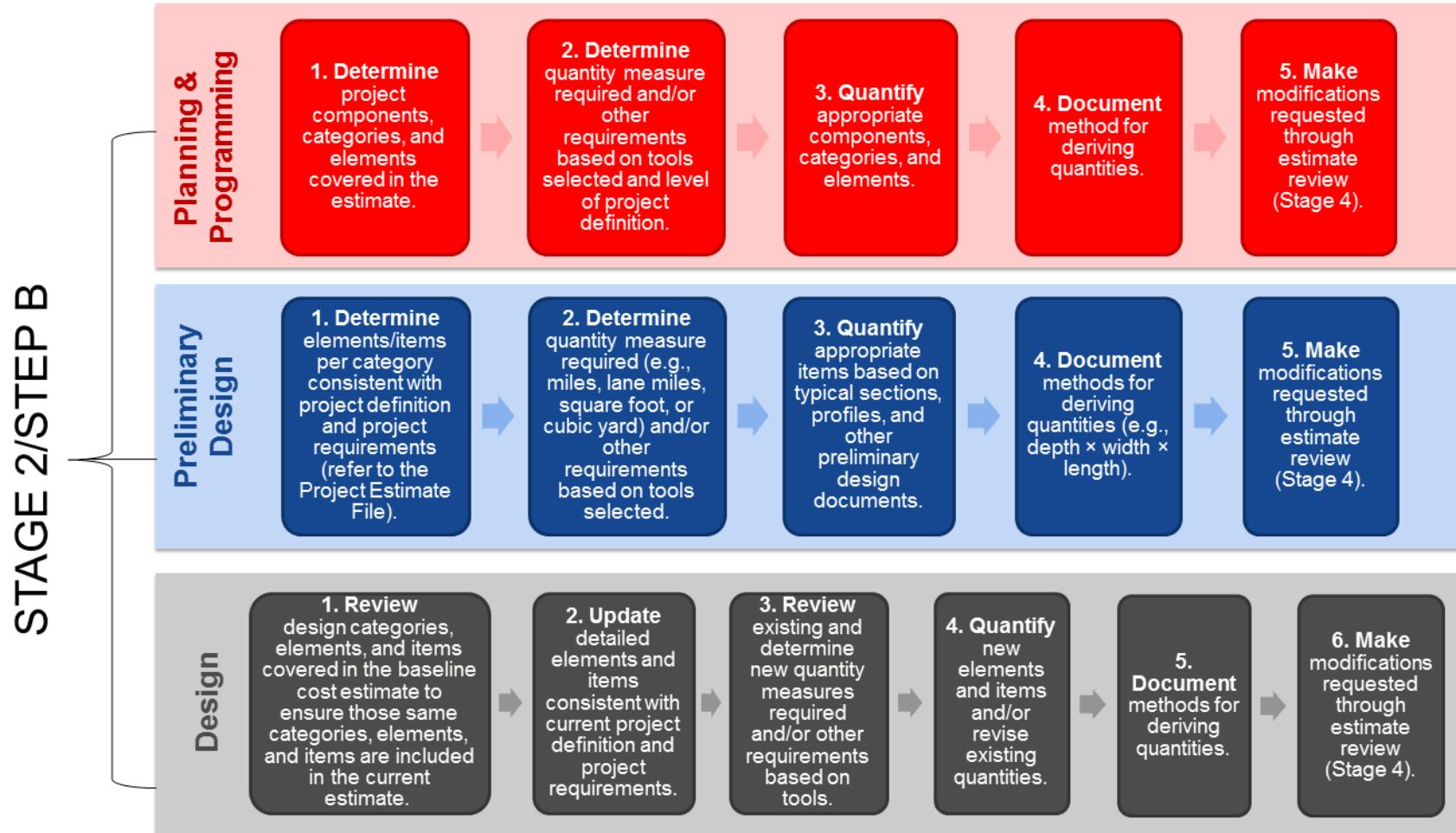


#### Guidance for All Phases

- Spreadsheets are also useful for compiling estimate calculations and assumptions, assessing estimate completeness, and communicating the estimate to others.
- Calculations of quantities should be documented, including all backup calculations and assumptions made when determining quantities.
- Special care should be taken while operating electronic spreadsheets or other computer based estimating tools. While they are quite helpful in performing calculations and are an expedient way to update an estimate, it is easy to make a small typing error or miscalculation in a cell that raises or lowers the estimate by an order of magnitude. Always double check entries and use reasonableness checks where possible.
- Complex projects that have many components will require functional groups and/or Divisions to identify estimate elements/major items and quantities associated with their category discipline.
- This documentation aids the estimate review ([Stage 4](#)) or when the Estimator has to modify elements due to review recommendations.
- Stage 2 is the calculation of the Base Estimate which represents those elements that are known. Accounting for unknowns and specific risks within the estimate will occur in [Stage 3](#).

## Process Flowchart

### Stage 2 Prepare/Update Base Estimate Step B Determine and Quantify Estimate Elements



## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Determine and quantify estimate elements.

### Specifics to the Planning and Programming Phase



1. Determine project components, categories, and elements covered in the estimate.
2. Determine quantity measure required and/or other requirements based on tools selected and level of project definition.
3. Quantify appropriate components, categories, and elements.
4. Document method for deriving quantities.
5. Make modifications requested through estimate review ([Stage 4](#)).



- [Historical Bids](#)
- [Cost Estimate Spreadsheet Template](#)
- [Typical Sections on a Per Mile Basis](#)
- [Similar Projects](#)
- [Parametric Estimating.](#)



- The Estimator should first determine what project components, categories, and elements are required to be estimated. The Estimator relies on the Estimate Basis ([Stage 1](#)) and the tool(s) selected in previous step to identify required components.
- The Estimator should be aware that all assumptions and calculations made during the Planning and Programming Phase can change as the process develops better concept definition. For example, the number of lane miles may increase or decrease as the project limits are better defined.
- The per-mile quantity is relatively straight forward and determined by approximate project boundary limits.
- The specific component, category, or element quantities could be related to other project features.
- Even when there are a limited number of components to be estimated, the how the quantities are derived should be documented.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Determine and quantify estimate elements.

### Specifics to the Preliminary Design Phase



1. Determine elements/items per category consistent with project definition and project requirements (refer to the Project Estimate File).
2. Determine quantity measure required (e.g., miles, lane miles, square foot, or cubic yard) and/or other requirements based on tools selected.
3. Quantify appropriate items based on typical sections, profiles, and other preliminary design documents.
4. Document methods for deriving quantities (e.g., depth × width × length).
5. Make modifications requested through estimate review ([Stage 4](#)).



- [Historical Bids](#)
- [Parametric Estimating](#)
- [Cost Estimate Spreadsheet Template](#)



- The Estimator relies on the preliminary design Basis of Estimate contained in the Project Estimate File and the tool(s) selected in the previous step to identify the different categories, elements, and items that define the project.
- The Estimator is responsible for the proper application of every tool and the complete quantification of the project's elements and major items.
- In instances where estimate reviews required modifications to estimate elements, the Estimator must revise these corresponding elements within their preliminary design estimate.
- The Estimator should identify issues that create uncertainty in their quantity calculations and account for possible variability in the calculated quantities and pricing.
- Again, the Estimator is calculating the Base Estimate which comprises what is known at this point in the design maturity. Creating hidden contingencies by inflating quantities should be avoided.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Determine and quantify estimate elements.

### Specifics to the Design Phase



1. Review design categories, elements, and items covered in the Baseline Cost Estimate to ensure those same categories, elements, and items are included in the current estimate.
2. Update detailed elements and items consistent with current project definition and project requirements.
3. Review existing and determine new quantity measures required and/or other requirements based on tools.
4. Quantify new elements and items and/or revise existing quantities.
5. Document methods for deriving quantities.
6. Make modifications requested through estimate review ([Stage 4](#)).



- [Cost Estimate Spreadsheet Template](#)



- Before quantifying the elements or items to be updated, the Estimator must be thoroughly familiar with the Preliminary Design cost estimate where the elements were originally quantified to know how to properly update them or perhaps add new elements or items not previously covered.
- Additionally, the Estimator relies on the Updated Cost Estimate Basis ([Stage 1](#)) to identify the different work elements and items that govern the estimate update.
- The Estimator then determines the appropriate quantity measure and calculates quantities for those elements that require updating of the quantity.
- The Estimator should identify issues that create uncertainty in their quantity calculations.
- The designer is responsible for complete quantification of every work element or item.
- New quantity calculations are necessary for items not previously defined. These are most commonly the elements quantified through percentages or allowances in previous estimates.
- When performing an estimate update, the Estimator should be aware of the interaction of all items with those previously estimated. Alternatively, if in Preliminary Design the amount of curing compound used on a project was directly related to the square yards of pavement, a change in the pavement quantity also necessitates a change in the curing compound quantity.
- Review major items of work to be updated; focus the efforts on these major items because they comprise the bulk of the project's costs. Further breakdown elements that were previously estimated using historical percentages or parametric estimating approaches into specific items.
- Almost as important as the quantification of the elements and items is the documentation of the calculation of element and item quantities. Quantities drive estimated costs and are needed for future reviews and adjustments, as well as for others to fully comprehend the estimated costs.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Determine and quantify estimate elements.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Develop estimate data.

### STEP C. DEVELOP ESTIMATE DATA

This step develops/updates the appropriate cost data for each category.



#### Roles

- Once the estimate is developed, the Estimator modifies any necessary cost data based on the feedback from the estimate review ([Stage 4](#)).
- The Estimator uses a number of different inputs to accomplish this step, such as elements and major item quantities, project characteristics, historical bids, and potential market impacts.



#### Guidance for All Phases

- Care should be given when adjusting the cost data for project specific characteristics or location (if the pricing is from another District), for age of historical bids, and for other factors. Historical bids used for estimating should reflect current costs; inflation to year of expenditure should be adjusted with the appropriate interest rate on the Total Construct Cost Estimate value.
- Unit prices should be understood in terms of how these data are developed for estimating a current project (e.g., using weighted averages based on low bid only or three-month versus 12-month rolling averages).
- Adjusting historical bids to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul routes and distance, work zone staging, and any market volatility. In developing the Base Estimate, the most likely unit price should take all of these factors into account. Stage 3 of this process will discuss accounting for uncertainty and variability of these unit prices. Table 13 presents how to generally adjust unit prices for typical project considerations
- A spreadsheet template or specific estimating software are excellent tools for ensuring all categories of project cost have been considered and accounted for in the estimate.
- Adding notes within a spreadsheet can be a quick way to document assumptions, adjustments, source, and other items related price data.
- Refer to the American Association of State Highway Transportation Officials (AASHTO) [“Practical Guide to Cost Estimating”](#) (2013) for consideration when adjusting and setting unit costs for local conditions.

## Stage 2. Prepare/Update Base Estimate

A	B	C	D	E
Develop estimate data.				

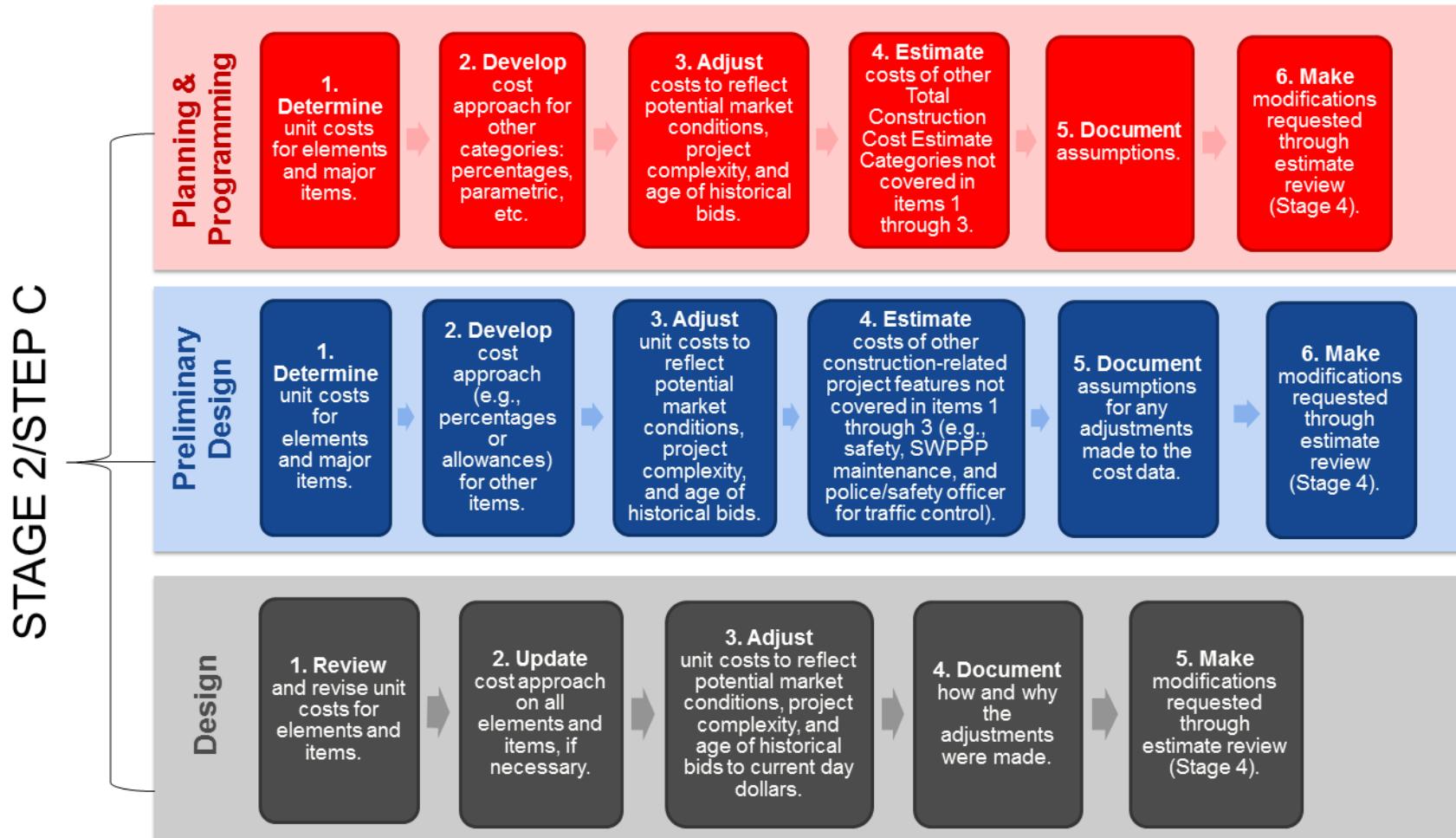
**Table 13. Project Considerations and Conditions That Can Impact Unit Prices.**

Consideration	Condition	Possible Impact on Unit Prices
<b>Geographic Considerations</b>	Urban Setting	Increase – confined workspace, high traffic, limits on work hours, night work Decrease – local contractors, materials, equipment, and personnel
	Rural Setting	Increase – lack of local contractors, materials, equipment, and personnel Decrease – open work space, low traffic, no work hour restrictions
	Distance to Material Sources	Increase – if material sources are far from projection location Decrease – if materials sources are close to project location
	Terrain	Increase – projects with mountainous terrain or steep slopes Decrease – project on level terrain
	Local Policies, Taxes, Restrictions, Air & Water Quality	Increase – most restrictions increase project cost
	Tribal Lands	Increase – tribal taxes could increase costs
<b>Quantity Considerations</b>	Large Quantities	Decrease – generally reduced unit cost because of supplier discounts, spread of mobilization, overhead, profit, and water over larger quantities and increased production rates
	Small Quantities	Increase – generally increased unit cost because of higher supplier charges, decreased production rates, and sub-contracting of small-quantity items
	Extremely Large Quantities	Increase – extremely large quantities can result in shortage or delay in delivery of some materials (e.g., structural steel, asphalt, concrete, etc.)
<b>Item Availability</b>	Readily Available Items	Decrease – commonly used items are generally less expensive
	Non-Standard Items	Increase – rarely used items are generally more expensive
<b>Site Specific Considerations</b>	Difficult Construction	Increase – examples include work adjacent to historic structures, environmentally sensitive or hazardous sites, and limited work space
	Site Constraints	Increase – examples include require a large amount of equipment and stall to relocation or if the contractor will need to mobilize several times
<b>Lump-Sum Items</b>	Mobilization	Increase – projects that require a large amount of equipment and staff to relocate, or if the contractor will need to mobilize several times

*Source: TxDOT Design Division*

## Process Flowchart

### Stage 2 Prepare/Update Base Estimate Step C Develop Estimate Data



## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Develop estimate data.

### Specifics to the Planning and Programming Phase



1. Determine the most likely unit costs for elements and major items.
2. Develop cost approach for other categories: percentages, parametric, etc.
3. Adjust costs to reflect potential market conditions, project complexity, and age of historical bids.
4. Estimate costs of other Total Construction Cost Estimate Categories not covered in items 1 through 3.
5. Document assumptions.
6. Make modifications requested through estimate review ([Stage 4](#)).



- [Historical Bids](#).
- [Typical Sections on a Per Mile Basis](#)
- [Similar Projects](#)
- [Parametric Estimating](#)
- [Cost Estimate Spreadsheet Template](#).



- It can be extremely helpful to review recently let projects to see how the actual contractors' pricing compared to what the unit pricing used in those projects' estimates. Actually pricing from multiple contractors may reveal pricing trends that are not captured in 3-month and 12-month rolling average bid tabs.
- In the Planning and Programming Phase, the categories identified are not very specific. It is easier and acceptably accurate at this stage to estimate a single category that is comprised of many related elements. For example, if a bridge is part of the project requirements, all bridge elements will not be individually detailed, therefore pricing at the bid item-level would not be possible. The bridge cost can then be estimated using a single parameter, such as square foot of bridge deck area, based on historical bids from similar types of bridges.
- Consider where the project is located and its key features, that is, rural/urban, two lane/four lane, etc., as these issues will impact cost parameter values. These features should be described in the basis for estimate identified in [Stage 1](#).
- Adjusting historical bids to fit a project is a challenge. Adjustments for differences between a similar-but-not-identical-project can be reflected in the cost values used or considered as variability or specific risks with appropriate contingency evaluations ([Stage 3](#)).

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Develop estimate data.

### Specifics to the Preliminary Design Phase

#### Process

1. Determine unit costs for elements and major items.
2. Develop cost approach (e.g., percentages or allowances) for other items.
3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids.
4. Estimate costs of other construction-related project features not covered in items 1 through 3 (e.g., safety, SWPPP maintenance, and police/safety officer for traffic control).
5. Document assumptions for any adjustments made to the cost data.
6. Make modifications requested through estimate review ([Stage 4](#)).

#### Tools

- [Cost Estimate Spreadsheet Template](#)

#### Guidance

- The Estimator should use evidence-based pricing. In other words, the Estimator should be able to indicate the source of the cost data used, why they were used, and what/why adjustments were made to the prices.
- Historical Percentages require analysis of historical bids for similar sets of elements. The cost of this set of elements is summed and converted to a percentage of all other construction costs.
- List of items with uncertain cost data should be identified for evaluating risk and contingencies ([Stage 3](#)).
- Referring to historical bid data may allow some of the design elements to move toward generic lines (e.g., “asphalt” but not a specific type of asphalt.)

### Specifics to the Design Phase

#### Process

1. Review and revise unit costs for elements and items.
2. Update cost approach on all elements and items, if necessary.
3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids to current day dollars.
4. Document how and why the adjustments were made.
5. Make modifications requested through estimate review ([Stage 4](#)).

#### Tools

- [Cost Estimate Spreadsheet Template](#)

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Develop estimate data.



### Guidance

- The estimate at the end of the Preliminary Design Phase typically becomes the project's Baseline Cost Estimate.
- The Estimator should be diligent to not be overly conservative in pricing in order to create hidden contingencies. Hidden contingencies can compound creating an inaccurate estimate.
- The Preliminary Design estimate can occur more than a year before the first Design cost estimate. During this time, TxDOT has continuously added to their historical cost database. These recent data should be used so that the updated estimate reflects current dollars at the time of the update.
- During Design, historical bid data are used more frequently and almost exclusively when the Design is nearing completion. Some project elements may be accounted for as an allowance within the estimate until the design matures to the level where specific bid items and quantities can be determined.
- Market conditions and project location greatly affect the cost data; however, factors such as material cost, special machinery, involvement of special agencies, technology, or method of construction should also be considered to make the cost data more accurate.
- Review carefully the unit costs on those work elements and items that comprise 80 percent of the cost. Spend time focusing on historical bids for these critical work elements.
- Look for recent trends such as rising materials costs or changes in specifications.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Calculate base cost estimate.

### STEP D. CALCULATE BASE COST ESTIMATE

This step calculates cost data for each estimate element and combines and summarizes in a spreadsheet.

#### Roles

- The Estimator inserts quantities and cost data for each estimate category into the cost estimating spreadsheet or software to calculate the base cost of a project.
- The Estimator performs reasonableness checks to make sure any large mistakes or miscalculations have not been made on the spreadsheet.
- After all of the quantities and prices are calculated, the Estimator combines these data together to calculate the base cost of a project.

#### Why

This step ensures all known categories, elements, and major items of work are covered in the estimate. Up to this point the data have yet to be compiled together for a single Base Estimate, so it is necessary to check if all categories are included. Contingencies for risk and other unknown items will be addressed in [Stage 3](#).

#### Guidance for All Phases

- Cost estimates provided by functional groups and/or Divisions should also be included.
- The cohesiveness of the resulting base cost estimate is imperative. While merging work from different functional groups and/or Divisions into a single, integrated estimate may be difficult, it must be integrated for the comprehension of reviewers and management approval.
- Contingency should not be included in any category cost/item estimates. These will be determined and included in the estimate during [Stage 3](#).

#### *Spreadsheets*

- Simple spreadsheets can aid in clearly communicating the total estimated cost of the project, as well as revealing what categories are included in the estimate and what they are expected to cost.
- A simple spreadsheet can be used to make the necessary detailed calculations of elements and items, as well as to summarize these elements and items by categories consistent with the concept of Total Construction Cost Estimate for a simple representation and eventually for reviews.
- A standard spreadsheet template allows for consistent and well-organized estimates.
- Formulas used in spreadsheets should be checked to ensure that all costs are properly calculated and aggregated to summary component levels.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Calculate base cost estimate.

- Spreadsheets should summarize the project categories in a manner consistent with the components of the Basis of Estimate (from [Stage 1](#)), which commonly follow the same structure as the bid items in the TxDOT standard specifications.

### *Reasonableness Checks*

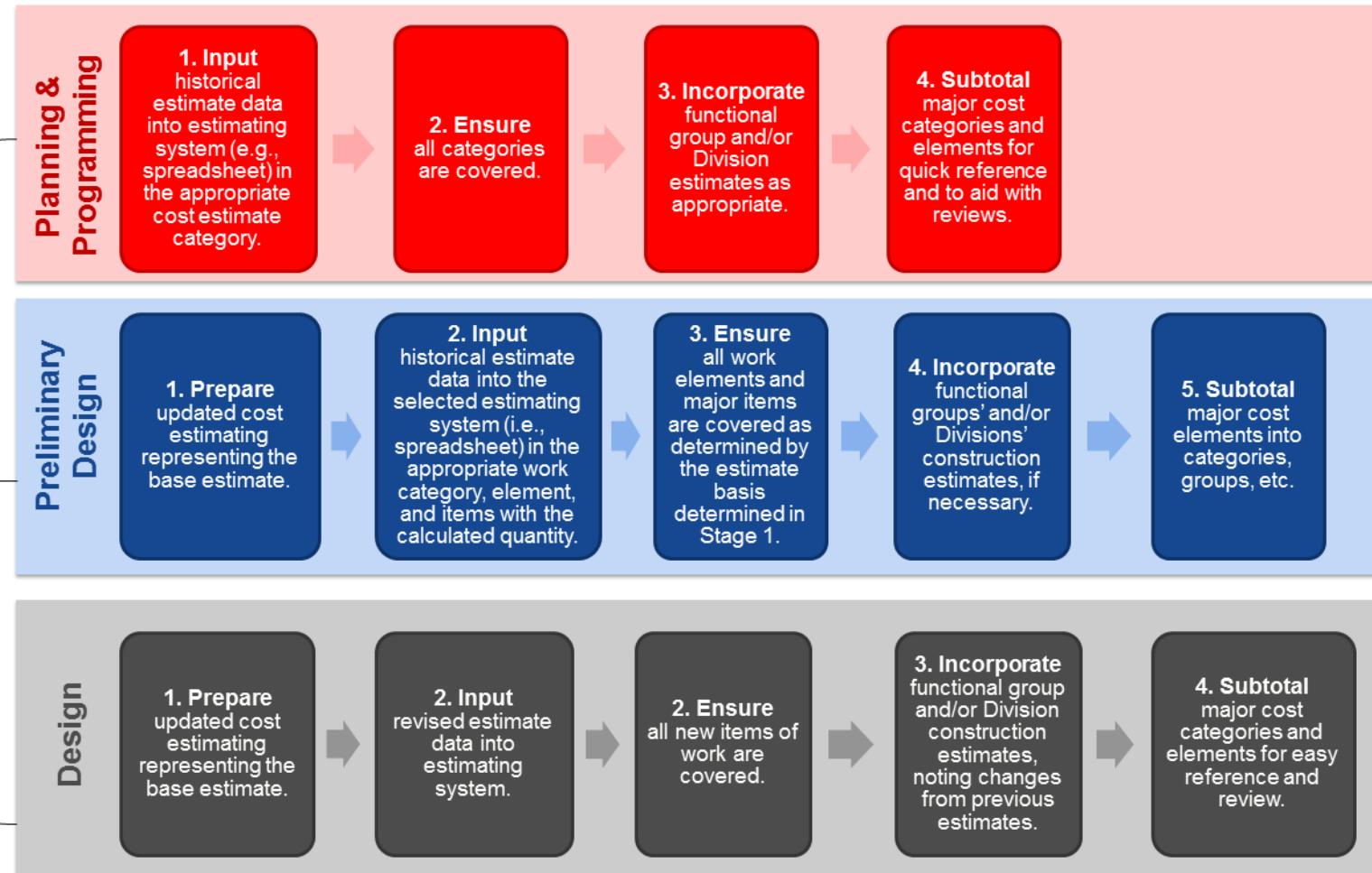
- Reasonableness checks can be made in a number of ways. For example, look at values in the spreadsheet to make sure none seem unrealistically large or small. If they are, review the calculations, the quantity value, and/or the unit prices.
- Another type of reasonableness check is reducing an entire project or item to cost per unit such as cost per mile to see if that value is realistic compared to similar or recently let projects.

## Process Flowchart

### Stage 2 Prepare/Update Base Estimate Step D Calculate Base Cost Estimate

S6

#### STAGE 2/STEP D



## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Calculate base cost estimate.

### Specifics to the Planning and Programming Phase



1. Input historical estimate data into estimating system (e.g., spreadsheet) in the appropriate cost estimate category.
2. Ensure all categories are covered.
3. Incorporate functional group and/or Division estimates as appropriate.
4. Subtotal major cost categories and elements for quick reference and to aid with reviews.



- [Cost Estimate Spreadsheet Template](#)



- The Estimator should ensure they are using the most current version of the spreadsheet template or software forms when creating their estimates.
- The Estimator should save each version of an official estimate and not merely overwrite the values in the same file. In Excel™, tabs within a single spreadsheet may be used depending on how the template is structured. Each estimate that is saved should be adequately documented to ensure that others can clearly identify to what Basis of Estimate the cost estimate applies.
- If using a template provided by another person, the Estimator should verify that the calculations within the spreadsheet or software are correct. Users should have a basic understanding of the calculations that the spreadsheet is performing. They should take time to familiarize themselves with the functionality of the template or software prior to completing the estimate.
- This is the time to ensure all project requirements have been accounted for in the estimate. Any exclusion due to lack of information at this project development phase should be noted within the Project Estimate File.

### Specifics to the Preliminary Design Phase



1. Prepare updated cost estimating representing the Base Estimate.
2. Input historical estimate data into the selected estimating system (i.e., spreadsheet) in the appropriate work category, element, and items with the calculated quantity.
3. Ensure all work elements and major items are covered as determined by the Basis of Estimate determined in [Stage 1](#).
4. Incorporate functional groups' and/or Divisions' construction estimates, if necessary.
5. Subtotal major cost elements into categories, groups, etc.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Calculate base cost estimate.



- [Cost Estimate Spreadsheet Template](#)



### Guidance

- The estimate should review the Project Estimate File to determine if some of the unknowns and questions identified in Stage 1 are resolved or still outstanding.
- Allowances can still be used at this phase for yet-to-be designed elements.
- It is common for the estimates in the Preliminary Design Phase to be higher, sometimes significantly higher, than the estimates developed in the Planning and Programming Phase. Don't panic—as the design matures and more details are identified there may be items accounted for in the Preliminary Design estimates that were not accounted for within earlier estimates using parametric techniques such as cost per mile. By utilizing a standard process consistently over time, future Planning and Programming Phase estimates can be improved by accounting for such deficiencies.
- All base costs should reflect current dollars. Inflation to year-of-expenditure dollars will be applied to the Total Construction Cost Estimate.

## Specifics to the Design Phase



1. Prepare updated cost estimating representing the Base Estimate.
2. Input revised estimate data into estimating system.
3. Ensure all new items of work are covered.
4. Incorporate functional group and/or Division construction estimates, noting changes from previous estimates.
5. Subtotal major cost categories and elements for easy reference and review.



- [Cost Estimate Spreadsheet Template](#)



- After all of the quantities and prices are updated, the Estimator updates and summarizes the base cost estimate spreadsheet prepared in the Preliminary Design to calculate the current base cost of the project.
- These estimates should be updated to reflect current day dollars and the latest design details.
- The completeness of the resulting updated cost estimate is imperative. Future Estimators will find complete and appropriately documented estimate valuable for future projects by allowing them to produce more relevant cost per mile calculations and percentages of major cost categories.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Calculate base cost estimate.

- An important part of this step is to fully analyze any changes in the estimates. As design estimates are updated, fewer allowances should be required, and more items should be included and estimated using recent bids.

## Stage 2. Prepare/Update Base Estimate

A	B	C	D	E
Review documented estimate assumptions, inputs, and calculations.				

### STEP E. REVIEW DOCUMENTED ESTIMATE ASSUMPTIONS, INPUTS, AND CALCULATIONS

This step ensures that the decisions and assumptions used in preparing the Base Estimate are compiled and documented in a structured format for communication to management. This step reviews the Project Estimate File and estimating tool(s) to confirm documentations was completed throughout Stage 2.

#### Roles

The Estimator reviews the documents associated with the base cost estimates by confirming the following items are contained in the Project Estimate File:

- The basis of the estimate (from [Stage 1](#)).
- The Base Estimate (from [Stage 2](#)).
- Source of cost data and any adjustments to data
- The assumptions used to calculate the Base Estimate.
- Back-up calculations if not included in the estimating tool (e.g., spreadsheet)
- The extent to which various estimate inputs are developed (i.e., the design maturity of the various elements).
- A description of force accounts assumed to be included in the contract (e.g., police assistance with traffic control or contractor incentives).

#### Why

- This step ensures all estimate information used during the preparation of the estimate is documented in a structured format within the Project Estimate File.
- This step ensures consistency across Districts and within the state.
- Documentation and preservation of estimate information and supporting data is important, as these data form historical bids for other future projects.
- Aids in risk analysis ([Stage 3](#)).
- Critical for estimate review and approval ([Stage 4](#)).
- Good documentation supports the cost estimate's credibility, enables reviewers to effectively assess the quality of the estimate, aids in the analysis of changes in project cost, and contributes to TxDOT historical cost databases for estimating the cost of future projects.

#### Guidance for All Phases

- A project's complexity and size may mean that more issues should be considered and accounted for when preparing the estimate. Additionally, estimates are commonly prepared in collaboration with many functional groups and/or Divisions.
- Documentation should include Basis of Estimate, assumptions, and calculations. The Project Estimate File should be created to assemble and update these items in a single location.

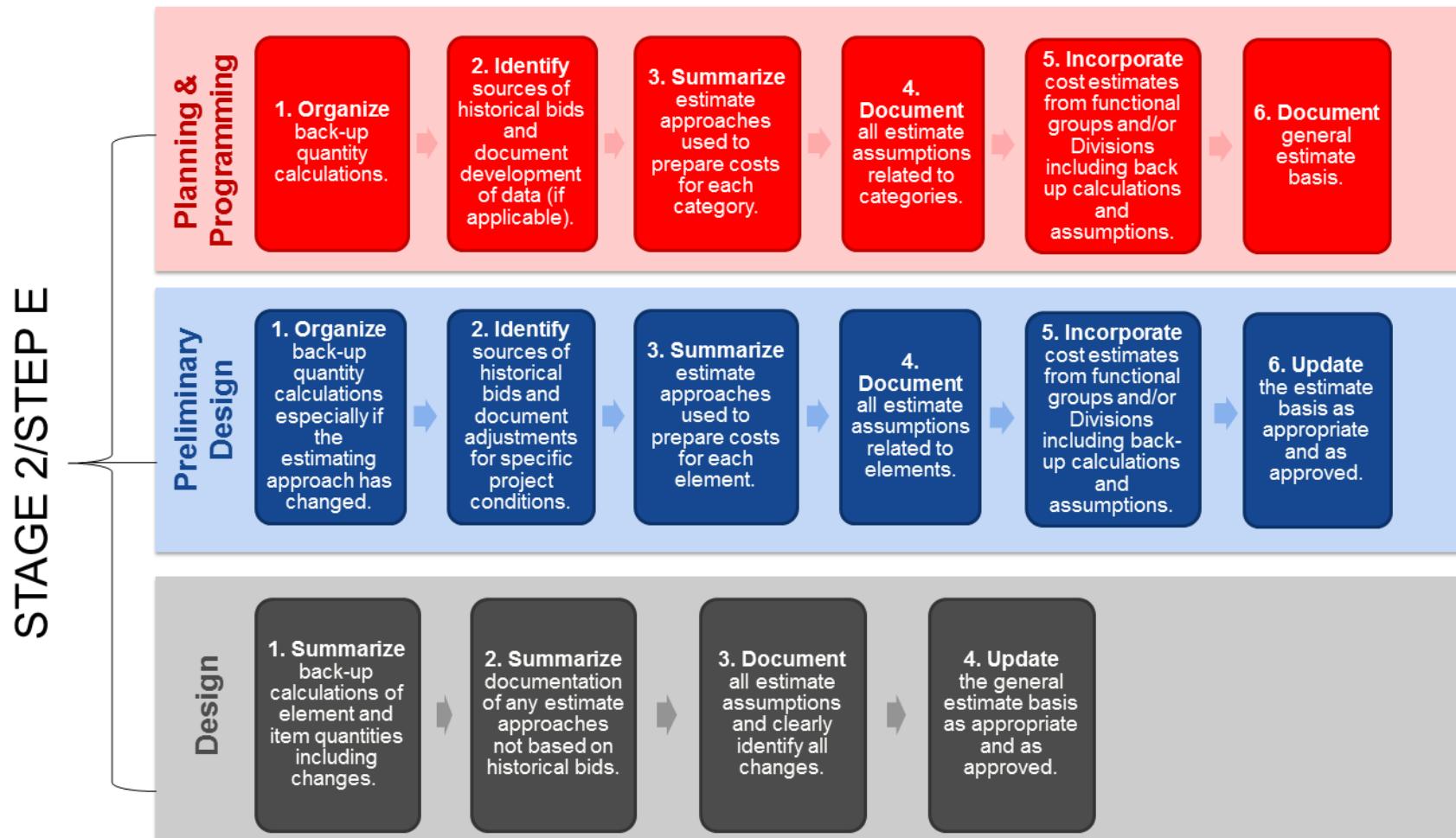
## Stage 2. Prepare/Update Base Estimate

A	B	C	D	E
Review documented estimate assumptions, inputs, and calculations.				

- Similar documentation structure of the estimate should be provided by each functional group and/or Division that prepares an estimate for a project and included in the Project Estimate File.
- As more details, items, notes, and documents are placed in the Project Estimate File, it may be helpful to create short summary sheets for each section to facilitate rapid location of information.
- Force accounts assumed and the calculations used to determine their costs should be explicitly documented.
- The Basis of Estimate, design decisions, and assumptions behind the choices that drive the estimate should be clearly stated and communicated to management (refer to [Stage 4](#) and [Stage 5](#)).
- Documenting how a cost estimate was developed (e.g., estimating technique, source of cost data, adjustments to cost data, and other assumptions) allows others to trace the Estimator's work through the process. Traceability allows others to review and validate the estimate. Traceability also provides the mechanism to assess cost impact when the planning estimate updates are made.

## Process Flowchart

Stage 2 Prepare/Update Base Estimate Step E Review Documented Estimate Assumptions, Inputs, and Calculations



## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Review documented estimate assumptions, inputs, and calculations.

### Specifics to the Planning and Programming Phase



1. Organize back-up quantity calculations.
2. Identify sources of historical bids and document adjustments to data (if applicable).
3. Summarize estimate approaches used to prepare costs for each category.
4. Document all estimate assumptions related to work categories.
5. Incorporate cost estimates from functional groups and/or Divisions including back up calculations and assumptions.
6. Document general Basis of Estimate.



- [Project Estimate File](#)



- Organizing information in the Project Estimate File along the way keeps the task of documentation less onerous.
- The Estimator should be deliberate in documenting the estimate; saving unrelated information in the Project Estimate File causes confusion for everyone.

### Specifics to the Preliminary Design Phase



1. Organize back-up quantity calculations especially if the estimating approach has changed.
2. Identify sources of historical bids and document adjustments for specific project conditions.
3. Summarize estimate approaches used to prepare costs for each element.
4. Document all estimate assumptions related to elements.
5. Incorporate cost estimates from functional groups and/or Divisions including back-up calculations and assumptions.
6. Update the Basis of Estimate as appropriate and as approved.

## Stage 2. Prepare/Update Base Estimate

A

B

C

D

E

Review documented estimate assumptions, inputs, and calculations.



- [Project Estimate File](#)



### Guidance

- Clearly document the changes, data origins, and approximations as any future estimates will be compared to this estimate and will be used to justify the changes in the cost of the project during the Design Phase.
- Identify and document project uncertainties. Documenting these uncertainties can aid in defining the unknown/undefined project components and will be used in the risk identification procedure discussed in [Stage 3](#).

### Specifics to the Design Phase



1. Summarize back-up calculations of element and item quantities including changes.
2. Summarize documentation of any estimate approaches not based on historical bids.
3. Document all estimate assumptions and clearly identify all changes.
4. Update the general Basis of Estimate as appropriate and as approved.



- [Project Estimate File](#)



- Clearly document the changes, data origins, and approximations as this estimate is being compared to the Baseline Cost Estimate.
- It is also important to document how historical bid prices are adjusted to current day dollars and to document changes in estimate tools used as the tools may result in changes in cost.
- Fewer assumptions should be needed at the Design phase than at the Preliminary Design phase since the project is further defined. More of the estimate is derived based on item quantity take-offs from the plans and specifications instead of using data from previous similar projects, using historical percentages, or using parametric approaches. This reduces the level of uncertainty.
- Assumptions still need to be documented.



## STAGE 3. DETERMINE RISK AND CONTINGENCY

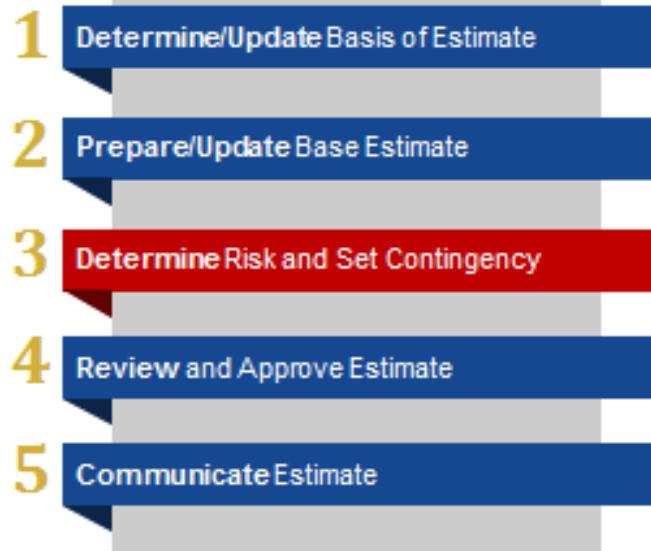
Risk-Based Estimating

# STAGE

# 3

## The Framework

5 Stages



### OVERVIEW

Stage 3 has six steps that address the uncertainty, unknowns, and risk within a construction estimate develop a contingency amount to add to the Base Estimate to arrive at the Total Construction Cost Estimate.

### Chapter Organization

This chapter contains the following topics.

Topic	See Page
Quick Reference Guide	108
Step A. Compile and Review Risk Information	112
Step B. Determine/Confirm Level of Risk Analysis	117
Step C. Identify/Update Risks	121
Step D. Estimate/Update Contingency	127
Step E. Document Risk and Contingency	133

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Step F. Prepare/Revise Total Construction Cost Estimate	137
---	-----

### Remember

- An element of uncertainty is inherent in any cost estimate. In order to account for as much of the uncertainty associated with a project cost estimate as is practical, project teams will use a risk analysis to estimate the contingency amount to be included in the Total Construction Cost Estimate.
- These steps, in combination with the tools, support the development of a contingency estimate. These steps identify risks and provide a framework to assess the amount of contingency that will properly cover estimate uncertainty during the three project development phases.
- The output of this stage is a contingency estimate, a documentation of the risk and contingency basis, and the total construction cost.
- All projects, regardless of project size and project complexity, require some form of risk analysis and risk management planning.
- For TxDOT, the project size generally determines the type of risk analysis suggested to identify risks and estimate contingency.
- Risk analysis and setting of contingency will rely on individual expert judgment (e.g., the Estimator, functional group experts, peer reviewers, district engineer). Personal expertise will always be a valuable part of the process.
- Risk analysis and risk management planning are iterative and continuous throughout the project development process.
- Estimating assumptions and issues of concern form the basis for risk identification. Clarifications regarding design assumptions and issues of concern inform the Estimator of possible risks and the need for contingency.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Stage 3. Determine Risk and Contingency			
Purpose	Steps	Outputs	Tools
Characterize the estimate uncertainty and develop contingency amount.	A. <a href="#">Compile and review risk information.</a> B. <a href="#">Determine/confirm level of risk analysis.</a> C. <a href="#">Identify/update risks.</a> D. <a href="#">Estimate/update contingency.</a> E. <a href="#">Document risk and contingency.</a> F. <a href="#">Prepare and revise Total Construction Cost Estimate.</a>	Total Construction Cost Estimate.	<ul style="list-style-type: none"> <li>• <a href="#">APRA</a></li> <li>• <a href="#">Crawford Slip Method.</a></li> <li>• <a href="#">Estimate Ranges – Monte Carlo Analysis</a></li> <li>• <a href="#">Estimate Ranges – Three Point Analysis</a></li> <li>• <a href="#">Expert Team.</a></li> <li>• <a href="#">Probability × Impact Matrix (P×I)</a></li> <li>• <a href="#">Project Estimate File.</a></li> <li>• <a href="#">Risk Breakdown Structure</a></li> <li>• <a href="#">Risk Checklist.</a></li> <li>• <a href="#">Risk Register</a></li> <li>• <a href="#">Risk Workshop.</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template.</a></li> </ul>

### How to Use This Chapter

For each step in Stage 3, the following information is provided:

- Important information across the three pre-construction phases of project development.
- The roles and responsibilities of the step.
- Why the step is needed.
- Guidance relevant to all three phases.
- Specifics to the Planning and Programming phase.
- Specifics to the Preliminary Design phase.
- Specifics to the Design phase.

# Quick Reference Guide

## Risk-Based Estimating

# STAGE

# 3

## The Framework

### 5 Stages

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

**Purpose:** Characterize the estimate uncertainty and develop contingency amount.

STEP	PURPOSE
A. Compile and review risk information.	Collect information for later use.
B. Determine/confirm level of risk analysis.	Define the level of risk analysis based on project complexity.
C. Identify/update risks.	Identify, categorize, and document risks that could affect the project.
D. Estimate/update contingency.	Determine/update an appropriate contingency for the project through risk assessment and analysis.
E. Document risk and contingency.	Document a transparent list of risks and uncertainties for Cost Management.
F. Prepare and revise Total Construction Cost Estimate.	Add the base cost estimate and contingency estimate to arrive at a Total Construction Cost.

### Key Reminders

- Using an estimate range communicates inherent variability and uncertainties as well as potential impact of identified risks.
- All projects—regardless of size or complexity—should consider project specific and agency risks.
- Have someone else review the estimate for completeness and accuracy.



#### Tools

- [Probability x Impact Matrix \(PxI\).](#)
- [Project Estimate File.](#)
- [Risk Breakdown Structure.](#)
- [Risk Checklists.](#)
- [Risk Register.](#)
- [Risk Workshop.](#)
- [Cost Estimate Spreadsheet Template.](#)
- [APRA.](#)
- [Crawford Slip Method.](#)
- [Estimate Ranges – Monte Carlo Analysis.](#)
- [Estimate Ranges – Three Point Estimate.](#)
- [Expert Team.](#)

### Stage 3: Determine Risk and Set Contingency

	Planning & Programming	Preliminary Design	Design
<p>A. Compile and review risk information.</p>	<ul style="list-style-type: none"> <li>Risks identification is continuous and iterative. Review all the information from previous risk analyses. Expect that the process and the risk information will be somewhat repetitive. Discussions with the Project Manager and other functional area staff will be helpful at this stage.</li> <li>Review the risk checklists and analyses from similar projects only after conducting a thorough review of the estimating and design assumptions. There may be project-specific risks that are not included in standard checklists and could be overlooked if reliant on checklists.</li> </ul>	<ol style="list-style-type: none"> <li>Examine Base Estimate for uncertainty.</li> <li>Review all estimating and design assumptions.</li> <li>Review project scope assumptions.</li> <li>Prepare risk information for analysis.</li> </ol>	<ol style="list-style-type: none"> <li>Examine Base Estimate for uncertainty.</li> <li>Review all estimating and design assumptions.</li> <li>Review issues and concerns.</li> <li>Prepare risk information for analysis.</li> </ol>
<p>B. Determine/confirm level of risk analysis.</p>	<ul style="list-style-type: none"> <li>Although project size is considered when determining the rigor level, other factors such as project uniqueness, complexity, and/or sensitivities of local stakeholders should be considered.</li> </ul>	<ol style="list-style-type: none"> <li>Evaluate project's rigor level.</li> <li>Choose corresponding level of risk analysis.</li> <li>Select appropriate risk identification tools.</li> <li>Select appropriate risk assessment/contingency tools.</li> </ol>	<ol style="list-style-type: none"> <li>Review project's rigor level to verify appropriate level of risk analysis was previously selected.</li> <li>Change the level of risk analysis if warranted.</li> <li>Select appropriate risk identification tools.</li> <li>Select appropriate risk assessment/contingency tools.</li> </ol>
<p>C. Identify/ update risks.</p>	<ul style="list-style-type: none"> <li>The eventual outcome of the risk identification is a list of risks typically summarized in a risk register (see Step E).</li> <li>The process of risk identification should promote open dialogue and leverage team experience and knowledge. Involving people responsible for various items aids in considering project risks from different points of view.</li> </ul>	<ol style="list-style-type: none"> <li>Consider gathered risk information.</li> <li>Identify risks.</li> <li>Categorize risks.</li> </ol>	<ol style="list-style-type: none"> <li>Review risk information.</li> <li>Identify risks.</li> <li>Categorize risks.</li> </ol>

### Stage 3: Determine Risk and Set Contingency

	Planning & Programming	Preliminary Design	Design
<p>D. Estimate/update contingency.</p>	<ul style="list-style-type: none"> <li>The list of risks, along with any historical information concerning cost growth, forms the basis for determining contingency.</li> <li>When tying contingency directly to individual line items, explicitly identify the contingency and do not bury it in the unit price for the item.</li> </ul>	<p><u>Low Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Determine contingency from an expected value (<math>P \times I</math>).</li> </ol> <p><u>Medium Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate expected value (<math>P \times I</math>) for highly significant risks.</li> <li>If warranted by the top risks, use additional contingency.</li> </ol> <p><u>High Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate a contingency ranges using a three-point estimating technique.</li> <li>Develop a risk-based cost and schedule model (if applicable).</li> <li>Choose appropriate contingency.</li> </ol>	<p><u>Low Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Determine contingency through an expected value (<math>P \times I</math>).</li> </ol> <p><u>Medium Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate expected value (<math>P \times I</math>) for most significant risks.</li> <li>If warranted by the top risks, use three-point estimating to determine contingency.</li> </ol> <p><u>High Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Use a specifically developed spreadsheet template.</li> <li>Develop a risk-based cost and schedule model (if applicable).</li> <li>Choose appropriate contingency.</li> </ol>
<p>E. Document risk and contingency.</p>	<ul style="list-style-type: none"> <li>The documentation of risk is the responsibility of the entire project team. The Estimator is responsible for updating the Project Estimate File to show how the contingency amount was determined.</li> <li>Each future estimate will involve an update of risks and an update of the contingency estimate.</li> <li>The Project Estimate File should contain a section for risk documentation.</li> </ul>	<ol style="list-style-type: none"> <li>Document risks and contingency.</li> <li>Add the document to the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>Document risks and contingency.</li> <li>Add the document to the Project Estimate File.</li> </ol>
<p>F. Prepare and revise Total Construction Cost Estimate.</p>	<ul style="list-style-type: none"> <li>Contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs.</li> <li>A risk analysis can itemize contingencies for the identified risks (e.g., separate contingencies for discrete risks).</li> </ul>	<ol style="list-style-type: none"> <li>Sum the base and contingency estimates.</li> <li>Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).</li> </ol>	<ol style="list-style-type: none"> <li>Sum the base and contingency estimates.</li> <li>Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).</li> </ol>

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

### Preview of Stage 3 Procedure

Table 14 provides an overview of the basic procedure, its purpose, who does it, and when in the Project Development Process it should be done.

**Table 14. Stage 3 Procedure.**

STEP	PURPOSE	WHO DOES IT?	WHEN?
A. <a href="#"><u>Compile and review risk information.</u></a>	Collect information for later use.	• Estimator	• All phases.
B. <a href="#"><u>Determine/confirm level of risk analysis.</u></a>	Define the level of risk analysis based on project complexity.	• Project Manager	• All phases.
C. <a href="#"><u>Identify/update risks.</u></a>	Identify, categorize, and document risks that could affect the project.	• Project Team	• All phases.
D. <a href="#"><u>Estimate / update contingency.</u></a>	Determine/update an appropriate contingency for the project through risk assessment and analysis.	• Estimator • Project Team	• All phases.
E. <a href="#"><u>Document risk and contingency.</u></a>	Document a transparent list of risks and uncertainties for Cost Management.	• Estimator • Project Team	• All phases.
F. <a href="#"><u>Prepare and revise Total Construction Cost Estimate.</u></a>	Add the base cost estimate and contingency estimate to arrive at a Total Construction Cost.	• Estimator	• All phases.

### Stage 3 Inputs and Sources of Information

Each phase builds on the previous phase's information. Planning and Programming inputs are listed in red, followed by Preliminary Design additions in blue, followed by Design additions in grey. Items listed for the Planning and Programming Phase are also used in the Preliminary Design and Design Phases. Items listed for the Preliminary Design Phase are also used in the Design Phase. At the end of Stage 3, the risk register and Total Construction Cost Estimate are the key outputs.

Compile and review risk information.

### STEP A. COMPILE AND REVIEW RISK INFORMATION

This step collects information for use during risk identification ([Step C](#)).



#### Roles

- The entire project team is responsible for identifying and managing project risk.
- The project team, led by the Project Manager, examines uncertainties, reviews assumptions and scope, and then prepares risk information for analysis and outlines/updates a risk register.
- The Estimator retrieves and compiles the risk items (e.g., unknowns and assumptions) contained in the Project Estimate File for consideration by the project team.



#### Why

Estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate.



#### Guidance for All Phases

- Risks identification is continuous and iterative. Review all the information from previous risk analyses. Expect that the process and the risk information will be somewhat repetitive. Discussions with the Project Manager and other functional area staff will be helpful at this stage.
- Review the risk checklists and analyses from similar projects only after conducting a thorough review of the estimating and design assumptions. There may be project-specific risks that are not included in standard checklists and could be overlooked if reliant on checklists.
- The determination of project risk stems from a review of the estimating assumptions made by the project Estimator and the design assumptions made by the design team. The Project Estimate file should have documentation on these assumptions and decisions.
- Although the Project Estimate File should already contain documentation of unknowns, assumptions, and other uncertainties that directly impact the cost estimate, there may be other items that are project risks with impacts other than cost that are not contained in the Project Estimate File. TxDOT is particularly interested in identifying risks with impacts to project objectives of quality, schedule, and cost; as well as risks to the Department's goals of safety, congestion relief, connectivity, and best-in-class agency (reputation). Such information should also be gathered and reviewed during this step because it should be included in the project's risk register.
- If the Estimator was afforded sufficient time to complete the estimate, the list of assumptions will likely be complete and comprehensive. If a Base Estimate was prepared quickly, then the list of assumptions may well be incomplete. In the latter case, risk checklists and similar project analyses will be useful.

### Stage 3. Determine Risk and Contingency

A

B

C

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E

F

Compile and review risk information.

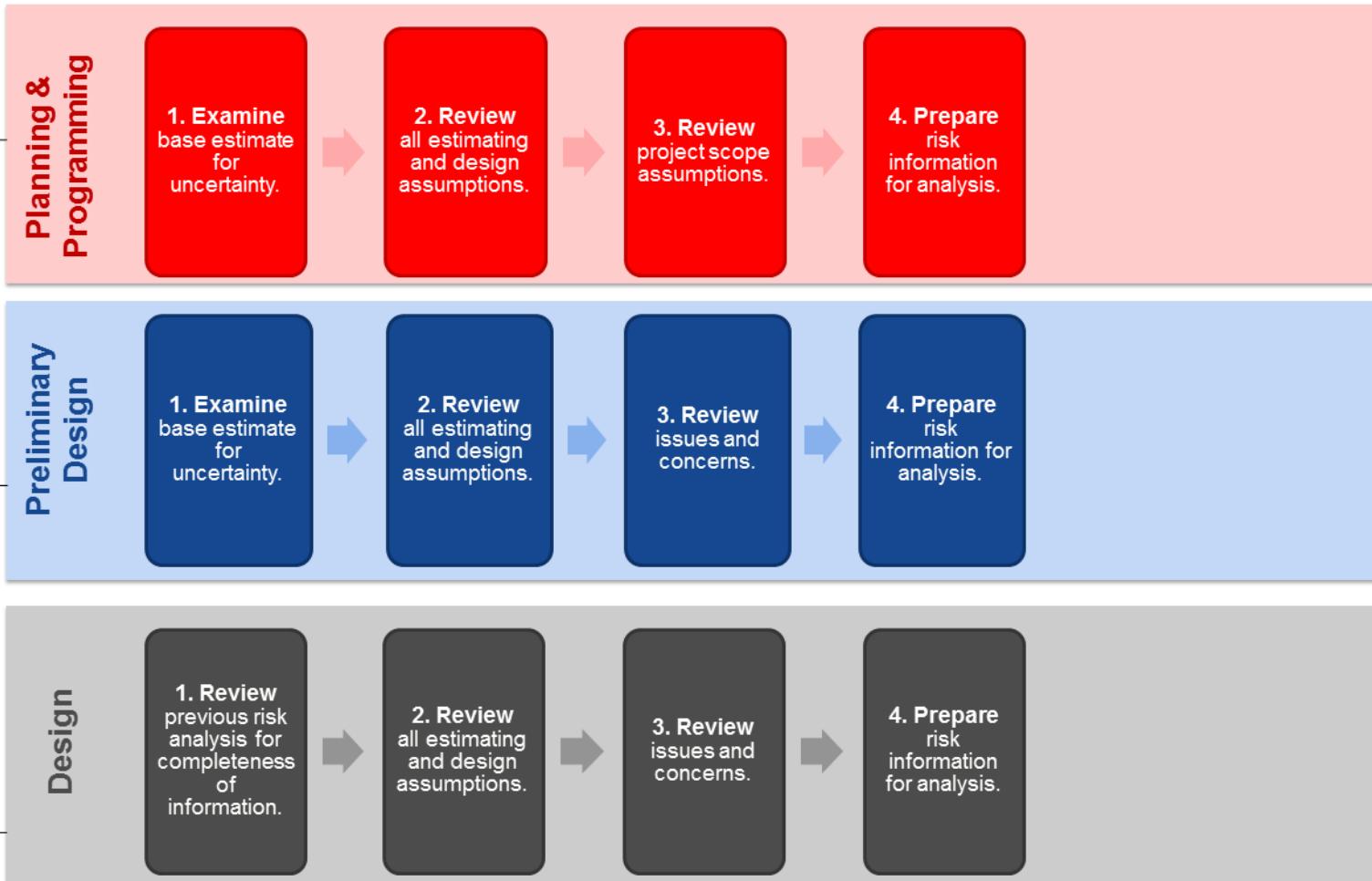
- The time spent and resources expended should be commensurate with the size of the project. For high rigor projects or complex medium rigor projects it may be prudent to bring in an outside facilitator to lead a risk workshop with all project team members in attendance.

## Process Flowchart

### Stage 3 Determine Risk and Contingency Step A Compile and Review Risk Information

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#### STAGE 3/STEP A



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Compile and review risk information.

### Specifics to the Planning and Programming Phase



- Process**
1. Examine Base Estimate for uncertainty.
  2. Review all estimating and design assumptions.
  3. Review project scope assumptions.
  4. Prepare risk information for analysis.



- Tools**
- [Project Estimate File](#)
  - [Advance Planning Risk Analysis \(APRA\)](#)



**Guidance**

- The Estimator will have made assumptions within the estimate during the Planning and Programming Phase because little design information would have been available.
- A final output of the Determine Risk and Set Contingency process is a risk register and Total Construction Cost Estimate. The risk register is scalable in detail depending on level of risk analysis determined by project rigor ([Step B](#)).

### Specifics to the Preliminary Design Phase



- Process**
1. Examine Base Estimate for uncertainty.
  2. Review all estimating and design assumptions.
  3. Review issues and concerns.
  4. Prepare risk information for analysis.



- Tools**
- [Project Estimate File](#)
  - [Advance Planning Risk Analysis \(APRA\)](#)
  - [Risk Register](#)



- Guidance**
- The Estimator would have continued to make assumptions within the estimate although some design details may have become finalized such as pavement design and typical sections.
  - As the Estimator resolves assumptions, specific risks may be addressed. The resolution of assumptions and the impact on risks should be considered in [Step C](#) and [Step D](#) of this stage.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Compile and review risk information.

### Specifics to the Design Phase



1. Review previous risk analysis for completeness of information.
2. Review all estimating and design assumptions.
3. Review issues and concerns.
4. Prepare risk information for analysis.



- [Project Estimate File](#)
- [Risk Register](#)



- As the project design matures and more details are included in the estimate, the Project Estimate File will most likely contain a significant volume of information. The Estimator should allow time to thoroughly review the Project Estimate File to assist with risk identification and analysis.
- For large projects with substantial information in the Project Estimate File, employing more than one person to compile the risk information may be prudent.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Determine/confirm level of risk analysis.

### STEP B. DETERMINE/CONFIRM LEVEL OF RISK ANALYSIS

This step defines the level of risk analysis based on project complexity.



The Project Manager determines the level of risk analysis based on the project rigor level (low, medium, or high) in accordance with the criteria in the Baseline Schedule Policy.



Determining the level of risk analysis will determine who needs to be involved in the risk analysis and the level of effort anticipated.



#### Guidance for All Phases

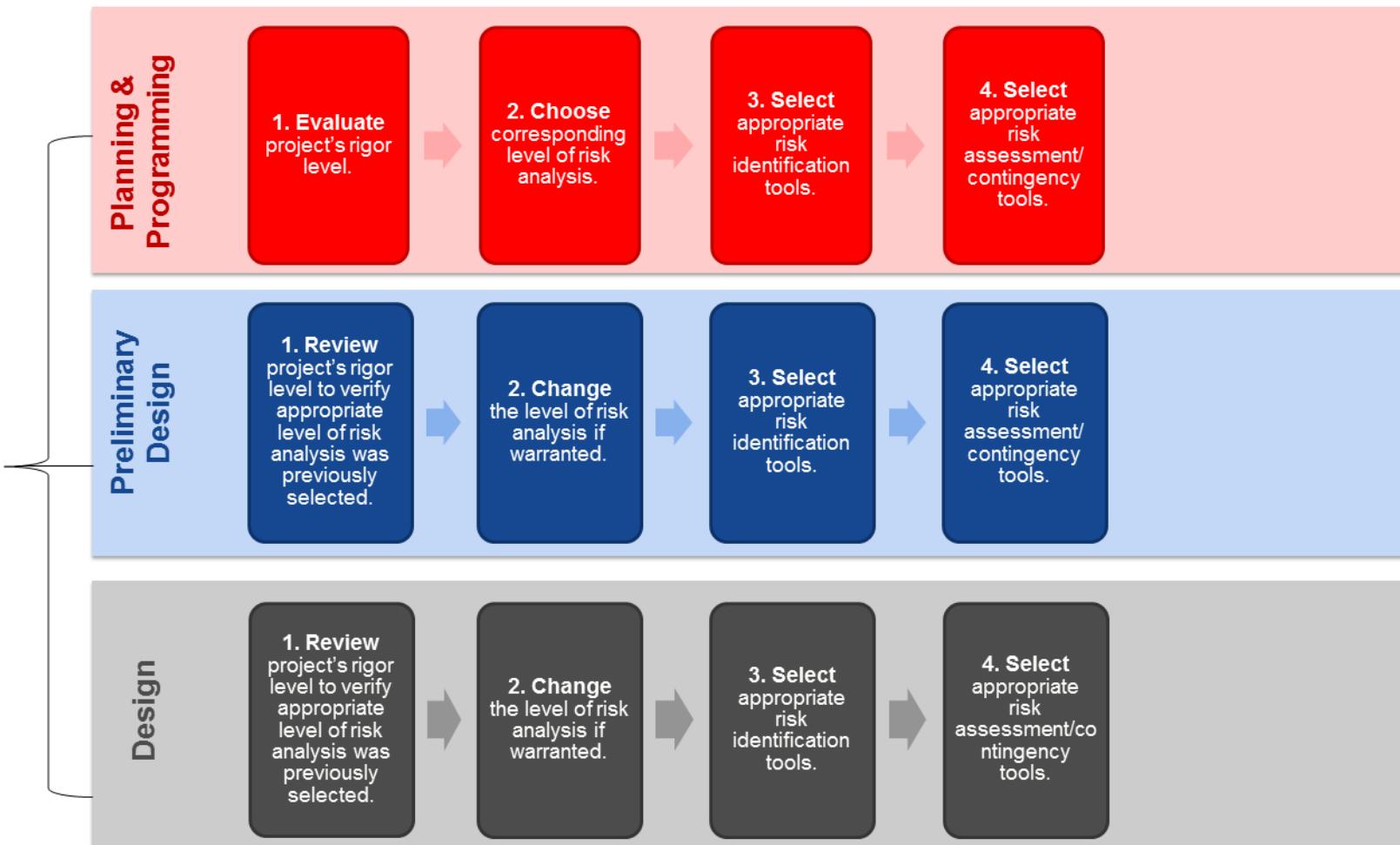
- Although project size is considered when determining the rigor level, other factors such as project uniqueness, complexity, and/or sensitivities of local stakeholders should be considered.
- The Estimator should keep the Project Manager informed of unusual assumptions made within the estimate or significant unknowns still excluded from the estimate.
- Although determined early in the project's lifecycle based on its rigor level, the sophistication of risk analysis may progress as design matures. The level of risk analysis selected at the beginning of the project is actually the level of analysis anticipated during the Design Phase. In the Planning and Programming Phase and, possibly, the Preliminary Design Phase, the level of risk analysis actually performed should be based on the amount of information available at the given time. For example, a project may warrant a high rigor level of risk analysis but in the early phases of the project there will not be enough design detail or other project information to conduct such analysis. A lower level of risk analysis would be more prudent early on but migrate towards the high rigor risk analysis as the project progresses.

## Process Flowchart

**Stage 3 Determine Risk and Contingency Step B Determine/Confirm Level of Risk Analysis**

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### STAGE 3/STEP B



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Determine/confirm level of risk analysis.

### Specifics to the Planning and Programming Phase



1. Evaluate project's rigor level.
2. Choose corresponding level of risk analysis.
3. Select appropriate risk identification tools.
4. Select appropriate risk assessment/contingency tools.



- No specific tools suggested.



- The Project Manager determines the level of risk analysis that will ultimately be followed during the Design Phase of the given project.
- The rigor levels do not have to be the only characteristic considered when selecting the level of risk analysis. Other atypical and unique project characteristics may warrant using a higher level of risk analysis.

### Specifics to the Preliminary Design Phase



1. Review project's rigor level to verify appropriate level of risk analysis was previously selected.
2. Change the level of risk analysis if warranted.
3. Select appropriate risk identification tools.
4. Select appropriate risk assessment/contingency tools.



- No specific tools suggested.



- The Project Manager verifies the appropriate level of risk analysis.
- During the Preliminary Design Phase, the Project Manager should look forward in the project's development process to see if a higher level of risk analysis might be warranted. Typically, the level of risk analysis selected during the Preliminary Design Phase remains the same during the Design Phase.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Determine/confirm level of risk analysis.

### Specifics to the Design Phase



*Process*

1. Review project's rigor level to verify appropriate level of risk analysis was previously selected.
2. Change the level of risk analysis if warranted.
3. Select appropriate risk identification tools.
4. Select appropriate risk assessment/contingency tools.



- No specific tools suggested.



- The Project Manager verifies the appropriate level of risk analysis.
- If warranted, a project will require a higher level of risk analysis and rarely a lower level.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Identify/update risks.

### STEP C. IDENTIFY/UPDATE RISKS

This step identifies, categorizes, updates, and documents risks that could affect the project.



- The project team identifies risks using tools appropriate to the level of risk analysis.
- The Project Manager and/or project team categorizes risks.



All projects—regardless of size and complexity—contain elements of uncertainty. These uncertainties can pose risks to meeting the project's objectives including being delivered on budget. A risk can have a positive effect (i.e., an opportunity that could be captured) or a negative effect (i.e., a threat that probably should be avoided or minimized) on a project's objectives. Identifying risk throughout project development helps TxDOT to eventually monitor and control those risks.



#### Guidance for All Phases

For more about the concepts and principles on risk, see [Risk Identification](#).

- The eventual outcome of the risk identification is a list of risks typically summarized in a risk register (see [Step E](#)).
- The process of risk identification should promote open dialogue and leverage team experience and knowledge. Involving people responsible for various items (e.g., ROW, utilities, construction, public information, and environmental) aids in considering project risks from different points of view.
- Avoid allowing personalities to sway the conversation during risk identification. The magnitude and significance of an individual risk will be determined during assessment ([Step D](#)).
- The risk identification exercise should be free of bias. There will likely be instances when team members do not agree on whether an identified item is a risk. This is often the case when risks are identified in brainstorming sessions where people are thinking quickly. When there is disagreement, the team should simply discuss the item candidly to determine whether the item should be considered further.
- It may be appropriate to use more than one risk identification tool to avoid group think or loss of potential risks because some individuals are afraid to voice their concerns.
- Use risk checklists and similar project risk analyses to determine if potential risks have been missed.
- Risks should be identified at an appropriate level of detail and independent of each other. Issues defined vaguely are difficult to assess ([Step D](#)); highly detailed risks listed separately but are actually overlapping can mask a larger issue.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Identify/update risks.

- The risk identification process should generally stop short of assessing or analyzing risks so as not to inhibit the identification of other risks that might be overlooked. Assessment of risks will occur in [Step D](#).
- During the risk monitor and control activity of the risk management process, you may retire or determine a risk to be dormant but never delete a risk that was previously identified. The project team may want to use the list of identified risk on this project to aid in identifying risks on similar, future projects.
- The TxDOT ePMO has defined a [Risk Breakdown Structure](#) to aid with categorizing individual risks. Placing risks into categories helps to determine if a large number of risks are associated with a specific project element (e.g., utility coordination or finalizing the drainage design). Categorization also aids in assigning risks to an owner who is responsible for addressing and/or monitoring those items.

## Process Flowchart

**Stage 3 Determine Risk and Contingency Step C Identify/Update Risks**

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**STAGE 3/STEP C**



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Identify/update risks.

### Specifics to the Planning and Programming Phase



1. Consider gathered risk information.
2. Identify risks.
3. Categorize risks.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Checklist</a>	✓	✓	✓
<a href="#">Expert Team</a>		✓ *	✓
<a href="#">Crawford Slip Method</a>	✓	✓	✓
<a href="#">Risk Workshop</a>		✓ *	✓
<a href="#">Risk Breakdown Structure</a>		✓	✓

\*Optional



- Identifying risks as early as possible is arguably the most critical activity in the risk management process. Not spending enough time or not involving the necessary people when identifying risks can eventually lead to issues on the project that might have been avoided.
- The project team will most likely migrate toward a preferred risk identification tool or two as they formally consider risks on more and more projects. For atypical and unique projects, it might be beneficial to try another risk identification tool to ensure the risk identification process is not marginalized due to over-familiarization with a single method.

### Specifics to the Preliminary Design Phase



1. Review risk information.
2. Identify risks.
3. Categorize risks.

## Stage 3. Determine Risk and Contingency

**A**

**B**

**C**

**D**

**E**

**F**

Identify/update risks.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Checklist</a>	✓		
<a href="#">Expert Team</a>		✓ *	✓
<a href="#">Crawford Slip Method</a>	✓	✓	✓
<a href="#">Risk Workshop</a>		✓ *	✓
<a href="#">Risk Breakdown Structure</a>		✓	✓

\*Optional



**Guidance**

- The project team should conduct a risk identification exercise periodically throughout the Preliminary Design Phase. New risks can manifest themselves as some design elements, project specifics, and other elements are determined.

### Specifics to the Design Phase



- Review risk information.
- Update identified risks.
- Identify new risks.
- Categorize risks.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Checklist</a>	✓		
<a href="#">Expert Team</a>		✓ *	✓
<a href="#">Crawford Slip Method</a>	✓	✓	✓
<a href="#">Risk Workshop</a>		✓ *	✓
<a href="#">Risk Breakdown Structure</a>		✓	✓

\*Optional

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Identify/update risks.



### *Guidance*

- As the design matures, some previously identified risk may have changed, been addressed, or generated additional risks. When this occurs, the risk documentation should be updated to reflect these changes.
- Inviting different people to the risk identification process as the project design matures can reveal risks that others have overlooked because of the familiarity with the project.
- By the Design Phase, the list of risks identified throughout the project development process can be substantial.
- The risk identification process should begin with a review of any risks identified during the previous phase. However, the risks identified during the previous phases will likely have changed substantially by the Design Phase. It may be helpful to go through a new risk identification exercise at the Design Phase and then use the previous phase risk identification outputs only as a check at the end of the process to ensure that no risks were overlooked.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Estimate/update contingency.

### STEP D. ESTIMATE/UPDATE CONTINGENCY

This step estimates/updates the appropriate contingency for the project through risk assessment and analysis.

#### Roles

- The Estimator evaluates the risk events documented in the preceding identification step, focusing on their probability of occurrence and the impacts of such occurrences.
- The Estimator uses the overall risk analysis to determine contingency values and to quantify individual impacts of high risk events.
- The variability in quantities and unit prices is almost always an unknown especially in the early phases of project and when letting may be years away. The Estimator should account for this variability as an uncertainty; how the Estimator accounts for quantity and price variability may be different depending on the estimating tool (e.g., spreadsheet template) used.
- To prevent this, unit costs should not be inflated for each line item to cover uncertainty. The risk of price escalation should be included either by an overall inflation factor or as a discrete risk.

#### Why

A key purpose of quantitative risk analysis is to combine the effects of the various identified and assessed risk events into an overall project risk analysis in order to determine the amount of contingency that should be carried in the estimate to cover the potential risks.

#### Guidance for All Phases

- The list of risks, along with any historical information concerning cost growth, forms the basis for determining contingency.
- On low rigor projects employing a Low Rigor risk analysis, assigning this contingency amount as a simple range of percentages (e.g., 6–8 percent) of the Base Estimate may be appropriate if validated from historical data on similar projects or based on the Estimator's judgment with agreement from the Project Manager.
- On major projects using a High Rigor risk analysis, assign the contingency through a more quantitative approach using tools suggested below.
- Medium Rigor risk analyses can use a combination of percentages and probabilistic analysis to estimate the contingency.
- When tying contingency directly to individual line items, explicitly identify the contingency and do not bury it in the unit price for the item.

### Stage 3. Determine Risk and Contingency

A	B	C	D	E	F
Estimate/update contingency.					

- It is highly likely that during the risk assessment and contingency determination step, the project team realizes that a single previously identified risk should be broken out into multiple, more specific risks. This is not only expected but highly encouraged in order to address the various nuances and aspects of the risks.

For more about concepts and principles, see [Risk Assessment and Analysis in Risk Management Process](#).

## Process Flowchart

### Stage 3 Determine Risk and Contingency Step D Estimate/Update Contingency

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## STAGE 3/STEP D



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Estimate/update contingency.

### Specifics to the Planning and Programming Phase



#### Low Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Determine contingency from an percentage range or estimate in a risk register.

#### Medium Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Estimate expected value ( $P \times I$ ) for highly significant risks.
3. If warranted by the top risks, use additional contingency.

#### High Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Estimate a contingency ranges using a three-point estimating technique.
3. Develop a risk-based cost and schedule model (if applicable).
4. Choose appropriate contingency.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Expert Team</a>		✓ *	✓
<a href="#">Estimate Ranges – Three Point Analysis</a>		✓	✓
<a href="#">Estimate Ranges – Monte Carlo Analysis</a>			✓
<a href="#">Risk Workshop</a>		✓ *	✓
<a href="#">Probability x Impact Matrix (<math>P \times I</math>)</a>	✓	✓	✓
<a href="#">Cost Estimate Spreadsheet Template</a>	✓	✓	✓

\*Optional



- When assessing a risk and determining a contingency amount to carry in the estimate, base the analysis and calculations on the information you know at the time. You can revise and update as the project design matures.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Estimate/update contingency.

### Specifics to the Preliminary Design Phase

#### Process

##### Low Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Determine contingency through an expected value ( $P \times I$ ).

##### Medium Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Estimate expected value ( $P \times I$ ) for most significant risks.
3. If warranted by the top risks, use three-point estimating to determine contingency.

##### High Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Use a specifically developed spreadsheet template.
3. Develop a risk-based cost and schedule model (if applicable).
4. Choose appropriate contingency.

#### Tools

Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#"><u>Expert Team</u></a>		✓ *	✓
<a href="#"><u>Estimate Ranges – Three Point Analysis</u></a>	✓	✓	✓
<a href="#"><u>Estimate Ranges – Monte Carlo Analysis</u></a>		✓	✓
<a href="#"><u>Risk Workshop</u></a>		✓ *	✓
<a href="#"><u>Probability x Impact Matrix (PxI)</u></a>	✓	✓	✓
<a href="#"><u>Cost Estimate Spreadsheet Template</u></a>	✓	✓	✓

\*Optional

#### Guidance

- If a risk is identified as an opportunity, the contingency may be a cost savings and should be shown with a negative value.
- The significances of individual risks may change as the design matures. When this occurs, recalculate the appropriate contingency to determine if this amount has also changed.
- Remember that risk with a very low probability of occurring could have a significant impact on the cost of the project if that risk actually does occur. The contingency for such low probability, high impact risk may need to be increased with the Project Manager's approval. These low probability-high impact risks are more common during the Preliminary Design Phase since many design elements are still in flux.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Estimate/update contingency.

### Specifics to the Design Phase



#### Low Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Determine contingency through an expected value ( $P \times I$ ).

#### Medium Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Estimate expected value ( $P \times I$ ) for most significant risks.
3. If warranted by the top risks, use three-point estimating to determine contingency.

#### High Rigor Risk Analysis

1. Rank risks ( $P \times I$ ).
2. Use a specifically developed spreadsheet template.
3. Develop a risk-based cost and schedule model (if applicable).
4. Choose appropriate contingency.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<u>Expert Team</u>		✓ *	✓
<u>Estimate Ranges – Three Point Analysis</u>	✓	✓	✓
<u>Estimate Ranges – Monte Carlo Analysis</u>		✓	✓
<u>Risk Workshop</u>		✓ *	✓
<u>Probability x Impact Matrix (<math>P \times I</math>)</u>	✓	✓	✓
<u>Cost Estimate Spreadsheet Template</u>	✓	✓	✓

\*Optional



- The Estimator should inform the Project Manager if risks are not being addressed during the Design Phase.
- The total contingency amount should be decreasing as the project moves toward letting.
- Contingency should not be perceived as money that has to be spent or consumed during the Design Phase. Contingency is not a budget reserve to expand the scope of a project at a whim.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Document risk and contingency.

### STEP E. DOCUMENT RISK AND CONTINGENCY

This step documents a transparent list of risks and uncertainties that was used to determine the contingency amount and for Cost Management.



The Estimator and project team:

- Documents a transparent list of risks and uncertainties.
- Keeps the list in the cost estimate file.
- Summarize the risks for communicating what is included in the cost estimate.



- Documentation of the risk and contingency basis is vital for Cost Management.
- Risks and contingency must be clearly documented with each estimate if they are to be actively managed.



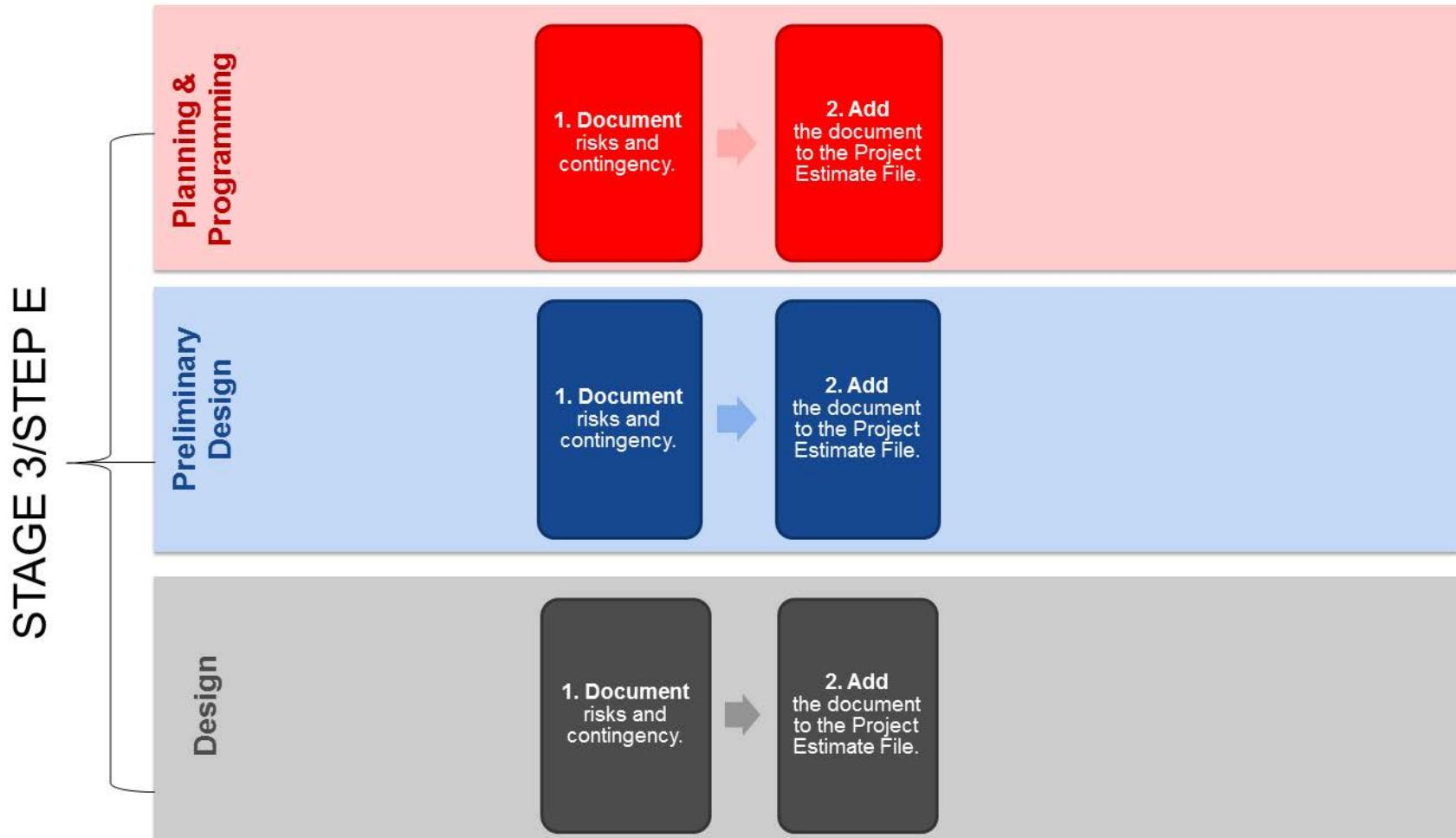
Guidance for All Phases

- The documentation of risk is the responsibility of the entire project team. The Estimator is responsible for updating the Project Estimate File show how the contingency amount was determined is documented.
- Collate all risk and contingency information for use in Cost Management throughout the project development process. Each future estimate will involve an update of risks and an update of the contingency estimate. Documentation will allow for active risk management and appropriate contingency resolution.
- The Project Estimate File should contain a section for risk documentation.
- Creation and maintenance of a risk register is recommended for medium and high rigor projects. It is also a good practice for low rigor projects but even if in a simplified format.

## Process Flowchart

**Stage 3** Determine Risk and Contingency **Step E** Document Risk and Contingency

154



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Document risk and contingency.

### Specifics to the Planning and Programming Phase



1. Document risks and contingency.
2. Add the document to the Project Estimate File.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Register</a>	✓ *	✓	✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional



- The level of detail associated with risk documentation at the Planning and Programming Phase may be relatively sparse since few design details are known.

### Specifics to the Preliminary Design Phase



1. Document risks and contingency.
2. Add the document to the Project Estimate File.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Register</a>	✓ *	✓	✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional



- Besides the risk register, the Estimator may include other documentation in the Project Estimate File that identifies where additional data were gathered in order to justify the contingency calculations. This is important during the Preliminary Design Phase because typically more time is spent assessing individual risks and determining a contingency amount than was spent in the Planning and Programming Phase.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Document risk and contingency.

- For risks that are frequently identified for similar projects, it may be more efficient to develop some standard documentation to explain and support the risk analysis and determined contingency value. Additionally, districts and divisions may determine ways to programmatically respond to common, recurring risks.

### Specifics to the Design Phase



- Document risks and contingency.
- Add the document to the Project Estimate File.



Recommended tools by project rigor level are indicated with a checkmark.

Tool	Low Rigor	Medium Rigor	High Rigor
<a href="#">Risk Register</a>	✓ *	✓	✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional



- As the project moves through the Design Phase, the Estimator should verify that the Project Contingency is decreasing as risks are addressed and managed within the design.
- Ideally, there should be no remaining risk at the time of letting.
- If there are unresolved risks as the project nears final development, each of the remaining risks and the resulting contingency should be addressed with District Administration on a case by case basis to determine how they will be captured in the final engineer's estimate.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Prepare/revise Total Construction Cost Estimate.

### STEP F. PREPARE/REVISE TOTAL CONSTRUCTION COST ESTIMATE

This step adds the base cost estimate and contingency estimate to arrive at a Total Construction Cost Estimate.



#### Roles

- The Estimator adds the base and contingency estimates. DCIS applies the inflation factor to the estimate.
- The Estimator may use the Design Divisions spreadsheet to properly format the final engineer's estimate for input into DCIS.



Total Construct Cost = Base Estimate + Contingency + Inflation



#### Guidance for All Phases

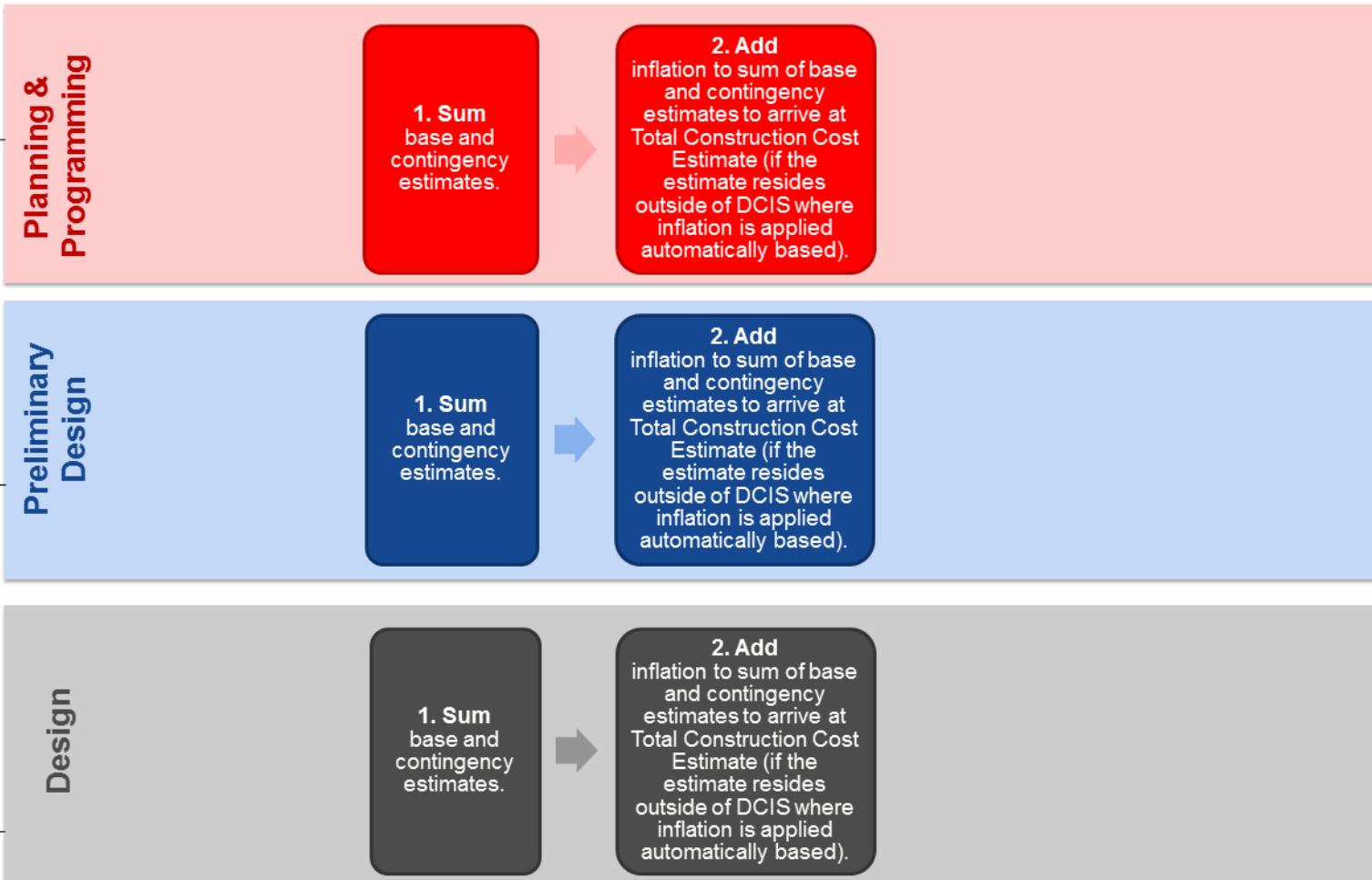
- Contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs.
- In the contingency estimate, include the greatest level of detail that the contingency estimate can support. For example, a Low Rigor analysis using a percentage contingency may include only one item for contingency based on a percentage of the total construction cost.
- A Medium Rigor or High Rigor analysis can itemize contingencies for the identified risks (e.g., separate contingencies for discrete risks).
- Individual items within a project may include a risk and associated contingency for escalation (e.g., steel bridge costs may have an identified contingency for probable steel escalation beyond the overall inflation rate).

## Process Flowchart

**Stage 3 Determine Risk and Contingency Step F Prepare/Revise Total Construction Cost Estimate**

8C1

**STAGE 3/STEP F**



## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Prepare/review Total Construction Cost Estimate.

### Specifics to the Planning and Programming Phase



1. Sum the base and contingency estimates.
2. Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS since inflation is applied automatically within that database.).



- [Cost Estimate Spreadsheet Template](#)



- For very early, long-range estimates, the total contingency amount could exceed the Base Estimate because so many assumptions are being made and several risks may be identified to account for the unknowns in the estimate.
- Total Construction Cost should be expressed as a range, particularly during the Planning and Programming Phase, because there is always variability, uncertainty, and unknowns with the project when so little specific design information is available.

### Specifics to the Preliminary Design Phase



1. Sum base and contingency estimates.
2. Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).



- [Cost Estimate Spreadsheet Template](#)



- Verify that the Total Construction Cost Estimate appropriately includes the Base Estimate and contingency since the Baseline Cost Estimate is often established at the end of the Preliminary Design Phase.

## Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Prepare/review Total Construction Cost Estimate.

- Since the elements of the project are in various levels of specificity during the Preliminary Design Phase, it can be easy to accidentally double-count contingency because contingency is not located in a consistent, standard location within the estimate (e.g., inflating unit cost in order to be conservative and then adding contingency on top of that pricing). This is especially true as various functional groups or divisions provide estimates for their elements of the project (e.g., bridges and other structures). This mistake can inflate the true Total Construction Cost Estimate. To prevent this, unit costs should not be inflated for each line item to cover uncertainty. The risk of price escalation should be included either as an overall inflation factor or as a discrete risk.
- Total Construction Cost should continue to be expressed as a range (when possible) during the Preliminary Design Phase because variability, uncertainty, and unknowns will continue to exist with the estimate.
- It is common for the Total Construction Cost estimate to be higher (sometimes considerably higher) in the Preliminary Engineering Phase than during the Planning and Programming Phase. This can be attributed to the fact that designers spend more time with the project during this phase and consider in greater detail the nuances and magnitude of each design element (e.g., the drainage design is identified as needing to be more complex because additional information has been gathered).
- With the use of a consistent estimating approach that involves reconciling new estimates with previous estimates (Stage 4), the problem of underestimating in the very early phases of the project should decrease because Estimators can see where they are deficient in previous phases and improve that on future projects.

### Specifics to the Design Phase



1. Sum base and contingency estimates.
2. Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).



- [Cost Estimate Spreadsheet Template](#)



- Total Construction Cost will be expressed as a single value (i.e., a point estimate) during the Design Phase since the Baseline Cost Estimate will have already been established and estimate updates during design will be measured and managed against the baseline estimate.
- When the engineer's estimate is entered into DCIS, inflation will be automatically applied to the project if appropriate.
- Ideally, there should be no remaining risk when the final Engineer's estimate is developed prior to letting.

### Stage 3. Determine Risk and Contingency

A

B

C

D

E

F

Prepare/review Total Construction Cost Estimate.

- If there are unresolved risks as the project nears final development, each of the remaining risks and the resulting contingency should be addressed with District Administration on a case by case basis to determine how they will be captured in the final engineer's estimate.



## STAGE 4. REVIEW AND APPROVE ESTIMATE

Risk-Based Estimating

# STAGE

# 4

## The Framework

5 Stages

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** **Review and Approve Estimate**
- 5** Communicate Estimate

### OVERVIEW

Stage 4 has five steps that provide a natural progression to review and approve the estimate. The number of steps varies slightly depending on the project development phase.

### Chapter Organization

This chapter contains the following topics.

Topic	See Page
Quick Reference Guide	145
Step A. Determine Level of Review	149
Step B. Review Estimate Assumptions	153
Step C. Verify Completeness and Cost Data	159
Step D. Reconcile with Latest Estimate	164
Step E. Approve Estimate Package	168

## Stage 4. Review and Approve Estimate

A

B

C

D

E

### Remember

- This stage ensures that the estimate is as complete and accurate as possible, based on the project requirements as described in the Project Estimate File.
- This stage is critical as it represents final acceptance of the cost estimate before the estimate is released to both internal and external project stakeholders.



Accountability and responsibility for the review steps will likely rest with the Estimator and the Project Manager. It is highly recommended that the accountability for the approval of the estimate be held by someone in District management with a gated process where approval is required to advance the project to the next development phase.

Stage 4. Review and Approve Estimate			
Purpose	Steps	Outputs	Tools
Ensure that the estimate is as complete and accurate as possible.	A. <a href="#">Determine level of review.</a> B. <a href="#">Review estimate assumptions.</a> C. <a href="#">Verify completeness and cost data.</a> D. <a href="#">Reconcile with latest estimate.</a> E. <a href="#">Approve estimate package.</a>	Approved estimate.  Updated Project Estimate File.	<ul style="list-style-type: none"><li>• <a href="#">Expert Team</a></li><li>• <a href="#">Formal Committee</a></li><li>• <a href="#">In-House/Peer.</a></li><li>• <a href="#">Project Estimate File</a></li><li>• <a href="#">Round Table Estimate Review</a></li><li>• <a href="#">Variance Reports on Cost</a></li></ul>

### How to Use This Chapter

For each step in Stage 4, the following information is provided:

- Important information across the three pre-construction phases of project development.
- The roles and responsibilities of the step.
- Why the step is needed.
- Guidance relevant to all three phases.
- Specifics to the Planning and Programming phase.
- Specifics to the Preliminary Design phase.
- Specifics to the Design phase.

## Stage 4: Review and Approve Estimate

### Quick Reference Guide

#### Risk-Based Estimating

# STAGE

# 4

## The Framework

### 5 Stages

- 1 Determine/Update Basis of Estimate
- 2 Prepare/Update Base Estimate
- 3 Determine Risk and Set Contingency
- 4 **Review and Approve Estimate**
- 5 Communicate Estimate

**Purpose:** Ensure that the estimate is as complete and accurate as possible.

STEP	PURPOSE
A. Determine level of review.	Determine the appropriate tool for review based on project type and complexity.
B. Review estimate assumptions.	Evaluate the Project Estimate File using the list of applicable tools to determine if the correct assumptions and conclusions were made.
C. Verify completeness and cost data.	Ensure the math is correct, the process is documented, and the estimate was developed following TxDOT guidelines.
D. Reconcile with latest estimate.	Reconciles the differences between the current and previous estimates.
E. Approve Estimate Package.	Complete the final estimate package and obtain a final formal review and approval.

#### Key Reminders

- Review the RACI matrix for roles and responsibilities, particularly during the review and approval of an estimate.
- Double check calculations and data sources when using specific tools.
- Using clear, concise, and consistent documentation will help with District and Division review and acceptance of the estimate.

#### Tools

- [Expert Team.](#)
- [Formal Committee.](#)
- [In-House/Peer.](#)
- [Project Estimate File.](#)
- [Round Table Estimate Review.](#)
- [Variance Reports on Cost.](#)
- [Annual Scope and Estimate Document \(ASED\)](#)

## Stage 4: Review and Approve Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Determine level of review.</u>	<ul style="list-style-type: none"> <li>• All estimates should be reviewed by someone other than the Estimator.</li> <li>• To achieve consistent and accurate cost estimates, project cost reviews should be conducted at phase gates throughout the project development process.</li> <li>• The Design Division will assist with the review of project estimates prior to letting for completeness and conformance with established procedures.</li> <li>• The estimate review in the District should take place before the central review of the estimate at the Design Division.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine the level of review appropriate for the project's rigor level.</li> <li>2. Consider available resources (personnel and time).</li> <li>3. Select the appropriate review tool(s) for the project's rigor level.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine the level of review appropriate for the project's rigor level.</li> <li>2. Consider available resources (personnel and time).</li> <li>3. Select the appropriate review tool(s) for the project's rigor level.</li> <li>4. Consider the tools that have been previously used in the project development process to perform this function and decide if those are still appropriate.</li> <li>5. Select the appropriate review tool(s) for the project's rigor level.</li> </ol>
<u>B. Review estimate assumptions.</u>	<ul style="list-style-type: none"> <li>• If an Estimator was required to make too many assumptions to complete the estimate, it is possible that the scope was not defined in enough detail to provide sufficient estimating information.</li> <li>• The people responsible for the estimate review should follow a consistent approach to ensure all items of the document are properly reviewed.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Total Construction Cost Estimate Package and the list of risks from Stage 3.</li> <li>2. Verify assumptions are correct and documented.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Total Construction Cost Estimate Package and the list of risks from Stage 3.</li> <li>2. Verify assumptions are correct and documented.</li> <li>3. Verify assumptions are correct or resolved and documented.</li> </ol>
<u>C. Verify completeness and cost data.</u>	<ul style="list-style-type: none"> <li>• When verifying the completeness of the data, consider any historical data that might be available and also review all calculations made to ensure their correctness.</li> <li>• For high rigor projects, specific reviewers may only need to review the portion of the estimate where their experience and expertise resides.</li> </ul>	<ol style="list-style-type: none"> <li>1. Verify that the estimate addresses the full scope of the project.</li> <li>2. Verify that the data are complete and that the cost estimates are correct.</li> <li>3. Verify a second time by another reviewer for medium and high rigor projects.</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify that the estimate addresses the full scope of the project.</li> <li>2. Verify that the data are complete and that the cost estimates are correct.</li> <li>3. Verify a second time by another reviewer for medium and high rigor projects.</li> <li>4. Verify a second time by another reviewer (recommended for all rigor levels).</li> </ol>

## Stage 4: Review and Approve Estimate

	Planning & Programming	Preliminary Design	Design
<p><u>D. Reconcile with latest estimate.</u></p> <ul style="list-style-type: none"> <li>• Be sure to note any changes and reasons for changes between estimates; this is important in order to determine if the estimate will or will not be approved as well as in the communication process.</li> <li>• When reconciling the current estimate with previous estimates, typically only the major work categories and items evaluated. Since approximately 80 percent of the project's cost is associated with 20 percent of the bid items, reconciling the big ticket items first often reveals the reason for any major changes between estimates.</li> </ul>	<ol style="list-style-type: none"> <li>1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>1. Compare the Baseline Cost Estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>
<p><u>E. Approve Estimate Package.</u></p> <ul style="list-style-type: none"> <li>• Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources.</li> <li>• Estimate approval is two-fold: approval that the estimate was completed using the appropriate procedure, tools, and knowledge; and approval of the estimate amount.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Project Estimate File.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain final approval of the estimate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Project Estimate File.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain final approval of the estimate.</li> <li>4. Define the approved estimate as the Baseline Cost Estimate at the end of the Preliminary Design Phase.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the final estimate package.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain approval of the estimate.</li> </ol>

## Stage 4. Review and Approve Estimate

A

B

C

D

E

### Preview of Stage 4 Procedure

Table 15 provides an overview of the basic procedure, its purpose, who does it, and when in the Project Development Process it should be done.

**Table 15. Stage 4 Procedure.**

STEP	PURPOSE	WHO DOES IT?	WHEN?
A. <a href="#"><u>Determine level of review.</u></a>	Determine the appropriate tool for review based on project type and complexity.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Project Manager</li> <li>• District Management</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
B. <a href="#"><u>Review estimate assumptions.</u></a>	Evaluate the Project Estimate File using the list of applicable tools to determine if the correct assumptions and conclusions were made.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Project Manager</li> <li>• District Management</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
C. <a href="#"><u>Verify completeness and cost data.</u></a>	Ensure the math is correct, the process is documented, and the estimate was developed following TxDOT guidelines.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Project Manager</li> <li>• District Management</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
D. <a href="#"><u>Reconcile with latest estimate.</u></a>	Reconciles the differences between the current and previous estimates.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Project Manager</li> <li>• District Management</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
E. <a href="#"><u>Approve estimate package.</u></a>	Complete the final estimate package and obtain a final formal review and approval.	<ul style="list-style-type: none"> <li>• Estimator</li> <li>• Project Manager</li> <li>• District Management</li> </ul>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>

### Stage 4 Inputs and Sources of Information

Each phase builds on the previous phase's information. Planning and Programming inputs are listed in red, followed by Preliminary Design additions in blue, followed by Design additions in grey. Items listed for the Planning and Programming Phase are also used in the Preliminary Design and Design Phases. Items listed for the Preliminary Design Phase are also used in the Design Phase. At the end of Stage 4, the Total Construction Cost Estimate Package is the primary output.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Determine level of review.

### STEP A. DETERMINE LEVEL OF REVIEW

This step determines the appropriate tool for reviewing the estimate based on project rigor level.



The Estimator and the Project Manager will determine the level of estimate review in accordance to the role and responsibilities defined by the individual districts using the diagrams in [Appendix B. RACI Diagrams](#).



Consistency in the level of review for projects ensures the appropriate amount of effort and diligence is applied to all estimates.



### Guidance for All Phases

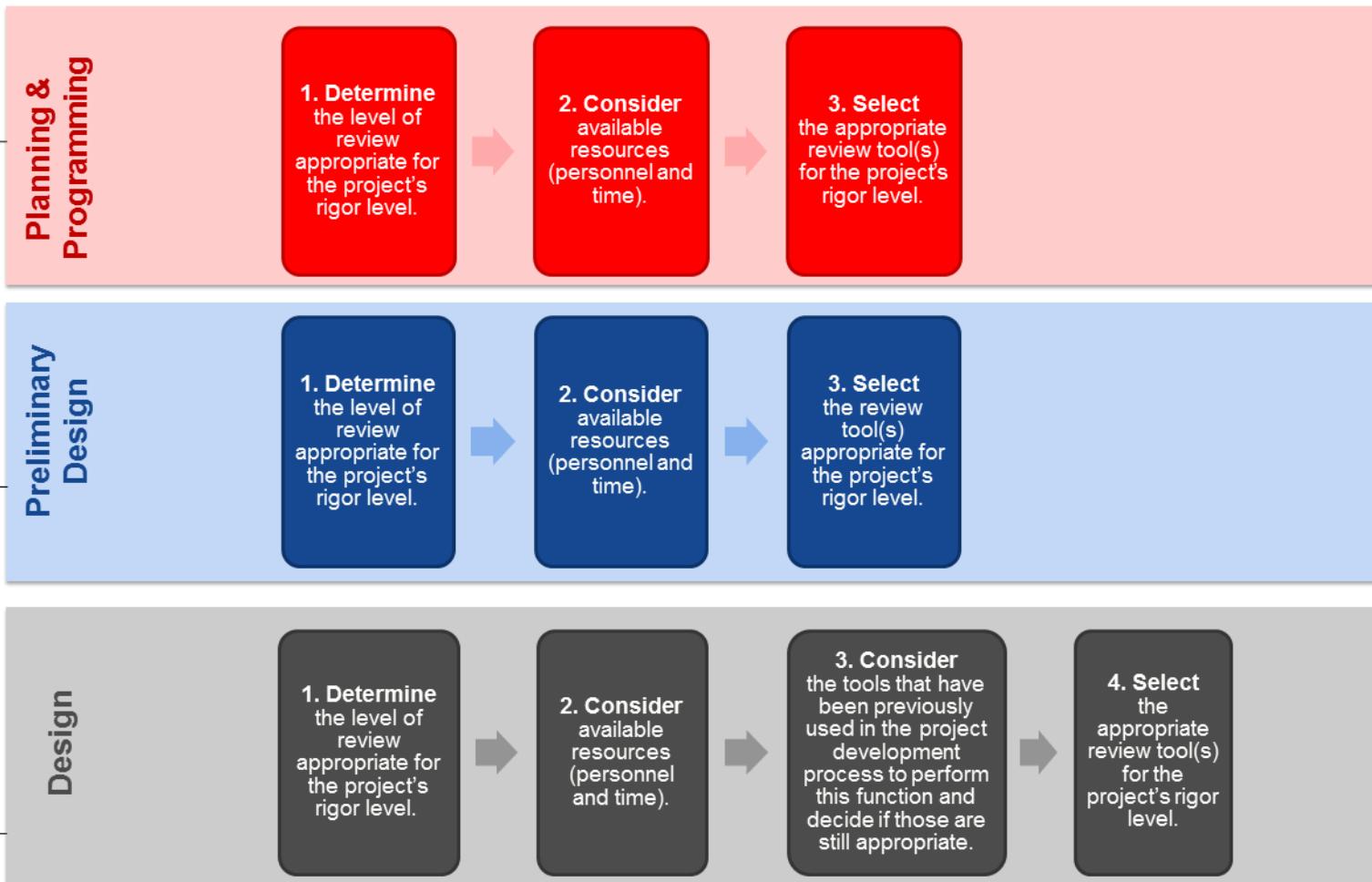
- All estimates should be reviewed by someone other than the Estimator.
- To achieve consistent and accurate cost estimates, project cost reviews should be conducted at phase gates throughout the project development process. Upon choosing the appropriate review tools, plan the review. The review plan should include a schedule for the review and a listing of people who will participate.
- The Design Division will assist with the review of project estimates for completeness and conformance with established procedures prior letting.
- The estimate review in the District should take place before the central review of the estimate at the Design Division.

## Process Flowchart

### Stage 4 Review and Approve Estimate Step A Determine Level of Review

O5I

#### STAGE 4/STEP A



## Stage 4. Review and Approve Estimate

A

B

C

D

E

Determine level of review.

### Specifics to the Planning and Programming Phase



1. Determine the level of review appropriate for the project's rigor level.
2. Consider available resources (personnel and time).
3. Select the appropriate review tool(s) for the project's rigor level.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#">In-House/Peer</a>	✓	✓	✓
<a href="#">Round Table Estimate Review</a>		✓*	✓
<a href="#">Formal Committee</a>			✓
<a href="#">Expert Team</a>			✓

\*Optional



- Projects that are atypical or have specific uniqueness may require a higher review level than suggested by the pre-defined levels of review even at the Planning and Programming Phase.

### Specifics to the Preliminary Design Phase



1. Determine the level of review appropriate for the project's rigor level.
2. Consider available resources (personnel and time).
3. Select the appropriate review tool(s) for the project's rigor level.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#">In-House/Peer</a>	✓	✓	✓
<a href="#">Round Table Estimate Review</a>		✓*	✓
<a href="#">Formal Committee</a>		✓*	✓
<a href="#">Expert Team</a>			✓

\*Optional

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Determine level of review.



### Guidance

- The Project Manager determines if the previously selected level of review is still appropriate for the specific estimate.
- For extremely low rigor projects, the Estimator asking the Project Manager to review the estimate is often sufficient through the Preliminary Design Phase.

### Specifics to the Design Phase



1. Determine the level of review appropriate for the project's rigor level.
2. Consider available resources (personnel and time).
3. Consider the tools that have been previously used in the project development process to perform this function and decide if those are still appropriate.
4. Select the appropriate review tool(s) for the project's rigor level.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#"><u>Variance Reports on Cost</u></a>	✓*	✓	✓
<a href="#"><u>In-House/Peer</u></a>	✓	✓	✓
<a href="#"><u>Round Table Estimate Review</u></a>		✓*	✓
<a href="#"><u>Formal Committee</u></a>		✓*	✓
<a href="#"><u>Expert Team</u></a>			✓

\*Optional



- The Project Manager confirms that the previously determined level of estimate review is sufficient and consistent with the pre-defined levels of review.
- The district should conduct their estimate review prior to submitting to the Design Division for their review prior to letting.

## Stage 4. Review and Approve Estimate

A	B	C	D	E
Review estimate assumptions.				

### STEP B. REVIEW ESTIMATE ASSUMPTIONS

This step evaluates the Total Construction Cost Estimate using the list of applicable tools to determine if the correct assumptions and conclusions were made.

#### Roles

- Using the selected tools, the reviewer(s) examines the Total Construction Cost Estimate Package and the list of assumptions and risks generated in the Determine Risk and Set Contingency stage.
- The reviewer(s) determines if the necessary assumptions and conclusions were made about the project.
- Using the tool descriptions as a guide, the reviewer(s) examines the Total Construction Cost Estimate Package to verify the assumptions are correct and documented.
- The reviewer(s) either confirms or disaffirms the assumptions in the Total Construction Cost Estimate Package.

#### Why

Conducting reviews at appropriate times during the development of estimates provides assurance that the estimates are reasonably accurate for the existing knowledge of project definition, maturity of design, and site conditions.

#### Guidance for All Phases

- Experience is key in this review. While the estimate tool checklist is helpful, an experienced reviewer can review the assumptions to qualitatively determine if enough scope is available to complete an accurate estimate. If an Estimator was required to make too many assumptions to complete the estimate, it is possible that the scope was not defined in enough detail to provide sufficient estimating information. This will generally result in less accurate estimates and higher range of costs due to the lack of clarity and certainty in the scope.
- The people responsible for the estimate review should follow a consistent approach to ensure all items of the document are properly reviewed.
- When considering an estimate checklist, remember that the checklist guides the reviewer(s) through suggested items and other factors that impact the project costs, but the reviewer(s) also considers items that are not on the checklist. For instance, the checklist may not include specialty or one-of-a-kind items.
- When software is used to generate the estimate, the information (e.g., unit cost tables) fed into the computer program must be examined during the review.

## Stage 4. Review and Approve Estimate

A	B	C	D	E
Review estimate assumptions.				

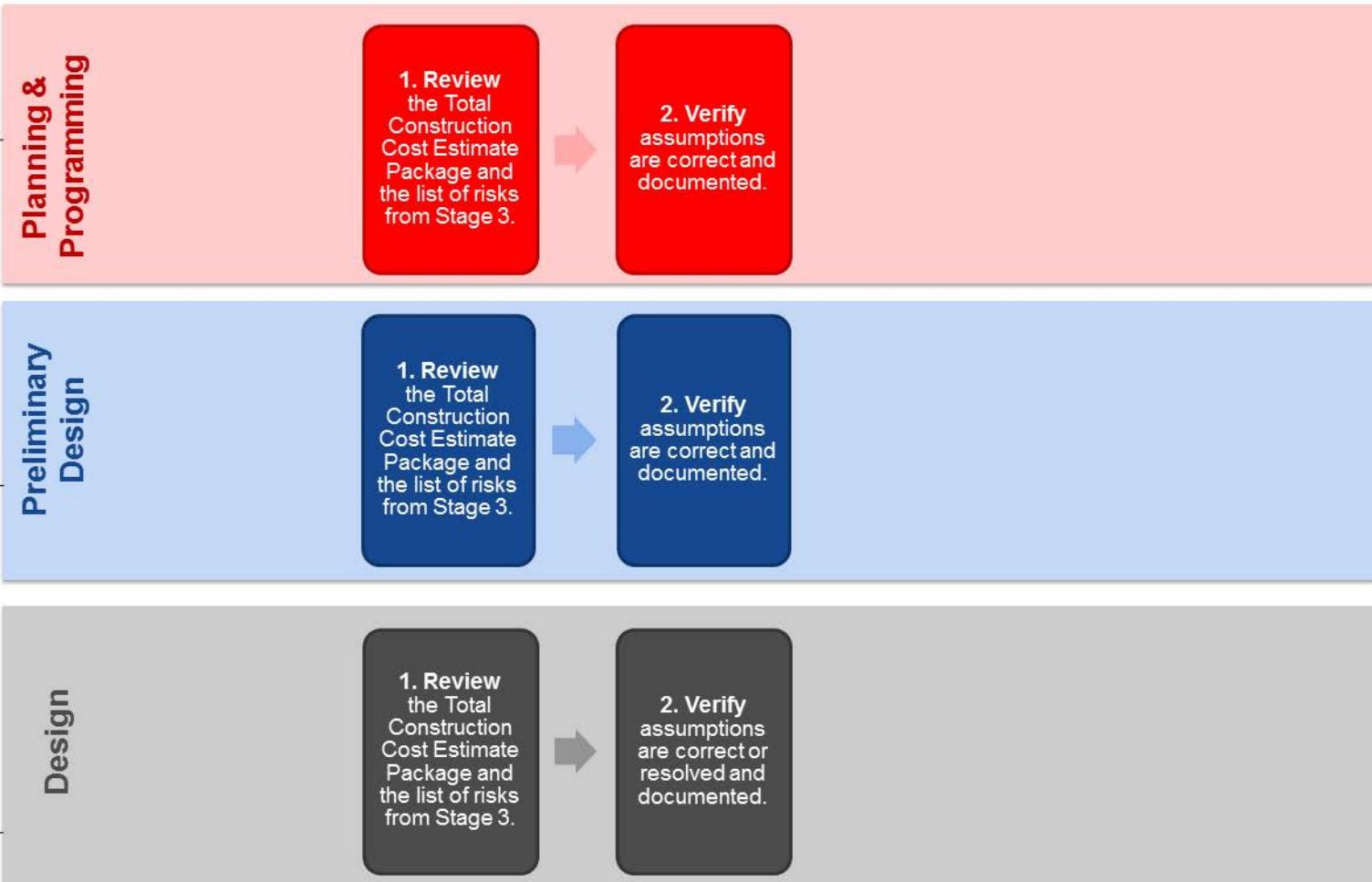
- Determination of risk and setting of contingency is not to be incorporated in individual line item costs, but rather should be contained in an identified contingency amount in the estimate. The reviewer(s) should verify that contingency is not buried in the line item costs during the Planning and Programming as well as the Preliminary Design Phases. At the end of the Design Phase when the engineer's estimate is developed, any remaining contingency will be moved back into the appropriate bid items at this time.

## Process Flowchart

Stage 4 Review and Approve Estimate Step B Review Estimate Assumptions

SSI

### STAGE 4/STEP B



## Stage 4. Review and Approve Estimate

A

B

C

D

E

Review estimate assumptions.

### Specifics to the Planning and Programming Phase



1. Review the Total Construction Cost Estimate Package and the list of risks from [Stage 3](#).
2. Verify assumptions are correct and documented.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#">In-House/Peer</a>	✓	✓	✓
<a href="#">Round Table Estimate Review</a>		✓*	✓
<a href="#">Formal Committee</a>		✓ *	✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional



- For the estimate review during the Planning and Programming Phase, answer the following questions:
  - Does this estimate have everything in it that is needed for this project?
  - Have appropriate allowances been made to account for items that are anticipated to be included, but details are not yet known (e.g. drainage)?
  - Since this is a very early estimate, is the contingency of an appropriate size for this point in project development and for this type of project?

### Specifics to the Preliminary Design Phase



1. Review the Total Construction Cost Estimate Package and the list of risks from [Stage 3](#).
2. Verify assumptions are correct and documented.

## Stage 4. Review and Approve Estimate

**A**

**B**

**C**

**D**

**E**

Review estimate assumptions.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<u>In-House/Peer</u>	✓	✓	✓
<u>Round Table Estimate Review</u>		✓*	✓
<u>Formal Committee</u>		✓*	✓
<u>Expert Team</u>			✓
<u>Project Estimate File</u>	✓	✓	✓

\*Optional



### Guidance

- During Preliminary Design, the estimate usually still contains several assumptions. These assumptions should be reviewed to see if new requirements or design decisions have altered those assumptions.
- Consult your District Director of Transportation Planning and Development for the roles and responsibilities associated with this project phase; there may be a difference in responsibilities depending on the complexity of the project.
- If an expert team is to be used in the review process, contact the Design Division and Project Management Office to assist with identifying the appropriate individuals and/or consultants.

## Specifics to the Design Phase



1. Review the Total Construction Cost Estimate Package and the list of risks from [Stage 3](#).
2. Verify assumptions are correct or resolved and documented.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<u>In-House/Peer</u>	✓	✓	✓
<u>Round Table Estimate Review</u>		✓*	✓
<u>Formal Committee</u>		✓*	✓
<u>Expert Team</u>			✓
<u>Project Estimate File</u>	✓	✓	✓

\*Optional

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Review estimate assumptions.



### *Guidance*

- The Estimator should verify that early design assumptions are confirmed or have been otherwise resolved during the Design Phase.
- The focus of estimate reviews during Design may be on one of two areas: the entire estimate or only on what has changed since the previous estimate. Details or the level of information may have changed for certain items since the previous estimate and its review. The entire estimate does not always have to be formally reviewed if changes were only made to certain elements of the project and estimate.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Verify completeness and cost data.

### STEP C. VERIFY COMPLETENESS AND COST DATA

This step ensures the scope of work is covered in the estimate, the math of the estimate is correct, the appropriate cost data were used, the appropriate items were documented, and the estimate was developed following TxDOT guidelines.



- The Estimator that prepared the estimate should conduct the initial review of the construction estimate prior to the submittal for a formal review. This is essentially a screening review that ensures for completeness.
- A second unbiased review of the estimate for completeness and appropriateness will afford managers and decision makers an opportunity to capture a different perspective, or at least a second opinion prior to approving the estimate.
- The same reviewer(s) associated with Step B (review assumptions) should also be involved with reviewing the estimate for completeness and accuracy in this step.



Because the outcome of this stage is the Approved Total Construction Cost Estimate that will be used as a cost performance measure throughout the project, the verification process step at this time is critical.



### Guidance for All Phases

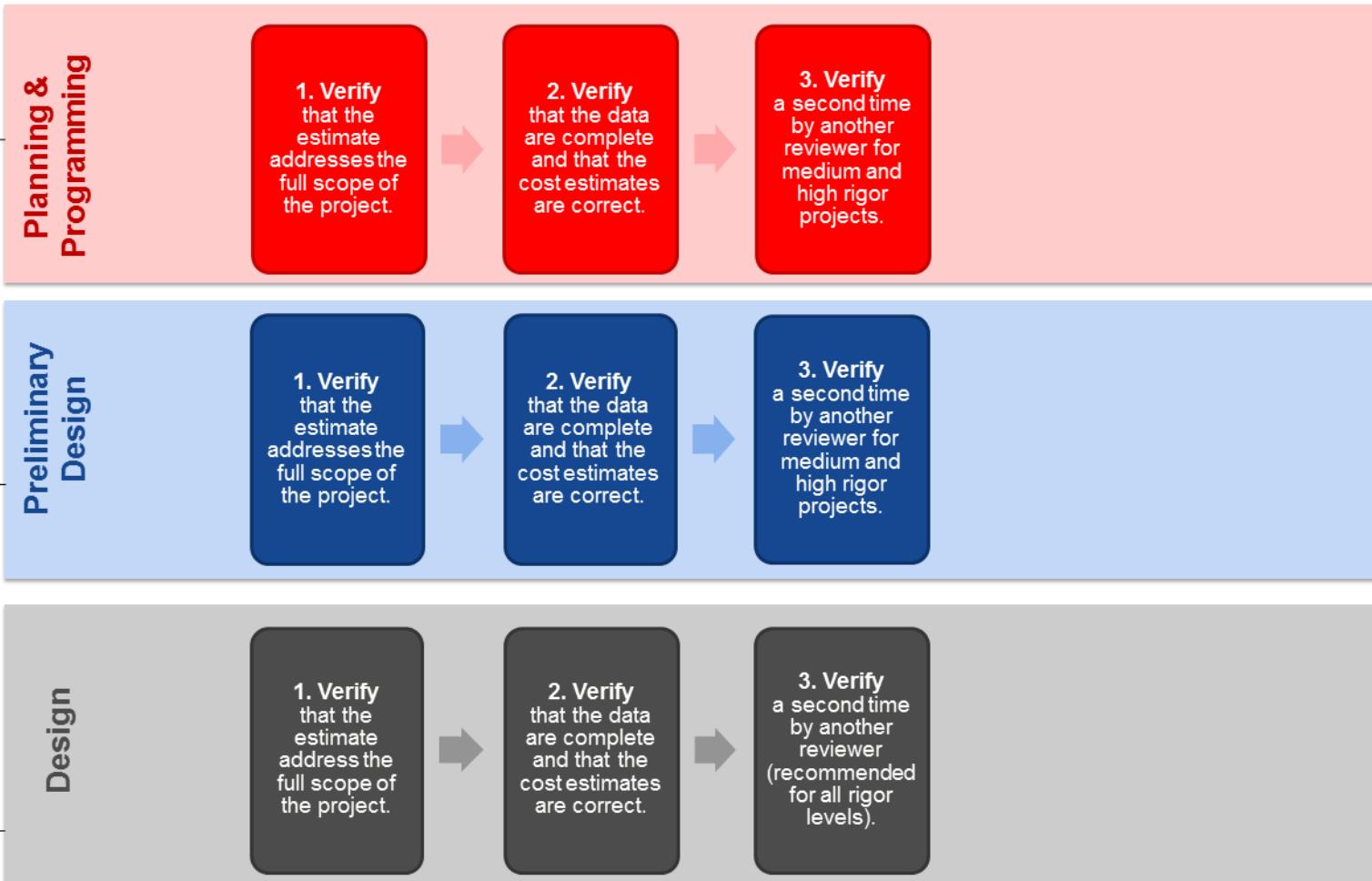
- The estimate checklist is the most informal of the tools. This tool can be used by itself or in combination with the other tools. When used with other tools, the estimate checklist can serve as a preliminary check for the Estimator.
- When verifying the completeness of the data, consider any historical data that might be available and also review all calculations made to ensure their correctness. Also, a site visit might aid in verifying the completeness of the data.
- For high rigor projects, specific reviewers may only need to review the portion of the estimate where their experience and expertise resides

## Process Flowchart

### Stage 4 Review and Approve Estimate Step C Verify Completeness and Cost Data

091

## STAGE 4/STEP C



## Stage 4. Review and Approve Estimate

A

B

C

D

E

Verify completeness and cost data.

### Specifics to the Planning and Programming Phase



1. Verify that the estimate addresses the full scope of the project.
2. Verify that the data are complete and that the cost estimate calculations are correct.
3. Verify a second time by another reviewer for medium and high rigor projects.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
In-House/Peer		✓	✓
Round Table Estimate Review		✓*	✓
Formal Committee		*	✓
Project Estimate File	✓	✓	✓

\*Optional.



- The reviewers should verify that all the project categories and elements described in the Basis of Estimate are accounted for within the estimate. During the Planning and Programming Phase when a cost per mile is commonly used, verify what that cost does and does not include.

### Specifics to the Preliminary Design Phase



1. Verify that the estimate addresses the full scope of the project.
2. Verify that the data are complete and that the cost estimates are correct.
3. Verify a second time by another reviewer for medium and high rigor projects.

## Stage 4. Review and Approve Estimate

**A**

**B**

**C**

**D**

**E**

Verify completeness and cost data.



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#">In-House/Peer</a>	✓	✓	✓
<a href="#">Round Table Estimate Review</a>		✓*	✓
<a href="#">Formal Committee</a>		✓*	✓
<a href="#">Expert Team</a>			✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional.



- The baseline estimate prepared at the end of the Preliminary Design Phase will require the most rigorous review.

### Specifics to the Design Phase



1. Verify that the estimate address the full scope of the project.
2. Verify that the data are complete and that the cost estimates are correct.
3. Verify a second time by another reviewer (recommended for all rigor levels).



Recommended tools by project rigor level are indicated with a checkmark.

Tools	Low Rigor	Medium Rigor	High Rigor
<a href="#">Variance Reports on Cost</a>	✓	✓	✓
<a href="#">In-House/Peer</a>	✓	✓	✓
<a href="#">Round Table Estimate Review</a>		✓*	✓
<a href="#">Formal Committee</a>		✓*	✓
<a href="#">Expert Team</a>			✓
<a href="#">Project Estimate File</a>	✓	✓	✓

\*Optional.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Verify completeness and cost data.



### *Guidance*

- At the Design Phase, particular focus should be given to the cost data used within the estimate. Besides considering just historical averages, pricing from recent lettings should be reviewed to see if current market conditions are affecting costs in a way not reflected in 3-month and 12-month averages.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Reconcile with the latest estimate.

### STEP D. RECONCILE WITH LATEST ESTIMATE

This step reconciles the differences between the current and previous estimates.



The Estimator reviews the Total Construction Cost Estimate as a whole and the individual pieces of this total project cost to check for differences and determines why these differences exist.



The output of this step will be a list of changes to the estimate from the previous estimate and/or a detailed description of any changes in the scope of the project that caused the estimate to change from previous estimates.



### Guidance for All Phases

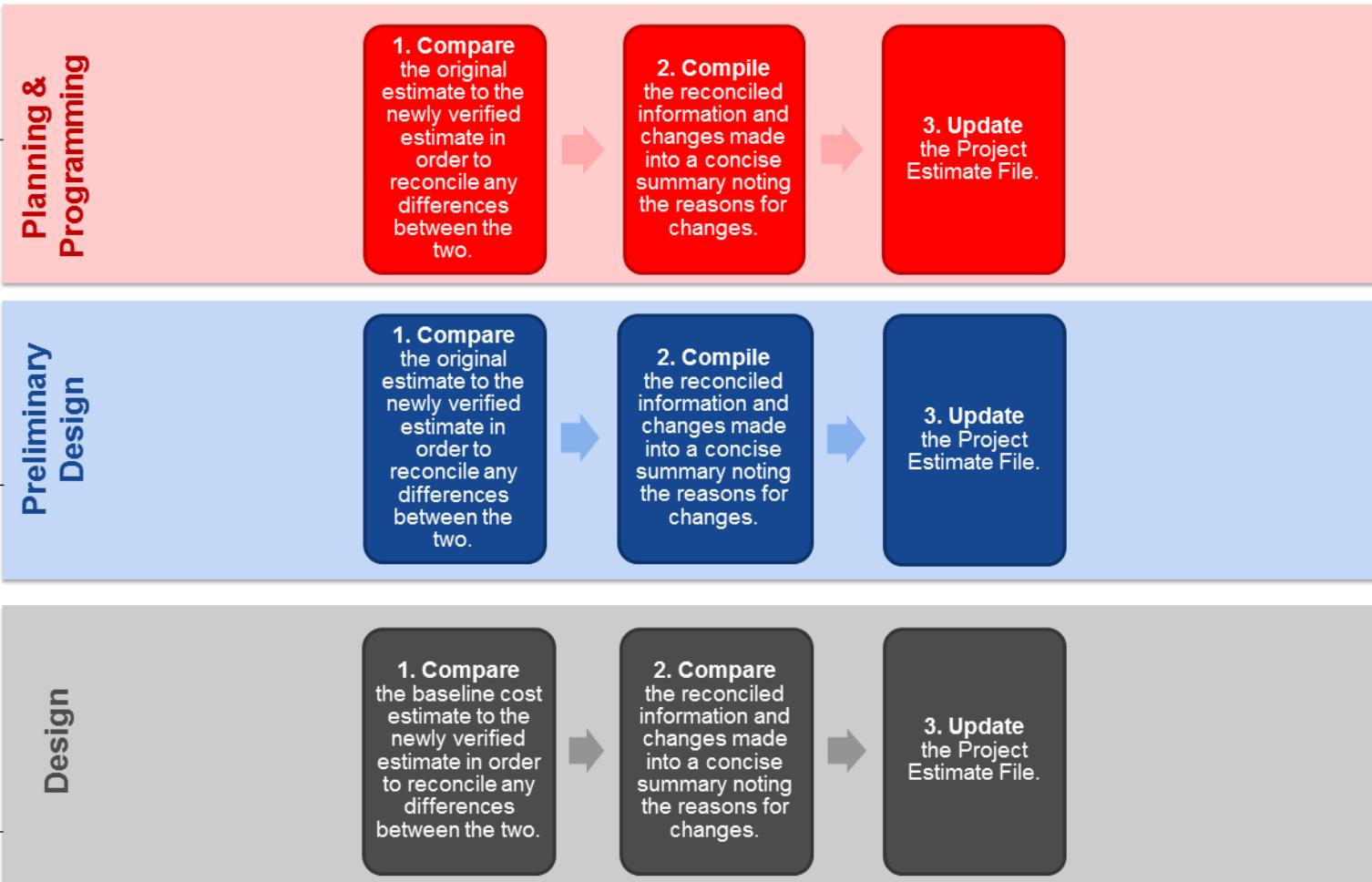
- The most indispensable tool for estimate review is judgment. Judgment is what identifies mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers.
- Be sure to note any changes and reasons for changes between estimates; this is important in order to determine if the estimate will or will not be approved as well as in the communication process ([Stage 5](#)).
- When reconciling the current estimate with previous estimates, typically only the major work categories and items evaluated. Since approximately 80 percent of the project's cost is associated with 20 percent of the bid items, reconciling the big ticket items first often reveals the reason for any changes between estimates.
- Estimates should be compared on an equal basis, which is at time of anticipated construction. Comparison between earlier estimates and the current estimate should first examine if the work items are the same and quantities are the same. If quantities are the same, then examine unit prices to see if those costs have escalated as anticipated or if unusual fluctuations in prices have caused the differences between estimates.

## Process Flowchart

### Stage 4 Review and Approve Estimate Step D Reconcile with Latest Estimate

S91

#### STAGE 4/STEP D



## Stage 4. Review and Approve Estimate

A

B

C

D

E

Reconcile with the latest estimate.

### Specifics to the Planning and Programming Phase



1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.
2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.
3. Update the Project Estimate File.



- [Variance Reports on Cost](#)
- [Annual Scope and Estimate Document \(ASED\)](#)



- Estimates during the Planning and Programming Phases should still be reconciled even if it appears very little has changed since the previous estimate.
- During the Planning and Programming Phase, differences between estimates can often be tied to differences in the basis of the estimate.

### Specifics to the Preliminary Design Phase



1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.
2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.
3. Update the Project Estimate File.



- [Variance Reports on Cost](#)
- [Annual Scope and Estimate Document \(ASED\)](#)



- Care should be taken when reconciling estimate during the Preliminary Design Phase because the estimate will be migrating from parametric estimating techniques to actual bid items. The Estimator may need to sum several bid items in the Preliminary Design estimate to compare against a single categorical line cost within the estimate generated during the Planning and Programming Phase.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Reconcile with the latest estimate.

- Review the documentation associated with the estimate, particularly changes to assumptions; this may highlight differences in estimate during the Preliminary Design Phase as design decisions are being made.
- Care should be taken during estimate reconciliation as costs that may have previously been included as uncertainty and risk may now appear as part of the Base Estimate.

### Specifics to the Design Phase



1. Compare the Baseline Cost Estimate to the newly verified estimate in order to reconcile any differences between the two.
2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.
3. Update the Project Estimate File.



- [Variance Reports on Cost](#)



- During a detailed estimate reconciliation, look at individual pieces of the construction cost estimate. Though the totals may be similar, there may be changes in the individual items that need to be reconciled.
- The Baseline Cost Estimate will remain unchanged unless the project's original requirements defined in the Design Summary Report change.

## Stage 4. Review and Approve Estimate

A	B	C	D	E
Approve estimate package.				

### STEP E. APPROVE ESTIMATE PACKAGE

This step culminates the estimate review process by officially approving the Total Construction Cost Estimate as the current, working cost for the project.



Project Managers must seek and obtain approval from District Management to either progress the project to the next phase of development or go to letting. The [RACI matrices](#) completed by each district will designate the individuals responsible for approving estimates.



The output is the approved Total Construction Cost Estimate package. If the estimate is to be designated as the Baseline Cost Estimate, this baseline is what the project will be measured against for the remainder of the project development and delivery, unless the appropriate actions are taken to modify the baseline.



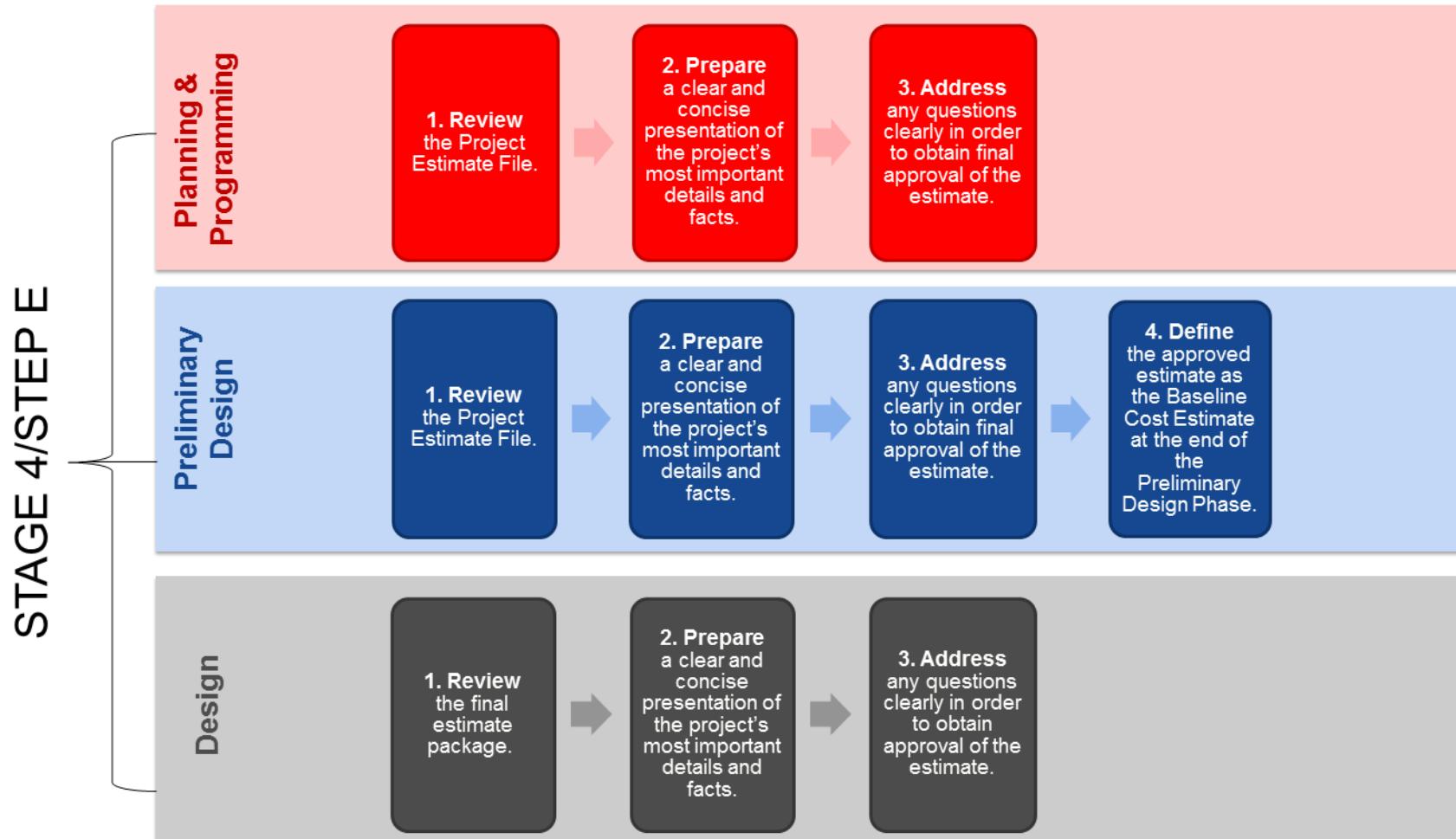
#### Guidance for All Phases

- Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources.
- Estimate approval is two-fold: approval that the estimate was completed using the appropriate procedure, tools, and knowledge; and approval of the estimate amount.

## Process Flowchart

### Stage 4 Review and Approve Estimate Step F Approve Estimate Package

691



## Stage 4. Review and Approve Estimate

A

B

C

D

E

Approve estimate package.

### Specifics to the Planning and Programming Phase



1. Review the Project Estimate File.
2. Prepare a clear and concise presentation of the project's most important details and facts.
3. Address any questions clearly in order to obtain final approval of the estimate.



- No specific tools suggested.



- During the Planning and Programming Phase, assumptions and design alternatives are numerous. The approved estimate should clearly acknowledge any changes to those assumptions and were agreed to during the review process.

### Specifics to the Preliminary Design Phase



1. Review the Project Estimate File.
2. Prepare a clear and concise presentation of the project's most important details and facts.
3. Address any questions clearly in order to obtain final approval of the estimate.
4. Define the approved estimate as the Baseline Cost Estimate at the end of the Preliminary Design Phase.



- No specific tools suggested.



- This approval is two-fold:
  - Approval that the estimate was completed using the appropriate procedure, tools, and knowledge.
  - Approval of the estimate amount.
- While each project phase has an associated Total Construction Cost Estimate, only the Total Construction Cost Estimate at the Preliminary Design Phase is designated as the Baseline Cost Estimate.
- Future project estimates will be managed against the Baseline Cost Estimate, which will remain the baseline until letting unless changes to the project's definition and requirements warrant a change to the baseline estimate.

## Stage 4. Review and Approve Estimate

A

B

C

D

E

Approve estimate package.

### Specifics to the Design Phase



1. Review the final estimate package.
2. Prepare a clear and concise presentation of the project's most important details and facts.
3. Address any questions clearly in order to obtain approval of the estimate.



- No specific tool suggested.



- No specific guidance for the Design Phase.



## STAGE 5. COMMUNICATE ESTIMATE

Risk-Based Estimating

# STAGE

# 5

## The Framework

5 Stages

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

### OVERVIEW

Stage 5 has four steps that prepare a communication package that succinctly conveys to both internal and external stakeholders key project information regarding project scope, cost, and uncertainty.

### Chapter Organization

This chapter contains the following topics.

Topic	See Page
Quick Reference Guide	175
Step A. Communicate the Estimate Basis	179
Step B. Communicate Estimate Costs	183
Step C. Communicate Uncertainty and Assumptions	187
Step D. Prepare One-Page Cost Estimate Summary	191

## Stage 5. Communicate Estimate

A

B

C

D

### Remember

- The key input required for this stage is the approved estimate and its supporting documentation.
- The first three steps of Stage 5 are likely performed at the same time.
- The output of this stage is a One-Page Project Cost Estimate Summary.

### About the One-Page Project Cost Estimate Summary

- The One-Page Project Cost Estimate Summary is key to communicating the project and its estimate to external stakeholders. This will be the prime source of information about the project for those not closely associated with the project.
- This information should be as thorough, concise, and accurate as possible and represent the project fairly.
- Information for this will include, but is not limited to the following:
  - Project scope.
  - Total construction cost range.
  - Major risks about the total construction cost.
  - Assumptions that are made about the project and project cost.
  - Project schedule (planned letting date and projected completion date).
  - Project development status.
  - Significant changes since previous estimate and one-page summary.

Stage 5. Communicate Estimate			
Purpose	Steps	Outputs	Tools
Develop a communication package that conveys key project information to internal and external project stakeholders.	A. <a href="#">Communicate the Basis of Estimate.</a> B. <a href="#">Communicate estimate costs.</a> C. <a href="#">Communicate uncertainty and assumptions.</a> D. <a href="#">Prepare one-page cost estimate summary.</a>	One-Page Cost Estimate Summary.	<ul style="list-style-type: none"><li>• <a href="#">One-Page Cost Estimate Summary.</a></li><li>• <a href="#">Project Estimate File</a></li><li>• <a href="#">Annual Scope and Estimate Document</a></li></ul>

### How to Use This Chapter

For each step in Stage 5, the following information is provided:

- Important information across the three pre-construction phases of project development.
- The roles and responsibilities of the step.
- Why the step is needed.
- Guidance relevant to all three phases.
- Specifics to the Planning and Programming phase.
- Specifics to the Preliminary Design phase.
- Specifics to the Design phase.

## Stage 5: Communicate Estimate

### Quick Reference Guide

Risk-Based Estimating

# STAGE

# 5

## The Framework

5 Stages

- 1 Determine/Update Basis of Estimate
- 2 Prepare/Update Base Estimate
- 3 Determine Risk and Set Contingency
- 4 Review and Approve Estimate
- 5 Communicate Estimate

**Purpose:** Develop a communication package that conveys key project information to internal and external project stakeholders.

STEP	PURPOSE
A. Communicate the Basis of Estimate.	Produce a concise and specific breakdown of the project and its Basis of Estimate.
B. Communicate estimate costs.	Communicate an easy-to-understand, yet specific, estimate that clearly lists all of the assumptions made about a project.
C. Communicate uncertainty and assumptions.	Clearly define and communicate project uncertainty.
D. Prepare one-page cost estimate summary.	Prepare the One-Page Cost Estimate Summary.

### Key Reminders

- Use clear, consistent, and concise communication of the estimate with external stakeholders.
- The estimate basis should be easy to correlate with the communicated costs.
- Highlight key assumptions, unknowns, and risks associated with the project and this estimate.

### Tools

- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)

## Stage 5: Communicate Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Communicate the Basis of Estimate.</u> <ul style="list-style-type: none"> <li>Define the details as concisely, yet completely, as possible. Technical terms may be used but should be understandable to the public and other external stakeholders.</li> <li>The Basis of Estimate should be easy to correlate with the communicated costs.</li> <li>Estimate communication will occur internally with project team members who will inherit the estimate for later project development and cost control.</li> <li>Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not.</li> </ul>	<ol style="list-style-type: none"> <li>Review approved estimate.</li> <li>Extract key Basis of Estimate items (e.g., project definition description).</li> <li>List the key items that adequately describe the project design.</li> </ol>	<ol style="list-style-type: none"> <li>Review Basis of Estimate and previously approved Estimate Package.</li> <li>Extract key Basis of Estimate items (e.g., project definition description).</li> </ol>	<ol style="list-style-type: none"> <li>Review Approved Updated Estimate with changes.</li> <li>Extract key Basis of Estimate items (e.g., project definition description).</li> <li>List the key items that adequately describe the project design.</li> </ol>
<u>B. Communicate estimate costs.</u> <ul style="list-style-type: none"> <li>The communication package should be reviewed thoroughly to identify all assumptions made in creating the estimate and communicate the estimate as a range to account of variability, uncertainty, and risks.</li> </ul>	<ol style="list-style-type: none"> <li>Review the Approved Estimate.</li> <li>Extract key cost elements and summarize.</li> <li>Extract key estimate assumptions used to prepare estimate.</li> <li>List key assumptions.</li> </ol>	<ol style="list-style-type: none"> <li>Review Baseline Estimate and Approved Cost Packages.</li> <li>Extract key cost elements and summarize.</li> <li>Extract key estimate assumptions use to prepare Base Estimate.</li> <li>List the key assumptions.</li> </ol>	<ol style="list-style-type: none"> <li>Review Approved Updated Estimates with Changes.</li> <li>Extract key cost elements and summarize.</li> <li>Extract key estimate assumptions use to prepare design estimate.</li> <li>List the key assumptions.</li> </ol>

## Stage 5: Communicate Estimate

	Planning & Programming	Preliminary Design	Design
<u>C. Communicate uncertainty and assumptions.</u>	<ul style="list-style-type: none"> <li>• An estimate with uncertainty is not a bad estimate; it is a realistic estimate.</li> <li>• Project uncertainty should be communicated with each estimate. A simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties.</li> <li>• Communication of estimate uncertainty is best conveyed through simply listing the assumptions, allowances, unknowns, and contingencies included in an estimate.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Approved Estimate Package.</li> <li>2. Extract key risks and cost elements with significant potential estimate variations.</li> <li>3. List key risks and other areas of uncertainty.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Baseline Estimate and Approved Cost Packages.</li> <li>2. Extract key risks and cost elements with significant potential estimate variations.</li> <li>3. List key risks and other areas of uncertainty.</li> </ol>
<u>D. Prepare one-page cost estimate summary.</u>	<ul style="list-style-type: none"> <li>• Understand that a project estimates will be communicated within TxDOT, with other appropriate authorities, and also the general public.</li> <li>• All costs should be expressed in terms of the Total Construction Cost Estimate and the year of construction.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Approved Estimate Package, the Identified Uncertainties, and the Estimate Basis.</li> <li>2. Prepare one-page summary.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Approved Planning Estimate, the identified uncertainties, and the Communication Package from Planning and Programming.</li> <li>2. Prepare one-page summary of Total Construction Cost Estimate Summary.</li> </ol>

## Stage 5. Communicate Estimate

A

B

C

D

### Preview of Stage 5 Procedure

Table 16 provides an overview of the basic procedure, its purpose, who does it, and when in the Project Development Process it should be done.

**Table 16. Stage 5 Procedure.**

STEP	PURPOSE	WHO DOES IT?	WHEN?
<b>A. <u>Communicate the Basis of Estimate.</u></b>	Produce a concise and specific breakdown of the project and its Basis of Estimate.	Estimator	• All phases.
<b>B. <u>Communicate estimate costs.</u></b>	Communicate an easy-to-understand, yet specific, estimate that clearly lists all of the assumptions made about a project.	Estimator	• All phases.
<b>C. <u>Communicate uncertainty and assumptions.</u></b>	Clearly define and communicate project uncertainty.	Estimator	• All phases.
<b>D. <u>Prepare one-page cost estimate summary.</u></b>	Prepare the One-Page Cost Estimate Summary	Estimator	• All phases.

### Stage 5 Inputs and Sources of Information

The major input for Stage 5 is the Baseline Estimate Package from [Stage 4](#).

Each phase builds on the previous phase's information. Planning and Programming inputs are listed in red, followed by Preliminary Design additions in blue, followed by Design additions in grey. Items listed for the Planning and Programming Phase are also used in the Preliminary Design and Design Phases. Items listed for the Preliminary Design Phase are also used in the Design Phase. At the end of Stage 5, the One-Page Summary is the key output.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate the estimate basis.

### STEP A. COMMUNICATE THE ESTIMATE BASIS

This step produces a concise and specific breakdown of the project and its Basis of Estimate.



#### Roles

- The Estimator communicates the Basis of Estimate accurately to avoid the risk of scope creep later in project development.
- The Estimator summarizes the voluminous Approved Cost Estimate Package for clear estimate communication. This package should be reviewed thoroughly to extract the key information for a summary communication.
- The Estimator gathers all the relevant information required to support the One-Page Cost Estimate Summary to communicate the Basis of Estimate.



#### Why

Estimate communication is vital to successful Cost Management, and it is even more important when communicating an estimate to various stakeholders.



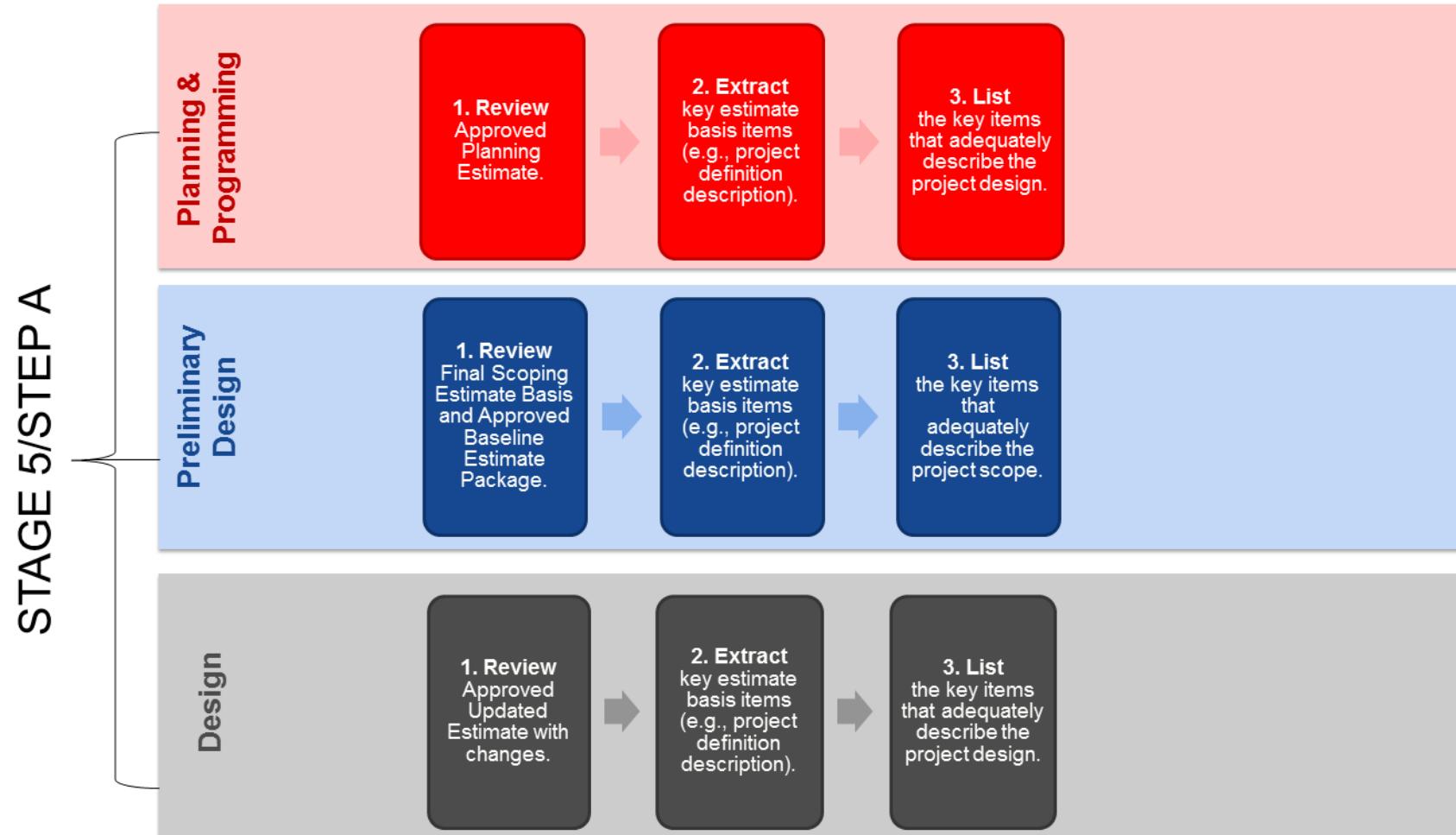
#### Guidance for All Phases

- Extract only the key project characteristics that comprise the limits of the project and what the scope entails. If multiple alternatives were considered, be specific as to which project elements were included in the final scope and estimate.
- Define the details as concisely, yet completely, as possible. Use a bulleted list to identify and describe key parts of the project. Technical terms may be used but should be understandable to the public and other external stakeholders.
- The Basis of Estimate should be easy to correlate with the communicated costs.
- Estimate communication will occur internally with Divisions and with project team members who will inherit the estimate for later project development and cost control.
- Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not.
- The final output is a concise and specific breakdown of the project and its Basis of Estimate.

## Process Flowchart

### Stage 5 Communicate Estimate Step A Communicate the Estimate Basis

081



## Stage 5. Communicate Estimate

A

B

C

D

Communicate the estimate basis.

### Specifics to the Planning and Programming Phase



- Process**
1. Review approved estimate.
  2. Extract key Basis of Estimate items (e.g., project definition description).
  3. List the key items that adequately describe the project design.



- Tools**
- [One-Page Cost Estimate Summary](#)



- Guidance**
- The Project Manager should help determine the relevant points of the Basis of Estimate to be conveyed.
  - Using a standard template aids in the development of the One-Page Cost Estimate Summary.

### Specifics to the Preliminary Design Phase



- Process**
1. Review Basis of Estimate and previously approved Estimate Package.
  2. Extract key Basis of Estimate items (e.g., project definition description).



- Tools**
- [One-Page Cost Estimate Summary](#).
  - [Project Estimate File](#)
  - [Annual Scope and Estimate Document](#)



- Guidance**
- The current Basis of Estimate should be concisely stated within the Project Estimate File.
  - Asking someone not familiar with the project to read the Basis of Estimate can aid in using accurate and understandable language.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate the estimate basis.

### Specifics to the Design Phase



1. Review Approved Updated Estimate with changes.
2. Extract key Basis of Estimate items (e.g., project definition description).
3. List the key items that adequately describe the project design.



- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- The Project Manager should review the description of the project that will be conveyed in the One-Page Cost Estimate Summary.
- Remember that external stakeholders are typically not familiar with technical jargon and acronyms.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate estimate costs.

### STEP B. COMMUNICATE ESTIMATE COSTS

This step communicates an easy-to-understand, yet specific, Total Construction Cost Estimate that clearly lists all of the assumptions made about a project.



- The Estimator reviews the estimate package and extracts the key cost items along with any assumptions made when preparing it.
- The Estimator gathers all the relevant information required to support the One-Page Project Cost Estimate to communicate the Total Construction Cost.



This package is communicated within TxDOT and other appropriate stakeholders. By actively providing this information, both internal and external parties can track the progression of the project through the development process.

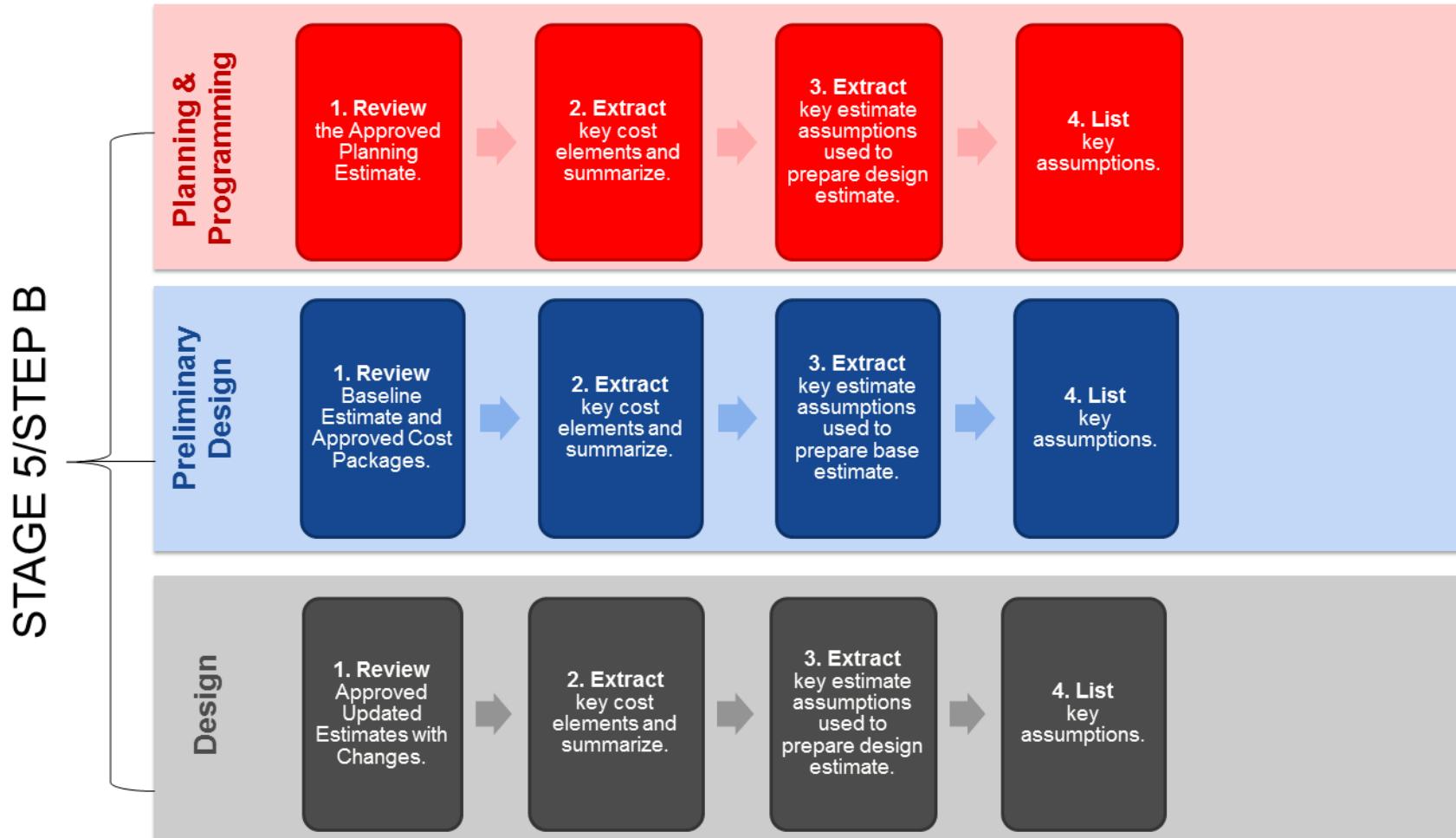


### Guidance for All Phases

- The package should be reviewed thoroughly to identify all assumptions made in creating the estimate and communicate the estimate as a range to account of variability, uncertainty, and risks

## Process Flowchart

### Stage 5 Communicate Estimate Step B Communicate Estimate Costs



## Stage 5. Communicate Estimate

A

B

C

D

Communicate estimate costs.

### Specifics to the Planning and Programming Phase



- Process**
1. Review the Approved Estimate.
  2. Extract key cost elements and summarize.
  3. Extract key estimate assumptions used to prepare estimate.
  4. List key assumptions.



- Tools**
- [One-Page Cost Estimate Summary](#).
  - [Project Estimate File](#)
  - [Annual Scope and Estimate Document](#)



- Guidance**
- Report the estimate as a range of values.
  - The cost during the Planning and Programming Phase of the project should be communicated as a range of cost clearly indicating what level of design maturity for the project.

### Specifics to the Preliminary Design Phase



- Process**
1. Review Baseline Estimate and Approved Cost Packages.
  2. Extract key cost elements and summarize.
  3. Extract key estimate assumptions use to prepare Base Estimate.
  4. List the key assumptions.



- Tools**
- [One-Page Cost Estimate Summary](#).
  - [Project Estimate File](#)
  - [Annual Scope and Estimate Document](#)



- Guidance**
- The estimate range reported during the Preliminary Design Phase may be broader than that during the Planning and Programming Phase; verify the approved estimate adequately explains why this may be the case.
  - The project cost should still be communicated as a range.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate estimate costs.

### Specifics to the Design Phase



1. Review Approved Updated Estimates with Changes.
2. Extract key cost elements and summarize.
3. Extract key estimate assumptions use to prepare design estimate.
4. List the key assumptions.



- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- If the bid award is significantly different than the estimate reported in the last One-Page Cost Estimate Summary, the District may wish to issue a revised Cost Estimate Summary explaining the reason for the difference.
- A Justification of Estimate Variance is required on all projects for which the apparent low bid varies 20 percent or more from the engineer's estimate, or when only a single bid is received and the apparent low bid varies 10 percent or more from the engineer's estimate. For projects that require this justification, the District is required to complete TxDOT Form 2195 for overruns or Form 2195-U for underruns ([eForms](#)).
- Until the project lets, reporting the estimate as a range, albeit a narrower range, is still appropriate.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate uncertainty and assumptions.

### STEP C. COMMUNICATE UNCERTAINTY AND ASSUMPTIONS

This step clearly defines and communicates project uncertainty.



- The Estimator identifies assumptions made during the process of identifying and estimating uncertainty.
- The Estimator reviews both estimate packages and extract the key risks and items that offer significant variation in cost.



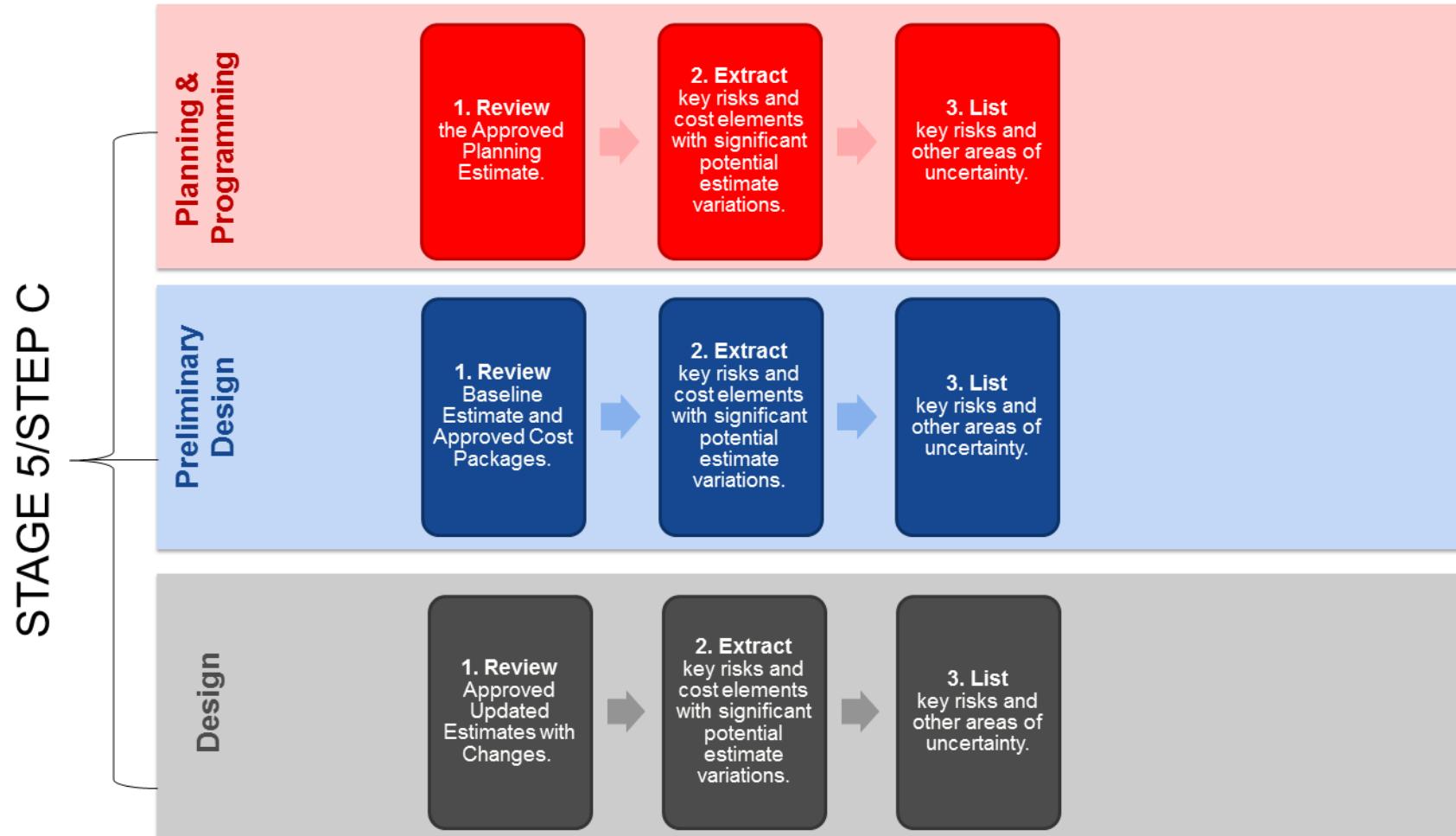
Communication of uncertainty creates transparency in the estimating process and allows for better decisions to be made from the estimate information.



- This step simply identifies the key areas of uncertainty from the estimate package.
- An estimate with uncertainty is not a bad estimate; it is a realistic estimate.
- Project uncertainty should be communicated within TxDOT and in meetings involving the Estimator staff and reviewers. In addition, a simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties.
- Communication of estimate uncertainty is best conveyed through simply listing the assumptions, allowances, unknowns, and contingencies included in an estimate.

## Process Flowchart

### Stage 5 Communicate Estimate Step C Communicate Uncertainty and Assumptions



## Stage 5. Communicate Estimate

A

B

C

D

Communicate uncertainty and assumptions.

### Specifics to the Planning and Programming Phase



1. Review the Approved Estimate Package.
2. Extract key risks and cost elements with significant potential estimate variations.
3. List key risks and other areas of uncertainty.



- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- The Project Manager and Estimator should be honest in reporting risks and uncertainties with a project in the early phases.
- Stating uncertainties and risks should convey that TxDOT is proactively tracking and attempting to address and resolve.

### Specifics to the Preliminary Design Phase



1. Review Baseline Estimate and Approved Cost Packages.
2. Extract key risks and cost elements with significant potential estimate variations.
3. List key risks and other areas of uncertainty.



- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- Ensure that the reported estimate range makes sense compared to the assumptions and risks presented in the communication package.
- Risks communicated to stakeholders should be succinct and specific.

## Stage 5. Communicate Estimate

A

B

C

D

Communicate uncertainty and assumptions.

### Specifics to the Design Phase



1. Review Approved Updated Estimates with Changes.
2. Extract key risks and cost elements with significant potential estimate variations.
3. List key risks and other areas of uncertainty.



- [One-Page Cost Estimate Summary.](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- The Estimator and Project Manager must verify that the Public Information Officer is conversant in the project uncertainty, risks, and assumptions in order to field questions from external parties.
- The communication package during the Design Phase should contain fewer risks and assumptions than during earlier phases of project development because they should have been addressed during detailed design.

## Stage 5. Communicate Estimate

A

B

C

D

Prepare one-page cost estimate summary.

### STEP D. PREPARE ONE-PAGE COST ESTIMATE SUMMARY

This step prepares easy-to-understand summaries and diagrams depicting the information about the projects and all the risks and assumptions that can be shared with various stakeholders.



The Estimator and/or Project Manager prepares easy-to-understand summaries depicting the information about the projects and all risks and assumptions.



A thorough, well-prepared estimate communication package conveys transparency and accountability in the project development process.



#### Guidance for All Phases

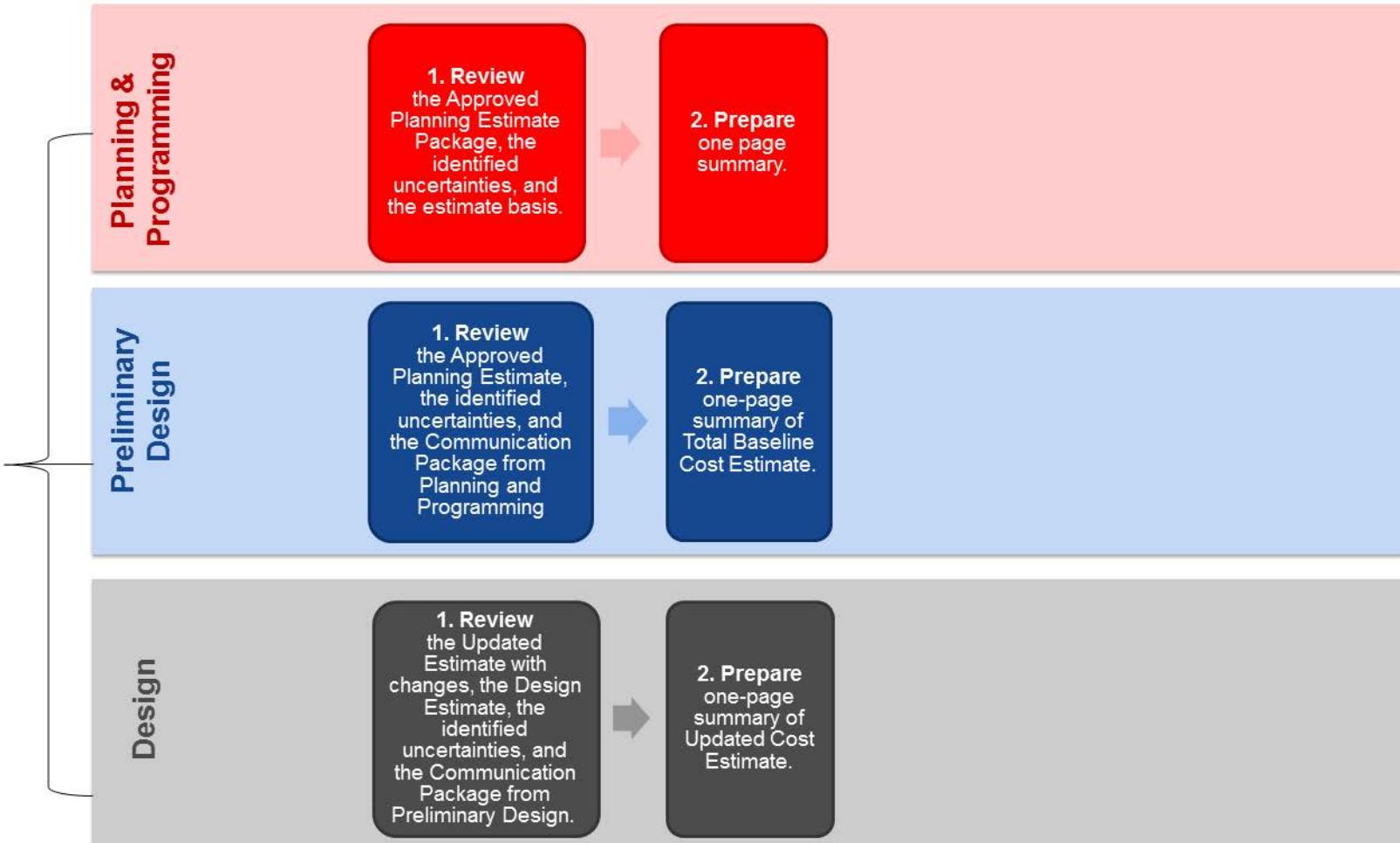
- Project estimate will not only need to be communicated within the TxDOT and other appropriate authorities, but also to the general public.
- All costs should be expressed in terms of the Total Construction Cost Estimate and the year of construction.

## Process Flowchart

**Stage 5 Communicate Estimate Step D Prepare One-Page Cost Estimate Summary**

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### STAGE 5/STEP D



## Stage 5. Communicate Estimate

A

B

C

D

Prepare one-page cost estimate summary.

### Specifics to the Planning and Programming Phase



1. Review the Approved Estimate Package, the Identified Uncertainties, and the Estimate Basis.
2. Prepare one page summary.



- [One-Page Cost Estimate Summary.](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



- Cost estimates for each phase will be documented in the One-Page Project Cost Estimate Summary, which should include the following:
  - A description of what the project is and is not.
  - The assumptions used.
  - The extent to which various estimate inputs are developed.
  - The Basis of Estimate.
  - The Base Estimate.
  - The separate contingency amount and a description of associated risks.
  - Incentives, if any are known.
- The One-Page Cost Estimate Summary may be the first time external stakeholders become aware of a planned project. Ensure the Summary answers more questions than it raises.

### Specifics to the Preliminary Design Phase



1. Review the Approved Planning Estimate, the identified uncertainties, and the Communication Package from Planning and Programming.
2. Prepare one-page summary of Total Construction Cost Estimate Summary.



- [One-Page Cost Estimate Summary.](#)
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)

## Stage 5. Communicate Estimate

A

B

C

D

Prepare one-page cost estimate summary.



### Guidance

- Use a standard template to prepare the One-Page Cost Estimate Summary so that stakeholders become accustomed to the format and where to look for various pieces of information.
- The Baseline Cost Estimate is for management purposes and does not need to be explicitly conveyed in the One-Page Cost Estimate Summary.

### Specifics to the Design Phase



### Process

1. Review the approved estimate package, the identified remaining uncertainties and risks, and the Communication package from the Preliminary Design Phase.
2. Prepare One-Page Cost Estimate Summary.



- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)



### Guidance

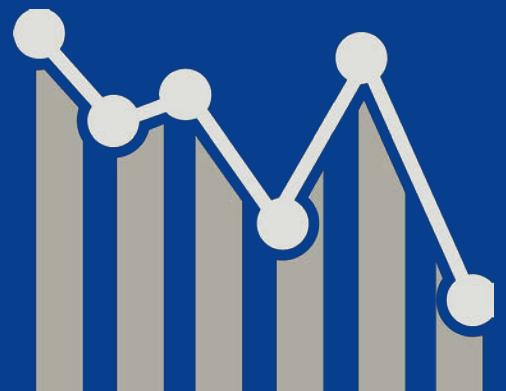
- Ensure the One-Page Cost Estimate Summary is thoroughly reviewed prior to releasing for publication.
- Annual updates to the One-Page Cost Estimate Summary during the Design Phase are sufficient. More frequent updates can cause unnecessary concerns or confusion with stakeholders.

ePMO

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## PART III – QUICK REFERENCE GUIDE

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# RISK-BASED COST ESTIMATE PROCESS

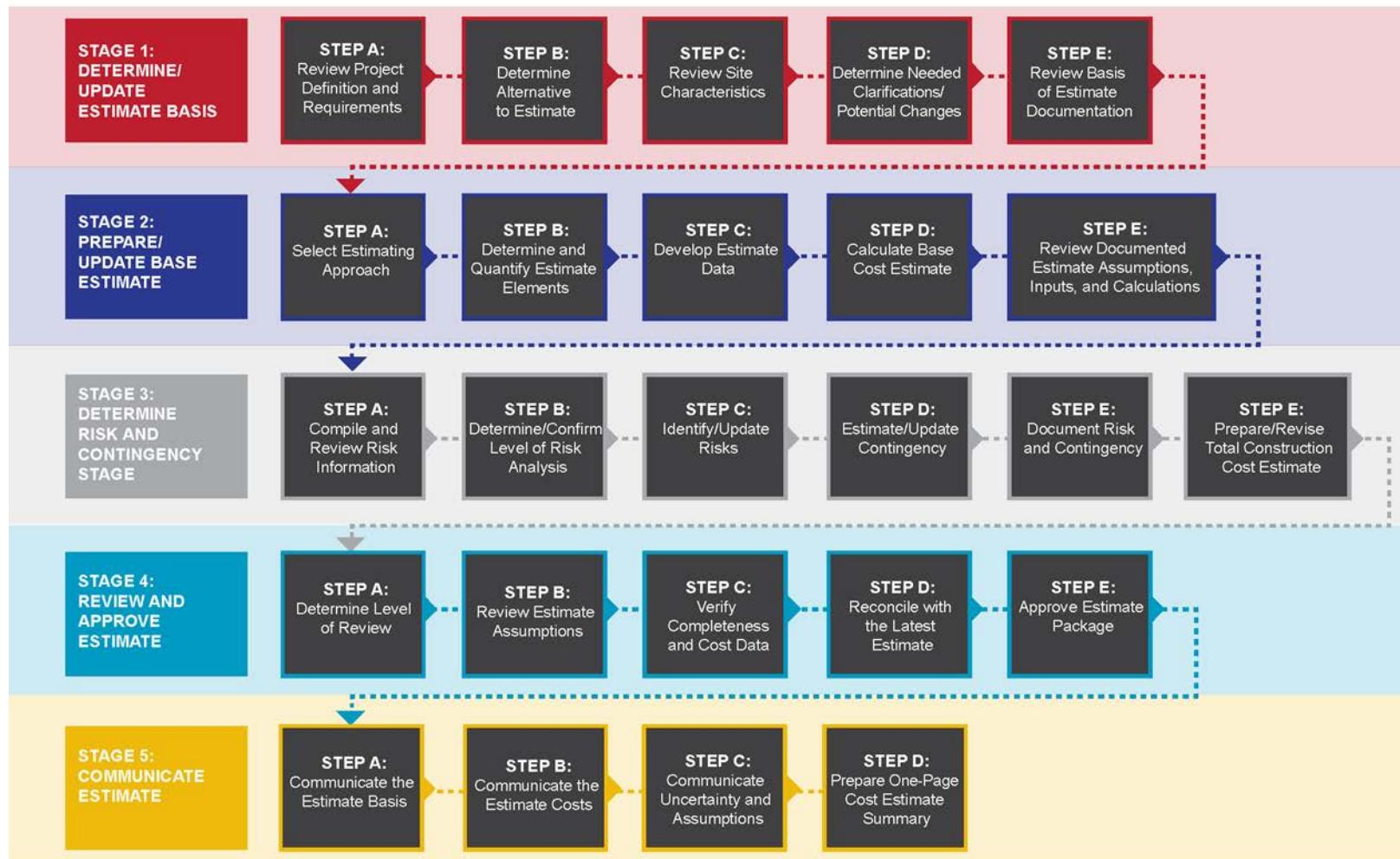


Figure 12. Flowchart of the Risk-Based Estimating Framework.

*Quick Reference Guide*

## Risk-Based Estimating

**STAGE****1****The Framework****5 Stages**

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

**Purpose:** Identify and use proper inputs and information sources that will serve as an accurate basis of the project estimates and its future updates.

STEP	PURPOSE
A. Review project definition and requirements.	Collect and review relevant project information to gain knowledge of the project in order to identify the proper items and inputs that will serve as an accurate basis of the estimate and its updates.
B. Determine alternative to estimate.	When a project has more than one solution to meet the purpose and need of the project, prioritize the alternative to estimate first.
C. Review site characteristics.	Helps the Estimator gain knowledge, insight, and a better understanding of the project site characteristics and their impact on cost and risk.
D. Determine needed clarifications/potential changes.	Assess the completeness of the key inputs to the cost estimation process and request additional information; notify Project Manager of potential changes.
E. Review Basis of Estimate documentation.	Summarize information used for the estimate for reviews and future reference for other cost estimates that will be prepared.

**Key Reminders**

- Document and communicate any changes to the estimate basis from previous estimates.
- Every project, regardless of size or complexity, needs an up-to-date Project Estimate File.
- Getting input from others avoids unnecessary or inaccurate assumptions.

 **Tools**

- [Project Estimate File](#)
- [Design Summary Report](#)
- [Annual Scope and Estimate Documentation Form](#)
- [Advance Planning Risk Analysis](#)

## Stage 1: Determine/Update Basis of Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Review project definition and requirements.</u>	<ul style="list-style-type: none"> <li>Reviewing the documents and changes to the documents helps the Estimator understand the scope of the project and assess the completeness and quality of the available inputs to the cost estimating process.</li> </ul>	<ol style="list-style-type: none"> <li>Review project requirement described by the concept definition at the time of estimate.</li> <li>Identify key project categories and parameters.</li> <li>Determine if more than one alternative should be considered for the project.</li> <li>Consider project complexity (i.e., taking into account project uniqueness and differences).</li> <li>Plan how the estimate will be prepared, what information and data are needed, and which functional groups or Divisions need to provide input.</li> </ol>	<ol style="list-style-type: none"> <li>Review all project requirements covered in Design Summary Report.</li> <li>Review available drawings (e.g., proposed schematic and proposed typical section).</li> <li>Understand key project design parameters.</li> <li>Determine if multiple estimates (one for each of the proposed alternatives) are required.</li> <li>Consider project complexity (i.e., taking into account project uniqueness and differences).</li> <li>Account for estimating activities in project schedule including necessary inputs from other functional groups.</li> </ol>
<u>B. Determine alternative to estimate.</u>	<ul style="list-style-type: none"> <li>When preparing cost estimates for the purpose of comparing alternatives, each estimate should be developed using the same procedure.</li> <li>The cost estimate for each alternative must have a documented Basis of Estimate, list of assumptions, and a list of considered risks for which the contingency is derived.</li> <li>If one alternative is to be the base case to which other alternatives will be compared, the base alternative estimate should be developed first.</li> </ul>	<ol style="list-style-type: none"> <li>Determine the alternative to estimate first.</li> <li>Prioritize the remaining alternatives for estimating.</li> </ol>	<ol style="list-style-type: none"> <li>Determine the alternative to estimate first.</li> <li>Prioritize the remaining alternatives for estimating.</li> <li>Document when and why an alternative was no longer considered and estimates where no longer developed.</li> </ol> <p><i>Not applicable for this phase</i></p>

## Stage 1: Determine/Update Basis of Estimate

	Planning & Programming	Preliminary Design	Design
<b>C. Review site characteristics.</b>	<ul style="list-style-type: none"> <li>A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos.</li> <li>Relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.</li> <li>It is also helpful to visit the site even if the project is not very complex and considered typical.</li> <li>For unusual or complex projects, it is recommended that the Estimator visit the site at least one time in each of the development phases especially if the project takes several years to develop.</li> </ul>	<ol style="list-style-type: none"> <li>Review project objectives and requirements.</li> <li>Review video log (if available) and aerial photos (e.g., Google Earth™) of site location.</li> <li>Visit site and walk project.</li> <li>Review site characteristics in view of concept definition (especially if alternatives are being considered to ensure there are no missing cost categories).</li> <li>Consider potential constructability issues that may have major impacts on estimated project costs.</li> </ol>	<ol style="list-style-type: none"> <li>Review project objectives and requirements as well as planning/design work completed to date.</li> <li>Visit site and walk project.</li> <li>Review video log and aerial photos of site location.</li> <li>Consider impact of site characteristics on project costs (material storage, batch plant, staging, etc.).</li> <li>Document constructability issues and related issues that may impact estimated project costs.</li> </ol>
<b>D. Determine needed clarifications/potential changes.</b>	<ul style="list-style-type: none"> <li>Request for clarifications is a means of communication. Efficient communication between the Project Manager, the Estimator, and functional groups improves the accuracy of the cost estimates.</li> <li>Documentation of requests for clarifications and the responses should be maintained in the Project Estimate File.</li> <li>Clarification requests should reduce as successive cost estimates are prepared.</li> <li>A potential change can alter the project definition, schedule, and/or estimate.</li> </ul>	<ol style="list-style-type: none"> <li>Develop lists of questions for functional groups and/or Divisions regarding their area of the project.</li> <li>Develop list of questions regarding project requirements and potential impacts of major construction constraints.</li> <li>Request clarification regarding project requirements or construction impacts.</li> <li>Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.</li> <li>Notify the Project Manager of the changes and request direction regarding the change.</li> </ol>	<ol style="list-style-type: none"> <li>Develop lists of questions for functional groups and/or Divisions regarding their area of the project.</li> <li>Develop list of questions regarding project requirements and impacts of constructability issues on cost estimate categories and elements.</li> <li>Request clarification regarding project definition or construction impacts.</li> <li>Identify potential changes that may occur (or actual changes than may have inadvertently occurred) since the previous estimate.</li> <li>Notify the Project Manager of the changes and request direction regarding the change.</li> </ol>
<b>E. Review Basis of Estimate documentation.</b>	<ul style="list-style-type: none"> <li>Documentation of project requirements is critical when updating the base cost estimate, risks, and contingency.</li> <li>A standard Project Estimate File format should be followed. The Project Estimate File provides uniformity in the documentation, which helps other Estimators to understand the project definition basis clearly.</li> </ul>	<ol style="list-style-type: none"> <li>Prepare file of Basis of Estimate to include all documents and information used to prepare planning-level estimates.</li> </ol>	<ol style="list-style-type: none"> <li>Prepare estimating file with documentation of Basis of Estimate to include:             <ol style="list-style-type: none"> <li>All Scoping Worksheets.</li> <li>Schematic or other preliminary drawings.</li> <li>Design criteria.</li> <li>Other specific project requirements.</li> </ol> </li> </ol>

*Quick Reference Guide*

## Risk-Based Estimating

# STAGE

# 2

**The Framework****5 Stages**

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

**Purpose:** Develop and update the base cost estimate.

STEP	PURPOSE
A. Select estimating approach.	Decide which tool(s) are used for preparing a quality and accurate estimate.
B. Determine and quantify estimate elements.	Determine the categories and quantities consistent with the estimating tool(s) used.
C. Develop estimate data.	Develop/update the appropriate cost data for each category.
D. Calculate base cost estimate.	Calculate cost data for each estimate element and combine and summarize in a spreadsheet.
E. Review documented estimate assumptions, inputs, and calculations.	State the decisions and assumptions used in the estimate for communication to management in a structured format. Accumulate and organize all details, summaries, and assumptions made in completing the estimate.

**Key Reminders**

- Document all assumptions and changes.
- Based on the maturing of project design and/or the amount of time that has passed since the previous estimate, a completely new estimate may be warranted.
- Have someone else review the estimate for completeness and accuracy.

 **Tools**

- [Typical Sections on a per Mile Basis.](#)
- [Similar Projects.](#)
- [Historical Bids.](#)
- [Parametric Estimating.](#)
- [Project Estimate File.](#)
- [Cost Estimate Spreadsheet Template.](#)

## Stage 2: Prepare/Update Base Estimate

	Planning & Programming	Preliminary Design	Design
<b>A. Select estimating approach.</b> <ul style="list-style-type: none"> <li>• Certain tools require specific information or that the required data is in a particular format; understanding what information is available often dictates what estimating approach is selected.</li> <li>• At times, an Estimator is asked to provide an initial estimate in short notice with little project information. Such situations can limit the Estimator to using a cost per mile based on a similar project.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review types of information contained in the Planning and Programming Estimate Basis (from Stage 1).</li> <li>2. Determine those tools that fit the level of project definition, complexity, and likely availability of historical bids.</li> <li>3. Consider time constraints for estimate preparation.</li> <li>4. Decide on best estimate tool(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. Review types of information contained in the Project Estimate File.</li> <li>2. Review available tools in tool appendix.</li> <li>3. Determine those tools that fit the level of project definition and complexity.</li> <li>4. Consider time restraints for estimate preparation.</li> <li>5. Decide on best estimate tool(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. Use historical bid-based estimating approach.</li> <li>2. Review level of design information available.</li> <li>3. Determine if other tools might be necessary for certain project elements due to level of detail available.</li> <li>4. Select other tools that are appropriate, if needed.</li> </ol>
<b>B. Determine and quantify estimate elements.</b> <ul style="list-style-type: none"> <li>• Calculations of quantities should be documented, including all backup calculations and assumptions made when determining quantities.</li> <li>• Special care should be taken while operating electronic spreadsheets or other computer based estimating tools. While they are quite helpful in performing calculations and are an expedient way to update an estimate, it is easy to make a small typing error or miscalculation in a cell that raises or lowers the estimate by an order of magnitude. Always double check entries and use reasonableness checks where possible.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine project components, categories, and elements covered in the estimate.</li> <li>2. Determine quantity measure required and/or other requirements based on tools selected and level of project definition.</li> <li>3. Quantify appropriate components, categories, and elements.</li> <li>4. Document method for deriving quantities.</li> <li>5. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine elements/items per category consistent with project definition and project requirements (refer to the Project Estimate File).</li> <li>2. Determine quantity measure required (e.g., miles, lane miles, square foot, or cubic yard) and/or other requirements based on tools selected.</li> <li>3. Quantify appropriate items based on typical sections, profiles, and other preliminary design documents.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review design categories, elements, and items covered in the Baseline Cost Estimate to ensure those same categories, elements, and items are included in the current estimate.</li> <li>2. Update detailed elements and items consistent with current project definition and project requirements.</li> <li>3. Review existing and determine new quantity measures required and/or other requirements based on tools.</li> <li>4. Quantify new elements and items and/or revise existing quantities.</li> <li>5. Document methods for deriving quantities.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>
<b>C. Develop estimate data.</b> <ul style="list-style-type: none"> <li>• A spreadsheet template or specific estimating software are excellent tools for ensuring all categories of project cost have been considered and accounted for in the estimate.</li> <li>• Adding notes within a spreadsheet can be a quick way to document assumptions, adjustments, source, and other items related price data.</li> <li>• Adjusting historical bids to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul routes and distance, work zone staging, and any market volatility.</li> <li>• Refer to the American Association of State Highway Transportation Officials (AASHTO) "Practical Guide to Cost Estimating" (2013) for consideration when adjusting and setting unit costs for local conditions.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine unit costs for elements and major items.</li> <li>2. Develop cost approach for other categories: percentages, parametric, etc.</li> <li>3. Adjust costs to reflect potential market conditions, project complexity, and age of historical bids.</li> <li>4. Estimate costs of other Total Construction Cost Estimate Categories not covered in items 1 through 3.</li> <li>5. Document assumptions.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine unit costs for elements and major items.</li> <li>2. Develop cost approach (e.g., percentages or allowances) for other items.</li> <li>3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids.</li> <li>4. Estimate costs of other construction-related project features not covered in items 1 through 3 (e.g., safety, SWPPP maintenance, and police/safety officer for traffic control).</li> <li>5. Document assumptions for any adjustments made to the cost data.</li> <li>6. Make modifications requested through estimate review (Stage 4).</li> </ol>	<ol style="list-style-type: none"> <li>1. Review and revise unit costs for elements and items.</li> <li>2. Update cost approach on all elements and items, if necessary.</li> <li>3. Adjust unit costs to reflect potential market conditions, project complexity, and age of historical bids to current day dollars.</li> <li>4. Document how and why the adjustments were made.</li> <li>5. Make modifications requested through estimate review (Stage 4).</li> </ol>

## Stage 2: Prepare/Update Base Estimate

Planning & Programming	Preliminary Design	Design
<ul style="list-style-type: none"> <li>• Cost estimates provided by functional groups and/or Divisions should also be included.</li> <li>• The cohesiveness of the resulting base cost estimate is imperative. While merging work from different functional groups and/or Divisions into a single, integrated estimate may be difficult, it must be integrated for the comprehension of reviewers and management approval.</li> <li>• Contingency should not be included in any category cost/item estimates. These will be determined and included in the estimate during Stage 3.</li> </ul>	<ol style="list-style-type: none"> <li>1. Input historical estimate data into estimating system (e.g., spreadsheet) in the appropriate cost estimate category.</li> <li>2. Ensure all categories are covered.</li> <li>3. Incorporate functional group and/or Division estimates as appropriate.</li> <li>4. Subtotal major cost categories and elements for quick reference and to aid with reviews.</li> </ol>	<ol style="list-style-type: none"> <li>1. Prepare updated cost estimating representing the Base Estimate.</li> <li>2. Input historical estimate data into the selected estimating system (i.e., spreadsheet) in the appropriate work category, element, and items with the calculated quantity.</li> <li>3. Ensure all work elements and major items are covered as determined by the Basis of Estimate determined in Stage 1.</li> <li>4. Incorporate functional groups' and/or Divisions' construction estimates, if necessary.</li> <li>5. Subtotal major cost elements into categories, groups, etc.</li> </ol>
<p><b>D. Calculate base cost estimate.</b></p> <ul style="list-style-type: none"> <li>• Documentation should include Basis of Estimate, assumptions, and calculations. The Project Estimate File should be created to assemble and update these items in a single location.</li> <li>• As more details, items, notes, and documents are placed in the Project Estimate File, it may be helpful to create short summary sheets for each section to facilitate rapid location of information.</li> <li>• Force accounts assumed and the calculations used to determine their costs should be explicitly documented.</li> <li>• Documenting how a cost estimate was developed (e.g., estimating technique, source of cost data, adjustments to cost data, and other assumptions) allows others to trace the Estimator's work through the process. Traceability allows others to review and validate the estimate. Traceability also provides the mechanism to assess cost impact when the planning estimate updates are made.</li> </ul>	<ol style="list-style-type: none"> <li>1. Organize back-up quantity calculations.</li> <li>2. Identify sources of historical bids and document adjustments to data (if applicable).</li> <li>3. Summarize estimate approaches used to prepare costs for each category.</li> <li>4. Document all estimate assumptions related to work categories.</li> <li>5. Incorporate cost estimates from functional groups and/or Divisions including back up calculations and assumptions.</li> <li>6. Document general Basis of Estimate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Organize back-up quantity calculations especially if the estimating approach has changed.</li> <li>2. Identify sources of historical bids and document adjustments for specific project conditions.</li> <li>3. Summarize estimate approaches used to prepare costs for each element.</li> <li>4. Document all estimate assumptions related to elements.</li> <li>5. Incorporate cost estimates from functional groups and/or Divisions including back-up calculations and assumptions.</li> <li>6. Update the Basis of Estimate as appropriate and as approved.</li> </ol>

**E. Review documented estimate assumptions, inputs, and calculations.**



## Quick Reference Guide

### Risk-Based Estimating

# STAGE

# 3

## The Framework

### 5 Stages

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

**Purpose:** Characterize the estimate uncertainty and develop contingency amount.

STEP	PURPOSE
A. Compile and review risk information.	Collect information for later use.
B. Determine/confirm level of risk analysis.	Define the level of risk analysis based on project complexity.
C. Identify/update risks.	Identify, categorize, and document risks that could affect the project.
D. Estimate/update contingency.	Determine/update an appropriate contingency for the project through risk assessment and analysis.
E. Document risk and contingency.	Document a transparent list of risks and uncertainties for Cost Management.
F. Prepare and revise Total Construction Cost Estimate.	Add the base cost estimate and contingency estimate to arrive at a Total Construction Cost.

### Key Reminders

- Using an estimate range communicates inherent variability and uncertainties as well as potential impact of identified risks.
- All projects—regardless of size or complexity—should consider project specific and agency risks.
- Have someone else review the estimate for completeness and accuracy.



#### Tools

- [Crawford Slip Method.](#)
- [Estimate Ranges – Monte Carlo Analysis.](#)
- [Estimate Ranges – Three Point Estimate.](#)
- [Expert Team.](#)
- [APRA.](#)

- [Probability × Impact Matrix \(PxI\).](#)
- [Project Estimate File.](#)
- [Risk Breakdown Structure.](#)
- [Risk Checklists.](#)
- [Risk Register.](#)
- [Risk Workshop.](#)
- [Cost Estimate Spreadsheet Template.](#)

### Stage 3: Determine Risk and Set Contingency

	Planning & Programming	Preliminary Design	Design
<p>A. Compile and review risk information.</p>	<ul style="list-style-type: none"> <li>Risks identification is continuous and iterative. Review all the information from previous risk analyses. Expect that the process and the risk information will be somewhat repetitive. Discussions with the Project Manager and other functional area staff will be helpful at this stage.</li> <li>Review the risk checklists and analyses from similar projects only after conducting a thorough review of the estimating and design assumptions. There may be project-specific risks that are not included in standard checklists and could be overlooked if reliant on checklists.</li> </ul>	<ol style="list-style-type: none"> <li>Examine Base Estimate for uncertainty.</li> <li>Review all estimating and design assumptions.</li> <li>Review project scope assumptions.</li> <li>Prepare risk information for analysis.</li> </ol>	<ol style="list-style-type: none"> <li>Examine Base Estimate for uncertainty.</li> <li>Review all estimating and design assumptions.</li> <li>Review issues and concerns.</li> <li>Prepare risk information for analysis.</li> </ol>
<p>B. Determine/confirm level of risk analysis.</p>	<ul style="list-style-type: none"> <li>Although project size is considered when determining the rigor level, other factors such as project uniqueness, complexity, and/or sensitivities of local stakeholders should be considered.</li> </ul>	<ol style="list-style-type: none"> <li>Evaluate project's rigor level.</li> <li>Choose corresponding level of risk analysis.</li> <li>Select appropriate risk identification tools.</li> <li>Select appropriate risk assessment/contingency tools.</li> </ol>	<ol style="list-style-type: none"> <li>Review project's rigor level to verify appropriate level of risk analysis was previously selected.</li> <li>Change the level of risk analysis if warranted.</li> <li>Select appropriate risk identification tools.</li> <li>Select appropriate risk assessment/contingency tools.</li> </ol>
<p>C. Identify/ update risks.</p>	<ul style="list-style-type: none"> <li>The eventual outcome of the risk identification is a list of risks typically summarized in a risk register (see Step E).</li> <li>The process of risk identification should promote open dialogue and leverage team experience and knowledge. Involving people responsible for various items aids in considering project risks from different points of view.</li> </ul>	<ol style="list-style-type: none"> <li>Consider gathered risk information.</li> <li>Identify risks.</li> <li>Categorize risks.</li> </ol>	<ol style="list-style-type: none"> <li>Review risk information.</li> <li>Identify risks.</li> <li>Categorize risks.</li> </ol>

### Stage 3: Determine Risk and Set Contingency

	Planning & Programming	Preliminary Design	Design
<p>D. Estimate/update contingency.</p>	<ul style="list-style-type: none"> <li>The list of risks, along with any historical information concerning cost growth, forms the basis for determining contingency.</li> <li>When tying contingency directly to individual line items, explicitly identify the contingency and do not bury it in the unit price for the item.</li> </ul>	<p><u>Low Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Determine contingency from an expected value (<math>P \times I</math>).</li> </ol> <p><u>Medium Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate expected value (<math>P \times I</math>) for highly significant risks.</li> <li>If warranted by the top risks, use additional contingency.</li> </ol> <p><u>High Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate a contingency ranges using a three-point estimating technique.</li> <li>Develop a risk-based cost and schedule model (if applicable).</li> <li>Choose appropriate contingency.</li> </ol>	<p><u>Low Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Determine contingency through an expected value (<math>P \times I</math>).</li> </ol> <p><u>Medium Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Estimate expected value (<math>P \times I</math>) for most significant risks.</li> <li>If warranted by the top risks, use three-point estimating to determine contingency.</li> </ol> <p><u>High Rigor Risk Analysis</u></p> <ol style="list-style-type: none"> <li>Rank risks (<math>P \times I</math>).</li> <li>Use a specifically developed spreadsheet template.</li> <li>Develop a risk-based cost and schedule model (if applicable).</li> <li>Choose appropriate contingency.</li> </ol>
<p>E. Document risk and contingency.</p>	<ul style="list-style-type: none"> <li>The documentation of risk is the responsibility of the entire project team. The Estimator is responsible for updating the Project Estimate File to show how the contingency amount was determined.</li> <li>Each future estimate will involve an update of risks and an update of the contingency estimate.</li> <li>The Project Estimate File should contain a section for risk documentation.</li> </ul>	<ol style="list-style-type: none"> <li>Document risks and contingency.</li> <li>Add the document to the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>Document risks and contingency.</li> <li>Add the document to the Project Estimate File.</li> </ol>
<p>F. Prepare and revise Total Construction Cost Estimate.</p>	<ul style="list-style-type: none"> <li>Contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs.</li> <li>A risk analysis can itemize contingencies for the identified risks (e.g., separate contingencies for discrete risks).</li> </ul>	<ol style="list-style-type: none"> <li>Sum the base and contingency estimates.</li> <li>Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).</li> </ol>	<ol style="list-style-type: none"> <li>Sum the base and contingency estimates.</li> <li>Add inflation to sum of base and contingency estimates to arrive at Total Construction Cost Estimate (if the estimate resides outside of DCIS where inflation is applied automatically based).</li> </ol>



## Quick Reference Guide

### Risk-Based Estimating

# STAGE

# 4

## The Framework

### 5 Stages

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** **Review and Approve Estimate**
- 5** Communicate Estimate

**Purpose:** Ensure that the estimate is as complete and accurate as possible.

STEP	PURPOSE
A. Determine level of review.	Determine the appropriate tool for review based on project type and complexity.
B. Review estimate assumptions.	Evaluate the Project Estimate File using the list of applicable tools to determine if the correct assumptions and conclusions were made.
C. Verify completeness and cost data.	Ensure the math is correct, the process is documented, and the estimate was developed following TxDOT guidelines.
D. Reconcile with latest estimate.	Reconciles the differences between the current and previous estimates.
E. Approve Estimate Package.	Complete the final estimate package and obtain a final formal review and approval.

### Key Reminders

- Review the RACI matrix for roles and responsibilities, particularly during the review and approval of an estimate.
- Double check calculations and data sources when using specific tools.
- Using clear, concise, and consistent documentation will help with District and Division review and acceptance of the estimate.

### Tools

- [Expert Team.](#)
- [Formal Committee.](#)
- [In-House/Peer.](#)
- [Project Estimate File.](#)
- [Round Table Estimate Review.](#)
- [Variance Reports on Cost.](#)
- [Annual Scope and Estimate Document \(ASED\)](#)

## Stage 4: Review and Approve Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Determine level of review.</u> <ul style="list-style-type: none"> <li>• All estimates should be reviewed by someone other than the Estimator.</li> <li>• To achieve consistent and accurate cost estimates, project cost reviews should be conducted at phase gates throughout the project development process.</li> <li>• The Design Division will assist with the review of project estimates prior to letting for completeness and conformance with established procedures.</li> <li>• The estimate review in the District should take place before the central review of the estimate at the Design Division.</li> </ul>	<ol style="list-style-type: none"> <li>1. Determine the level of review appropriate for the project's rigor level.</li> <li>2. Consider available resources (personnel and time).</li> <li>3. Select the appropriate review tool(s) for the project's rigor level.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine the level of review appropriate for the project's rigor level.</li> <li>2. Consider available resources (personnel and time).</li> <li>3. Select the appropriate review tool(s) for the project's rigor level.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine the level of review appropriate for the project's rigor level.</li> <li>2. Consider available resources (personnel and time).</li> <li>3. Consider the tools that have been previously used in the project development process to perform this function and decide if those are still appropriate.</li> <li>4. Select the appropriate review tool(s) for the project's rigor level.</li> </ol>
<u>B. Review estimate assumptions.</u> <ul style="list-style-type: none"> <li>• If an Estimator was required to make too many assumptions to complete the estimate, it is possible that the scope was not defined in enough detail to provide sufficient estimating information.</li> <li>• The people responsible for the estimate review should follow a consistent approach to ensure all items of the document are properly reviewed.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Total Construction Cost Estimate Package and the list of risks from Stage 3.</li> <li>2. Verify assumptions are correct and documented.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Total Construction Cost Estimate Package and the list of risks from Stage 3.</li> <li>2. Verify assumptions are correct and documented.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Total Construction Cost Estimate Package and the list of risks from Stage 3.</li> <li>2. Verify assumptions are correct or resolved and documented.</li> </ol>
<u>C. Verify completeness and cost data.</u> <ul style="list-style-type: none"> <li>• When verifying the completeness of the data, consider any historical data that might be available and also review all calculations made to ensure their correctness.</li> <li>• For high rigor projects, specific reviewers may only need to review the portion of the estimate where their experience and expertise resides.</li> </ul>	<ol style="list-style-type: none"> <li>1. Verify that the estimate addresses the full scope of the project.</li> <li>2. Verify that the data are complete and that the cost estimates are correct.</li> <li>3. Verify a second time by another reviewer for medium and high rigor projects.</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify that the estimate addresses the full scope of the project.</li> <li>2. Verify that the data are complete and that the cost estimates are correct.</li> <li>3. Verify a second time by another reviewer for medium and high rigor projects.</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify that the estimate address the full scope of the project.</li> <li>2. Verify that the data are complete and that the cost estimates are correct.</li> <li>3. Verify a second time by another reviewer (recommended for all rigor levels).</li> </ol>

## Stage 4: Review and Approve Estimate

	Planning & Programming	Preliminary Design	Design
<p><u>D. Reconcile with latest estimate.</u></p> <ul style="list-style-type: none"> <li>• Be sure to note any changes and reasons for changes between estimates; this is important in order to determine if the estimate will or will not be approved as well as in the communication process.</li> <li>• When reconciling the current estimate with previous estimates, typically only the major work categories and items evaluated. Since approximately 80 percent of the project's cost is associated with 20 percent of the bid items, reconciling the big ticket items first often reveals the reason for any changes between estimates.</li> </ul>	<ol style="list-style-type: none"> <li>1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>1. Compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>	<ol style="list-style-type: none"> <li>1. Compare the Baseline Cost Estimate to the newly verified estimate in order to reconcile any differences between the two.</li> <li>2. Compile the reconciled information and changes made into a concise summary noting the reasons for changes.</li> <li>3. Update the Project Estimate File.</li> </ol>
<p><u>E. Approve Estimate Package.</u></p> <ul style="list-style-type: none"> <li>• Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources.</li> <li>• Estimate approval is two-fold: approval that the estimate was completed using the appropriate procedure, tools, and knowledge; and approval of the estimate amount.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Project Estimate File.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain final approval of the estimate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Project Estimate File.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain final approval of the estimate.</li> <li>4. Define the approved estimate as the Baseline Cost Estimate at the end of the Preliminary Design Phase.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the final estimate package.</li> <li>2. Prepare a clear and concise presentation of the project's most important details and facts.</li> <li>3. Address any questions clearly in order to obtain approval of the estimate.</li> </ol>



*Quick Reference Guide*

## Risk-Based Estimating

**STAGE****5****The Framework****5 Stages**

- 1** Determine/Update Basis of Estimate
- 2** Prepare/Update Base Estimate
- 3** Determine Risk and Set Contingency
- 4** Review and Approve Estimate
- 5** Communicate Estimate

**Purpose:** Develop a communication package that conveys key project information to internal and external project stakeholders.

STEP	PURPOSE
A. Communicate the Basis of Estimate.	Produce a concise and specific breakdown of the project and its Basis of Estimate.
B. Communicate estimate costs.	Communicate an easy-to-understand, yet specific, estimate that clearly lists all of the assumptions made about a project.
C. Communicate uncertainty and assumptions.	Clearly define and communicate project uncertainty.
D. Prepare one-page cost estimate summary.	Prepare the One-Page Cost Estimate Summary.

**Key Reminders**

- Use clear, consistent, and concise communication of the estimate with external stakeholders.
- The estimate basis should be easy to correlate with the communicated costs.
- Highlight key assumptions, unknowns, and risks associated with the project and this estimate.
- Update DCIS, ROWIS, and other systems as appropriate.

 **Tools**

- [One-Page Cost Estimate Summary](#).
- [Project Estimate File](#)
- [Annual Scope and Estimate Document](#)

## Stage 5: Communicate Estimate

	Planning & Programming	Preliminary Design	Design
<u>A. Communicate the Basis of Estimate.</u> <ul style="list-style-type: none"> <li>• Define the details as concisely, yet completely, as possible. Technical terms may be used but should be understandable to the public and other external stakeholders.</li> <li>• The Basis of Estimate should be easy to correlate with the communicated costs.</li> <li>• Estimate communication will occur internally with project team members who will inherit the estimate for later project development and cost control.</li> <li>• Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review approved estimate.</li> <li>2. Extract key Basis of Estimate items (e.g., project definition description).</li> <li>3. List the key items that adequately describe the project design.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Basis of Estimate and previously approved Estimate Package.</li> <li>2. Extract key Basis of Estimate items (e.g., project definition description).</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Approved Updated Estimate with changes.</li> <li>2. Extract key Basis of Estimate items (e.g., project definition description).</li> <li>3. List the key items that adequately describe the project design.</li> </ol>
<u>B. Communicate estimate costs.</u> <ul style="list-style-type: none"> <li>• The communication package should be reviewed thoroughly to identify all assumptions made in creating the estimate and communicate the estimate as a range to account of variability, uncertainty, and risks.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Approved Estimate.</li> <li>2. Extract key cost elements and summarize.</li> <li>3. Extract key estimate assumptions used to prepare estimate.</li> <li>4. List key assumptions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Baseline Estimate and Approved Cost Packages.</li> <li>2. Extract key cost elements and summarize.</li> <li>3. Extract key estimate assumptions use to prepare Base Estimate.</li> <li>4. List the key assumptions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Approved Updated Estimates with Changes.</li> <li>2. Extract key cost elements and summarize.</li> <li>3. Extract key estimate assumptions use to prepare design estimate.</li> <li>4. List the key assumptions.</li> </ol>

## Stage 5: Communicate Estimate

	Planning & Programming	Preliminary Design	Design
<u>C. Communicate uncertainty and assumptions:</u>	<ul style="list-style-type: none"> <li>• An estimate with uncertainty is not a bad estimate; it is a realistic estimate.</li> <li>• Project uncertainty should be communicated with each estimate. A simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties.</li> <li>• Communicate maturity, estimate class &amp; contingency for update in DCIS.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Approved Estimate Package.</li> <li>2. Extract key risks and cost elements with significant potential estimate variations.</li> <li>3. List key risks and other areas of uncertainty.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review Baseline Estimate and Approved Cost Packages.</li> <li>2. Extract key risks and cost elements with significant potential estimate variations.</li> <li>3. List key risks and other areas of uncertainty.</li> </ol>
<u>D. Prepare one-page cost estimate summary:</u>	<ul style="list-style-type: none"> <li>• Understand that a project estimates will be communicated within TxDOT, with other appropriate authorities, and also the general public.</li> <li>• All costs should be expressed in terms of the Total Construction Cost Estimate and the year of construction.</li> </ul>	<ol style="list-style-type: none"> <li>1. Review the Approved Estimate Package, the Identified Uncertainties, and the Estimate Basis.</li> <li>2. Prepare one-page summary.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review the Approved Planning Estimate, the identified uncertainties, and the Communication Package from Planning and Programming.</li> <li>2. Prepare one-page summary of Total Construction Cost Estimate Summary.</li> </ol>



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## PART IV – APPENDICES

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## APPENDIX A. GLOSSARY

- Allowance.** An amount included in the Base Estimate for items that are known to be included in the construction costs but the details of which have not yet been determined.
- Base Estimate.** The most likely construction cost estimate in any phase at any time, which normally includes all estimated known project costs, but does not include Project Contingency.
- Baseline Cost Estimate.** The most likely estimated construction cost including Project Contingency, which constitutes the approved project budget against which project costs are managed.
- Basis of Estimate (or Estimate Basis).** A documentation of the project type and scope for each cost estimate, including items such as drawings that are available (defining percent engineering and design completion), project design parameters, project complexity, unique project location characteristics, and disciplines required to prepare the cost estimate.
- Bid-Based Estimating.** Method of estimating in which historical bid data are used.
- Conceptual Estimate.** A cost estimate prepared from only a concept description of a project. This estimate is generally considered high-level in nature and prepared before plans, specifications, and other project details have been fully developed.
- Construction Cost Estimating.** The processes for approximating all construction costs. Construction cost estimating involves the following steps: determine Basis of Estimate, prepare Base Estimate, determine risk and set contingency, and review total estimate.
- Cost Escalation.** Increases in the cost of a project or item of work over a period of time.
- Cost Estimating and Cost Management Process Model.** A tool for standardization and documentation of the project cost estimating and cost management activities and deliverables, from the Planning and Programming phase through the end of the Design phase.
- Cost Management.** The process for managing the cost estimate through reviews and approvals, communicating estimates, monitoring of scope and project conditions, evaluating the impact of changes, and making estimate adjustments as appropriate.
- Engineer's Estimate.** The construction cost estimate used as a benchmark to compare against contractor bids. This estimate is prepared using 100 percent completed plans with all itemized pay items, quantities, and contract documents.
- Inflation.** The rate that the cost of goods or services increases or, consequently, the decrease in purchasing power. Therefore, an estimated cost must be adjusted for the time difference between historical bids and the assumed date of project execution.
- Initial Estimate.** The first estimate released publicly by TxDOT. This estimate is usually made with only minimal scope definition.

**Market Conditions.** A reflection of a moment of the market. Current market conditions reflect today's conditions, which can be a result of market fluctuations in the past few months and can affect the coming phases of the project.

**Materials.** Materials that are installed permanently in the completed project.

**Plans, Specifications & Estimate (PS&E).** The contract plans, specifications package, and estimate submittal used for project authorization, advertisement, and letting.

**Probability.** A measure of how likely a condition or event is to occur. It ranges from 0 to 100 percent (or 0.00 to 1.00).

**Project Contingency.** An estimate of costs associated with identified risks, the sum of which is added to the Base Estimate.

**Project Cost Control.** The process of controlling deviations from the estimated project costs and monitoring the risks and contingencies associated with changes.

**Project Management.** Management of the project scope, schedule, and cost through seamless integration of the project purpose and need, the stakeholder requirements, and the resources for project development, engineering, safety, and quality.

**Qualitative Risk Assessment.** Performing a qualitative analysis of risks and conditions to prioritize their effects on project objectives. It involves assessing the probability and impact of project risk(s) and using methods such as the probability and impact matrix to classify risks into categories such as high, moderate, and low for prioritized risk response planning.

**Quantitative Risk Analysis.** Measuring the probability and consequences of risks and estimating their implications for project objectives. Risks are characterized by probability distributions of possible outcomes. This process uses quantitative techniques such as simulation and decision tree analysis.

**Risk.** An uncertain event or condition that, if it occurs, has a negative or positive effect on a project's objectives.

**Risk Acceptance.** This technique of the Risk Response process indicates that the project team has decided not to change the project plan to deal with a risk, or is unable to identify any other suitable response strategy.

**Risk Avoidance.** This technique of the Risk Response process involves changing the project plan to eliminate the risk or to protect the project objectives from its impact.

**Risk Documentation.** Recording, maintaining, and reporting assessments, handling analysis and plans, and monitoring results. It includes all plans, reports for the Project Manager and decision authorities, and reporting forms that may be internal to the Project Manager.

**Risk Identification.** Determining which risks might affect the project and documenting their characteristics.

**Risk Management.** All of the steps associated with managing risks: risk identification, risk assessment and analysis (qualitative or quantitative), risk response, and risk monitoring and control.

**Risk Mitigation.** This technique of the Risk Response process seeks to reduce the probability and/or impact of a risk to below an acceptable threshold.

**Risk Monitoring and Control.** The capture, analysis, and reporting of project performance, usually as compared to the risk management plan.

**Risk Register.** A document detailing all identified risks, including description, cause, probability of occurring, impact(s) on objectives, proposed responses, owners, and current status.

**Risk Response.** Analyzing risk response options (acceptance, avoidance, mitigation, or transference) and deciding how to approach and plan risk management activities for a project.

**Risk Transference.** This technique of the Risk Response process seeks to shift the impact of a risk to a third party together with ownership of the response.

**Scope.** Encompasses the elements, characteristics, and parameters of a project and work that must be accomplished to deliver a product with the specified requirements, features, and functions.

**Scope Changes.** Changes in the requirements or specifications on which the design is based. Examples would include changes to project limits, work types, or capacity factors, such as traffic loads, vehicles per lane, or storm water factors.

**Scope Creep.** As opposed to scope change, which is a major change affecting project cost and schedule, scope creep is an accumulation of minor scope changes that incrementally change project scope, cost, and schedule.

**Simulation.** A simulation uses a project model that translates the uncertainties specified at a detailed level into their potential impact on objectives that are expressed at the level of the total project. Project simulations use computer models and estimates of risk at a detailed level, and are typically performed using the Monte Carlo technique.

**Total Construction Cost Estimate.** The sum of the construction Base Estimate and the Project Contingency, in any phase at any time.

**Unit Price.** The price (including materials, labor, equipment, overhead, and profit) in a contract for a specifically described unit of work. This is also known as the in-place cost or contract unit price.

## APPENDIX B. RACI DIAGRAMS

<b>What is it?</b>	<b>What does it do?</b>
A chart that defines the roles and responsibilities for each task or step or sub-process in risk-based estimation.	<ul style="list-style-type: none"> <li>• Addresses TxDOT management's vision of defining clear accountability for the steps in the cost estimate and cost management process throughout project development.</li> </ul>
<b>When to use it?</b> A RACI chart must be prepared when a project team is first formed, especially for large or complex projects on which communication plays a decisive role in project success.	<ul style="list-style-type: none"> <li>• Designates:</li> <li>○ Who is <i>responsible</i> for performing the task (R).</li> <li>○ Who is <i>accountable</i>, i.e., who has the final authority for directing the work or making key decisions (A).</li> <li>○ Who must be <i>consulted</i> when performing the task, especially before finalizing key decisions (C).</li> <li>○ Who must be <i>informed</i> when performing the task (I).</li> </ul>
<b>Why use it?</b> <ul style="list-style-type: none"> <li>• Helps project team members understand their roles, responsibilities, and accountabilities to various tasks during project development and execution.</li> </ul>	
<b>How to use it?</b>	
<ul style="list-style-type: none"> <li>• Tailor the RACI chart(s) to your specific District and project needs.</li> <li>• Hold a meeting to complete the RACI chart(s) and have players from Management, Estimating, and Project Management in attendance.</li> <li>• Discuss the roles and responsibilities that are going to be assigned.</li> <li>• Assign the roles in this order: R, A, C, I.</li> <li>• Once the roles have been assigned for each step and there is a consensus that they are properly assigned, look at the completed charts and each of the vertical columns. For each column, consider the following: <ul style="list-style-type: none"> <li>a. Are there too many Rs? Having a high number of Rs may be too much work for any one person if there are other roles that this position plays within the organization.</li> <li>b. Does any one column have no empty spaces or very few? Again, if the sole role of this person within TxDOT is to work with the Risk-based estimating framework, this may be acceptable, but consider the work load. This person may be working on multiple projects or may have too much involvement?</li> <li>c. Are there too many As assigned to any one person? There is a need to push accountability to the lowest level possible within TxDOT while maintaining the necessary authority associated with the accountability.</li> </ul> </li> <li>• Once produced, review the RACI chart(s) periodically, particularly at the gates in project development and other subsequent milestones.</li> </ul>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>• Development of the RACI should be a group effort.</li> <li>• One individual should typically be accountable for each distinct task or step or sub-process. However, multiple individuals can be responsible or have to be consulted or informed.</li> <li>• In order to keep the RACI chart manageable, the project team needs to keep the total number of people associated with a task or a step to a minimum.</li> <li>• Keep the number of rows and the number of people associated with each row to a minimum will help keep the team focused and make the use of the RACI chart effective.</li> <li>• There may be multiple Rs for each step, but this should be limited to those actually doing the step. If there are too many Rs, then the step may not get completed. If there are no Rs, then this step will never get completed, as everyone is waiting to approve, consult, or inform.</li> <li>• This may or may not be the same as R, but remember there can only be one A for each step. Since this is</li> </ul>	

the position that is ultimately answerable for the step, there should be some authority with the assignment of this role. If there is no A for each step, then there is no personal consequence for getting the job done, or done right. There must be at least one A for each step.

- When assigning Cs and Is, consider whether this a two-way or one-way communication? Consulting is a two-way communication, and consultation must take place prior to completing the step. Informing is a one-way communication; the communication takes place after the step is completed and is for informational purposes.
- If there are large numbers of Cs for a step, consider whether all of these positions really need to be consulted? An answer of “yes” is acceptable, but make sure that there is benefit added from the exchange.
- If there are a lot of Is, consider whether all of the individuals need to be informed routinely or just in special circumstances. If information is only required in special circumstances, be sure to note those times.
- Identify how communication to inform should be delivered for each I. “Push” information requires sending the information to the person, for example via email. “Pull” information means the information can be obtained by the individual through a readily available source such as a website.
- If there are no Cs or Is, consider whether this is because there is a lack of communication or because no Cs or Is are required?

The example RACI Diagrams presented are for illustration purposes (see Figure 13, Figure 14 and Figure 15). Districts are encouraged to modify these diagrams to meet the needs of the individual districts and projects. In addition, separate RACI matrices may be warranted for the different project rigors.

	Management Groups														
	Management			Estimating		Project Management			External Stakeholders						
	District Engineer	Assistant District Engineer	Director of TP&D	Area Engineer/Design Lead	Functional Groups/Division	PMO	Project Manager	Divisions	Consultants	Legislature	Public	Businesses	Local Partners	FHWA	Regulatory Agencies
Determine Estimate Basis															
Prepare Base Estimate															
Determine Risk and Set Contingency															
Review & Approve Estimates															
Communicate Estimate															

**Figure 13. Example of General RACI Diagram**

	Management	Estimating	Project Management	External Stakeholders
Step A. Determine Review Level	District Engineer			
Step B. Review Estimate Assumptions	Assistant District Engineer			
Step C. Verify Completeness & Cost Data	Director of TP&D	Area Engineer/Design Lead		
Step D. Reconcile with Latest Estimate		Functional Groups/Division		
Step E. Approve Estimate Package		PMO		
		Project Manager		
		Divisions		
		Consultants		
		Legislature		
		Public		
		Businesses		
		Local Partners		
		FHWA		
		Regulatory Agencies		
		Media		

**Figure 14. RACI for Review and Approve Estimate (Stage 4)**

	Management			Estimating		Project Management		External Stakeholders								
	District Engineer	Assistant District Engineer	Director of TP&D	Area Engineer/Design Lead	Functional Groups/Division	PMO	Project Manager	Divisions	Consultants	Legislature	Public	Businesses	Local Partners	FHWA	Regulatory Agencies	Media
Step A. Communicate Estimate Basis																
Step B. Communicate Estimated Costs																
Step C. Communicate Uncertainty and Assumptions																
Step D. Prepare One-Page Cost Estimate Summary																

**Figure 15. RACI for Risk-Based Estimating for Preliminary Design for Communicate Estimate**

## APPENDIX C. TOOLS

The tools described in this Tool Appendix of the Reference Guide are adapted from the Tool Appendix included in NCHRP Report 574, *Guidance for Cost Estimating and Management during Planning, Priority Programming, and Preconstruction*. Report 574 Tool Appendix has 72 different tools that are described in terms of over 90 different applications. The tools included in this Reference Guide were selected based on an assessment of current TxDOT practices, tools, and resources as well as the desire to implement tools that would support adoption of best practices. A number of the Report 574 tools were refined or the existing TxDOT-equivalent was substituted. The tools in this appendix represent the final set of tools selected by TxDOT for the first version of the Reference Guide. New tools will be added, existing tools will be refined, and some tools will be retired.

This Tool Appendix describes all the tools referenced in the Reference Guide. The material presented in this appendix is a synopsis and distillation of good practices currently being used by state highway agencies, only adapted to fit within the TxDOT culture. Utilization of individual tools in an “al la Carte” fashion will have limited impact on improving the accuracy of cost estimates and managing project costs. To be effective, appropriate tools should be used to support the structured estimating approach presented in the body of this Reference Guide.

A common informational structure for describing each tool is the following:

- What is the tool?
- What is the tool used for, and why is the tool used?
- What does the tool do or create?
- When should the tool be used?
- How should the tool be used (includes examples or applications of the tool)?
- What tips will lead to successful use of the tool?
- Where can the user find more information to support development of a specific tool?

Table 17 presents a summary of the tools recommended for risk-based estimating. The tools are categorized by stage. Within each stage, a tool is listed under the specific project phases in which it is suggested.

**Table 17. Summary of Tools by Project Phase.**

STAGE	Planning & Programming	Preliminary Design	Design
1. <u>Determine/ Update Estimate Basis</u>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Design Summary Report</a></li> <li>• <a href="#">Advance Planning Risk Analysis Tool</a></li> <li>• <a href="#">Annual Scope and Estimate Documentation Form</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Design Summary Report</a></li> <li>• <a href="#">Advance Planning Risk Analysis Tool</a></li> <li>• <a href="#">Annual Scope and Estimate Documentation Form</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Design Summary Report</a></li> <li>• <a href="#">Annual Scope and Estimate Documentation Form</a></li> </ul>
2. <u>Prepare/ Update Base Estimate</u>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template</a></li> <li>• <a href="#">Typical Sections on a Per Mile Basis</a></li> <li>• <a href="#">Parametric Estimating</a></li> <li>• <a href="#">Similar Projects</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Historical Bids</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template</a></li> <li>• <a href="#">Typical Sections on a Per Mile Basis</a></li> <li>• <a href="#">Similar Projects</a></li> <li>• <a href="#">Parametric Estimating.</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Historical Bids</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template</a></li> <li>• <a href="#">Typical Sections on a Per Mile Basis</a></li> <li>• <a href="#">Similar Projects</a></li> <li>• <a href="#">Parametric Estimating.</a></li> </ul>
3. <u>Determine Risk and Set Contingency</u>	<ul style="list-style-type: none"> <li>• <a href="#">Advance Planning Risk Analysis (APRA)</a></li> <li>• <a href="#">Crawford Slip Method.</a></li> <li>• <a href="#">Estimate Ranges – Monte Carlo Analysis</a></li> <li>• <a href="#">Estimate Ranges – Three Point Analysis</a></li> <li>• <a href="#">Expert Team.</a></li> <li>• <a href="#">Probability × Impact Matrix (PxI)</a></li> <li>• <a href="#">Project Estimate File.</a></li> <li>• <a href="#">Risk Breakdown Structure</a></li> <li>• <a href="#">Risk Checklist.</a></li> <li>• <a href="#">Risk Register</a></li> <li>• <a href="#">Risk Workshop.</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template.</a></li> <li>• <a href="#">Risk Assessment for Low Rigor Projects</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Advance Planning Risk Analysis (APRA)</a></li> <li>• <a href="#">Crawford Slip Method.</a></li> <li>• <a href="#">Estimate Ranges – Monte Carlo Analysis</a></li> <li>• <a href="#">Estimate Ranges – Three Point Analysis</a></li> <li>• <a href="#">Expert Team.</a></li> <li>• <a href="#">Probability × Impact Matrix (PxI)</a></li> <li>• <a href="#">Project Estimate File.</a></li> <li>• <a href="#">Risk Breakdown Structure</a></li> <li>• <a href="#">Risk Checklist.</a></li> <li>• <a href="#">Risk Register</a></li> <li>• <a href="#">Risk Workshop.</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template.</a></li> <li>• <a href="#">Risk Assessment for Low Rigor Projects</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Crawford Slip Method.</a></li> <li>• <a href="#">Estimate Ranges – Monte Carlo Analysis</a></li> <li>• <a href="#">Estimate Ranges – Three Point Analysis</a></li> <li>• <a href="#">Expert Team.</a></li> <li>• <a href="#">Probability × Impact Matrix (PxI)</a></li> <li>• <a href="#">Project Estimate File.</a></li> <li>• <a href="#">Risk Breakdown Structure</a></li> <li>• <a href="#">Risk Checklist.</a></li> <li>• <a href="#">Risk Register</a></li> <li>• <a href="#">Risk Workshop.</a></li> <li>• <a href="#">Cost Estimate Spreadsheet Template.</a></li> <li>• <a href="#">Risk Assessment for Low Rigor Projects</a></li> </ul>
4. <u>Review and Approve Estimate</u>	<ul style="list-style-type: none"> <li>• <a href="#">Expert Team</a></li> <li>• <a href="#">Formal Committee</a></li> <li>• <a href="#">In-House/Peer</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Round Table Estimate Review</a></li> <li>• <a href="#">Variance Reports on Cost</a></li> <li>• <a href="#">Annual Scope and Estimate Document</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Expert Team</a></li> <li>• <a href="#">Formal Committee</a></li> <li>• <a href="#">In-House/Peer</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Round Table Estimate Review</a></li> <li>• <a href="#">Variance Reports on Cost</a></li> <li>• <a href="#">Annual Scope and Estimate Document</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Expert Team</a></li> <li>• <a href="#">Formal Committee</a></li> <li>• <a href="#">In-House/Peer</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Round Table Estimate Review</a></li> <li>• <a href="#">Variance Reports on Cost</a></li> </ul>
5. <u>Communicate Estimate</u>	<ul style="list-style-type: none"> <li>• <a href="#">One-Page Cost Estimate Summary.</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Annual Scope and Estimate Document</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">One-Page Cost Estimate Summary.</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Annual Scope and Estimate Document</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">One-Page Cost Estimate Summary.</a></li> <li>• <a href="#">Project Estimate File</a></li> <li>• <a href="#">Annual Scope and Estimate Document</a></li> </ul>

ADVANCE PLANNING RISK ANALYSIS	
What is it?	What does it do?
<ul style="list-style-type: none"> <li>The Advance Planning Risk Analysis (APRA) tool was developed under TxDOT research project 0-5478.</li> <li>A spreadsheet-based tool to measure project scope definition for completeness and identify potential risks early in the project. It helps optimize the identification of project requirements during the project development process across all major disciplines, including right-of-way, utilities, environmental, design, transportation planning and programming, and construction.</li> </ul>	<ul style="list-style-type: none"> <li>It identifies and precisely describes each critical element of the project scope and allows a project team to quickly predict factors impacting project risk.</li> <li>It is intended to evaluate the completeness of the scope definition at any point prior to plans, specifications, and estimates (PS&amp;E) development and construction.</li> <li>The APRA provides a means for all project participants to communicate and reconcile differences using an objective tool as a common basis for project scope evaluation.</li> </ul>
When to use it?	
<ul style="list-style-type: none"> <li>Planning and Programming.</li> <li>Preliminary Design.</li> </ul>	
Why use it?	Effective early project planning improves project performance in terms of both cost and schedule. Research has shown the importance of scope definition during the early stages of a project and its potential impact on project success.
How to use it?	<ul style="list-style-type: none"> <li>Refer to the User's Guide developed for the Advance Planning Risk Analysis (APRA) tool.</li> </ul>
Tips	<ul style="list-style-type: none"> <li>Commit to advance planning. Effective planning in the early stages of transportation projects can greatly enhance cost, schedule, and operational performance while minimizing the possibility of financial failures and disasters.</li> <li>Gain and maintain project team alignment by using the APRA throughout the advance planning phase and the project development process. Discussions around the scope definition checklists are particularly effective in helping with team alignment.</li> <li>Adjust the APRA as necessary to meet the specific needs of your project. The APRA was designed so that certain elements considered not applicable on a particular project can be zeroed out, thus eliminating them from the final scoring calculation.</li> <li>Use the APRA to improve advance planning. Build your own internal database of projects that are scored using the APRA. Compute APRA scores at the various times during scope development and compare versus project success. Based upon the relationship between APRA scores and project success, establish your own basis for the level of scope definition that you feel is acceptable for moving forward from phase to phase.</li> <li>Use caution when beginning detailed design of projects with high APRA scores. The higher the APRA score, the less defined the project scope, thus there is more likelihood that the project will have poor performance.</li> </ul>

<b>ANNUAL SCOPE AND ESTIMATE DOCUMENTATION FORM</b>	
<b>What is it?</b>	<b>What does it do?</b>
A summary form and spreadsheet template to record intermittent updates to a project's scope and cost.	<ul style="list-style-type: none"> <li>Used to document the estimate values listed on the Cost Estimate History (P8) screen in the Design/Construction Information System (DCIS) database.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Reasonable and accurate cost estimating, and intermittent updating of these costs, helps maintain public confidence and trust throughout the life of a project. When a project cost estimate escalates, it impacts the funding for other needed projects and requires that the department has a record to explain the reason for rising estimated costs.</li> <li>Used in conjunction with the Estimate Variance Report, can aid in reconciling differences with previous estimates.</li> </ul>
<b>How to use it?</b>	<ol style="list-style-type: none"> <li>Complete the scope and estimate summary form using current project information.</li> <li>Give a detailed account of the scope including all items of work so that subtle changes in scope which cause estimate changes can be documented and tracked.</li> <li>Use the spreadsheet accompanying the form to calculate the quantity-based cost of the major work categories for the project.</li> </ol>
<b>Tips</b>	<ul style="list-style-type: none"> <li>The form should be used to track costs at the least complicated level, the control-section-job number (CSJ). Use this form for one CSJ only.</li> <li>The Estimator should keep a file for each project/CSJ with any other documentation supporting the quantities, unit costs, etc.</li> </ul>

CONTINGENCY – LOW RIGOR PROJECTS	
What is it?	What does it do?
A method for qualitatively examining the potential risks on low rigor projects and establishing a contingency amount based on judgment of the risk analysis.	<ul style="list-style-type: none"> <li>Used to document the consideration of possible risks on low rigor projects without the need to conduct a full risk workshop or other extensive risk identification/analysis procedure.</li> <li>Quickly allows the project team to deliberately consider the uniqueness of smaller projects that are often considered “typical.”</li> <li>The contingency provides funds to cover unforeseeable items that will get resolved as the design progresses.</li> </ul>
When to use it?	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
Why use it?	<ul style="list-style-type: none"> <li>At any stage on project development, there are inherent difficulties in predicting the future and having all uncertainties resolved. The Base Estimate will contain the known and quantifiable costs. This qualitative analysis aids in determining a contingency percentage to apply to the base cost to cover unquantified or unknown costs.</li> </ul>
How to use it?	<ol style="list-style-type: none"> <li>Using the risk checklist, consider the possibility of each potential risks on the given low-rigor project.</li> <li>If a risk is identified as possible, indicate if the impact to the project’s construction cost would be “low”, “medium”, or “high” if that risk occurs. Think in terms of impact to total construction cost, and not the necessarily to the impact of one or a few bid items.</li> <li>Once complete, review the checklist to determine if there are generally more “low”, “medium”, or “high” potential costs impacts.</li> <li>Apply a contingency percentage based on the consideration of total project risks, similar projects, and engineering judgment.</li> </ol>
Tips	<ul style="list-style-type: none"> <li>For low rigor projects, consider the impact to construction cost of individual risks. The probably of a risk occurring should weigh in the where in the percentage range the contingency should be established.</li> <li>Until a thorough analysis of TxDOT’s low-rigor projects by district is completed to determine what percentages should be used, the following ranges are suggested as a starting point: <ul style="list-style-type: none"> <li>Mostly “low” impact risks: 3%-7% contingency.</li> <li>Mostly “medium” impact risks: 5%-12% contingency.</li> <li>Mostly “high” impact risks: 10%-20% contingency.</li> </ul> </li> <li>When choosing a contingency percentage, consider the development phase of the project and how much more information will be gathered and how defined are individual design elements (e.g., structures, drainage, alignment, etc.)</li> </ul>

## Risk Assessment for Low Rigor Projects

Context	Risk Description	Level of Impact to Project Cost		
		Low	Medium	High
Technical Risk	Unanticipated geotechnical issues			
	Inaccurate assumptions of technical issues during planning phase			
	Survey late, inaccurate, or incomplete			
	Consultant design not up to department standards			
External Risk	Uncooperative land owners			
	Local communities pose objections			
	Inconsistent cost, time, scope, and quality objectives			
	Political factors			
Environmental Risk	Influential stakeholders request late changes			
	Permits or agency actions delayed or take longer than expected			
	New information required for permits			
	Historic site, endangered species, or wetlands present			
	Formal NEPA 404 consultation required			
	Formal Section 7 consultation required			
	Section 4(f) resources impacted			
	Project in the Coastal Zone			
	Project in a floodplain or a regulatory floodway			
	Project located in an area of non-attainment for air quality standards			
	Negative community impacts anticipated			
	Hazardous waste preliminary site investigation required			
Right-of-Way Risk	Environmental Impact Statement (EIS) required			
	Utility relocations may delay project			
	Railroad involvement			
	Objections to right-of-way appraisal (i.e. Eminent Domain proceedings)			
Design Risk	Other acquisition problems			
	Lengthy bridge design requirements			
	Traffic demand issues			
	Sufficient staff volume or experience to perform work			
Construction Risk	Availability of consultant design services			
	Contaminated soils			
	Natural hazards			
	Limited work window			
	Insufficient staging areas			
	Unique traffic issues			

COST ESTIMATE SPREADSHEET TEMPLATE	
What is it?	What does it do?
<p>Electronic spreadsheet programs offer the computing power of the computer and text editing and formatting capabilities at high speed and low cost. The electronic spreadsheet can store both the formulas and the computed values returned by the formulas and, therefore, provide great economies when there are numerous repetitive calculations to be made.</p>	<ul style="list-style-type: none"> <li>Simple electronic spreadsheets can be developed to estimate small projects or they can be created to support other estimation programs.</li> <li>Spreadsheets are also excellent tools for supporting and documenting quantity takeoff work.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>All phases.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>Electronic spreadsheet programs speed up estimate calculations and will automatically update all calculations when values are changed. In the case of repetitive calculations, there is only the need to formulate the mathematics once.</li> <li>Spreadsheets are something that everyone is already familiar with and how the software works, so training time is almost nonexistent.</li> </ul>	
<b>How to use it?</b>	
<ol style="list-style-type: none"> <li>Identify the categories, elements, and/or items covered in the estimate.</li> <li>Select predefined or input categories, elements, and/or items.</li> <li>Input quantity information for each element and/or item.</li> <li>Refer to historical data to determine the unit cost for elements and items that comprise the project. A historical cost database spreadsheet can be directly linked to this cell, which will automatically capture unit price values.</li> <li>Enter historical unit price data for the elements and/or items.</li> <li>Check the values of the data entered.</li> <li>Generate the estimated cost for categories, elements, and/or items contained on the spreadsheet.</li> <li>Separate the items of the Base Estimate from the risk and other items that make up the Project Contingency.</li> <li>Do not bury contingency by using overly conservative qualities and/or inflated unit prices.</li> <li>Prepare a summary report with the help of the spreadsheet template.</li> <li>Include the report and estimation support documents in the Project Estimate File.</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>Spend time setting up calculations; verify that calculations are made correctly and cost</li> <li>Ensure that spreadsheet supports all the project requirements and work categories.</li> <li>Use tabs to perform different functions.</li> <li>When updating an estimate, do not merely overwrite the cells of the previous project estimate. A copy of each unique estimate should be maintained in order to see the how the historical estimates for a project have changed over time.</li> <li>Figure 21 and Figure 22 are examples from a spreadsheet template that demonstrates the organization of elements and cost within the construction estimate.</li> </ul>	

Highway:	H 410
County:	Bexar
C.S.J.:	0521-04-274
Filename:	
Description:	Reconstruct interchange
Limits:	at SH 151 to interchange
Length:	1.321 miles
Estimate By:	Joe Texan
Date:	2/26/2014



Default Quantity Range (Percentage of Most Likely Value)			Default Cost Range (Percentage of Most Likely Value)		
Minimum	Most Likely	Maximum	Minimum	Most Likely	Maximum
100%	100%	100%	100%	100%	100%

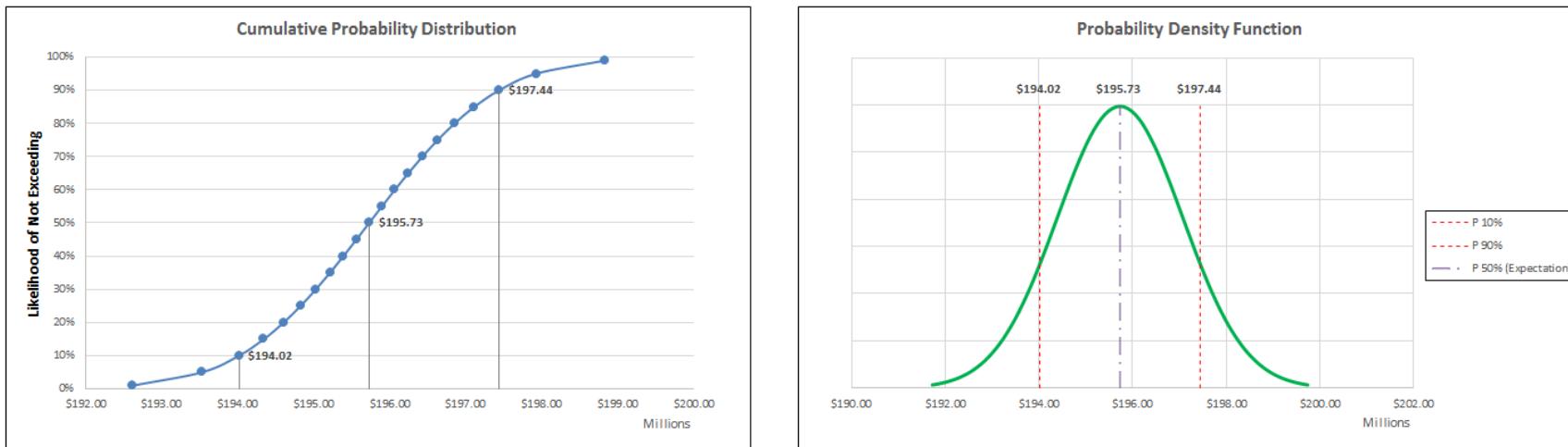
ITEM	DESCRIPTION	UNITS	EST. QTY.			UNIT COST			AMOUNT			Expected Value	Variance	NOTE			
			Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.						
<b>Earthwork and Landscape</b>																	
<b>Earthwork</b>																	
100	Preparing Right of Way	STA	320.00	320.00	320.00	\$2,000.00	\$2,000.00	\$2,000.00	\$640,000.00	\$640,000.00	\$640,000.00	0.00E+00					
110	Excavation (Roadway)	CY	100,000.00	100,000.00	100,000.00	\$7.50	\$7.50	\$7.50	\$750,000.00	\$750,000.00	\$750,000.00	0.00E+00					
112	Subgrade Widening		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
132	Embankment	CY	250,000.00	250,000.00	250,000.00	\$3.00	\$3.00	\$3.00	\$750,000.00	\$750,000.00	\$750,000.00	0.00E+00					
134	Backfilling Pavement Edges		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
150	Blading		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
152	Road Grader Work		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
154	Scraper Work		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
156	Bulldozer Work		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
158	Specialized Excavation Work		0.00	0.00	0.00	\$1.00	\$1.00	\$1.00	\$0.00	\$0.00	\$0.00	0.00E+00					
<b>Landscape</b>										<b>Sub-Total (Earthwork)</b>			<b>\$6,325,454.73</b>	<b>0.00E+00</b>			

Additional Items	<b>Sub-Total (Additional Items)</b>	<b>\$36,800.00</b>	<b>0.00E+00</b>						
	<b>SUB-TOTAL (Base Estimate)</b>	<b>\$178,072,138.69</b>	<b>0.00E+00</b>						
<b>Risk Items (Contingency)</b>									
	<b>Sub-Total (Risk Items -- Contingency)</b>	<b>\$17,658,820.42</b>	<b>1.78E+12</b>						
<b>TOTAL = Base + Contingency</b>									
	P (50%)	\$195,730,959.11	1.78E+12						
<table border="1"> <tr><td>Agressive (10% chance of NOT exceeding)</td><td>\$194,019,394.40</td></tr> <tr><td>Expected (50% chance of NOT exceeding)</td><td>\$195,730,959.11</td></tr> <tr><td>Conservative (90% chance of NOT exceeding)</td><td>\$197,442,523.82</td></tr> </table>				Agressive (10% chance of NOT exceeding)	\$194,019,394.40	Expected (50% chance of NOT exceeding)	\$195,730,959.11	Conservative (90% chance of NOT exceeding)	\$197,442,523.82
Agressive (10% chance of NOT exceeding)	\$194,019,394.40								
Expected (50% chance of NOT exceeding)	\$195,730,959.11								
Conservative (90% chance of NOT exceeding)	\$197,442,523.82								

## Sample Cost Estimate Spreadsheet Template.

**Estimation Method: Three-point estimate using BETA DISTRIBUTION**

*(Without Inflation)*



Probability Values	
P (5%) =	\$ 193,534,189.58
P (10%) =	\$ 194,019,394.40
P (15%) =	\$ 194,346,759.78
P (20%) =	\$ 194,606,939.41
P (25%) =	\$ 194,830,150.36
P (30%) =	\$ 195,030,600.70
P (35%) =	\$ 195,216,347.81
P (40%) =	\$ 195,392,603.65
P (45%) =	\$ 195,563,133.22
P (50%) =	<b>\$ 195,730,959.11</b>
P (55%) =	\$ 195,898,784.99
P (60%) =	\$ 196,069,314.56
P (65%) =	\$ 196,245,570.40
P (70%) =	<b>\$ 196,431,317.51</b>
P (75%) =	\$ 196,631,767.85
P (80%) =	\$ 196,854,978.80
P (85%) =	\$ 197,115,158.43
P (90%) =	\$ 197,442,523.82
P (95%) =	\$ 197,927,728.63

*(Without Inflation)*

**Probability Outputs using Sample Cost Estimate Spreadsheet Template.**

## CRAWFORD SLIP METHOD

<b>What is it?</b>	<b>What does it do?</b>
A rapid, independent brainstorming session that generates a large number of risks in a short period of time.	<ul style="list-style-type: none"> <li>• Identifies risks that can later be examined in more detail.</li> <li>• Allows individuals to identify risks in a group setting without influence from other team members.</li> <li>• Generates a large number of potential risks.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>• Helps to independently identify risks, rather than being guided by the opinion of the group.</li> </ul>
<b>How to use it?</b>	<ol style="list-style-type: none"> <li>1. Introduce the process to the team members.</li> <li>2. For 10 minutes, each participant writes down one risk each minute.</li> <li>3. After each minute, the current risk is set aside and each member starts a new one. This forces each participant to write down one, and only one, risk during each minute.</li> <li>4. At the end of the 10 minutes, collect all of the risks.</li> <li>5. Collate and organize the risks, eliminating duplicates.</li> <li>6. Present the results to the group afterward to clarify the intention of the risk identifiers, as well as to evaluate each risk as a group.</li> <li>7. After presenting the results to the group, ask the participants whether there are any additional risks they may have thought of after hearing the ideas of others.</li> </ol>
<b>Tips</b>	<ul style="list-style-type: none"> <li>• Since the Crawford Slip method generates a large number of risks, allow for time to collate like risks. This can be done independently by the facilitator or it can be done in a group setting.</li> <li>• Use the Crawford Slip as a starting point for risk identification. Do not rely solely on the Crawford Slip for risk identification. While it is a powerful tool, it may not comprehensively identify all risks on the project because the nature in which risks are identified is dependent on the people participating. For example, if someone from ROW is not present during the risk identification process, then some risks associated with ROW could be inadvertently overlooked.</li> </ul>

<b>DESIGN SUMMARY REPORT</b>	
<b>What is it?</b>	<b>What does it do?</b>
A document that will help ensure that the project team does not overlook potential critical issues in the development of the project's scope.	<ul style="list-style-type: none"> <li>• Aids in the preparation for the Design Concept Conference.</li> <li>• </li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>• All phases.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>• To document the agreed upon fundamental aspects, concepts, and design criteria of a project.</li> <li>• Serves as the definition of the project's scope.</li> </ul>	
<b>How to use it?</b>	
<ol style="list-style-type: none"> <li>1. Complete appropriate parts of DSR and circulate to all applicable parties.</li> <li>2. Obtain concurrence or disagreement by approval entities listed in the DSR.</li> <li>3. Update DSR as project progresses, and make updated DSRs available to approval entities and other parties with a need to know.</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>• While all items will not be applicable to all projects, overlooking any item within the DRS may significantly delay the project.</li> <li>• The recommended DSR form is available in PDF format.</li> <li>• The form should be considered a work in progress and additional information can be added as the project develops.</li> <li>• For low rigor projects, a “mini” version of the DSR form may be sufficient. Attached are two versions of truncated design concept and criteria forms: one developed by the Houston District (Form DF-DD100) and one developed by the Beaumont District (Design Criteria Report.)</li> </ul>	

**PROJECT DESIGN ELEMENTS****"Mini" Design Concept Conference**

Hwy \_\_\_\_\_ Project No. \_\_\_\_\_ CSJ \_\_\_\_\_ County \_\_\_\_\_  
 Limits: \_\_\_\_\_ Letting: \_\_\_\_\_ (MMM/YYYY)

Total Project Length \_\_\_\_\_ Roadway \_\_\_\_\_ Bridge \_\_\_\_\_  
 \_\_\_\_\_ KM \_\_\_\_\_ MI \_\_\_\_\_ KM \_\_\_\_\_ MI \_\_\_\_\_ KM \_\_\_\_\_ MI

Existing Facility: \_\_\_\_\_

Scope of Work: \_\_\_\_\_  
 \_\_\_\_\_

Applicable Sections of Design Manual: \_\_\_\_\_

Design Supervisor/Designer: \_\_\_\_\_

Construction/Area Engineer: \_\_\_\_\_  
 "Mini" DCC \_\_\_\_\_ Functional \_\_\_\_\_

Date Held: \_\_\_\_\_ Classification: \_\_\_\_\_

RAP: Amount/ Type anticipated: \_\_\_\_\_

Disposition: \_\_\_\_\_

Is SW3P needed  Yes  No? Are Railroad Agreements needed  Yes  No?

DES submissions needed: Typical Sections  Yes  No? Design Exceptions  Yes  No?

Brief sequence of work: \_\_\_\_\_  
 \_\_\_\_\_

TCP( If site specific TCP is required) submitted by: \_\_\_\_\_

**Attach: estimate, project layout, typical section, and traffic control sections (if required).**

**PROGRAMMING AND FUNDING**

Work Program: \_\_\_\_\_ Program No.: \_\_\_\_\_

Authorized Funds	\$	MIL	Estimated Cost (State & FHWA)	\$	MIL
			Estimated Cost (Other)	\$	MIL
			Total Cost	\$	MIL

Breakdown of Funding Participation:  
 FHWA \_\_\_\_\_ Construction (%) \_\_\_\_\_ Row (%) \_\_\_\_\_ Utilities (%) \_\_\_\_\_  
 State \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_  
 County \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_  
 City \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_  
 Other \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_  
 Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**PROPOSED BASIC DESIGN DATA**

Control \_\_\_\_\_

County \_\_\_\_\_

Work Program Title(s) \_\_\_\_\_

Work Type (Layman's Description) \_\_\_\_\_

Proposed Design Standards (Structures) \_\_\_\_\_

Proposed Design Standards (Roadway) \_\_\_\_\_

Proposed Design Standards (Traffic) \_\_\_\_\_

Design Speed \_\_\_\_\_  mph Mainlane Terrain: \_\_\_\_\_\_\_\_\_\_  mph Ramp \_\_\_\_\_\_\_\_\_\_  mph Cross Street \_\_\_\_\_\_\_\_\_\_  mph \_\_\_\_\_

Traffic: Existing \_\_\_\_\_ Projected: \_\_\_\_\_

Highway Functional Class (Urban) \_\_\_\_\_ (Rural) \_\_\_\_\_

Design Criteria Recommended for Approval (District)

Date \_\_\_\_\_

Signed \_\_\_\_\_

Title \_\_\_\_\_

Design Criteria Approval (Division)

Date \_\_\_\_\_

Signed \_\_\_\_\_

Title \_\_\_\_\_

**Exceptions Requested**

(List and indicate occurrence, i.e., over total project, at 3 locations, at 1 structure, etc.)

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

Design Exception Recommended for Approval: (Project

Date \_\_\_\_\_

Signed \_\_\_\_\_

Title \_\_\_\_\_

**Waivers Requested**

(List and indicate occurrence, i.e., over total project, at 3 locations, at 1 structure, etc.)

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

Waiver Recommended for Approval: (District)

Date \_\_\_\_\_

Signed \_\_\_\_\_

Title \_\_\_\_\_

**DESIGN EXCEPTION RECOMMENDED FOR  
(EXCEPTION REVIEW COMMITTEE)**

Date: \_\_\_\_\_

Signed: \_\_\_\_\_

Title: \_\_\_\_\_

Action:

Approval  Non-Approval   
Reasons \_\_\_\_\_Date: \_\_\_\_\_  
Signed: \_\_\_\_\_  
District Engineer**WAIVER COMMITTEE**

(To be filled out in District Office)

Bridge Design \_\_\_\_\_  
Roadway Design \_\_\_\_\_  
Bicycle Paths \_\_\_\_\_  
Traffic \_\_\_\_\_

Recommended Action:

Approval  Non-Approval   
Reasons \_\_\_\_\_Date: \_\_\_\_\_  
Signed: \_\_\_\_\_  
(Title) \_\_\_\_\_

### REQUIRED AGREEMENTS, PERMITS AND CERTIFICATIONS

YES	NO	IF YES, RESPONSIBILITY ASSIGNED TO:	
<input type="checkbox"/>	<input type="checkbox"/>		<b>RAILROAD AGREEMENT</b> NAMES:
<input type="checkbox"/>	<input type="checkbox"/>		<b>UTILITY ESCROW AGREEMENT</b> NAMES:
<input type="checkbox"/>	<input type="checkbox"/>		<b>THIRD PARTY FUNDING ESCROW AGREEMENT</b> NAMES
<input type="checkbox"/>	<input type="checkbox"/>		<b>FAA CERTIFICATION (AIRWAY-HIGHWAY CLEARANCE)</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>ENVIRONMENTAL CERTIFICATION</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>US COAST GUARD PERMIT</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>US ARMY CORPS OF ENGINEER PERMIT</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>NOTIFICATION OF INTENT (SWP3)</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>ROW CERTIFICATION</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>DOES CONTROL OF ACCESS NEED TO BE CONSIDERED</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>UTILITY CERTIFICATION</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>HAZARDOUS MATERIAL</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>CONSTRUCTION SPEED ZONE</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>SIGNAL AGREEMENTS</b>
<input type="checkbox"/>	<input type="checkbox"/>		<b>OTHER</b> Names:



## **Design Criteria Report (DCR)**

Date:

## Highway

Count

CSJ:

from:

Length:

### Proposed Letti

Type of work:

## **Plan Review Schedule Projected Dates**

- 100% \_\_\_\_\_
  - 50% \_\_\_\_\_
  - 100% \_\_\_\_\_
  - 30% \_\_\_\_\_
  - 60% \_\_\_\_\_
  - 100% \_\_\_\_\_

#### **DESIGN PARAMETERS:**

- Classification: ? ?
  - Highway Type: ?
  - ADT: Existing: Projected:
  - Terrain: ?
  - Proposed Design Standards (Structures): ?
  - Proposed Design Standards (Roadways): ?
  - Proposed Design Standards (Traffic): ?

COMMENTS: \_\_\_\_\_

## **FUNDING:**

- Authorized Amount:
  - Estimated Amount:
  - Advanced Funding Agreement:  Yes  No
  - Miscellaneous:

• MISCELLANEOUS:  
COMMENTS: \_\_\_\_\_

## **GEOMETRIC DESIGN CRITERIA:**



COMMENTS: \_\_\_\_\_

## PROPOSED HYDRAULIC ELEMENTS

 Shaded Boxes Denote Recommended Design Frequencies.

Functional Classification and Structure Type	Design Frequency (years)					Check 100-yr Flood?
	2	5	10	25	50	
<b>Freeways (main lanes)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Culverts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Bridges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
<b>Principal arterials</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Culverts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Small bridges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Major river crossings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
<b>Minor arterials and collectors</b> (including frontage roads)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Culverts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Small bridges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Major river crossings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
<b>Local roads and streets</b> (off-system projects)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Culverts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Small bridges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
<b>Storm drain systems</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Interstate and controlled access highways (main lanes)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
inlets and drain pipe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
inlets for depressed roadways	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
Other highways and frontage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
inlets and drain pipe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
inlets for depressed roadways	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	yes
<b>Other</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

- Hydraulic Programs Required For Analysis:
- Are Flood Insurance Study Streams Within Project Limits:  Yes  No
- Is FEMA Coordination Required:  Yes  No
- Are There Any Specialized Concerns:  Yes  No

COMMENTS: \_\_\_\_\_

\_\_\_\_\_

### UTILITIES:

- Are Any Adjustments Anticipated At This Time:  Yes  No
- If Yes, Which Utility Companies Are Affected:

COMMENTS: \_\_\_\_\_

\_\_\_\_\_

### MISCELLANEOUS

- Railroad Agreements:  Yes  No
- Pavement Design Report Required:  Yes  No
- Illumination Needed:  Yes  No
- Traffic Signals Needed:  Yes  No
- Geotechnical:  Yes  No
- ADA Requirements Satisfied:  Yes  No
- Exceptions Or Waivers Anticipated:  Yes  No

COMMENTS: \_\_\_\_\_

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#### **REQUIRED ATTACHMENTS**

- Typical Sections, Existing & Proposed (Show Pavement Structure)
- Estimate
- Project Location Map
- Preliminary Traffic Control Plan With Sequence Of Work (As Warranted)
- Schematic (As Warranted)

#### **SIGNATURES**

District Engineer \_\_\_\_\_

Director of TP&D \_\_\_\_\_

Director of Construction \_\_\_\_\_

Director of Maintenance \_\_\_\_\_

Director of Traffic Operations \_\_\_\_\_

Area Engineer \_\_\_\_\_

ESTIMATE RANGES – MONTE CARLO ANALYSIS	
What is it?	What does it do?
A sophisticated probabilistic model process that can be used to generate a range estimate through simulation methods.	<ul style="list-style-type: none"> <li>Provides detailed, illustrative information about risk impacts on the project cost and schedule.</li> <li>Determines project cost and schedule ranges and the most likely values for each.</li> <li>Determines risk effects for cost and schedule models that are too complex for common analytical methods.</li> <li>Provides a graphical distribution of project cost or schedule.</li> <li>Incorporates the risk knowledge and judgment of the Estimators, project team, and subject matter experts for both cost and schedule risk events. Requires that the project team be familiar with all project risks and be able to quantitatively describe the risks.</li> <li>Requires the user to know and specify probability distribution information, mean, standard deviation, and distribution shape.</li> </ul>
When to use it?	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
Why use it?	<ul style="list-style-type: none"> <li>Helps to generate an estimate range and calculate a contingency.</li> <li>Helps to show, through sensitivity analysis, the impact of specific risk events on the project cost and schedule.</li> </ul>
How to use it?	Several commercial software packages exist to help teams run Monte Carlo analyses. As well as software that integrates within existing spreadsheet programs, spreadsheet macros can be developed to produce simple Monte Carlo analyses.
Tips	<ul style="list-style-type: none"> <li>Monte Carlo analysis can provide insights into complex projects that might not be apparent through conventional estimating and scheduling techniques.</li> <li>Sometimes, the output is used only for go/no-go decisions or a one-time generation of a baseline cost.</li> <li>Monte Carlo analyses should only be conducted or facilitated by trained professionals.</li> <li>Remember the output of the model is only as accurate as the assumptions used to generate the output and the ability of the model to represent the actual project.</li> </ul>

ESTIMATE RANGES – THREE POINT ANALYSIS	
What is it?	What does it do?
A range estimate created by estimating the lowest possible, the most likely, and the highest probable cost estimate based on a combination of available project data and informed judgment.	<ul style="list-style-type: none"> <li>Communicates the uncertainty associated with an estimate.</li> <li>Conveys the certainty and uncertainty inherent in the project and educate the stakeholders about cost variability.</li> <li>Demonstrates the certainty and uncertainty about the project to other personnel who may not be intimately familiar with the project.</li> </ul>
When to use it?	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
Why use it?	<ul style="list-style-type: none"> <li>Federal planning regulations indicate that a three-point estimate or cost ranges/cost bands in the outer years of the metropolitan transportation plan are acceptable. Therefore, single point estimates should be avoided before sufficient detail about the project is known, when it is unrealistic to prepare a reasonably accurate single-point estimate.</li> <li>Helps to ensure that decisions based upon the estimate are appropriate considering its precision.</li> </ul>
How to use it?	<ol style="list-style-type: none"> <li>Have subject matter experts develop three estimates for each item of work:             <ol style="list-style-type: none"> <li>An optimistic estimate (o): the lowest credible cost assuming that everything goes right. For TxDOT, generally considered the estimate with a 10% probability of not exceeding.</li> <li>A most-likely estimate (m): the expert's best guess of the cost. Generally considered the estimate with a 50% probability of not exceeding.</li> <li>A pessimistic estimate (p): the highest credible cost, assuming that virtually everything goes wrong. For TxDOT, generally considered the estimate with a 90% probability of not exceeding.</li> </ol> </li> <li>The average cost of the item is <math>(o+4m+p)/6</math>. The average is always greater than the most likely estimate. This is because there is a finite lowest-possible cost. Even in the most optimistic situation, the work package will have a cost that is greater than zero. At the other end of the scale, there is no highest-possible cost. It is always possible to spend more money.</li> </ol>
Tips	<ul style="list-style-type: none"> <li>The generation of a range can be as simple as applying a historic plus-minus factor to estimated cost (i.e., -10 percent to +20 percent).</li> <li>While estimate ranges transparently convey the uncertainty involved in a project, they can be misunderstood. The range theoretically shows the highest probable cost for a project. If people focus on the high end of the range, the project can be slowed or stopped.</li> <li>The range should be used as part of a comprehensive risk management plan. If the risks and uncertainties that are driving the range can be understood, they can likely be mitigated and the project can be completed at the lowest possible cost.</li> </ul>

ESTIMATE REVIEW -- EXPERT TEAM	
What is it?	What does it do?
An external (non-TxDOT) review of the estimate by selecting a qualified panel of independent professionals that have as broad a range of engineering experience as the project demands.	<ul style="list-style-type: none"> <li>Provides a viewpoint completely external to that of the state highway agency.</li> <li>Provides discerned cost drivers that can be addressed by design changes, which reduces project cost.</li> <li>Concentrates on the estimation process and methodology.</li> <li>Are based on project scope and design development at the point in time when the review is conducted.</li> <li>Includes a risk analysis that identifies the critical elements of the estimate and possible impacting risks.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>Preliminary Design Phase.</li> <li>Design Phase.</li> <li>Used for high rigor projects.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>Helps the Estimator to properly account for all cost drivers in large projects with multiple interacting activities, urban projects with numerous stakeholders, and projects using new technology.</li> </ul>	
	<b>How to use it?</b>
<ol style="list-style-type: none"> <li>The reviewers seek to assess the reasonableness of the assumptions supporting the cost and schedule estimates and assess the rationale for the methodology used.</li> <li>Reviewers receive a briefing from the project team and the Estimators and are given access to all available project documentation.</li> <li>By applying parametric techniques or ratios to analyze costs and schedule reasonableness, they check the completeness of the estimate. However, they usually do not perform quantity takeoffs or estimate individual items.</li> <li>The result is a report that details findings and recommendations. In the case of a very complex project with critical cost drivers, it is sometimes necessary for the reviewers to develop an independent, bottom-up estimate of their own to ensure estimate reasonableness. This may or may not involve quantity takeoffs but usually does necessitate vendor quotations and productivity analysis of the critical cost items.</li> </ol>	
	<b>Tips</b>
<ul style="list-style-type: none"> <li>The most indispensable tool for estimate review is judgment.</li> <li>The reviewers need to be experienced professionals who have an understanding of engineering and construction complexities.</li> <li>Independent external reviews are more typically employed on PS&amp;E of large, complex projects.</li> <li>Market conditions or changes in the macro-environment can affect the costs of a project, particularly large projects.</li> <li>Often, only large contractors or groups of contractors can handle the construction tasks or even obtain bonding for a large project. The size of the project affects competition for a project and the number of bids that a state highway agency receives for the work.</li> </ul>	

<b>ESTIMATE REVIEW -- FORMAL COMMITTEE</b>	
<b>What is it?</b>	<b>What does it do?</b>
A cost validation tool that entails an objective review of the estimate by a group of experienced TxDOT individuals who did not participate in development of the estimate.	<ul style="list-style-type: none"> <li>Ensures that estimation criteria and requirements have been met and that a well-documented, defensible estimate has been developed.</li> <li>Enhances estimate accuracy.</li> <li>Determines subjectively the estimate accuracy based on the totality of the information available.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>All phases.</li> <li>Mostly for high rigor projects, but can also be used with medium rigor projects.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Helps refine the methods of identifying errors and omissions.</li> </ul>
<b>How to use it?</b>	<p>The formal committee reviews each estimate at different stages in project development and prior to the bid letting. The committee does the following:</p> <ol style="list-style-type: none"> <li>Determines whether the estimate satisfies the project criteria: The committee seeks to ensure that the estimate conforms to the project scope and design documents.</li> <li>Appraises the estimate methodology: The committee must be able to follow and check the estimate methodology. Steps to do this would include verifying estimation techniques and sources of estimate data. The committee should be able to clearly understand the origin of all numerical data in the estimate.</li> <li>Identifies uncertainties: The committee should confirm all uncertainties documented in the estimate and identify other uncertainties in the estimate that were missed or glossed over. It is good to note these uncertainties at this time so that an accurate estimate can be developed.</li> <li>Documents the findings: The findings of the estimate review must be documented. The committee may use an estimate review checklist (an example follows) or prepare a concise written report that documents the findings. A sample estimate review checklist is presented in the example part of this section.</li> </ol>
<b>Tips</b>	<ul style="list-style-type: none"> <li>As the project design is developed and the revised estimates are generated, it is good practice to conduct a review of the revised estimate, particularly at the major design development stages, 30 percent and 60 percent. These earlier reviews can provide real benefit because they often discern cost drivers that can be addressed by design changes and, in so doing, reduce project cost.</li> <li>The reviewer must try very hard to eliminate confusion in the contract documents and specifications. Check the estimated cost of any items that represent unfamiliar work or items for which there is only a limited database of historical information. Investigate whether the percentages used to estimate overhead and other costs besides the direct cost are realistic.</li> <li>It is good practice to include younger TxDOT staff as members of the committee so that they can learn from the discussion, but many times they will also contribute a completely new perspective.</li> </ul>

### **ESTIMATE REVIEW CHECKLIST (Formal Committee)**

- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• Review Date:</li><li>• Review Location:</li><li>• Project Name:</li><li>• Reviewers' Names and Organizations:</li><li>• Background Data and Conditions:</li><li>• Is there complete technical scope documentation, including the following elements?<ul style="list-style-type: none"><li>◦ Description of the work to be performed;</li><li>◦ Performance criteria and requirements;</li><li>◦ Discrete tasks and deliverables;</li><li>◦ Resource requirements;</li><li>◦ Sequence of events and discrete milestones;</li><li>◦ Work not included in the scope.</li></ul></li><li>• Have milestone descriptions been developed for each milestone associated with the project?</li><li>• Does the technical scope documentation for the estimate include descriptions of support associated with the work to be performed?</li><li>• Is the technical scope for the estimate consistent with the site, regulatory requirements and constraints (e.g., permit conditions, regulations) identified during the Planning and Programming Process?</li></ul> | <ul style="list-style-type: none"><li>• Are activities, quantities, and unit costs associated with the work to be performed clearly identified and defined in the cost estimate?</li><li>• Are the assumptions and exclusions upon which the cost estimate is based clearly identified and defined in the estimate?</li><li>• Are time and cost assumptions and cost elements associated with each activity clearly identified, defined, and documented in the estimate?</li></ul> <p><b>Cost elements for program activities include the following:</b></p> <ul style="list-style-type: none"><li>• Unit of measure</li><li>• Material cost</li><li>• Are significant Estimator findings identified during preparation of the estimate documented?</li><li>• Have factors been used to adjust the costs? If so, have they been adequately documented and appropriately applied?</li><li>• Have escalation factors been used to escalate the estimate?</li><li>• Are the escalation factors adequately documented and appropriately applied?</li><li>• Are estimate summary and detailed reports included, and do they provide cost totals for each cost element in the estimate?</li><li>• Is a schedule included with the estimate?</li><li>• Are activities included in the schedule consistent with those included in the technical scope?</li><li>• Are milestones and deliverables included in the schedule consistent with those included in the technical scope documentation and the estimate?</li></ul> |
|---|---|

#### **Cost Estimate**

- Are appropriate historical cost data used in the estimate?
- Are direct costs that are associated with individual activities included in the cost estimate clearly and individually identified?
- Are indirect, overhead, or other costs clearly and individually identified?
- Has the cost estimate been updated in a timely manner in response to relevant changes in its basis, background data, or assumptions?
- Are an appropriate change control document and an estimate development history attached to the cost estimate?
- Does the estimate development history include an itemized and chronological list of the changes made to the cost estimate since initiation of its preparation, along with the rationale for each change?

## ESTIMATE REVIEW -- IN-HOUSE/PEER

<b>What is it?</b>	<b>What does it do?</b>
An objective estimate review by a group of experienced TxDOT individuals who did not participate in development of the estimate.	<ul style="list-style-type: none"> <li>• Ensures accuracy and minimizes the potential for unanticipated surprises concerning the financial condition of the project.</li> <li>• Involves an estimate validation by a TxDOT Estimator who has not worked on the estimate being reviewed.</li> <li>• Checks mathematical extensions and correctness.</li> <li>• Checks takeoff for omissions or oversights.</li> <li>• Checks for conformity between amounts of work (item quantities) with the schedule durations to determine correctness.</li> <li>• Checks the calculations of the indirect costs.</li> <li>• Examines the estimate for buried contingency.</li> <li>• Compares the estimate with any similar project for an order of magnitude check.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>• All phases.</li> <li>• Can be used with projects of all rigor levels.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>• Helps eliminate general errors and omissions from plans and quantities, general estimation procedure, and technique inadequacies.</li> </ul>	
<b>How to use it?</b>	
The reviewer must have the experience and knowledge to carefully appraise the materials presented. In the case of larger projects, this peer validation may involve a peer team.	
For large or complex projects, the review is usually conducted with the project team and Estimator so that the reviewers can better understand the execution plan, Basis of Estimate, and project challenges in regard to scope and costs.	
<b>Tips</b>	
The peer review should consider the following:	
<ul style="list-style-type: none"> <li>• What is the basis for the assumptions made in developing the estimate?</li> <li>• Are the assumptions made in the estimate consistent with the technical scope and schedule of the project?</li> <li>• Are the activity durations in the schedule consistent with the estimated cost?</li> <li>• Are indirect rates, escalation factors, and other factors used appropriately?</li> <li>• Have the findings and recommendations of the peer review been documented in a peer review document?</li> <li>• Is the peer review document included with the cost estimate documentation?</li> <li>• Have the findings and recommendations of the peer review been addressed in revisions to the cost estimate?</li> <li>• Are activities included in the schedule consistent with those included in the technical scope documentation and estimate?</li> </ul>	

ESTIMATE REVIEW – ROUND TABLE	
What is it?	What does it do?
A periodic review of an estimate from TxDOT experts in order to validate the Estimator's assessment. Much like the other estimate reviews, the round-table review examines the estimate and the basis. However, unlike other estimate reviews, the round-table review has the advantage of bringing a greater body of knowledge and experience to the review to encourage a dialogue.	<ul style="list-style-type: none"> <li>• Examines the estimate and the basis.</li> <li>• Brings a greater body of knowledge and experience to the review to encourage a dialogue.</li> <li>• All project estimates are very complex in terms of the factors that can determine work item costs, and Estimators must make numerous judgments based on perceptions of work conditions and the physical conditions at the project site as the estimate is developed. A round-table review reviews those assumptions from different perspectives.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>• All phases.</li> <li>• Mostly for high rigor projects, but can also be used with medium rigor projects.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>• Helps to ensure accuracy and minimizes the potential for unanticipated surprises concerning the financial condition of the project.</li> </ul>	
<b>How to use it?</b>	
<ol style="list-style-type: none"> <li>1. Assemble the project team and discuss in detail the schedule, conditions, expected construction methods for the major cost items, and all known site conditions.</li> <li>2. Review total cost and item costs. The cost review is top down by broad classes: direct cost total and major items, TxDOT field support cost, TxDOT administrative support cost, and included contingency.</li> <li>3. Complete a round table review document.</li> <li>4. After a general overview analysis of the estimate, concentrate on the items that are the project's primary cost drivers (using the 80/20 rule).</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>• The reviewers who compose the committee should represent diverse sections of TxDOT, having specific knowledge of cost-impacting factors—for example, personnel from the TxDOT's right-of-way section for reviews during planning and design development and personnel from the construction office for a review of PS&amp;E.</li> <li>• The project team should present information to the reviewers that aids in completion of the document.</li> <li>• There should be comparisons of costs to benchmark ratios and factors for similar projects.</li> <li>• An example of a Round Table review document follows.</li> </ul>	

## Estimate Review Document – Round Table

### **1. Project Review Information**

Project Name: \_\_\_\_\_

Review Date: \_\_\_\_\_

Review Location: \_\_\_\_\_

Reviewers' Names and Titles: \_\_\_\_\_

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### **2. Summary Project Description**

Please use the items below to present a project summary and provide a very brief written description. Please reference appropriate sections in the Preliminary Design Document for more information, if applicable.

Summary of Scope (including alternatives):  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Design:

- Design level: \_\_\_\_\_
- Structural: \_\_\_\_\_
- Foundations: \_\_\_\_\_
- Drainage: \_\_\_\_\_
- Pavement: \_\_\_\_\_
- Materials: \_\_\_\_\_
- Maintenance: \_\_\_\_\_
- Compliance with design standards: \_\_\_\_\_

Environmental:

- Environmental documentation: \_\_\_\_\_
- Wetlands: \_\_\_\_\_
- Streams: \_\_\_\_\_
- ESA: \_\_\_\_\_
- Floodplain: \_\_\_\_\_
- Stormwater: \_\_\_\_\_
- Contaminated/hazardous waste: \_\_\_\_\_
- Section 106: \_\_\_\_\_
- 4(f): \_\_\_\_\_
- Permitting (incl. 404): \_\_\_\_\_

Right-of-way and other agreements:

- Right-of-Way: \_\_\_\_\_
- Utilities: \_\_\_\_\_
- Railroad: \_\_\_\_\_
- Other stakeholders: \_\_\_\_\_

Procurement:

- Delivery method: \_\_\_\_\_
- Contract packaging: \_\_\_\_\_
- Market: \_\_\_\_\_

Construction:

- Construction access/restrictions (including shifts): \_\_\_\_\_
- Maintenance of traffic: \_\_\_\_\_
- Construction phasing: \_\_\_\_\_

Project Schedule:

- Design schedule: \_\_\_\_\_
- Construction schedule: \_\_\_\_\_

### 3. Categorization of Project Rigor

Project rigor significantly influences the methods and tools used for cost estimating. This section of the Report Card categorizes project rigor using the definitions in the Reference guide. Please categorize the project as one of the following:

- High Rigor Project
- Medium Rigor Project
- Low Rigor Project

Comments: \_\_\_\_\_  
\_\_\_\_\_

Please use the following scale of evaluation for Sections 4, 5, and 6.

Scale of Evaluation	
Grade	Description
A	Excellent Treatment of Issue
B	Very Good Treatment of Issue
C	Good Treatment of Issue
D	Fair Treatment of Issue
F	Poor Treatment of Issue

### 4. Estimate Basis Review

Step	Issue	Grade	Comments and Action Items
Review Preliminary Design Document	<ol style="list-style-type: none"><li>1. Division Scoping Worksheets identify technical requirements for each group relevant to project for this estimate.<ol style="list-style-type: none"><li>a. Items pertinent to project listed on worksheets checked</li><li>b. Drawings available (schematics – plans, cross sections, others,)</li><li>c. Key parameters provided</li><li>d. Consistent with project purpose and need</li><li>e. Missing information identified</li></ol></li><li>2. Level of project complexity is identified.</li><li>3. Preferred alternative is selected.</li></ol>	_____	

<b>Step</b>	<b>Issue</b>	<b>Grade</b>	<b>Comments and Action Items</b>
Review Site Characteristics	4. Estimator visited the project site to review site characteristics and their potential impact on estimate elements and cost basis. 5. Estimator used video logs and aerial photos to assess potential impact of site characteristics on estimate elements and cost basis. 6. Results of site visit are documented. 7. Technical scope for the estimate is consistent with the site, regulatory requirements and constraints (i.e., permit conditions, regulations) identified during the Preliminary Design Process.	_____	
Determine if Clarification Needed	8. Estimator has considered the need for additional information from various Divisions (e.g., clarification of group requirements). 9. Estimator has asked for clarifications from the various Divisions, where necessary. 10. Divisions have provided the requested additional information.	_____	
Document Preliminary Engineering Estimate Basis	11. Estimate development history is documented that itemizes and chronologically lists changes made to any previous cost estimate for this project, and includes the rationale for each change. 12. A Project Estimate File is prepared that includes documentation of the Basis of Estimate.	_____	

**Summary Estimate Basis Review Grade**

- A – Excellent Treatment of Issue
- B – Very Good Treatment of Issue
- C – Good Treatment of Issue
- D – Fair Treatment of Issue
- F – Poor Treatment of Issue

**Summary Estimate Basis Review Comments and Action Items**

## 5. Base Estimate Preparation Review

<b>Step</b>	<b>Issue</b>	<b>Grade</b>	<b>Comments and Action Items</b>
Select Appropriate Approach	<ul style="list-style-type: none"> <li>1. Estimate approach(es) used to prepare cost estimate are documented (e.g., historical bid based, cost based, similar project, parametric (LDW), percentages).</li> <li>2. Estimate approach(es) align with the type of project definition/information/requirements available and the complexity of the project.</li> </ul>	_____	
Quantify Estimate Elements	<ul style="list-style-type: none"> <li>3. Documentation provided to substantiate number of estimate elements considered.</li> <li>4. Documentation provided to support quantity calculations for key estimate elements.</li> </ul>	_____	
Develop Estimate Data	<ul style="list-style-type: none"> <li>5. Cost basis is appropriate and consistent with estimate approach(es) (e.g., use of historic bid prices).</li> <li>6. Documentation is provided justifying adjustments made to cost basis for estimate elements.</li> <li>7. Documentation is provided to support development of cost basis for estimate elements.</li> <li>8. Estimator incorporates cost estimate information from Divisions.</li> <li>9. Estimator identifies inflation guidance for year-of-construction cost calculation.</li> </ul>	_____	
Calculate Cost Estimate	<ul style="list-style-type: none"> <li>10. Estimator checks to ensure that all work items are included in estimate including cost estimate input from Divisions.</li> <li>11. Estimator verifies that all estimate elements are input correctly.</li> <li>12. Estimate system calculates base cost and summarized estimate elements.</li> <li>13. Estimator ensures that other/all categories representing the total construction cost are included.</li> </ul>	_____	
Document Estimate Assumptions	<ul style="list-style-type: none"> <li>14. Assumptions and exclusions upon which the cost estimate is based are clearly identified, defined, and documented in the estimate backup.</li> <li>15. Adjustments to historical cost data used as the cost basis for estimate elements are clearly documented.</li> <li>16. Escalation factors have been used to escalate the estimate.</li> <li>17. Base estimate does not include any contingency.</li> </ul>	_____	

Step	Issue	Grade	Comments and Action Items
Prepare Estimate Package	18. Documentation of Basis of Estimate and all assumptions is covered including why each assumption was made and how. 19. Identify uncertain items and list them. 20. Escalation factors are adequately documented and appropriately applied. 21. Project schedule is included with the estimate. 22. Cost summaries are included such as: a. Summary of total cost by category b. Detailed cost summaries by major line item 23. Base estimate package is prepared. a. Total cost summary b. Detail cost summaries c. Estimate basis d. Estimate assumptions e. Uncertain items listed f. Other supporting documentation	_____	

**Base Estimate Preparation Review Grade**

- A – Excellent Treatment of Issue
- B – Very Good Treatment of Issue
- C – Good Treatment of Issue
- D – Fair Treatment of Issue
- F – Poor Treatment of Issue

**Summary Base Estimate Review Comments and Action Items**

**6. Risk and Uncertainty Review**

Step	Issue	Grade	Comments and Action Items
Review Risk Information	1. Review previous estimates for list of risk items. 2. The current estimate explicitly identifies contingency. 3. The current estimate has been reviewed for any contingency “buried” in line items or not explicitly identified. 4. All contingency items have been listed separately and summed for the total cost summary.	_____	
Determine Level of Risk Analysis	5. A detailed approach to risk analysis has been defined.	_____	

<b>Step</b>	<b>Issue</b>	<b>Grade</b>	<b>Comments and Action Items</b>
Identify Risks	<p>6. A list of risk has been compiled through a review of:</p> <ul style="list-style-type: none"> <li>• Key Basis of Estimate assumptions</li> <li>• Key Base Estimate assumptions</li> <li>• Any project team issues or concern (all major disciplines should be consulted)</li> <li>• Market conditions</li> </ul> <p>7. A checklist of risks has been consulted to ensure that no common risks have been overlooked.</p>	_____	
Estimate Contingency	<p>8. The estimate contains an explicit contingency estimate that is based on the identified risks</p> <p>9. The contingency estimate has been compared to other contingency estimates on similar projects.</p>	_____	
Document Contingency Estimate	<p>10. The contingency estimate has been adequately documented.</p> <ul style="list-style-type: none"> <li>• Risks and uncertainties have been documented.</li> <li>• The method of calculating contingency has been documented.</li> </ul>	_____	
Prepare Total construction Cost Estimate	11. The total construction cost (base plus contingency) has been completed.	_____	

#### **Risk and Uncertainty Review Grade**

- A – Excellent Treatment of Issue
- B – Very Good Treatment of Issue
- C – Good Treatment of Issue
- D – Fair Treatment of Issue
- F – Poor Treatment of Issue

#### **Summary Risk and Contingency Estimate Review Comments and Action Items**

#### **7. Summary of the Total Cost Estimate**

**Total Construction Cost Estimate = Base Estimate + Contingency**

<b>HISTORICAL BID DATA</b>	
<b>What is it?</b>	<b>What does it do?</b>
Identified items and quantities for each item so historical unit bid prices can be used to calculate item costs for the project.	<ul style="list-style-type: none"> <li>Is based on bids from recent projects.</li> <li>Relies heavily on items with quantities and good historical bid data for determining item cost.</li> <li>Allows for easily prepared cost estimates.</li> <li>Is a relatively straightforward and quick process.</li> <li>Enables TxDOT to estimate the cost of proposed work using a minimum of resources.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Helps prepare estimates quickly, which may be a driver when the agency is developing a number of project estimates for programming purposes.</li> <li>Helps maintain bid history, which helps evaluate contractor proposed changes, such as value engineering/analysis proposals.</li> </ul>
<b>How to use it?</b>	<p>The following steps should be followed when using historical bid based estimating:</p> <ol style="list-style-type: none"> <li>Determine elements/items that can be estimated based on historical bid cost.</li> <li>Scan the TxDOT database to find projects that are similar to the current project.</li> <li>Study and analyze the changes, bids, and unit prices of the historical data selected.</li> <li>Relate the unit prices to the current project by considering the characteristics of the project.</li> <li>Select the unit rates that apply to the current project and can be used to calculate the cost estimate.</li> <li>Apply any inflation factors to the unit prices for each item (if appropriate).</li> <li>Use these data to calculate the cost estimate.</li> <li>Consider other regional, local, political, and material factors that may affect the estimate of the project.</li> <li>Perform final calculations by adding extra costs to the estimated values (if appropriate).</li> </ol>
<b>Tips</b>	<ul style="list-style-type: none"> <li>For the historical bid based estimating to be successful, it is necessary that the bid data are complete and consistent.</li> <li>The bid data should be captured and updated on a regular basis. This will provide adequate data to review.</li> <li>If the quantity of any item is too small or too high with respect to a previous project, special care should be taken when using a historic unit price.</li> <li>Items that do not quantify for evaluation by historical data should be calculated by other methods.</li> <li>Estimators should use their experience and skills to identify the items that may be affected by external factors, such as material availability and/or other special conditions.</li> <li>There are several historical databases available that provide current values for estimating costs of the various units of work for a project.</li> <li>There is a danger of applying any historical database pricing without first adjusting the data for the particular aspects of the project under consideration.</li> <li>Location factors should also be applied, but only after first considering the project size and particular nature, to determine where the bidders will come from. If it is a large project in a small town, the location factor for that town will likely not apply, as the bidders will be coming from elsewhere. The bids may as a result be much higher than the factor would indicate as the wages will be based on another location and the bidders may have to pay accommodation and travel costs for some of their workers.</li> </ul>

<b>ONE-PAGE COST ESTIMATE SUMMARY</b>	
<b>What is it?</b>	<b>What does it do?</b>
A proactive conveyance of project information to internal and external stakeholders.	<ul style="list-style-type: none"> <li>Provides a means of communicating the current project estimate based on the level of design maturity.</li> <li>Communicates the estimate as a range of probable values.</li> <li>Highlights current assumptions, risks, and other uncertainties that are incorporated into the estimate.</li> <li>Quickly summarizes changes that may have occurred since the previous estimate.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Helps to convey estimate information in a concise and transparent manner.</li> <li>Aids in cost estimation management.</li> </ul>
<b>How to use it?</b>	<ul style="list-style-type: none"> <li>A standard template (to be developed by TxDOT) ensures information is conveyed in a consistent manner.</li> <li>Information contained within the Project Estimate File is used to complete the One-Page Cost Estimate Summary.</li> </ul>
<b>Tips</b>	<ul style="list-style-type: none"> <li>A communication plan and the activation of the plan can create an open and honest dialogue between TxDOT and the public. It creates accountability in cost estimation management for both TxDOT and the public.</li> <li>TxDOT projects need to have public awareness plans that make information available to the public for not only large projects, but also regarding smaller, less controversial projects. This does not have to be a high-cost initiative on all projects.</li> <li>Ensure the information contained on the One-Page Cost Estimate Summary is consistent with other information being published such as on TxDOT's Project Tracker website.</li> </ul>

# I-405 Congestion Relief and Bus Rapid Transit Projects

Revised July 2003

## Scenario

Tukwila to Bothell  
(Option C)



### Project Descriptions:

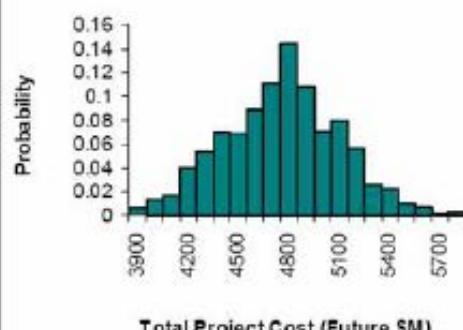
- Continuous multi-modal corridor improvement projects from I-5 in Tukwila to SR 522 in Bothell.
- Adds one lane each direction from I-5 to SR 181 in Tukwila.
- Adds two lanes each direction from SR 181 in Tukwila to I-90 in Bellevue.
- Adds one lane each direction from I-90 in Bellevue to SR 522 in Bothell.
- On SR 167, adds one lane between I-405 and S. 180<sup>th</sup> St.
- Constructs Bus Rapid Transit system with stations, HOV direct access ramps and Park & Ride lots and coaches.
- Expands the vanpool program.

### Schedule:

Begin Construction  
Range: 2006-2007

End Construction  
Range: 2013-2014

### CEVP Result:



Total Project Cost (Future \$M)

### Project Benefits:

- Reduces congestion and improves freight movement.
- Provides bus rapid transit system from SeaTac to Lynnwood.
- Constructs 2300 new Park & Ride spaces.
- Adds 600 new vanpools and increases commute reduction programs.
- Improves water resources.

### Project Cost Range:

10% chance the cost < \$ 4.2 Billion

50% chance the cost < \$ 4.7 Billion

90% chance the cost < \$ 5.1 Billion

### Project Risks:

- Changing environmental requirements for project mitigation (stormwater, wetlands, fish resources and streams) may increase project costs—primarily for added right-of-way purchases.
- Delays in right-of-way purchases may result in construction delays and project cost increases.
- Early stage of project development leads to scope uncertainty.
- Legal challenges and delays in obtaining environmental permits may result in project delay.
- Utility relocations may require extra time to negotiate and complete.

### What's Changed Since 2002:

- Scope: Project limits are smaller.
- Schedule: Begin construction range has been delayed up to one year. End construction range has been accelerated two years.
- Costs: Costs have gone down approximately \$1 billion due to scope revisions.
- Risk Management: Identifying new strategies for improved environmental clearances and right-of-way processes. Coordinating decision strategies with FHWA.

### Financial Fine Print (Key Assumptions):

- Full project funding becomes available in July 2005. State I-405 Nickel funds will roll-over into this package.
- Inflation escalation is to 2010, the approximate midpoint of construction.
- Additional federal, state, regional and local money may be needed.
- Project cost range includes \$18.5 million in past expenses, beginning in 1999.
- Assumes funding decisions do not interrupt or cause construction delays.

### Level of Project Design:

Low      Medium      High

July 16, 2003

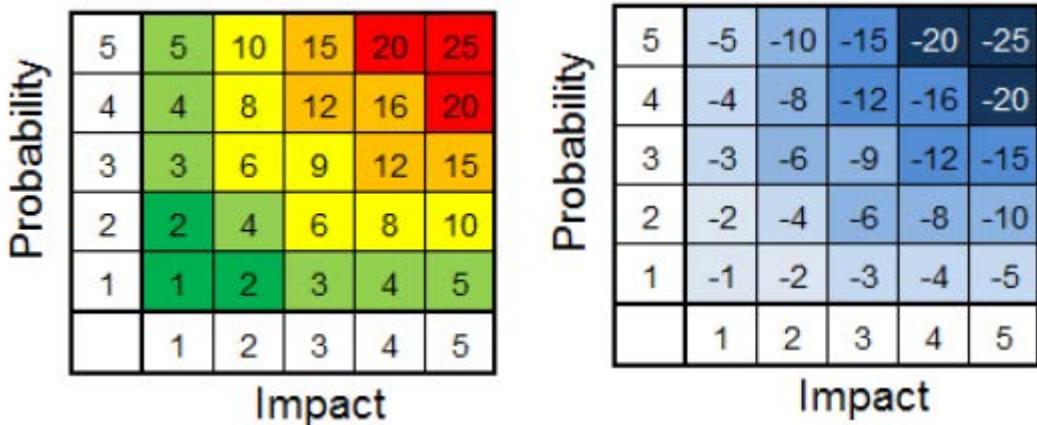


Sample One-Page Estimate Communication used by Washington DOT.

## PARAMETRIC ESTIMATING

<b>What is it?</b>	<b>What does it do?</b>
Statistical relationships and/or non-statistical ratios between historical bids and other parameters. Primarily used to support early estimates where there is limited project information.	<ul style="list-style-type: none"> <li>• Develops early project estimates when information is restricted to only approximate dimensions of facility features.</li> <li>• Develops factors based on roadway sections for different dimensions and associate them with a historical cost database considering all major items to construct the roadway. The individual factors are extracted as applicable to the project and then cumulated for all elements in the estimate to derive a single factor that is multiplied with a cost multiplier (ratio) closely representing a past project of similar type and scope.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>• Planning and Programming Phase.</li> <li>• Preliminary Design Phase.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>• Parametric estimating provides reasonable estimate accuracy in a timely manner.</li> <li>• The purpose of parametric estimating is to develop early project estimates when information is restricted to only approximate dimensions of facility features.</li> <li>• The tool is developed to provide simplified, reliable, early estimates that are based on current prevailing costs.</li> </ul>
<b>How to use it?</b>	<ul style="list-style-type: none"> <li>• Experience engineers, designers, and subject matter experts in functional groups and Divisions can supply parametric values (e.g., cost of a bridge structure based on the anticipated square foot area of bridge deck.)</li> <li>• Apply the parametric costs to the appropriate items in the estimate; document the source of the data, what items are and are not included in the parametric values, and when the values were obtained.</li> </ul>
<b>Tips</b>	<ul style="list-style-type: none"> <li>• Parametric estimating may be best used on less complex projects that tend to be more standard in terms of project components.</li> <li>• The Estimator needs to ensure that all project costs are covered, especially those costs that may not be generated using the parametric approach, such number of driveways.</li> <li>• Identification and inclusion of cost items that contribute to 80 percent of the cost for each estimate are crucial for its success.</li> <li>• The standardization of such elements in relation to project types is to a large extent the basis of implementing this tool. The tool can model additional items that may not be standard, as long as historical information is available.</li> </ul>

PROBABILITY × IMPACT MATRIX (PxI)										
What is it?			What does it do?							
A matrix used for qualitative analysis of risks on a project, formed by combining each risk's probability of occurrence (frequency) with its impact (severity) on project objectives to rank risks or determine the level of priority to be assigned to that risk on the project (e.g., high, medium, low).			<ul style="list-style-type: none"> <li>Is formed using each project risk's probability and its corresponding impact.</li> <li>Is typically used in conjunction with the risk register.</li> <li>Can be used as the sole tool for ranking risks in a qualitative analysis.</li> <li>Can be used for an initial assessment of risks before a more precise measure of probability and impact is made for probabilistic calculations.</li> </ul>							
When to use it?			<ul style="list-style-type: none"> <li>All phases.</li> </ul>							
Why use it?			<ul style="list-style-type: none"> <li>Helps a project team rank the myriad of project risks so that the Project Manager can direct the majority of the available resources to the high and medium impact items.</li> </ul>							
How to use it?										
<ol style="list-style-type: none"> <li>Determine the probability of occurrence and the corresponding likely impact for each risk. TxDOT uses five levels of risks probability and five levels for risk impacts as described in Figure 22 and Figure 23 below.</li> <li>Prioritize the risks so that the project team can effectively allocate the resources to the risks that have the highest potential to adversely affect the project (refer to Figure 21).</li> </ol>										
Tips										
<ul style="list-style-type: none"> <li>The PxI matrix is most effective when used to prioritize the limited resources at a project team's disposal.</li> <li>A key requirement of successful use of this tool is the involvement of subject matter experts who can provide informed judgments about the probabilities of occurrence and the likely impact based on past experience, as well as data, when available.</li> </ul>										



P x I Matrices for Threats (Left) and Opportunities (Right)

Context	Impact Rating				
	Project Impacts				
	1 Low	2 Medium-Low	3 Medium	4 Medium-High	5 High
Quality	Negligible impacts to design quality	Requires Design Variance	Requires Design waiver	Does not meet acceptable standards and requires Design Exception	Does not meet acceptable standards and Design Exception not likely
	Negligible impacts to long-term maintenance	Minor impacts to long-term maintenance	Significant impacts to long-term maintenance	Major impacts to long-term maintenance	Unacceptable impacts to long-term maintenance
	Barely noticeable	Minor scope reduction	Major scope reduction	Changes unacceptable to TxDOT or stakeholders	Project does not meet need and purpose
Cost (% of project cost)	cost increase = 1%	cost increase = 2%	cost increase = 3%	cost increase = 4%	cost increase > 5%
Schedule (% of project schedule, subject to schedule analysis)	delay = 1%	delay = 2%	delay = 3%	delay = 4%	delay > 5%

Context	Agency Impacts				
	1 Low	2 Medium-Low	3 Medium	4 Medium-High	5 High
	First Aid	Restricted Duty / Doctor Visit	Recordable	Lost Time	Major injury or death
Congestion	Minor additional congestion or reduction in capacity from anticipated scope	Noticeable additional congestion or reduction in capacity from anticipated scope	Significant additional congestion or reduction in capacity from anticipated scope at several points or major congestion at single point within the corridor	Major additional congestion or reduction in capacity from anticipated scope at several points along the corridor or exceptional congestion at single point within the corridor	Unacceptable additional congestion or reduction in capacity from anticipated scope at any point within the corridor
	Negligible decrease from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Minor decrease from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Significant decrease from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Major decrease from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Unacceptable decrease from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways
	Negligible impact to agency's reputation	Noticeable impact to agency's reputation, single press release	Significant impact to agency's reputation, multiple press releases in regional news	Major impact to agency's reputation, multiple press releases, statewide news	Potential legal action, multiple press releases, national news
Best-in-class agency					

Probability of occurrence	Probability Rating				
	1 Low	2 Medium-Low	3 Medium	4 Medium-High	5 High
	10%	30%	50%	70%	90%

### TxDOT Definitions for Risk (Threats) Probability Levels and Impact Levels

Context	Impact Rating				
	Project Impacts				
	-1 Low	-2 Medium-Low	-3 Medium	-4 Medium-High	-5 High
Quality	Negligible improvements to design quality	Noticeable improvements to design quality	Significant improvements to design quality	Major improvements to design quality	Exceptional improvements to design quality
	Negligible improvements to long-term maintenance	Minor improvements to long-term maintenance	Significant improvements to long-term maintenance	Major improvements to long-term maintenance	Exceptional improvements to long-term maintenance
	Barely noticeable	Minor scope improvements	Significant scope improvements	Major scope improvements	Exceptional scope improvements
Cost (% of project cost)	cost savings = 1%	cost savings = 2%	cost savings = 3%	cost savings = 4%	cost savings > 5%
Schedule (% of project schedule, subject to schedule analysis)	schedule savings = 1%	schedule savings = 2%	schedule savings = 3%	schedule savings = 4%	schedule savings > 5%

Context	Agency Impacts				
	-1 Low	-2 Medium-Low	-3 Medium	-4 Medium-High	-5 High
	Negligible safety improvements	Minor safety improvements	Significant safety improvements	Major safety improvements	Exceptional safety improvements
Congestion	Negligible congestion relief or additional capacity from anticipated scope within corridor	Noticeable congestion relief or additional capacity from anticipated scope within corridor	Significant congestion relief or additional capacity from anticipated scope at several points within the corridor or major congestion relief at single point within the corridor	Major congestion relief or additional capacity from anticipated scope at several points along the corridor or exceptional congestion relief at single point within the corridor	Exceptional congestion relief or additional capacity from anticipated scope at several points within the corridor
	Negligible improvement from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Minor improvement from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Significant improvement from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Major improvement from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways	Exceptional improvements from anticipated scope to project limits; or to throughput or connectivity at intersections, interchanges, or parallel or connecting roadways
	Negligible benefit to agency's reputation	Minor benefit to agency's reputation, single press release	Significant benefit to agency's reputation, multiple press releases in regional news	Major benefit to agency's reputation, major industry awards, multiple press releases, statewide news	Exceptional industry recognition, multiple press releases, national news
Probability Rating					
Probability of occurrence	1 Low	2 Medium-Low	3 Medium	4 Medium-High	5 High
	10%	30%	50%	70%	90%

## TxDOT Definitions for Risk (Opportunities) Probability Levels and Impact Levels

PROJECT ESTIMATE FILE	
What is it?	What does it do?
A master reference file that contains the critical scope, policy, and supporting information (assumptions, methods, and procedures), which is used to prepare the project estimate.	<ul style="list-style-type: none"> <li>Ensures that each project has a well-documented and easily retrievable history of the assumptions, methods, and procedures used to estimate the costs associated with the project's specific scope of work.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>Provides a corporate memory and historical database for cataloging the basic reasons behind the original estimated cost and reasons for subsequent cost revisions.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Lists and explains all specific assumptions (e.g., excavation costs assume 30 percent rock).</li> <li>Allows easy comparison of the current estimate to previous estimates and resolution of discrepancies.</li> </ul>
<b>How to use it?</b>	
For each work (bid) item element, describe the derivation of its estimated cost in sufficient detail to allow an independent reviewer to determine whether the estimate is complete, accurate, and realistic. A sample outline for a Project Estimate File is presented in Figure 24	
<ol style="list-style-type: none"> <li>Identify level of knowledge about scope (e.g., project maturity level).</li> <li>Provide level of estimate detail (e.g. project estimate class.)</li> <li>Provide Item Number and Title.</li> <li>Provide Item description and any tailoring used for this estimate.</li> <li>Discuss methodology and techniques used to estimate costs.</li> <li>Explain how all lump sum items are handled.</li> <li>Identify the base year of the cost calculation. For long duration projects, it is good practice to present the item's estimated cost in Constant Year dollars, both total dollars and distributed across fiscal years.</li> <li>Provide a written description for each contingency allowance assigned to the various parts of the estimate. If extraordinary conditions exist that call for higher contingencies, the rationale will be documented.</li> <li>Include level of risk analysis.</li> <li>List all uncertainties and risks associated with the estimate (confidence level for the estimate).</li> <li>Include Cost Tractability. When a prior cost estimate exists, a cost track should be prepared. The cost track should provide a concise explanation for any cost change to an item from the prior estimate.</li> <li>List all participants in the development of the estimate.</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>The Project Estimate File should, at a minimum and regardless of project development phase, include any assumptions that have been made, current project scope, maps, photos, as-built plans, functional classification, design criteria, and a copy of or reference to the cost data that was used to develop the estimate.</li> <li>The creation of the file begins with the very first estimate. A sheet should be placed in the front of each estimate file so the Project Manager can record the date and current project milestone or project development stage each time the project estimate is changed, updated, or reviewed. A signature line should also be included to document the Project Manager's review of the estimate file.</li> <li>The project estimate information should be retained in the central filing system from the time the initial project estimate is prepared until project close-out. The Project Estimate File should include all cost estimates prepared for the project up to and including the completed Contract Plans (PS&amp;E) Estimate.</li> <li>Archiving the cost estimate files is good practice, as they can be useful in reconciling completed project cost and responding to inquiries.</li> </ul>	

- When items are estimated by percentages of other costs, as is often done for miscellaneous and utility costs, variations to normal the percentage should also be documented in the Project Estimate File. Some projects that are not complex and have a small scope of work may warrant the inclusion of a cost adjustment factor to compensate for the short project development time and project uncertainties. These cost adjustment factors should be well-documented in the Project Estimate File and have a reproducible basis. These factors should only be applied to projects that fall into the small, non-complex category. They should not be applied to all project estimates as a matter of common practice.
- A cost adjustment factor will never be considered as an acceptable substitute for preparing a well-documented and accurate estimate if adequate project information is available.
- Depending on the level of project development that has taken place, the amount and type of documentation contained in the Project Estimate File will vary. Information used to develop the initial estimate, such as cost per mile factors or generic factors should be well-documented and included in the Project Estimate File. This information may consist of references to software databases, bid tabulation data, unit bid price book data, or some other reputable resources. Additionally, any deviations that are determined to be warranted by the Estimator from the generic cost factors should be well-documented in the Project Estimate File.

## Sample Outline for a Project Estimate File

### **TOTAL CONSTRUCTION ESTIMATE SUMMARY**

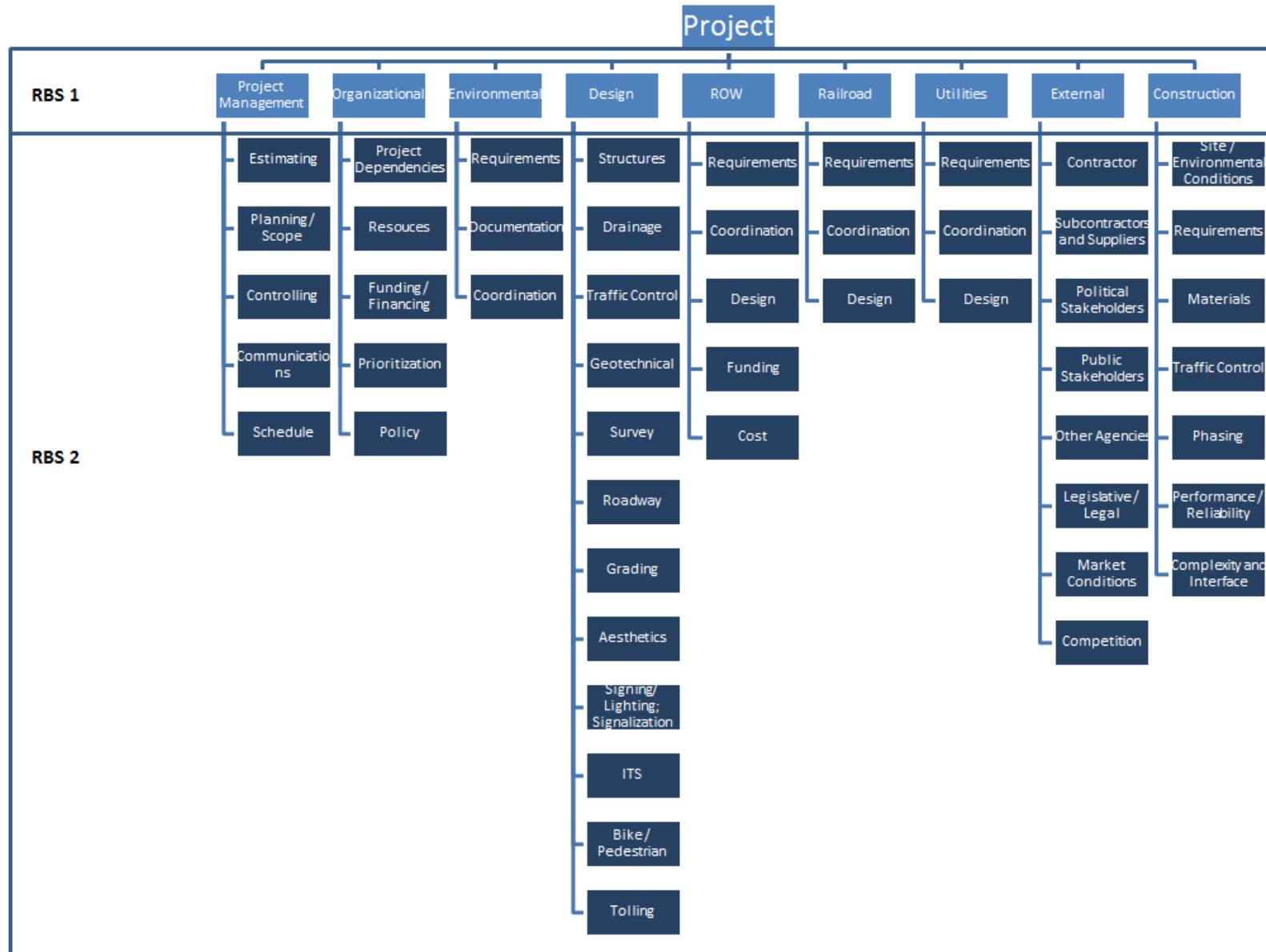
- Total Construction Cost Estimate Summary One Page
- Key Project Requirements
- Key Estimate Assumptions
- Major Risks

### **TOTAL PROJECT COST ESTIMATE DETAILS** (changes with project development phase)

- Estimate Basis
  - Project Description (narrative description of project requirements)
  - Drawings (schematic, preliminary, final)
  - Specifications
- Cost Estimate
  - Cost Estimate Summary (categories and some elements)
  - Cost Estimate Details (categories, elements and line items)
  - General Estimate Basis (impacts all cost in estimate)
  - Assumptions (as required for different category, element, or item estimate)
  - Backup Calculations (for different category, element, or item estimate)
  - Review notes and recommended changes
- Risk Analysis
  - Risks (checklist or risk register)
  - Contingency (contingency basis and calculation)

**Notes:**

<b>RISK BREAKDOWN STRUCTURE</b>	
<b>What is it?</b>	<b>What does it do?</b>
A formal coding of risks that can supplement the risk register and explore the relationships of different risks to each other. It can be helpful for an agency when organizing similar risks across multiple projects.	<ul style="list-style-type: none"> <li>Illustrates the interrelationships between risks pertaining to different aspects of a project.</li> <li>Shows the relationships between project components that may be difficult to explain using only words.</li> <li>Facilitates risk identification and assists in the other steps of the risk management process.</li> <li>The risk breakdown structure helps to categorize risks.</li> <li>The use of an RBS helps handle risks systematically, rather than individually.</li> <li>Similar risks, as classified by their RBS can utilize similar management strategies.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>For a comprehensive and consistent understanding of project risks across the project team and among project stakeholders when appropriate.</li> <li>Although specifications and contracts address most risks, a risk breakdown structure can be very effective in preparing project team members to successfully mitigate or resolve risks as the project moves forward.</li> </ul>
<b>How to use it?</b>	<ul style="list-style-type: none"> <li>The RBS used by TxDOT and incorporated into the risk register is shown in Figure 25. The TxDOT RBS has two levels: RBS-1 is the broad categorization of risks and RBS-2 breaks those broad categories into more detailed subcategories.</li> <li>When selecting the RBS-1 and RBS-2 categories for a particular risk, it is likely that the risk could fall into more than one level 1 and level 2 categories simultaneously. Choose the categories that dominate the discussion of the risk. The RBS categories selected can be changed during the course of implementing the risk management plan.</li> </ul>
<b>Tips</b>	<ul style="list-style-type: none"> <li>A risk breakdown structure is appropriate for use on projects with scope in all or most elements of the total project cost, or on complex projects.</li> <li>Ensure that the risk breakdown structure reflects the most useful categorizations for the project team.</li> <li>A common principle is that the categorization should focus on risk cause rather than risk effect.</li> <li>It is helpful to try and standardize the risk breakdown structure across several projects, or throughout the agency. This can aid in the use of other tools that rely on a historical database of risks.</li> </ul>



**TxDOT Risk Breakdown Structure (RBS).**

## RISK CHECKLIST

<b>What is it?</b>	<b>What does it do?</b>
Risk checklists are a tool for risk identification that can be used at the earliest stages of risk identification to learn from past projects and past team member experience.	<ul style="list-style-type: none"> <li>The use of a historical list of project risks from experience or specific past projects that is used to aid in the risk identification process.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>All phases.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>The use of a risk checklist is the final step of risk identification to ensure that common project risks are not overlooked.</li> <li>The benefit of maintaining risk checklists is to capture corporate knowledge within a state highway agency and ensure that common risks are not overlooked in the estimating or risk management process.</li> </ul>	
<b>How to use it?</b>	
<ol style="list-style-type: none"> <li>1. Risk checklists should be used only after the team has identified risks on its own (e.g., through an examination of scope and estimating assumptions, the brainstorming of issues and concerns).</li> <li>2. A risk checklist should be reviewed at the start of a project and potentially several more times throughout the project.</li> <li>3. The list should be reviewed by a project team, and the risks that may have impacts should be documented and added to the risk register and possibly marked for quantitative analysis.</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>Risk checklists should not be used as the first step in risk identification because they may not contain important project-specific risks.</li> <li>If a project team relies too heavily on a risk checklist, it could easily overlook project-specific risks, and the risks may not be phased correctly for the unique aspects of the project.</li> <li>Risk checklists are simple to maintain by individual Estimators, Project Managers, or Districts.</li> </ul>	

## Sample Risk Checklist

CONTEXT	Risk Description
Cost	ROW acquisition costs higher than anticipated
Cost	Unexpected geotechnical or groundwater issues
Cost	Contingency consumption above anticipated based on planned risk distribution/sharing
Cost	Unanticipated escalation in right of way values or construction cost
Cost	Unplanned work that must be accommodated
Cost	Estimating and/or scheduling errors
Cost	Force Majeure Events such as natural catastrophes, sabotage and terrorism
Cost	Developer uses non-standard components in maintenance replacements not in line with Department then-current technical requirements or standards, e.g. different tolling or ITS components
ENVIRONMENTAL	Design changes require additional Environmental analysis
ENVIRONMENTAL	Environmental regulations change
ENVIRONMENTAL	MPO model changes due to conformity
ENVIRONMENTAL	Air quality attainment impacts travel demand
ENVIRONMENTAL	Hazardous waste site analysis incomplete
ENVIRONMENTAL	NEPA compliance 150d lawsuit window – will we get sued?
FINANCIAL	Lack of understanding of complex internal funding procedures
FINANCIAL	Funding changes for fiscal year
FINANCIAL	Capital funding unavailable for right of way or construction
FINANCIAL	Global market conditions
FINANCIAL	Potential inadequate local access to materials, labor, resources
FINANCIAL	Labor shortage or strike
FINANCIAL	Contract execution may need revisions to financial terms in the agreement
FINANCIAL	Financial failure of Developer during construction or full term
FINANCIAL	Bond availability & favorable terms secured
FINANCIAL	Developer not financially closing
LEGAL	Unforeseen agreements required
LEGAL	External agreement development
LEGAL	Unable to meet Americans with Disabilities Act requirements
LEGAL	Developer contract legal sufficiency determination
LEGAL	Terms of toll service agreement
LEGAL	Added workload or time requirements because of new direction, policy, or statute
LEGAL	Dispute on terms of agreement or technical provisions during construction
OPERATIONAL	Functional units not available, overloaded
OPERATIONAL	Internal “red tape” causes delay getting approvals, decisions
OPERATIONAL	Inexperienced staff assigned
OPERATIONAL	Lack of specialized staff (biology, anthropology, geotechnical, archeology, etc.)
OPERATIONAL	Readiness to prepare, review, & deliver ROW acquisition packages
OPERATIONAL	Operational concerns relative to timing of support staff

## Sample Risk Checklist (Continued)

CONTEXT	Risk Description
OPERATIONAL	Readiness & ability to review & approve design deliverables
OPERATIONAL	Railroad involvement causes delays or additional scope/cost
OPERATIONAL	No control over staff priorities
OPERATIONAL	Goals & needs to aid the project may counter District or higher level goals & needs, e.g. good relationships with locals
OPERATIONAL	Communication/Coordination failure between state, project, developer, public, MPOs, etc.
OPERATIONAL	Unanticipated Project Manager workload
OPERATIONAL	Data management system malfunction
POLITICAL / PUBLIC	Local agency support not attained
POLITICAL / PUBLIC	Priorities change on existing program
POLITICAL / PUBLIC	New stakeholders emerge and request changes
POLITICAL / PUBLIC	Reviewing agency requires longer than expected review time
POLITICAL / PUBLIC	Public perception during construction, e.g. lane closures, business disruption
POLITICAL / PUBLIC	Public Perception of Value of (interim) facility being constructed
POLITICAL / PUBLIC	Successful Attainment of DBE Compliance by Developer
POLITICAL / PUBLIC	Landowners unwilling to sell
POLITICAL / PUBLIC	Controversy on environmental grounds causing project delay or re-evaluation
POLITICAL / PUBLIC	Stakeholders request late changes
POLITICAL / PUBLIC	Political factors or support for project changes
POLITICAL / PUBLIC	Unreasonably high expectations from stakeholders
POLITICAL / PUBLIC	Construction or pile driving noise and vibration impacting adjacent businesses or residents
POLITICAL / PUBLIC	Anti-toll groups challenge NEPA decision
POLITICAL / PUBLIC	Legislative support for TxDOT and SPD – political position viable?
POLITICAL / PUBLIC	Highly involved local leadership preferences for project in control of developer
POLITICAL / PUBLIC	Public acceptance of tolling roads
POLITICAL / PUBLIC	Additional congestion in proximity to corridor during construction
QUALITY / PERFORMANCE / SCOPE	Inconsistent cost, time, scope and quality objectives
QUALITY / PERFORMANCE / SCOPE	Overlapping of one or more project limits, scope of work or schedule
QUALITY / PERFORMANCE / SCOPE	Construction quality sufficient to meet short- and long-term maintenance expectations
QUALITY / PERFORMANCE / SCOPE	Construction quality sufficient to meet specifications and expectations for aesthetics and safety
QUALITY / PERFORMANCE / SCOPE	Unforeseen design exceptions required
QUALITY / PERFORMANCE / SCOPE	Unresolved constructability items

## Sample Risk Checklist (Continued)

CONTEXT	Risk Description
QUALITY / PERFORMANCE / SCOPE	Inaccurate assumptions on technical issues in planning stage
QUALITY / PERFORMANCE / SCOPE	Scope creep
QUALITY / PERFORMANCE / SCOPE	Unresolved project conflicts not escalated in a timely manner
QUALITY / PERFORMANCE / SCOPE	Change requests due to differing site conditions
QUALITY / PERFORMANCE / SCOPE	Project purpose and need is not well-defined
QUALITY / PERFORMANCE / SCOPE	Project scope definition is incomplete
QUALITY / PERFORMANCE / SCOPE	Project scope, schedules, objectives, cost, and deliverables are not clearly defined or understood
QUALITY / PERFORMANCE / SCOPE	Department-directed changes required during detailed design stage due to Department preference, political or public pressure or other external influences
QUALITY / PERFORMANCE / SCOPE	Unexpected 3 <sup>rd</sup> party requirements during construction
QUALITY / PERFORMANCE / SCOPE	Capacity improvements not built within timeframes originally predicted or not built to suit reasonable travel demand so resulting in deteriorating level of service, not meeting stakeholder expectations, and/or not meeting environmental commitments
SAFETY	Safety (During Construction) for traveling public
SAFETY	Safety (During Construction) for Developer or TxDOT employees
SAFETY	Responsiveness to Traffic Safety concerns, e.g. timely replacement of safety devices
SCHEDULE	Permits delayed or take longer than expected
SCHEDULE	ROW acquisition progressing slower than anticipated
SCHEDULE	Consultant or contractor delays
SCHEDULE	Utility relocation requires more time than planned
SCHEDULE	Delay in earlier project phases jeopardizes ability to meet programmed delivery commitment
SCHEDULE	Underestimated support resources or overly optimistic delivery schedule

## RISK REGISTER

<b>What is it?</b>	<b>What does it do?</b>
<p>A living document throughout project development that describes all identified risks, causes, probability of occurrence, impact(s) on project/agency objectives, team responses, individual(s) assigned to monitor the evolution and the resolution of each risk, and current status.</p>	<ul style="list-style-type: none"> <li>• Documents the identified risks, the assessment of their root causes, the areas of the project affected (e.g., work breakdown structure elements), the analysis of their likelihood of occurring, their impact should they occur, the criteria used to make those assessments, and the overall risk rating of each identified risk by objective (e.g., cost, time, scope, and quality).</li> <li>• Includes the risk triggers, the response strategies for high-priority risks, and the assigned risk owner who will monitor the risk.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>• All phases.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>• Helps the project team to communicate project risks and understand the status of the risks as a project moves from inception to completion.</li> </ul>
<b>How to use it?</b>	<p>The TxDOT risk register template is shown in Figure 26 and can be found on the <i>Crossroads</i> intranet. Instructions for using the risk register is contained on a separate worksheet within the spreadsheet file.</p>
<b>Tips</b>	<ul style="list-style-type: none"> <li>• A risk register is best used as a living document throughout project development to record the evolution of project risks. There is no prescription for how extensive a project team's risk register should be.</li> <li>• The project team needs to decide upon the most beneficial use of the risk register, with the objective of minimizing the risk impact.</li> <li>• A risk register is an important part of the project file for all projects, regardless of size or type. The level of detail in the risk register can vary depending upon the project size, and rigor level.</li> </ul>

Template Updated: 3/13/2014

No.	Date Identified	Date Updated	Project	RBS Group 1	RBS Group 2	Project Phase	Status	Opportunity / Threat	Summary Risk Description	Detailed Description of Risk Event (If → Then) or (Due to <definite cause>, <uncertain event> may occur, resulting in <effect on objectives>.)	Probability	Project Impact (pre-response)	Agency Impact (pre-response)	
												Safety	Congestion	Agency Impact (pre-response)
												Quality	Schedule	Cost
												0	0	0
												0	0	0
												0	0	0

Response (Plan to manage risk before it occurs)		Response Category	Urgency	Probability	Quality	Schedule	Cost	Severity (P)	Safety	Congestion	Connectivity	Best-in-class	Severity (A)	Severity (max)	Risk Owner	Contingency Plan (plan for if risk occurs)	Trigger(s)	Response cost (\$M)
			0	0	0	0	0	0	0	0	0	0	0	0				
			0	0	0	0	0	0	0	0	0	0	0	0				
			0	0	0	0	0	0	0	0	0	0	0	0				

Agency Risk (X)	Cost Impacts (X)	Schedule Impacts (X)	Probability	Residual Risk Cost Impact (\$M)	Residual Risk Schedule Impact (Mo.)	Residual Risk Cost Severity (most likely, \$M)	Residual Risk Schedule Severity (most likely, Mo.)	Comments

### Sample TxDOT Risk Register.

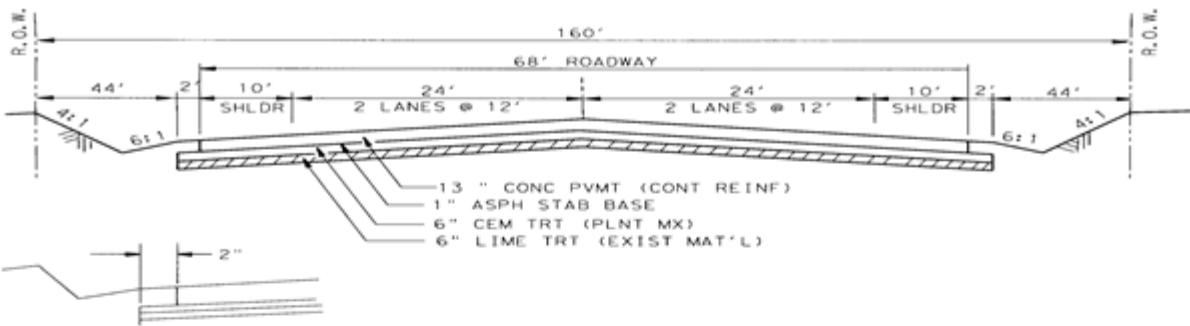
RISK WORKSHOP	
What is it?	What does it do?
A formal meeting where Estimators, project team members, subject matter experts, and risk analysis facilitators work together to identify and analyze project risks.	<ul style="list-style-type: none"> <li>Identifies and ranks project risks (or quantify uncertainty in the case of a quantitative analysis).</li> <li>Produces other risk management documents such as a risk register or risk management plan.</li> <li>Focuses on either qualitative or quantitative risk analysis techniques.</li> </ul>
When to use it?	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
Why use it?	<ul style="list-style-type: none"> <li>Helps to assemble all those who can influence the project with the goal of identifying risks and helping the project team understand and plan for project uncertainty.</li> <li>Helps to align project team members' understanding of project risks and focus resources in the areas that are most affected.</li> </ul>
How to use it?	<ol style="list-style-type: none"> <li>Prepare an agenda and objectives for the meeting.</li> <li>Present the project background and issues in a concise way.</li> <li>Focus on the agreed topics (usually risk identification and quantification).</li> </ol>
Tips	<ul style="list-style-type: none"> <li>When used, the workshops must be conducted well in advance of finalizing the cost estimate because Project Managers and cost Estimators need sufficient time to incorporate the findings into the project plans and estimates.</li> <li>The products of risk workshops vary depending upon the complexity of the project being studied, the current phase in the project development process, and time available for the workshop.</li> <li>Qualitative analyses typically identify and rank risks.</li> <li>Quantitative analyses typically identify risks, quantify uncertainty in project performance (e.g., for generating ranges for total project cost and schedule), and quantify the significance of each risk (e.g., for subsequent risk management cost-benefit analysis).</li> <li>Without proper facilitation, participants can deviate from these objectives to risk mitigation, value engineering, or issue solving rather than identifying and quantifying them for later mitigation efforts.</li> </ul>

SIMILAR PROJECTS	
What is it?	What does it do?
The concept of using the costs of project that is highly similar to the project being estimated as the basis for developing the estimate. Uses the values of parameters, such as scope, cost, and time, or measures of scale, such as size, quantities, and complexity, from a similar previous project as the basis for estimating the same parameters or measures for a future project.	<ul style="list-style-type: none"> <li>Provides accurate estimate data when previous projects are very similar in terms of major parameters and not just in appearance.</li> <li>Provides an approach to preparing an estimate that has sufficient reliability and accuracy for use in programming a project.</li> <li>Provides sufficient detail to subsequently track changes in quantities and unit costs as the project is designed.</li> <li>Reduces likelihood of missing items.</li> <li>Is quick, easy to use, and cost effective.</li> </ul>
<b>When to use it?</b>	
<ul style="list-style-type: none"> <li>All phases.</li> </ul>	
<b>Why use it?</b>	
<ul style="list-style-type: none"> <li>Helps to rapidly assess the approximate costs for addressing transportation needs based on limited design information.</li> </ul>	
<b>How to use it?</b>	
Steps for applying this tool are:	
<ol style="list-style-type: none"> <li>Identify similar project – one that is very similar in terms of project definition and within the same location (e.g., same District).</li> <li>Identify items that apply to current project – use standard item number and descriptions to guide selection of pertinent items.</li> <li>Calculate quantities for current project.</li> <li>Adjust similar projects' unit prices to reflect project specific conditions, quantity differences, time basis, location, size of project, and market conditions.</li> <li>Apply final unit prices to quantities of project being estimated.</li> </ol>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>Confirm that the reference project is, in fact, similar to the project being estimated and not <i>just</i> similar in appearance.</li> <li>Make a careful assessment of the definitions and site conditions of both the project being estimated and the reference project. Adjustments may be required to the reference project's definition and cost data to fit the project being estimated.</li> <li>Carefully document differences between the similar project and the current project as part of the estimate backup calculations.</li> <li>The main disadvantage of using a previous project is when the previous project is not highly similar.</li> </ul>	

TYPICAL SECTIONS ON A PER MILE BASIS	
What is it?	What does it do?
The concept of using typical sections/components representing common types of facilities and historical cost data to derive key cost parameters.	<ul style="list-style-type: none"> <li>Develops approximate total construction costs for a transportation need or needs so that estimates of funds required for long-range plans can be determined.</li> </ul>
<b>When to use it?</b>	<ul style="list-style-type: none"> <li>Relies on historical bid data for developing standardized or typical configurations that represent types of transportation facilities.</li> </ul>
<b>Why use it?</b>	<ul style="list-style-type: none"> <li>Is easy to use.</li> </ul>
<ul style="list-style-type: none"> <li>Helps to provide a quick approximation of the conceptual cost for addressing a transportation need or correcting a deficiency.</li> </ul>	<ul style="list-style-type: none"> <li>Can be used for a specific District to provide a location specific cost parameter.</li> </ul>
<b>How to use it?</b>	
<p>The Estimator can develop these data for a specific application. The steps are as follows:</p> <ol style="list-style-type: none"> <li>Create a typical section for an element over common parameter (e.g., a one mile pavement section including structure, sub-grade materials).</li> <li>Identify typical item costs that reflect the items that comprise the element.</li> <li>Find historic cost data for the items.</li> <li>Develop quantities for the standard section and apply item cost data.</li> <li>Summarize cost for total parameter (e.g., lane-mile).</li> <li>Calculate parameter quantity for current project.</li> <li>Apply cost per parameter factor to current quantity.</li> </ol> <p>Figure 27 shows an example of determining the cost of a typical section on a per mile basis from the Houston District.</p>	
<b>Tips</b>	
<ul style="list-style-type: none"> <li>Applying this tool requires the Estimator to match basic items to typical configurations and/or sections representing different types of transportation need solutions.</li> <li>The Estimator also must ensure that all project definition elements are covered and that the database provides sufficient information to estimate all pertinent elements for the proposed solution.</li> <li>The estimate must cover all categories of total construction cost that apply. Cost adjustments may also be necessary when the project definition is different from that used to make the estimate or when unique conditions exist.</li> <li>Simple spreadsheets can be used to make calculations and summarize cost estimate elements.</li> </ul>	

## Sample Determination of a Cost Per Mile of Typical Section (Houston District)

### 4 Lane Undivided Rural Section w-10' Concrete Shoulders



	Description			Quantity	Unit Price	Cost
<b>13" CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED)</b>						
$68' \times 5,280' / 9 = 39,893.33 \text{ SY}$				39,893.33	\$50.00	\$1,994,667
68						
<b>1" ASPHALT STABILIZED BASE (GR 4)(PG-64)</b>						
$72' \times 5,280' / 9 = 42,240 \text{ SY} \times 110 \text{ LB/SY/IN} / 2000 \text{ LB/TON} = 2,323.20 \text{ TONS}$				2,323.20	\$75.00	\$174,240
72						
<b>6" CEMENT TREATMENT (PLANT MIX)(CL N)(TY E)(GR 4)</b>						
$72' \times 5,280' / 9 = 42,240 \text{ SY}$						
72				42,240.00	\$8.00	\$337,920
<b>6" LIME TREATMENT (EXIST MATERIAL)</b>						
$72 \times 5,280' / 9 = 42,240 \text{ SY}$				42,240.00	\$1.75	\$73,920
<b>LIME (HYDRATED, COMM, OR QUICKLIME (SLRY)) OR QUICKLIME (DRY)</b>						
$(72' \times 5,280' \times 0.5') \times (100 / 2,000) \times 0.06 = 570.24 \text{ TONS}$						
72 5280 0.5 100 2000 0.06 570.24						
<b>CEMENT STABILIZED BACKFILL EMBANKMENT</b>						
$2 \times [(72' \times 65' \times 20') + (2 \times 65' + 72') \times (20' \times 60' / 2) + 72' \times (20' \times 20' / 2)] / 27$				16,977.78	\$25.00	\$424,444
<b>EARTHWORK</b>						\$70,000
					<b>SUBTOTAL PER MILE</b>	<b>\$3,160,727</b>

**Sample Determination of a Cost Per Mile of Typical Section (Houston District).**  
**[Continued.]**

DRAINAGE						\$820,000
PREP ROW	(52.8 Rounded to) 53 STA		53.00	\$15,000.00	\$795,000	
BRIDGE (CONC SLAB BEAM)	71' x 250' = 17,750 SF		17,750.00	\$70.00	\$1,242,500	
BARRICADES AND TRAFFIC HANDLING	12 MO		12.00	\$15,000.00	\$180,000	
SIGNALS 2 EA			2.00	\$150,000.00	\$300,000	
SIGNING					\$30,000	
STRIPING					\$30,000	
LIGHTING					\$228,100	
CONCRETE PAVEMENT TERMINALS	2 EA X 68'		136.00	\$360.00	\$48,960	
SW3P (TOPSOIL, TEMP & PERM SEEDING)						
2 x (46' x 5,280') / 9 = 53,973.33 SY @ \$(1.50+0.15+0.15)			53,973.33	\$1.80	\$97,152	
				<b>SUBTOTAL PER MILE</b>	<b>\$3,771,712</b>	
MOBILIZATION (10% OF TOTAL ESTIMATE)						\$693,244
				<b>TOTAL PER MILE</b>		<b>\$7,625,683</b>

VARIANCE REPORTS ON COST	
What is it?	What does it do?
A tool for alerting project personnel, particularly the Project Manager, to deviations from the project budget or baseline cost.	<ul style="list-style-type: none"> <li>Captures changes in cost and schedule.</li> <li>Provides a mechanism for budget control through tracking changes and alerting project personnel of changes.</li> <li>Creates a transparent notification system for alerting project personnel of deviations in project baseline costs.</li> <li>Supports project change requests.</li> </ul>
When to use it?	<ul style="list-style-type: none"> <li>All phases.</li> </ul>
Why use it?	<ul style="list-style-type: none"> <li>Helps the Project Manager to control the cost variance of the project at the stages of project.</li> <li>Helps to ensure proper resource allocation.</li> </ul>
How to use it?	<ul style="list-style-type: none"> <li>Calculate the difference between the Baseline Cost Estimate and the updated cost estimate.</li> <li>Provide an explanation to support the reasons behind the cost increase or decrease.</li> <li>An example structure for a cost variance report is shown in</li> </ul>
Tips	<ul style="list-style-type: none"> <li>Be sure to generate variance reports at key project milestones or when significant changes in the project occur.</li> <li>Consider different variance report details and intervals depending on the level of project rigor or phase of project development.</li> <li>Intervals should be closer together on high rigor projects or projects that are in a phase of high activity, such as during the Design Phase.</li> <li>Even during periods of inactivity, projects should be regularly examined to ensure that there are no variances in project costs or schedule. Variances should be reported to appropriate levels of management if the magnitude of the deviation warrants.</li> <li>Consideration should be given to the impact of multiple small deviations that alone do not account for much difference from the budget or schedule but collectively amount to a problem. Safeguards should be in place to watch for this type of activity.</li> <li>Regular estimate updates will help uncover the impact of small deviations from the Baseline Cost Estimate.</li> <li>This cost variance check can follow the Pareto principle in that 80 percent of the estimated cost of construction is covered in 20 percent of the items.</li> </ul>

## Sample Cost Variance Report.

### Estimate Reconciliation

SP Number:

Estimate Completion Date:

Project Location:

Project Description:

Components	Baseline Cost Estimate				Updated Cost Estimate				Delta				Explanation
	Base	Contingency	Total (Current Yr.)	Construction Year	Base	Contingency	Total (Current Yr.)	Construction Year	Base	Contingency	Total (Current Yr.)	Construction Year	
DIVISIONS													
GROUP													
CATEGORY													
ELEMENTS													
ITEM													
TOTAL													



