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Department of Transportation

Cost Estimating Manual for Projects

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Foreword

WSDOT's vision is to be the best at providing a sustainable and integrated multimodal transportation system. Its mission is to provide and support safe, reliable, and cost-effective transportation options to improve livable communities and economic vitality for people and businesses.

Estimators should be shielded from pressures to keep estimates within desired amounts.

This update to the WSDOT Cost Estimating Guide is part of an ongoing process to keep technical information relevant and current, as well as provide consistency with the department's vision.

More of an art than a science, cost estimating requires a thorough understanding of project scope, past price history, and current market conditions, as well as with a generous application of human judgment.

Key goals of the estimating process described in this manual include:

1. **Departmentwide priority on estimating, managing, and controlling costs:**
    - Fully developed and integrated policies, processes, and tools for cost estimation, management, and control
    - Baseline estimates that align with early project scope development and include an initial assessment of uncertainty
    - Clearly defined and documented cost management endorsement processes to authorize changes in scope and cost after the baseline estimate is established
    - Dedicated resources that are focused on effective scoping, project cost estimating, and cost management
2. **Reliable and accurate estimates:**
    - Well-documented and complete cost estimates
    - Clearly spelled-out assumptions, risks, and uncertainties that can be easily communicated
3. **Statewide uniformity and consistency:**
    - Uniform application and consistent statewide use of well-documented processes, tools, and templates
    - Use of processes and tools during the planning, scoping, design, and letting phases

4. **Improved communication and credibility with external stakeholders:**
    - Consistent and clear communication of cost estimates to external stakeholders at milestone points
    - The ability to communicate cost estimates with confidence, leading to stronger relationships with external stakeholders, greater possibility for collaboration, and increased funding support of transportation initiatives
5. **Clear accountability:**
    - Accountability for cost estimating and cost management at all levels of the agency
    - Defined roles and responsibilities for every person involved
    - Accountability that is tracked at key milestones in the process

This manual is intended as a guide for developing and managing project cost. It provides policies, rules, procedures, and tools to aid WSDOT staff in preparing project cost estimates and managing cost throughout WSDOT's project development process. Although the manual is primarily written for project managers and estimators, it is strongly recommended that others involved in WSDOT's project delivery activities familiarize themselves with this information.

The term "project cost estimate," as used during the project development process, includes all direct capital outlay costs, including right of way, structures, and landscaping, but does not normally include indirect capital outlay support costs.

Project cost estimates should be as accurate as possible. Estimates should never be artificially reduced to stay within the funding limits, nor should they be reduced to make available more funding for region projects. Likewise, project cost estimates should not be artificially raised beyond the contingency percentages provided for in this manual unless adequately justified.

Cost estimating and cost management tools continue to be developed and will be added to the department's estimating tool box as they become available. Please note that while cost estimating in support of design-bid-build projects is covered in depth in this manual, there are certain other conditions, such as design-build project delivery, accelerated projects, and accelerated estimates, which are not addressed in detail.

Important Notice

The detailed estimate of any phase of an estimate shall not be disclosed to the public and will be kept confidential until the end of the bid opening.

Definitions

A comprehensive glossary for cost risk estimating management is posted at:
www.wsdot.wa.gov/publications/fulltext/cevp/glossary.pdf

Key Terms

Allowance – Additional resources included in an estimate to cover the cost of known but undefined requirements for an activity or work item. Allowance is a base cost item.

Base Cost Estimate – The term "base cost estimate" was developed by WSDOT for cost risk analysis and represents the reviewed and/or validated project cost estimate to be used in the quantitative risk analysis for a project. The base cost represents the cost that can reasonably be expected if the project materializes as planned, including PE, RW, and CN costs. The base cost estimate is unbiased and neutral—it is not optimistic and it is not conservative. It does not include any risks, but does include the WSDOT standard construction contingency, since that amount is based upon historical usage. Base costs reported to program management shall be in current-year dollars (the un-inflated estimate). Refer to the *Plans Preparation Manual* 800.03(2).

Baseline – The approved time-phased plan (for a project, a work breakdown structure component, work package, or schedule activity), plus or minus approved project scope, cost, schedule, and technical changes. Generally refers to the current baseline, but may refer to the original or some other baseline. Usually used with a modifier (e.g., cost baseline, schedule baseline, performance measurement baseline, technical baseline).

Baseline Preliminary Engineering (PE) – The effort (budget/cost) of taking a project from planning through the scoping and design phases of project development. Planning and scoping typically have separate budgets but are encompassed under Design or Preliminary Engineering (PE). The terms "Design" or "Design Phase" are sometimes used interchangeably with PE.

Basis of Estimate (BOE) – Documentation to enable the agency to easily track changes to project scope, cost, and schedule. A well-documented estimate basis and documentation of assumptions used can eliminate overlap of future estimate assumptions. This document provides a trail about what is known about the project. This allows project "knowns" as well as "unknowns" to be clearly identified. This documentation is important because multiple estimators may be involved on the project; complex projects in particular take years to develop and estimates must be completed multiple times.

Construction Contingency – A standardized markup applied to the construction cost of a project that accounts for uncertainties in quantities, unit costs, and minor risk events that typically take place during construction. Refer to the *Plans Preparation Manual,* Section 800.03, for guidance on estimating construction contingency.

Construction Engineering (CE) – The project management effort (budget/cost) applied to the contract execution and construction phases of the project. Refer to the *Plans Preparation Manual,* Section 800.03, for guidance on estimating the CE cost.

Cost Estimate – A prediction of quantities, cost, and/or price of resources required by the scope of an asset investment option, activity, or project. As a prediction, an estimate must address risks and uncertainties. Estimates are used primarily as inputs for budgeting; cost or value analysis; decision making in business; asset and project planning; or for project cost and schedule control processes. Cost estimates are determined using experience and calculating and forecasting the future cost of resources, methods, and management within a scheduled time frame. (Source: Copyright 2007, AACE International, Inc., AACE International Recommended Practices, Number 10S-90)

Estimator – A knowledgeable professional assigned to evaluate the probable cost of projects.

Parametric Estimate – A method of estimating the cost of a project (or part of a project) based on one or more project-based cost factors. Historical bid data is commonly used to define parameters related to the cost of a typical transportation facility construction, such as cost per lane mile, cost per interchange or cost per square foot. Percentages can also be used to estimate the cost of project elements based on historical cost information. Parametric methods are often used in early estimating, such as planning and scoping estimates. (Source: WSDOT working definition)

Risk-Based Estimate – An approach that involves simple or complex risk modeling based on inferred and probabilistic relationships among cost, schedule, and events related to the project. Risk-based estimating uses historical data and/or cost-based estimating techniques and an expert's best judgment to develop the project "base cost" (project cost if the project proceeds as planned). Risk elements (defined as opportunities or threats) are then defined and applied to the Base Cost through risk modeling to provide a probable range for both project cost and schedule. (Source: WSDOT working definition)

Risk – The effect of uncertainty on objectives. (Source: ISO 31000, *Risk management – Principles and Guidelines*)

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Chapter 1 Purpose

Cost estimating[1] is the predictive process used to quantify, cost, and price the resources required by the scope of the project, to better manage budgets and deliver projects that do not exceed the identified scope, and that are on time throughout the development process.

The need to solidify the estimation process can be seen in four areas:

1. State financial plan
2. Creation of public satisfaction and a positive response
3. Project control
4. Problems currently being encountered

The **state financial plan** is affected as cost estimates are used to obtain and allocate funding for the overruns of the estimated project costs. This leads to the second reason for the need for cost estimates: influencing public opinion.

Public satisfaction is increased if transportation projects show and prove to the general public that they are timely and within budget. Public declaration of the estimated cost of projects needs to be thoughtfully provided only after care is taken to produce a well-documented, quality estimate.

Project control relies on cost estimates to help keep projects within the appropriate fiscal boundaries. Although not necessarily a "check and balance" format, the existence of the original estimate will keep the project from growing and expanding beyond its spending limit.

As **projects encounter problems,** and their estimates come "under fire," great scrutiny is given to the project and its associated estimates. The ability to confront and solve problems and obstacles relies in large part on the quality of the estimate and the documentation, which, if done properly, will provide critical support to project success.

[1] *AACEI: III. PROJECT CONTROL PROCESS* – CHAPTER 7 – PROJECT CONTROL PLANNING
7.3 Cost Estimating and Budgeting
7.3.1 Description
Note: Guidance for calculating quantities of a proposed design is found in the WSDOT Design Manual.

The reliability of project cost estimates at every stage in the project development process is necessary for responsible fiscal management. Unreliable cost estimates result in severe problems in WSDOT programming and budgeting, affecting staffing and budgeting decisions that could impair effective use of department resources. Communication with decision makers on critical budget issues is also adversely affected.

This manual provides guidance and instruction to design staff and project managers for a consistent approach to cost estimating. At the same time, it provides guidance on how to treat the common and recurring challenges encountered in the estimating process.

The manual provides cost estimating data and useful links to cost estimating resource materials that may be found on WSDOT intranet websites. It also provides “considerations,” “tips,” and “cautions” regarding the different phases of an estimate.

Chapter 2 Cost Estimating Process

2-1 Introduction

Projects benefit from following a thoughtful and deliberate process when developing project cost estimates. The process presented in Figure 2-1 describes the way WSDOT develops its project cost estimates. It is applied to all phases of project delivery, starting with the planning phase estimate and ending with the Plans, Specifications, and Estimates (PS&E) phase (or ad ready).

Each phase of an estimate may require different estimating inputs, methods, techniques, and tools. The task of cost estimating, by its very nature, requires the application of prudent judgment, from the initiation to the completion. Following is a short description of each step in the cost estimating process.

2-2 Determine the Basis of Estimate

The Basis of Estimate describes the project. It includes underlying assumptions, notes, and exclusions, and is required prior to the preparation of every project estimate. The Basis of Estimate document includes project information and previously developed project scope and schedule data, from which a project cost estimate can be prepared.

The level of detail provided in the Basis of Estimate varies depending on a project's phase, type, and complexity, but would include the design matrix and criteria, all assumptions, and pertinent scope details.

The Basis of Estimate provides a documented history of the estimate process. It becomes a part of the project documentation, with the end result being a complete traceable history for each estimate.

2-3 Prepare a Baseline Estimate

Baseline estimated costs for the project components (items and aggregates of items) are determined in current year dollars. These components may be estimated using different techniques depending on the level of scope definition and the size and complexity of the project. The number and detail of components estimated may vary depending on the data available at the time of the estimate.

For example, in the scoping phase, the cost estimate covers preliminary engineering (PE), right of way (ROW), and construction (CN). As the design progresses and more details are known, estimate components become more detailed. Key inputs to this activity include project scope details, historical databases, and other cost databases.

WSDOT has internal specialty groups that should be consulted within their respective areas of expertise when preparing baseline estimates.

The baseline estimate is also dependent on the estimated project schedule. The estimated schedule should be attached to the Basis of Estimate.

At a minimum, estimates developed in the early stages of project development should include the major milestones that WSDOT uses to measure performance and progress on projects. An early schedule may only include a few activities, but typically should include estimated durations for the environmental, design, ROW, ad/bid/award, and construction phases.

2-4 Review the Baseline Estimate

This activity confirms that: (1) project and estimate assumptions, as documented in the Basis of Estimate, are appropriate for the project; (2) the baseline cost estimate is an accurate reflection of the project's scope of work; (3) scope, schedule, and cost items are calculated properly, and required components are not missing or double counted; and (4) historical data and other data was used reasonably, and it reflects project scope and site conditions. Internal specialty groups and/or subject matter experts (SMEs) must participate in the baseline estimate review.

2-5 Perform a Risk Assessment

This activity captures the effect of uncertainties on project cost and schedule using a structured and documented approach. Secretary's Executive Order E 1053.00 provides instructions on how and when a risk assessment must be performed. Instructional Letter IL 4071 provides detailed instructions on how the results of the risk assessment are used. The WSDOT *Project Risk Management Manual* provides the needed detail of how risk assessment is employed.

http://wwwi.wsdot.wa.gov/publications/policies/fulltext/1053.pdf

http://wwwi.wsdot.wa.gov/publications/policies/fulltext/4071.pdf

www.wsdot.wa.gov/publications/fulltext/cevp/projectriskmanagement.pdf

2-6 Determine the Estimate Communication Approach

Regardless of whether risk assessment is employed, project cost estimate data normally needs to be communicated to both internal and external constituencies. The communication approach determines what estimate information should be shared, who should receive this information, and how and when the information should be communicated.

Cost estimate information should be included when the communication plan is developed as part of the project management process. Often the words are as important as the numbers. The Basis of Estimate document can be used effectively as a communication tool to convey key information about the project to others.

2-7 Obtain Management Endorsement

Estimates are key products of the project management process and are fundamental documents upon which management decisions are based. Given their importance, all estimates should be reviewed by an independent party, and then be reconciled and revised as needed to respond to independent reviewers' comments. Once the independent review comments have been addressed, estimates should be presented to management staff for their endorsement.

Management endorsement of estimates developed for initial budgeting or baseline definition is defined as a step in the project management process. Revised estimates, typically developed if project requirements change, or as design is developed, should also be reviewed by management staff, revised as necessary to reflect management comments, and endorsed. Revised estimates shall be incorporated into project cost baselines through the established project change management process.

Estimates are not altered to fit a predetermined budget outside of the formal estimating process. In the event that management endorsement of an estimate cannot be obtained, revisit the estimating process starting with the project definition step (project information, project scope, project location, and site characteristics) in Figure 2-1.

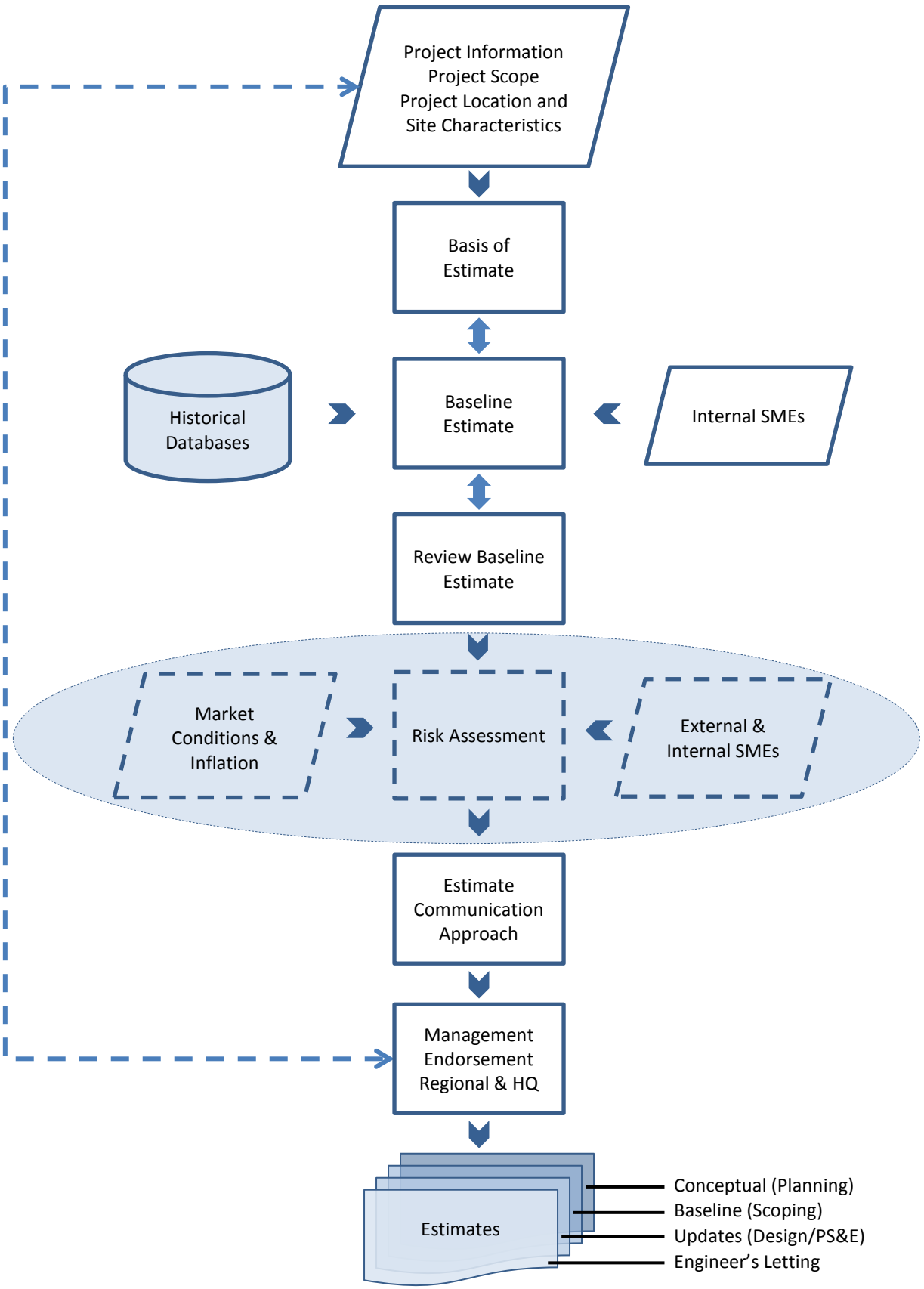

Figure 2-1 Cost Estimating Process

Chapter 3 Cost Estimating Methodology

Estimating methodologies that may be applied to WSDOT projects at various stages of project development include: (1) parametric, (2) historical bid-based, (3) cost based, and (4) risk-based. These categories encompass scores of individual techniques/tools to aid the estimator in preparing cost estimates. A combination of methods may be found in any given estimate.

There are a number of specialty items in WSDOT projects that are estimated by designated offices. These items include bridges and nonstandard retaining walls, traffic items, right of way and other properties, environmental features, and utilities. The procedures to estimate these items are covered in Chapter 5, Specialty Groups.

Parametric methods are applied to projects in the planning, scoping, or early design stage. These methods involve techniques that use historical data to define the cost of the typical transportation facility using measurements that are easily determined, such as cost per lane mile, cost per interchange, cost per square foot, and cost per intersection.

Two techniques are commonly used in parametric estimating: (1) analogous (similar) projects and (2) historical percentages. WSDOT uses an Access database estimating program to support parametric estimating:

- Planning-Level Project Cost Estimating (PLCE)

The tool can be found in the *Planning Level Cost Estimation Manual*:
www.wsdot.wa.gov/mapsdata/travel/pdf/plcemanual_12-12-2012.pdf

Historical bid-based methods are commonly used to develop WSDOT construction cost estimates, and are appropriate when design definition has advanced to the point where detailed quantification of bid items is possible. The unit cost prices used are collected and stored from prior projects. They should be modified or adjusted to reflect current prices and project-specific conditions such as geographic location, quantity of item(s) needed, and the scheduled timing of project advertisement. Techniques such as historical bid pricing, historical percentage, and cost-based estimating are also used to determine unit prices.

Historical cost data sources include:

- E-base
- BidTabs Professional
- Unit Bid Analysis
- RS Means, when WSDOT-specific unit costs are not available (this tool can be used for both historic bid-based and cost-based methods)

Oman Systems BidTabs Professional (contact IT to set up):
www.wsdot.wa.gov/design/projectdev/engineeringapplications/bidtabs.htm

WSDOT Unit Bid Analysis:
www.wsdot.wa.gov/design/projectdev/engineeringapplications/unitbidhistory.htm

Cost-based estimate methods are based on estimating the contractor's cost for materials, equipment, and labor for an item or a set of items. Estimated contractor overhead and profit are added. This may be appropriate in situations where historical unit prices are not available, or where historical bid-based information is not suitable for the project under consideration.

Contractors also generally utilize a cost-based estimating approach to prepare their bids. This method can be used to support the decision for contract award/rejection and to support any future price negotiations with the contractor after contract award.

Cost-based estimates frequently focus on those items that comprise the largest dollar value of the project, typically 20% of items of work that account for 80% of project cost. The cost of the remainder of estimate line items can be determined using historical bid-based estimate methods. This approach provides for a more efficient use of estimating resources and reduces the total time and cost of preparing cost-based estimates. Cost-based estimating is also a good way to check a few large items of work in a historical bid-based estimate to ensure the historical prices are still valid.

Risk-based estimate methods use the probabilistic relationships between base cost, base durations, and risks related to the project. This approach may incorporate a variety of techniques, including historical data, cost-based estimating, and the best judgment of subject matter experts for given types of work, to develop the base cost (the cost of the project if all goes as planned). Risks (opportunities or threats) are then defined and applied to the base cost through modeling (Monte Carlo simulation) to provide a probable range for both project cost and schedule. The schedule and cost are integrated into the same model.

For more information about risk-based estimates, please see the links provided in Section 2-5, Risk Assessment.

Chapter 4 Cost Estimating and Project Development Phases

4-1 Introduction

Typical phases of project development in the preconstruction phase are:

1. Planning
2. Scoping
3. Design
4. Plans, Specifications, and Estimates (PS&E)

Figure 4-1 illustrates how the phases of project development in the preconstruction phase overlap and succeed each other.

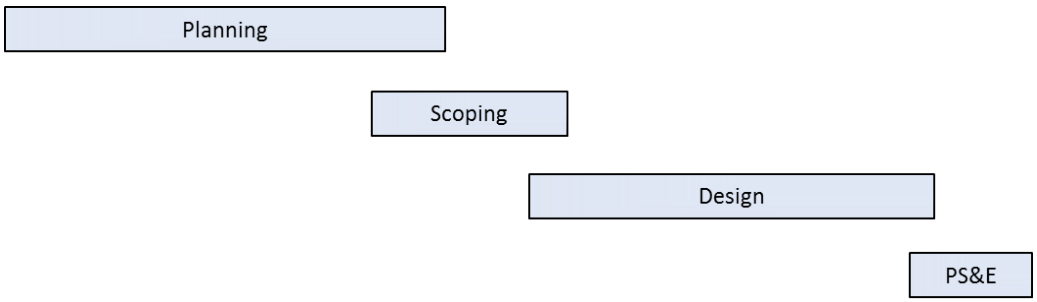

Figure 4-1 Gant Diagram of Preconstruction Phases

Blending art and science, cost estimating requires a thorough understanding of project scope, past price history, and current market conditions, along with a generous application of human judgment. While the science part is relatively easy to master, the art part can take much longer to develop. The following section is intended to provide information and insight into the art and science of the estimating process.

4-2 Preconstruction General Guidance

WSDOT provides a number of useful tools and resources, including the documents listed below, which you can access at:
www.wsdot.wa.gov/projects/projectmgmt/riskassessment/information.htm

4-2.1 WSDOT Estimating Documents and Steps

4-2.1.1 Estimating Documents

- *Cost Estimating Manual for WSDOT Projects*
- Basis of Estimate Form (doc 99kb)
- Estimate Order of Calculations, Tax Rates, & 700 & 800 Items (doc 36kb)
- Estimating Template (xls 1mb)
- Estimating Forms

4-2.1.2 Estimating Steps

Regardless of the project development phase of an estimate, a good estimator must consider the following:

1. Review the "Estimating Template" (which includes the "Estimate Summary") and "Estimate Order of Calculations, Tax Rates, & 700 & 800 Items" forms, and seek clarification if necessary. Also review the other resources at "Estimating Forms": www.wsdot.wa.gov/projects/projectmgmt/riskassessment/information.htm

2. When determining a project's Basis of Estimate, see the Basis of Estimate form (www.wsdot.wa.gov/projects/projectmgmt/riskassessment/information.htm) and complete the following:

   - Visit the site in person.
   - Review all available documents and design parameters relating to project definition.
   - Account for unique project location characteristics, such as land use context, travel modes, and construction challenges.
   - Review aerial photos and/or video logs.
   - Document initial estimating assumptions, including factors that will need further investigation.
   - Establish an estimate file in which estimate calculations will be placed over the life of the project.

3. When preparing the cost estimate, document the level of preconstruction phase (see Figure 4-1). Document the baseline estimate in each account (PE, ROW, and CN) and the contingency amount separately to facilitate tracking of deviations.

4. When reviewing the total estimate, engage knowledgeable and experienced individuals who are independent from the project. Perform reviews in each project development phase.

5. Use the tools and documents that have been prepared by others to your advantage. Review estimates from similar projects and use as a starting point for items and costs. Use spreadsheets and databases others have developed as templates for building your estimate.

6. Use the expertise of specialty groups at WSDOT to provide input to your estimate. Special items may have a significant effect on a project's cost. The information obtained from specialists can greatly increase the accuracy of an estimate. Be sure to inform the specialty groups about any unique issues or uncertainties that you think might affect their estimates.

7. Ask specialty groups about what kind of contingency they recommend for the specialty work and justification of it.

8. Economy of scale plays a large factor in estimating projects. When using a previous project's data to determine unit prices, be sure both projects are similar in size for the given item.

9. Have someone check your work. One of the easiest and most often overlooked ways to eliminate errors is simply to have your estimate reviewed by an experienced co-worker. Have the person look at the spreadsheets as well as your backup calculations.

10. Become familiar with the region in which the project will be constructed and any unique local policies. Market conditions may be different across the state, which will affect the cost of construction and/or materials. Knowing the general locations where materials might be obtained could be beneficial. Even a basic familiarity with contractors and their past practices can help you understand how they may bid on your project.

11. Use checklists throughout the estimating process to make sure no basic items are left out of an estimate.

12. Make sure the appropriate human and technical resources are dedicated to the estimating process.

13. Allow adequate time to estimate the costliest items; in most cases, they have the most important influence on overall cost.

4-2.2 Cost Management

Regarding cost management, it is wise to consider the following procedures:

1. Obtain endorsements at milestone points during project development. Consider using peer reviews prior to key milestones. If an endorsement is not indicated, the project team may also see value in a peer review involving knowledgeable and experienced individuals from outside the project team.

2. Establish good communication practices within the team and with management about the estimate, including assumptions, uncertainty, and other issues that may influence decisions about the project.

3. Protect estimators from internal and external pressures to deviate from established estimating guidelines, in order to foster and promote objectivity and impartiality.

4. Document updates to the base estimate and the use of miscellaneous items in each project development phase (planning, scoping, preliminary design (30%, 60%, 90%, ad ready), with reference to the scope, cost, and schedule that correspond to the prior endorsed estimate.

5. Contingencies identified in the planning or scoping phases that are not needed at the design or advertising phases should not be used to increase project scope. Return any unused contingency to region program management.

6. Keep region program management and HQ Capital Program Development and Management informed about project changes and external impacts that affect the baseline/project budget. Provide procedures that require endorsements prior to budget changes.

Each project development phase is inherently different from the others; therefore, they all have unique challenges to overcome during the estimating phases. In the following pages, techniques and considerations related to the best estimating practices are presented for each phase. The considerations include: (1) general advice, (2) tips, and (3) cautions.

Each tip can be used to either increase the quality of the estimate or reduce the time spent on the estimate. The cautions focus on situations that can be detrimental to the quality of an estimate. They generally include warnings about improper use of information, external factors that can affect an estimate, or even common pitfalls the estimators have encountered in the past.

While the list of considerations is a good compilation of pointers and warnings, the best advice will come from an experienced estimator who has worked on similar projects.

4-3 Planning

The planning phase estimate is used to estimate the funding needs for long-range planning and to prioritize needs for the Highway System Plan. These estimates are typically prepared with limited project information.

4-3.1 Techniques

Parametric estimating techniques are most commonly used for planning estimates. Lane mile and square foot are two examples of parametric estimating techniques.

Historical bid prices and historical percentages can also be used to generate costs for these parameters.

Analogous project estimating is another approach that can be used at the planning phase.

WSDOT supports a planning phase estimate tool that uses the above techniques:

- Planning Level Project Cost Estimating (PLCE): an Access database

Refer to this tool at: www.wsdot.wa.gov/mapsdata/travel/pdf/plcemanual_12-12-2012.pdf

4-3.2 Considerations

4-3.2.1 General Advice

Analogous projects: The chosen historical project must be truly analogous. Determine the similarities and differences between the historical project(s) and the current project before using historical data.

Older projects: Project data from older projects is less reliable due to variations in prices, standards, construction technology, and work methods. The analogous method is best used as a tool to determine broad price ranges for simple, straightforward projects or as a check to verify estimates prepared using another method.

Communication: Due to the lack of scope definition or preliminary design, care should be taken to properly communicate with project stakeholders regarding the range of possible cost and schedule changes as the project becomes more defined.

Assumptions: Given the large-scale assumptions inherent in parametric estimating methods, the estimator must document all assumptions clearly.

Uncertainty: Provide an adequate range of costs that reflects the unknowns in the project (see Table 4-1).

Maintenance: Keep the estimate current as the project waits to move into scoping phase.

1. Tips

a. **Project scope:** Although the project has not been fully defined, do your best to determine the full scope of the project before putting an estimate together. Develop a comprehensive list of all of the components that will be required in the project (within the time and resources allowed).

b. **Field review:** "Walking the job" is an excellent way to begin the process of obtaining good quality, factual data to back up the cost estimates and establish confidence in the process. To be confident that the project is adequately planned, perform a systematic field review.

   A project field review provides an important perspective that supplements the mapping, photos, survey data, and other sources of information about the project that are used in the office. Seeing the proposed project site first-hand minimizes the possibility of overlooking significant design features.

   While in the field, project personnel should be looking for potential high-cost items (costs of mitigating hazardous waste and other environmental impacts; utility relocation; noise barriers; retaining walls; major storm drains; need for a transportation management plan; traffic handling, etc.). Document where high-cost items may be present on the project so they can be considered in more detail during project scoping. A strip map and proposed typical sections are very useful in the field to document the occurrence of project features of special interest.

c. **Worst probable case:** Determine and assess in the field the "worse probable case" scenario, particularly on reconstruction projects. Existing facilities previously thought to be adequate may have become inadequate because of changes to standards, new data, etc. Design feature decisions, project constructability, construction staging, etc., can often be evaluated and documented in the field in preparation for further study later.

2. Cautions

a. **Market conditions:** Unit prices can vary greatly over time based on market conditions. Petroleum products, concrete, and steel prices have probably been the most volatile recently. It is important to review the unit prices, especially for larger-cost items on a project, to reflect current trends. Market conditions are important in all phases, but most prominently in planning, since the construction date is so far into the future.

b. **Ongoing maintenance:** Planning estimates may sit on the shelf for many years before moving to scoping, design, and construction. Planning estimates should be reviewed and refreshed regularly to reflect potential changes in scope, unit prices, regulatory requirements, etc. This is also a good time to review the assumptions and revise as necessary.

c. **Precision:** The total cost may be displayed by computer estimating tools to the nearest dollar, sometimes even to the penny. When these estimates are shared within the organization, or even outside the organization, they may give the impression that the estimate is very precise. Round planning phase estimates up to the nearest thousand, ten thousand, or hundred thousand dollars, depending on the magnitude of the estimated cost.

4-4 Scoping

Scoping estimates set the baseline cost for the project. A project is programmed when it is entered into the Capital Improvement and Preservation Program (CIPP) and the Biennial Transportation Program. The scoping estimate is important because it is the baseline used by the Legislature to set the budget; future estimates will be compared against it. Clearly document assumptions and scope definitions in the Basis of Estimate document so that changes can be accurately compared to this estimate.

4-4.1 Techniques

Historical bid-based and parametric techniques have been described previously, and both may be used in the scoping phase.

Cost-based estimating uses the same process as historical bid-based estimating, except that the costs applied during estimating are based on analysis of items other than bid research. Historical bid-based and cost-based approaches both utilize quantities estimated for items such as asphalt, concrete pavement, structures, and roadway excavation.

Other items that are not yet quantified may be estimated parametrically or through the use of historical percentages. At this time, risks associated with the calculation of item quantities should be identified, and a Risk Management Plan should be developed and included in the estimating file for future reference.

4-4.2 Considerations

4-4.2.1 General Advice

Create/Update Basis of Estimate: Clearly document all changes, assumptions, and data sources in the Basis of Estimate. This documentation is crucial because future estimates will reference this work to justify any changes in the cost of the project.

False precision: Do not assume a level of precision that is not warranted to the phase of the estimate. A properly developed estimate will include well-documented assumptions; many of the details that impact project cost are not defined at the time a scoping estimate is prepared. Miscellaneous item allowances at this phase of design typically range from 20% to 30%, and may be higher for nonstandard projects (see Table 7-1). Ensure costs and quantities are rounded to the appropriate significant figure.

Unit costs: Choose the correct unit costs for items in current dollars.

Major risks: Ensure major risks to the project are identified and documented.

1. Tips

a. When preparing the baseline estimate in the scoping phase, recognize complexity and the work that needs to be done to minimize uncertainty, such as stakeholder involvement and permits to be documented. If appropriate, call suppliers or specialists to get ideas about cost. Contact city/county engineers to discuss local issues, such as utility work and coordination, and use the expertise of offices within the agency, such as right of way, materials, traffic, environment, and bridge.

b. Once again, a site visit and investigation can be quite valuable. The more familiar an estimator is with the site, the more likely it will be that the estimator will not miss anything while estimating the project. During scoping, all existing structures, utilities, and any other potential obstructions should be noted and quantified. (Look for: costs of mitigating hazardous waste and other environmental impacts; utility relocation; noise barriers; retaining walls; major storm drains; need for a transportation management plan; traffic handling, etc.) Keep in mind that operations and maintenance personnel are aware of problems that are not apparent from a cursory site review.

c. Understand the current design standards and their project impacts. Anticipating potential design changes by staying actively engaged in design development can help while performing a scoping estimate.

d. Define the work as completely as possible. What work will be included in the project? What work is excluded?

e. Identify the major items of work for the type of project being scoped. Focus the efforts on these major items. For example, on a paving project, hitting the cost of striping to the exact penny of the final cost means nothing if the paving quantities are misestimated or the unit cost is way off.

f. Review the project constructability and make sure you are comfortable with constructing the project. Can the project be constructed as planned? Will there be adequate time to complete the project without carrying it into another season beyond what is planned? Are there local contractors who can perform the work?

2. Cautions

a. Watch out for traffic problems that will be caused by construction. If detour routes are necessary or available, will the estimate include addressing damage done to the detour route by the added traffic? If detour routes are not available, will daytime lane closures be allowed? If night work is necessary, address in the estimate.

b. What utility impacts are there? Utility impacts can be direct costs to a project and may result in change orders due to delays when the utility work is concurrent with the highway construction. This holds true for both public and private utilities.

c. Watch out for areas within the project limits with a high number of accidents. These areas may need safety improvements that weren't initially identified.

d. The same personnel who originally scoped the project should not be the only ones estimating it. More people and fresh perspectives should always be welcomed.

e. Not including enough risk on major improvement projects can be a problem during scoping. What can't be seen poses a significantly higher risk than what can be seen. There may be much more work than what is initially apparent.

4-5 Design

Estimates prepared at various design phases, including Geometric Review, General Plans Review, and Preliminary Contract Review, are used to track changes in the estimated cost to complete the project in relation to the current budget (legislative budget). Each time the estimate is updated, the cost estimating process detailed in Figure 2-1 should be followed. Compare the current budget for the project cost and schedule to the new estimate.

Document each update and provide a written explanation of any significant changes to include in the estimate file. If the budget or scope of the project is to be updated, fill out and submit a Project Change Request Form. The final Engineer's Estimate, along with supporting documents, is required to be filed in the Design Documentation Summary (DDS).

At design approval, the scope of work becomes more stable and many items become better known. These include right of way needed, permit conditions, environmental mitigation, quantities of major items, and stakeholder needs. As the scope of work becomes stable, the confidence in the estimate should improve.

4-5.1 Techniques

Historical bid-based estimating methodologies are typically used for standard bid items known to be included in the project.

Cost-based estimating methodologies can be used for items where there is little or no WSDOT bid history. Cost-based estimating may also be used for major items of work that are known project "cost drivers." Cost-based key resources are suppliers and other individuals knowledgeable about current prices for the subject items, typical construction methodology and production rates, and equipment used. The estimator should contact these resources to develop basic cost data for materials, labor, and equipment.

Risk-based estimating is used to capture the effect of a project's uncertainties on the project cost and schedule. Review risks identified earlier in the project development process and update the Risk Management Plan to reflect the current design phase and risks.

4-5.2 Considerations

4-5.2.1 General Advice

Guard the estimate against false precision. We often do not know as much about the project as we think we do, particularly early in design. Project definition continues to be refined until the project is ready for advertisement. Use appropriate item allowances for estimates (see Table 7-1).

If cost-based estimating techniques are used, pay special attention to documenting assumptions such as crew size, crew make up, production rates, and equipment mix and type. The costs assumed for contractor overhead and profit as well as for subcontractor work should also be documented. It is important to remember that these assumptions may not reflect the decisions of the individual contractors that will bid the job, thus introducing elements of uncertainty into the estimate.

1. Tips

a. Early in the project, get rights of entry for all properties adjacent to the project, not only those that seem to be necessary. Repeatedly sending a real estate services employee to obtain these documents is costly and can impact the schedule.

b. Understand the staging needed to construct the project. Work with the proper functional groups to verify traffic control strategy. (A functional or specialty group is a team that has authority in a particular area and profound knowledge or skills in a particular area of endeavor).

c. Do your research. If there are materials sources near your project site, you can often get a better price. If you need fill, and another project has excavation to waste, maybe their excavation can be stockpiled for your fill needs (results in haul and placement costs only). Don't forget your local agency projects. Develop a good relationship with the cities and counties you work in.

d. Consider the timing of your advertisement. If you advertise in late fall or winter, your estimate may be lower. Demand is typically lower in these months, resulting in lower prices. Contractors usually have more crews free during this time, and you may end up with their best or most experienced crew for off-season work.

e. Ask the experts. Do not be afraid to call suppliers, specialists, or contractors to get an idea about cost. And don't be afraid to change their numbers to fit your situation (remoteness, limitations, working days, work hours).

2. Cautions

a. Assuming the scoping estimate and project definitions are correct is not a good way to begin an estimate. When you start an estimate, look with fresh eyes and identify all substandard conditions. Coordinate with the appropriate entities to determine whether deviations will be approved.

b. Not enough contact with functional groups will lead to less accurate estimates. Do not be afraid to ask questions. Spend time getting to know those in functional groups who will be reviewing the project.

c. Be sure to pay enough attention to lump sum items. These have the greatest potential for cost overruns.

d. Be aware of structures. Work with the functional groups to confirm the estimate for any structures. Reconfirm structure estimate after the geotechnical report is complete.

e. Do not take the historical bid data at face value and simply average the prices shown. There are always circumstances that should be taken into account.

f. Avoid dictating the methods the contractor is to use on items that do not require it. It limits the contractor's flexibility and raises your cost. The contractor will find the least expensive way to perform the work since the lowest bidder will be awarded the project.

4-6 PS&E

The Engineer's Estimate is prepared for the Final Contract Review in preparation for advertisement. It is used to obligate construction funds and to evaluate contractors' bids.

4-6.1 Techniques

Historical bid-based, cost-based, and risk-based estimates are the same as Section 4π5 (Design). Pay attention to the miscellaneous item allowances (see Table 7π1). At the PS&E phase (letting) the allowances are terminated because the estimator should have all the data needed for the projects. The project data used at this phase shall be identical to the project data provided to potential bidders.

4-6.2 Considerations

4-6.2.1 General Advice

Carry out the final independent QA/QC checks of calculations, prices, and assumptions during the review estimates. Review the Basis of Estimate for completeness, accuracy, and clarity, and ensure all figures, from detailed backup to summary phases, are traceable.

- Double-check quantities of major items and cost drivers.
- Review specialty group estimates for scope and cost.
- Review Contract Special Provisions.

1. Tips

a. Do not use any documents for the PS&E (letting) estimate that the contractor will not have. If you need additional documentation to complete an estimate, it may be an indication that the plans and specifications are not complete.

b. If possible, use historical data from the region the project will be performed in. These historical bids are probably from the same contractors who will bid on this project.

c. Construction staff can help evaluate the potential impact of staging, materials storage, hauling of materials, location of batch plants, and other constructability-related issues. The information in this step is exceedingly important, since the estimate at this phase is completed as though the bidders prepared it.

2. Cautions

a. Recent drastic changes in material costs or availability may cause a knee-jerk reaction with the contractors while preparing their bids. The WSDOT estimator should think like a contractor.

b. Previous estimates using elements and categories should now all be reduced to items. Be sure you know everything that was included in the aggregations before splitting them into items. Not doing so is an easy way to miss some items.

Table 4-1 Cost Estimating Matrix

Project Development Phase	Percentage of Design Completed	Purpose of Estimate	Methodology	Tools	Estimate Range
Planning Washington Transportation Plan Highway System Plan Design Studies Route Dev. Plans	0% to 2%	Screening or Feasibility WTP/HSP (20-Year Plan) WTP – Washington Transportation Plan HSP – Highway Systems Plan	Parametric	PLCE and/or MP3	-50% to +200%
	1% to 15%	Concept Study or Feasibility Implementation Plan (10 Yr. Plan)	Parametric Risk-Based	PLCE and/or MPE Risk assessment models	-40% to 100%
Scoping Project Summary (PD, DDS)	10% to 30%	Budget Authorization or Control Capital Improvement & Preservation Plan (CIPP)	Parametric Historical Bid-Based Risk-Based	PLCE and/or MP3 UBA, BidTabs Pro Risk assessment models	-30% to +50%
Design Design Documentation I/S Plans for Approval Design Approval	30% to 90%	Design Estimates (Project Control of Scope Schedule Budget)	Historical Bid-Based Cost-Based Risk-Based	UBA, BidTabs Pro Risk assessment models	-10% to +25%
PS&E Plans, Specs, Estimate (R/W Plans approved)	90% to 100%	Engineer's Estimate (prior to bid)	Historical Bid-Based Cost-Based Risk-Based	EBASE, UBA, BidTabs Pro, Risk assessment models	-5% to +10%

Chapter 5 Cost Estimate Training

As of the publication of this manual, no formal training for cost estimating is being provided by WSDOT. However, it is hoped that several classes offered in the past, specifically addressing cost estimating, will return in the not-too-distant future. They include:

- CZV: Introduction to Cost Estimating
- A4J: Contract Plans and Estimate Preparation
- CZ2: Risk-Based Transportation Cost and Schedule Estimating

Resources from the HQ Strategic Analysis and Estimating Office are also available to assist with specific questions about estimate preparation and the use of individual techniques or tools described in this document (www.wsdot.wa.gov/design/saeo/).

Chapter 6 Documentation/Basis of Estimate

6-1 Introduction

An estimate without documentation is not an estimate. The estimate file should be a well-organized, easy-to-follow history from the first estimate through preparation of the final estimate. The documentation should track changes as the estimate evolves, including updating the scope; assumptions; quantity and price calculations; and risks from the previous estimate.

A well-documented estimate enhances credibility and contributes to transparency and confidence in project estimates. Clear documentation is particularly important as the project passes from one group to another, or as team membership changes. The project estimate file should follow the project through the various stages so that each new estimate can be easily tied to the previous one.

6-2 Techniques

Estimating time should be scheduled into the project management plan for each phase of the project. This will ensure adequate time and resources are allotted for performing cost estimating.

As part of the estimate review process, someone external to the project team should perform a review of the estimate file. This external review will help ensure the estimator has clearly recorded the assumptions and decisions made in the estimating process.

6-3 Basis of Estimate (BOE)

A well-written BOE clearly and concisely states the purpose of the prepared estimate (cost study, project options, benefit/cost study, funding, etc.); project scope; pricing basis; allowances; assumptions; exclusions; cost threats and opportunities; and any deviations from standard practices. The BOE is a documented record of pertinent communications with and agreements made between the estimator and other project stakeholders.

A well-prepared Basis of Estimate will:

- Document the overall project scope.
- Document the items that are excluded in the project scope.
- Document the key project assumptions.

- Communicate the estimator's knowledge of the project by demonstrating an understanding of scope and schedule as it relates to cost.
- Alert the project team to potential cost risks (threats and opportunities).
- Provide a record of key communications made during estimate preparation.
- Provide a record of all documents used to prepare the estimate.
- Act as a source of support during dispute resolutions and for bid analysis.
- Establish the initial baseline for scope, quantities, and cost for use in cost trend evaluations throughout the project.
- Provide the historical relationships between estimates throughout the project lifecycle.
- Facilitate the review and validation of the cost estimate.
- Concisely and completely describe the facts.
- Support facts and findings.
- Identify estimating team members and their roles (including Specialty Groups).
- Describe the tools, techniques, estimating methodology, and data used to develop the cost estimate.
- Identify other projects that were referenced or benchmarked during estimate preparation.
- Establish the context of the estimate, and support review and validation.
- Qualify any rates or factors that are referenced either in the estimate or BOE; e.g., productivity can be expressed as either units/time (linear feet/hours) or time/units (hours/linear feet).

The cost of work items is estimated, including the Miscellaneous Items Allowance in design, and then the markups such as mobilization, sales tax, preliminary engineering (PE), and construction engineering (CE) are applied to them.

Table 7-1 presents data related to the markups. The order of calculation is provided at: www.wsdot.wa.gov/publications/fulltext/cevp/700%20800%20items.pdf

Table 7-1 Markups Summary

Cost Estimating Elements[1][2]	Planning	Scoping	Design	PS&E
Mobilization	Per EBASE www.wsdot.wa.gov/design/projectdev/engineeringapplications/adready.htm			
Sales Tax	Site-specific, based on Control Section. Data can be found in TRIPS or EBASE. Specific direction is found in Standard Specification 1-07.2. www.wsdot.wa.gov/nr/rdonlyres/c1b02cbf-ea4c-4a3f-afff-f13cc43cc9de/96366/taxes.pdf			
Preliminary Engineering	See Table 9-1		PM's Workplan + Actuals to Date	Actual
Miscellaneous Item Allowance in Design[3]	30% to 50%	20% to 30%	10% to 20%	0% (all items should be defined)
Contingency	Applies to parametric, historical bid-based, and cost-based estimates only. Per EBASE www.wsdot.wa.gov/nr/rdonlyres/c1b02cbf-ea4c-4a3f-afff-f13cc43cc9de/96724/engineeringandcontpercentagetables.pdf			
Construction Engineering	Per EBASE www.wsdot.wa.gov/nr/rdonlyres/c1b02cbf-ea4c-4a3f-afff-f13cc43cc9de/96724/engineeringandcontpercentagetables.pdf			

(See table notes on the following page.)

Notes:

[1] Round to appropriate significant digit; for example, $196,526,918.00 is rounded to $197 million.

[2] Report cost estimates in current dollars to program management. The Construction Cost Index (CCI) will be used to inflate the estimate to midpoint of construction by program management. Note: Public declarations of estimated project costs should be presented in the form of a range in Year-Of-Expenditure (YOE) dollars.

[3] Miscellaneous Item Allowance in Design accounts for lack of scope definition and those items too small to be identified at the stage of project design. This allowance is eliminated for final PS&E estimates on design-bid-build projects because the scope and estimate for all items should be identified at that point.

Miscellaneous Item Allowance in Design will vary along with advances on design. Figure 7-1 illustrates the ideal situation: as items are Identified and Quantified during the Scoping and Design phases, Miscellaneous Item Allowance should correspondingly decrease (see Table T1)

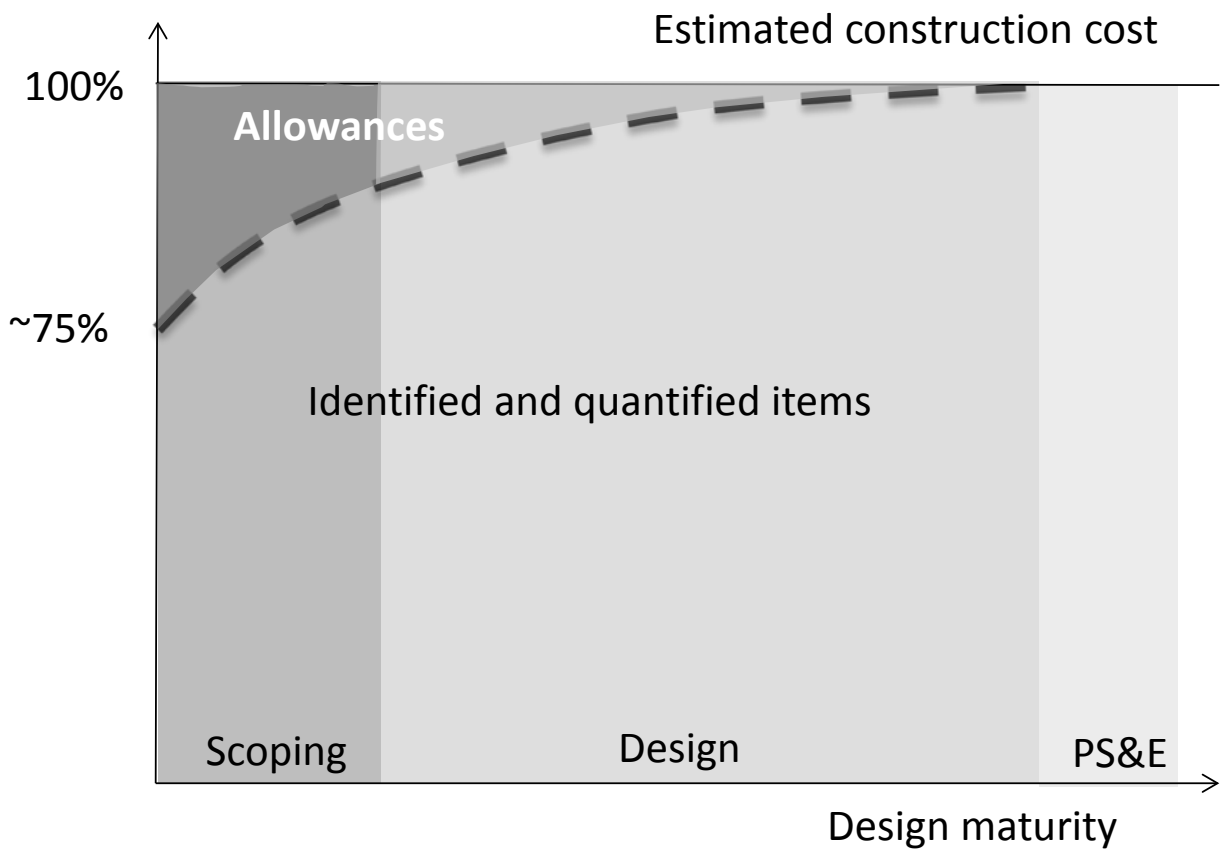

Figure 7-1 Identified and Quantified Items vs. Miscellaneous Item Allowances in Design

Chapter 8 Specialty Groups

Specialty groups provide cost estimates for portions of the project relevant to their areas of expertise.

8-1 Bridges, Nonstandard Retaining Walls, and Structures

The costs to construct bridges and nonstandard retaining walls and other structures are estimated by the Headquarters (HQ) Bridge and Structures Office.

For planning and scoping phase estimates, contact the Bridge Projects Unit in the HQ Bridge and Structures Office. They will help prepare the estimate using historical bid-based methods and take into account structure type, size, and location. For Design and PS&E phase estimates, the Bridge Projects Unit will provide a detailed cost-based estimate for project structures.

Estimators must understand and document what is included and what is not included in estimates from specialty groups. Items not included by the specialty group but required for the project must be included elsewhere in the project estimate.

8-2 Right of Way

Right of way (ROW) costs vary widely throughout Washington State. Region and/or HQ Real Estate Services should be involved early to help determine appropriate costs for the project. ROW estimates typically include administration, relocation, cleanup costs, and allowances for condemnation.

Real estate markets are best characterized by those familiar with the geographic area. In consideration of this fact, subject matter experts (SMEs) such as region Real Estate Services and region Right of Way staff should be asked to provide this estimate. These SMEs can provide input regarding the cost of right of way and the uncertainty associated with the real estate market in the geographic area of the project. Other issues to consider include zoning changes, speculation, growth management plans, and pending comprehensive plan changes.

8-3 Environmental

Region and/or environmental staff must be involved in the design and estimating process early. The costs and time durations of complying with environmental impact analysis, mitigation, permit, and public involvement requirements in environmental laws and regulations and interagency agreements can be significant and need to be included in the project estimate.

8-4 Traffic Design and Operations

Traffic conditions have a significant effect on prices. Prices should be adjusted to reflect difficulties, hazards, and expenses caused by traffic conditions. Contractors are inclined to raise their prices on projects to be constructed with work sites exposed to considerable traffic.

8-5 Utilities

The Utilities Office should also be involved early in the process. Subsurface and overhead utilities are located on a majority of project sites, and conflicts with these utilities can increase a project's cost dramatically. When a utility is located on an easement and WSDOT acquires the property through ROW acquisitions, WSDOT must pay all relocation costs in addition to providing the affected utility with a new easement. Also note that city-owned utilities that are impacted within the city's limits can add similar costs to a project.

Another risk that may affect project costs is triggered when utilities that are not identified during the design phase (due to insufficient engineering investigation or inaccuracy in utility as-builts) are discovered while the project is under construction. Utility conflicts not identified until the construction phase can result in costly change orders and project delays.

Chapter 9 Preliminary Engineering Costs

Preliminary Engineering (PE) percentages can be used at early stages (planning and scoping) to estimate the cost of design for a project. These percentages will vary by project type and total dollar amount of the project. On average, PE costs for WSDOT-designed projects are approximately 15% of project cost. This should be used when Table 9-1 does not provide data.

As the project moves through design, the PE cost should reflect actual costs to date plus the anticipated costs to complete the design work as determined from the project work plan.

There is a reasonable minimum cost for PE, because of the cost of the Ad, Bid, and Award process, which even a very small project will incur as full fare. If the project cost is under $200,000, it might be more efficient to combine it with another project in order to reduce the Ad, Bid, and Award cost.

For projects that include consultant design, PE costs can be significantly different than for projects designed by WSDOT. The cost of design by consultant is almost always more than the typical WSDOT design costs. PE cost estimates should reflect the type of resources (WSDOT and consultant) involved in the design effort.

Table 9-1 Preliminary Engineering Percentage

IMPROVEMENT PROGRAM PE as % of CN			I1 Mobility				I2 Safety			I3 Economic Initiative			I4 Environmental Retrofit	
Subprogram			IA	IB	IC	IQ	ID	IE	IF	IG	IH	II	IK	IL
			Urban	Rural	Urban Bike Connection	HOV Lane	Collision Reduction	Collision Prevention	All-Weather Highway	Trunk System Completion	New Safety Rest Area	Bridge Restriction	Storm-water Runoff	Fish Barrier Removal
$0	-	$250,000	ND	ND	ND	ND	40%	20%	ND	ND	ND	ND	40%	40%
$250,000	-	$500,000	ND	ND	15%	ND	30%	20%	ND	ND	ND	ND	25%	30%
$500,000	-	$1,000,000	ND	ND	ND	ND	22%	20%	ND	ND	ND	ND	20%	20%
$1,000,000	-	$2,000,000	15%	20%	12%	ND	20%	20%	ND	ND	ND	ND	20%	15%
$2,000,000	-	$5,000,000	15%	20%	12%	ND	20%	15%	10%	ND	ND	ND	ND	15%
$5,000,000	-	$10,000,000	15%	ND	ND	10%	12%	15%	10%	ND	ND	ND	ND	ND
$10,000,000	-	+	15%	10%	ND	10%	12%	15%	10%	14%	ND	ND	ND	ND

PRESERVATION PROGRAM PE as % of CN			P1 Roadway	P2 Structures		P3 Other Facilities				
Subprogram			PA	PB	PC	PD	PE	PF	PG	PH
			Paving Safety Restoration	Structure Preservation	Catastrophic Reduction	Rest Area	Unstable Slope	Weigh Station	Program Support	Major Drain Electrical
$0	-	$250,000	15%	20%	40%	20%	30%	ND	ND	30%
$250,000	-	$500,000	12%	15%	30%	20%	20%	ND	ND	20%
$500,000	-	$1,000,000	12%	13%	20%	20%	15%	ND	ND	20%
$1,000,000	-	$2,000,000	10%	12%	13%	ND	10%	ND	ND	20%
$2,000,000	-	$5,000,000	8%	12%	13%	ND	10%	ND	ND	20%
$5,000,000	-	$10,000,000	6%	12%	13%	ND	10%	ND	ND	ND
$10,000,000	-	+	6%	11%	13%	ND	ND	ND	ND	ND

Notes:

1. The percentages in this table are based on actual WSDOT project costs statewide from July 2001 through March 2007.
2. ND indicates that there is no data for that cell.
3. Yellow highlighted cells indicate that there is limited data for that cell.
4. For project type definitions, see below and the *Plans Preparation Manual*, Section 800.03.
5. A factor must be applied to the PE amount for consultant work. Typical factors for the consultant portion of the work range between 1.8 and 2.8, depending on the type and scope of consultant involvement.

Chapter 10 Key Factors that Influence Estimating Practice

The key factors that may affect the project cost and schedule estimated number are described in this chapter.

10-1 Geographic Considerations

Geographic considerations are powerful project characteristics that may substantially affect the selection of unit bid prices. The project's location, whether in an urban, suburban, or rural setting, should be considered in establishing bid prices. Some of the cost considerations relating to a project's location may be accounted for in the mobilization bid item, dependent on the restrictions of Standard Specification 1-09.7.

A project in an urban setting generally has to contend with construction operations occurring in more confined work spaces, with greater volumes of traffic, limited hours of operation, nighttime work, etc. Some of these factors may be offset by the availability of local contractors, materials, equipment, and personnel.

Projects located in rural settings have factors that affect the establishment of unit bid prices different from the projects located in urban settings. Construction operations may have less restricted work areas, less traffic to contend with, and additional hours to complete the work—all factors that increase productivity. On the other hand, materials, equipment, and personnel may have to be brought in from out of the area, which may increase costs related to transportation, support, wages, per diem, etc.

For projects that utilize large quantities of aggregate, whether for base, surfacing, or earthwork, the location of material sources and disposal sites may have a large impact on costs. Nearby material sources or disposal sites reduce hauling costs. On rural projects, the cost of bringing in a concrete batch plant, hot mix asphalt plant, or similar facility, may increase unit bid prices. Again, dependent on the restrictions of Standard Specification 1-09.7, those costs may be directly attributed to and reflected in the mobilization bid item.

Terrain may also be a consideration in establishing an item's cost. Mountainous terrain and steep grades cause production rates to fall, whereas level terrain and straight roadways generally have the opposite effect.

Groundwater conditions can vary greatly and need to be investigated to determine the extent of dewatering required for foundations and other structures such as stormwater retention ponds. Varying geotechnical conditions are covered in Section 10-17, Soil Conditions.

Material hauling that must be accomplished by entering and exiting only on interchange ramps, hauling uphill rather than downhill, working on the top of slopes or retaining walls, etc., is always more expensive to construct than work that is easy to accomplish on level or gentle slopes. The ease of accessibility to the work will affect the cost to do the work.

10-2 Restrictive Work Hours or Method of Work

Restricting the contractor's working hours or the method of work on a project may have major effects on prices. The prices for work that is limited to short shifts, or required to be completed in long shifts, or limited to nighttime operations should be increased to reflect the cost of premium wages required for such work and for the general inefficiencies and decreased productivity that may result. Night work for plant operations (e.g., asphalt concrete production) can be especially expensive when small quantities are involved. Plants usually do not operate at night and may require special production runs at much higher than normal operating costs.

10-3 Quantity Considerations

The quantity of a given material on a project impacts the unit cost of constructing and/or supplying that item. This is not simply a supply and demand issue, but also one of production efficiency and economy of scale.

- On one hand, the unit price for larger quantities of a given material will be less than for smaller quantities. Larger quantities may give rise to efficiency by gained experience and the expertise of the contractor's personnel in completing the work.
- On the other hand, for some projects, very large quantities of certain materials may cause an increase to the unit bid price. For example, a project with numerous or large structures may affect the market for a particular type of steel or the availability of cement, or may even tie up a region's labor resources.

Small quantities of items of work are often less cost-effective to construct and lead to higher unit prices. Suppliers charge more for smaller purchases, and in some instances the minimum amount that has to be purchased is greater than needed for the project. Smaller-quantity items may be subcontracted out; this increases a contractor's overhead and usually results in a markup being applied to those items.

10-3.1 Separate Operations

Separate operations will usually increase item costs, especially if the order of work or the work unit is to be constructed in scattered locations throughout the project (each requiring move-in and move-out costs). If this is the case, unit prices should be based upon the smaller unit sizes and should not be based upon the entire quantity for the total project.

10-3.2 Handwork and Inefficient Operations

Handwork and small or inefficient operations (even though equipment may be used) will have higher unit costs than work that is able to be mass produced or constructed by using techniques that result in higher production rates.

10-4 Item Availability

Materials that are readily available, or ones that are commonly used, are generally less expensive to purchase and install/construct. Materials that are in short supply are more expensive. This should be considered in establishing the unit price.

Large quantities of materials required in a short period of time may result in a temporary shortfall in product availability and potential cost increases or delays to a project.

10-5 Scheduling/Lead Time

To be efficient, a contractor needs to optimize the scheduling of resources, including labor, equipment, and materials. The ability to plan for and maximize resources allows contractors to be more competitive in bidding. Lead times need to be considered in estimating the project based upon when it is expected to be built. For example, a project that is two seasons long may have the majority of its paving in either the first or the second year.

10-6 Difficult Construction/Site Constraints

Difficult construction and site constraints will increase the cost of construction for a contractor. Examples of site constraints that should be considered include: placing piles under water; working near active railroads or nearby historical buildings (possibly fragile); constructing on or near culturally important or environmentally hazardous sites; and working in areas with limited room to construct an item.

10-7 Estimating Lump Sum Items

Lump sum bid items can be more difficult to estimate. They can reduce administrative costs in contract administration, as well as allow a contractor a bit more freedom to be innovative with regard to work means and methods. Lump sum items transfer the risk of performance and quantities to the contractor. If the work to be performed can be quantified, then a payment method that includes a quantity should be used.

Lump sum bid items may also be used when an item of work can only be defined in general terms, such as when the finished product can be defined but not all the components or details can be easily determined. This can make estimating lump sum items difficult for the estimator. It is recommended that the lump sum item be defined as detailed as feasible in order to accomplish a reasonable lump sum estimate.

An estimator should define a lump sum item in terms of its simplest, most basic components and should also consider other factors that may not be easily estimated. By breaking out a lump sum item into smaller items of work that have historical data, and then applying reasonable estimated prices to those subunits, the estimator can calculate the overall lump sum item.

Using lump sum items typically transfers risk to a contractor, and the contractor may adjust the price upward to take on this risk. Contractors cannot necessarily rely on overruns to cover work that they did not foresee.

Lump sum items are typically bid at higher costs than component costs due to the transfer of risk from the owner to the contractor. Therefore, the use of lump sum items should be used with great care.

In some situations, as may be the case for a time-based lump sum bid item such as project temporary traffic control, the lump sum payment may provide the incentive to perform the work more quickly. In such situations, hourly pay items offer no incentive, and may result in the contractor remaining in the work zone for a longer period of time.

In many cases, lump sum bid items can lead to higher contractor bids. Therefore, lump sum items should only be used when the following conditions apply:

1. The lump sum item is a standard item with no appropriate alternative non-lump sum standard item available for use.
2. The work is not easily defined. In other words, the final product is known, but the construction techniques or other components are difficult to determine.
3. The project has complex items with many components (although the designer is encouraged to break down constituent items if possible).
4. The lump sum payment may be justified as incentive to complete the work in a more timely or efficient manner than if other units of measure were used.
5. The lump sum item may be justified as less expensive than a force account item (see below) or where the risk assumed by the contractor is low.

The use of a lump sum item must be justified and the work breakdowns documented in the estimate file. Use of earned value techniques may aid in determining the performance of the contractor on lump sum bid items.

10-8 Force Account

Force account is a method of payment that pays the contractor the actual expenses for all labor, materials, and equipment to complete the work. Markups for material costs, labor surcharges, overhead, and profit are usually added to this figure. This method of payment is used primarily for “extra work” (i.e., work that is unforeseen at the time a project is let or advertised and is discovered during construction) or for items of work that are poorly defined and may/may not be used during construction.

The case of poorly defined items of work is the one most frequently encountered by the estimator. Since the contractor does not usually bid on this work, there is little incentive to reduce costs or execute the work diligently. Because of this, the force account method of payment should only be used when necessary.

When a reasonable cost estimate for a force account item is required, the estimator should try to establish the scope of work to be accomplished. Once the scope is developed, it can be compared to historical bid price data for similar items of work.

If no comparable history exists, the force account item should be broken out into its anticipated core components. The estimator can then rely on historical bid data for those items and the given limitations to come up with a reasonable force account estimate. If no such data exists, the estimator may need to estimate the amount and costs of materials, equipment, and labor to execute the work.

Force account may also be considered as a tool for transferring risk from the contractor to the owner. If the work is properly directed by the project inspector, force account may actually cost less than an equivalent lump sum item.

Use of force account items and their estimated costs must be documented and justified in the project estimate file.

10-9 Timing of Advertisement

The timing of a project advertisement can influence bid prices. Contractors can have a time of year that is busier than others. This relates to weather and construction windows; for example, asphalt paving is not done during cold, wet weather. The appropriate timing of advertisement can also be affected by other items like fish and HMA paving windows or other outside constraints.

The peak season for most highway projects is April through October. The peak season for marine work is November through March. The best time to advertise a project is several months before the work season for that type of work, to allow time for contract execution and for contractors to mobilize their resources in time to take advantage of the full work season.

If contractors have fully allocated resources for the upcoming season, they are less likely to bid on a project and, if they do bid, it is in a less competitive environment. For this reason, there is a benefit to WSDOT to advertise a project as soon as possible prior to the peak season, to allow contractors time to plan, schedule, and seek as many opportunities as possible to find efficiencies in their work plans. Hopefully, this promotes a more competitive bidding environment.

The estimator preparing the final Engineer's Estimate needs to be aware of the timing of the advertisement. The estimator should account for any expected fluctuations in bid prices due to the season, such as lower production during temperature extremes, additional protections for weather-sensitive materials, and so forth.

It is important to know if the work can be accomplished before winter weather causes the project to shut down. If the job cannot be finished before the end of the construction season, and the project needs to be suspended, contractors will increase their bid prices to cover their overhead during the winter and repair any damage that may occur. Even if contractors reasonably expect to finish before the winter, they may protect themselves to allow for an early winter.

10-10 Inflation

The estimate represents the probable cost at the time of estimate. Any time an estimate is created or updated, the unit prices must reflect the cost at the time the estimate is done. It may require the estimator to go back to the unit price database and get the latest information.

The estimator must always adjust the unit price for inflation considering the interval of time from when the price was used and the estimating time.

Figure 10-1 illustrates the ideal situation, when the current prices representing the cost at the time of estimate increase because of the Past Inflation (PI) applied to the prior prices. Simultaneously, the figure shows that the estimated amount created by Future Inflation (FI) (*what program management does*) decreases since the time span decreases. WSDOT inflation tables are found at:

CPMS CCI Tables: http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/cci.txt

CPMS PECI Tables: http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/pe.infl.txt

CPMS RWCI Tables: http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/rw.infl.txt

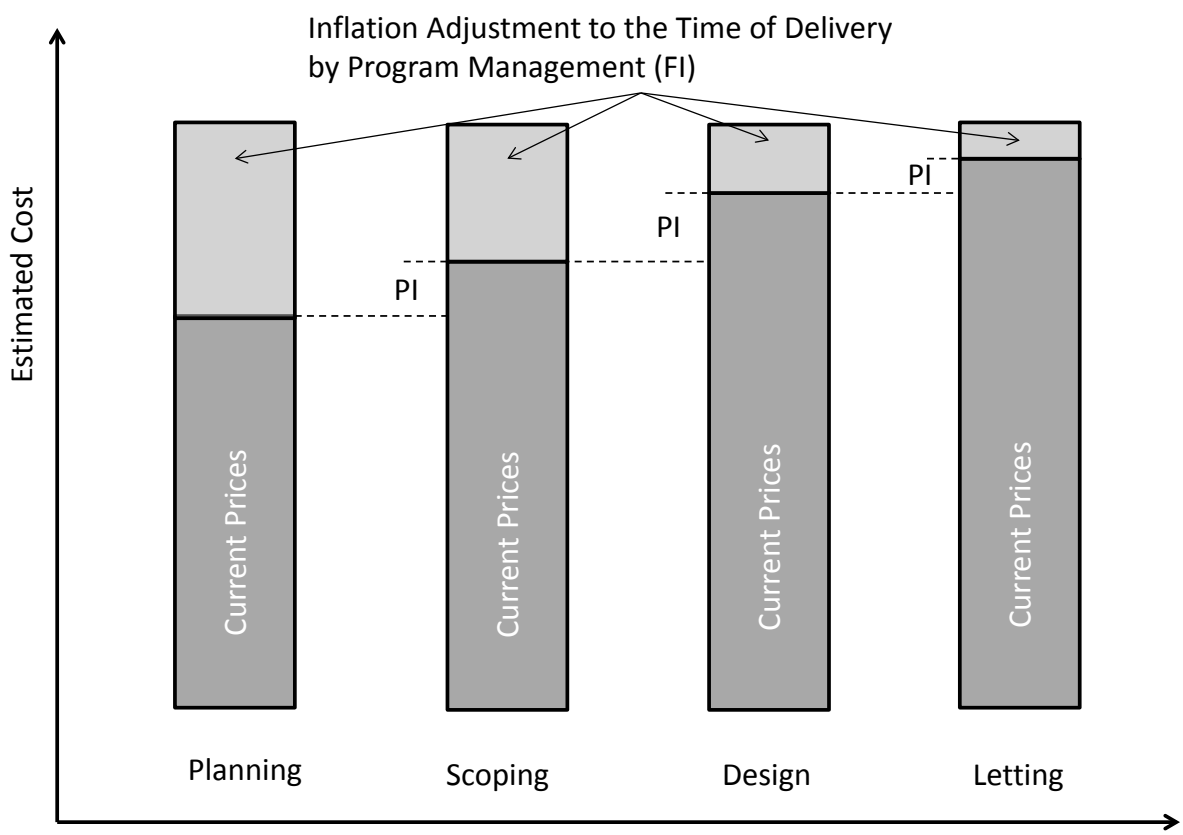

Figure 10-1 Past Inflation (PI) and Future Inflation (FI)

10-11 Expected Competition/Contractor Availability

Projects that are advertised for bids late in the season or after contractors have scheduled their work for the year, can expect higher bid prices. This is due to the lack of competition or contractor availability. Projects that are bid during a period of time when a large number of contractors are available may be bid more competitively.

Competition could be a major factor of the cost of the construction. When the estimator expects just one bidder, then the project cost may be much higher than otherwise. On the other hand, if there are many bids, the project cost may be significantly lower than the estimate. Figure 10-2 represents the Comparison of the Low Bid vs. the Deterministic Estimate Based on Number of Bidders, as provided by WSDOT and Caltrans. There is a noticeably dramatic effect of the number of bidders upon the value of the lowest bid. The figure indicates a dramatic decrease in the project cost once three or more contractors bids on a project. Once the number of bidders is greater than 10–12, it looks as if the prices reach the bottom line (not much room to go down and remain in business).

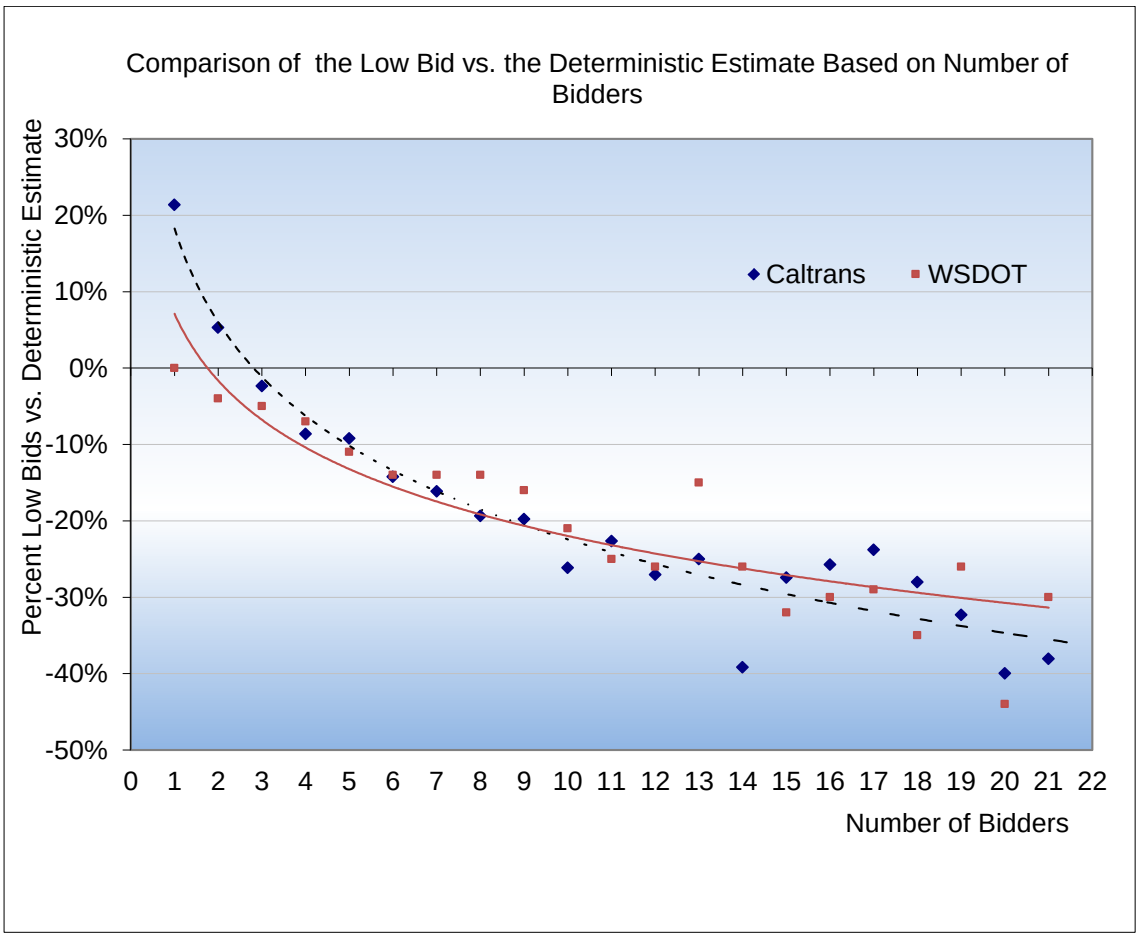

Figure 10-2 Comparison of the Low Bid vs. the Deterministic Estimate Based on Number of Bidders

10-12 Other Contracts

Multiple projects being advertised at the same time can influence bid prices in much the same way as lack of competition and availability. The contractors only have so many resources available to develop bids for projects. In the case of large projects, a contractor may not have the resources to develop bids for more than one project at a time.

The most prudent course of action in this case is to manage the program of projects to ensure this does not become an influencing factor on the bids. If this cannot be prevented, then the estimate needs to reflect that multiple bids will be developed at the same time.

The estimator should consider to what extent the reduction below the normal number of bidders will influence the bid amount. A reasonable range of impact is a 0% to 8% increase over the Engineer's Estimate for construction. The probability of the occurrence of this risk should be evaluated by the estimator. Common mitigation strategies include timing of the advertisement and work packaging. On the other hand, in extremely competitive bidding environments, with large numbers of contractors bidding, the bids may actually come in lower than expected.

Another factor to consider is that multiple active projects can create conflicts in an area. For example, multiple large-scale bridge projects in a given area may create a shortage in structural steel or skilled labor. In these cases, the estimator must be aware of the ability of the market to support multiple projects.

Other conflicts could include traffic control, labor issues, and direct coordination issues, among others. These conflicts need to be considered in the calculation of production rates and subsequent bid item prices. Project managers should be aware of adjoining projects and nearby work (even from other regions or local agencies). There may be opportunities for collaboration and coordination that will result in more competitive bids and better maintenance of traffic.

10-13 Specialty Work

Specialty items are not necessarily new items or new construction methods. Rather, they are items that are somehow different than the majority of the work on a given project. For example, on a pavement rehabilitation project, the signal work may be classified as specialty work, although it would not be classified as such on a project that was predominantly signal and lighting work. Estimating the cost of specialty work requires a thorough understanding of the work involved and the resources required for accomplishing it.

When estimating specialty work you are not familiar with, seek the advice of experts who can help. Consider the number of qualified contractors capable of doing the project or elements of work.

10-14 Material Shortages

Material shortages will have a major effect on prices, since prices are directly affected by supply and demand. Where a shortage is especially acute, a change in design might be considered rather than increasing prices.

10-15 Standard Items vs. Nonstandard Items

Standard items, as listed on the WSDOT Standard Item Table, are familiar to both WSDOT and the contractors. These items of work typically represent a known quantity and quality to both WSDOT and the contractor, and bid history tends to reflect that. When an item is changed in some way to become a nonstandard item, then uncertainty is introduced. This uncertainty typically results in an increased price for the item, especially the first time contractors see it in a contract. Typical practice should be to use standard items whenever possible. When a standard item is changed and becomes a nonstandard item, the estimator should recognize that the price may differ from the historical prices.

10-16 First-Time-Use Items

On occasion, items of work are included in a project for which WSDOT has little or no historical data to establish unit prices. In these instances, similar items may provide some guidance, but additional investigative work may be necessary. If the item is thought to be of minor significance, there may be little benefit in spending much time in determining a reasonable bid price. If the item is considered major or is likely to be significant to the overall project bid, research should be conducted to establish a cost. Contacting others who are familiar with use of the item can usually help in determining a cost.

Suppliers, other state departments of transportation, the HQ Strategic Assessment and Estimating Office (SAEO), Regional Transportation Commissions, Port Authorities, Consultant Letting, RS Means Publications, and contractors can be valuable resources in establishing costs. Be wary of relying on estimates from a single contractor or source. Multiple sources should be utilized in developing an estimate for first-time-use items.

If the item in question is unique in some manner (innovative, new, or experimental), or it is considered a specialty item, costs may need to be adjusted to account for the contractor's lack of experience with it and the potential increased risk in construction. If the work is likely to be subcontracted out, then the prime contractor may also add a markup to the subcontractor's price.

10-17 Soil Conditions

General assumptions about soil conditions may be made early in the estimating process, but they may turn out to be wrong. As the estimate progresses, geotechnical data may help improve the information and prevent costly change orders and claims. In the early estimates, the assumptions regarding soil conditions and the potential effects of unknown soil conditions should be clearly documented.

A common estimate omission is an improper allowance for shrink and swell of material. The Region Materials Engineer should be consulted to determine the appropriate shrink or swell factor to use. Soil conditions can be a significant cost risk to a project. Risk-based estimating techniques should be utilized to quantify geotechnical risks if they pose a significant threat or opportunity.

10-18 Permit Conditions

Throughout the stages of planning, scoping, and design, various projections of permit conditions for construction can be obtained from region or HQ environmental offices. Engaging these groups early helps to identify specific permits or conditions that can drive up construction costs and identify opportunities to avoid costly environmental conflicts.

At the same time, the estimate must address:

- The actual out-of-pocket costs for developing and constructing transportation projects.
- The labor, material usage, equipment usage, and travel expenses of staff or consultants doing environmental analysis and documentation during project development.
- The purchase of ROW, materials, and installation labor, and additional purchases for major environmental mitigation features such as wetlands restoration and noise walls during construction.

Be aware that considerable costs may be required due to: stormwater collection and treatment; wetland protection and mitigation; hazardous materials testing; containment and treatment; and removal and disposal of underground fuel tanks, creosote timbers, and contaminated soils.

10-19 Allowances

Allowances cover items known to be needed for the project but yet not specifically identified and/or quantified. It is different from construction contingency.[1] Allowances account for a lack of project definition during the preparation of estimates.

In WSDOT estimates, allowances should be shown as a separate line item in the baseline cost estimate. Allowance amounts should be identified with an explanation as to what they are intended to cover so they can be managed and reduced appropriately as the design progresses. This will assist in review of the estimate.

Figure 7.1 illustrates the negative correlation between the amount of allowances and the amount of identified and quantified items. Once identified and quantified items are added to the baseline estimate, the allowances should be reduced in order to reflect the new data available.

10-20 Construction Contingencies

Construction contingencies are typically meant to cover a variety of possible risks or events that are not specifically identified or quantified, such as uncertainties in quantities and minor risk events related to quantities, work elements, or other project requirements during construction. Refer to the *Plans Preparation Manual*, Section 800.03, for guidance on estimating construction contingencies.

10-21 Other Funding Sources/Agreement Work for Others

Funding sources should be documented in the Basis of Estimate. Federal funding, participation from local agencies (e.g., participation in intersection improvements), or funding from public/private partnerships should all be documented.

[1] Construction Contingency – A standardized markup applied to the construction cost of a project that accounts for uncertainties in quantities, unit costs, and minor risk events that typically take place during construction.

Chapter 11 Independent Estimate/Estimate Review

11-1 Introduction

Each estimate should have some level of review, as indicated on the flow chart provided in Figure 2-1, Cost Estimating Process. Project complexity is an important driver of the level of estimate review. The level of review should be carefully chosen by the project manager.

Estimates are key outputs of the project management process and are fundamental documents upon which key management decisions are based. It is recommended, and may become policy at a region's discretion, that all cost estimates be independently reviewed by estimating staff specialists, subject matter experts, and others as appropriate. Estimates will then be reconciled and revised as needed to respond to independent reviewer comments. In the event of a significant difference of opinion, an estimate reconciliation meeting will be held and the results documented. The final results of the independent review and reconciliation meeting must receive management endorsement before any project is advertised.

Independent reviews (check estimates) should be made by experienced estimators who are familiar with the type of work inherent in the project, and who have had no involvement in the development of the project estimate to date. The independent estimator consults with other independent sources such as design engineers, construction managers, or other estimators as needed on specialty items of work. Checks performed by independent estimators include:

- Reviewing the estimate file and Basis of Estimate document for completeness and readability.
- Ensuring the name(s) of estimator(s) involved in preparing the estimate are shown.
- Ensuring the estimating methodologies are noted by individual items of work.
- Reviewing the overall estimate documentation to ensure it is clear and the figures are traceable, from detailed backup to summary phases.
- Conducting a detailed check of the estimate to include:
    - Checking the development of unit rates and quantities of those items that drive the majority of the bottom line cost (the 20% of the items that comprise 80% of the estimated project cost).
    - Making note of comments on unit rates and quantities.
    - Checking for mathematical errors.

11-2 Internal Project Team

The internal project team review should include a quality control check of quantities and prices. It should also include a quality assurance check that the proper procedures were followed, the documents are complete and clearly understandable, and the final costs and schedule are deemed reasonable for the project scope, size, location, and complexity. The advantages of the internal project team review are that the project team's schedule is easier to coordinate than outside resources and the reviewers have a base knowledge of the project. The internal reviews tend to be conducted with the same vision, framework, and assumptions as the project teams and this may introduce unwanted bias. This can lead to a review that does not objectively assess all the parameters that affect the estimate.

One useful double-check is to prepare estimates in two different ways and then compare them. For example, if a project team utilizes historical bid-based methods for preparing the project cost estimate, then consider selecting the top five to ten items in terms of cost and estimate them using a cost-based approach (materials, equipment, and labor). The comparison of the two estimates may be enlightening.

11-3 Peer Review

This type of review is similar to the internal project team review, but it uses another project team or office to conduct the review. Offices can often perform reviews for each other in this way. The advantage to this type of review over the internal review is that the project gets a review with a fresh perspective on the estimate. This can provide an increased level of confidence in the estimate. This is also a good way to share lessons learned and information between project offices and serves to efficiently utilize fixed engineering resources within the department.

11-4 Region/Headquarters Review

This type of review at the region and Headquarters level is typically more formal. One advantage to this type of review is that the reviewers are external to the project team and can thus provide a truly independent perspective on the project. However, the biggest advantage is that the reviewers typically have significantly more experience in performing this type of independent review. Region reviews can be coordinated with region staff. Headquarters reviews should be coordinated with Strategic Analysis Estimating Office staff (www.wsdot.wa.gov/design/saeo/).

11-5 External

In this type of review, external experts are brought in to review either specific pieces of the estimate or the entire estimate. This type of review can be combined with any of the other types of reviews to supplement knowledge of a specific item of work or to provide an outside perspective. This type of review has a wide range of costs but can provide significant confidence in the estimate that might not be otherwise attainable from internal WSDOT resources.

Table 11-1 is a matrix that identifies which position has responsibility for reviewing and endorsing each type of WSDOT estimate.

Table 11-1 Activity/Responsibility Matrix

Changes – Scope Changes, Schedule Changes, Budget Requests	PE/PM through Region PDE or EM Must Process Control Change Form through the PC&R Office
Planning Phase	Region Planning Manager
Scoping Phase, including: Design Documentation Package (DDP)	Region Plans Office and Programming
Design Approval Design Report Alternative Analysis	ASDE, PE/PM, PDE/EM, and Region Plans Office
Determine Contingencies	PE/PM, PDE/EM
PS&E Phase Estimates	Estimator, Designer, and PE/PM
Documentation, including: Assumptions Quantities and Adjustments Prices and Adjustments	Estimator, Designer, and PE/PM
Review Estimates	Region Plans Office and Peer Review Team
Check Estimates and Calculations	Region Plans Office
Prepare Engineer's Estimate	Estimator, Designer, and PE/PM
Independent Estimate	To be determined

ASDE – Assistant State Design Engineer
EM – Engineering Manager
PC&R – Project Control and Reporting
PDE – Project Development Engineer
PE – Project Engineer
PM – Project Manager

Note:

The Region Project Engineer, Project Manager, Project Development Engineer, and Engineering Manager should be informed of changes and updates to project scope, schedule, and cost estimates. This table is based on the *Project Control and Reporting Manual* (M 3026), January 2006 revision.

Chapter 12 Resources

AASHTO Standing Committee on the Environment, *Guide to Estimating Environmental Cost*, 2008.

AASHTO Technical Committee on Cost Estimating, *A Practical Guide to Estimating*:
http://design.transportation.org/documents/aashtoguidetocostestimating_july2009_lt.pdf

Bridge Design Manual (Chapter 12, Appendix 12-A):
www.wsdot.wa.gov/publications/manuals/M23-50.htm

Caltrans, *Project Development Procedures Manual*, Chapter 20 – Project Development Cost Estimates, 2007

Connecticut DOT, *Cost Estimating Guidelines*, 2013

CPMS CCI Tables:
http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/cci.txt

CPMS PECI Tables:
http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/pe.infl.txt

CPMS RWCI Tables:
http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/rw.infl.txt

EBASE (Estimates and Bid Analysis System):
www.wsdot.wa.gov/design/projectdev/engineeringapplications/adready.htm

FHWA Major Project Delivery Guidance:
http://www.fhwa.dot.gov/ipd/project_delivery/index.htm

Instructional Letter: IL 4071:
http://wwwi.wsdot.wa.gov/publications/policies/fulltext/4071.pdf

Minnesota Department of Transportation, *Cost Estimation and Cost Management*, *Technical Reference Manual*, 2008

Montana Department of Transportation, *Cost Estimation Procedure for Highway Design Projects*, 2007

NCHRP 8-36 Task 72: *Guidelines for Cost Estimation Improvements at State DOTs*, 2008

Nevada DOT, *Project Cost Estimation Manual*, 2013

New Jersey Department of Transportation, *Construction Cost Estimating Guide*, 2010.

Oman Systems BidTabs Professional (see your IT to set up):
www.wsdot.wa.gov/design/projectdev/engineeringapplications/bidtabs.htm

Online Project Management Guide:
www.wsdot.wa.gov/projects/projectmgmt/pmog.htm

Oregon Department of Transportation, *Estimating Manual*, 2010

RS Means:
www.rsmeans.com/

Self-Modeling Excel worksheet:
www.wsdot.wa.gov/projects/projectmgmt/riskassessment/information.htm

Virginia Transportation Research Council, Highway Project Cost Estimating Methods Used in the Planning Stage of Project Development, 2001

WSDOT Glossary for Cost Risk Estimating Management:
www.wsdot.wa.gov/publications/fulltext/cevp/glossary.pdf

WSDOT Project Bid Results and Contract Awards:
www.wsdot.wa.gov/biz/contaa/bidstats/

WSDOT Unit Bid Analysis:
www.wsdot.wa.gov/design/projectdev/engineeringapplications/unitbidhistory.htm