Key Message
Welcome participants to AASHTO Estimating Course.
Confirm they are in the right location.

Background (do this only if this is a standalone module)
Introduce yourself and share information regarding your experiences with estimating and with teaching this class. Recognize the sponsorship of AASHTO and NCHRP in developing the course materials.

Interactivity (do this only if this is a standalone module)
Before the class begins, greet each student individually and find out something about them, like their location, their job function, and estimating experience. If an executive is attending the overview in the first part of the course, ask them to help you introduce the course by providing their perspective on the importance of estimating and on its job relevance for attendees.

Notes (do this only if this is a standalone module)
This is also a good time to cover logistics and administration. The participants will need to know about breaks, lunch, location of bathrooms, telephones, smoking areas, start and stop times, forms to be completed.
What is Bid-Based Estimating?

- The most common estimating method is:
  - historical bid-based approach which uses recently let contract data to determine unit prices for a future project.

- Historical bid price data:
  - stored in a database for 3 to 5 years.

Key Message
Bid-based estimating most common approach.

Background Information
The most common estimating method used by STAs for developing transportation project cost estimates is the historical bid-based approach. Historical bid-based estimating uses data from recently let contracts as the basis for determining estimated unit prices for a future project. Historical bid price data from previously let projects are typically stored in a database for 3 to 5 years. However, for price averaging and use in new estimates, the data retrieval period is often limited to 1 to 2 years. If there is not sufficient bid data for an item, then dated historic data can be used. In such an instance, the estimator may search the bid database across a longer time period.

Historical data can be easily sorted and analyzed in a multitude of ways.

Interactivity
How many years of data are included in your organizations estimating database?

Notes
None
What is Bid-Based Estimating

The estimator matches elements and items to:

- scope reflected in project documents
- appropriate historical bid data

Key Message
Bid-based estimates rely on historic bid prices

Background Information
Creating cost estimates from historic bid prices is a relatively straightforward process. After determining the quantities for different elements and items from project documents, the estimator matches the items to appropriate historical unit bid prices or to average historic unit bid prices. To generate unit price data, STAs systematically compile bid data from past project lettings. These data are broken down by bid line item. Average prices can be calculated from these data in numerous ways for the estimator’s use.

Interactivity
How do you ensure that the item scope matches the historic data item scope?

Notes
The estimator needs to be confident that the current item reflects similar scope to the historic item that was used to estimate the cost of the current item. If not adjustments will be required.
Why Bid-Based Estimates?

- Bid-Based Estimates:
  - efficient in terms of staff resources.
  - provide reasonable estimates on typical projects.
  - quicker to assemble.

Key Message
Bid-based estimating can produce reasonable estimates.

Background Information
Due to the fact that this method is efficient in terms of staff resources versus other methods of estimating and has proven to provide reasonable estimates on typical projects, the historical bid-based estimating method is used to some extent by all STAs. However, there are many factors that need to be considered to develop an accurate construction estimate using historical bid prices. These factors can pose a certain level of risk in using this method to develop an estimate. Consequently, the estimator must ensure that the selected historical prices match the conditions of the project being estimated.

Interactivity
None

Notes
Because it is an easy technique to use in practice, adjustments to historic bid prices is often overlooked.
Project Characteristics

Preparing a bid-based estimate:
- project location
- construction season
- traffic control
- work-hour restrictions
- coordination with:
  - multiple utility companies
  - railroads
  - agencies granting environmental permits
  - local agencies and jurisdictions.

Key Message
Project characteristics influence cost.

Background Information
When preparing a bid-based estimate, careful attention must be directed to project location, construction season, traffic control, work-hour restrictions, and coordination with multiple utility companies, railroads, or agencies granting environmental permits. By nature, complex projects are more difficult to estimate and contain more construction risk elements.

Interactivity
What is the potential impact on cost of these items?

Notes
The impact of coordination with other entities often difficult to estimate early.
Project Characteristics (cont’d)

- Impact on estimating if using:
  - first-of-a-kind technology
  - new materials
  - new methods of construction
  - Buy America requirements

Key Message
Project characteristics influence cost.

Background Information
The FHWA advises that special attention be given to the impact of any requirement to use first-of-a-kind technology, new materials, or new methods of construction. Typically, there is very little historical cost data related to these types of requirements. Other approaches will be needed to estimate costs.

Interactivity
None

Notes
One approach is to find a work item that is close in scope to new requirements and then adjust the price to reflect apparent differences. Another approach is to use cost based estimating where the unit cost is built up based on an estimate of labor, material, equipment, overhead, and profit (see Module 5). Finally, the potential impact on cost could be covered through contingency as a risk to the project (see Module 6).
Key Message
Project characteristics influence production.

Background Information
Complicated construction staging, haul routes, accessibility to the site, and requirements for night work all impact productivity. Adjustments to historic bid prices may be necessary. Finally, the issue of small quantities of work should not be overlooked because these items can result in separate and inefficient operations that are usually more costly due to lower production rates and higher material costs. When adjusting estimate bid prices, all of these factors must be considered by the estimator.

Complicated construction staging makes work tasks more difficult to complete. Longer haul routes related to material deliveries add costs and impacts the rate of production. Tight site access can increase the complexity of locating materials and construction equipment around the site. Finally, night work adds costs and can reduce efficiency of the work force. This impacts productivity.

Interactivity
Are these issue for the Interchange project?

Notes
None
Key Message
Prepare base estimate covers known costs without contingency.

Background Information
There are two key input that are required to prepare a base estimate in addition to the projects definition and its characteristics. These key inputs are historical data and an understanding of the external project environment.

Interactivity
None

Notes
The next slides will elaborate on these two key inputs.
Key Message
External conditions impact estimated unit prices.

Background Information
The external environment and current market conditions must be examined to ensure historical bids properly reflect current conditions where the project will be constructed. As the estimator selects historic bid prices from the database, modifications may be necessary for work season or seasons, expected competition, contractor availability, specialty work, and factors like contract incentives.

Interactivity
None

Notes
These five issues will be discussed in the following slides.
Key Message
Work season can impact estimated unit prices bid.

Background Information
When the project work will be conducted has a major influence on bid prices. Contractors consider the expected work season or seasons when bidding a project. This is directly correlated with the weather effects on certain activities, particularly earthwork, placement of concrete, and paving. If multiple seasons are required this will likely increase mobilization costs and unit prices due to inflation.

If a contractor or contractors have fully allocated company resources for the season, bid prices will be higher and there may be limited competition. Projects that can be constructed with an expectation of good weather usually draw lower bid prices, and the opposite is equally true. If forced to work out of season, there is increased risk to the contractor, and the result is higher bid prices.

The estimator preparing the final engineer’s estimate needs to be especially aware of the time of the advertisement and account for any expected fluctuations in bid prices due to seasonal factors, lower production during temperature extremes, and additional protections for weather-sensitive materials.

Interactivity
Ask the participants which of these issues often results in the largest impact on unit prices.

Notes
Elaborate as needed on each of these points.
Macro-Environmental and Market Conditions
Competition/Contractor Availability

- Higher bid prices if advertised:
  - late in the season
  - after contractors have scheduled their work for the year.

- High bid prices due to:
  - lack of competition
  - limited contractor capacity

Key Message
Competition and contractor availability can impact estimated unit prices.

Background Information
Projects that are advertised late in the season or after contractors have scheduled their work for the year can expect higher bid prices. This is due to a lack of competition caused by limited contractor capacity. Projects that are bid during a period of time when contractors are trying to acquire backlog for the season are bid more competitively.

Interactivity
None

Notes
Refer to Module 9, Letting Strategies for Cost Control, and 10, Analysis of Contractor Bids, for more information on this topic.
Multiple projects approach increase competition.

A contractor already in the vicinity have:
- lower mobilization costs
- lower material sources → **Economies of Scale**

**Key Message**
Multiple projects can have positive impacts on estimated unit prices.

**Background Information**
There are potential benefits of having multiple contracts in an area. This approach could increase competition which would result in lower bid prices. Also, a contractor already in the vicinity may have lower mobilization costs and already have established material sources, resulting in economies of scale.

**Interactivity**
None

**Notes**
None
Key Message
Multiple projects can have negative impacts on estimated unit prices.

Background Information
Having multiple contracts in an area may create conflicts between the projects. These conflicts result from impacts such as construction staging and traffic control, labor availability and skill level issues, and coordination between contractors. Increased coordination increases the number of interfaces that a contractor has to manage. Also ensuring there is no scope overlap or a gap in the work as a result of multiple contracts can be a con for this approach. The effect of such conflicts need to be considered in the adjustment of historical bid prices.

Interactivity
Ask the participants if there are any other pros and cons associated with multiple contracts.

Notes
None
Macro-Environmental and Market Conditions
Specialty Work

Examples of specialty work:
- landscaping
- Stream Restoration
- Rockfall & Slope Stabilization
- building work

Key Message
Specialty work needs special consideration.

Background Information
Specialty items are not necessarily new items or new construction methods but are items that are somehow different than the majority of the work on a given project. On a pavement rehabilitation project, signal work may be classified as specialty work, whereas it would not be on a project that included predominately signal and lighting work. Examples of specialty work include landscaping, guideposts, fencing, or mechanical rehabilitation of moveable bridge components.

Interactivity
None

Notes
None
**Key Message**
Specialty work needs special consideration.

**Background Information**
Projects that include specialty work or are comprised totally of specialty work items need to be characterized correctly when estimating. Estimating specialty work bid items requires a thorough understanding of the work involved and the resources required to accomplish the work. When estimating specialty items utilizing historical bid data, the comparisons between the current and past work and the differences between them must be fully accounted for in the development of the estimate. Another factor to consider is the number of qualified contractors/subcontractors capable of performing the project or project elements of work. There may not be historic bid data on specialty type work or the unit might be lump sum. This may require the use of another estimating technique.

**Interactivity**
None

**Notes**
When estimating an item using a lump sum cost based estimating is often recommended as an effective technique (see Module 5, Cost Based Estimating).
Prepare Base Estimates

1. Quantify estimate components.
2. Develop estimate data.
3. Compile cost estimate.

Key Message
Prepare base estimate covers known costs without contingency.

Background Information
There are six general steps for preparing a base estimate when using bid based estimating technique. Each step will be briefly discussed in the following slides.

Interactivity
None

Notes
These steps appear to be linear but in reality they are performed concurrently in many instances. Also, the first five steps are repeated for different elements/items of work.
Key Message
Designers estimate quantities for line items at PS&E.

Background Information
Historical bid-based estimating is most frequently used when preparing PS&E estimates. In that application, a schedule of pay items is developed by the design group based on final plans and contract documents. Quantities for each pay item are computed by the design group. The estimator is then charged with developing estimated prices that reflect current costs using historic unit prices.

Interactivity
None

Notes
Next slide discusses quantity development during earlier project phases.
Prepare Base Estimate
Quantify Estimate Components

- During scoping phase estimator is often responsible for:
  - identifying work items
  - deriving the quantities
  - selecting the best historical bid price to employ.

Key Message
Estimator calculates quantities during earlier project development phases.

Background Information
Historical bid-based estimating can be used for developing a scoping phase estimate. In that application, the estimator is often responsible for identifying work items and deriving the quantities as well as selecting the best historical bid price to employ. The estimator may not necessarily have specific pay items but will consider elements that represent a composite of similar pay items. For example, estimating asphalt paving may focus on an item-level bid-based cost that reflects both the base course and wearing course (e.g., $60 per ton). The exact asphalt types may not be available when generating the scoping estimate for the asphalt. As the design is further developed, different asphalt items and quantities are defined and the historical bid-based pricing can be modified to reflect more specific information.

Interactivity
None

Notes
Designers could also perform quantity calculations if they are assuming the role of an estimator.
Prepare Base Estimate
Develop Estimate Data

• Developing estimate data for a project requires two steps:
  
  (1) accessing historic unit prices;
  
  (2) adjusting historic unit prices to fit the project being estimated.

Key Message
Develop estimate data input requires accessing and adjusting historic unit prices.

Background Information
Developing estimate data for a project and its unique items requires two steps: (1) accessing historical unit prices from the agency database; and (2) adjusting the unit price to fit the project being estimated. Accessing unit prices may require analysis by the estimator depending on how the unit cost data are stored in the database. Adjusting a historical unit costs requires that the estimator understand the key features of the item affecting cost (e.g., location, time, and scope) and how these features relate to the project being estimated.

Interactivity
None

Notes
There is rarely a prefect fit between a historic item and a similar item used in a current estimate. An approach is to select the historic item that is closest in scope to the item in the current estimate and then adjust the unit cost appropriately.
Key Message
Develop estimate data input based on most recent information possible

Background Information
It is imperative that estimators have the most up-to-date data for establishing unit prices to use in preparing estimates. For example, looking at unit bid prices from too far back in time can be problematic when selecting an appropriate unit bid price for the estimate. For example, standards may have changed over time.

Depending upon the bid items selected and the data in a given database, three months of data may be sufficient in establishing a unit bid price. However, there may be instances when bid data are not available for a specific item. In this case, the estimator must review bid data that are much older. The estimator will need to adjust the bid price to reflect current market conditions including past inflation impacts.

In addition, during times of rapidly fluctuating prices, it is advisable to limit the period of time from which unit bid data are analyzed.

Interactivity
None

Notes
Addressing these issues requires a good database of historic unit costs and the capability to search the database for items of interest.
**Prepare Base Estimate**

**Develop Estimate Data**

- Using similar active or recent projects is an alternative to database search
- Project must be truly similar in terms of:
  - items
  - content
  - quantities
- Using similar projects can reduce the time and effort

**Key Message**
Develop estimate data input from similar projects.

**Background Information**
Another source of historical data comes from similar projects that were recently bid. In this case, the similar project must be truly similar in terms of number of bid items (scope), the work content of the items, and the quantities for each item. Location differences must be considered.

Using bid prices from similar projects reduces the time and effort in accessing and adjusting bid prices when compared to using a historical database to find unit prices.

**Interactivity**
What are the pros and cons of using similar projects?

**Notes**
Discuss question.
Key Message
Three general issues are considered when applying historic estimate data.

Background Information
Developing estimate data for pricing elements and items of work requires a three basic considerations shown on this slide.

Interactivity
None

Notes
Each of these considerations will be discussed in the following slides in more detail.
Key Message
Accessing historic unit costs

Background Information
Once tables of collected data have been established, database queries are a good way to retrieve the stored information. A properly constructed query will retrieve data that are relative to the situation for which an estimate is being prepared.

A spreadsheet is an excellent tool to perform computations and analysis of a set of specific data providing basic requirements are met. It is possible to easily perform a number of mathematical operations after data are placed in a spreadsheet.

Interactivity
What types of data analyses are performed by your agency to support bid based estimating?

Notes
There are other tools to aid in data manipulation and analysis such as specific software design to perform computations on a given data set. Some agencies have provided access to data sets that perform analysis of historic bid prices through web applications.
Key Message
Unit price calculation are based on different approaches.

Background Information
When analyzing data to determine a unit price for use in an estimate, contractor unit bid prices that are obviously unbalanced, either high or low, should not be included in any analysis. Using only the lowest unit bid prices received for each item of work on a given project to determine unit bid prices may result in an estimate that under predicts project costs, whereas using only the average unit bid prices received for each item of work may result in a construction estimate that over predicts costs.

Interactivity
Ask the participants if they agree – why or why not?

Notes
None
**Prepare Base Estimate**

**Unit Price Calculation**

The most accurate method to consider is:

1. dropping outlying data from the set
2. using statistical techniques such as
   - weighted averages
   - regression
   - standard deviations

**Key Message**
Accurate unit price calculation

**Background Information**
The most accurate method to consider is dropping outlying data from the set and then using statistical techniques such as weighted averages or regression analysis to determine the most appropriate unit bid price that represents a contractor’s actual costs plus reasonable profit. Care must be exercised with average data, as they can obscure seasonal pricing.

**Interactivity**
Ask participants if they agree.

**Notes**
None
Key Message
Pareto principle or 80-20 rule focuses on key historic unit prices

Background Information
Constraints of time and manpower at times cause estimates to be prepared quickly and with a minimum of effort. Spreadsheets can optimize resource utilization by focusing on the items in a project that account for the majority of the total cost. For most projects, the bulk of the cost can be accounted for in a relatively small number of work items (Pareto Principle or 80-20 Rule, which asserts that generally 20 percent of the pay items represent 80 percent of a project’s cost). Using normal spreadsheet functions, it is possible to compute average prices for each item of contract work. At this point, major items can be determined as a percentage of the total amount. Major items can be defined as those items that comprise a set percentage of the total project cost. Eighty percent has been used effectively in typical estimating practices. For example, on a mill and overlay project, the majority of cost may be in the cold milling, plant mix, shoudering material, mobilization, and traffic control items, with relatively minor costs associated with striping and guideposts.

Interactivity
Is this concept applied as estimates are developed at your agency?

Notes
Often estimates are prepared with a limited amount of time and the lack of resources to research historical databases. Focusing on those items that make the largest contribution to the construction cost helps. The 80/20 is an excellent guiding principle. The estimator should use other methods to calculate the remaining 80 percent of the items such as historical percentages.
**Key Message**

Historical bid analysis using regression

**Background Information**

Readily available software allows computation of statistical information such as averages, weighted averages, and standard deviations. Data can be sorted, filtered, plotted, and analyzed in numerous ways, as this example shows.

Based on experience, an estimator can use basic spreadsheet functions to select and analyze data appropriate to the situation being estimated to arrive at a reasonable unit cost for the anticipated work. For minor items of work on a project, using average prices or regional prices is as effective as using more detailed analysis. Data can also be sorted to refine the analysis to consider factors such as by region or by project type.

**Interactivity**

None

**Notes**

While identifying a unit price for a given quantity is straightforward from the regression curve, other adjustments to that estimated unit price must be considered. In other words, do not use the curve estimate blindly!
Key Message
Consider significance of item in terms of its potential cost contribution

Background Information
On occasion, items of work, for which a transportation agency has little or no historical data, are included in a project. In those instances, similar items may provide guidance, but additional investigative work may be necessary. If the item is thought to be of minor significance, spending extra time in determining a reasonable bid price is of little benefit. If the item is considered major or is likely to be significant to the bid, research should be conducted to establish a cost. Contacting others that may be familiar with the use of the item in question can usually help in determining a price. Suppliers, other state transportation agencies, the Transportation Estimators Association’s List Service, regional transportation commissions, port authorities, RS Means publications, and even contractors can be a valuable resource in establishing prices. Be wary of relying on estimates from a single source; multiple sources should be utilized.

Interactivity
None

Notes
None
Key Message
Key bid price adjustments considerations.

Background Information
The discussion contained herein is meant to identify factors that should be considered because they can have an effect on the cost of construction and more specifically on individual contract bid items and their unit prices. The degree to which any factor may affect the cost of any given bid item is indeterminate, that is, there is no one approved answer in selecting a unit price. Common sense, experience, and judgment all play a role in using historical bid prices to determine a reasonable unit bid price to use in an estimate.

Interactivity
None

Notes
These five considerations will be discussed in more detail in the following slide. The art of cost estimating is really important when making adjustments to historic bid prices.
Bid Price Adjustments
Geographic Considerations

Each STA needs consider:

- Regional factors
- Local factors
- Political factors
- Material issues

Key Message
Regional bid price adjustments must be considered.

Background Information
Regional, local, and political factors as well as materials should also be considered by each STA to determine if they add value to their particular situation and bid history database. In addition, other factors may need to be considered in establishing unit bid price estimates and overall contract costs.

Many STA databases are available for the state as well as for specific districts/regions within the state.

Interactivity
Do political factors have an influence? If so, should they be addressed when adjusting unit prices.

Notes
Briefly discuss each.
**Key Message**  
Geographic considerations for bid data adjustment

**Background Information**  
Geographic considerations can have a profound effect on the selection of unit bid prices. A project’s location, whether in an urban, suburban, or rural setting, and in relation to material supply sources should be considered in establishing prices for an estimate.

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

Alternatively, haul distances can be a significant issue for rural projects or if the material borrow pits are a considerable distance for suburban/urban site locations.

**Interactivity**  
Is this a potential issue for the interchange project? If so, how would it impact estimated bid prices for the asphalt pavement and subbase.

**Notes**  
Discuss question.
Bid Price Adjustments
Geographic Considerations

- Large quantities of borrow fill materials and aggregates
  - the distance to material sources has a large impact on costs.
- Mountainous terrain and steep grades.

Key Message
Haul distance and terrain are geographic considerations requiring price adjustments.

Background Information
On projects that utilize large quantities of borrow fill and aggregates, whether for base, surface, and/or earthwork or plants, the distance to material sources can have a substantial impact on costs because of increased travel time and fuel requirements. Material sources in close proximity to the work reduce trucking and material handling costs and can increase production rates. On rural projects, the cost of erecting a concrete batch plant or hot mix asphalt plant may increase unit bid prices.

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.

Interactivity
Is this an issue that might impact the interchange estimated unit costs?

Notes
The degree of price adjustment will depend on the scope and project characteristics of the historic pricing that is used as a basis for estimating a project with these geographical features.
Bid Price Adjustments
Geographic Considerations

location-related considerations:
- local policies
- locally rules and regulations governing:
  - noise and pollution
  - disposal of materials
  - working hours
  - construction season
- tribal lands

Key Message
Specific location related geographic considerations

Background Information
Other location-related considerations that affect costs could occur due to local policies, taxes, restrictions, air (attainment vs. not-attainment areas) and water quality. In some locations, locally specific rules and regulations governing noise, pollution, disposal of materials, working hours, and the construction season all can increase the cost of construction.

Another example of a location-related consideration is that of projects located on tribal lands. Tribes may impose Tribal Employment Rights Office Taxes for projects on tribal lands. These taxes generally range from 1 to 4 percent of the cost of the construction on the tribal lands but vary from tribe to tribe.

Interactivity
Any comments on the potential impact of these areas that might require adjustments to estimated unit prices?

Notes
Tribal land is an issue for some states but not others. Again, the STA database may have historic prices that reflect construction work on tribal lands.
Bid Price Adjustments
Quantity Considerations

• Quantity of a given work item:
  – affects the unit cost of constructing and/or supplying the item.

• Suppliers offer discounts for larger quantity orders.

Key Message
Quantity considerations in estimating unit prices.

Background Information
The plan or expected quantity of a given work item affects the unit cost of constructing and/or supplying the item. This is not just a supply and demand issue but one of production efficiency and the ratio of fixed cost to variable cost in producing an item. Generally speaking, the unit price for larger quantities of a given material will be less than smaller quantities. Suppliers offer discounts for larger quantity orders, and mobilization, overhead, and profit are all spread out over a larger quantity, thereby reducing their effect on a per-unit basis. Waste is also spread over a larger quantity, thereby having a smaller impact on unit cost. Larger quantities give rise to efficiency by gaining experience and expertise in completing the work.

Interactivity
Is the asphalt quantity sufficiently large to warrant an adjustment based on the information provided for this interchange project? Explain.

Notes
Discuss question.
**Bid Price Adjustments**

**Quantity Considerations**

- Generally, small quantity items are less cost effective to construct.

- Projects with extremely large quantities of certain materials may actually cause an increase to the unit bid price.

**Key Message**
Quantity considerations in estimating unit prices.

**Background Information**

Generally, small quantity items are less cost effective to construct and hence lead to higher unit prices (loss of economy of scale). Not only do suppliers charge more for smaller purchases, but in some instances, the lot size or the amount that has to be purchased is greater than the needed quantity. Small quantities do not generally allow for high production rates or other efficiencies, again causing a higher unit cost. Smaller-quantity items are frequently subcontracted out; this practice increases contractors’ overhead, and they usually apply a markup to the items.

In some instances, projects with extremely large quantities of certain materials may actually cause an increase to the unit bid price. A project with numerous or large structures may affect both the production and delivery for specified steel, asphalt, or cement. This impact may be due to the location where these materials can be obtained, that is, not close to the site and also perhaps the difficulty related to construction of larger structures.

**Interactivity**

Ask the participants if they have had similar experiences with large quantities as expressed in the second bullet on this slide.

**Notes**

None
**Key Message**
Item availability impact estimated unit prices.

**Background Information**
Materials that are readily available or ones that are commonly used are generally less expensive to purchase and install/construct. The contracting community is familiar with these types of items, and this experience reduces costs and risks. Non-standard pay items or materials that are in short supply are usually more expensive, and this should be considered in establishing the unit price.

**Interactivity**
None

**Notes**
As much as possible the design should specify commonly used materials.
Bid Price Adjustments
Difficult Construction/Site Constraints

- Difficult construction and site constraints increase the cost of construction.
  - Placing piles under water
  - working near active railroads or adjacent to historic buildings
  - constructing on or near environmentally hazardous sites
  - having limited room to construct an item.

Key Message
Difficult construction and site constraints increase unit prices.

Background Information
Difficult construction and site constraints will increase the cost of construction for a contractor. Placing piles under water, working near active railroads or adjacent to historic buildings (possibly fragile), constructing on or near environmentally hazardous sites, and having limited space to construct work items are all examples of constraints that should be considered when deriving an estimated unit price.

Interactivity
Is this an issue for your agency? Provide some examples from your experience.

Notes
Again, the estimator has to relate these items to the scope of historic unit prices used to estimate a current project.
Key Message
Compile cost estimate for all bid items to develop a total construction cost.

Background Information
Once items are defined and quantified and a suitable unit price is derived, then the estimator can compile the estimate. This can be accomplished using a spreadsheet. The AASHTO Trnsp•port Proposal and Estimating System® (PES) and/or Estimator® can be used as an alternative to a spreadsheet in the scoping and design phase. In the letting phase, the AASHTO Trnsp•port Cost Estimating System® is often used. Many STAs have their own in-house system to aid in compiling cost estimates. If a spreadsheet is used, care must be taken to ensure the formulas are working properly for each item. This is also true if cost summaries are generated; the formulas to generate the summary cost information should be checked. The AASHTO Trnsp•port PES, Estimator®, and CES programs ensure that calculations are consistent and accurate.

Interactivity
None

Notes
None
Document Assumptions

Support documentation includes:
- project work narratives and schedule,
- assumptions,
- unit price adjustments
- backup calculations,
- sketches and drawings.

Key – documentation must be understood, checked, verified, and easily corrected.

Key Message
Documentation is important for reviews and estimate updates.

Background Information
Documentation is needed to support the cost estimate. This documentation must be in a form that can be understood, checked, verified, and easily corrected. Assumptions about what the contract documents required should be available as estimator notes. Other assumptions made in preparing the estimate should also be documented. The reasons for all unit price adjustments must be documented. Documentation is important for assessing estimate variability and risks and reviews.

Interactivity
None

Notes
Documenting estimate information is critical and must be a priority when preparing an estimate. This effort is often overlooked when time to prepare the estimate is limited.
**Key Message**
Documenting the estimate basis is important for reviews, estimate updates and identifying changes.

**Background Information**
References to sketches or early drawings, preliminary plans, final plans, specifications and contract requirements, project location, and unique project conditions are all information that supports the estimate. This information should be included in the estimate backup documentation. Such information is critical for risk analysis and reviews of estimate. Also, changes in the project scope can be tracked with proper referencing of the estimate basis documents.

**Interactivity**
Agree? Is this effort performed consistently in your agency?

**Notes**
None
Estimate Backup Data

The following estimate-related information should be documented:

- Quantity computations and assumptions
- Estimated bid price and adjustments
- Source of pricing.

Key Message
Documenting estimate backup data is critical for reviews, estimate updates and identifying changes.

Background Information
Estimators draw data from multiple sources when creating a bid-based estimate. These sources must be documented together with any adjustments made based on engineering judgment or experience. The following estimate-related information should be documented:

Quantity computations: The quantity take-off computations for items should be referenced to drawings. Dimensional information should be clearly shown in the backup calculations. Estimators should use sketches as necessary to support quantity calculations.

Estimated bid price: The source of historical bid prices that are used to develop item pricing should be explained (e.g., age of data, geographical location of bids, type of project, number of bids considered [low only, low, second and third bid]). The rationale for selecting an estimated unit price, such as using a weighted average or a best-fit regression curve, should be documented. Adjustments made to estimated unit prices for current market conditions and any macro-environmental conditions must be documented. Other adjustments to estimated bid prices for geographical location, quantity considerations, item availability, and difficult site conditions and/or constraints should be captured in written form.

Interactivity
Agree? Is this effort performed consistently in your agency?

Notes
This effort is extremely important.
**Risk Analysis and Contingency**

- The contingency amount should be developed separately based on a risk analysis process.
- When the design is completed, item bid pricing should reflect known risks.
- Adjustment of item bid prices for risks should be documented in the Project Estimate File.

**Key Message**
Risk and contingency should be directly linked together.

**Background Information**
The contingency amount should be developed separately based on a risk analysis process, as discussed Module 6, starting early in the project development process during the planning phase. During the scoping phase, contingency should be added separately from unit pricing. However, as the design is completed and the PS&E estimate is prepared, the item bid pricing should reflect known risks. Adjustment of item bid prices for risks should be clearly documented in the project estimate file.

**Interactivity**
Ask the participants how they handle contingency in their agencies as a project is developed over time.

**Notes**
Emphasize that contingency should be covered as a separate category throughout the project development process until the agency prepares a PS&E estimate. At this point contingency should be included in the unit price to make comparisons to bid prices.
Contingency

- Bid-based estimates should incorporate uncertainty under the contingency cost category.

- Variability in either the quantity or the bid price should be covered under the risk analysis and then incorporated into the contingency estimate.

Key Message
Contingency dollars should be estimated to cover uncertainty in bid pricing.

Background Information
Bid-based estimates prepared during the scoping and design phases should incorporate uncertainty under the contingency cost category. This means that estimated bid prices should reflect the estimator’s best judgment and experience based on known conditions and current-day pricing. Variability in either the quantity or the bid price should be covered under the risk analysis and then incorporated into the contingency estimate. The estimator is probably in the best position to assess the uncertainty associated with bid pricing. If quantities are determined by the estimator, this person should also provide input on uncertainty associated with any quantity take-off.

In the PS&E engineer’s estimate, the estimator is providing bid prices for a schedule of work items. In this case, the estimator should adjust his or her bid prices to reflect uncertainty associated with the particular item of work being estimated. This uncertainty should be captured in the bid price as an adjustment (i.e., contingency). This is necessary so that bid prices in the engineer’s estimate can be compared directly to the contractor’s bid prices when performing a bid analysis.

Interactivity
None

Notes
None
Lump-Sum Items
Alternative Technique

- Lump-sum bid items are used when:
  - A general item of work can be easily defined but its components are not easily determined.
- Consider other factors that are not easily estimated.
- Avoid or minimize use when possible.

Key Message
Estimating lump-sum items can be difficult.

Background Information
From an estimating standpoint, use of lump-sum bid items should be avoided or minimized where possible. If the work to be performed can easily be quantified, then a payment method that includes a quantity should be used. However, lump-sum bid items are often used when an item of work can be easily defined but not all the components or details can be clearly determined. This fact can make estimating lump-sum items difficult for the estimator. The more information and breakdown of a lump-sum item that an estimator possesses, the greater the likelihood that an accurate lump-sum estimate can be developed. In any case, an estimator should try to define a lump-sum item in terms of its simplest, most basic components and should consider other factors that may not be easily estimated. By breaking out a lump-sum item into smaller items of work for which the estimator may have historical data and then applying reasonable estimated prices to those sub-units, the estimator can more accurately establish a price for the overall lump-sum item.

Interactivity
None

Notes
Cost based estimating is likely the best technique to develop a lump sum estimate for an work item. See Module 5, Cost Based Estimating.
Lump-Sum Items (cont’d)

- Breaking out a lump-sum item can difficult and time consuming, therefore:
  - apply percentages or ranges based upon *historical data* from *similar project* with similar items.

**Key Message**
Estimating lump-sum items can be difficult.

**Background Information**
Since breaking out a lump-sum item into smaller components is difficult and time consuming, many transportation agencies apply percentages or ranges to estimate lump-sum items based upon historical data from similar project conditions. When determining estimates in these instances, the more consideration that can be given to an item’s many components, there will be greater confidence in determining a reasonable estimated price. Estimating methods other than historical bid-based techniques may be more applicable for lump-sum items.

**Interactivity**
None

**Notes**
Cost based estimating is likely the best technique to develop a lump sum estimate for an work item. See Cost Based Estimating Module 5.
**Key Message**
Estimating lump-sum items can be difficult.

**Background Information**
Using lump-sum items typically transfers risk to a contractor. Contractors cannot necessarily rely on overruns to cover work that they, and possibly the transportation agency, did not foresee.

Different transportation agencies use the lump-sum method of payment for different items or types of work. The items of work discussed here are some representative examples of what some states use when applying the lump-sum method of payment.

**Interactivity**
Ask for other typical lump-sum items encountered by the participants agency.

**Notes**
Each category will be covered in the follow slides.
**Lump-Sum Items**

**Mobilization**

- Mobilization:
  - preconstruction expenses
  - the costs of preparatory work and operations.
  - Risk is often bid into mobilization.

- Mobilization costs are dependent on:
  - amount and size of equipment and contractor staff.

**Key Message**
Mobilization covers the cost of setting up the field site to start work.

**Background Information**
Mobilization is a contract pay item used to cover a contractor’s preconstruction expenses and the costs of preparatory work and operations to start construction. Since there is no clear list as to what this work effort would cover, and each contractor has the ability to adjust its bid as needed to cover these expenses, there are no definite rules as to what percentage or value should be used per project. Mobilization costs are most often dependent on the amount and size of equipment and staff the contractor will need to support construction of the project. Many projects will require that the contractor mobilize crews and equipment multiple times.

**Interactivity**
Ask the participants how their state estimates the cost of mobilization.

**Notes**
None
Key Message
Mobilization cost are influenced by specifications and payment schedules.

Background Information
Another major factor to consider when estimating mobilization costs is the contract specifications in regards to mobilization. Do the specifications include payment restrictions or limits? When will the contractor receive partial or full payment for mobilization? How much of the mobilization cost will the contractor be required to finance? Full payment up front may result in higher mobilization prices and bid item unbalancing for other bid items. The specifications may play a significant role in determining an estimated value for mobilization.

Interactivity
Do these agree with points in the background information.

Notes
Discuss these two points with the participants.
Lump-Sum Items
Mobilization

• Consideration should be given to:
  – the location of a project
  – the complexity of a project
  – work requiring specialized equipment
  – the type of work
  – and the work season(s).

Key Message
Mobilization cost is influenced by a number of factors.

Background Information
Consideration should be given to the location of a project, the complexity of a project, work requiring specialized equipment, the type of work, and the work season or seasons. If the project will extend over more than one construction season, this should be considered when determining mobilization costs, as the contractor may demobilize for the winter and remobilize in the spring. Rural verses urban projects, projects with multiple work sites, projects with a substantial level of preparatory removal items, and projects with large quantities of excavation, typically require a higher mobilization percentage.

Interactivity
None

Notes
None
**Key Message**
Mobilization cost is often estimated based on a percent of construction cost.

**Background Information**
To adequately estimate mobilization costs on a project utilizing historical-based data, the overall project must be very comparable in size, location, and work involved to the project being estimated. For this reason, organizations that rely on historical bid-based estimating methods often use a parametric figure to estimate mobilization costs. This figure is normally a percentage of the overall construction item total and in the range of 6 percent to 18 percent. Some examples of this are:

Typical mobilization estimates for a roadway project may be 8 percent based on past history for a state.

Typical mobilization estimates for a structures project may be 10 percent based on past history for a state.

Typical mobilization estimates for small projects that are not complicated may be 12 percent based on past history for a state.

**Interactivity**
Ask the participants if there agency uses a percent to estimate mobilization or do they use some other technique.

**Notes**
None
**Key Message**
Clear and grub is another important cost that can be underestimated.

**Background Information**
Clearing and grubbing is the removal and disposal of all vegetation, trash, and natural and manmade objects from a project’s worksite in order to allow construction of the anticipated improvements. Although payment for clearing and grubbing is sometimes measured by square yard or acre, it is frequently paid for on a lump-sum basis. When payment is made on a lump-sum basis, the estimator needs to have knowledge of the area to be cleared. Knowledge of the size of the area to be cleared; the type of terrain; types of obstructions to be removed or filled in; and density of brush, trees, and rocks will aid in estimating this item. By analyzing this information and comparing to previous projects with similar characteristics, the estimator can determine a reasonable lump sum estimate.

**Interactivity**
None

**Notes**
The estimator must understand the existing conditions of the site, so a site visit is recommended.
Key Message
Clearing and grubbing a site can require different types of work.

Background Information
If the breadth or scope of a project is unique, then breaking the clear and grub item out into smaller components may aid in determining an estimated price to perform the work. By breaking the area to be cleared into quantifiable segments that may be similar to clearing and grubbing that has been previously performed, an estimator can add up the segments to produce the estimate. Similarly, if the area is broken out into subunits for which there may be historical data, the individual units can be estimated and summed to form a reasonable lump sum estimate.

Interactivity
None

Notes
If historic unit pricing is not available for developing a reasonable estimate, the cost based estimating approach may be a good alternative technique to estimate this item. Historical percentages may be used as well.
Lump-Sum Items
Structural Steel

Some states pay for structural steel for bridges by the lump-sum payment method:
- nuts
- bolts
- washers
- stud connectors
- scuppers
- plates and anchorages
- all costs of fabrication, delivery, and erection.

Key Message
Structural steel should be estimated by individual items then converted to a lump sum.

Background Information
Some states pay for structural steel for bridges by the lump-sum payment method. The lump-sum payment will usually include the cost of all metal used in the construction of the bridge including nuts, bolts, washers, stud connectors, scuppers, plates, and anchorages and includes all costs of fabrication, delivery, and erection. The cost must cover labor, materials and equipment plus contractor overhead and profit. These costs can be summarized for a lump sum value.

Interactivity
Ask the participants how they estimate bridge costs.

Notes
Early estimates may use a parametric value such as $ per bridge deck area or when more detailed drawings are available the component parts of the bridge can be estimated individual and summed for a lump sum estimate.
**Lump-Sum Items**

**Structural Steel**

- Calculate weight of material.
- Apply cost per pound.
- Adjust for project-specific conditions.

**Key Message**
Structural steel is often estimated using weights of different components.

**Background Information**
In order to determine a reasonable cost estimate to use for a structural steel lump-sum item, the weight of material needs to be calculated. This, however, is time consuming to calculate and has a high potential for error. When calculating the weight of each plate, every clip has to be cut out, the weight of holes has to be deducted, and the weight of bolts must be added to obtain an accurate total weight. The main girders themselves are not too difficult to calculate, but the cross-frames, bearings, and splices are time consuming and always difficult. Because of these difficulties, an approximate weight is calculated.

Once the approximate weight is calculated, a cost per pound is applied to derive an estimate of cost. This cost is based on historic bid price data for projects with bridges or bridge projects with similar characteristics. Pricing can also be obtained through suppliers. The estimate is then adjusted for any project-specific issues.

**Interactivity**
None

**Notes**
Ensure that the cost per pound includes labor, materials and equipment. If not then materials, labor and equipment must be estimated separately. Be sure to include contractor overhead and profit.
Lump-Sum Items
Demolition

- Demolition work involves excavators, trucks, and other specialty equipment.

- Consider:
  - number of days the operation will take.
  - disposal and distance to disposal facility related costs.

Key Message
Demolition is unique for each project.

Background Information
Estimating demolition lump-sum items requires that the estimator understand the work involved and the commonalities between the work proposed and the historical bid items. Many times, demolition work is similar in nature, involving an excavator and trucks with trash trailers. This type of operation is the most common, and the difference in bid item price is determined based on the number of days the operation will take to remove the necessary items. Special care should be taken when known environmental hazards exist within the demolition area. Hazardous material removal and remediation should be accounted for in the bid item.

Interactivity
None

Notes
None
**Traffic Control and Maintenance of Traffic**

- Item where innovation by contractors can improve the traffic control plan.
- Lump-sum for traffic control can reduce:
  - preliminary engineering effort
  - construction inspection effort

**Key Message**
Contractor developed traffic control and maintenance of traffic plans can substantially impact costs.

**Background Information**
No matter how much time and effort a transportation agency spends in evaluating how a project will likely be constructed, contractors will have different ideas on how to prosecute the work to their advantage. Innovation by contractors can realize cost savings for transportation agencies and can quickly make all their efforts in developing a usable traffic control plan obsolete. This fact is why many states now use the lump-sum method for payment of traffic control/maintenance in lieu of developing full-scale traffic control plans with unit prices.

The use of the lump-sum item for traffic control can have a significant reduction in preliminary engineering effort and also a reduction in construction inspection efforts as well. Even so, considerable effort on the part of the transportation agency needs to occur to approximate the types and quantities of traffic control devices, the number of times an item has to be moved, and the duration that the items will be needed.

**Interactivity**
How does your state handle this item when estimating construction costs?

**Notes**
Traffic control and maintenance of traffic often is an item that changes once the contractor commences work.
Traffic Control and Maintenance of Traffic

- Special provisions/specifications examples:
  - lane restrictions can be imposed
  - duration that a detour can be in place
  - maximum length of work zone.

**Key Message**
The cost of traffic control and maintenance of traffic is driven by specifications.

**Background Information**
If the transportation agency believes that certain limitations around traffic control are of significant importance, then those limitations need to be identified and stated in the special provisions/specifications for the project. Items such as when lane restrictions can be imposed, duration that a detour can be in place, and maximum length of work zone will all have a bearing on the minimum number and type of devices that are necessary to prosecute the work. Significant items that the STA will require such as minimum amounts of portable precast concrete barrier rail and number of changeable message signs, arrow boards, and truck-mounted impact attenuators should all be identified. This informs the contractor that these items have to be used in the construction of the project and that they need to be included in the bid. The inclusion of these items may reduce risk to the contractor, which can be reflected in a lower lump-sum price. It will at least reduce the potential for claims once the project is under construction.

The establishment and identification of these significant items and consideration of the anticipated phasing/staging of the work along with imposed limitations, as well as approximate types and numbers of other anticipated traffic control devices, will all aid the estimator in establishing a reasonable lump-sum cost. By breaking out the larger portions of cost in a lump-sum item, the estimator can rely on historic bid data for those items and the given limitations to come up with a reasonable lump-sum cost.

**Interactivity**
None

**Notes**
Discuss other issues that might influence the cost of traffic control/maintenance of traffic.
Key Message
Develop reasonable cost taking into considerations project conditions.

Background Information
The goal of Bid-based estimating is to determine a reasonable cost to deliver a project. Quantities should be estimated based on the most current drawings available. Estimated bid prices should be based on recent historical bid prices adjusted for current market conditions and other factors, such as geographical location, seasons, quantity differences, and difficult site conditions and/or constraints.

To create a base estimate plus a reasonable contingency, it is necessary to prepare a fully detailed and accurate estimate for the cost of performing many items. When using historical bid data, the estimator must ensure that this historical bid data reflects the scope of the item that is being estimated.

Interactivity
None

Notes
None
Summary (cont’d)

- Estimate reviews take time and resources.
- Estimate reviews are vital to achieving consistent and accurate estimates.

Key Message
Estimate reviews are critical.

Background Information
Estimate reviews take time and resources, and they are an easy step to skip when project estimators are busy with other tasks. However, reviews are vital to achieving consistent and accurate estimates.

Interactivity
None

Notes
None
Resources


Resources


Photo References

- http://donegalnews.com/2013/04/planning-applications-on-the-rise-for-second-consecutive-year/
- http://laborrightsblog.typepad.com/international_labor_right/trade/
- http://gasparlino.com/international-approach/
- http://www.psc.state.ne.us/hrv/hrv.html
- http://metropolitanpartnership.com/category/services/
- http://www.compassinternational.net/
- http://www.bayviewconstruction.ca/