

Assessment of Federal Highway Administration Highway Project Cost Estimation Tools

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FOREWORD

Estimating project costs can be a major challenge for transportation agency personnel. Cost estimates typically must be developed over multiple points during a project's development, any time between the initiation of a project and the completion of construction. The research project described in this final report provides an essential step in simplifying such a complex process by detailing what practices are often used and have proven effective in cost estimating. The researchers interviewed subject matter experts and conducted a literature review to develop a series of flowcharts and checklists to aid in developing and overseeing cost estimates. The findings presented in this report shed new light on the practices used to conduct cost estimate review and program oversight. Research of this kind will benefit agencies across the Nation.

This report describes the best practices used in developing cost estimates and provides guidance for overseeing the development of such estimates. It serves as a line of communication among different State and Federal agencies involved in the creation and oversight of cost estimates. Private parties, such as contractors and consultants, can also benefit from the product of this research.

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Research and Development

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1,000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ABBREVIATIONS

CFR	Code of Federal Regulations
CM/GC	construction manager/general contractor
DB	design-build
DBB	design-bid-build
DO	division offices
DOT	department of transportation
EE	engineer's estimate
FAHP	Federal-aid Highway Program
FFPR	final field plan review
FHWA	Federal Highway Administration
FLH	Office of Federal Lands Highway
FLHP	Federal Lands Highway Program
NEPA	National Environmental Policy Act
NHCCI	National Highway Construction Cost Index
NHS	National Highway System
PM	project manager
PODI	project of division interest
PS&E	plans, specifications, and estimates
ROW	right-of-way
STA	State transportation agency
STIP	Statewide Transportation Improvement Program

CHAPTER 1. INTRODUCTION

PROJECT BACKGROUND

Transportation agencies are charged with developing and delivering highway construction and maintenance programs that enhance the safety, mobility, and economic competitiveness of communities. While the design and construction of these projects are vital, accurate estimates of project costs during the multiple developmental stages are incredibly important in both developing the agency's project budget as the project advances and verifying that contractor bids represent fair market value during award. Having consistent and reliable cost estimates provides agencies with numerous benefits when making financial decisions and providing oversight related to estimating project funds, conducting benefit-cost analysis to prioritize projects, determining the funds needed to deliver projects, obligating funds for specific project phases, and determining the basis for cashflow requirements over time.

Cost estimating establishes the basis for significant project decisions, establishes a baseline cost to help measure project success, and communicates the project's status to internal and external stakeholders. For the Federal Highway Administration (FHWA), accurate and effective cost estimating is critical during the National Environmental Policy Act (NEPA) process and the development of the initial financial plan for major projects (House of Representatives 2020a). The ability to develop reasonable and defensible cost estimates is also important in maintaining public trust and confidence during a project.

Cost estimate methods typically fall within five different approaches (Molenaar, Anderson, and Schexnayder 2013):

1. Historical bid-based estimation—uses a bid-history database to estimate unit bid costs for major items. Based on the historical averages, FHWA can use the estimated quantities of a proposed project to develop a target price. Much of this approach's accuracy relies on the quantity and level of detail in the bid-history database.
2. Conceptual estimation—is usually performed during the early planning and scope development stage and typically uses primary project parameters (e.g., project location, length, type of project, scope details, design parameters, site characteristics, and broad design assumption) to develop a cost estimate.
3. Risk-based estimation—involves developing probable costs for project components and the project as a whole, based on identified quantities, costs, and contingencies developed from a list of identified uncertainties from both opportunities and threats and their potential impact on the project.
4. Cost-based estimation—involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs. The method also involves adding a reasonable amount for a contractor's overhead and profit. The process mimics the method that a contractor uses for preparing a bid-day estimate. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

5. Combination of historical and cost-based estimation—involves estimating the cost for items of work based on the cost of each component of a project and considering the associated labor, equipment, and materials costs, based on historical bid items of past projects. The method also involves adding a reasonable amount for a contractor’s overhead and profit. The process involves developing cost estimates for each project (like the cost-based method). However, it uses a bid-history database instead of cost estimates from material suppliers and historical production rates that are typically used in a cost-based method.

Familiarity with these methods is an important aspect of helping provide oversight for other agencies that conduct cost estimates required by FHWA (FHWA 2018).

PROJECT OBJECTIVE

The primary objective of this task order was to identify what, when, why, and how FHWA and the Office of Federal Lands Highway (FLH) oversee and/or develop costs estimations for transportation construction projects. FHWA will use this information to provide more consistent oversight of project cost estimates by State transportation agencies (STAs).

FHWA’s program is delivered through two main administrative areas: the Federal-Aid Highway Program (FAHP) and the Federal Lands Transportation Program and Tribal Transportation Program.

The FAHP provides Federal financial resources and technical assistance to State and local governments for constructing, preserving, and improving the National Highway System (NHS), a 163,000-mi network that carries approximately 45 percent of the Nation’s highway traffic. The program also provides resources for an additional 1 million mi of urban and rural roads that are not on the NHS but are eligible for FAHP assistance (Earsom et al. 2010). The FAHP is administered by the FHWA division offices (DOs) in each State, Puerto Rico, and the District of Columbia.

The Federal Lands Highway Program (FLHP) provides financial resources and technical assistance for a coordinated program of public roads that service the transportation needs of Federal and Indian lands. The program provides funding for public roads and highways within federally owned lands and Tribal lands that are not a State or local government responsibility. The FLHP is subdivided into seven core areas: U.S. National Parks Service, U.S. Fish and Wildlife Service, U.S. Department of Agriculture Forest Service, U.S. Bureau of Land Management, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and independent Federal agencies with natural resource and land management responsibilities (House of Representatives 2020b). One of the major factors associated with the program’s success is FHWA’s strong relationship with Federal, State, local, and Tribal partners. The FLHP is administered by FLH headquarters and three DOs.

REPORT OVERVIEW

This report presents the relevant findings related to cost estimate and cost estimate oversight for transportation construction projects, both by FHWA DOs and STAs. The report includes four sections. Chapter 1 provides the research background. Chapter 2 describes the research methodology used to process diagrams and checklists designed to help DOs and FLH provide cost estimation oversight. Chapter 3 presents the process diagrams and checklists. Finally, the appendices include the surveys used by the research team.

CHAPTER 2. RESEARCH METHODOLOGY

This project used a qualitative research method in which the two major components were an extensive literature review and interviews with subject matter experts. The literature review was instrumental in developing the questionnaires used in the interviews. The research panel selected and later contacted the subject matter experts. The following sections describe the literature review and data collection process.

LITERATURE REVIEW

The research team conducted a literature review to compile the most common practices for cost estimating and cost estimate development oversight for transportation agencies. A portion of the literature used for the development of the project was obtained from extensive internet research. Additionally, multiple agencies from different States, including FHWA Federal-aid DOs and STAs, provided guidelines and documentation on how to create, document, review, and oversee cost estimates.

DATA COLLECTION

Once the researchers gathered relevant information from the literature review, they created the survey for the first of two rounds of structured interviews (appendix A and appendix C). They distributed the survey to the previously selected subject matter experts from DOs, STAs, and FLH. The participants were selected because of their experience, roles, and responsibilities in the cost estimate development and oversight processes in their respective agencies.

The experts were asked to review the survey, which was completed during a videoconference interview conducted by the researchers. These interviews were then used to determine the most useful cost estimate development and oversight methods.

The purpose of the first round of interviews was twofold. First, the interviews were conducted to validate the cost estimate development and oversight practices found in the literature. Second, the interviewees played a key role in contributing information about practices used in their States as well as practices that they had seen used in other agencies. After the first round of interviews, the researchers compiled a list of best practices for the second round of interviews along with diagrams describing the cost estimate oversight processes.

The purpose of the second round of interviews was to validate the practices obtained during the first round of interviews. After the second round of interviews, the researchers developed a final list of practices and multiple diagrams to include in the final report.

First Round of Interviews

In total, eight DOs, six STAs, and one FLH office participated in the first round of interviews. The interviews consisted of a series of questions related to the participant's knowledge of approaches used in cost estimation, efficacy of the methods, perception of counterparts' knowledge in cost estimation (i.e., what do STAs think of the DOs and vice versa), challenges,

cost performance measures, cost estimate development, estimate oversight, and post-bid practices. Copies of the interview guides are provided in appendices A and C.

This report identifies States using unique capital letters to protect the interviewees’ privacy. If experts from a DO and STA from the same State were interviewed, they are presented as X-DO and X-STA, respectively. Compiled transcripts of the interviews can be found in the appendices: appendix B includes the compiled transcripts from STA interviews, and appendix D includes the compiled transcripts from DO interviews.

Response to Approaches

In the first interviews, the agencies were asked how familiar they are with the different cost estimating methods, including the historical bid-based method, cost-based method, conceptual estimation, risk-based approach, and a combination of historical bid-based and cost-based methods.

The agencies’ overall familiarity with the different methods varied depending on what they use the most. Overall, the agencies are more familiar with (i.e., most commonly use) the historical bid-based method, especially DOs and STAs. Next, DOs and FLH were familiar with a combination historical and cost-based and conceptual estimation, while STAs were familiar with conceptual estimation and a combination of historical and cost-based. DOs and FLH were least familiar with risk-based and cost-based methods, while STAs followed a similar trend of being least familiar with cost-based and risk-based methods. Table 1 and table 2 present a ranking of the familiarity of the aforementioned methods for DOs and STAs, respectively.

Table 1. Ranking of the level of familiarity for DOs and FLH.

Method	Ranking
Historical bid-based	1
Combination of historical and cost-based	2
Conceptual estimation	3
Risk-based	4
Cost-based	5

Table 2. Ranking of the level of familiarity for STAs.

Method	Ranking
Historical bid-based	1
Conceptual estimation	2
Combination of historical and cost-based	3
Cost-based	4
Risk-based	5

For the next set of questions, it is important to define what a min-max normalization is. This type of normalization uses the minimum and maximum scores obtained in a set of questions and converts them to the original range to show the new normalized values (figure 1). This method is used for consistency among questions answered.

$$A' = \left(\frac{A - \text{minimum value of } A}{\text{maximum value of } A - \text{minimum value of } A} \right) * (D - C) + C$$

Figure 1. Equation. Min-max normalization.

Where:

A' = normalized score value.

A = original score value.

$[C,D]$ = range of the original conversion.

For example, if the range used is [1,10] and the minimum and maximum for a respondent are 6.5 and 8, respectively, then the normalized values for 6.5 and 8 are 1 and 10, respectively (Saranya and Manikandan 2013).

Additionally, the responses to the next questions include blank cells. The blank cells mean that no interview was conducted for that agency. For example, in table 3, State A's DO did not participate in the interviews, whereas State A's STA did participate.

Response to Efficacy

Regarding the efficacy of the cost estimating methods, the overall perception, both from DOs and STAs, is quite similar. The general idea is that estimates have room for improvement, but they serve as benchmarks for comparison. In this section of the interviews, the interviewees were asked about three subjects: confidence in the cost estimates, confidence about estimating methods, and accuracy of the estimates developed. Table 3 summarizes the questions asked about the efficacy of the cost estimates and the methods used to develop them. This question summarizes the responses for questions 1–3 on page 55.

Table 3. Perception of efficacy of the estimating methods.

State	DOs	STAs
A	—	3.0
B	—	8.4
C	7.8	6.7
D	4.0	6.3
E	7.8	3.8
F	—	5.7
G	7.8	—
H	7.4	—
I	7.0	—
J	—	—
K	9.3	—
L	—	5

—No data.

Note: The scale was from 1 to 10, where 1 is low perception of efficacy and 10 is high perception of efficacy. Min-max normalization was used to make equivalent comparison between the responses from individuals from DOs and STAs.

Response to Perceptions

When it comes to how agencies perceive their counterparts, the interpretations differ depending on whether a DO or an STA is asked and depending on the State the agency represents. The comments described both positive and negative interactions. While the sample is not big enough to support any statistical analyses, the perception seems to be polarized. The low scores observed in table 4 result from the lack of communication between some STAs and their respective DOs. This question summarizes the responses to questions 4–8 on pages 56–58.

Table 4. Perception of the knowledge and involvement of the counterpart.

State	DOs Perception of STAs	STAs Perception of DOs
A	—	5.8
B	—	9.6
C	1.0	7.5
D	2.0	7.3
E	8.5	2.6
F	—	6.8
G	7.0	—
H	9.0	—
I	8.9	—
J	9.4	—
K	8.5	—
L	—	N/A

—No data

N/A = not applicable.

Note: The scale was from 1 to 10, where 1 is a low perception of knowledge and involvement and 10 is a high perception of knowledge and involvement. Min-max normalization was used to make equivalent the responses from different individuals. STAs are DOs counterparts and vice-versa.

Comments received about the perceptions are included in the following section to help illustrate the source of some of these differences.

State A

A-STA

“We do not have a daily oversight. We have to give them [FHWA] a report of how we’ve done over a year, so it’s an *annual report*. I’m sure what happens to that or what’s done about that.”

State B

B-STA

“We do not have that much interaction with them [FHWA], but whenever we talk, the interactions are good. This happens so very seldom.”

State C

C-DO

“Before we start, let me save you some time. We are not involved at all with estimates. We only help them [STA] with new estimating strategies or if they need approvals.”

C-STA

“The only person I’ve talked to in FHWA that I’ve really talked to that is super interested in what we’re doing is [person from FHWA headquarters]. That’s the only contact I have with estimating on a regular basis.”

Q: So, you do not talk to C-DO?

A: “Not a lot. I’ve tried to send stuff over to them [FHWA], and they say ‘No, no, no.’”

State E

E-STA

“We do not get any support from them [FHWA]. We have asked for information and recommendations, and we’ve had no response. We’ve sat with them [FHWA] in person, they say they’ll get us what we need, and then there’s no followup. We now talk directly to an FHWA committee that I am part of, and that is the only way we get oversight. We also go to other States instead of our DO.”

E-DO

“If they [STA] want to fully reject a bid, they have to check in with us.”

“We have monthly contact, at least. They [STA] like to check and make sure.”

State J

J-DO

“FHWA is trying to take a step back and let STAs run the show.”

“J-STA is a leader in cost estimating. We learn from them.”

Response to Challenges

The interviews identified the following challenges experienced by the participating STAs when developing cost estimates:

- Time available to develop estimates.
- New bid item estimations (especially for States using the historical bid-based approach).
- Staff shortages.
- Lump-sum items.

Likewise, the most common challenges for overseeing cost estimates among the DOs interviewed for the study included:

- Lack of early-stage involvement.

- Limited access to available software systems.
- Rework required for shelved projects.
- Quantity of bid items.
- Package to the bidder lacks details (e.g., no locations).
- Lump-sum items.

Table 5 summarizes the responses from the STAs and DOs about how challenging it is to develop and oversee cost estimates. When asked about the challenges of working with the DOs, the STAs reported communication—or lack thereof—was the biggest challenge. Some STAs also mentioned that the DOs are understaffed, which makes it harder to work with them. This question summarizes the responses to questions 4–7 on pages 59 and 60.

Table 5. Summary of how challenging it is to develop/oversee cost estimates.

State	DOs Response	STAs Response
	Value	Value
A	—	6.6
B	—	5.8
C	7.2	6.4
D	5.3	7.1
E	6.7	3.3
F	—	5.0
G	6.7	—
H	8.8	—
I	8.0	—
J	8.8	—
K	8.3	—
L	—	5

—No data.

Note: The scale was from 1 to 10, where 1 is not challenging at all and 10 is highly challenging. Min-max normalization was used to make equivalent the responses from different individuals. STAs are DOs counterparts and vice-versa.

Response to Cost Performance and Competition Measures

For the performance measures, four respondents (one STA and three DOs) use State Transportation Improvement Program (STIP) performance measures. In contrast, all respondents from STAs, DOs, and FLH use plans, specifications, and estimates (PS&E) performance measures. All the interviewees stated that their agencies use the cost performance and competition measure stipulated in the FHWA guide (low bid to be within +/-10 percent of the PS&E estimate for 50 percent of all projects) (FHWA 2020). On top of the +/-10 percent stipulated by FHWA, 50 percent of the respondents compare the PS&E to the low bid.

An interesting concern brought up by an STA is that they do not like to use the phrase “performance measures.”

“...we’re trying not to chase the contractor’s bid. We’re trying to determine what something should really cost. We want to see the difference between the bids and the engineer’s estimate [EE]. These are not really measures; these are indicators.”

Two agencies also use other measures. For example, B-STA uses the low bid within –25 percent +10 percent of the PS&E, but if the project is less than \$500,000, they use –25 percent/+15 percent. Alternatively, E-STA compares the original bid to the final cost.

Regarding competition, none of the interviewees stated that their agency rejects bids for lack of competition. However, when the number of bidders is low, the bids are reviewed more thoroughly. Similarly, if the low bid is too far from the EE, the bids are not automatically rejected, but the bids are reviewed to see if the differences are justified. If that is the case, some STAs (three out of six) are allowed to award the bid, whereas one agency mentioned that they have to verify the funding available for the difference. Usually, the threshold for a bid to be too high is 110 percent of the EE, and that mostly applies to design-bid-build (DBB) projects. For other contracting methods (e.g., design-build (DB)), one agency mentioned that it requires at least three bidders to award a project.

Response to Cost Estimate Development

Generally, STAs update estimates on a timely basis once the projects go into the STIP estimate. Most States update estimates annually, but some do it every 6 mo (as the guidance suggests). E-STA said it found that not everyone meets the 6-mo goal (according to their internal STA guidance), but *those that use it achieve better results*.

STAs prepare estimates for each milestone of a project. Agencies have different milestone classifications, but the most common stages are 30 percent, 60 percent, 90 percent (draft PS&E), and final PS&E. Unlike the majority of STAs interviewed, F-STA uses 95 percent for its draft PS&E. B-STA mentioned that it requires a minimum of three estimates, but the standard is eight estimates. Most STAs (four out of six) mentioned that they require an annual estimate during the preliminary phases (once the project enters the STIP) and then one estimate per milestone.

A concern brought up by both STAs and DOs is that their counterparts seem to be overwhelmed with work or are understaffed. One STA, in particular, mentioned that neighboring States with smaller programs have significantly larger teams.

Response to Contingency and Risk

Regarding Contingency from State to State and from project to project, four out of six STAs interviewed use percentages that decrease as the project estimate advances toward the final PS&E. The percentages used for each stage vary from State to State, ranging from 40 percent in the early planning stages to 5 percent for the final PS&E. The highest contingency percentage for the early stages was 40 percent, and the lowest percentage for the early stages was 25 percent. However, all the States that use the percentage approach use 5 percent for the final PS&E. The remaining two STAs use one of two approaches. One uses contingency on items that are hard to quantify, and the other one sets aside money once the project is let. (It is unclear how they determine the amount.)

When it comes to risk, one STA sees it as a contingency. Those that do not see it as contingency have different approaches that vary in complexity. One STA tries to find projects with similar risks and copy the risks to the new projects. One agency uses a risk registry, which is a tool that allows people involved in the project to document and manage risks as well as actions to mitigate the risks identified for all their projects. Five out of six agencies use probabilistic risk approaches for larger projects and alternative delivery methods (i.e., DB and construction manager/general contractor (CM/GC)). Finally, three agencies use a combination of risk registries and probabilistic approaches (for smaller and larger projects, respectively). Generally, the more complex risk approaches are used for larger projects. B-STA mentioned that for very large projects (greater than \$500 million), they hire consultants to perform a risk assessment. However, one agency in particular—I-STA—said that they do not track risk because “[Risk] is embedded in the historical bid prices.”

Response to Price Tracking

The research team asked the STAs whether they contact vendors and suppliers to inquire about prices. All of the STAs interviewed contact vendors. However, they have different approaches, as follows:

- A-STA routinely contacts vendors and suppliers about prices.
- B-STA has consultants inquire about prices.
- C-STA gets quotes but stated that it is difficult to get information without revealing key aspects of a project.
- D-STA asks for prices mostly on alternative project delivery contracts.
- E-STA only requests prices for unique items.
- F-STA asks for general pricing information, not on a project-to-project basis.

E-STA pointed out that the price variation was more significant when it was linked to location than when it depended on the supplier or type of material. For example, one STA said, “We found out that the asphalt prices vary \$3–5 per unit depending on the type of mix, but the variation was about \$20 per unit depending on the location.”

In dealing with location-related prices, two agencies said that they could conduct site visits to identify vendors and labor costs, but two other agencies indicated that they do not have enough personnel or are too centralized to conduct site visits. Nevertheless, 83 percent of the STAs interviewed are adjusting for individual project conditions, such as location, traffic, terrain, season, accessibility, and project size. The remaining 17 percent said that these adjustments are unnecessary because they are inherent in historical bid prices.

Response to Cost Indexes

All interviewed STAs use some type of cost index, and 83 percent of them have at least one kind of in-house developed index, whether it is a fuel index, asphalt index, or a cost index. The cost indexes do not necessarily follow the same methodology as the National Highway Construction Cost Index (NHCCI) (FHWA 2021). Those that do not mimic the NHCCI mentioned that they follow the methodology developed by other States.

Response Bidding and Post-Bid Practices

The research team asked the agencies about the information that is publicly available about the EE when it comes to bidding and post-bid practices.

During the advertising period, the information available in the EE differs from State to State. For instance, 83 percent of the STAs provide information about the project's size, whether by publishing a range of the EE, a price category into which the project is expected to fall, an exact number (not the EE), or the exact EE, along with the other documents. One interviewee pointed out that providing the exact EE "Is very unusual." All the State agencies interviewed said that the information they release is available online. The remaining 17 percent of the interviewed STAs do not provide information about the size of a project before advertising the bid.

The information provided by the DOs interviewed is similar to what the STAs provide. Only one of the States said that their STA does not publish anything. In contrast, the other seven said that their respective STAs provide information about the size of the project, whether by providing an exact number or a price range of the EE. On the other hand, for a minority of projects, FLH provides a range of project sizes, based on the EE, in private meetings.

One STA mentioned that it is illegal in their State to release the EE, even after the bid is awarded. For those States where releasing the EE is legal, two STAs do not publish it at all, one STA publishes only the total (i.e., with no detailed breakdown), and two STAs and FLH publish it in detail (i.e., with a detailed breakdown). However, one of the STAs that does not publish the EE mentioned that if someone challenges it, the STA would have to release it because there is no law or regulation protecting it. This same agency pointed out that they have no recollection of having a request for the release of the EE.

The research team also asked about changes to the estimate during the advertising period, discounting addenda or quantity changes. Only two STAs responded positively to this question. One adjusts for fuel price changes, and the other said that if the bids come in very different from the EE, they will look at the prices and may revise the bids at that point. Currently, more than 50 percent of the States reject all bids and potentially reach out to bidders. The States might also reevaluate if they have to use force account work, which is work for which the payment falls under a cost plus system, for supplemental agreements, or for claims obtained through a judicial procedure (Jorge and Herbsman 1989).

IDENTIFIED BEST PRACTICES IN COST ESTIMATE DEVELOPMENT AND COST ESTIMATE OVERSIGHT

After completing the first round of interviews, the team developed an interim report containing a compilation of the common practices for cost estimate analysis and oversight. As mentioned earlier, these practices were found in the literature review as well as in the guidelines provided by the interviewees. The common practices identified are as follows:

- Practice A: Applying the Pareto principle.
- Practice B: Comparing historical projects.
- Practice C: Monitoring and updating cost estimates.

- Practice D: Identifying factors that influence project cost.
- Practice E: Analyzing cost estimates.

Each of the aforementioned practices is described in the following section.

Practice A: Applying the Pareto Principle

One of the most common practices among the interviewed States (both STAs and DOs) is when using the *Pareto principle*—also known as the 80/20 rule—for reviewing cost estimates. The principle states that 80 percent of a project’s associated cost can be explained by 20 percent of the items. In this way, States encourage estimators to identify which bid items comprise 80 percent of the estimates, so they can focus on these items while conducting estimate reviews (as shown in table 6, extracted from the Wisconsin Department of Transportation’s (WisDOT’s esd-template) (WisDOT n.d.). Nonetheless, this practice must complement other practices to avoid mathematically or materially unbalanced bids. For example, the California Department of Transportation (Caltrans) states the following in their “Cost Estimating On-The-Job Training,” “Remember never use single low bid data point, it could be from an unbalanced low bid¹.” This practice is recommended for checking bid unit prices to ensure that the low bid unit price is not unbalanced.

Table 6. Sample from WisDOT’s esd-template (WisDOT n.d.).

ITEM LEVEL DOCUMENTATION
Significant Items List—Top 20 percent of items out of total contract costs and lump sum items
Enter item documentation or list significant items with attachment containing documentation
Nonsignificant Items Summary—Summary of estimating methodology
Enter text.
Estimate Review Summary
Consultant Reviewer(s):
Region Reviewer(s):

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In table 6, the first field, “Significant Items List” refers to the items to be checked, which should comprise 80 percent of the estimate, according to the Pareto principle. The second field, “Nonsignificant Item Summary,” describes the approach used to create the estimate. Finally, the third field, “Estimate Review Summary,” is where comments that had a direct impact on unit prices should be written. This section should not include iterations of comments between the review and design teams; the final decision should be enough. A typical list of items that comprise 80 percent of the estimate includes excavation, embankment, pavements, drainage, structural steel, and structural concrete. However, it is important to note that this list will vary depending on the type of project (Pennsylvania Department of Transportation 2018).

¹Caltrans. 2018. “Cost Estimating On-The-Job Training.” Presentation.

Practice B: Comparing Historical Projects

Another commonly recommended practice for estimate oversight is to check prices for existing projects with similar conditions (e.g., location, size, type of project, material type). This comparison helps the reviewer find relevant historical data to complete their oversight or to develop the cost estimate of new projects. WisDOT (2022) developed a spreadsheet used to compare projects with historical data using nine different filters (figure 2). In this tool, the user selects the characteristics of the project to be analyzed. These characteristics will filter similar projects, extracted from an existing database of more than 1,000 executed projects, so that the historical data used in the comparison are more relevant and accurate.

This tool also helps identify the relevant items for the Pareto principle. After selecting the filters, the results (figure 3) show the relevant item classes and their percentage relative to the project. It also shows the average number of bidders for the filtered options (WisDOT n.d.).

Filters

Sample Size: 1,813

Proposal Improvement/Work Type

Improvement Type	Improvement Concept	Contract Work Type	Work Rating
Bridge Rehabilitation	BRIDGE ELIMINATION	Asphaltic Pavement	Asphaltic Surfacing
Bridge Replacement	BRIDGE REHABILITATION	Bridge Painting	Asphaltic Surfacing and Incidental Const
Expansion	BRIDGE REHABILITATION (SHRM)	Concrete Pavement	Bridge Painting
Miscellaneous	BRIDGE REPLACEMENT, EXPANSION	General Construction	Building and Incidental Construction
Pavement Replacement	BRIDGE REPLACEMENT, PRESERVATION	Grading	Building Construction
Preservation/Restoration	MISCELLANEOUS	Street or Airport Lighting	Gen Const and Asph Surf and Incidental
Reconditioning	NEW BRIDGE	Structures	Gen Const and Asph Surf and Structures
Reconstruction	PARTIAL DEPTH CIR WITH <= 2.5 INCH CAP		Gen Const and Brg Painting and Inc Const

Proposal Information

Region	County	Project Size	Urban/ Rural	Route
NC	Lafayette	\$ 0.5M or less	Rural	Sth 310
NE	Lanlade	\$ 0.5M to \$ 1M	Unknown	Sth 312
NW	Lincoln	\$ 1M to \$ 2M	Urban	STH 441
SE	Manitowoc	\$ 2M to \$10M		TWN RD
SW	Marathon	\$10M to \$20M		USH 002
	Marquette	\$20M or more		Ush 002/053
	Menominee			USH 008
				USH 010

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Asph Surf = asphalt surface; Brg = bridge; CIR = circumference; Gen Const = general construction; Inc = incomplete; NC = north central; NE = northeast; NW = north west; SE = southeast; SHRM = State highway rehabilitation-maintenance; SW = south west; sth = State highway; TWN RD = town road; USH = U.S. Highway.

Figure 2. Chart. WisDOT's filters for obtaining historical data for similar projects.

Results

Mobilization Results	
Sample Size:	1,813
Expected Range (lower limit):	3.4%
Typical Middle Value:	5.9%
Expected Range (upper limit):	9.3%

Traffic Control Project Results		
Sample Size:	1,811	
Expected Range (lower limit):	0.2%	\$2,000
Typical Middle Value:	0.5%	\$5,242
Expected Range (upper limit):	1.3%	\$24,489

Average Number of Bidders	3.4
---------------------------	-----

Item Classification Totals		
Expected Range:	<div style="border: 1px solid black; padding: 2px;"> Lower Limit ^ Middle Value ▼ Upper Limit ▼ </div>	
Item Class	Middle Value	Item Class Code
SP Vs (Default)	4.3%	AAA
Asphalt	6.4%	ASPH
Base Aggregate	4.1%	BASE
Bridge Painting	0.0%	BRPT
Concrete Pavement	0.4%	CONC
Curb & Gutter, Sidewalk	0.1%	CURB
Drainage Culverts Conduits	1.0%	DRNG
Electrical	0.0%	ELEC
Erosion Control	2.1%	EROC
Earthwork	4.5%	ERTH
Gates and Fences	0.0%	FENC
Beamguard	0.0%	GDRL
Intelligent Transportation Systems	0.0%	ITS
Landscaping	0.2%	LSCP
Lighting	0.0%	LTNG
Miscellaneous or Specialty Work	1.4%	MISC
Mobilization	5.9%	MOBL
Pavement Marking	1.4%	PVMK
Removal Asphalt Pavement	0.4%	RMVA
Removal Old Structures	0.0%	RMVB
Removal Concrete Pavement	0.0%	RMVC
Removals	0.2%	RMVL
Signs	0.3%	SIGN
Structures	0.7%	STRC
Survey	0.4%	SURV
Traffic Control Permanent	0.0%	TRFP
Traffic Control Temporary	1.5%	TRFT

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 SP Vs = special provisions.

Figure 3. Screenshot. Sample data from historical data.

Practice C: Monitoring and Updating Cost Estimates

Project cost estimates must be kept current. After developing the initial cost estimate, most STAs use the following updates to ensure that the project cost estimates are current:

- Annual updates: Estimates should be updated once a year to reflect any changes in the quantities or scope of the estimate. Estimates should also be updated with current unit costs for the bid items included in the estimate.
- Programming cycle: Each programming cycle should require an updated estimate to be used as a benchmark for the next programming cycle.
- Significant changes in project costs: If a project has substantial changes in scope, size, risks, or other factors that might represent a significant change in the project cost, a new estimate should be prepared to accommodate said costs.
- PS&E expiration: Once a project reaches the final PS&E estimate, the costs must be updated every 3 mo to reflect current market conditions.

Knowing these updates are being performed would help conduct oversight of a cost estimation program.

Practice D: Identifying Factors that Influence Projects Cost

Cost oversight reviewers and estimators should keep in mind the factors that influence project cost. Following are some of the factors that must be considered when providing cost oversight or developing an estimate:

- Direct costs to the contractor:
 - Materials: Consumables that will become part of the project.
 - Labor: People in charge of executing the work.
 - Equipment: Tools and machines necessary to execute the work.
- Overhead and other indirect costs: Administration, management, and some major pieces of equipment used across multiple tasks (e.g., cranes).
- Profit: Margin gained by the contractor as a result of completing the project.
- Direct cost price trends: Behavior of market prices and their impact on materials and labor costs.
- Average prices from recent lettings: Prices of similar items in recent lettings. If recent prices have increased or decreased, new prices will likely behave similarly.
- Competition: Historical projects and literature show that competition influences project costs. Usually, the fewer bidders there are, the farther away from the EE the actual cost.

- Characteristics of the work that may impact the overall or unit costs:
 - Type: Whether it is paving, bridge construction, repairs, reconstruction, and so on.
 - Size: The dollar value associated with the project might impact the prices due to economies of scale.
 - Location: If the project is far from material or labor sources, the prices will likely increase as a consequence of hauling or labor per diem.
 - Project accessibility: Similar to location, long haul distances or road qualities affect project prices.
 - Staging area locations and their accessibility to the project's location: Same effects of location and accessibility.
 - Necessary restrictions (restricted work hours and/or tight time frames to complete the project): These restrictions affect the duration of projects. Additionally, nonordinary work shifts tend to be more expensive.
 - Special construction problems: Special problems require special solutions, which tend to be expensive.
 - Traffic: Traffic affects how the project can be conducted and poses additional safety risks.

- Specialized work: Nontraditional work that is not repetitive in nature tends to have different prices than linear work (e.g., paving project). Following is a list of specialized work:
 - Signs and traffic control devices.
 - Lighting, buildings, rest areas, and so on.
 - Landscaping.
 - Railroads.
 - Utilities.
 - Bridges, walls, and other structures.

Practice E: Analyzing Cost Estimates

Using a standardized process for analyzing cost estimates provides consistency across an agency. The following is a list of procedures and considerations for evaluating a cost estimate based on interviews and documents obtained from interviewees (Vermont Agency of Transportation (VTrans) 2018; VTrans 2019):

1. Project parameters.

As mentioned in the previous sections, it is important to identify the following characteristics before analyzing a cost estimate. These first steps ensure that the prices used for the cost estimate are as aligned with the reality of the project as possible.

- a. Identify work type.
- b. Identify highway type.
- c. Identify urban/rural type.
- d. Identify season.
- e. Identify county.
- f. Identify region.
- g. Identify terrain type.

2. Major cost deviations analysis for reasonableness and unbalancing.

- a. Items to be analyzed are selected. Using the Pareto principle, 20 percent of the items that comprise roughly 80 percent of the estimate are selected to be analyzed.

- i. The acceptable deviation, in dollars, for a single item is determined. Typically, the deviation is 1 percent of the contract total low bid or the total contract estimate (whichever is lower). This deviation is the maximum allowable for any particular item for the estimate being analyzed. In other words, no item should deviate more than 1 percent of the low bid or total contract amount.

- ii. The items where the actual difference of the extended low bid amount (quantity multiplied by unit price) is higher or lower than the extended estimate amount by more than the acceptable deviation as determined in a.i) are identified.

- iii. An acceptable level of cost variance is determined.

An acceptable level is considered to be 80 percent of the sum of the absolute value of the difference of the extended low bid amount minus the extended estimate amount for all pay items in the contract. Using the absolute values ensures that all variances will be analyzed whether high or low. This method provides a better analysis of projects with an overall low bid that is reasonably close to the estimate but with individual pay items with high variance between the extended low bid amount and the extended estimate amount.

- iv. The sum of the absolute value of the difference of the extended low bid amount compared to the extended estimate amount for the items identified in item a.ii is compared to the acceptable level of the cost variance as determined in a.iii to determine if a reasonable analysis level has been met.

If the sum of the absolute values of the difference of the extended low bid amount minus the extended estimate amount for the identified pay items is not greater than, or reasonably close to, the acceptable level of the cost variance, then the acceptable deviation from a.i is adjusted up or down to add to the identified item list until the acceptable level is met.

- b. A detailed analysis is performed on the selected items. The analysis can include quantity checks, estimated price checks, specifications review, bidder questioning, low bid relation to second and third bids, bid comparison to similar projects, and other methods. The intent is to determine the reasonableness of the bid and if it is unbalanced.

3. Unit price deviation analysis for unbalancing.

- a. Identify the items where the low bid unit price exceeds the estimated unit price. As a starting point, analyze items where the low bid unit price exceeds the estimated unit price by 25 percent or more.
- b. Identify the items where the low bid unit price is lower than the estimated unit price. As a starting point, analyze items where the low bid unit price is lower than 75 percent of the estimate.
- c. If an item has been analyzed as part of step 2 (major cost deviations analysis for reasonableness and unbalancing), no additional analysis is needed.
- d. If an item has not been analyzed as part of step 2, perform an estimate and quantity check to determine if unbalancing is present.
- e. Additional considerations may include the number of bidders, bids from second and third bidders, project urgency, and market conditions.

4. Competition analysis.

- a. Identify the EE.
- b. Identify the number of bidders.
- c. Identify the range of bids.
 - i. If the number of bids and corresponding bid amounts are classified as adequate competition per table 7, no further analysis is required for step 4.c.

Table 7. Competition analysis.

Number of Competitive Bids*	Competition May Be Considered Adequate When the Low Bid Does Not Exceed
5	120 percent of EE
4	115 percent of EE
3	110 percent of EE
2	105 percent of EE
1	EE

*Range = low bid + 20 percent.

- ii. If the number of bids and corresponding bid amounts fall outside of the classification of adequate competition per table 7, justification regarding why the contract should be executed is required and should consider the following:
 - 1. Safety of the traveling public.
 - 2. Emergency work and/or situations.
 - 3. Analysis of bid history on similar (scope and/or geography and/or cost) projects—identifying whether improved competition would be anticipated if the project were re-let.
5. Documentation of results and recommendations. Documentation of the analysis is in the form of a memo to contract administration.
- a. The documentation will include a narrative of general observations, the number of bidders, range of bids, acceptable deviation used, any findings from step 2 of the analysis, and a summary statement of what the analysis found.
 - b. The documentation will include a detailed narrative for each pay item analyzed in steps 2 and 3.
 - c. The documentation will include the results of the analysis in step 4.
 - d. The documentation will contain a recommendation for the award or rejection of the bid.

Second Round of Interviews

After conducting the first round of interviews and writing up the interim report, the research team met to review the report and evaluate the next steps. They decided to conduct a second round of interviews to evaluate the subject matter experts’ views on the identified best practices for cost estimate oversight, cost estimate oversight checklist, and process diagrams developed for cost estimate oversight at a project and program level. The followup interview document can be found in appendix E.

Responses for Identified Best Practices for Cost Estimate Oversight

The researchers asked the interviewees to rank their familiarity with each of the six practices described previously on a score from 1 to 10. The interviewees were also asked to provide a separate score for how useful they considered each practice to be. For both questions, 1 is the lowest, and 10 is the highest for their respective characteristics. The responses are summarized in table 8 through table 13.

Practice A: Applying the Pareto Principle

A project cost review can be governed by the principle that 80 percent of a project’s associated cost can be explained by 20 percent of the items.

Table 8. Responses for familiarity and usefulness of the Pareto principle.

State	Familiarity	Usefulness
A	1	6
B	1	1
C	10	10
D	10	1
E	10	7
F	10	10
G	10	10
H	1	6
Median score	10	6

Practice B: Comparing Historical Projects

This practice compares the proposed cost to historical costs of previous projects.

Table 9. Responses for familiarity and usefulness of historical project comparison.

State	Familiarity	Usefulness
A	10	10
B	10	10
C	10	10
D	10	1
E	1	10
F	10	5
G	10	10
H	5.5	1
Median score	10	10

Practice C: Monitoring and Updating Cost Estimates

This practice ensures the estimated project costs are kept updated and current throughout the project development process.

Table 10. Responses for familiarity and usefulness of monitoring and updating cost estimates.

State	Familiarity	Usefulness
A	1	1
B	9	8
C	10	10
D	1	1
E	1	1
F	10	7
G	10	10
H	10	10
Median score	9	8

Practice D: Identifying Factors that Influence Project Cost

Cost oversight reviewers and estimators should be familiar with how different project characteristics influence costs.

Table 11. Responses for familiarity and usefulness of knowledge of factors that influence projects cost.

State	Familiarity	Usefulness
A	6	6
B	10	8
C	1	1
D	10	10
E	1	10
F	10	10
G	3	10
H	6	10
Median score	6	10

Practice E: Analyzing Cost Estimate Procedures

This practice applies industry-recognized procedures to analyze a project estimate.

Table 12. Responses for familiarity and usefulness of procedures for analyzing a cost estimate.

State	Familiarity	Usefulness
A	1	10
B	8	6
C	3	10
D	10	4
E	1	7
F	1	1
G	1	1
H	1	1
Median score	1	7

Developing Estimate Oversight

This additional practice refers to how different DOs currently conduct the oversight process for STA programs and projects. On September 25, 2020, FHWA’s Office of Stewardship, Oversight, and Management issued the revised *FHWA Risk-based Project Involvement Guidance* (FHWA 2020). Although FHWA had been implementing risk-based stewardship and oversight procedures for several years, the revised guidance provides an updated process and procedures. The new guidance requires DOs to document their risk-based project oversight procedures in their stewardship agreements. FHWA DOs will continue to perform reviews of State department of transportation (DOT) programs on a risk basis. DOs will also use risk assessments to develop their oversight procedures for project activities. Thus, FHWA’s involvement in a State’s estimating program and project-specific estimates will be determined by the DO’s risk assessment procedures. Table 13 through table 15 summarize the interviewees’ responses regarding their familiarity and usefulness of estimate development oversight practices.

Table 13. Responses for familiarity and usefulness of estimate development oversight.

State	Familiarity	Usefulness
A	1	3
B	7	1
C	10	3
D	10	1
E	0	7
F	1	1
G	6	4
H	1	1
Median score:	4	2

Table 14. Rank of practices by perceived usefulness.

Practice	Usefulness
Knowledge of factors that most influence a project	1
Historical project comparison	2
Pareto principle	3
Monitoring and updating cost estimates	4
Procedures for analyzing cost estimates	5
Estimate development oversight	6

Table 15. Rank of practices by familiarity.

Practice	Familiarity
Historical project comparison	1
Pareto principle	2
Monitoring and updating cost estimates	3
Knowledge of factors that influence project cost	4
Estimate development oversight	5
Procedures for analyzing cost estimates	6

From the preceding tables, it is clear that knowledge of factors that influence project cost, Pareto principle, and historical project comparison are instrumental in providing a good level of oversight and usually are used in conjunction. For example, if a historical project comparison is being used to compare a cost estimate with a complete project, it is convenient to select the 20 percent of items that comprise roughly 80 percent of the estimate (Pareto principle). For this 20 percent of items, it is important to have knowledge of factors that influence project cost.

SUMMARY

Through a literature review and two rounds of interviews, five specific cost oversight practices were identified and defined. Interview participants were asked to rate each practice in terms of

their familiarity and usefulness in providing cost estimate oversight. These five practices, listed in order from their most to least useful, are as follows:

- Practice D: Identifying factors that influence project cost (knowing how different project characteristics influence project costs).
- Practice B: Comparing historical projects (comparing proposed cost to historical costs of previous projects).
- Practice A: Pareto principle (a project cost review governed by the principle that 80 percent of a project's associated cost can be explained by 20 percent of the items).
- Practice C: Monitoring and updating cost estimates (ensuring the estimated project costs are kept updated and current throughout the project development process).
- Practice E: Analyzing cost estimate procedures (applying industry-recognized procedures to analyze a project estimate).

CHAPTER 3. OVERSIGHT CHECKLISTS AND PROCESSES

To research team developed a series of process diagrams to help illustrate how the cost oversight practices fit into a cost estimation oversight program as well as the cost estimation oversight for a single project. The oversight provided by the FHWA Federal-aid DOs can be divided into two approaches, program-level oversight and project-level oversight. Additionally, FLH has a unique way of operating. FLH develops its own estimates and does not receive oversight from another agency. In this regard, the program-level oversight applies only to interactions between STAs and their respective DOs. Figure 4 through figure 6 depict each of these oversight scenarios.

OVERSIGHT CHECKLISTS

This section describes the research team’s process for finalizing the checklist compiled during the interim report review. This checklist was part of the followup interviews with DOs, STAs, and FLH. The interviewees were asked whether the items on the checklist were appropriate. During the process, several questions were identified as redundant or unnecessary. This process reduced the number of items on the checklist without sacrificing its exhaustive nature. This reduction kept the items to the minimum number necessary to avoid overcomplicating the checklist while including critical aspects of a cost estimate oversight.

The researchers asked the interviewees whether each item was worth keeping (“keep”) or not (“drop”). The team removed any item at or below a 50-percent keep rate. Table 16 through table 21 include the results from the interviews. The final checklists can be found in the next section.

Table 16. Oversight checklist keep percentage—guidance items.

Guidance Items	Keep (percent)
Has the purpose of the estimate been defined?	63
Has the estimating method been identified?	75
Is the estimating method available for review?	75
Is the estimate written down and available?	100
Have allowances and factors been validated and are appropriate for the level of the estimate?	88
Is the oversight team knowledgeable about the estimating method used?	75
Has the estimate been prepared using a typical cost model (e.g., bid item codes)?	63
Has the basis of the estimate been completed/updated with an explanation of changes?	88
Is a basis of estimate document available?	75
Has the estimate been independently validated?	100
Have all spreadsheet formulas been reviewed and totals been cross checked?	50

Note: These items are used to inquire about general aspects of a cost estimate. They are related to the general purpose of the estimate and not to specific items of an estimate.

Table 17. Oversight checklist keep percentage—uncertainty items.

Uncertainty Items	Yes (percent)
Was a risk assessment conducted to identify, analyze, and evaluate risks?	88
Is the estimate adjusted for inflation to year-of-expenditure dollars for each element of the project?	63
Is project complexity considered in the estimate?	88
Does the process include risk-based assessments of unknown and all uncertain costs?	88
Are risk contingencies sufficiently removed from unit bid item prices in the base cost estimate?	88

Note: These items refer to the unknowns (known unknowns and unknown unknowns) of the estimate and their respective assessments.

Table 18. Oversight checklist keep percentage—construction items.

Construction Items	Yes (percent)
Are the estimate of unit prices reasonable for the areas, times, and characteristics of the work to be done?	100
Have incentive/disincentive or escalation clauses been considered in determining the estimated unit costs?	75
Have all costs and durations been checked for conformity between amounts of work (item quantities) with the schedule durations to determine correctness?	100
Is the estimate consistent with the project scope?	88
Does the estimate include all initial preliminary engineering costs and final design costs?	38
Does the estimate include construction administration?	50
Are the unit costs of the estimate aligned with the costs used by the agency?	50
Is a haul road restoration item provided?	50

Note: These items are associated with the quantities and elements related to the physical execution of the projects.

Table 19. Oversight checklist keep percentage—finance items.

Finance Items	Yes (percent)
Is force account work adequately justified?	63
Is salvage credit shown (if applicable)?	63
Does the estimate include a management reserve? Is this value sufficient for the project?	50
Does the estimate include a public outreach cost?	38
Are market conditions being taken into consideration?	88

Table 20. Oversight checklist keep percentage—nonconstruction items.

Nonconstruction Items	Yes (percent)
Are utility and railroad force account work covered?	75
Does the estimate include all right-of-way (ROW) and administrative costs?	75
Does the estimate include all transportation system management/transportation demand management costs?	75
Is nonparticipating work shown?	88

Note: These items are not part of the physical execution of the project but should be considered part of the estimates.

Table 21. Oversight checklist keep percentage—regulation items.

Regulation Items—Analyzing Bids	Yes (percent)
Is the estimate materially balanced?	88
Is the estimate mathematically balanced?	88
Is a noncollusion statement included?	88

Note: These items refer to the general quality and adherence to regulations of the estimate (letting).

For the questions related to risk-based oversight (table 22), the consensus was that these items were relevant for projects that the DOs deem appropriate to oversee based on risk factors. However, the perception varies from State to State, primarily because of the size of each program. The FHWA guidelines define large projects as those with an EE of \$500 million or more (FHWA 2020). However, the DOs of several smaller States said that, for them, high-risk projects are those of \$10 million or more, and one of those States has not had a project exceeding \$60 million. Additionally, the DOs highlighted that a project needing oversight was not necessarily a large project; States are more interested in the public impact of the project, the project visibility, and the risks involved.

Along with the information provided previously, it is imperative for each State to have clear specifications of what makes a project worthy of oversight.

Table 22. Oversight checklist keep percentage—risk items.

For Risk-Based Estimates	Yes (percent)
Is the risk assessment process documented and available?	100
If a consultant produced the risk assessment, what process is the consultant following, and are they willing to share the model they used to produce the final results?	100
Did the State hold a risk workshop to provide input to the final results? If so, is a risk workshop final report available?	88
What is the date on the risk workshop report compared to the date when the estimate was last updated?	88
Did the staff responsible for developing the risk registry have the right level of subject matter experts attending to develop a robust risk register? If so, were subject matter experts in attendance representing design, ROW, roadway, structure, environment, permitting, utilities, lighting, etc.?	75
Did the staff responsible for developing the risk registry identify minor risks or significant risks to project cost and schedule?	100
What risks were identified as most significant in terms of driving cost and schedule completion?	100
Is a project risk tornado diagram available?	75
Were the risks in the risk register ranked?	100
Did the staff responsible for developing the risk registry use the risk expected value cost impact, schedule impact, etc.?	88
If risks are ranked by expected value, how are low-probability, high-impact risk events addressed?	88
How were the project budget and completion date determined from the probability cost and schedule forecast curves?	88
Does the State have a reliability level to establish budget and schedule completion? How was this level determined?	88
For the risk workshop forecast curves, are the curves wide or narrow?	75
How does the State account for market conditions in the risk assessment model?	100

Note: These items are relevant for projects not developed using conventional estimating methods and involving high risks.

FINAL CHECKLIST

After going through the second round of interviews and receiving input from the subject matter experts, the research team compiled the most relevant questions into a checklist with a manageable number of items. The final checklist, with differentiation between the different categories that resulted from the development process, is shown in table 23 through table 29.

Table 23. Final oversight checklist—guidance items.

Guidance Items	Yes	No	N/A
Has the purpose of the estimate been defined?	—	—	—
Has the estimating method been identified?	—	—	—
Is the estimating method available for review?	—	—	—
Is the estimate written down and available?	—	—	—
Have allowances and factors been validated and are appropriate for the estimate level?	—	—	—
Is the oversight team knowledgeable about the estimating method used?	—	—	—
Was the estimate prepared using a typical cost model (e.g., bid item codes)?	—	—	—
Has the basis of estimate been completed/updated with an explanation of changes?	—	—	—
Is a basis of estimate document available?	—	—	—
Has the estimate been independently validated?	—	—	—

—No data.

Note: These items are used to inquire about general aspects of a cost estimate. They are related to the general purpose of the estimate and not to specific items in an estimate.

Table 24. Final oversight checklist—uncertainty items.

Uncertainty Items	Yes	No	N/A
Was a risk assessment conducted to identify, analyze, and evaluate risks?	—	—	—
Is the estimate adjusted for inflation to the year of expenditure dollars for each element of the project?	—	—	—
Is project complexity considered in the estimate?	—	—	—
Does the process include risk-based assessments of all unknown and uncertain costs?	—	—	—
Are risk contingencies sufficiently removed from unit bid item prices in the base cost estimate?	—	—	—

—No data.

Note: These items refer to the unknowns (known unknowns and unknown unknowns) of the estimate and their respective assessments.

Table 25. Final oversight checklist—construction items.

Construction Items	Yes	No	N/A
Are unit price estimates reasonable for the areas, times, and characteristics of the work to be done?	—	—	—
Have incentive/disincentive or escalation clauses been considered in determining the estimated unit costs?	—	—	—
Have all costs and durations been checked for conformity between amounts of work (item quantities) with the schedule durations to determine correctness?	—	—	—
Is the estimate consistent with the project scope?	—	—	—

—No data.

Note: These items are associated with the quantities and elements related to the physical execution of the projects.

Table 26. Final oversight checklist—finance items.

Finance Items	Yes	No	N/A
Is force account work adequately justified?	—	—	—
Is salvage credit shown (if applicable)?	—	—	—
Are market conditions being taken into consideration?	—	—	—

—No data.

Table 27. Final oversight checklist—nonconstruction items.

Nonconstruction Items	Yes	No	N/A
Are utility and railroad force account work covered?	—	—	—
Does the estimate include all ROW and administrative costs?	—	—	—
Does the estimate include all transportation system management/transportation demand management costs?	—	—	—
Is nonparticipating work shown?	—	—	—

—No data.

Note: These items are not part of the physical execution of the project but should be considered part of the estimates.

Table 28. Oversight checklist—regulation items.

Regulation Items—Analyzing Bids	Yes	No	N/A
Is the estimate materially balanced?	—	—	—
Is the estimate mathematically balanced?	—	—	—
Is a noncollusion statement included?	—	—	—

—No data.

Note: These items refer to the general quality and adherence to regulations of the estimate (letting).

Table 28 is only for projects meeting at least one of the following criteria:

- Large project per State standards.
- High-visibility project.
- High-risk project.

A large project, per State standards, is a project whose size represents a significant portion of the State program’s budget. There should not be a dollar value attached to this definition because a small project for a large program could represent almost the entire annual budget for a small program. For example, the annual budget for some States does not exceed \$500 million for the whole program. Rather, a relative number is necessary to meet each specific agency’s “large project” oversight threshold.

Table 29. Final oversight checklist—risk items.

For Risk-Based Estimates	Yes	No	N/A
Is the risk assessment process documented and available?	—	—	—
If a consultant produced the risk assessment, what process is the consultant following, and are they willing to share the model they used to produce the final results?	—	—	—
Did the State hold a risk workshop to provide input on the results? If so, is a risk workshop final report available?	—	—	—
What is the date on the risk workshop report compared to the date the estimate was last updated?	—	—	—
Did the staff responsible for developing the risk registry have the right level of subject matter experts attending to develop a robust risk register? If so, were subject matter experts in attendance representing design, ROW, roadway, structure, environment, permitting, utilities, lighting, etc.?	—	—	—
Did the staff responsible for developing the risk registry identify minor or significant risks to project cost and schedule?	—	—	—
What risks were identified as most significant in terms of driving cost and schedule completion?	—	—	—
Is a project risk tornado diagram available?	—	—	—
Were the risks in the risk register ranked?	—	—	—
Did the staff responsible for developing the risk registry use the risk expected value cost impact, schedule impact, etc.?	—	—	—
If risks are ranked by expected value, how are low-probability, high-impact risk events addressed?	—	—	—
How were the project budget and completion date determined from the probability cost and schedule forecast curves?	—	—	—
Does the State have a reliability level to establish a budget and schedule completion? How was this level determined?	—	—	—
For the risk workshop forecast curves, are the curves wide or narrow?	—	—	—
How does the State account for market conditions in the risk assessment model?	—	—	—

—No data.

Note: These items are relevant for projects not developed using conventional estimating methods and involving high risks.

COST OVERSIGHT PROCESSES

The oversight provided by the FHWA Federal-aid DOs can be divided into two approaches: program-level oversight and project-level oversight. FLH has a unique way of operating because they develop their own estimates but do not receive oversight from another agency. In this regard, the program-level oversight applies only to interactions between STAs and their respective DOs. The researchers developed a series of oversight process diagrams to help illustrate how the cost oversight practices and checklists can be used in a cost estimation oversight program as well as a single project. The following diagrams depict each of the scenarios described previously.

Project-Level Oversight Process

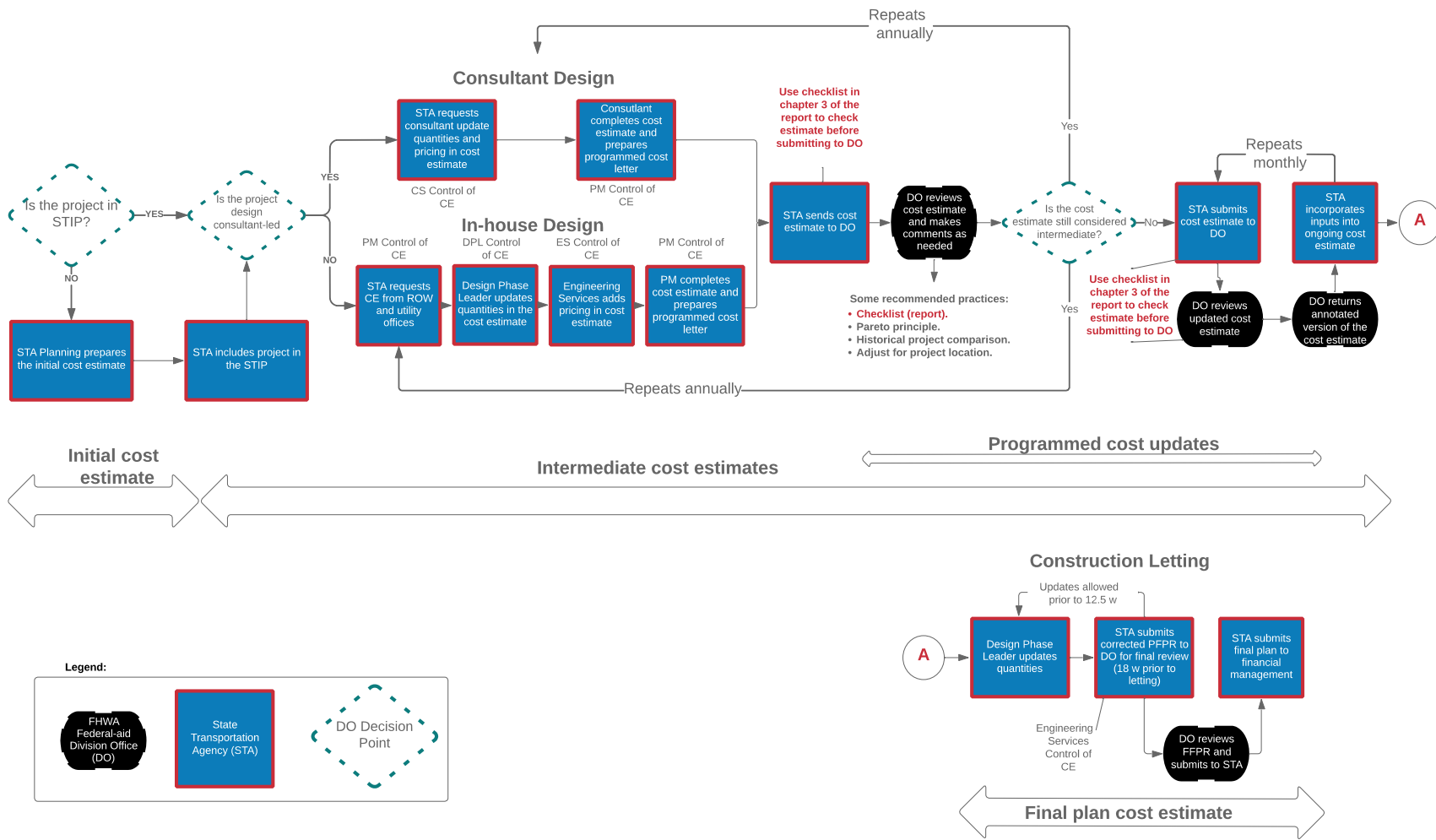
There are different perspectives to consider for the project-level oversight process. Since the STAs and DOs use different internal processes, the research team created different diagrams for the same process as viewed by STAs and DOs. Additionally, since FLH operates as a hybrid between STAs and DOs by creating their own estimates but only receives internal oversight instead of oversight from a DO, there is also a diagram that describes the FLH process.

Overall, the process has to meet several milestones regardless of which perspective is considered. These milestones are described as follows:

1. The initial cost estimate should reflect anticipated preliminary engineering, reimbursable utility, right-of-way (ROW), construction, and other costs.
2. The initial cost estimate approval must be followed by the project manager (PM) requesting estimates from the ROW and utilities offices.
3. The preliminary field plan review must include all updated cost estimates, including ROW and utilities, and design phase leader approval (Georgia DOT 2012, 2013, 2020).

Project-Level Oversight Process—STA and DO Perspectives

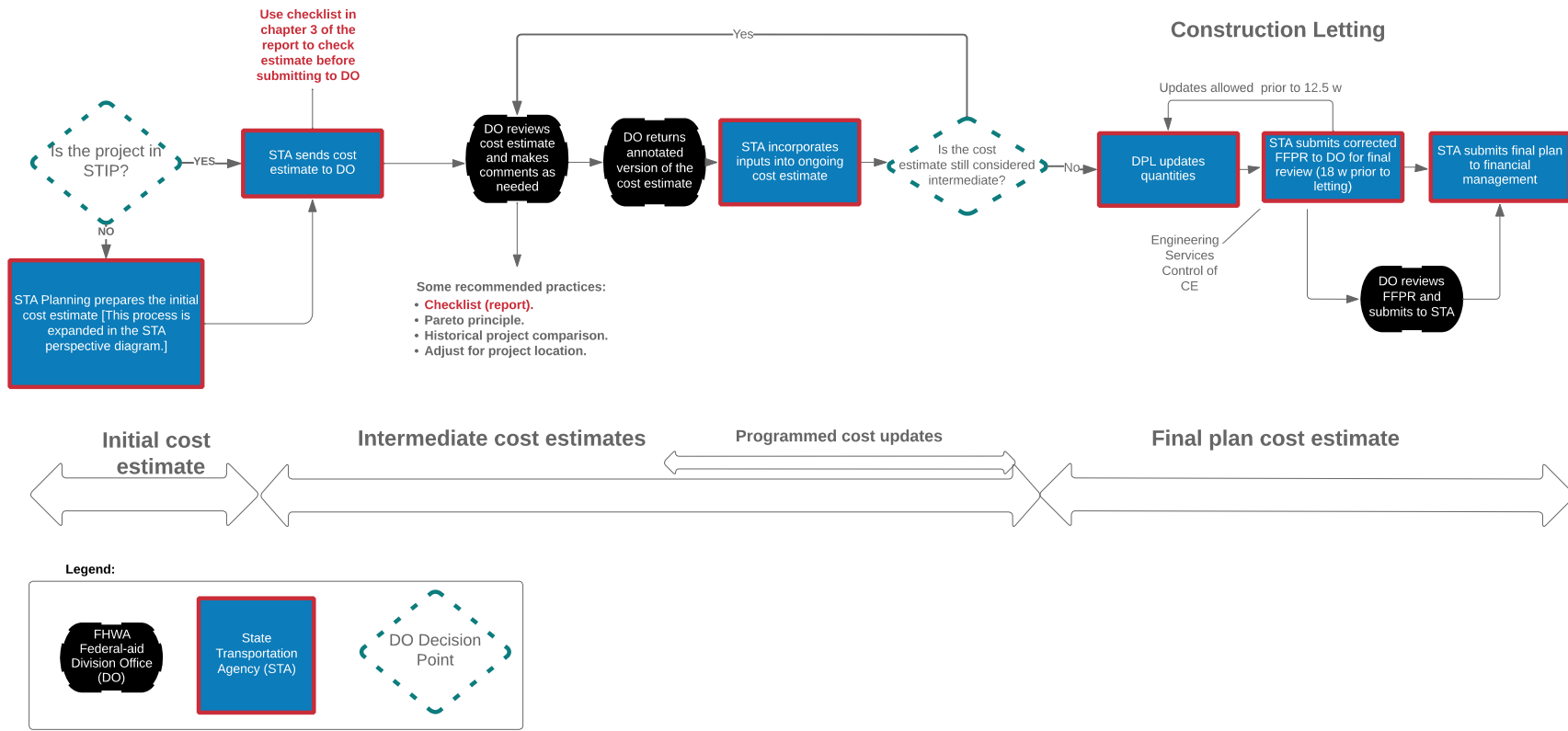
The diagrams in figure 4 and figure 5 show the project-level oversight process from an STA perspective and the DO perspective, respectively. The STA perspective diagram depicts the interfacing between FHWA Federal-aid DOs and STAs for project-related activities selected by the DO risk assessment. The described process only happens for projects in which the DOs provide oversight. Usually, these projects are considered major projects (FHWA 2018). The DO perspective diagram shows what would interest someone from a DO providing oversight to an STA. These and the other cost oversight diagrams were presented in an FHWA national webinar, which is available online at <https://connectdot.connectsolutions.com/pyif2h64b2ei/> (Nevett, Goodrum, and Corrigan 2022).



Source: FHWA.

CE = construction cost estimate; CS = consultant; DPL = design phase leader; ES = STA office of engineering services; FFPR = final field plan review.

Figure 4. Flowchart. Project-level oversight process—STA perspective (Nevett, Goodrum, and Corrigan 2022).



Source: FHWA.

Note: The STA should prepare an initial cost estimate prior to adding the project to the STIP.

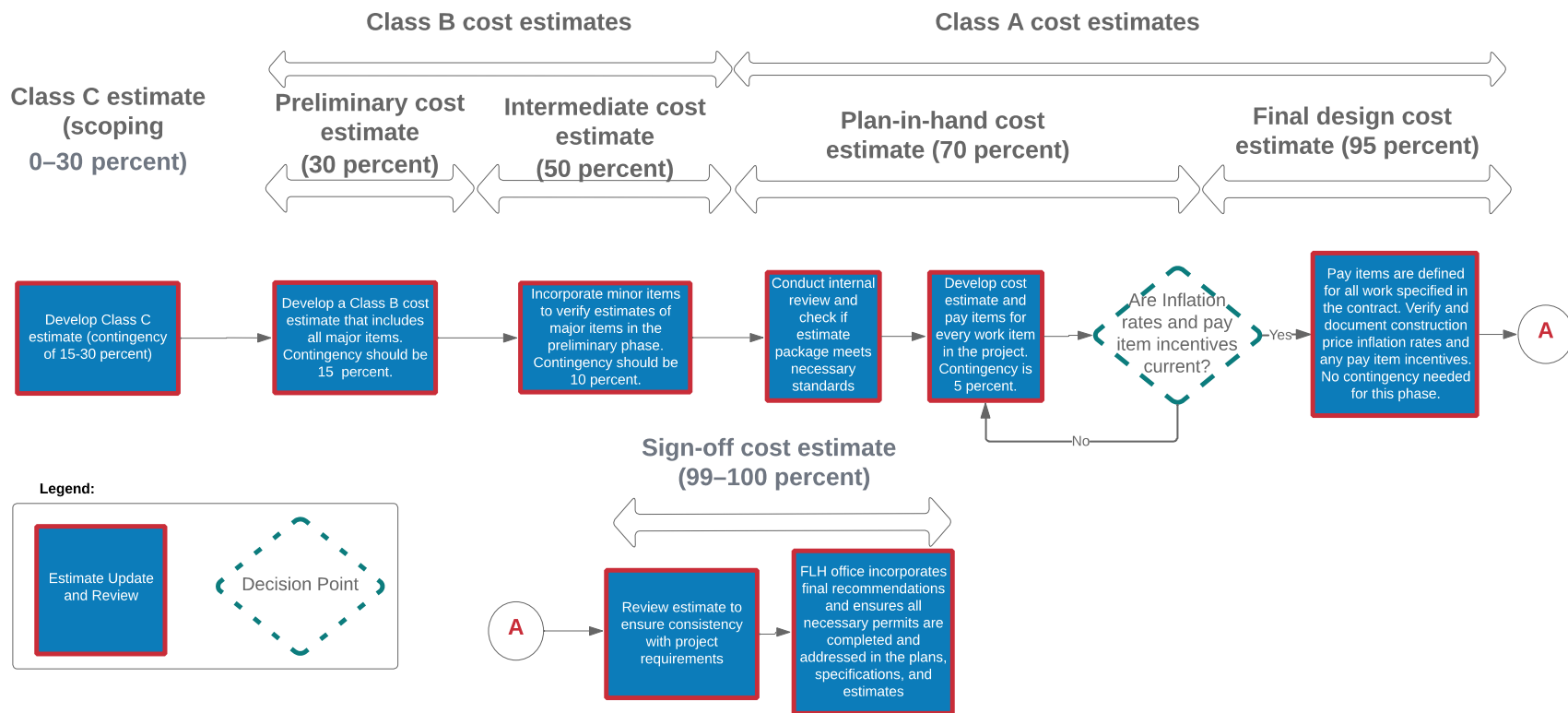
Figure 5. Flowchart. Project-level oversight process—DO perspective (Nevett, Goodrum, and Corrigan 2022).

Project-Level Oversight Process—FLH Perspective

Figure 6 represents the internal oversight process that an FLH project goes through in its lifecycle to improve the accuracy of the cost estimate. Because FLH does not receive oversight from other agencies, all the interfacing described happens internally. Otherwise, the process is similar to that of STAs.

In general, there are six major milestones in the FLH oversight process:

1. Scoping cost estimate (0–30 percent): A Class C cost estimate is conducted.
2. Preliminary cost estimate (30 percent): The initial estimate should reflect anticipated preliminary engineering, reimbursable utility, ROW, construction, and other costs.
3. Intermediate cost estimate (50 percent): This milestone is not used in eastern Federal lands. For this milestone, minor items are included to verify the major items in the preliminary cost estimate.
4. Plan-in-hand cost estimate (70 percent): Pay items for every work item in the project are developed.
5. Final design cost estimate (95 percent): The PS&E must include all updated cost estimates, including ROW, utilities, and design phase leader approval. The chief engineer revises this estimate and approves it for submission. Pay items are defined for all work specified in the contract.
6. Sign-off cost estimate: The FLH office incorporates final recommendations and ensures all necessary permits are completed and addressed in the PS&E.



Source: FHWA.

Figure 6. Flowchart. Project-level oversight process—FLH perspective (Nevett, Goodrum, and Corrigan 2022).

CHAPTER 4. CONCLUSION

The overall intention of the research was to analyze the benefits, complexities, similarities, and differences in the roles FHWA provides for cost estimate reviews. The researchers successfully identified and ranked a series of five practices used to oversee the cost estimation process. The researchers developed and validated a set of tools, including an oversight checklist and multiple process diagrams. These tools are useful for providing oversight for a single project cost estimate. However, the researchers went further and used the research project to integrate the tools into a comprehensive cost estimation oversight program to maximize their benefits.

APPENDIX A—FIRST-ROUND INTERVIEW STRUCTURED INTERVIEW DOCUMENT—STA

INTRODUCTION

[Provide an overview of the project for the benefit of the respondent.]

PROJECT’S PRIMARY OBJECTIVES

This task order’s primary objective was to identify what, when, why, and how FHWA and the STAs develop costs estimations. FHWA will use this information to provide more consistent oversight of project cost estimates by STAs. For this research, FLH includes projects on Federal lands managed by the U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. National Park Service, and the U.S. Forest Service.

PROJECT’S SECONDARY OBJECTIVES

The project’s secondary objectives were as follows:

- Identify what type of projects these agencies provide cost estimates for, including types of projects defined by function (e.g., roadway and bridge), size, and complexity.
- Identify when the agencies develop project cost estimates, including by which phase of a project and the frequency with which a project cost estimate is updated.
- Identify why the agencies develop project cost estimates, including factors relating to risk and location that may trigger FHWA to develop a project cost estimate.
- Identify how the agencies develop project cost estimates. Do aspects related to what, when, and why influence when the historical bid-based model, the cost-based model, the risk-based estimation model, or the parametric time estimation model are used to develop a project cost estimation model?

IDENTIFICATION

The interviewer asked the interviewee for the following information:

1. What is your name? [This is a confidential interview, only the data analyst will read this answer.]
2. What is the name of your agency?
3. What is your job title and role in the agency?
4. How many overall years of experience do you have?
5. How many years of experience do you have with the agency?
6. How many years of experience do you have in your current position?
7. How many years of estimating experience do you have?
8. Do you develop your own cost estimates?
9. Do you provide oversight on cost estimates developed by other agencies (e.g., consultants)?

APPROACHES USED IN COST ESTIMATES

On a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar (table 30), please indicate your level of familiarity with each of the following cost estimation methods.

Table 30. Scale from 1–10.

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

Historical bid-based method.

Using the historical bid-based approach, FHWA and STAs usually use a bid-history database to estimate unit bid costs for major items. Based on the historical averages, FHWA can use the estimated quantities of a proposed project to develop a target price. This approach's accuracy depends on the quantity and level of detail of the bid-history database.

10. Cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs. The method also involves adding a reasonable amount for a contractor's overhead and profit. The process mimics the same method that a contractor uses for preparing a bid-day estimate. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

11. Conceptual estimation.

Typically performed during the early planning and scope development stage, conceptual cost estimates usually use primary project parameters (e.g., project location, length, type of project, scope details, design parameters, site characteristics, and broad design assumption) to develop a cost estimate.

12. Risk-based estimation.

Risk-based estimation involves developing probabilistic costs for a project and its components based on identified known quantities, costs, and contingencies developed from a list of identified uncertainties from both opportunities and threats and their potential impact on the project.

13. Combination of historical and cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs based on historical bid items of past projects. The method also involves adding a reasonable amount for a contractor's overhead and profit. The process involves developing cost estimates for each project (like the cost-based method), but it uses a bid-history database instead of cost estimates from material suppliers and historical production rates, which are typically used in a cost-based method. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

14. Other practice.

[Insert answer]

EFFICACY

On a scale from 1 to 10, where 1 is strongly disagree, 10 is strongly agree, and N/A is not applicable (table 31), please answer the following statements:

Table 31. Scale from 1–10.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

1. I feel confident about the cost estimates developed by this agency.
2. I feel confident about the methods used to estimate cost.
3. The cost estimates developed here are always on target.
4. I feel confident about the oversight provided by the FHWA DOs for cost estimation.
5. The FHWA DOs provide good support on cost estimation.
6. The FHWA DOs are knowledgeable about the cost estimation procedures used in this agency.
7. The performance measures developed by FHWA (e.g., comparison of the EE with the low bid) are aligned with the performance measures developed by this agency.
8. The FHWA DOs stay updated about the current practices used for cost estimation.

CHALLENGES

1. What are the biggest challenges encountered when developing a cost estimate?
2. What are the biggest challenges when working with FHWA on cost estimation?
3. Does the State have an estimating section? Which other portions of the agency become involved in preparing, checking, or approving the cost estimates?

On a scale of 1 to 10, where 1 is the lowest, 10 is the highest, and N/A is not applicable (table 32), please rate the following aspects of the cost estimates developed in-house:

Table 32. Scale from 1–10.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

4. Accuracy.
5. Effort required to develop the estimate (1 indicates low effort and 10 extremely high effort).
6. Reliability (1 indicates extremely unreliable and 10 extremely reliable).
7. Experience required to develop the estimates (number of years of experience required).
8. Technology available to develop the estimates (1 indicates all manual and 10 highly automated).

COST PERFORMANCE MEASURES

1. During your oversight of other agencies’ cost estimating programs, do you use any of the following performance measures?
 - a. STIP cost estimating performance measures (yes or no).
 - i. Initial STIP cost estimate versus 60 percent design cost estimate. (The initial STIP cost estimate comes approximately 4 yr from the letting of the project. During the 4 yr, additional design is completed, and a new estimate is created. These two estimates are then compared to find their percent difference.)
 - ii. Final STIP cost estimate versus low bid. (The final STIP cost estimate occurs when more design and scope are known but before the final EE. This estimate is compared to low bid amounts to find a percent difference.)
 - iii. Initial STIP cost estimate versus final STIP cost estimate. (This measure compares the initial STIP estimate to the final STIP estimate to find the percent difference.)
 - iv. Other?
 - b. PS&E performance measures (yes or no).
 - i. PS&E estimate versus low bid.
 - ii. Low bid to be within +/-10 percent of the PS&E estimate for 50 percent of all projects let.
 - iii. Low bid to be within +/-7 percent of the PS&E estimate for 50 percent of all projects let.

- iv. Low bid to be within –15 percent to +5 percent of the PS&E estimate for 50 percent of all projects let.
- v. Within –25 percent/+10 percent, or –25 percent/+15 percent if it's a smaller proposal.
- vi. PS&E estimate versus final construction costs. (This measure compares the final engineer's PS&E estimate to the final construction costs when the project is complete.)
- vii. PS&E estimate versus STIP estimate. (This measure compares the STIP program estimate to the PS&E estimate.) Competition measures (yes or no).
 - i. Number of bidders and mean unit prices. (This measure examines the number of bidders per project and the associated mean unit prices.)
 - ii. Average number of bidders (This measure examines the number of bidders on average for all projects in a specific period.)
 - iii. Average number of bidders by size of contract. (This measure examines the number of bidders based on the contract amount. It could also be refined to types of work.)
 - iv. PS&E versus the low bid, segregated by the number of bidders. (This measure compares the PS&E to the project's low bid in the case of one, two, three, four, or more bidders.)

COST ESTIMATE DEVELOPMENT

1. How often are the developed project estimates updated?
2. How many times does an estimate have to be prepared for each project?
3. How far in advance of the letting date is the EE prepared?
4. Briefly describe the personnel resources available within your agency for preparing estimates, and note any workload changes versus personnel available over the past 3 yr.
5. What methods does your agency use to identify and incorporate anticipated changes in the cost of labor, equipment, and material?
6. How does your agency keep track of inflation or cost indices? Does the agency have in-house developed indices?
7. Does your agency consider upcoming labor negotiations in the process?
8. Does your agency contact material suppliers for anticipated material costs?
9. Does your agency make adjustments for individual project conditions? In what way?

10. What other factors does your agency use to adjust the primary basis to determine the estimated prices for the project?
11. How often does your agency revise the estimate during the advertising period? Discounting addenda and quantity changes, what are the usual reasons for revising estimated prices?
12. Is every estimate in your agency routinely evaluated by anyone other than the preparer? If so, when?
13. If possible, describe how often further study and/or revision is desirable but not accomplished due to workload restrictions.
14. What approaches does your agency use for project contingency?
15. What approaches does your agency use for risk?
16. Do you use any formally documented estimating guidance procedures (e.g., checklists)?
17. If so, how often are they updated, or when were they last updated?

ESTIMATE OVERSIGHT

1. Table 33 is a typical checklist for conducting a cost estimate review. Which of the following factors do you check when conducting a review?

Table 33. Cost estimate oversight checklist.

Yes	Factor
—	Estimate is escalated to year of expenditure dollars for each element of the project.
—	Process includes risk-based assessments of all unknown and uncertain costs.
—	Estimate is well documented.
—	Estimate has been prepared using a typical cost model (e.g., code of accounts).
—	Estimate has been independently validated.
—	Estimate is consistent with the project scope.
—	Estimate includes all initial preliminary engineering costs and final design costs.
—	Estimate includes all ROW and administrative costs.
—	Estimate includes all third-party (e.g., utility, railroad) costs.
—	Estimate includes all TDM/TSM costs.
—	Estimate includes all construction costs.
—	Estimate includes construction contingencies.
—	Estimate includes construction administration.
—	Estimate includes public outreach cost.
—	Estimate includes a management reserve.
—	For planning or conceptual estimates, consideration was given to expressing the estimate as a range.
—	For projects under design, estimates include a design contingency at each stage of design.
—	The unit costs are aligned with the costs used by the agency.

—Empty cell for the respondent to check.

TDM/TSM = Transportation Demand Management/Transportation System Management.

2. Are there other factors not listed that you typically check when conducting a review?

In addition to the factors listed in the table, there are a number of cost estimating practices an agency may use to develop accurate estimates.

POST-BID PRACTICES

1. Are there any State laws or regulations in effect regarding the release or protection of the EE?
2. Are there any State laws or administrative regulations in effect to determine whether a contract award is proper, based on estimate overrun, competition, or other factors?
3. Is any information released publicly that may indicate the actual or approximate value of the estimate prior to opening bids? If so, when and where is it published?
4. Is the EE published in detail, or is only the total cost provided?

5. In the case of poor competition or excessive difference between the estimate and the low bid or best value, does the contracting agency contact the bidders and nonbidders who examined proposal forms?
6. Are there any “ground rules” for adjusting estimates after receiving bids? Is such action taken on its own merits, or may it be prompted by pressure to award an excessive bid?

WRAP-UP

Does your agency have any documentation that you follow to develop and/or provide oversight on cost estimates that you can share?

APPENDIX B—FIRST-ROUND INTERVIEW—STAS RESPONSES COMPILED

Note that the responses throughout appendix B and appendix D are listed in the order the interviews were conducted.

IDENTIFICATION

[Provide an overview of the project for the benefit of the respondent.]

1. Overall years of experience:

- A-STA—25+.
- B-STA—25.
- D-STA—35.
- C-STA—35+.
- E-STA—10.
- F-STA—11.

2. Years of experience with the agency:

- A-STA—9+.
- D-STA—29.
- B-STA—6.
- C-STA—35+.
- E-STA—4.5.
- F-STA—11.

3. Years of experience in your current position:

- A-STA—1.
- B-STA—5.
- D-STA—19.
- C-STA—9.
- E-STA—4.5.
- F-STA—2.

4. Years of experience in estimating:

- A-STA—Most of past years 1+.
- B-STA—10.
- D-STA—19.
- C-STA—17.
- E-STA—4.5.
- F-STA—6.

5. Do you develop your own cost estimates?

- A-STA—Yes.
- B-STA—“Yes. The official estimate is B-STA’s responsibility.”
- D-STA—Yes.
- C-STA—“Yes (DBB are all in-house, CM/GC, consultants).”
- E-STA—“Depends on who the designer is. Yes.”
- F-STA—Yes.

6. Do you provide oversight on cost estimates developed by other agencies (e.g., consultants)?

- A-STA—“Some estimates are developed by consultants, but A-STA is responsible for the final estimate.”
- B-STA—“Some districts fully rely on consultants up until the very end.”
- D-STA—Yes.
- C-STA—Yes.
- E-STA—Yes.
- F-STA—“Yes. Specs but not estimate.”

APPROACHES USED IN COST ESTIMATES

On a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of familiarity with each of the following cost estimation methods (table 34 through table 39).

1. Historical bid-based method.

Using the historical bid-based approach, FHWA and STAs usually use a bid-history database to estimate unit bid costs for major items. Based on the historical averages, FHWA can use the estimated quantities of a proposed project to develop a target price. Much of the accuracy of this approach is based on the quantity and level of detail of the bid-history database.

Table 34. Historical bid-based method.

Agency	Raw Score	Normalized Score
A-STA	10	10.0
B-STA	9	10.0
C-STA	9	10.0
D-STA	10	10.0
E-STA	10	10.0
F-STA	9.5	9.4

2. Cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs. This method also involves adding a reasonable amount for a contractor’s overhead and profit. The process mimics

the method that a contractor uses to prepare a bid-day estimate. When prepared with the proper skill, experience, and effort, cost-based estimates are usually the most accurate of the five methods.

Table 35. Cost-based method.

Agency	Raw Score	Normalized Score
A-STA	5	1.0
B-STA	7	7.4
C-STA	9	10.0
D-STA	8	6.7
E-STA	3	3.0
F-STA	4.5	2.9

3. Conceptual estimation.

Typically performed during the early planning and scope development, conceptual cost estimates usually use primary project parameters (e.g., project location, length, type of project, scope details, design parameters, site characteristics, and broad design assumption) to develop a cost estimate.

Table 36. Conceptual estimation.

Agency	Raw Score	Normalized Score
A-STA	7.5	5.5
B-STA	9	10.0
C-STA	8.5	9.2
D-STA	9	8.4
E-STA	8	8.0
F-STA	9	8.7

4. Risk-based estimation.

This method involves developing probabilistic costs for the project and its components based on identified known quantities, costs, and contingencies developed from a list of identified uncertainties from both opportunities and threats and their potential impact on the project.

Table 37. Risk-based estimation.

Agency	Raw Score	Normalized Score
A-STA	5	1.0
B-STA	7	7.4
C-STA*	7.5	7.5
D-STA	5	1.8
E-STA	2	2.0
F-STA	8	7.4

*C-STA—“We have a risk registry for all the projects. We find the probability and the cost so that we can set aside the contingency.”

5. Combination of historical and cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs, based on historical bid items of past projects. The method also involves adding a reasonable amount for a contractor’s overhead and profit. The process involves developing cost estimates for each project (like the cost-based method), but it utilizes a bid-history database instead of cost estimates from material suppliers and historical production rates that are typically used in a cost-based method. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

Table 38. Combination of historical and cost-based method.

Agency	Raw Score	Normalized Score
A-STA	9.5	9.1
B-STA	8	8.7
C-STA *	9	10.0
D-STA	8	6.7
E-STA	3	3.0
F-STA	6	4.9

*C-STA—“We mostly do this.”

6. Other practice.

A-STA is starting to use @Risk™ to develop estimates using Monte Carlo simulations for each item and a range of the final cost (Palisade n.d.).

Table 39. Other practice.

Agency	Raw Score	Normalized Score
A-STA	5	1.0
B-STA	—	—
C-STA	—	—
D-STA	—	—
E-STA	—	—
F-STA	—	—

—No data.

EFFICACY

On a scale from 1 to 10, where 1 is strongly disagree and 10 is strongly agree, please answer the following statements:

1. I feel confident about the cost estimates developed by this agency (table 40).

Table 40. Confidence in cost estimates agency develops.

Agency	Raw Score	Normalized Score
A-STA	6.5	3.7
B-STA	8	8.7
C-STA*	6	5.1
D-STA	8	6.7
E-STA	3	3.0
F-STA	8	7.4

*C-STA—“As a benchmark, I feel confident.”

2. I feel confident about the methods used to estimate cost table 41).

Table 41. Confidence in cost estimate methods used.

Agency	Raw Score	Normalized Score
A-STA	6	2.8
B-STA	7	7.4
C-STA	9	10.0
D-STA	9	8.4
E-STA	6	6.0
F-STA	7	6.1

3. The cost estimates developed here are always on target (table 42).

Table 42. Developed cost estimates are on target.

Agency	Raw Score	Normalized Score
A-STA*	7	4.6
B-STA	7	7.4
C-STA	6	5.1
D-STA	5	1.8
E-STA	5	5.0
F-STA	5	3.6

*A-STA—“Seven, provided we have enough bidders.”

4. I feel confident about the oversight provided by the FHWA DOs for cost estimation (table 43).

Table 43. Confidence in DO cost estimate oversight.

Agency	Raw Score	Normalized Score
A-STA*	5	1.0
B-STA**	9	10.0
C-STA†	N/A	—
D-STA	9	8.4
E-STA††	1	1.0
F-STA	N/A	—

—No data.

*A-STA—“We don’t have a daily oversight. We have to give them a report of how we’ve done over a year, so it’s an annual report, so I’m not sure what happens to that or what’s done about that.”

**B-STA—“We don’t have that much interaction with them, but whenever we talk, the interactions are good. This happens so very seldom.”

†C-STA—“The only person I’ve talked to in FHWA, that I’ve really talked to, that is super interested in what we’re doing is [person within agency]. That’s the only contact I have with estimating on a regular basis.”

Q: “So you don’t talk to your DO?”

A: “Not a lot. I’ve tried to send stuff over to them, and they say, ‘No, no, no.’”

††E-STA—“We don’t get any support from them. We have asked for information and recommendations, and we’ve had no response. We’ve sat with them in person; they say they’ll get us what we need, and then there’s no followup. We now talk directly to an FHWA committee that I am now part of, and that is the only way we get oversight. We also go to other States instead of our DO.”

5. The FHWA DOs provide good support on cost estimation (table 44).

Table 44. DOs cost estimation support.

Agency	Raw Score	Normalized Score
A-STA*	—	—
B-STA	9	10.0
C-STA	—	—
D-STA**	8	6.7
E-STA	1	1.0
F-STA	N/A	—

—No data.

*A-STA—“I haven’t had any contact with them. I have not talked to FHWA. I talk to other States. I contact them with my questions.”

**D-STA—“We don’t necessarily reach out to them a lot, but they’ll let us know if they think we’re not right. Our division staff is really good.”

6. The FHWA DOs are knowledgeable about cost estimation procedures used in this agency (table 45).

Table 45. DOs knowledge of agency cost estimation procedures.

Agency	Raw Score	Normalized Score
A-STA	—	—
B-STA	9	10.0
C-STA	—	—
D-STA	9	8.4
E-STA	1	1.0
F-STA	N/A	—

—No data.

7. The performance measures developed by FHWA (e.g., comparison of the EE with the low bid) are aligned with the performance measures developed by this agency (table 46).

Table 46. FHWA and agency performance measures aligned.

Agency	Raw Score	Normalized Score
A-STA*	10	10.0
B-STA	9	10.0
C-STA**	9	10.0
D-STA	10	10.0
E-STA	5	5.0
F-STA	10	10.0

*A-STA—“They’ve given us guidance, and our guidance matches what they’ve told us to do. I don’t necessarily agree with the metrics 100 percent. They say that overall, for the year, our cost estimates have to be +/-3 percent for actual awarded projects. If we don’t have any estimates that are under the low bid, we will never be below the 3 percent. In my opinion, this should be between 2-5 percent. We should be between the first and second bidder.”

**C-STA—“We don’t like the idea that we are measuring our estimates. We like the idea that we’re measuring the contractor’s bid to contractor’s bid because we’re trying not to chase the contractor’s bid. We’re trying to determine what something should really cost. We want to see the difference between the bids and the EE. These are not really measures; they are indicators.”

8. The FHWA DOs stay updated about the current practices used for cost estimation (table 47).

Table 47. DOs stay updated on current cost estimation practices.

Agency	Raw Score	Normalized Score
A-STA	—	—
B-STA	9	10.0
C-STA	—	—
D-STA	9	8.4
E-STA*	—	—
F-STA	—	—

—No data.

*E-STA—“I have no idea; I have no communication.”

CHALLENGES

- What are the biggest challenges encountered when developing a cost estimate?
 - A-STA—“New items that we don’t have historical data on.”
 - B-STA—“Knowing the scope and the particulars of a project. Special circumstances or characteristics of a project.”
 - D-STA—“Our biggest challenge is consistency. Right now, we don’t have estimating staff. People develop estimates differently, even when using the same methods.”
 - C-STA—“Time. We don’t get a lot of time to prepare the EE. Because we’re a centralized office, it’s almost impossible to do field visits, and that creates challenges. Tendency to try to use lumpsum pay items.”
 - E-STA—“Designers usually don’t have the time to do a good job developing an estimate. Because of this lack of time, this is usually delegated to the engineer with less experience, and then the reviewers don’t have time to go over the estimates.”
 - F-STA—“Getting within the +/-10 percent and being able to predict the economy. Also, labor shortages.”
- What are the biggest challenges when working with FHWA on cost estimation?
 - A-STA—N/A.
 - B-STA—“We don’t work with them very often, so I guess knowing what resources they have to assist us with cost estimation.”
 - D-STA—“They are really knowledgeable and easy to work with. Communicating the basis of the estimates might be the biggest challenge.”
 - C-STA—“No challenges because we don’t really work together. Communication.”

- E-STA—“FHWA seems to be busier; they have fewer and fewer people, and they have more tasks that they need to perform. These [circumstances] make it hard to work with them. There are plenty of openings in our regional offices here.”
 - F-STA—N/A.
3. Does the State have an estimating section? Which other portions of the agency become involved in preparing, checking, or approving the cost estimates?
- A-STA—“Preliminary: Designers/maintenance. Estimating: Final.”
 - B-STA—“PMs, planning group, and finance group.”
 - D-STA—“Technically, we have an estimating section (I am it, though). Estimates are done by the designers (in-house or consultants). Prepared by a lead designer, and final approval is done by the PM. I provide tools and methodologies to develop these estimates.”
 - C-STA—“Districts and bridge prepare the 20-yr plan and STIP, and update the estimates yearly; materials and bridge lifecycle cost analyses; risk handles what might affect the overall program or special proposed items; the final EE happens in this office; and finally, a group in the construction office handles change orders.”
 - E-STA—“Our statewide estimating section is me. We do have other portions involved, quality assurance engineers. I also lean on them to get assistance.”
 - F-STA—“We have an estimation section. Project engineers prepare the estimates. Approval depends on project cost but ultimately goes up to management to prepare the estimates.”

On a scale of 1 to 10, where 1 is the lowest and 10 is the highest, please rate the following aspects of the cost estimates developed in house:

4. Accuracy (table 48).

Table 48. Accuracy.

Agency	Raw Score	Normalized Score
A-STA*	8	6.4
B-STA	7	7.4
C-STA	6	5.1
D-STA	5	1.8
E-STA	5	5.0
F-STA	5	3.6

*A-STA—“Provided that we have enough bidders, 8.”

5. Effort required to develop the estimate (1 indicates low effort and 10 extremely high effort) (table 49).

Table 49. Effort required.

Agency	Raw Score	Normalized Score
A-STA	7	4.6
B-STA	6	6.1
C-STA	7	6.7
D-STA	4.5	1.0
E-STA	4	4.0
F-STA	6	4.9

6. Reliability (1 indicates extremely unreliable and 10 extremely reliable) (table 50).

Table 50. Reliability.

Agency	Raw Score	Normalized Score
A-STA*	8	6.4
B-STA	7	7.4
C-STA	7	6.7
D-STA	7	5.1
E-STA	3	3.0
F-STA**	6	4.9

*A-STA—"Provided we have enough bidders, 8."

**F-STA—"We don't always get our estimates aligned with the low bid."

7. Experience required to develop the estimates (number of years of experience required) (table 51).

Table 51. Experience required to develop estimates.

Agency	Raw Score	Normalized Score
A-STA	6	2.8
B-STA	2	1.0
C-STA	3.5	1.0
D-STA	9	8.4
E-STA	2	2.0
F-STA	3	1.0

8. Technology available to develop the estimates (1 indicates all manual and 10 highly automated) (table 52).

Table 52. Estimating technology available.

Agency	Raw Score	Normalized Score
A-STA	5.5	1.9
B-STA*	8	8.7
C-STA	8	8.4
D-STA	8	6.7
E-STA	4	4.0
F-STA	5	3.6

*B-STA—“We developed software in-house to develop estimates.”

COST PERFORMANCE MEASURES

1. During your oversight of other agencies’ cost estimating programs, do you use any of the following performance measures?
 - a. STIP cost estimating performance measures (yes or no):
 - A-STA—No.
 - B-STA—Yes.
 - D-STA—No.
 - C-STA—“I don’t know. We have a system called CHIMES (Capital Highway Information Management Enterprise System). They keep track of estimates that are prepared every year after they go into the STIP (total project cost).”
 - E-STA—No.
 - F-STA—No.
 - b. Initial STIP cost estimate versus 60 percent design cost estimate. (The initial STIP cost estimate comes approximately 4 yr from the letting of the project. During the 4 yr, additional design is completed, and a new estimate is created. These two estimates are then compared to find their percent difference.)
 - A-STA—“We have not done that, but we’re attempting to do that currently. The way we measure this is whether the staff asks for more money. The estimate developed for the STIP used to be developed with knowledge, experience, and a rule of thumb. Nothing was done on paper.”
 - B-STA—“We use this one.”

- c. Final STIP cost estimate versus the low bid. (The final STIP cost estimate occurs when more design and scope is known but before the final EE. This estimate is compared to low bid amounts to find a percent difference.)

B-STA—"We use this one as well."

- d. Initial STIP cost estimate versus final STIP cost estimate. (This measure is a comparison of the initial STIP estimate to the final STIP estimate to find the percent difference.)

B-STA—"To my knowledge, we don't use this one."

- e. Other.

2. PS&E performance measures (yes or no).

- a. PS&E estimate versus low bid:

- A-STA—Yes.
- B-STA—Yes.
- E-STA—Yes.
- F-STA—Yes.

- b. Low bid to be within +/-10 percent of the PS&E estimate for 50 percent of all projects let:

- A-STA—"We use this one."
- D-STA—"We use this one."
- C-STA—"We use this; we follow the Federal Highway guidance on this."
- E-STA—"Letting estimate for this measure. This is pretty much all we use."
- F-STA—"This one."

- c. Low bid to be within +/-7 percent of the PS&E estimate for 50 percent of all projects let.

- d. Low bid to be within -15 percent to +5 percent of the PS&E estimate for 50 percent of all projects let.

- e. Other:

- B-STA—"25 percent/+10 percent, or if it's a smaller proposal, -25 percent/+15 percent. Small projects <\$500,000."
- E-STA—"Original bid to final cost."

- f. PS&E estimate versus final construction costs. (This measure compares the final engineer's PS&E estimate to the final construction costs when the project is complete.)

- B-STA—"We have the numbers, but we don't use them."

- D-STA—“Not formally, but we believe we should. Our staffing does not allow it.”
 - C-STA—“I think they probably do, but I don’t know if this actually goes into CHIMES.”
- g. PS&E estimate versus STIP estimate. (This measure compares the STIP program estimate to the PS&E estimate.)
- D-STA—“Not formally, but we believe we should. Our staffing does not allow it.”
 - B-STA—“We have the numbers, but we don’t use them.”
 - F-STA—No.
3. Competition measures (yes or no):
- B-STA—Yes.
 - A-STA—Yes.
 - F-STA—“I don’t think we do (for structures). There is a whole separate unit in charge of contract awards.”
- a. Number of bidders and mean unit prices. (This measure examines the number of bidders per project and the associated mean unit prices).
- A-STA—Yes.
 - D-STA—“Not formally, but we believe we should. If asked, we can provide this information.”
 - C-STA—“Not something we’re doing right now, but something we’d like to do (same for next three questions).”
- b. Average number of bidders. (This measure examines the number of bidders on average for all projects in a specific period.)
- A-STA—“Yes, monthly.”
 - B-STA—Yes.
 - D-STA—“Not formally, but we believe we should. If asked, we can provide this information.”
 - E-STA—“We do this. We’ve found use for this programwide. When the program drastically increases, the average number of bidders decreases.”
 - C-STA—“Same as previous.”

- c. Average number of bidders by size of contract. (This measure estimates the number of bidders based on the contract amount. This estimate could also be refined to types of work.)
 - A-STA—“Yes, monthly.”
 - D-STA—“Not formally, but we believe we should. If asked, we can provide this information.”
- d. PS&E versus the low bid, segregated by the number of bidders. (This measure compares the PS&E to the low project bid in the case of one, two, three, four, or more bidders.)
 - A-STA—“Yes, monthly. Maybe not formally, but I present it every month (internal, not public).”
 - D-STA—“Not formally, but we believe we should. If asked, we can provide this information.”

COST ESTIMATE DEVELOPMENT

1. How often are the developed project estimates updated?
 - A-STA—“We would like to have an FIR (field initial review) estimate. We want to have a FOR (final office review) that has to do with plans and specs, and then a final EE at advertising.”
 - B-STA—“Every 6 mo if they are in our 5-yr work program.”
 - D-STA—“On a general basis, at least annually. Fast-track projects might go faster. We do it at each milestone (preliminary plans, final plans, contract plans, semifinal, precontract).”
 - C-STA—“Once they go into the STIP, every year.”
 - E-STA—“Every 6 mo, according to the guidance. Most people don’t follow this. However, we found that those that do have better accuracy.”
 - F-STA—“Ideally, annually. But that does not always happen. After the preliminary design is 30 percent, 60 percent, 90 percent. Typically, more than one per year.”
2. How many times does an estimate have to be prepared per project?
 - A-STA—“We would like it to be a minimum of three times (times change depending on the PM).”
 - B-STA—“Minimum is three, but the standard is eight.”
 - D-STA—“One with each milestone.”

- C-STA—“It’s a 4-yr STIP (4), then they prepare an estimate before it’s turned in (1), and the PS&E (1), so six total. These don’t include the 20-yr plan from the pavement management system.”
 - E-STA—“Scoping, 30 percent, 60 percent, 90 percent (draft PS&E), PS&E, and final before letting (based upon addenda and stuff).”
 - F-STA—At each phase: 30 percent, 60 percent, 95 percent (draft PS&E), final PS&E. During preliminary phases, annually.”
3. How far in advance of the letting date is the EE prepared?
- A-STA—“Right up until advertising, which is usually 2 w prior. Standard of 2 w to provide an estimate (turnaround time).”
 - B-STA—“60–90 d before letting, but we finish it 2 d before the letting.”
 - D-STA—“EEs are our final design estimate. We do estimates for contract plans and PS&E estimates roughly 4 w before advertisement (7 w before letting). We don’t do a true EE that mimics a bid once it’s advertised (before a letting).”
 - C-STA—“We want to have them prepared before the project is advertised. (Projects are advertised between 3 and 5 w, depending on project size).”
 - E-STA—“3–5 mo before letting.”
4. Briefly describe the personnel resources available for preparing estimates and note any workload changes versus personnel available over the past 3 yr.
- A-STA—“Five individuals in the department, and the workload varies. Constant increase, and it goes in waves.”
 - B-STA—“We have had a lot of turnover, but we have pretty much the same amount of people working with us.”
 - D-STA—“It’s only me. There used to be someone else that retired and has not been replaced (within the last 3 yr).”
 - C-STA—“We have about five people in-house and teams of consultants. We’ve increased the personnel over the last 3 yr.”
 - E-STA—“Designer is in charge of preparing estimates and everything. Our local program has drastically decreased. Now plans are coming not up to date and with reduced quality.”
 - F-STA—“We have about 20 people in the structures, and workload is very high over the last year. We have to work a lot of overtime.”

5. What methods does your agency use to identify and incorporate anticipated changes in the cost of labor, equipment, and material?
 - A-STA—“We do analysis of the bids that we are getting and try to figure out the reasons for variation (increase or decrease).”
 - B-STA—“We have a consultant in charge of this, contacting contractors and materials suppliers without revealing their trade secrets. For our cost-based templates, we update them every 6 mo, and we look at all these costs.”
 - D-STA—“Not many. We don’t have any statewide indexes. If cement prices are going up, we know why. It’s more of a vague approach than a formal index (news and current trends). Most of our steel manufacturers are from out of State.”
 - C-STA—“We update costs yearly. For labor, we select a region in the software. For equipment, we can adjust when we do the site visits. For materials, we get quotes and oil prices. These prices are inflated.”
 - E-STA—“We currently don’t track this. We contact steel suppliers. We have a fuel index.”
 - F-STA—“We have a bridge cost index that sometimes indicates trends. Mostly we look at historical cost, so we look behind. We occasionally contact industry and suppliers to ask questions. We also talk to construction to find where to place the cranes and such.”

6. How does your agency keep track of inflation or cost indices? Does the agency have in-house developed indices?
 - A-STA—“Colorado Construction Cost Index every quarter, similar to NHCCI. (They follow their example).”
 - B-STA—“We have an in-house developed index. The finance people are in charge of this. We compare it to the NHCCI. Our index needs some tweaking/help. It is quite volatile.”
 - D-STA—“We don’t have our own index, but we refer to the NHCCI. We don’t incorporate them too much into our estimating.”
 - C-STA—“We have our construction cost index, and we have prices that represent prices for the commodities that we use as indicators. Our economist takes these and develops our cost index.”
 - E-STA—“WisDOT construction cost index (very similar to Ohio’s).”
 - F-STA—“Bridges index and highway cost index.”

7. Does your agency consider upcoming labor negotiations considered in the process?

- B-STA—N/A.
 - D-STA—N/A.
 - C-STA—N/A.
 - E-STA—N/A.
 - F-STA—No.
8. Does your agency contact material suppliers for anticipated material costs?
- A-STA—“Yes. Concrete, asphalt, riprap, road base, steel (maybe), prefab, lighting. Asphalt is the most volatile, along with technology.”
 - B-STA—“We have the consultants in charge of this, as mentioned in 6.5.”
 - D-STA—“Once in a while, mostly on projects that use alternative design (e.g., CM/GC).”
 - C-STA—“We get quotes.”
 - E-STA—“Only for unique items.”
 - F-STA—“Not for a project-to-project basis, but for general info.”
9. Does your agency make adjustments for individual project conditions? In what way?
- A-STA—“Yes. Location, regions, time of year, accessibility, source availability.”
 - B-STA—“Yes. We have estimators in the districts that develop their estimates. They have the task to adjust for project conditions (location, accessibility, contractors, material plants, etc.).”
 - D-STA—“Yes. Maybe not consistently, but we’ll look at the bid history for different items and adjust for conditions such as location and terrain.”
 - C-STA—“Distance, traffic control, weather, labor prices (by location), size of the project.”
 - E-STA—“Unfortunately, no (except the mentioned asphalt price tracking).”
 - F-STA—“Locations, etc.”
10. What other factors does your agency use to adjust the primary basis to determine the estimated prices for the project?
- B-STA—N/A.
 - D-STA—“Time of year of the letting and anticipating completion dates of the projects.”

- C-STA—“Competition but try not to use this so much. In the end, that might be a justification.”
 - E-STA—“None. We have some tools that help us find similar past projects.”
 - F-STA—“Traffic and environmental constraints, as well as geometry constraints.”
11. How often does your agency revise the estimate during the advertising period? Discounting addenda and quantity changes, what are the usual reasons for revising estimated prices?
- A-STA—“Yes. If we get new info on some price that we’ve missed. Market price conditions.”
 - B-STA—“We usually just revise the estimate once, just to review if we have more current historical bids or tariffs affecting the estimate.”
 - D-STA—“Not a practice.”
 - C-STA—“For typos. We get a lot of pushback on this, so it is not a common practice here.”
 - E-STA—“No. It’s a big no-no.”
 - F-STA—“Never.”
12. Is every estimate routinely evaluated by anyone other than the preparer in your agency? If so, when?
- A-STA—“QC controls for every project.”
 - B-STA—“We do a high-level review every year.”
 - D-STA—“We’ll review and evaluate the estimates (right now, it’s on a request basis because we’re short-staffed).”
 - C-STA—“We have some peer review going on, especially when we have something new that we’ve built (like a cost sheet). Some spot checks happen too.”
 - E-STA—“It should be reviewed by the PM at all stages and by me at the PS&E.”
 - F-STA—“At least one reviewer and each project need an estimate certification.”
13. If possible, describe how often further study and/or revision is desirable but not accomplished due to workload restrictions.
- F-STA—“That’s a tough one because we don’t do the estimating.”
 - D-STA—“Only when there is something unique that we need to look at.”

- C-STA—“Sometimes we have to work on incomplete plans. There are a lot of projects, and we cannot review them all.”
- E-STA—“I am usually reminiscent about how Minnesota and Ohio have more people than we do, based on the program size. That helps them better review estimates and perform better collusion analyses. (We don’t have that in the State because I don’t have time to do it).”
- F-STA—“We can’t always update the estimates annually based on our workload.”

14. What approaches does your agency use for project contingency?

- A-STA—“In the planning phase, percentage (set percentage that has been evaluated).”
- B-STA—“We follow the guidelines from AASHTO [American Association of State Highway and Transportation Officials] for cost estimating, but we don’t force anyone to have these contingencies (Molenaar, Anderson, and Schexnayder 2013). If they don’t feel like they need them, they don’t need to have them.”
- D-STA—“Straight-up percentages. Depending on what milestone we’re at, it’ll range from 5 percent up to 25 percent. At the time of advertising, it is always 5 percent.”
- C-STA—“We set aside money once the project is let. We also create a contingency estimate based on incentives. Early estimates are based on risk registry/Monte Carlo.”
- E-STA—“We call them allowance items for items that are hard to quantify.”
- F-STA—“Early, 40 percent, planning, 25 percent, and it goes down to 5 percent depending on the project.”

15. What approaches does your agency use for risk?

- A-STA—“Contingency. With larger projects, there is more involved.”
- B-STA—“We have a consultant-developed tool for risk in smaller projects. We absolutely comply with the FHWA major projects cost and risk assessment. For smaller projects, It is not standard throughout the State; it is left to the district to determine their risks or whether to hold workshops.”
- D-STA—“If we find that there’s a risk in something on a typical DBB project, we will up the estimates. We would double the estimates for the risky items. On CM/GC, we use risk items. We’ll include a pool of money to do the job if the risk is encountered. If it’s not encountered, the money is not paid.”
- C-STA—“Each project is supposed to have a risk registry (not all have it). We also do Monte Carlo for larger projects. We don’t always have time to do this.”
- E-STA—“Essentially, all we can do is try to find projects with similar risks.”

- F-STA—“There’s currently an effort to start quantifying to separate the risks from general contingency. We have a risk registry, but we don’t always assign a dollar to the risks. We use a probabilistic cost estimate using Monte Carlo simulations.”

16. Do you use any formally documented estimating guidance procedures (e.g., checklists)?

- A-STA—“No. Most people have been in the unit for a minimum of 8 yr.”
- B-STA—“We don’t have a State guideline.”
- D-STA—“We have some. Not necessarily checklists. We have a [collaboration] site for exchanging info with the designers.”
- C-STA—“We have cost sheets and spreadsheets used to guide people through estimating. We also have a manual that might be really old, but it is really good.”
- E-STA—“We used to have a documentation checklist, but these items are covered in the template (sent via email).”
- F-STA—Yes.

17. If so, how often are they updated, or when were they last updated?

C-STA—“We try to update them every year.”

ESTIMATE OVERSIGHT

1. Table 53 is a typical checklist for conducting a cost estimate review. Which of the following factors do you check when conducting a review?

Table 53. Cost estimate review checklist.

Yes	Factor
—	Estimate is escalated to year of expenditure dollars for each element of the project.
—	Process includes risk-based assessments of unknown and all uncertain costs.
—	Estimate is well documented.
—	Estimate has been prepared using a typical cost model (e.g., code of accounts)
—	Estimate has been independently validated.
—	Estimate is consistent with the project scope.
—	Estimate includes all initial preliminary engineering costs and final design costs.
—	Estimate includes all ROW and administrative costs.
—	Estimate includes all third party (e.g., utility, railroad) costs.
—	Estimate includes all TDM/TSM costs.
—	Estimate includes all construction costs.
—	Estimate includes construction contingencies.
—	Estimate includes construction administration.
—	Estimate includes public outreach cost.
—	Estimate includes a management reserve.
—	For planning or conceptual estimates, consideration was given to expressing the estimate as a range.
—	For projects under design, estimates include a design contingency at each stage of design.
—	The unit costs are aligned with the costs used by the agency

—Empty cell for respondent to check.

2. Are there other factors not listed that you typically check when not conducting a review?
 - C-STA—“Environmental mitigation. If we’re going to use consultants, we have to consider them.”
 - E-STA—“We verify that the correct estimating tools are used, project characteristics checked; we thoroughly check the most significant items (using the 20-80 rule) with a tool we have.”
 - F-STA—“Biggest thing we check is project constraints in project-specific requirements.”

POST-BID PRACTICES

1. Are there any State laws or regulations in effect regarding the release or protection of the EE?

- A-STA—“We release the bid tabs with the EE (can’t be released until after the bid has been awarded).”
 - B-STA—Yes.
 - D-STA—“There are no laws, but we don’t release them. But if someone challenges us, we’d probably have to release them. When we are creating the annual budget, projects are there with their estimated costs. However, it’s the overall cost (design, construction, etc.), no EE.”
 - C-STA—“There actually are. EE is not available after [the project is] awarded. We just publish unit prices.”
 - E-STA—“Our EE is always confidential, before and after award.”
 - F-STA—“We release the totals, but not the details.”
2. Are there any State laws or administrative regulations in effect to determine whether a contract award is proper, based on estimate overrun, competition, or other factors?
- A-STA—“We have in-State laws [and] procedures to follow if the bids are too high (State law) or too low (internal) compared to EEs. If there are items that are grossly misrepresented, we can reject the low bid and move to the next bidder. (e.g., they adjust bid amounts just to meet the estimate).”
 - B-STA—“No. We have internal procedures but not a State law. We look at the number of bidders [and] thresholds.”
 - D-STA—“No. There are not rules for automatic award or reject if it’s within or outside of certain parameters, respectively.”
 - C-STA—“There’s not too much there. We try to control that the bid doesn’t become materially unbalanced. If the bid is off, and they can justify, it is still awarded.”
 - E-STA—“We don’t have laws, but if a bid is 15 percent over the estimate, they want to review that project. Not laws but practices. If [there] is a single bidder and [the bid] is 15 percent over, they’ll scrutinize it.”
 - F-STA—“We check that they’re not mathematically or materially unbalanced. They are also working in bid collusion detection. Not sure about the number of bidders, but we do have a State commission, who we have to ask for more money if bids are more than 20 percent over.”
3. Is any information released publicly that may indicate the actual or approximate value of the estimate prior to opening bids? If so, when and where is it published?
- A-STA—“Not before award.”

- B-STa—"We have an advertised estimate at the time of advertisement. It is an EE *at the time of advertising.*"
 - D-STa—"There is a category assigned to each project, which is descriptive of project size or complexity."
 - C-STa—"We provide one number that is available publicly, but it's not an exact value."
 - E-STa—"We do have a master contract schedule that provides estimate ranges for each project. It is online."
 - F-STa—"We release the EE total, along with the rest of the project documents. I realize this is very unusual."
4. Is the EE published to the public in detail, or is only the total cost provided?
- A-STa—"In detail."
 - B-STa—"Only the total."
 - D-STa—"EE is never published."
 - E-STa—"Total estimate ranges (based on FHWA guidance)."
 - F-STa—No.
5. In the case of poor competition or excessive difference between the estimate and the low bid or best value, does the contracting agency contact the bidders and nonbidders who checked out proposal forms?
- A-STa—"We built it into a spreadsheet. We upload the low bid into the spreadsheet and compare low bid versus EE and low bid versus other bidders. The number of bidders and the project size affect the procedures to follow in this flowchart."
 - B-STa—Yes.
 - D-STa—"We do—in my opinion, not enough. Especially if there's five or six plan holders and only one bid. More when there are nonobvious things than when it is obvious. We ask for justification of their numbers. It is on a project-to-project basis."
 - C-STa—"We only contact the low bidder. If the prices are high, we ask [them] to tell us why. Then we consider whether it is appropriate or not."
 - E-STa—"Yes, to ask why they didn't bid."
 - F-STa—"Typically contact low bid, especially when there are items that were way higher than what we estimated."

6. Are there any “ground rules” for adjusting estimates after receiving bids? Is such action taken on its own merits, or may it be prompted by pressure to award an excessive bid?
- A-STA—“No. The EEs can be adjusted up until the bid opening. If anything, it is rejected and re-bid.”
 - B-STA—“We very rarely adjust our estimates, but if we do, [it] is because we missed something crucial in the plan or [noticed] typos. Otherwise, we cannot adjust the estimate. If we have the money, and it makes sense, we can just award it.”
 - D-STA—“If there is something that we notice upon receiving the bids, typos (writing 10 instead of 100, or similar mistakes).”
 - C-STA—“Only typos and things of that nature.”
 - E-STA—“We never do. I know a State that does.”
 - F-STA—No.

APPENDIX C—FIRST ROUND OF INTERVIEWS STRUCTURED INTERVIEW DOCUMENT—FHWA DO

INTRODUCTION

[Provide an overview of the project for the benefit of the respondent.]

PROJECT'S PRIMARY OBJECTIVES

The primary objective of this task order was to identify what, when, why, and how FHWA and FLH develop costs estimations. FHWA will use this information to provide more consistent oversight of project cost estimates by STAs. For the purpose of the research, FLH includes the U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. National Park Service, and the U.S. Forest Service.

PROJECT'S SECONDARY OBJECTIVES

The project's secondary objectives were as follows:

- Identify what type of projects these agencies provide cost estimates for, including types of projects defined by function (e.g., roadway and bridge), size, and complexity.
- Identify when the agencies develop project cost estimates, including by which phase of a project and the frequency with which a project cost estimate is updated.
- Identify why the agencies develop project cost estimates, including factors relating to risk and location that may trigger FHWA to develop a project cost estimate.
- Identify how the agencies develop project cost estimates. Do aspects related to what, when, and why influence when the historical bid-based model, the cost-based model, the risk-based estimation model, or the parametric time estimation model are used to develop a project cost estimation model?

IDENTIFICATION

1. Name. [This is a confidential interview, only the data analyst will read this answer.]
2. Name of your agency.
3. Your job title and role in the agency.
4. Overall years of experience.
5. Years of experience with the agency.
6. Years of experience in your current position:
7. Years of experience in estimating.
8. Do you provide oversight on cost estimates developed by other agencies (e.g., STA or consultants)?

APPROACHES USED IN COST ESTIMATES

On a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar (table 54), please indicate your level of familiarity with each of the following cost estimation methods.

Table 54. Scale from 1–10.

1	2	3	4	5	6	7	8	9	10
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1. Historical bid-based method.

This method involves using the historical bid-based approach. FHWA and STAs usually use a bid-history database to estimate unit bid costs for major items. Based on the historical averages, FHWA can use the estimated quantities of a proposed project to develop a target price. Much of the accuracy of this approach is based on the quantity and level of detail of the bid-history database.

2. Cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs. The method also involves adding a reasonable amount for a contractor's overhead and profit. The process mimics the same method that a contractor uses for preparing a bid-day estimate. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

3. Conceptual estimation.

Typically performed during the early planning and scope development, conceptual cost estimates typically use primary project parameters (e.g., project location, length, type of project, scope details, design parameters, site characteristics, and broad design assumption) to develop a cost estimate.

4. Risk-based estimation.

Risk-based estimation involves developing probabilistic cost for a project and its components based on identified known quantities, costs, and contingencies developed from a list of identified uncertainties from both opportunities and threats and their potential impact on the project.

5. Combination of historical and cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs based on historical bid items of past projects. The method also involves adding a reasonable amount for a contractor's overhead and profit. The process involves the development of cost estimates for each project (like the cost-based method), but it uses a bid-history database instead of cost estimates from material suppliers and historical production rates, which are typically used in a cost-based method. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

6. Other practice.

<i>[Insert answer]</i>

EFFICACY

On a scale from 1 to 10, where 1 is strongly disagree, 10 is strongly agree, and N/A is not applicable (table 55), please answer the following statements:

Table 55. Scale from 1–10.

N/A	1	2	3	4	5	6	7	8	9	10
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1. I feel confident about the cost estimates developed by this agency.
2. I feel confident about the methods used to estimate cost.
3. The cost estimates developed here are always on target.
4. The STAs develop accurate estimates.
5. The STAs are knowledgeable about cost estimation procedures.
6. The STAs keep cost estimation procedures updated.
7. The STAs use outdated techniques of cost estimation.

CHALLENGES

1. Which other portions of your office become involved in checking the cost estimates?
2. What are the biggest challenges encountered when overseeing a cost estimate?
3. What are the biggest challenges for providing oversight to STAs on cost estimation programs?

On a scale of 1 to 10, where 1 is the worst, 10 is the best, and N/A is not applicable (table 56), please rank the following aspects of the cost estimates you oversee being developed by other agencies:

Table 56. Scale from 1–10.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

4. Accuracy of the estimates (i.e., do the EEs typically reflect the low bid).
5. Reliability of the estimates (i.e., is there consistency between the EE and the low bid).
6. Experience of individuals within the other agency that developed the estimates.
7. Technology available within the other agency to develop the estimates.

COST PERFORMANCE MEASURES

1. During your oversight of other agencies’ cost estimating programs, do you use any of the following performance measures?
 - a. STIP cost estimating performance measures.
 - i. Initial STIP cost estimate versus 60 percent design cost estimate. (The initial STIP cost estimate comes approximately 4 yr from the letting of the project. During the 4 yr, additional design is completed, and a new estimate is created. These two estimates are then compared to find their percent difference).
 - ii. Final STIP cost estimate versus low bid. (The final STIP cost estimate occurs when more design and scope is known but before the final EE. This estimate is compared to low bid amounts to find a percent difference.)
 - iii. Initial STIP cost estimate versus final STIP cost estimate. (This measure is a comparison of the initial STIP estimate to the final STIP estimate to find the percent difference.)
 - iv. Other?
 - b. PS&E performance measures.
 - i. PS&E estimate versus low bid.
 - ii. Low bid to be within +/-10 percent of the PS&E estimate for 50 percent of all projects let.
 - iii. Low bid to be within +/-7 percent of the PS&E estimate for 50 percent of all projects let.
 - iv. Low bid to be within -15 percent to +5 percent of the PS&E estimate for 50 percent of all projects let.

- v. PS&E estimate versus final construction costs. (This measure compares the final engineer's PS&E estimate to the final construction costs when the project is complete.)
 - vi. PS&E estimate versus STIP estimate. (This measure compares the STIP program estimate to the PS&E estimate.)
- c. Competition measures.
- i. Number of bidders and mean unit prices. (This measure examines the number of bidders per project and the associated mean unit prices.)
 - ii. Average number of bidders. (This measure examines the number of bidders on average for all projects in a specific period.)
 - iii. Average number of bidders by size of contract. (This measure examines the number of bidders based on the contract amount. It could also be refined to types of work.)
 - iv. PS&E versus low bid, segregated by the number of bidders. (This measure compares the PS&E to the project's low bid in the case of one, two, three, four, or more bidders.)

ESTIMATE OVERSIGHT

1. Briefly describe the personnel resources available within your agency for preparing estimates and note any workload changes versus personnel available over the past 3 yr.
2. What methods does your agency use to identify and incorporate anticipated changes in cost of labor, equipment, and material?
3. How does your agency keep track of inflation or cost indices? Does the agency have in-house developed indices?
4. Does your agency consider upcoming labor negotiations in the process?
5. Does your agency contact material suppliers for anticipated material costs?
6. Does your agency make adjustments for individual project conditions? In what way?
7. What other factors does your agency use to adjust the primary basis to determine the estimated prices for the project?
8. How often does your agency revise estimates during the advertising period? Discounting addenda and quantity changes, what are the usual reasons for revising estimated prices?
9. Is every estimate in your agency routinely evaluated by anyone other than the preparer? If so, when?

10. If possible, describe how often further study and/or revision is desirable but not accomplished due to workload restrictions.
11. What approaches does your agency use for project contingency?
12. What approaches does your agency use for risk?
13. Do you use any formally documented estimating guidance procedures (e.g., checklists)?
14. If so, how often are they updated, or when were they last updated (referring to the guides)?
15. How often are cost estimations reviewed on a project, and does the frequency vary based on project size, type, or other project characteristics?
16. Table 57 is a typical checklist for conducting a cost estimate review. Which of the following factors do you check when conducting a review?

Table 57. Cost estimate review checklist.

Yes	Factor
—	Estimate is escalated to year of expenditure dollars for each element of the project.
—	Process includes risk-based assessments for all unknown and uncertain costs.
—	Estimate is well documented.
—	Estimate has been prepared using a typical cost model (e.g., code of accounts).
—	Estimate has been independently validated.
—	Estimate is consistent with the project scope.
—	Estimate includes all initial preliminary engineering costs and final design costs.
—	Estimate includes all ROW and administrative costs.
—	Estimate includes all third party (e.g., utility, railroad) costs.
—	Estimate includes all TDM/TSM costs.
—	Estimate includes all construction costs.
—	Estimate includes construction contingencies.
—	Estimate includes construction administration.
—	Estimate includes public outreach cost.
—	Estimate includes a management reserve.
—	For planning or conceptual estimates, consideration was given to expressing the estimate as a range.
—	For projects under design, estimates include a design contingency at each stage of design.

—Empty cell for respondents to check.

17. Are there other factors not listed that you typically check when conducting a review (e.g., bid ethics, front-end loading, possibility of collusion)?

POST-BID PRACTICES

1. Are there any State laws or regulations in effect regarding the release or protection of the EE?
2. Are there any State laws or administrative regulations in effect to determine whether a contract award is proper, based on estimate overrun, competition, or other factors?
3. Is any information released publicly that may indicate the actual or approximate value of the estimate prior to opening bids? If so, when and where is it published?
4. Is the EE published in detail, or is only the total cost provided?
5. Are there any written procedures for evaluating bids within your agency?
6. In the case of poor competition or excessive difference between the estimate and the low bid or best value, does the contracting agency contact the bidders and nonbidders who examined proposal forms?
7. Are there any “ground rules” for adjusting estimates after receiving bids? Is such action taken on its own merits, or may it be prompted by pressure to award an excessive bid?

WRAP-UP

1. Does your agency have any documentation that you follow to develop and/or provide oversight on cost estimates that you can share?
2. Is there anything you believe we should have asked about that we did not cover during this interview?

APPENDIX D—FIRST ROUND OF INTERVIEWS—DO RESPONSES COMPILED

IDENTIFICATION

1. Overall years of experience:

- E-DO—20+.
- D-DO—20.
- H-DO—35+.
- C-DO—30+.
- I-DO—30+.
- J-DO—35+.
- K-DO—22.
- G-DO—25.

2. Years of experience with the agency:

- E-DO—18+.
- D-DO—18.
- H-DO—20+.
- C-DO—30+.
- I-DO—20.
- J-DO—20+.
- K-DO—14.
- G-DO—3.

3. Years of experience in your current position:

- E-DO—9.
- D-DO—2.
- H-DO—3.
- C-DO—9.
- I-DO—9.
- J-DO—12.
- K-DO—2.
- G-DO—1.

4. Years of experience in estimating:

- E-DO—18+.
- D-DO—20.
- H-DO—25+.
- C-DO—19.
- I-DO—9.
- J-DO—20+.

- K-DO—10.
 - G-DO—25.
5. Do you provide oversight on cost estimates developed by other agencies (e.g., STA or consultants)?
- E-DO—“Yes. E-STA is our primary. They have consultants that develop estimates. Any comments we have are through E-STA.”
 - D-DO—“Technically, we have the ability to provide oversight on any of the projects. However, we use a risk-based approach in our project involvement and have been involved throughout the entire span of projects. Our involvement changes depending on the scope and scale of the projects. Currently, we have 600-plus active projects on State D with Federal funds on it. Obviously, we can’t provide oversight on everything with an office of four people.”
 - H-DO—“We do. FHWA recently changed how we provide oversight. All the DOs have a stewardship oversight agreement. Now we provide oversight on projects that are determined to be projects of division interest. Based on risk, we determine which projects are going to receive oversight, specific to the areas that we deem need oversight. It all depends on the information that we know about the project and the risk in it.”
 - C-DO—“Not on a project-by-project basis. Our oversight is provided on a risk-based approach. If we identify that something is not right on an estimate area, we would identify that as a division DOT high risk. We would conduct a process review, or we would go and do spot checks on several projects to validate whether there is a risk or not. If it’s not a risk, then it’s good to go. If there is actually a risk, we would then find ways to mitigate it, address it, bring our concerns forward to the DOT, and have it fixed. If they ask for technical assistance to improve their practices, we would provide such assistance in a stewardship sense.”
 - I-DO—Yes.
 - J-DO—“Very limited these days. We don’t consider cost estimates as a high risk. We mostly do it for major projects.”
 - K-DO—Yes.
 - G-DO—Yes.

APPROACHES USED IN COST ESTIMATES

On a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of familiarity with each of the following cost estimation methods (table 58 through table 63).

1. Historical bid-based method.

Using the historical bid-based approach, STAs usually use a bid-history database to estimate unit bid costs for major items. Based on the historical averages, FHWA can use the estimated quantities of a proposed project to develop a target price. Much of the accuracy of this approach is based on the quantity and level of detail of the bid-history database.

Table 58. Historical bid-based method.

Agency	Value	Min-Max
E-DO	9	8.5
G-DO	9	10.0
D-DO	10	10.0
H-DO	10	10.0
C-DO	10	10.0
I-DO	10	10.0
J-DO	10	10.0
K-DO	10	10.0

Min-max = minimum to maximum.

2. Cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs. This method also involves adding a reasonable amount for a contractor's overhead and profit. The process mimics the method that a contractor uses to prepare a bid-day estimate. When prepared with the proper skill, experience, and effort, cost-based estimates are usually the most accurate of the five methods.

Table 59. Cost-based method.

Agency	Value	Min-Max
E-DO	7	5.5
G-DO	9	10.0
D-DO	7	5.5
H-DO	4.5	1.8
C-DO	9	7.4
I-DO	2	1.0
J-DO	9	8.9
K-DO	9	8.9

3. Conceptual estimation.

Typically performed during the early planning and scope development, conceptual cost estimates usually use primary project parameters (e.g., project location, length, type of project, scope

details, design parameters, site characteristics, and broad design assumption) to develop a cost estimate.

Table 60. Conceptual estimation.

Agency	Value	Min-Max
E-DO	8	7.0
G-DO	7	6.4
D-DO	7	5.5
H-DO	7	5.5
C-DO	10	10.0
I-DO	10	10.0
J-DO	9	8.9
K-DO	9	8.9

4. Risk-based estimation.

This method involves developing probabilistic costs for the project and its components based on identified known quantities, costs, and contingencies developed from a list of identified uncertainties from both opportunities and threats and their potential impact on the project.

Table 61. Risk-based estimation.

Agency	Value	Min-Max
E-DO	10	10.0
G-DO	4	1.0
D-DO	7	5.5
H-DO	4	1.0
C-DO	10	10.0
I-DO	5	4.4
J-DO	8.5	8.3
K-DO	10	10.0

5. Combination of historical and cost-based method.

This method involves estimating the cost for items of work based on the cost of each component of a project, considering the associated labor, equipment, and materials costs, based on historical bid items of past projects. The method also involves adding a reasonable amount for a contractor’s overhead and profit. The process involves developing cost estimates for each project (like the cost-based method), but it utilizes a bid-history database instead of cost estimates from material suppliers and historical production rates that are typically used in a cost-based method. When prepared with the proper skill, experience, and effort, cost-based estimates are usually considered the most accurate of the five methods.

Table 62. Combination of historical and cost-based method.

Agency	Value	Min-Max
E-DO	8.5	7.8
G-DO	9	10.0
D-DO	8	7.0
H-DO	7	5.5
C-DO	10	10.0
I-DO	7.5	7.2
J-DO	9.5	9.4
K-DO	10	10.0

6. Other practice.

N/A

Table 63. Other practices.

Agency	Value	Min-Max
E-DO	—	—
G-DO	—	—
D-DO	—	—
H-DO	—	—
C-DO	—	—
I-DO	—	—
J-DO	7.5	7.2
K-DO	—	—

—No data.

EFFICACY

On a scale from 1 to 10, where 1 is strongly disagree and 10 is strongly agree, please answer the following statements:

1. I feel confident about the cost estimates developed by this agency (table 64).

Table 64. Confidence in cost estimates agency develops.

Agency	Value	Min-Max
E-DO	8	7.0
G-DO	8	8.2
D-DO	6	4.0
H-DO	7.5	6.3
C-DO	7	2.3
I-DO	8	7.8
J-DO	—	—
K-DO	9	8.9

—No data.

2. I feel confident about the methods used to estimate cost (table 65).

Table 65. Confidence in cost estimate methods used.

Agency	Value	Min-Max
E-DO	9	8.5
G-DO	9	10.0
D-DO	6	4.0
H-DO	9	8.5
C-DO	10	10.0
I-DO	8	7.8
J-DO	—	—
K-DO	10	10.0

—No data.

3. The STAs develop accurate estimates (table 66).

Table 66. STAs develop accurate estimates.

Agency	Value	Min-Max
E-DO	9	8.5
G-DO	7	6.4
D-DO	5	2.5
H-DO	8	7.0
C-DO	6.5	1.0
I-DO	8	7.8
J-DO	8.5	8.3
K-DO	8	7.8

4. The STAs are knowledgeable about cost estimation procedures (table 67).

Table 67. STAs are knowledgeable about cost estimation procedures.

Agency	Value	Min-Max
E-DO	9	8.5
G-DO	8	8.2
D-DO	5	2.5
H-DO	10	10.0
C-DO	6.5	1.0
I-DO	9	8.9
J-DO	10	10.0
K-DO	9	8.9

5. The STAs keep cost estimation procedures updated (table 68).

Table 68. STAs keep cost estimation procedures updated.

Agency	Value	Min-Max
E-DO	9	8.5
G-DO	7	6.4
D-DO	4	1.0
H-DO	10	10.0
C-DO	—	—
I-DO	10	10.0
J-DO	10	10.0
K-DO	9	8.9

—No data.

CHALLENGES

- Which other portions of your office become involved in checking the cost estimates?
 - E-DO—“Just the engineers.”
 - D-DO—“Mainly engineering and planning.”
 - H-DO—“For construction and design cost estimates, if it’s a PODI (project of division interest). If it’s a project during design, we can look at the estimate for the design, and then we have a checklist to assist people in checking what the consultants did and what the State is providing to us. For construction, we have a checklist to help review prior to advertising. Every DO might have different checklists for different things.”
 - I-DO—“That would be with the transportation engineers.”

- J-DO —“Planning, environment, ROW, financial, field ops., value engineering.”
- K-DO—“It’s only my team.”
- G-DO—“Engineers and planners.”

6. What are the biggest challenges encountered when overseeing a cost estimate?

- E-DO—“They use too many bid items, so it is hard to check. We can only check the big ones. Programming of projects. Budgeting and programming process. They put estimates on the shelf (for funding purposes), and when it’s time to bid, there is a lot of rework required to update plans (e.g., utility relocation, changes in the jobsite).”
- D-DO—“The fact that we are not involved in the entire project on a day-to-day scale. We don’t have access to all the programs (e.g., estimator), which would be helpful.”
- H-DO—“Package that goes out to bidder does not give locations; it just gives quantities. The bidders are coming up with quantities based on no location, whereas previously, the packages would include locations. Without locations, it is harder to check costs.”
- I-DO—“Routinely, there are not many major challenges. Sometimes there may be projects where we know there might be some additional risk factors or additions that might account for potential changes in the cost estimates.”
- J-DO—“Changing environment. Sometimes estimates are too high, depending on market conditions and the contractor’s hunger. A lot of projects start simultaneously, and this influences material shortages. Construction season goes from April to October (summer heat is an issue). Projects are put out to bid in the fall because contractors are not performing too much work. It is believed that contractors won’t bid high because they’re already busy. For our division, since J-STA is the leader in cost estimates, it’s not a challenge. We learn from them.”
- K-DO—“Innovative delivery estimates/use of consultants. K-STA has some oversight for the consultant-developed estimates.”
- G-DO—“Not having all the details that we need to make an evaluation of whether it was an appropriate cost estimate. For example, rural versus urban, number of contractors, [bid item quantities].”

On a scale of 1 to 10, where 1 is the worst and 10 is the best, please rank the following aspects of the cost estimates you oversee that are developed by other agencies:

7. Reliability of the estimates (i.e., is there consistency between the EE and the low bid) (table 69).

Table 69. Reliability of the estimates.

Agency	Value	Min-Max
E-DO	8	7.0
G-DO	6	4.6
D-DO	6	4.0
H-DO	8	7.0
C-DO	6.5	1.0
I-DO	8	7.8
J-DO	9	8.9
K-DO	9	8.9

8. Experience of individuals within the other agency that developed the estimates (table 70).

Table 70. Experience of individuals within the other agency that developed the estimates.

Agency	Value	Min-Max
E-DO	8	7.0
G-DO	6	4.6
D-DO	5	2.5
H-DO	9	8.5
C-DO	7.5	3.6
I-DO	7	6.6
J-DO	9	8.9
K-DO	9	8.9

9. Technology available within the other agency to develop the estimates (table 71).

Table 71. Available technology to develop estimates.

Agency	Value	Min-Max
E-DO	4	1.0
G-DO	8	8.2
D-DO	5	2.5
H-DO	9.5	9.3
C-DO	7.5	3.6
I-DO	9	8.9
J-DO	8.5	8.3
K-DO	7	6.6

COST PERFORMANCE MEASURES

1. During your oversight of other agencies' cost estimating programs, do you use any of the following performance measures?

- a. STIP cost estimating performance measures.
 - E-DO—“In our major projects, we have an STIP reference, but it is a very high-level overview. Our primary duties are to see how it compares to the CFR [Code of Federal Regulations]. We don’t have the resources to go any deeper than that.”
 - D-DO—“No STIP performance measures. One of the reasons is because the STIP in State D is really broadline items, and unless it’s bigger projects, it’s very hard to compare.”
 - H-DO—“Initially, when the project is put in the STIP and planning, the estimate is very general. As it moves along in design, the State has a CTP (consolidated transportation program) That helps them put info into the STIP. This is updated yearly, so it helps them program based on the State dollars and transportation dollars.”
 - C-DO—“I do not know. It is known by the planners and not by the engineers.”
 - G-DO—“Nothing here.”
- b. Initial STIP cost estimate versus 60 percent design cost estimate. (The initial STIP cost estimate comes approximately 4 yr from the letting of the project. During the 4 yr, additional design is completed, and a new estimate is created. These two estimates are then compared to find their percent difference.)
 - E-DO—“They use the 60 percent as the STIP, but I don’t know if there’s a measurement for it.”
 - I-DO—No.
 - J-DO—“We don’t. I don’t know if J-STA does (I am pretty sure they don’t). They are very State-legislative driven. They try to make the project match the budget and not the other way around.”
 - K-DO—No.
- c. Final STIP cost estimate versus the low bid. (The final STIP cost estimate occurs when more design and scope are known but before the final EE. This estimate is compared to low bid amounts to find a percent difference.)
 - I-DO—Yes.
 - J-DO—“The most we would do is when we authorize construction funding, we want to make sure that the construction authorization is within 30 percent of the STIP.”
- d. Initial STIP cost estimate versus final STIP cost estimate. (This measure is a comparison of the initial STIP estimate to the final STIP estimate to find the percent difference.)

- C-DO—“There’s not a measurement, but there is a check with the estimate versus the STIP. Then they have to make an amendment prior to award, prior to advertising. They’re checking that at 90 percent in PS&E to make sure the STIP is in line with estimates.”
- J-DO—“We don’t. Our planning side might, but I don’t think they do.”

e. Other.

2. PS&E performance measures.

- H-DO—“We just started this stewardship program. We don’t have a full year yet.”
- C-DO—“Yes. The biggest dragging force here is they don’t set the scope early on in the project, and they allow the scope creep to keep increasing the cost. They keep adding scope and things they miss, and when it goes out on the street, the contractor keeps adding more. This [process] keeps dragging all prices up, and that’s why most of them are significantly over.”
- K-DO—“PS&E are based on the initial estimate and are updated a couple of weeks before letting (4 w approximately). PS&E transforms into the EE.”
- G-DO—Yes.

a. PS&E estimate versus low bid.

- H-DO—“+10 percent/−15 percent for the EE. If it’s outside this range, they need to have a justification.”
- C-DO—Yes.
- J-DO—“J-STA does that, and they share the numbers with us.”

b. Low bid to be within +/-10 percent of the PS&E estimate for 50 percent of all projects let.

- E-DO—“We use this one. They have been fairly close over time.”
- D-DO—“This one is the only one they track. They started to compare each phase of the design to the final bid.”
- C-DO—“Try to, but not meeting it.”
- I-DO—“Only this one.”
- K-DO—“We want to see them within 10 percent. If they are over 10 percent, they cannot be recommended for award. There are ways to make sure we’re not overpaying.”

- G-DO—“We use this one.”

c. Low bid to be within +/-7 percent of the PS&E estimate for 50 percent of all projects let.

C-DO—“Not meeting this one either.”

d. Low bid to be within -15 percent to +5 percent of the PS&E estimate for 50 percent of all projects let.

C-DO—“Not meeting this one either.”

e. PS&E estimate versus final construction costs. (This measure compares the final engineer’s PS&E estimate to the final construction costs when the project is complete.)

- C-DO—“I do not know if they measure this. It is not an important measure to the DOT. They started measuring it now that they have time. It’s new as of roughly one year ago.”

- E-DO—“We would compare whatever is let to the final construction cost.”

f. PS&E estimate versus STIP estimate. (This measure compares the STIP program estimate to the PS&E estimate.)

C-DO—“I can’t give you an answer on that one. They talk about it, and preletting is informally checking. It’s informal.”

3. Competition measures.

a. Number of bidders and mean unit prices. (This measure examines the number of bidders per project and the associated mean unit prices.)

- E-DO—“We get the results and bid tabs for the three lower bidders.”
- H-DO—No.
- C-DO—“We do not, but the DOT tracks all of that. They have all the statistics for this.”
- I-DO—“Yes. They pretty much follow what our guidance document says on that.”
- J-DO—“On occasion. If we see something that is questionable, or if we are doing a review. J-STA does a letting every Wednesday. We review unique projects or projects that are too high.”
- K-DO—“If we see something strange with a unit price, we compare with second, third, or fourth bidders.”

- G-DO—“Numbers of bidders, yes. If the bids are varying a lot from the EE, then they look at the mean unit prices.”
- b. Average number of bidders. (This measure examines the number of bidders on average for all projects in a specific period.)
- E-DO—“No. We’ve seen projects with just one bidder, but we still have to award it. Sometimes they (E-STA) can’t move forward because the one bidder is out of the ordinary.”
 - D-DO—“I don’t think they look at this a lot. The information is there, but they don’t use it. We do have this information, and the report on this is done annually, I believe.”
 - H-DO—“If there’s only two bidders, the low bidder has to be within 105 percent of the EE, per the documents sent to us by [FHWA].”
 - C-DO—“Average number of bidders does not matter to the DOT. That said, that’s a statement made on DBB. When we get into innovative contracts (e.g., DB, CM/GC), it does matter, meaning you want no less than three (every State is a little bit different with their regulations).
- “Bid averaging method is not allowed in the [United States], but it works well in Europe. This is something to keep in mind.”
- I-DO—“This is also part of the analysis. Number bids, difference between estimate and low bid, and range of bids.”
 - J-DO—“On occasion. If we see something that is questionable, or if we are doing a review. J-STA does a letting every Wednesday. We review unique projects or projects that are too high.”
 - K-DO—“We have between 3 and 10 bidders per project. Some of the larger projects might have two bidders.”
 - G-DO—“If they only have a few bidders, they evaluate the estimate to see if they make sense.”

COST ESTIMATE OVERSIGHT

1. Briefly describe the personnel resources available within your agency for preparing estimates and note any workload changes versus personnel available over the past 3 yr.
 - E-DO—“It has been pretty stable. It is important for the State DOT.”
 - D-DO—“The resources they have are AASHTOWare® Project Estimation™ and AASHTOWare Project™ BAMS/DSS™ (AASHTO n.d.a; AASHTO n.d.b.). They only have one person that reviews all the estimates. Agencies become leaner and leaner. This

(estimating) has become a side thought. About 40 percent of their projects are estimated by consultants. They also have a senior estimator that deals with all the State projects and gets involved a lot in CM/GC. I would say it's a pretty lean [organization]."

- H-DO—"I have not noticed anything. What we do notice is that, since the new governor is here, they are getting more money in their tax revenue, and they planned for that. Now that the money flow is slowing down, they're already saying that there will be fewer projects. So that is what has happened related to this."
- I-DO—"I have not noticed any changes. They use a lot of consultants, so any needs are covered by the consultants. I would say the resources are adequate."
- J-DO—"We've had people come and go, but our team is pretty well-resourced. We can always go ask our resource center for help."
- K-DO—"We have five engineers in my team, and most of them have been together for the past 6 yr. We pick projects based on risk (price, location, traffic, low cost, environmental, political, influence). We don't view every minor detail, just the projects we choose to oversee. There is a sample that we pick for every district, but in monthly meetings, we review every project as an aggregate. We can pick the projects that we want to review."
- G-DO—"They seem to have adequate personnel. In my year here, I haven't seen a lot of turnover."

10. What methods does your agency use to identify and incorporate anticipated changes in cost of labor, equipment, and material?

- E-DO—"They do. Recently, the market has heated up, which has made them adjust the estimates because of that. We have not seen any issues with material or equipment."
- D-DO—"There is a 5 percent contingency on DBB and 10 percent on DB. It depends on the project manager. There is not a lot of consistency between groups."
- H-DO—"I know in the past they had a price adjustment for asphalt mix, for concrete strength. It is in the specs and has been there for years. They just recently added steel adjustment. Forced account work is in their specs. Usually, work is based on unit price that they bid. If something is added to the contract, and they can't negotiate, they do it by force accounted work, which includes labor, material, and equipment. But the specs don't have anything about adjusting them."
- I-DO—"Not anything systematic, but I think that when they see dramatic price fluctuations in steel, asphalt, or portland cement, they try to address the increases in the bid cost."
- J-DO—"If there's something like that, we reach out to other divisions and see if they have something happening of that nature."

- K-DO—“They rely on people in every district (in the field); they talk to providers; they provide feedback on availability of materials and equipment; they report to us any market condition changes. For example, labor cost can affect a lot [in] the Atlanta metro area, but not as much [as in] the rest of the State. Market prices of commodities and word of mouth (talking to contractors). Additionally, we have monthly meetings to discuss EEs for every project, and a week after the meetings, we do the bid reviews. We are not voting members, but we participate enough. Prelet meetings are 1 to 2 h, and postlet meetings are 2 to 3 h. If we need additional analysis, we will break it apart.”
- G-DO—“They have price escalation clauses built into their contracts for materials, especially for items like asphalt.”

11. How does your agency keep track of inflation or cost indices? Does the agency have in-house developed indices?

- E-DO—“They subscribed to a service that provides insights (market by market and region by region inflation factors).”
- D-DO—“They have a fuel index. It is only updated about every 5 yr.”
- H-DO—“They have a bid price index that gets updated every 6 mo that can be found on their website. This is for unit cost of items that were installed within the last 6 mo. Every month they get new indexes for asphalt, and they use those indexes. For construction, they do account for inflation, but I don’t know how they keep track of it.”
- I-DO—“I don’t know if they do it internally. They used to submit bid data to FHWA, and that was tracked by FHWA years ago. They have a pretty good electronic system, so they can access the data and run a lot of reports if they want to.”
- J-DO—“We try to keep nationwide indices (such as gas index), but not in our office. For inflation, [it] depends on the stage of the project.”
- K-DO—“Since their estimates are cost based, this is embedded when they develop an estimate.”
- G-DO—“They keep track of all the prices used on the project and regularly update them. They have an in-house developed index.”

12. Does your agency consider upcoming labor negotiations in the process?

- E-DO—“Unions have decreased their influence lately, but some contractors may be inclined to subscribe to unions.”
- D-DO—N/A.
- H-DO—N/A.

- I-DO—N/A.
- J-DO—“This is more J-STA; we rely on them to tell us. They definitely consider that in their estimates.”
- K-DO—N/A.
- G-DO—N/A.

13. Does your agency contact material suppliers for anticipated material costs?

- E-DO—“It is pretty rare. I remember it happened once. General inquiry about availability and not cost.”
- D-DO—“Sometimes with CM/GC (mostly the CM), they are heavily involved with material suppliers and larger projects.”
- H-DO—“I hope so, but I don’t know.”
- I-DO—“Same as [question] 2.”
- J-DO—“J-STA will, especially if they know about a specific issue.”
- K-DO—“Yes.”
- G-DO—“They might contact them after a bid is put out if there are big price fluctuations.”

14. Does your agency make adjustments for individual project conditions? In what way?

- E-DO—“They do regionalize the estimates. I believe they can break it down to the county level.”
- D-DO—“I hope they would, but I have no idea. Other than risk registry and contingency, I don’t know.”
- H-DO—“I am not aware of that (for weather/seasons). I don’t know if project characteristics are taken into account for the estimates. Some environmental issues are taken into account and written into the contracts, so the contracts are bid accordingly.”
- I-DO—“This is reflected in historical data.”
- J-DO—“J-STA does (e.g., anything in the downtown area would be nighttime, and they adjust for that).”
- K-DO—“They take into consideration distance from the projects to quarries, plants, and so forth. They go into very specific details about every project (distance, speed, number of trips, etc.).”

- G-DO—“Yes. They take the basis, average prices, and adjust those for particular project conditions.”

15. What other factors does your agency use to adjust the primary basis to determine the estimated prices for the project?

- E-DO—“They may have to do more investigation for environmental factors. Steel procurement to slack the steel prices. The State buys and provides to the contractor.”
- D-DO—“Small quantity versus large quantity project risk (risk registry for each project). They initially tried to do it for every project, but they only ended up doing it for larger projects.”
- I-DO—“Larger projects (over \$100 million or anything that requires financial plans) they’ll do a year of expenditure type of thing to the midpoint of construction.”
- J-DO—In (State capital), there are more cranes than ever (for private development), so this is an example of something to consider. Eastern side has less resources available. Federal-aid projects would also be higher. J-STA has been tasked to do practical design by State legislation.”
- K-DO—“Competition (players in the area). They know who the bidders, suppliers, and contractors are, so they adjust the prices accordingly.”
- G-DO—“Volume of work, area (zone), contractors available in the area.”

16. How often does your agency revise estimates during the advertising period? Discounting addenda and quantity changes, what are the usual reasons for revising estimated prices?

- E-DO—“We do fuel cost adjustments.”
- D-DO—“I don’t think it’s revised during advertising unless there’s an addendum.”
- I-DO—“Only quantity changes or addenda. Open Q&A process with the contractors in their electronic systems, so they’d see any changes in variations of quantities.”
- J-DO—“Never.”
- K-DO—“This is not typical. They have done it when they have found something specific with an item of material. There are no adjustments within the 4-w period.”
- G-DO—“If the bids come in very different from the EE, they will look at the prices and may revise the bids at that point.”

17. Is every estimate in your agency routinely evaluated by anyone other than the preparer? If so, when?

- E-DO—“Region develops the estimates, and central office checks them.”

- D-DO—“The senior estimator. The ‘when’ depends on the project. ‘When he has time (chuckles).’ Before advertising, definitely.”
- H-DO—“If H-STA does it, I am not aware of it.”
- J-DO—“They have a couple of different sets of eyes looking at this, but I am unsure of who and when.”
- I-DO—“I-STA is a rather decentralized organization. They’re set up by district offices. Each district office has a contract management group that is responsible for advertising. They typically will review the estimate prepared by the PM.”
- K-DO—“People in the district provide some of the information and verify the design. Estimators in the office make the main estimates, and then they go to their supervisors for the final check. I only deal with the chief estimator.”
- G-DO—“Not that I know of.”

18. If possible, describe how often further study and/or revision is desirable but not accomplished due to workload restrictions.

- E-DO—“I have not seen that happen.”
- D-DO—“All the time. I’d say, at a minimum, annually. He’s a busy dude.”
- H-DO—“I have never seen this.”
- I-DO—“Very rare instance.”
- J-DO—“I don’t know. I don’t think they throw those out very often.”
- K-DO—“I don’t have enough information to answer this.”
- G-DO—“I have not seen that being an issue.”

19. What approaches does your agency use for project contingency?

- E-DO—“As the design moves further along, the contingency goes lower and lower: 30, 60, 90 checks.”
- D-DO—“Standard is 5 percent for DBB and can go up to 20 percent, depending on the project. For instance, ‘rock ledge, when you don’t really know what you’re getting into.’”
- H-DO—“20 percent to 40 percent during planning, and this decreases as the project evolves, until PS&E, where there is no contingency at all.”

- I-DO—“At the PS&E stage, they don’t do contingency. They have various percentage contingency for the project development process that reduces as the project evolves. As it goes out for advertising, there is no contingency in the estimate.”
- J-DO—“In planning stages, they have a more inflated contingency, and this lowers as it gets closer to the EEs.”
- K-DO—“Cost-based estimation; they don’t do contingencies.
“On DB projects, they usually do 10–15 percent. They only add a contingency to DB projects.”
- G-DO—“I know they have some contingency, but I am not sure how they do it. I think it’s a contingency overall, and they add it to the estimate.”

20. What approaches does your agency use for risk?

- E-DO—“Risk assessment for major projects (>\$500 million).”
- D-DO—“Risk registry. They try to address risk by delivery method (e.g., using DB and CM/GC).”
- H-DO—“I don’t know what their approach is.”
- C-DO—“RBSO (Risk Based Stewardship and Oversight).”
- I-DO—“Major projects use a risk-based approach. In this method, we strip the percentage contingencies out as we put in the risks and their magnitudes. On any individual project, if they are aware of risk factors that affect the cost, they would address it. There is not something systematic. The vast majority of the projects are pretty vanilla.”
- J-DO—“Depending on the size of the project, the risk analysis changes. In the process, they have different amounts of risks they are willing to accept. They have a very thorough approach for risks and opportunities.”
- K-DO—“They look at urban, suburban, or rural conditions. They also look at the competition.”
- G-DO—“If they see items that will increase the risk of the project, they will adjust the price accordingly, and the estimate will increase.”

21. Do you use any formally documented estimating guidance procedures (e.g., checklists)?

- J-DO—“We do on major projects (>\$500 million).”
- E-DO—“We have developed standard operating procedures. There is a checklist associated [with] the procedures.”

- D-DO—“We only have the FHWA guidelines (FHWA 2020) for preparing estimates.”
- H-DO—“The State highway agency has a cost estimating manual.”
- I-DO—“We do have a cost estimating manual, and I do believe there are some checklists in there.”
- K-DO—“FHWA guide (FHWA 2020).”
- G-DO—“Not that I know of.”

22. If so, how often are they updated, or when were they last updated (referring to the guides)?

- E-DO—“They were updated within the last year. We are trying to finish the PS&E checklist. It will be integrated within a new software (Masterworks Cloud software) (Aurigo® n.d.).”
- D-DO—“Last updated January 2004.”
- I-DO—“I am sure it is every year or on a needed basis (whatever happens first).”
- J-DO—“They are not updated often.”

23. How often are cost estimations reviewed on a project, and does the frequency vary based on project size, type, or other project characteristic?

- E-DO—“Multiple times. At least two cost estimate reviews (one before the environmental reports and one before the letting).”
- D-DO—“It varies depending on the project, the project manager, and the type of project. They don’t have an SOP [standard operating procedure] for the estimating process.”
- H-DO—“Estimates are looked at and updated yearly because it’s based on the money that they’re getting from the State, so they have to budget for the projects that are going to move forward and the ones that are not.”
- I-DO—“They have established project developing procedures:
 - “Initial scoping cost estimates.
 - “30 percent design (design field view cost).
 - “Final design office meeting (90 percent) completion.
 - “Final PS&E cost estimates.
 - “On larger projects, they might do interim updates.

- “Major project categories follow a different path completely; basically, they send a team out, and they develop these estimates.
- “The cost estimate reviews are sometimes done by consultants too, based on workload. It varies when they’re required, but typically we’re talking about a minimum of two (Pre-NEPA and Preconstruction).”
- J-DO—“For major projects, we do it often. Ad hoc on every other project.”

24. Table 72 is a typical checklist for conducting a cost estimate review. Which of the following factors do you check when conducting a review?

Table 72. Cost estimate review checklist.

Yes	Factor
—	Estimate is escalated to year of expenditure dollars for each element of the project.
—	Process includes risk-based assessments for all unknown and uncertain costs.
—	Estimate is well documented.
—	Estimate has been prepared using a typical cost model (e.g., code of accounts).
—	Estimate has been independently validated.
—	Estimate is consistent with the project scope.
—	Estimate includes all initial preliminary engineering costs and final design costs.
—	Estimate includes all ROW and administrative costs.
—	Estimate includes all third party (e.g., utility, railroad) costs.
—	Estimate includes all TDM/TSM costs.
—	Estimate includes all construction costs.
—	Estimate includes construction contingencies.
—	Estimate includes construction administration.
—	Estimate includes public outreach cost.
—	Estimate includes a management reserve.
—	For planning or conceptual estimates, consideration was given to expressing the estimate as a range.
—	For projects under design, estimates include a design contingency at each stage of design.

—Empty cell for respondent to check.

25. Are there other factors not listed that you typically check when conducting a review (e.g., bid ethics, front-end loading, possibility of collusion)?

- E-DO—“The [State] DOT does a good job controlling these.”
- C-DO—“At the program level, if we identify a risk in this area, we will conduct a process review or spot check to validate if the risk is there or not.”

POST-BID PRACTICES

1. Are there any State laws or regulations in effect regarding the release or protection of the EE?
 - E-DO—“They do not publish the EEs. It is that way, and we don’t know the reason.”
 - D-DO—“There are no laws, regulations, or policies, but the standard practice is that it’s not published or released. To date, there have been no challenges to this. For the advertising process, they publish a range (different levels).”
 - H-DO—“They don’t release them unless there is a specific request, but this is only done after award.”
 - C-DO—“Yes; 90 percent and farther [sic] is confidential until award.”
 - I-DO—“They provide a range; they do not release the actual estimate.”
 - J-DO—“I don’t know if it is a law or not, but J-STA doesn’t release until the bid has been announced.”
 - K-DO—“It is confidential. EEs are never released, not even an estimated cost.”
 - G-DO—“I believe the EE is not released.”

2. Are there any State laws or administrative regulations in effect to determine whether a contract award is proper, based on estimate overrun, competition, or other factors?
 - E-DO—“Not that we are aware of.”
 - D-DO—“Only those of the 23 CFR (House of Representatives 2020b).”
 - H-DO—“I am not aware. I don’t know anything other than what I told you before.”
 - C-DO—“I don’t know if it’s a State law or administrative requirement for them. They do bid analyses, but I don’t know that it’s based on State statutes.”
 - I-DO—“I don’t think there’s anything legislatively. They pretty much follow the guidance. They go through the analysis and determine whether they should expect better bids or not.”
 - J-DO—“I don’t think there is anything that stops them from doing this.”
 - K-DO—“10 percent is a trigger for review. They want to be under 10 percent. That is the threshold. There are no similar considerations related to competition. We (K-STA) want to be as close to the EE as possible.”

- G-DO—“They have a committee that looks at all bids that come in. Every other week, they revise them to make sure that contracts are awarded properly. The committee makes the recommendation whether to award to the low bidder—or otherwise—or reject the bids. Then another person will review that and agree or disagree.”
3. Is any information released publicly that may indicate the actual or approximate value of the estimate prior to opening bids? If so, when and where is it published?
- E-DO—“Overall project during NEPA. In terms of total project cost.”
 - D-DO—“There is a range published, so contractors know the approximate size.”
 - H-DO—“They publish a range during the advertising period. STIP is online. If the project has its own page, it specifies something with Federal funding. If a project’s EE is \$50 million, I expect the STIP to be higher than this because we have to include the cost of inspection and such. This information is available online. We need to make sure that the estimate that we are authorizing Federal funds [for] is actually available.”
 - C-DO—“They put a number out there to show how big the project is (the STIP is public). Contractors only want to know how big it is.”
 - I-DO—“They publish a range when the project is actually (electronically) advertised through the system.”
 - J-DO—“Range beforehand and actual value after. Arkansas doesn’t release it at all.”
 - G-DO—“I do not think they publish anything that gives information about this. The STIP is the only information available ahead of time.”
4. Is the EE published in detail, or is only the total cost provided?
- I-DO—“Nothing is published in detail.”
 - J-DO—“At some point, they will post the bid tabs.”
5. Are there any written procedures for evaluating bids within your agency?
- E-DO—“They have documented certain policies that are built into their software now.”
 - D-DO—“Yes; will be provided.”
 - H-DO—“I am not aware that they do.”
 - C-DO—No.
 - I-DO—“There is a guide.”

- J-DO—“They have a process that depends on what the project is. They run it through several groups, and this is laid down in the process. (They have a process).”
 - K-DO—“EE is not published, but the awarded bid is published.”
 - G-DO—“I don’t know.”
6. In the case of poor competition or excessive difference between the estimate and the low bid or best value, does the contracting agency contact the bidders and nonbidders who examined proposal forms?
- E-DO—“Informally, they try to do that. They have a mechanism in which they can ask them, ‘What happened to this?’ We ask the State E Transportation Builders Association.”
 - D-DO—“They more likely reject all bids and, potentially, reach out to bidders. They’ll reevaluate maybe if they have to use ‘force account work’ or something, depending on the size of the project.”
 - H-DO—“They do contact them sometimes.”
 - C-DO—Yes.
 - I-DO—“Yes. They contact plan holders that did not bid if they see inadequate competition to find out why they did not bid.”
 - J-DO—“Yes. Even recently, they had a weird thing happen, and they sent a letter for the contractors to review.”
 - K-DO—“They might ask what happened.”
 - G-DO—“If there is a huge difference, they will contact the low bidders and other bidders to try to determine if there’s any basis for that.”
7. Are there any “ground rules” for adjusting estimates after receiving bids? Is such action taken on its own merits, or may it be prompted by pressure to award an excessive bid?
- E-DO—“They can’t make any adjustments. They are not allowed to negotiate or anything like that.”
 - D-DO—“I hope not! I’ve never seen this. I have no idea.”
 - H-DO—“To my understanding, estimates are not adjusted after the advertising period.”
 - C-DO—“They would do an abstract on DB because ATCs (alternative technical concepts) change.”
 - I-DO—“There is no adjusting the EE after a project has been bid.”

- J-DO—“Most likely, they don’t rebid the projects; they can’t negotiate. This will only happen if there is a very obvious error on their end. They do have ground rules on some projects.”
- K-DO—“I don’t know.”
- G-DO—“I don’t know. They do adjust them if they believe it makes sense, but they detail why they believe it could be adjusted so people can have documentation about why they were adjusted.”

WRAP-UP

1. Does your agency have any documentation that you follow to develop and/or provide oversight on cost estimates that you can share?

E-DO—“We have some procedures.”

2. Is there anything you believe we should have asked about that we did not cover during this interview?

- E-DO—“If they want to fully reject a bid, they have to check in with us. We have monthly contact, at least. They like to check and make sure. See what standard operating procedures exist in the division. We have a hub for the FHWA past reviews conducted by the DOs. We might find one that has cost estimates.”
- D-DO—“We should try to talk to H-DO.”
- H-DO—“What the division does [to provide] oversight?”

“We provide oversight at various moments of a project’s life. It is not continuous, but we do provide oversight. We provide oversight for the areas we are approving funds for (e.g., preliminary engineering funds, construction funds, utility funds). Mostly done for PODIs.”

- J-DO—“FHWA is trying to take a step back and let STAs run the show.”
- K-DO—“Mathematical or material unbalance is something I personally check, based on my previous experience with DOTs.”
- C-DO—“We are not involved at all with estimates. We only help them with new estimating strategies or if they need approvals.”

APPENDIX E—FOLLOW-UP INTERVIEW

**FHWA TASK ORDER “ASSESSMENT OF FHWA HIGHWAY PROJECT COST
ESTIMATION TOOLS”**

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SECTION I – INTRODUCTION

PURPOSE

The purpose of this document is to provide enough background information for the reader to understand the current status of the research being conducted in the current project. This understanding is necessary for the requested follow-up interview with members of FHWA Federal Aid Division Offices (DOs) and State Transportation Agencies (STAs). It is important for the reader to read this document prior to attending the interview, as the contents of this guide provide the necessary background information for the questions to be asked during the interview. The interview process has the main objective of receiving feedback from the different participating agencies for the development of a cost estimate oversight guide. The guide that will be developed includes oversight for project-level cost estimates as well as program-level estimates oversight.

To achieve consistency and agreements across DOs and STAs, regarding the practices used for Cost Estimate oversight, the research team has conducted multiple interviews with agencies across 11 different states. The present document shows an aggregate of the best practices found in literature and obtained from interviews with different agencies. While described in detail below, a list of these practices includes Pareto Principle, Historical Project Comparison, Monitoring and Updating Cost Estimates, Knowledge of Factors that Influence Project Cost, Procedures for Analyzing Cost Estimates, and Estimate Development Oversight.

It also serves as a summary for a follow-up interview with agencies that participated in the first round of interviews. This process will aid in the objective of achieving consistency of the Cost Estimate Oversight process for project-level and program-level.

Identified Good Practices on Cost Estimate Development and Cost Estimate Oversight

Based on the first round of interviews and literature review, the team identified a number of good practices, both for cost estimate development and cost estimate oversight. Said practices were extracted from interviews and documents received from the agencies. Most of the practices mentioned below are related to the development of cost estimates. However, they can be used as checklist items when providing oversight. Before providing oversight for cost estimates, it is important to understand how to develop an estimate in the first place. Therefore, the final guide should include the best practices to develop estimates, so that whoever has the responsibility to provide oversight can do it in a well-informed manner.

Practice: Pareto Principle

One of the most common practices among the interviewed states (both, STAs and DOs) when uses the *Pareto Principle* – also known as the 80/20 – for reviewing cost estimates. The Principle states that 80% of a project’s associated cost can be explained by 20% of the items. In this way, states encourage estimators to identify which bid items comprise 80% of the estimates, so that they can focus on these items while conducting estimate reviews (see Appendix 1, extracted from WisDOT’s ‘esd-template’). Nonetheless, this practice has to be complemented with other practices to avoid issues with mathematically or materially unbalanced bids. For example,

Caltrans states this on their ‘Cost Estimating On-The-Job Training’: “*Remember never use single low bid data point, it could be from an unbalanced low bid*”. This practice is recommended for checking bid unit prices to ensure that the low bid unit price is not unbalanced.

Practice: Historical Project Comparison

Another common recommended practice for estimate development is to check for existing projects with similar conditions (e.g., location, size, type of project, material type, etc.). This helps the estimator find relevant historical data to complete/develop the cost estimates for new projects. WisDOT developed an excel spreadsheet used to compare projects with historical data using 9 different filters (Appendix 2). In this tool, the user selects the characteristics of the project to be analyzed. These characteristics will filter similar projects, extracted from an existing database of over 1000 executed projects so that the historical data used is more relevant and accurate.

This tool also helps identify the relevant items for the Pareto Principle. After selecting the filters, the results (Appendix 3) show the relevant items classes, along with their percentage relative to the project. It also shows average number of bidders for the filtered options.

Practice: Monitoring and Updating the Cost Estimates

Project cost estimates should be kept current. After the development of the initial estimate, the following updates are recommended to be submitted.

- Annual updates: Cost estimates should stay current. This means that the estimates should be updated once a year. If quantities or scope of the estimate have changed, then these have to be reflected in the annual estimate. Otherwise, estimates should be updated with current unit costs for the bid items present in the estimate.
- Programming cycle: Each programming cycle should require an updated estimate. This update would provide an estimate to be used as a benchmark for the next programming cycle.
- Significant changes in project costs: If a project has significant changes in scope, size, risks, or other factors that might represent a significant change in the project cost, a new estimate should be prepared to accommodate for said costs.
- Expiration of the PS&E: Once a project reaches the final PS&E estimate, the costs should be kept updated every three months.

Practice: Knowledge of Factors that Influence Projects Cost

Estimators should keep in mind the factors that influence projects cost. Some of these factors, that should be considered when developing an estimate include, but are not limited to:

- Direct cost to the contractor:
 - Materials
 - Labor

- Equipment
- Overhead and other indirect cost
- Profit
- Direct cost price trends
- Average prices from recent lettings
- Characteristics of the work:
 - Type
 - Size
 - Complexity
 - Location
 - Accessibility
 - Staging
 - Necessary restrictions (restricted work hours and/or tight time frames to complete the project)
 - Special construction problems
 - Traffic
 - Other related factor affecting the cost of the project
- Experience and judgement of the Estimating Staff.
- Specialized Work:
 - Signs and Traffic Control Devices
 - Lighting, Buildings, Rest Areas, etc.
 - Landscaping
 - Railroads
 - Utilities
 - Bridges, Walls, and other Structures
- Competition
- Inflation
- Market Conditions
- Material Availability

Practice: Procedures for Analyzing a Cost Estimate.

The following is a list of procedures and considerations when evaluating a cost estimate. The list should be helpful to FHWA personnel when reviewing STAs estimates and should also be helpful for DOs when analyzing bids.

1. Identify the purpose of the Estimate

Identifying the purpose of the estimate is critical to determine the level of detail of the estimate and the methodology used for developing the estimate.

2. Identify Project Parameters

As mentioned in the previous sections, it is important to identify the following characteristics before analyzing a cost estimate. These first steps ensure that the prices used for the cost estimate are as aligned with the reality of the project as possible.

- a. Identify Work Type
 - b. Identify Highway Type
 - c. Identify Urban/Rural Type
 - d. Identify Season
 - e. Identify County
 - f. Identify Region
 - g. Identify Terrain Type
3. Major Cost Deviations Analysis for Reasonableness and Unbalancing (Vermont Agency of Transportation 2018):
- a. Items to be analyzed are selected. Using the Pareto Principle, 20% of the items that comprise roughly 80% of the estimate are selected to be analyzed.
 - i. The acceptable deviation, in dollars, for a single item is determined. Typically, this is 1% of the contract total low bid or the contract total estimate (whichever is lower). This is the maximum allowable deviation for any particular item for the estimate being analyzed. In other words, no item should deviate more than 1% of the low bid or total contract amount.
 - ii. The items where the actual difference of the extended low bid amount (quantity multiplied by unit price) is above or below the extended estimate amount by more than the acceptable deviation as determined in i) above are identified.
 - iii. An acceptable level of cost variance is determined.
 - b. An acceptable level is considered to be 80% of the sum of the absolute value of the difference of extended low bid amount minus the extended estimate amount for all pay items in the contract. Using the absolute values ensures that all variance will be analyzed whether it is high or low. This method provides for better analysis of projects that have an overall low bid that is reasonably close to the estimate but have individual pay items with high variance between the extended low bid amount and the extended estimate amount.
 - i. The sum the absolute value of the difference of extended low bid amount minus the extended estimate amount for the items identified in ii above is compared to the acceptable level of the cost variance as determined in iii above to determine if a reasonable analysis level has been met.
 - ii. If the sum of the absolute values of the difference of extended low bid amount minus the extended estimate amount for the identified pay items is not greater than, or reasonably close to, the acceptable level of the cost variance then the acceptable deviation from i above is adjusted up or down to add to the identified item list until the acceptable level is met.
 - c. A detailed analysis is performed on the selected items. The analysis can include quantity checks, estimated price checks, review of specifications, questioning of bidder, relation of low bid to second and third bids, comparison of bids to similar projects, and other methods. The intent is to determine reasonableness of the bid and if unbalancing is present.
4. Unit price deviation analysis for unbalancing:

- a. Identify the items where the low bid unit price exceeds the estimate unit price. A starting point of items to analyze is those items where the low bid unit price exceeds the estimate unit price by 25% or more.
- b. Identify the items where the low bid unit price is lower than the estimate unit price. A starting point of items to analyze is those items where the low bid unit price is lower than 75% of the estimate.
- c. If an item has been analyzed as part of step 2, no additional analysis is needed.
- d. If an item has not been analyzed as part of step 2, perform an estimate check and quantity check to determine if unbalancing is present.
- e. Additional consideration can include number of bidders, bids of second and third bidder, project urgency, and market conditions.

An example of this process and more details can be found in Appendix 4 and the original source ([Vermont Agency of Transportation 2018](#))

5. Competition Analysis

- a. Identify the Engineer's Estimate (EE).
- b. Identify the number of bidders. This consideration will help determine whether the bids are within an acceptable range. Figure 3 shows an example of how CalTrans uses this information to compare bids with the EE.
- c. Identify the range of bids.
- d. Analysis of bid history on similar (scope and/or geography and/or cost) projects – identifying whether improved competition would be anticipated if the project were re-let.

6. Documentation of results and recommendations

- a. Documentation of the analysis is in the form of a memo to Contract Administration.
 - i. The Documentation should include a narrative of general observations, number of bidders, range of bids, what acceptable deviation was used, any findings from Step 2 of the analysis, and a summary statement of what the analysis found.
 - ii. The Documentation should include a detailed narrative for each pay item analyzed in Steps 2 and 3.
 - iii. The Documentation should include the results of the analysis in Step 4.
 - iv. The Documentation should contain a recommendation as to award or rejection of the bid.

Practice: Estimate Development Oversight

The following list is a compilation of relevant practices collected for cost estimate oversight procedures.

Estimate Development Oversight Checklist

Appendix 6 shows checklist lists relevant items that should be considered when providing oversight for a cost estimate. These items were collected from documentation provided by

several states. The following list is only a draft, and as will be discussed in the next section, part of the intent of Task 4 is to further develop the list with input from different FHWA Division Offices.

Cost Estimate Oversight Process – Project-level

Appendix 7 shows flowchart is a sample diagrammatic representation, developed by the current research team, of the cost oversight process for an individual project from the FHWA Federal-aid Division Office's perspective. The diagram is intended to identify typical timing of DO reviews and will eventually include references to specific practices (some mentioned prior in this report and other to be identified through further interviews) along with suggested timing of each practice. For the final deliverable, the current research team will develop a similar diagram to depict the process from a program-level perspective. The reason for having two separate diagrams is that project-level oversight and program-level oversight, even when similar in nature, are different processes.

SECTION II - INTERVIEW

PURPOSE

Having read Section I, the interviewee should have enough clarity to answer the questions provided in this follow-up interview, which are related to the methods used to provide oversight for cost estimates at a project-level as well as at a program-level. The methods described were obtained from the first round of interview, in which you, and other members from other agencies. The agencies interviewed in the first round of interviews were State transportation Agencies (STAs) and FHWA Federal Aid Division Offices (DOs) from 11 states, as well as a Federal Lands (FL) office.

Based on the first round of interviews and literature review, the team identified a number of good practices, both for cost estimate development and cost estimate oversight. Said practices were extracted from interviews and documents received from the agencies. Most of the practices mentioned below are related to the development of cost estimates. However, they can be used as checklist items when providing oversight. Before providing oversight for cost estimates, it is important to understand how to develop an estimate in the first place. Therefore, the final guide should include the best practices to develop estimates, so that whoever has the responsibility to provide oversight can do it in a well-informed manner.

1. Practices

[On a scale from 1 to 10, where 1 is low and 10 is high, please grade your familiarity with the following practices, as well as your perception of how useful the practices are.]

- a. **Pareto Principle.** The Principle states that 80% of a project’s associated cost can be explained by 20% of the items.
 - i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with the Pareto Principle**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness – on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Pareto Principle** in providing oversight for cost estimates. N/A – not applicable in terms of you having no familiarity or experience with using the **Pareto Principle**.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

- b. **Historical Project Comparison.** This practice is used to compare the project being estimated to other projects with similar conditions (size, location, etc.)

- i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with the Historical Project Comparison practice.**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness - on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Historical Project Comparison** in providing oversight for cost estimates. N/A – not applicable in terms of you having no familiarity or experience with using the **Historical Project Comparison practice.**

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

- c. **Monitoring and Updating the Cost Estimates.** This practice is used to keep the cost estimate up to date relative to changes in design, quantities, market conditions, and other factors that might affect the estimate.

- i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with Monitoring and Updating the Cost Estimates.**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness - on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Monitoring and Updating the Cost Estimates** in providing oversight for cost estimates. N/A – not applicable in terms of you having no familiarity or experience with using the **Monitoring and Updating the Cost Estimates.**

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

- d. **Knowledge of Factors that Influence Projects Cost.** Estimators use this practice to know which are the factors that influence projects cost. This is relevant for questions in section 1.3.

- i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with the Knowledge of Factors that Influence Projects Cost**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness - on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Knowledge of Factors that Influence Projects Cost** in providing oversight for cost estimates.

N/A – not applicable in terms of you having no familiarity or experience with using the **Knowledge of Factors that Influence Projects Cost**.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

- e. Procedures for Analyzing a Cost Estimate. This practice relates to standard procedures used to evaluate cost estimates.
 - i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with the Procedures for Analyzing a Cost Estimate**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness - on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Procedures for Analyzing a Cost Estimate** in providing oversight for cost estimates. N/A – not applicable in terms of you having no familiarity or experience with using the **Procedures for Analyzing a Cost Estimate**.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

- f. Estimate Development Oversight. This practice is used to provide oversight to cost estimates being developed.
 - i. Familiarity- on a scale from 1 to 10, where 1 is strongly unfamiliar and 10 is strongly familiar, please indicate your level of **familiarity with the Estimate Development Oversight**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- ii. Usefulness - on a scale from 1 to 10, where 1 not useful at all and 10 is the most useful, please indicate the **usefulness of the Estimate Development Oversight** in providing oversight for cost estimates. N/A – not applicable in terms of you having no familiarity or experience with using the **Estimate Development Oversight**.

N/A	1	2	3	4	5	6	7	8	9	10
-----	---	---	---	---	---	---	---	---	---	----

2. Usage

If you have used any of the following practices in the past, please describe your lessons learned on how it can be used effectively.

- a. Pareto Principle
- b. Historical Project Comparison

- c. Monitoring and Updating the Cost Estimates
- d. Knowledge of Factors that Influence Project Costs
- e. Procedures for Analyzing a Cost Estimate
- f. Estimate Development Oversight

3. Input

Below is a draft of a cost estimate checklist that could be used to help review a project’s cost estimate. It was developed based on existing checklists from different state transportation agencies and FHWA division offices. To help improve the efficiency of the checklist, can you state whether or not each element is instrumental in a cost estimate checklist.

a. Sample Cost Estimating Checklist

Guidance Items. These items are used to inquire about general aspects of a cost estimate. They are related general purpose of the estimate and not to specific items of an estimate.	Y/N
Has the purpose of the estimate been defined?	-
Estimating method is identified.	-
The estimating method is available for review	-
Estimate is written down and available.	-
Allowances and factors have been validated and are appropriate for the level of estimate.	-
Oversight team is knowledgeable about the estimating method used.	-
Estimate has been prepared using a typical cost model (e.g. bid item codes)	-
Has the basis of estimate been completed / updated with explanation of changes?	-
Is a basis of estimate document available?	-
Estimate has been independently validated.	-
Have all spreadsheet formulas been reviewed and totals been cross-checked?	-

Uncertainty Items. These items refer to the unknowns (known unknowns and unknown unknowns) of the estimate and their respective assessments.	Y/N
A risk assessment was conducted to identify, analyze, and evaluate risks	-
Estimate is adjusted for inflation to year of expenditure dollars for each element of the project.	-
Project complexity is considered in the estimate.	-
Process includes risk-based assessments of unknown and all uncertain costs.	-
Risk contingencies are sufficiently removed from unit bid item prices in the base cost estimate	-

Construction Items. These items are associated to the quantities and elements related to the physical execution of the projects.	Y/N
Estimate of unit prices are reasonable for the areas, times, and characteristics of the work to be done	-
All unit costs have been validated by professional judgment and/or historical cost information.	-
Incentive/disincentive or escalation clauses have been considered in determining the estimated unit costs	-
All costs and durations have been checked for conformity between amounts of work (item quantities) with the schedule durations to determine correctness.	-
Estimate is consistent with project scope.	-
Estimate includes all initial preliminary engineering costs and final design costs.	-
Estimate includes construction administration.	-
The unit costs of the estimate are aligned with the costs used by the agency	-
Haul road restoration item provided	-

Finance Items	Y/N
Force account work is adequately justified	-
Salvage credit* shown (if applicable)	-
Estimate includes a management reserve. Is this value sufficient for the given project?	-
Estimate includes public outreach cost.	-
Market conditions are being taken into consideration.	-

* Benefits on the value of capital equipment at the end of the period being analyzed.

Non-Construction Items. These items refer to items that are not part of the physical execution of the project but that should be considered part of the estimates.	Y/N
Utility and railroad force account work covered	-
Estimate includes all right-of-way and administrative costs.	-
Estimate includes all third party (e.g. utility, railroad) costs.	-
Estimate includes all Transportation System Management/Transportation Demand Management costs.	-
Nonparticipating work shown	-

Regulation Items - Analyzing Bids. These items refer to the general quality and adherence to regulations of the estimate.	Y/N
The Estimate is Materially Balanced	-
The Estimate is Mathematically Balanced	-
Non-collusion statement included	-

For Risk-Based Estimates. These items are relevant for projects not developed using conventional estimating methods and that involve high risks.	Y/N
Is the risk assessment process documented and available?	-
If a consultant produced the risk assessment, what process is the consultant following and are they willing to share the model they used to produce the final results?	-
Did the state hold a risk workshop to provide input to the results? If so, is a risk workshop final report available?	-
What is the date on the risk workshop report compared to the date the estimate was last updated?	-
Did the group have the right level of subject matter experts attending to develop a robust risk register? If so, were subject matter experts in attendance representing Design, ROW, Roadway CN, Structure, Environment, Permitting, Utilities, Lighting, etc?	-
Did the group identify minor risks or did they identify significant risks to project cost and schedule?	-
What risks were identified as most significant in terms of driving cost and schedule completion?	-
Do you have a project risk tornado diagram available?	-
Were the risks in the risk register ranked?	-
Did they used risk expected value, by cost impact, by schedule impact, etc.?	-
If risks are ranked by expected value how are low probability, high impact risk events addressed?	-

For Risk-Based Estimates. These items are relevant for projects not developed using conventional estimating methods and that involve high risks.	Y/N
How was the project budget and completion date determined from the probability cost and schedule forecast curves?	-
Does the state have a reliability level to establish budget and schedule completion? How was this level determined?	-
For the risk workshop forecast curves, are they wide curves or narrow curves?	-
How does the state account for market conditions in the risk assessment model?	-

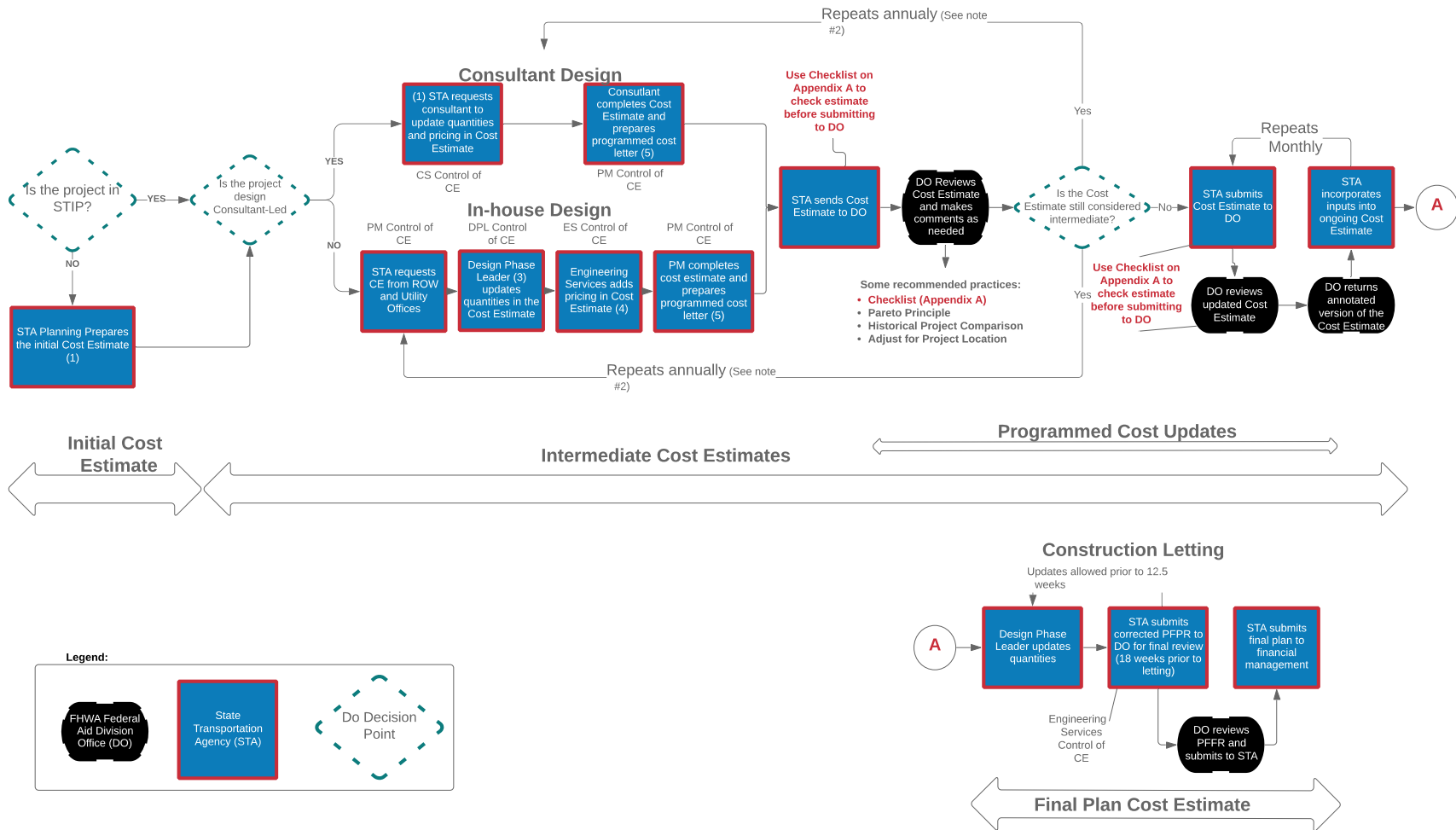
Note to the curves: Provide backing analysis for each of the phases.

b. Cost Estimate Oversight at a Project-level

This flowchart is a sample diagrammatic representation of the cost oversight process for an individual project from the FHWA Federal-aid Division Office’s perspective. The diagram is intended to identify typical timing of DO reviews and will eventually include references to specific practices (some mentioned prior in this report and other to be identified through further interviews) along with suggested timing of each practice.

Can you answer the following questions?

- i. Do you follow any similar project review process? If so, how does it compare?
- ii. Are there missing steps that you think should be added?
- iii. Are there proposed steps that you think are redundant or unnecessary?



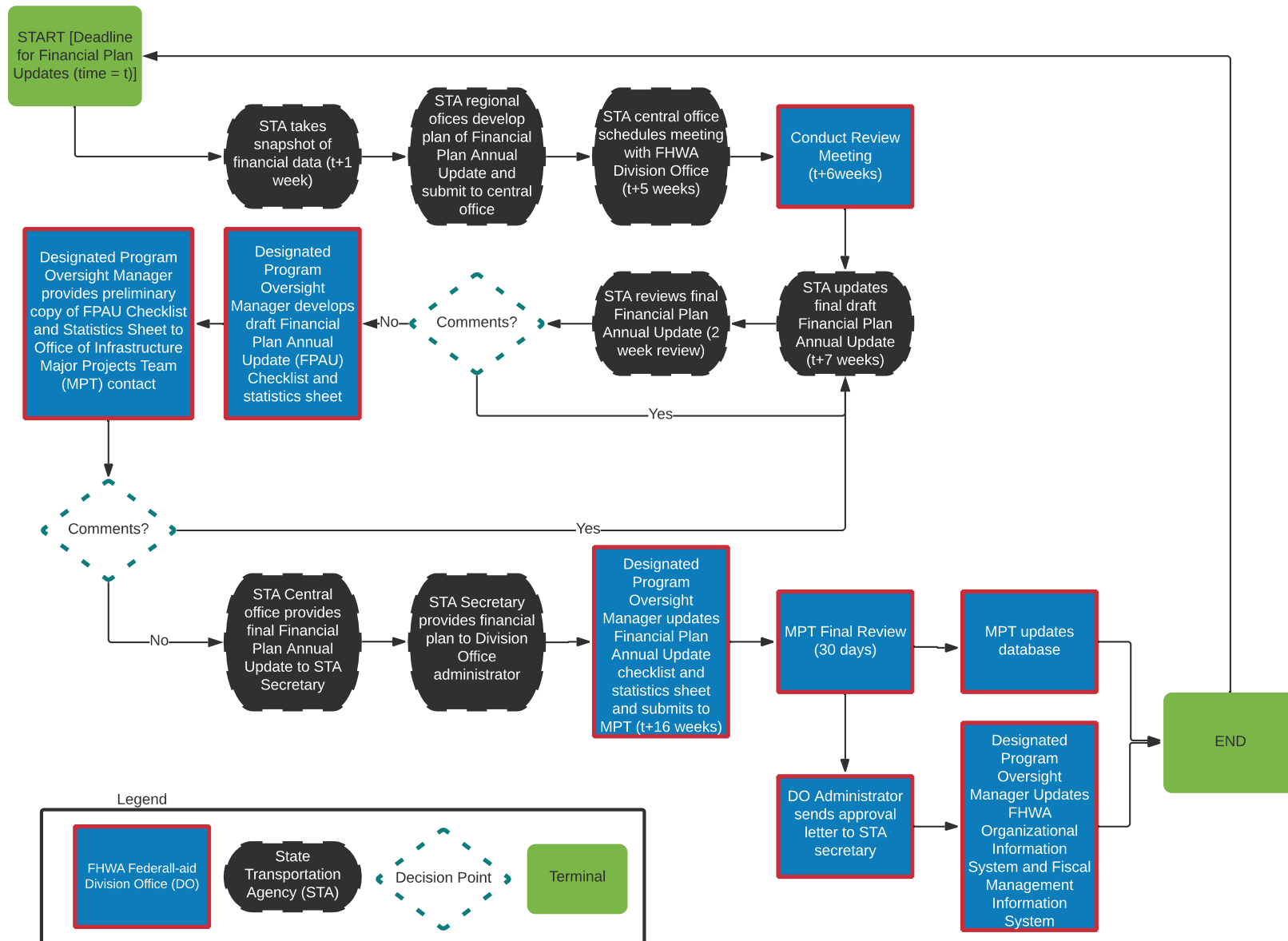
A preliminary diagram was included here. For the actual diagram, refer to page 37 in the main report.

c. Cost Estimate Oversight at a Program-level

This flowchart is a sample diagrammatic representation of the cost oversight process for a whole STA Program the FHWA Federal-aid Division Office's perspective. The diagram is intended to identify typical timing of DOs reviews and will eventually include references to specific practices (some mentioned prior in this report and other to be identified through further interviews) along with suggested timing of each practice.

Can you answer the following questions?

- i. Do you follow any similar project review process? If so, how does it compare?
- ii. Are there missing steps that you think should be added?
- iii. Are there proposed steps that you think are redundant or unnecessary?



The Financial Plan Checklist is shown in Appendix 8.

4. Comments

In this section we would like to ask about specific practices that your agency might use that were not included in this interview as well as any additional questions or comments you might have for the research team.

APPENDIX

Appendix 1 – Pareto Principle

Table 1. Capture from WisDOT’s esd-template

ITEM LEVEL DOCUMENTATION
Significant Items List – Top 20% of items out of total contract costs and lump sum items Click here to enter item documentation or list significant items with attachment containing documentation
Non-Significant Items Summary – Summary of estimating Methodology Click here to enter text.
Estimate Review Summary Consultant Reviewer(s): Region Reviewer(s):

In the above, the first field ‘Significant Items List’ refers to the items to be checked, which should comprise 80% of the estimate, according to the pareto principle. The second field ‘Non-Significant Item Summary’ describes the approach used to create the estimate. Finally, the third field ‘Estimate Review Summary’ is where comments that had a direct impact on unit prices should be written. This section should not include iterations of comments between the review and design teams. Instead, just the final decision should be enough.

Appendix 2 – Historical Project Comparison

Filters

Sample Size: 1,813

Proposal Improvement/Work Type

Improvement Type	Improvement Concept	Contract Work Type	Work Rating
Bridge Rehabilitation	BRIDGE ELIMINATION	Asphaltic Pavement	Asphaltic Surfacing
Bridge Replacement	BRIDGE REHABILITATION	Bridge Painting	Asphaltic Surfacing and Incidental Const
Expansion	BRIDGE REHABILITATION (SHRM)	Concrete Pavement	Bridge Painting
Miscellaneous	BRIDGE REPLACEMENT, EXPANSION	General Construction	Building and Incidental Construction
Pavement Replacement	BRIDGE REPLACEMENT, PRESERVATION	Grading	Building Construction
Preservation/Restoration	MISCELLANEOUS	Street or Airport Lighting	Gen Const and Asph Surf and Incidental
Reconditioning	NEW BRIDGE	Structures	Gen Const and Asph Surf and Structures
Reconstruction	PARTIAL DEPTH CIR WITH <= 2.5 INCH CAP		Gen Const and Brg Painting and Inc Const

Proposal Information

Region	County	Project Size	Urban/ Rural	Route
NC	Lafayette	\$ 0.5M or less	Rural	Sth 310
NE	Langlade	\$ 0.5M to \$ 1M	Unknown	Sth 312
NW	Lincoln	\$ 1M to \$ 2M	Urban	STH 441
SE	Manitowoc	\$ 2M to \$10M		TWN RD
SW	Marathon	\$10M to \$20M		USH 002
	Marinette	\$20M or more		Ush 002/053
	Marquette			USH 008
	Menominee			USH 010

Appendix 3 – Historical Project Comparison (part 2)

Results

Mobilization Results	
Sample Size:	1,813
Expected Range (lower limit):	3.4%
Typical Middle Value:	5.9%
Expected Range (upper limit):	9.3%

Traffic Control Project Results		
Sample Size:	1,811	
Expected Range (lower limit):	0.2%	\$2,000
Typical Middle Value:	0.5%	\$5,242
Expected Range (upper limit):	1.3%	\$24,489

Average Number of Bidders	3.4
---------------------------	-----

Item Classification Totals		
Expected Range:	Lower Middle Inner	
Item Class	Middle Value	Item Class Code
SPVs (Default)	4.3%	AAA
Asphalt	6.4%	ASPH
Base Aggregate	4.1%	BASE
Bridge Painting	0.0%	BRPT
Concrete Pavement	0.4%	CONC
Curb & Gutter, Sidewalk	0.1%	CURB
Drainage Culverts Conduits	1.0%	DRNG
Electrical	0.0%	ELEC
Erosion Control	2.1%	EROC
Earthwork	4.5%	ERTH
Gates and Fences	0.0%	FENC
Beamguard	0.0%	GDRL
Intelligent Transportation Systems	0.0%	ITS
Landscaping	0.2%	LSCP
Lighting	0.0%	LTNG
Miscellaneous or Specialty Work	1.4%	MISC
Mobilization	5.9%	MOBL
Pavement Marking	1.4%	PVMK
Removal Asphalt Pavement	0.4%	RMVA
Removal Old Structures	0.0%	RMVB
Removal Concrete Pavement	0.0%	RMVC
Removals	0.2%	RMVL
Signs	0.3%	SIGN
Structures	0.7%	STRC
Survey	0.4%	SURV
Traffic Control Permanent	0.0%	TRFP
Traffic Control Temporary	1.5%	TRFT

Appendix 4 – Procedures for Analyzing a Cost Estimate Example

GENERAL OBSERVATIONS:

Engineer's Estimate: \$1,919,815.94

Low Bid: \$1,578,986.55

Difference: -\$340,829.39 or 17.75 %

The subject project was estimated at \$1,919,815.94. There were a total of six bidders, three bids were lower than the engineer's estimate and three bids were higher than the engineer's estimate. These bids ranged from \$1,578,986.55 to \$2,257,110.00. [Statement regarding the number of bidders and the corresponding range of bids is required.]

For the purposes of this bid analysis, only the construction items that were overbid or underbid by \$15,789.87 or more in cost between the engineer's estimate and the low bid price were analyzed. This amount (\$15,789.87) represents 1.00% of the low bid price. The low bid unit prices not included in this range were reviewed and no outliers were present, meaning that these items of lesser dollar amounts can be considered insignificant. [Statement explaining how construction items were chosen for analysis is required. The majority of Highway, Safety & Design projects will utilize the 1.00% of low bid price procedure described above, however an alternate threshold may be applied based on specific project characteristics. Review of low bid unit prices outside of this range should be performed. Any construction items that vary significantly should be analyzed and the calculated quantities verified. If these additional items are included in the bid analysis, justification for their selection should be provided with each individual construction item.]

As indicated and discussed in the attached sheets, several unit bid prices varied from the engineer's estimate, yet this analysis has failed to reveal any unbalancing of low bid unit prices by the Contractor and therefore recommend that this bid be accepted. [Provide a summary statement that explains the general result of the bid analysis with a recommendation for acceptance or denial. The statement above is an adequate sample and should be used in place of the common "reveal any clear cut advantage for the Contractor with an equally corresponding disadvantage to the State." Note that a bid may be accepted even if it is determined that it is unbalanced if it is the best course of action and any potential overrun would not create a situation where the low bidder was no longer the low bidder.]

Item Number: 201.15

Estimated Quantity: 7000 CM

Item Description: Common Excavation

Estimate	Extended Unit Price Estimate	Low Bid Unit Price	Extended Low Bid	Low Bid Difference
\$13.65	\$95,550.00	\$7.85	\$54,950.00	-\$40,600.00

[Item number, item description, quantity, estimate unit price, extended estimate, low bid unit price, extended low bid, and low bid difference are all required. Low bids that are less than the engineer’s estimate shall be notated with a “-“, and those that are higher than the engineer’s estimate shall be notated with a “+” in the low bid difference column.]

Description: The low bid unit price is lower than the regression price (estimate unit price) for this construction item. While the low bid unit price is on the lower side it does fall within the range of the bid trend for projects of similar size and is consistent with the second and fourth low bidders, as well as with past bids submitted by J. Hutchins, Inc. [Comparison to other received bids, similar projects, and/or contractor bid history should be performed and described. The Quality Assurance Unit is available to assist, as necessary, to obtain this information.] The listed quantity of 7000 CM has been verified. [For items carrying units of measure other than LS a statement indicating that the estimated quantities have been verified is required.] Recommend acceptance of low bid unit price. [If it is determined that an error in the engineer’s estimate was made, it should be stated and explained.]

[Other considerations should be listed under “Description” on a project specific basis. These considerations include but are not limited to; geographic location of the bidders, potential for savings if the project is re-advertised, presence of front-loading or un-balanced bids, variance from a construction item’s “normal” installation, and any unique project characteristics that could influence the low bid unit price.]

Response letter to the bid analysis:

Dear [REDACTED]

[REDACTED] has completed the bid analysis for the [REDACTED] project. Included below is the bid analysis. A tabulation of all the bids is also attached.

The bids were opened on March 8, 2010 and there were a total of ten bids received. The bid total of the low bid was \$108,875.00 and the second low bid was \$1 19,961.50. The engineer's estimate was \$137,257.54 (not including a 10% contingency).

The low bid of \$108,875.00, which was submitted by [REDACTED], represents 79.32% of the engineer's estimate. The second lowest bid from [REDACTED] had mathematical errors in their bid tabulation but did not change their ranking or affect the low bid price. The high bid \$191,695.30, submitted by [REDACTED], did not include a non-collusion affidavit in their submittal and therefore was considered a non-responsive bid.

For the low bid from [REDACTED], 12 of the 32 unit prices were higher than the engineer's estimate. Seven of these 12 higher unit prices were less than 130% of the engineer's estimated unit prices. For all but 1 of these 7 items, the difference between the estimate item total and the bid item total was less than \$300.00. While only 104% of the engineer's estimate, Item 616.210 Vertical Granite Curb was \$963.00 more than the estimate item total and had a unit cost of \$31.00. Out of all the responsive bidders, 8 of 9 had higher unit pricing than the estimate and these unit costs ranged from \$30.00 to \$39.00. The engineer's estimate was \$29.93. Only the Engineers Construction bid had a lower unit price at \$29.00.

There were 4 unit prices that were more than 130% of the engineer's estimate in the low bid. Item 646.310 Crosswalk Marking was nearly double the estimate at [REDACTED] per unit. Because the project only requires 55 lf, the overage is only \$275.45 and not significant. The 156% overage for Item 646.400 Durable 4" White Line was also insignificant because it resulted in a \$198.00 difference in the amount total.

Two remaining items in the low bid that were over the engineer's estimate unit prices were Item per CY, the unit price for Item 203.150 Common Excavation on the low bid was 218% over the engineer's estimate. The low bidder's total cost for this item is \$3,272.50 more than the estimate. All nine of the responsive bidders, including the low bidder, had a unit price higher than the engineer's estimate Of \$5.05 a CY. These unit prices ranged from \$7.00 to \$20.00 a CY.

For Item 406.250 Bituminous Concrete Pavement, the low bidder had a unit of \$150.00 a TON which is 158% over the engineer's estimate. All nine of the responsive bidders, including the low bidder, had a unit price higher than the engineer's estimate of \$94.94. Only the [REDACTED], ranked 7th lowest bid overall, had a lower unit price for this item. The 6th lowest bid overall, [REDACTED], had the same unit price as the low bidder.

The remaining 20 unit prices were either the same or less than the engineer's estimated unit prices. [REDACTED] has reviewed all of these bid unit prices and compared these bid unit prices to the engineer's estimate. There were two unit prices from the low bidder that were significantly below the engineer's estimate. The low bid unit price for Item 618.100 Portland Cement Concrete Sidewalk 5 inch (\$42.00 per S Y) was 58% of the engineer's estimate. All 8 of the other responsive bids had a unit price for this item lower than the estimate with 6 of these bids under the low bidder. The low bidder was \$12,000.00 under the engineer's estimate for Item 635.110 Mobilizations/1)emobilization. This is a lump sum item and will not over-run.

Based on this analysis, there does not seem to be any unbalanced unit prices that appear to give the bidder an unfair advantage. Also the plans and item quantities seem to be in order and the chances of significant item quantity over-runs are small.

[REDACTED] is currently on the [REDACTED] prequalification list. As a result of this bid analysis, we are recommending that the project should be awarded to the low bidder, [REDACTED], for the amount of \$108,875.00. The low bid offers no advantage to the contractor or disadvantage to the town.

Please feel free to call if you have any questions or would like any additional information. If the bid analysis and our recommendation are acceptable, please sign in the space provided below. This will authorize the [REDACTED] to proceed with signing a contract with [REDACTED] for the amount of \$108,875.00.

[REDACTED]

Sincerely,

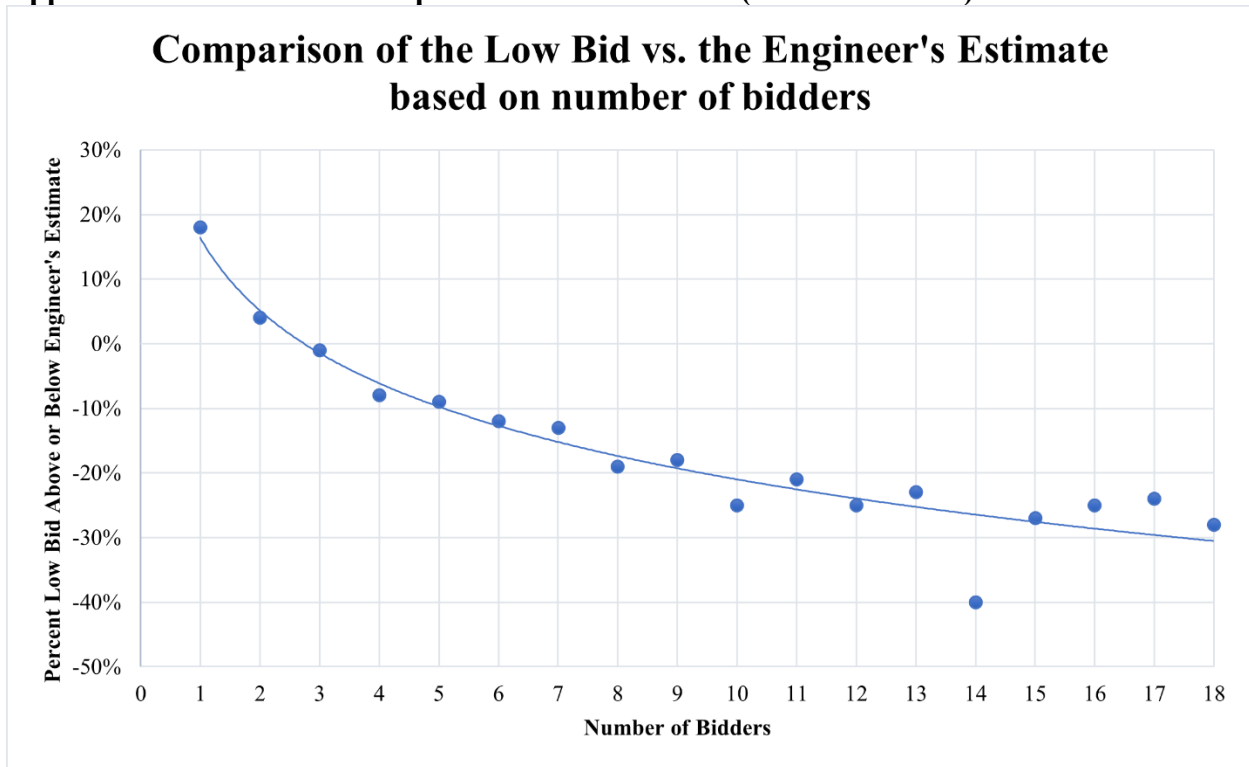
[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Appendix 5 – Low Bid vs. EE per Number of Bidders (Source: FHWA)



Data source: CalTrans on 14,188 projects from 1993 until 2018 (Updated 2019)

Appendix 6 – Sample Cost Estimate Checklist

Guidance Items	Yes	No	N/A
Has the purpose of the estimate been defined?	-	-	-
Estimating method is identified.	-	-	-
The estimating method is available for review	-	-	-
Estimate is written down and available.	-	-	-
Allowances and factors have been validated and are appropriate for the level of estimate.	-	-	-
Oversight team is knowledgeable about the estimating method used.	-	-	-
Estimate has been prepared using a typical cost model (e.g. bid item codes)	-	-	-
Has the basis of estimate been completed / updated with explanation of changes?	-	-	-
Is a basis of estimate document available?	-	-	-
Estimate has been independently validated.	-	-	-
Have all spreadsheet formulas have been reviewed and totals have been cross-checked?	-	-	-
Allowances and factors have been validated and are appropriate for the level of estimate.	-	-	-

Uncertainty Items	Yes	No	N/A
A risk assessment was conducted to identify, analyze, and evaluate risks	-	-	-
Estimate is adjusted for inflation to year of expenditure dollars for each element of the project.	-	-	-
Project complexity is considered in the estimate.	-	-	-
Process includes risk-based assessments of unknown and all uncertain costs.	-	-	-
Risk contingencies are sufficiently removed from unit bid item prices in the base cost estimate	-	-	-
For deterministic estimates, does the estimate include a contingency to account for project risks?	-	-	-

Construction Items	Yes	No	N/A
Estimate of unit prices are reasonable for the areas, times, and characteristics of the work to be done	-	-	-
All unit costs have been validated by professional judgment and/or historical cost information.	-	-	-
Incentive/disincentive or escalation clauses have been considered in determining the estimated unit costs	-	-	-
All costs and durations have been checked for conformity between amounts of work (item quantities) with the schedule durations to determine correctness.	-	-	-
Estimate is consistent with project scope.	-	-	-
Estimate includes all initial preliminary engineering costs and final design costs.	-	-	-
Estimate includes all construction costs from project bidding to the completion of the project construction.	-	-	-
Estimate includes construction contingencies for unforeseen scenarios.	-	-	-
Estimate includes construction administration.	-	-	-
The unit costs of the estimate are aligned with the costs used by the agency	-	-	-
Haul road restoration item provided	-	-	-

Finance Items	Yes	No	N/A
Force account work is adequately justified	-	-	-
Salvage credit* shown (if applicable)	-	-	-
Estimate includes a management reserve. Is this value sufficient for the given project?	-	-	-
Estimate includes public outreach cost.	-	-	-
Market conditions are being taken into consideration.	-	-	-

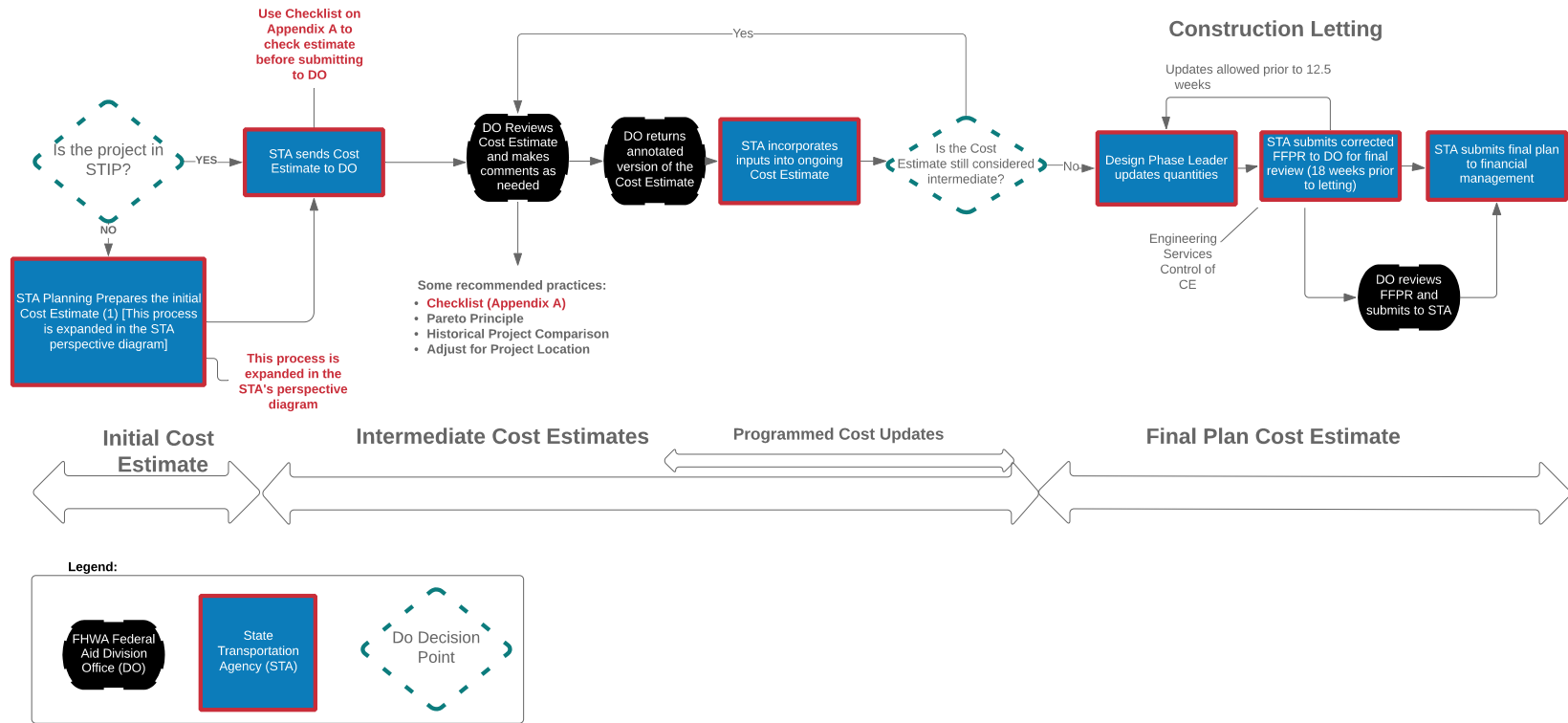
* Benefits on the value of capital equipment at the end of the period being analyzed.

Non-Construction Items	Yes	No	N/A
Utility and railroad force account work covered	-	-	-
Estimate includes all right-of-way and administrative costs.	-	-	-
Estimate includes all third party (e.g. utility, railroad) costs.	-	-	-
Estimate includes all Transportation System Management/Transportation Demand Management costs.	-	-	-
Nonparticipating work shown	-	-	-

Regulation Items - Analyzing Bids	Yes	No	N/A
The Estimate is Materially Balanced	-	-	-
The Estimate is Mathematically Balanced	-	-	-
Non-collusion statement included	-	-	-

For Risk-Based Estimates	Yes	No	N/A
Is the risk assessment process documented and available?	-	-	-
If a consultant produced the risk assessment, what process is the consultant following and are they willing to share the model they used to produce the final results?	-	-	-
Did the state hold a risk workshop to provide input to the results? If so, is a risk workshop final report available?	-	-	-
What is the date on the risk workshop report compared to the date the estimate was last updated?	-	-	-
Did the group have the right level of subject matter experts attending to develop a robust risk register? If so, were subject matter experts in attendance representing Design, ROW, Roadway CN, Structure, Environment, Permitting, Utilities, Lighting, etc?	-	-	-
Did the group identify minor risks or did they identify significant risks to project cost and schedule?	-	-	-
What risks were identified as most significant in terms of driving cost and schedule completion?	-	-	-
Do you have a project risk tornado diagram available?	-	-	-
Were the risks in the risk register ranked?	-	-	-
Did they used risk expected value, by cost impact, by schedule impact, etc.?	-	-	-
If risks are ranked by expected value how are low probability, high impact risk events addressed?	-	-	-
How was the project budget and completion date determined from the probability cost and schedule forecast curves?	-	-	-
Does the state have a reliability level to establish budget and schedule completion? How was this level determined?	-	-	-
For the risk workshop forecast curves, are they wide curves or narrow curves?	-	-	-
How does the state account for market conditions in the risk assessment model?	-	-	-

Appendix 7 – Cost Estimate Oversight Process - Project-level



A preliminary diagram was included here. For the actual diagram, refer to page 38 in the main report.

Appendix 8 – Financial Plan Checklist

FINANCIAL PLAN CHECKLIST

Project Name: _____

1. Project Description

- a. Narrative description of project scope
- b. Map
- c. Date of NEPA Decision Document(s) (month/year)
- d. Documentation of Operationally Independent and Non-Concurrent Construction (OINCC) determinations, if applicable
- e. If a phasing plan is presented, include detail description of the funded phase

2. Schedule

- a. Present current schedule including major milestones
- b. Compare with Initial Financial Plan (IFP) and prior Annual Update (AU) schedule
- c. Clearly identify estimated completion date (Month/Year)
- d. If a phasing plan is presented, include anticipated schedule (Month/Year) for the funded phase

3. Project Cost

- a. Provide a total cost estimate for the full project
- b. Provide a breakdown of cost by project component (contract, section, phase, etc.)
- c. Provide a breakdown of cost by activity (feasibility studies, preliminary engineering, environmental assessment, right-of-way acquisition, construction, construction engineering and inspection, project management, contingencies, ITS activities, etc.).
- d. All costs should be expressed on a year-of-expenditure basis and should include a narrative describing assumptions used to arrive at such estimates
- e. IFP cost should equal at least the 70% percentile cost amount from the most recent Cost Estimate Review (CER)
- f. Compare current estimated cost with IFP and prior AU estimated cost
- g. If a phasing plan is presented, include the cost estimate and breakdown of cost the funded phase

4. Project Funds

- a. Provide all funding sources
- b. Show dedicated and anticipated funds separately
- c. Identify project listing in TIP/STIP and fiscally constrained Metropolitan Long Range Transportation Plan
- d. Show Federal funds and State and/or local funds separately
- e. Address potential unanticipated changes in expected funding
- f. Include information for special funding techniques such as advance construction, if applicable
- g. If a phasing plan is presented, funding should only be shown for the funded phase

5. Financing Issues

- a. Identify the type of financing proposed
- b. Estimate interest rates and associated fees
- c. Estimate the total financing costs associated with the project
- d. If a phasing plan is presented, financing costs should only be shown for the funded phase

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