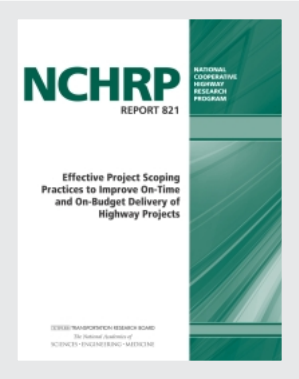

Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects

DETAILS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 821

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TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research is the most effective way to solve many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation results in increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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The needs for highway research are many, and NCHRP can make significant contributions to solving highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement, rather than to substitute for or duplicate, other highway research programs.

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FOREWORD

By Lori L. Sundstrom
Staff Officer
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NCHRP Report 821: Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects is a guidebook that demonstrates how a state department of transportation (state DOT) can improve its scoping process and practices to produce a project cost estimate and schedule that facilitate programming decision making and accountability. The guidebook illustrates the effort needed to develop a robust cost estimate and then manage to a baseline budget and scope throughout the project delivery cycle. The guidebook is applicable to a range of project types and is scalable in its ability to accommodate projects of varying complexity.

The guidebook should be of immediate use to DOT senior managers and staff who are responsible for developing project cost estimates for statewide transportation improvement plans and for managing the cost and scope of projects during project delivery.

Transportation agencies have significantly improved many aspects of project delivery, yet they continue to be challenged by cost increases and time delays that occur after a project is programmed and funded. Increasing or otherwise changing the scope of a project to improve facility performance is a common source of cost increases and schedule delays, as is failure to adequately consider project impacts on utilities, communities, or the environment. While evaluating and accommodating risk are essential and ongoing activities throughout the project development process, the negative impacts that scope growth and related problems can have on a highway project's cost and schedule can be minimized if these problems are identified and mitigated early in project development.

Industrial and commercial building construction sectors have experienced similar problems with construction project scope growth, cost increases, and time delays that occur after a project has been authorized for detailed design and construction. Recent research in these sectors has produced a structured and systematic process to help owners meet project cost and schedule objectives by defining a project to a suitable level of development prior to authorization of detailed design. Statistical evidence indicates that earlier and more detailed scoping efforts can reduce total design and construction cost by as much as 20%, and shorten total design and construction schedules by as much as 39%. Such scoping processes, with supporting indices and tools to calibrate the level of scoping effort required to achieve these results, have become standard procedures that many private U.S. corporations use in their capital facilities development efforts. With modifications, these processes and tools may be transferable to the transportation industry.

Transportation projects that are programmed before they are well defined have a greater risk of increased project cost and/or schedule delays. Because transportation funding is constrained, cost overruns on one project can mean that funding for other projects is

reduced or even eliminated. These outcomes can have negative repercussions for transportation agency relationships with the public and legislative bodies. Recognizing that project delivery performance can be improved by using more sophisticated scoping and programming processes tailored to the type of project, a number of state DOTs have modified their scoping processes with varying degrees of success.

Under NCHRP Project 08-88, the Texas A&M Transportation Institute was asked to (1) develop a literature review; (2) identify the state of practice in state DOTs and in related industries; (3) define the scoping process; (4) identify the optimum level of project development needed to establish a baseline scope, cost, and schedule for programming and management purposes; and (5) provide a guidebook that is both comprehensive and scalable.

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SUMMARY

Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects

Transportation agencies have significantly improved many aspects of project delivery, yet they continue to be challenged by cost increases and time delays that occur after a project is programmed and funded. Increasing or changing the scope of a project to improve facility performance is a common source of cost increase and time delay.

This guidebook provides an effective project scoping process that transportation agencies can apply to overcome the negative impact of scope creep and scope changes. The process consists of elements subdivided into increasing levels of detail pertaining to scoping activities, actions, data requirements, constraints, teams, tools, and outcomes.

Considerable variation in scoping processes across state transportation agencies (STAs) exists in practice. Variations include the definition of the project scoping process (PSP), formality of the PSP, timing of the PSP within project development, and project maturity at the point when the project is programmed.

An effective PSP can benefit state agencies by:

- Reducing project costs and shortening schedules for design and construction.
- Improving interaction between project disciplines based on a multidisciplinary integrated team approach.
- Improving the relationship with external stakeholders.
- Improving on-time and on-budget project delivery.
- Providing a consistent and reliable approach to project scoping.

The project scoping continuum proposed in this guidebook is also designed to address scalability issues that reflect different levels of project complexity. The high end of the project scoping continuum, applicable to complex projects, requires agencies to perform all the PSP activities proposed in this guidebook. The other end of the project scoping continuum, applicable to the least complex projects, requires agencies to perform a limited number of PSP activities.

Many projects fall between these two extreme ends of the project scoping continuum. These projects require more than the minimum activities but may not require all PSP activities to be performed. For example:

- If the project scope does not include return on investment (ROW) requirements and utility relocation, then those activities related to ROW and utility relocation are not performed.
- If the project does not have potential alternative solutions to achieving the purpose and need, then those activities related to alternative analysis are not performed.
- Projects may have different environmental requirements, so those activities related to environmental assessment may be performed at different levels of detail depending on the specific requirements for a project.

The level of design effort, traffic management, and public involvement will vary as well depending on the project type and its characteristics. Adjustments to the PSP in these activity areas might require different levels of effort to complete these activities.

The guidebook consists of two parts and two appendices. Part 1, "Research Results about the PSP," addresses the following issues:

- Why should STAs formalize the PSP? This focuses on benefits such as payoffs from an effective PSP.
- What is the current practice? What is an effective PSP? This focuses on the current practices for PSP, critical issues and challenges to implement an effective PSP, PSP definition, and the model and framework used in this guidebook to develop an effective PSP.
- How can an agency implement an effective PSP? How can an agency use this guidebook? This focuses on a consistent process that is comprised of a comprehensive set of activities, data requirements, and tools and techniques to perform an effective PSP at the state level.

Part 2, "Implementation Guidelines," provides an easy-to-understand layout and describes how to implement the PSP. The guidelines are divided into three sections. Each section details one of the three major activities of the PSP—develop the project, analyze the alternatives and document findings, and develop the recommended alternative. Each of these three major activities is further subdivided into lower levels of activities. A consistent structure is used for describing each of the lowest-level activities. This structure contains activity objectives, actions required for performing the activity, data requirements and information needed to initiate the activity, restrictions, tools and resources, and outcomes from performing the activity.

The guidelines have two appendices. The first appendix summarizes the tools that can be used while performing different activities in the scope development process. Many of these tools are different processes and techniques that have been developed in other related research. The second appendix is the list of online links to various resources and tools to support the PSP, as referenced in this guidebook.

This guidebook, a product of NCHRP Project 08-88, was developed through research conducted by the Texas A&M Transportation Institute. Practical inputs were solicited from experienced industry professionals through questionnaire surveys and interviews. A Research Advisory Team, with members from STAs, state public works department, and consultants familiar with the scoping process, provided feedback and guidance during the research process.

PART 1

Research Results about the PSP

CHAPTER 1

Why Should STAs Formalize the PSP?

Background

Transportation agencies have significantly improved many aspects of project delivery, yet they continue to be challenged by cost increases and time delays that occur after a project is programmed and funded. Increasing or changing the scope of a project to improve facility performance is a common source of cost increase and time delay. The negative impacts that scope growth and related problems can have on a transportation project's cost and schedule can be minimized if these problems are identified and mitigated early in the project delivery process (PDP).

Current research has identified considerable variation in scoping processes across STAs, including the definition of the PSP, formality of the process, timing of the PSP within project development, and project maturity at the point when the project is programmed. Other areas of variation include scoping activities and the outputs of the scoping process.

This research revealed that most agencies ended scoping during the preliminary design phase, and most processes contained activities related to design activities, environmental impact assessments, ROW issues, some level of cost and schedule estimating, and identification of a preferred alternative. The manner in which these activities are integrated in the scoping effort is not performed consistently by STAs. In addition, few agencies have developed scoping-specific analytic tools that are used during the scoping process.

The Payoffs of an Effective PSP

The biggest payoffs of implementing an effective PSP are:

- The potential for reduced costs and shortened schedules for design and construction.
- Improved interaction between project disciplines based on a multidisciplinary team approach.
- A better relationship with external stakeholders.
- Improved on-time and on-budget project delivery.
- A consistent and reliable approach.

Potential for Reduced Costs and Shortened Schedules for Design and Construction

The industrial and commercial building construction sectors have experienced similar problems with scope changes and cost increases. Research in these sectors has produced a structured and systematic process to help owners meet project cost and schedule objectives by defining a project to a suitable level of development prior to authorization of detailed design. The statistical evidence from research in these two sectors indicates that earlier and more detailed scoping efforts

have the potential to reduce total design and construction costs by as much as 20 percent, and shorten total design and construction schedules by as much as 39 percent.

Integrated Multidisciplinary Team Approach

On the most complex project many disciplines are involved in project scoping. A "stovepipe" approach to scoping is often common practice where scope details are developed by individual project disciplines and then passed to other disciplines as work is completed. Identifying the disciplines involved in scoping and showing how these disciplines interact to produce key scoping information improves the likelihood of meeting project performance targets.

Better Relationship with External Stakeholders

Maintaining a consistent and reliable transportation construction program is one way to have a good relationship with external stakeholders. Because of limited funds, cost or schedule overruns on one transportation project can mean that funding for other projects is reduced or even eliminated. These outcomes can have negative repercussions for transportation agency relationships with public and legislative bodies.

Improved On-Time and On-Budget Project Delivery

Better predictability during the early project development phase offers significant benefits to STAs and their stakeholders in terms of project value and improve the chance of on-time and on-budget project delivery. However, current planning and programming among STAs appear to fall short of meeting this goal and necessitate a new and effective PSP.

Consistent and Reliable Approach

Recognizing that a comprehensive and scalable PSP has a positive impact on project delivery performance, a number of STAs have modified their scoping processes. However, the on-time and on-budget delivery of projects is still difficult to attain due to the lack of a consistent and reliable approach. An effective PSP can address this need.

CHAPTER 2

What Is the Current Practice?

This discussion of the current status of the PSP includes a description of outreach and definition of the PSP, time frame, tools in use, activities covered, performance measurement techniques, experts involved, and critical issues and challenges.

Outreach and Definition

Only 40 percent of STAs have publicly available information on their PSP. These published processes show variations in the definition of the PSP, formality of the process, sequence of scoping activities, scoping activities, time frame for performing the PSP, and outputs from the scoping process.

Time Frame for Performing the PSP

The difference in definitions resulted in variations in the time frames for performing the PSP. While most agencies ended scoping during the preliminary design phase, a few ended scoping at the end of the planning phase or during the early stages of the detailed design phase.

Tools in Use

Outside of preliminary cost and schedule estimates, relatively few agencies have developed scoping-specific analytical tools to be used during the scoping process. Among the various tools and techniques used in scoping activities, STAs use a variety of desktop and server-based databases to aid in decision making during project planning and scoping.

Activities Covered

In the majority of STAs, the activities covered during the PSP are often limited to environmental impact assessment, cost and schedule estimation, and preferred alternative(s) descriptions.

Performance Measurement Techniques

STAs usually do not have a formal, standard practice for measuring the effectiveness of scoping activities, although they might keep track of items, specifically change orders. Less than 20 percent of STAs have some techniques to measure the effectiveness of project scoping. While several agencies have checklists to track scoping activities, the Texas Department of Transportation's Advance Planning Risk Analysis (APRA) is the only available tool to measure the completeness of the PSP.

Experts Involved

This research indicated that design, environmental, and maintenance experts are often involved in the PSP. Environmental experts are involved because the scoping process tends to focus on environmental issues, and maintenance personnel are involved because they help assess the performance of a road or bridge to determine project needs. Some STAs have also developed mechanisms to involve public stakeholders.

Critical Issues and Challenges

An effective scoping process needs to address the potential for scope changes, cost overruns, and schedule delays. Table 1 indicates the critical challenges identified for implementation of an effective PSP.

The important elements of an effective PSP involve commitment and support from an agency's senior management, early detailed engineering/design, more accurate project baselines, construction expertise, and a process that will provide the necessary framework and tools to facilitate an effective PSP to lead the PSP.

Commitment of the Agency's Senior Management

The paradigm shifts for an effective PSP should start with the agency's senior management. Management should take an active interest in the implementation of an effective PSP. The following shifts should be considered:

- **Provide adequate duration.** STAs should allocate adequate time to perform the comprehensive PSP based on the size and complexity of each transportation project.

Table 1. Critical issues or challenges for an effective PSP.

Category	Critical Challenges	Action Required
Process	Lack of a comprehensive and flexible PSP	• Use a scalable process tailored to meet the requirements of every project • Use the necessary framework and tools to facilitate an effective PSP
Definition	PSP outreach and consistency in definition	• Offer guidance to help ensure consistent implementation of the PSP across multiple STAs • Use a PSP for every project • Use a consistent definition throughout the STAs
Time frame	Inadequate and inappropriate time frame for performing the PSP	• Use a flexible time frame, intended to complete the PSP before the start of detailed design
Activities covered	Lack of PSP activities covering critical areas of project development	• Perform activities related to project requirements for ROW, utilities, environmental, traffic management plan (TMP), cost, and schedule
Techniques	Lack of performance measurement techniques	• Identify technique(s) to identify the effectiveness of the PSP before setting the project's baseline
Tools	Lack of tools to support the PSP	• Develop tools to support the PSP
Experts involved	Absence of construction experts in the PSP	• Include construction experts in the PSP
Detailed design complete	Advancing detailed engineering/design earlier	• Target to complete 20%–30% of the design by the end of the PSP
Public engagement	Lack of public engagement during the PSP	• Consider the requirements of public and other stakeholders

- **Involve experienced personnel.** Senior management should ensure the involvement of experienced personnel during the PSP, representing design, hydrology/hydraulics, environment, construction, operation, ROW, utilities and railroad, and maintenance disciplines. The lack of experienced personnel for feasibility analyses negatively impacts the effectiveness of the PSP. The need to involve experts is based on the assumption that the PSP will be performed in-house and experts will be available during the PSP. Alternatively, this process could be performed by a consultant, who would do something similar.
- **Define the start and end of the PSP.** STAs should consider a time frame where the PSP, and the National Environmental Policy Act (NEPA) process, is substantially completed before commencement of the detailed design phase.

Early Detailed Design

An effective PSP should involve completing 20 to 30 percent of the detailed design in order to achieve improved project cost and schedule objectives. STAs should select only experienced design personnel to lead the PSP.

More Accurate Baselines

An effective PSP should be intended to develop more accurate baselines by establishing:

- A baseline scope based on project parameters and project objectives.
- A baseline schedule based on preliminary work activities.
- A baseline cost that accounts for available resources and allocation of resources across all scheduled activities.

These baselines help to improve project control, project performance measurement, and project outcome prediction.

Involvement of Construction Expertise

The involvement of construction expertise in the PSP ensures improvements in project management activities related to construction risks, planning and scheduling, cost estimation, and resource identification and utilization. This is especially true for large and complex projects.

A Process to Facilitate Project Scoping

This guidebook presents a process for an effective project scoping. The PSP is designed to be flexible and can be customized for individual projects. This approach uses a hierarchy of activities and steps essential to conduct a comprehensive PSP. The tools and techniques required to support these activities are detailed in the appendix of this guidebook.

CHAPTER 3

What Is an Effective PSP?

Definition

Based on the current research, the definition of the proposed effective PSP is:

> The project scoping process is a series of project-focused activities that develop key design parameters and other project requirements to a sufficient level of definition such that scope discovery is complete and a budget and project completion date can be accurately established to minimize the risk of significant change and project overruns.

This definition is the stepping stone for the development of the PSP detailed in this guidebook.

A Generic Approach

The PSP proposed in this guidebook is applicable to most projects. However, since the PSP is complex, each state should check its state-specific regulations that may or may not apply to a project. This PSP is designed to be flexible concerning specific project characteristics and requirements. This process consists of three major activities:

- **Develop the project.** The objective of the first activity of the PSP is to update and refine the project parameters, project definition, and project purpose and need to a sufficient level, which facilitates selection of the best alternative and development of a more accurate baseline scope, cost, and schedule. This includes selecting a PSP team, visiting the site, soliciting public input, refining the project concept, preparing conceptual cost estimates, and summarizing key project characteristics.
- **Analyze alternatives and document findings.** The objective of the second activity of the PSP is to analyze the identified project alternatives and document the findings in order to assess, prioritize, and recommend a preferred alternative for further detailing the next step of the PSP. This includes performing various activities for each of the alternatives, such as ROW research, traffic analysis, survey of existing conditions covering environmental and utility issues, development of the conceptual TMP, and establishment of preliminary scoping cost estimates.
- **Develop a recommended alternative.** The objective of the last activity of the PSP is to develop and document the recommended alternative. This includes developing preliminary drawings, finalizing environmental documentation, finalizing the TMP, determining real property requirements, engaging the public, preparing the baseline cost and schedule, and preparing the project scoping report.

Each of these activities is further expanded into an increasing set of detailed activities to facilitate the PSP.

Model Used for Development

The PSP is developed using the Integrated Definition (IDEF) function modeling technique. The IDEF modeling technique is a graphic description of a process or system using cell modeling graphic representation, as shown in Figure 1.

The graphic description uses the following convention:

- A function is an activity that describes what is accomplished.
- Inputs are the data or objects the function transforms into outputs.
- Controls are the conditions required to produce the correct output (often called a constraint).
- Mechanisms are the means used to perform a function.
- Outputs are the data or objects the function produces.

Figure 2 and Figure 3 depict the proposed process's Level 1 and Level 2 activities respectively, representing a general framework for the PSP developed using the IDEF modeling technique.

The Framework

The PSP is divided into four levels of activities. Figure 4 shows the framework for the overall PSP with the division of three levels of activities (Level 4 is not shown):

- Level 1 is project scoping (A0).
- Level 2 activities represent the main functions that describe a PSP (A1, A2, and A3).
- Level 3, further hierarchical breakdowns of these three activities, describes the details of activities required to perform these functions (A11 through A37).

For example, A1: Develop Project is broken down into six activities in Level 3. These six activities are further broken down into 17 Level 4 activities, shown in Figure 5. Likewise, the activities A2

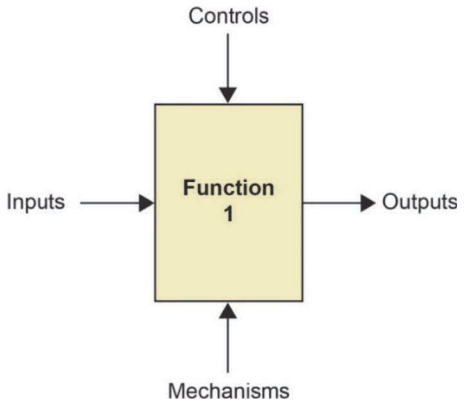


Figure 1. Basic IDEF structure.

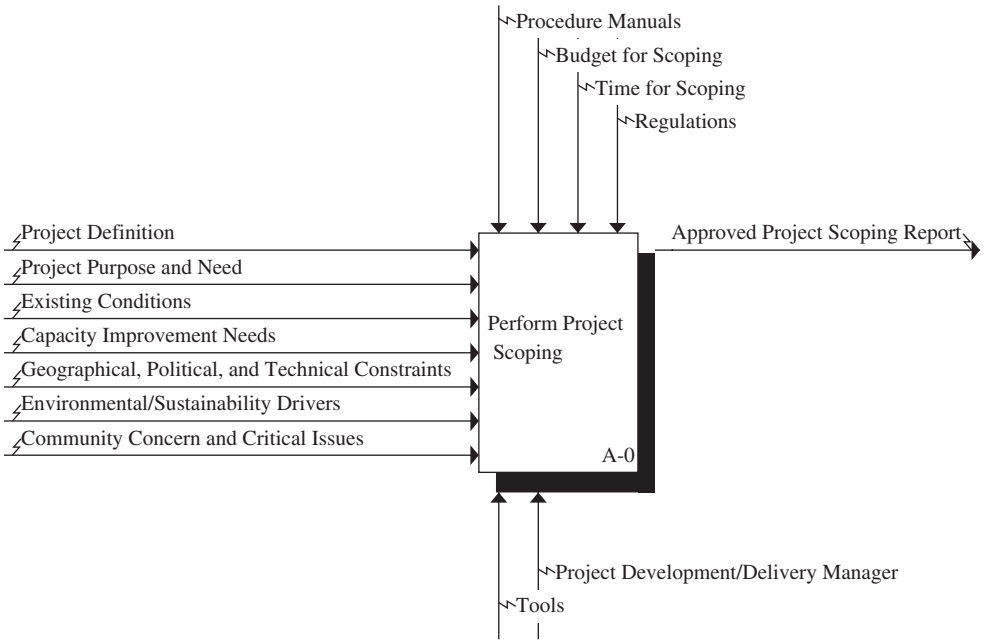


Figure 2. Level 1 IDEF model.

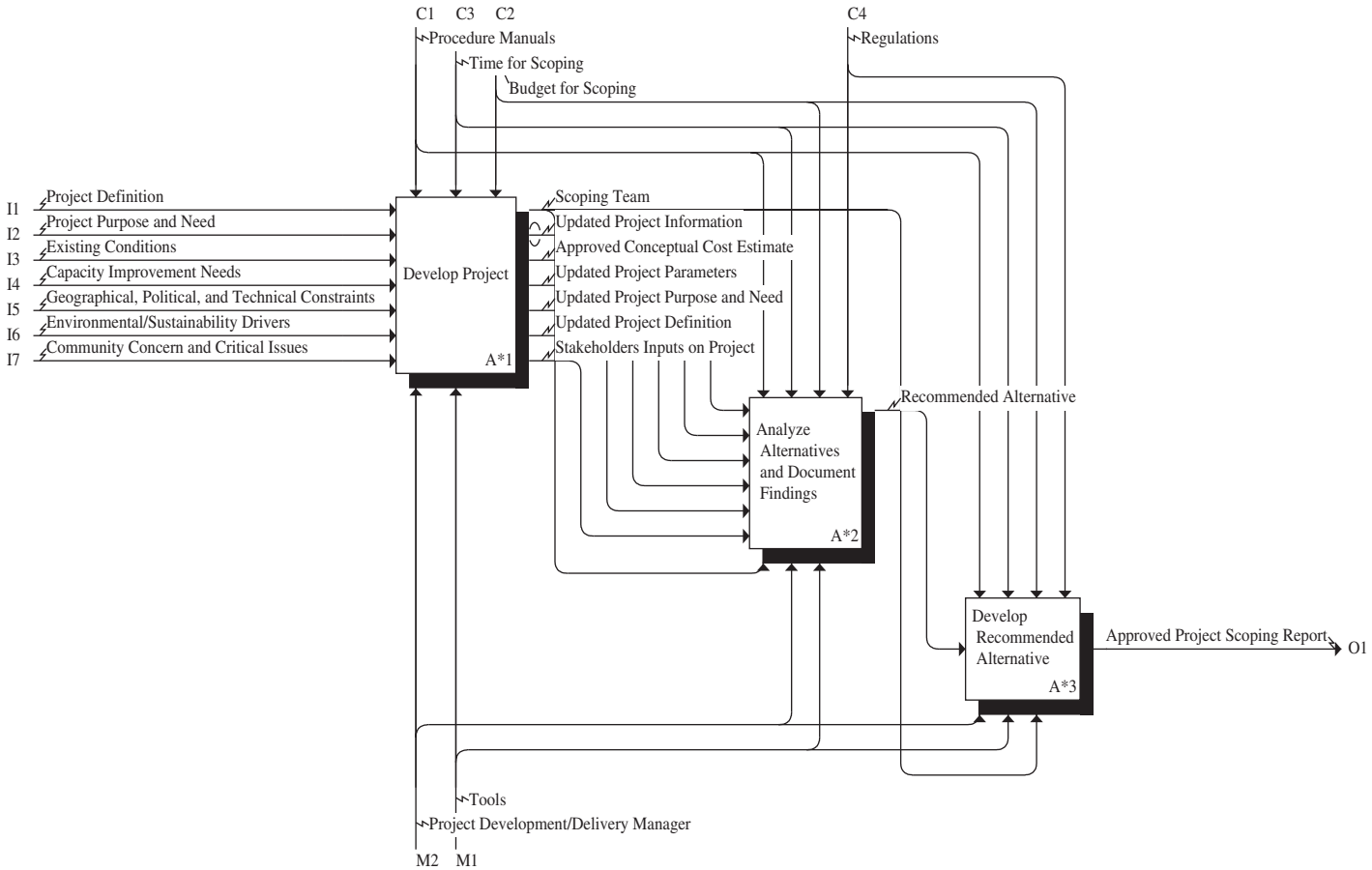


Figure 3. IDEF0 model.

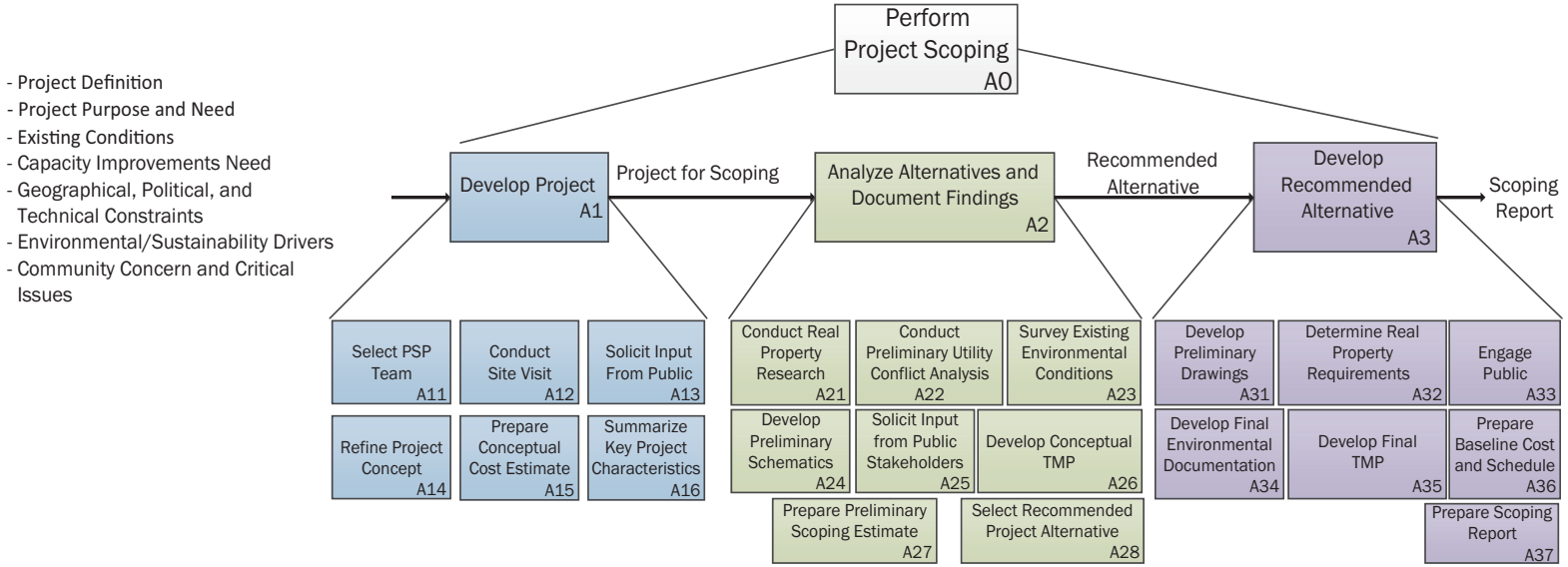


Figure 4. PSP framework.

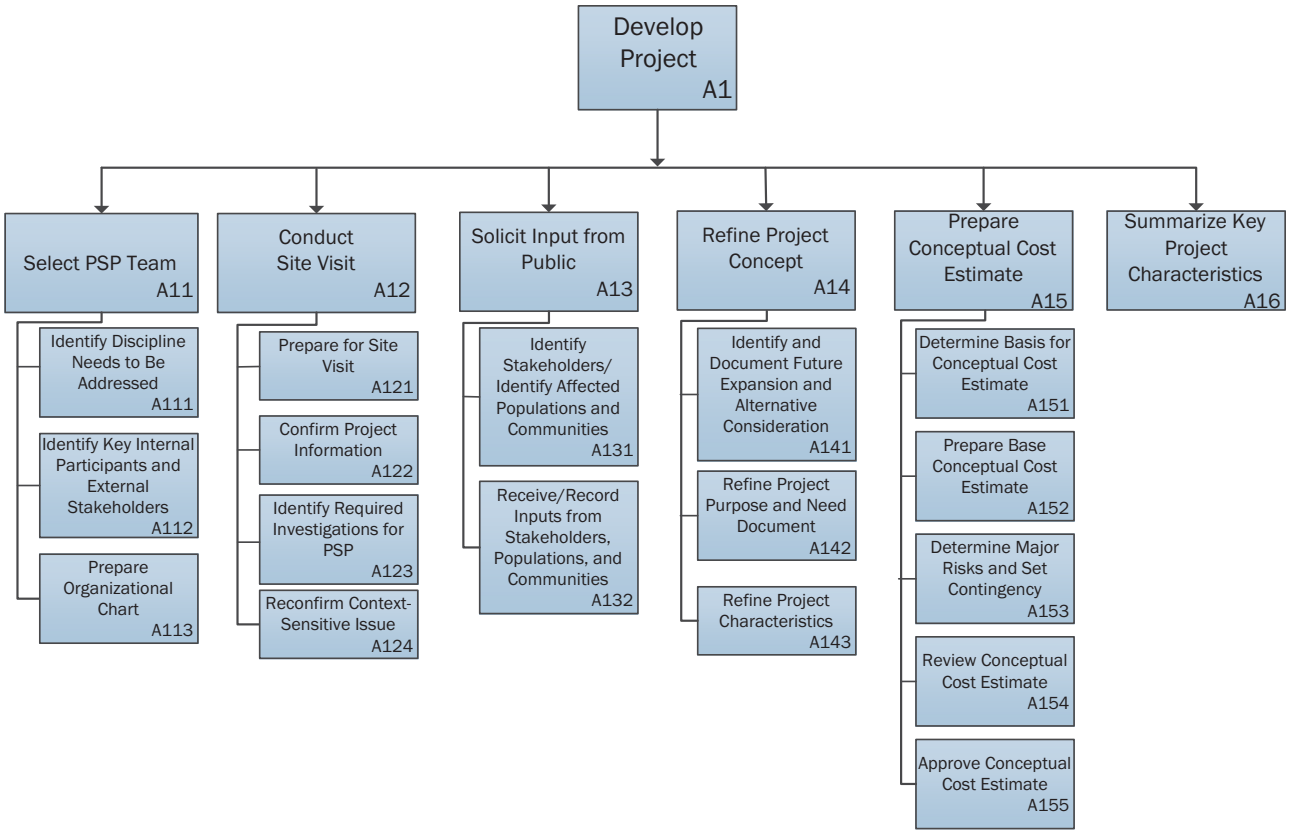


Figure 5. PSP framework—develop project.

and A3 break down into Level 3 and 4 activities, shown in Figure 6 and Figure 7, respectively. In total, the complete PSP is divided into 104 activities, including three activities in Level 2, 21 in Level 3, and 79 in Level 4.

The activity number assigned to each activity in this guidebook is based on the IDEF0 function alpha-numeric syntax as explained in Table 2.

When to Perform the PSP

The PSP should be performed after a project is included in the transportation program and at a time when the ability to influence the project cost and schedule is the greatest, that is, before the design parameters are fixed and expenditures on the project are the lowest. Figure 8 describes the relationship between the ability to influence the project outcomes and project expenditures over the different phases of the project life cycle. Therefore, early completion of the PSP may result in greater flexibility to change or modify the project scope, cost, and schedule with minimal impact on project expenditures.

While there are different opinions about when the PSP starts, this research found that the PSP, including NEPA review, should start in the planning phase, with a target to achieve completion before commencement of the detailed design phase. However, depending on the nature of the project, availability of inputs, and other resources, this time frame should be considered flexible between the planning and detailed design phases.

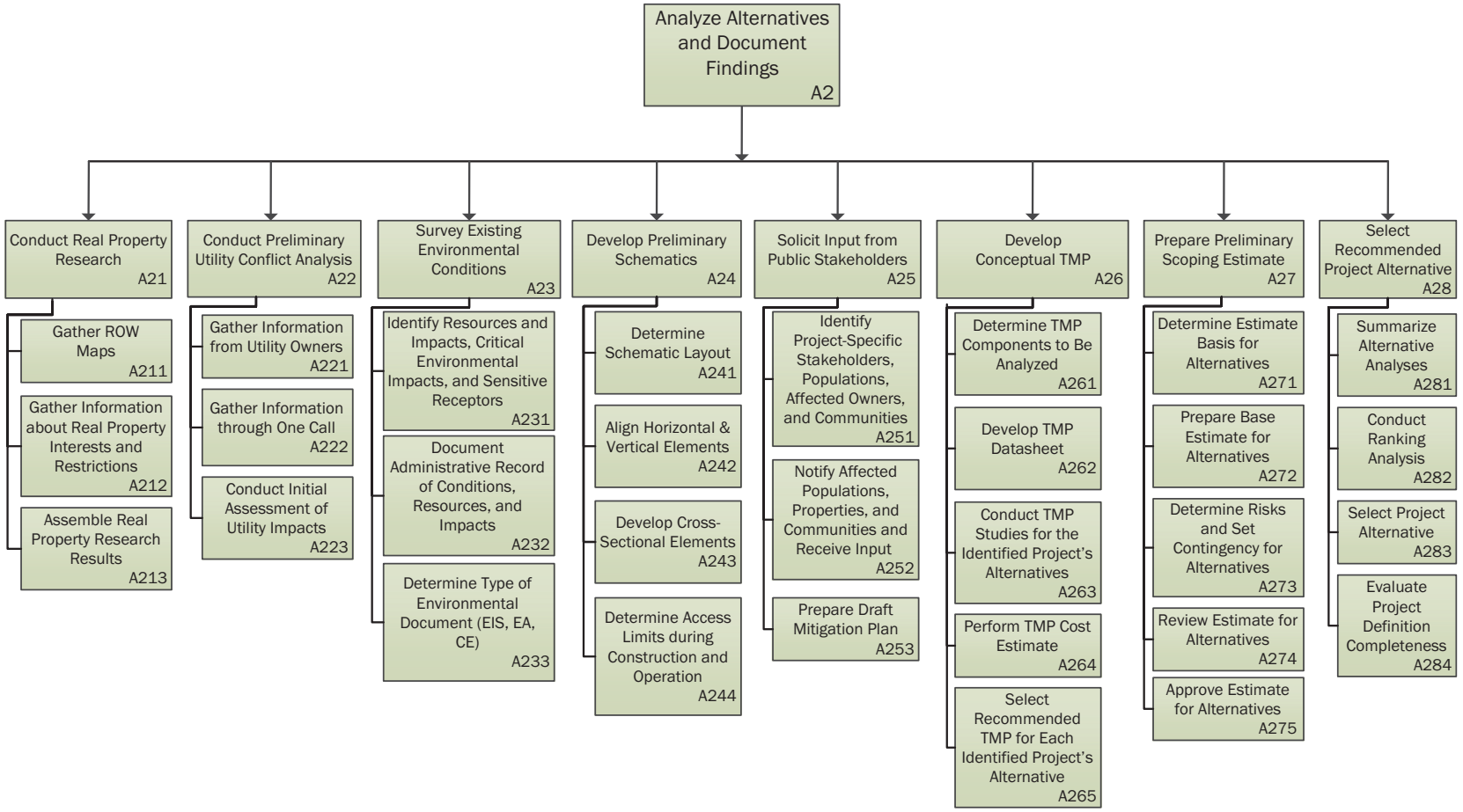


Figure 6. PSP framework—analyze alternatives and document findings.

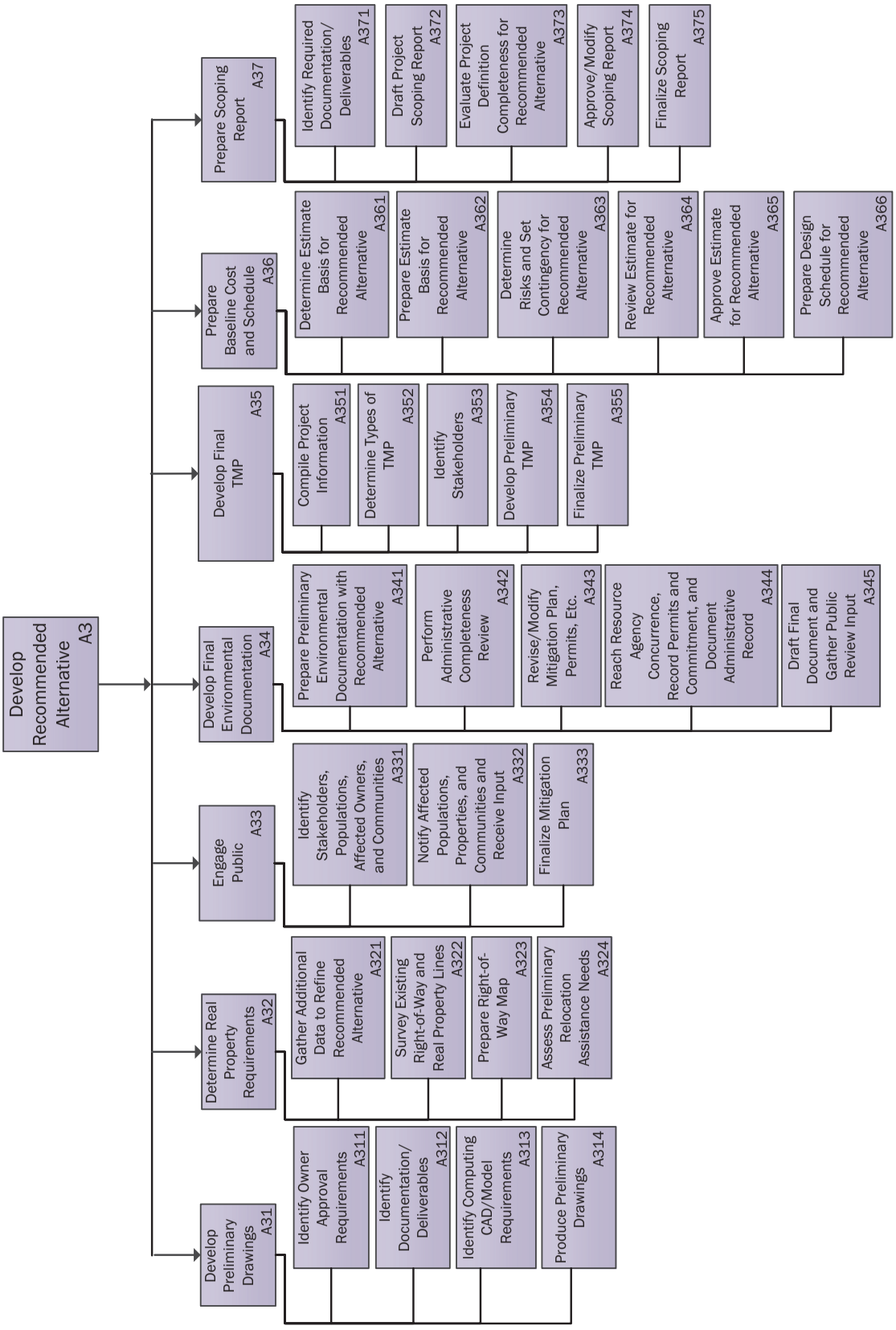


Figure 7. PSP framework—develop recommended alternative.

Table 2. Activity number system followed in this guidebook.

Level	Previous Level Activity	Activity Number	Number of Activities in Guidebook
Level 1	–	A0	1
Level 2	A0	A1, A2, and A3	3
Level 3	A1	A11, A12,...A16	6
	A2	A21, A22,...A28	8
	A3	A31, A32,...A37	7
Level 4	A11	A111, A112, A113	3
	A12	A121, A122,...A124	4
	A13	A131, A132	2
	A14	A141, A142, A143	3
	A15	A151, A152,...A155	5
	A16		0
	A21	A211, A212, A213	3
	A22	A221, A222, A223	3
	A23	A231, A232, A233	3
	A24	A241, A242,...A244	4
	A25	A251, A252, A253	3
	A26	A261, A262,...A265	5
	A27	A271, A272,...A275	5
	A28	A281, A282,...A284	4
	A31	A311, A312,...A314	4
	A32	A321, A322,...A324	4
	A33	A331, A332, A333	3
	A34	A341, A342,...A345	5
	A35	A351, A352,...A355	5
	A36	A361, A362,...A366	6
	A37	A371, A372,...A375	5

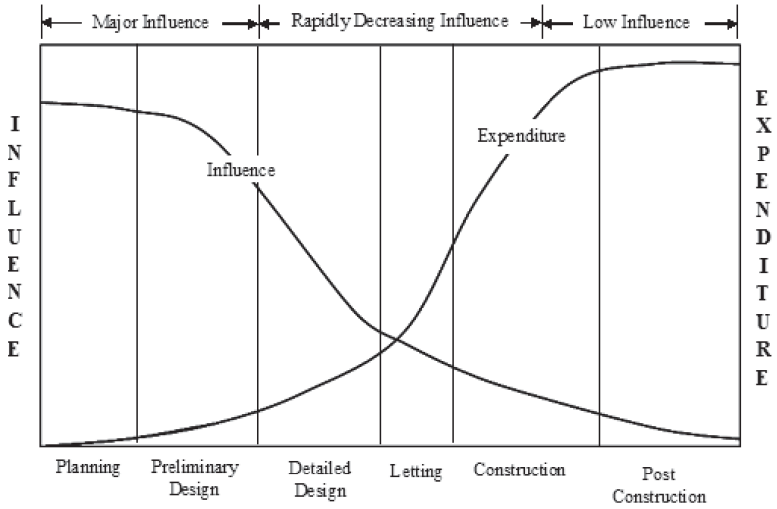


Figure 8. Influence and expenditure curves for project life cycle (Adapted from the Construction Industry Institute Primer on Constructability, 1987).

Integration of the Project Delivery and Project Scoping Processes

Typically, the PDP consists of six phases—planning, preliminary design, detailed design, letting, construction and post construction, as shown Figure 9. The integration of the PSP in the PDP may include performing some of the planning phase's activities, complete preliminary design phase's activities including environmental process, ROW map development, preliminary utility conflict analysis, etc., and some of the detailed design phase's activities. The window for performing the PSP may occur any time from the end of the planning phase to before the start of the detailed design phase. The integration is shown in Figure 10.

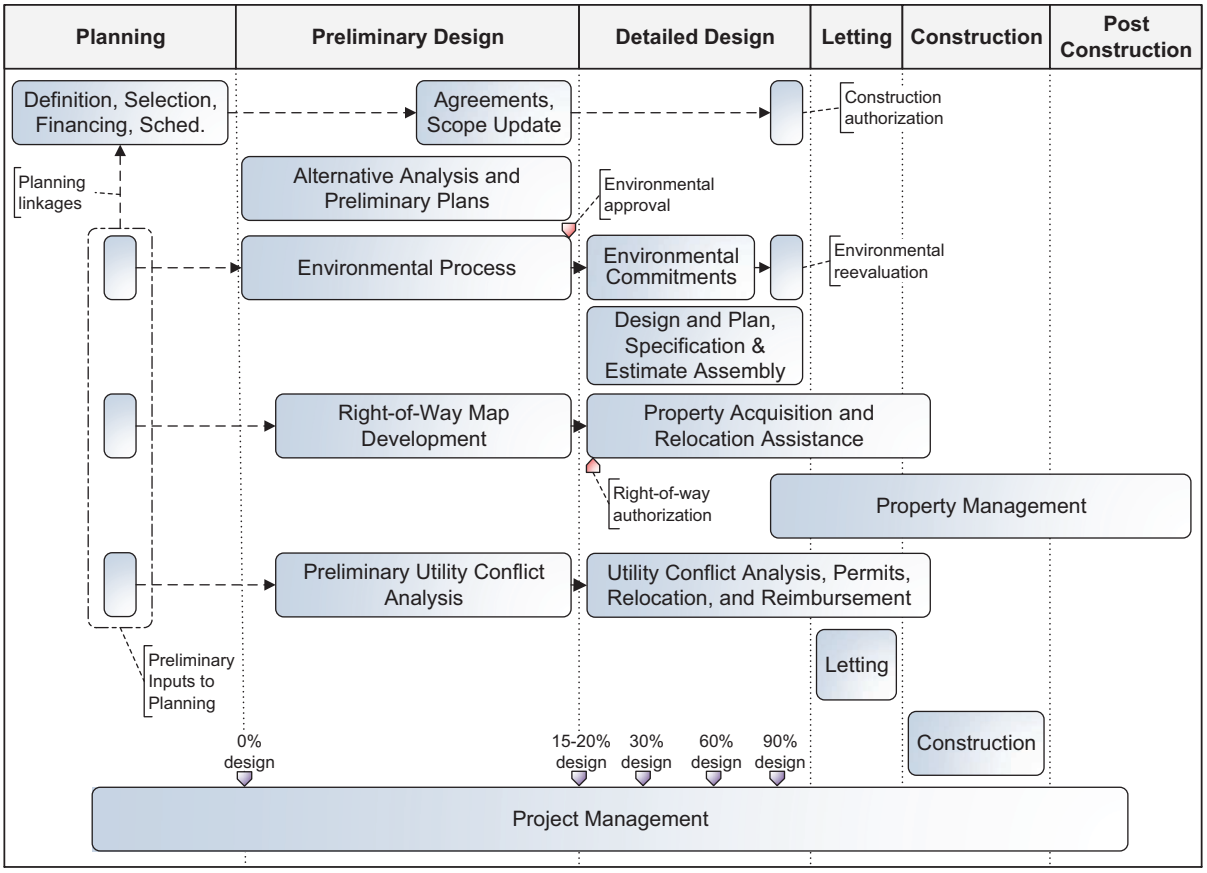


Figure 9. Project delivery process (NCHRP Report 771).

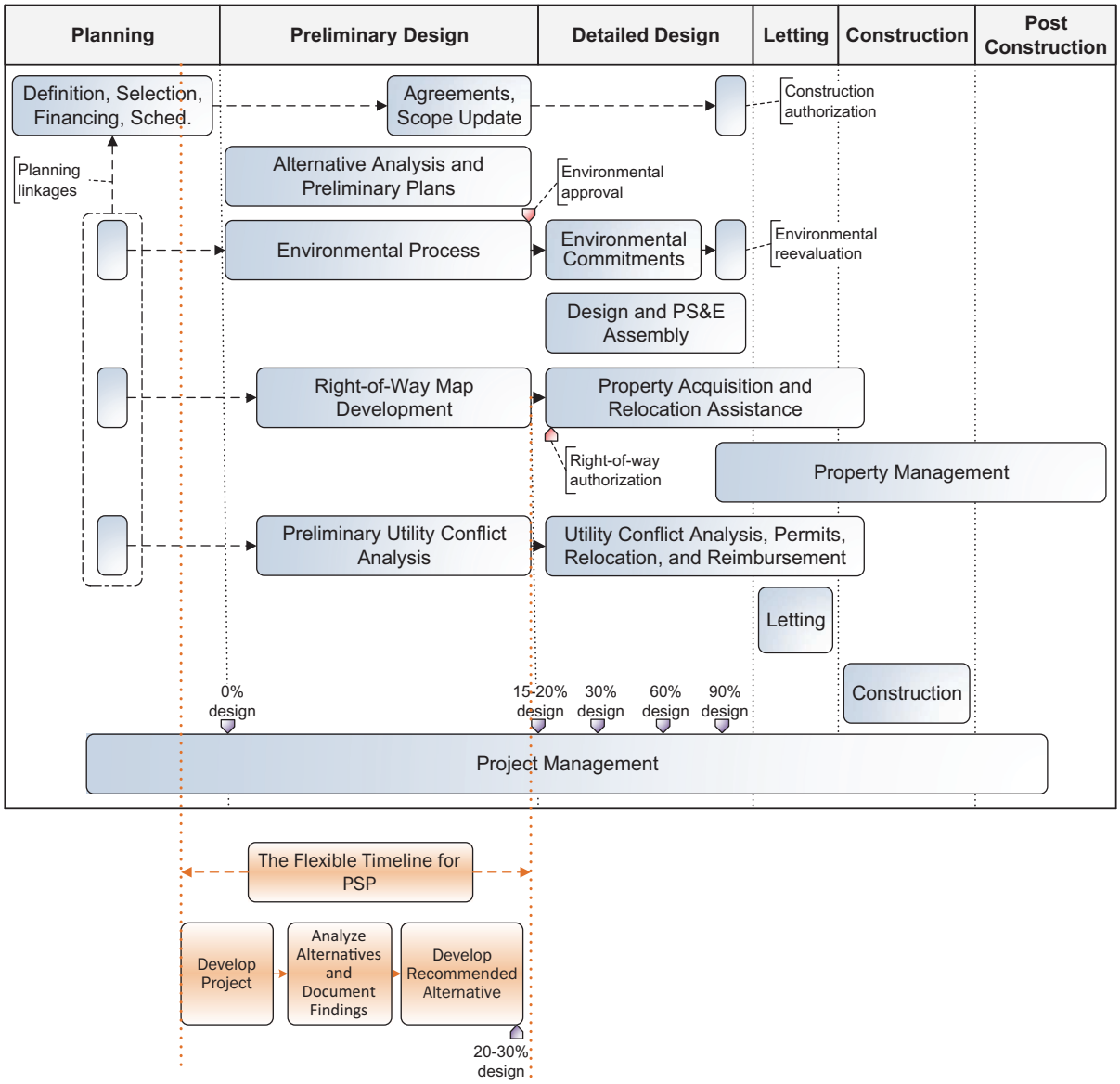


Figure 10. Integration of PSP and PDP.

CHAPTER 4

How Can an Agency Implement an Effective PSP?

The level of effort and information required to perform project scoping activities are usually different depending on the type, size, and complexity of the project, with large and complex projects requiring more effort during the scoping phase. This guidebook offers a comprehensive and scalable PSP in order to improve on-time and on-budget delivery of projects. This part of the guidebook describes strategies for implementing an effective PSP.

Process Implementation

The PSP should be performed before commencement of the detailed design phase. Therefore, the best time to implement the PSP is during the preliminary design phase. This ensures the availability of information for performing the PSP, resulting in a well-defined project scope, a more accurate cost and schedule at the end of the process, and the availability of the same before the start of the detailed design phase.

Early Advance Engineering and Design

STAs should target 20 to 30 percent completion of total project engineering and design activities during the PSP. This requires advancing engineering efforts to this early phase of the PDP.

Involvement of Multiple Disciplines

STAs should ensure the involvement of multiple disciplines' experts, representing design, environment, ROW, utilities, railroad, hydrology/hydraulics, construction, operation, and maintenance.

The current research indicates that the majority of the agencies often do not involve personnel from the construction discipline in the PSP. Early inputs from above disciplines, including construction, are critical for an effective PSP.

Setting the Project's Baselines

STAs should adopt strategies to develop a well-defined baseline scope and accurate cost and schedule using the activities and steps detailed in Part 2 of this guidebook. The early setting of well-defined and accurate baselines not only improves project management but also helps in better assessment of project performance and improvements in future schedule and cost estimation.

Process Time Allotment

The time required for completion of the process will depend on the type, size, and complexity of the project. STAs should ensure that adequate time has been allocated to carry out an effective PSP. This time should include a contingency for risks associated with the PSP, such as the utilization rate, requirement of additional investigations, environmental permits, and other factors.

Process Adoption

This guidebook outlines a flexible PSP. STAs should adopt this process in accordance with the requirements of the individual project. For example, if a project does not have ROW requirements, then the agency does not have to address all the Level 4 activities of ROW. The same applies to utility relocation and alternative analysis.

CHAPTER 5

How Can an Agency Use This Guidebook?

This guidebook:

- Provides a consistent way to perform the PSP across the districts/regions of the SHA.
- Provides a comprehensive process with a hierarchical breakdown of activities for performing the PSP.
- Identifies data requirements and conditions needed to perform the PSP.
- Provides tools and techniques to perform the PSP.

Project Scoping Continuum

The project scoping continuum proposed in this guidebook is designed considering a highly complex project that involves many different disciplines and other characteristics of such a project.

Scalability

The project scoping continuum proposed in this guidebook is also designed to address scalability issues that reflect different levels of project complexity.

In general, the complexity of the project drives the selection of activities performed when implementing the PSP. Because the type of project can determine project complexity, the type of project is also a driving force behind the selection of activities. A commonly used characterization of project types is as follows:

- **New construction.** New construction projects involve the design and construction of a roadway on a new alignment, or major widening or improvement of an existing facility.
- **Reconstruction.** Reconstruction projects frequently involve substantial changes to the horizontal and/or vertical alignment of a road, generally within the currently available ROW (although some real property acquisition may be necessary). Types of improvement under this category include road widening to increase capacity.
- **Resurfacing, restoration, and rehabilitation (3R).** 3R projects generally focus on extending the service life of existing facilities, in many cases to enhance safety.

The high end of the project scoping continuum requires agencies to perform all the PSP activities proposed in this guidebook. This high-end continuum is applicable for new construction/reconstruction projects such as complete removal and replacement of pavement, major alignment improvements, the addition of lanes for through traffic, new roadways and/or bridges, complete bridge deck or superstructure replacement, intermittent grade modifications, and so on.

These projects involve environmental impact studies or complex environmental assessment, ROW plans, major utility relocations or heavy multi-utility coordination, comparative studies of multiple alternatives, and controversial and high-profile project stakeholders.

The other end of the project scoping continuum is applicable to minor complex projects such as overlay projects, simple widening, or non-complex enhancement projects without new bridges. These projects typically do not require ROW plans, utility coordination, comparison of alternatives, or considerable public involvement, and qualify for environmental categorical exclusion. For such projects, a PSP is simple, and agencies perform only certain activities like developing the project (A1) and relevant activities to develop the recommended alternative (A3).

However, many projects fall between these two extreme ends of the continuum. This is applicable for 3R projects like resurfacing, repairing pavement structures and joints, widening minor lanes and shoulders, making minor alterations to horizontal and/or vertical alignments, repairing bridges, and removing or protecting roadside obstacles. These projects may not require all of the PSP activities. For example, if a project does not have ROW requirements, then the PSP does not involve all Level 4 activities related to ROW. A project with no alternatives to compare may not require analysis of alternatives and document findings (A2).

Tools and Techniques to Support a PSP

Numerous tools and techniques support the PSP and can be used for different PSP activities. Some of these tools are different processes and techniques that have been developed in other related research efforts. Appendix A of this guidebook summarizes these tools and techniques, and describes when and how to use them.

Links to Resources and Tools to Support a PSP

Appendix B provides links to online resources and tools to support various PSP activities.

PART 2

Implementation Guidelines

Introduction

After the agency has identified the PSP's activities for the project, the agency should refer to the implementation guidelines presented in Part 2 to understand and perform the project scoping process activities. The selected activities should be performed in the same order as they appear on the identified path.

Hierarchy

The implementation guidelines are structured to follow the basic hierarchical configuration of the PSP as described in Figure 4 through Figure 7. The guidelines are divided into three sections. Each section details one of the three major activities (Level 2) of the PSP:

- Develop Project (A1).
- Analyze Alternatives and Document Findings (A2).
- Develop Recommended Alternative (A3).

Each of these three Level 2 activities is further divided into required Level 3 activities. Each of these Level 3 activities is finally divided into required Level 4 activities, in order to meet the objectives of the major activities.

Layout

A consistent structure is used for detailing each of the Level 4 activities and their procedures. This structure contains:

- Activity objectives.
- Actions required for performing the activity.
- Data requirements and information needed to initiate the activity.
- Restrictions.
- Tools and resources.
- Outcomes of this action.

The following icons are used as quick references for the last four elements of the Level 4 structure:

Data Requirements and Information Needed to Initiate the Activity: Describes the inputs that are required to perform a Level 4 activity.

Restrictions: Describes the controls or conditions required to produce the desired outcomes.

Tools and resources: Describes the mechanisms or means to perform a Level 4 activity.

Outcomes of This Action: Describes the data or object produced by a Level 4 activity.

Project Scalability Considerations

If the project scope does not include ROW requirements, then those activities related to ROW are not performed. If the project scope does not include utility relocation, then those activities related to utility relocation are not performed. If the project does not have potential alternative solutions to achieving the purpose and need, then those activities related to alternative analysis (A2) are not performed. A complex project will typically have ROW, utility relocation, and alternatives.

Projects may have different environmental requirements so those activities related to environmental assessment may be performed at different levels of detail depending on the specific requirements for a project. This may impact the level of effort around the environmental activities.

The level of design effort, traffic management, and public involvement will vary as well depending on the project type and its characteristics including project location. Adjustments to the PSP in these activity areas might require some reduction in the estimated level of effort to complete these activities.

Qualification

The guidelines do not cover interaction with railroads as this is a very specialized activity area. The process activities for the railroad area would likely be similar to the utility relocation activities. The user of these guidelines should review the *SHRP 2 Report S2-R16-RR-1: Strategies for Improving the Project Agreement Process Between Highway Agencies and Railroads* for a comprehensive treatment of this topic area (see Appendix B).

A1 Develop Project

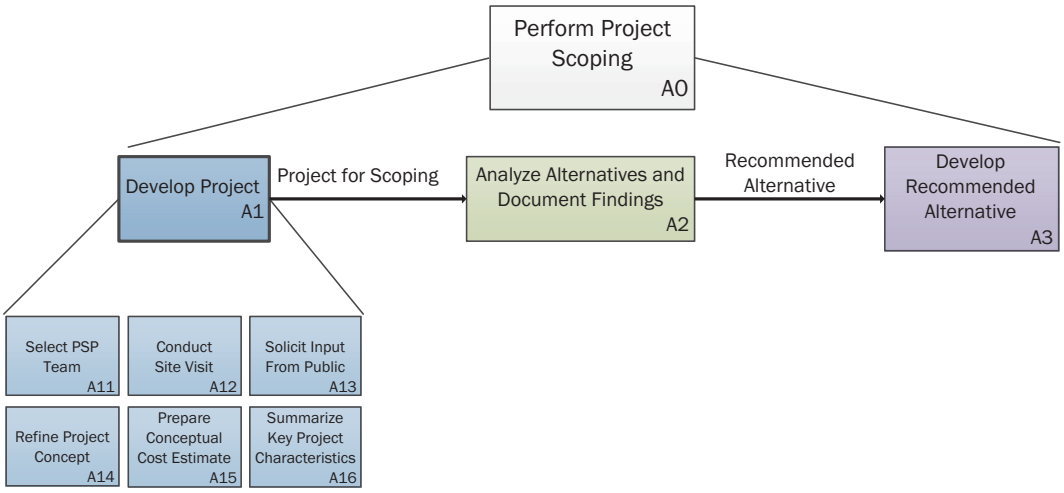


Figure A1. The PSP starts with developing the project.

The PSP starts with Develop Project (A1) (Figure A1). The objective of the first activity of the PSP is to update and refine the project parameters, project definition, and project purpose and need to a sufficient level, which facilitates selection of the best alternative and development of a more accurate baseline scope, cost, and schedule.

The six major activities performed to develop projects are:

- **A11: Select PSP team**—The project manager or other person responsible for overseeing the project's development through planning and design should develop the PSP team. The PSP team is the core team performing all the activities of the PSP. The team includes project personnel from each of the disciplines involved in the project delivery and post-construction phases, and personnel representing outside agencies. The objective of this activity is to select members for the team such that they collectively have all the required expertise to perform an effective PSP.
- **A12: Conduct site visit**—Sometimes actual project site conditions are unknown, and a site visit at the beginning of the PSP may significantly enhance the ability of the project to meet its project budgetary constraints and objectives. The objectives of the site visit are to ascertain the available project information or physical parameters, assess the need for additional investigations critical to the PSP, and determine any sensitive issues that may later affect the project cost and schedule.

Purpose: *To ensure that the agency is achieving goals and objectives outlined in local, regional, and state plans.*

To meet this purpose: *The agency must obtain relevant information from the planning phase, and use this information to redefine the project concept and make sure it is in line with the agency's strategic goals.*

- **A13: Solicit inputs from public**—Every project has to consider some level of public involvement. The agency must inform the public of issues associated with the project and measure public opinions about the development process.
- **A14: Refine project concept**—The objective of this activity is to refine the project concept and make sure it is in line with the agency's strategic goals, based on the outcome of the site visit and public input to the project.
- **A15: Prepare conceptual cost estimate**—The agency must prepare relatively accurate cost estimates based on data available to the project team at this point. The time and effort required for estimate preparation varies with project complexity and the level of definition related to project requirements.
- **A16: Summarize key project characteristics**—After finalizing the conceptual cost estimate and before analyzing the alternative and documenting findings, all the key project characteristics are reviewed thoroughly and summarized for further use in the PSP. The objective of this activity is to develop updated project definitions, project parameters, and project purpose and need.

Project Scalability Considerations

The PSP team size and make up is a function of the type of project, its complexity, project characteristics, and the magnitude of the project in terms of dollar size. The PSP should be designed to reflect these attributes of the project.

The level of effort for less complex projects, such as resurfacing and restoration project types, will reduce the effort needed to perform the Level 4 (Axxx) activities.

Project location and other project characteristics could increase or decrease the level of effort. This determination should be made as the activities of A1 are planned and performed.

The time to perform the PSP is a function of the level of scope definition, the complexity of the project and project location characteristics. In general, with lower project definition there is a corresponding increase in project uncertainty. This would translate into a greater level of risk and a higher percentage of contingency for cost estimates.

A11 Select PSP Team

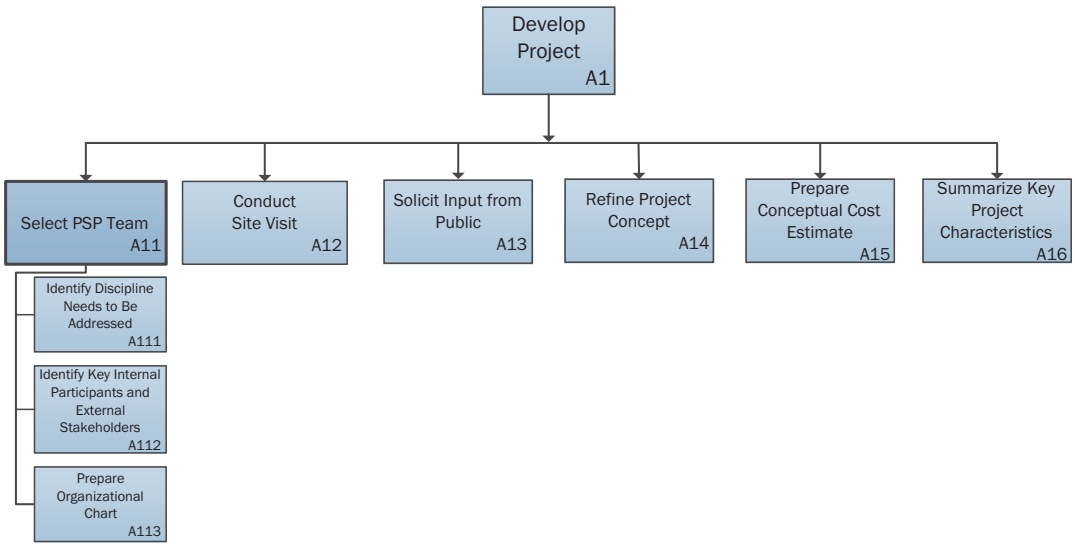


Figure A11. The first step in developing the project is selecting the PSP team.

The project manager or other person responsible for overseeing the project's development through planning and design should develop the PSP team. The PSP team is the core team performing all the activities of the PSP. The team includes project personnel from each of the disciplines involved in the project delivery and post-construction phases, and personnel representing outside agencies. The objective of this activity is to select members for the team such that they collectively have all the required expertise to perform an effective PSP.

The three major activities performed to select a PSP team (Figure A11) are:

- **A111: Identify discipline needs to be addressed**—The objective of this activity is to identify each of the disciplines involved during the project delivery and post-construction phases based on the project definition, project purpose and need statement, and project characteristics.
- **A112: Identify key internal participants and external stakeholders**—The objective of this activity is to assemble a PSP team that contains both internal key participants and external stakeholders to address all relevant technical issues during the PSP.
- **A113: Prepare organizational chart**—To align individual team members' goals with the project and the organizational goals, it is critical to finalize the roles and responsibilities of each team member. The objective of this activity is to prepare an organizational chart with explicit details about the roles and responsibilities of each team member.

A111 Identify Discipline Needs to Be Addressed

The objective of this activity is to identify each of the disciplines involved during the project delivery and post-construction phases based on the project definition, project purpose and need statement, and project characteristics.

The two actions performed in this activity (Figure A111) are:

- **Collect information about the project**—project-specific information should be collected from all the possible sources. The idea is to gather and develop the project information so as to identify the project requirements.
- **Identify disciplines involved**—based on the identified project requirements, the complete list of disciplines or functional areas involved in the project should be prepared.

Data Requirements and Information Needed to Initiate the Activity

Planning phase input:

- **Capacity improvement needs**—existing levels of traffic service and an estimate of future traffic demands.
- **Community concerns and issues**—including but not limited to cultural concerns, historical artifacts, adjacent facilities, and land use.
- **Social, environmental, and economic factors**—including current and future economic development needs; geographic, political, and political restraints; environmental drivers; safety improvement needs; existing infrastructure conditions; and suggestions of needs from operations and maintenance, planners, local elected officials, and the public.
- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).

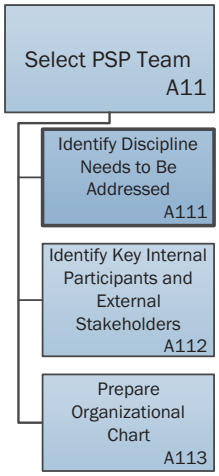


Figure A111. The first step in selecting the PSP team is identifying the discipline needs to be addressed.

- **Project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **Typical project stakeholders**—including experts from key functional groups within the transportation agency and communities, interest groups, and the general public who provide inputs to find the best transportation solution to fulfill the purpose of the project.
- **Functional group experts**—including experts from key functional groups of similar projects.
- **Project development/delivery manager**—responsible for identifying discipline requirements for the project and approval of the project team and various documents prepared during the PSP.
- **Appendix A**—T13: Project Purpose and Need Statement; and T15: Scoping Worksheets/Scoping Checklists.

Outcomes of This Action

- **List of required functional disciplines**—a complete list of disciplines or functional areas most likely to be addressed during the project delivery and post-construction phases. Typical PSP team members could include:

  Key Members
  Project manager; lead engineer/designer; pavement engineer; bridge engineer; traffic engineer; hydraulic engineer; materials engineer; construction engineer; environmental engineer/coordinator; land management engineer (ROW); utility coordinator; and maintenance engineer.

  Supporting Team Members
  Principal surveyor; access management staff; and state patrol officer.

  Decision Makers
  District engineer and project delivery/development manager.

A112 Identify Key Internal Participants and External Stakeholders

The objective of this activity is to assemble a PSP team that contains both internal key participants and external stakeholders to address all relevant technical issues during the PSP.

The three actions performed in this activity (Figure A112) are:

- **Identify key internal participants**—internal participant should include personnel from all key disciplines (design, environmental, ROW, utilities, construction, etc.) to ensure informed decisions.
- **Identify external stakeholders**—including external stakeholders such as residency administrators and utility owners improves the odds of a smooth project development process.
- **Select team members**—the team members should be selected based on their experience in similar projects and the likelihood they will be present through the project delivery and post-construction phases.

Data Requirements and Information Needed to Initiate the Activity

- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Inputs from internal participants**—project development knowledge from key functional groups (design, utilities, construction, etc.) within the agency.
- **Interests of external stakeholders**—including communities, interest groups, and the general public who provide inputs to find the best transportation solution to fulfill the purpose of the project.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **Internal participants**—expertise from key functional groups within the transportation agency.
- **External stakeholders**—communities, interest groups, and the general public who provide inputs to find the best transportation solution to fulfill the purpose of the project.
- **Communication tools**—such as a stakeholder contact information list, flowcharts that show communication channels for different issues, and file management software.
- **Project development/delivery manager**—responsible for identifying discipline requirements for the project and approval of the project team and various documents prepared during the PSP.
- **Appendix A**—T13: Project Purpose and Need Statement and T15: Scoping Worksheets/Scoping Checklists.

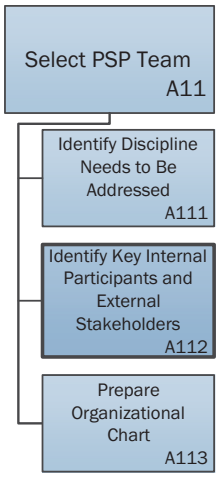


Figure A112. The second step in selecting the PSP team is identifying key internal participants and external stakeholders.

Outcomes of This Action

- **Identified participants and external stakeholders**—key project team members including utilities, community interest groups, and municipal planning organizations.

A113 Prepare Organizational Chart

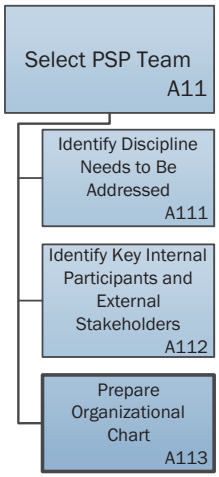


Figure A113. The third step in selecting the PSP team is preparing the organizational chart.

To align individual team members' goals with the project and the organizational goals, it is critical to finalize the roles and responsibilities of each team member. The objective of this activity is to prepare an organizational chart with explicit details about the roles and responsibilities of each team member.

The two actions performed in this activity (Figure A113) are:

- **Identify PSP Level 4 activities**—all possible Level 4 activities required to be performed for the PSP should be identified based on the collected project information, project requirements, and project definition.
- **Finalize the organizational chart**—the explicit roles and responsibilities of each team member should be defined for identified Level 4 activities. This organizational chart shall be reviewed at the end of activity A1.

Data Requirements and Information Needed to Initiate the Activity

- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Identified participants and external stakeholders**—key project team including utilities, community interest groups, and municipal planning organizations.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **Project development/delivery manager**—responsible for identifying discipline requirements for the project and approval of the project team and various documents prepared during the PSP.
- **Appendix A**—T15: Scoping Worksheets/Scoping Checklists.

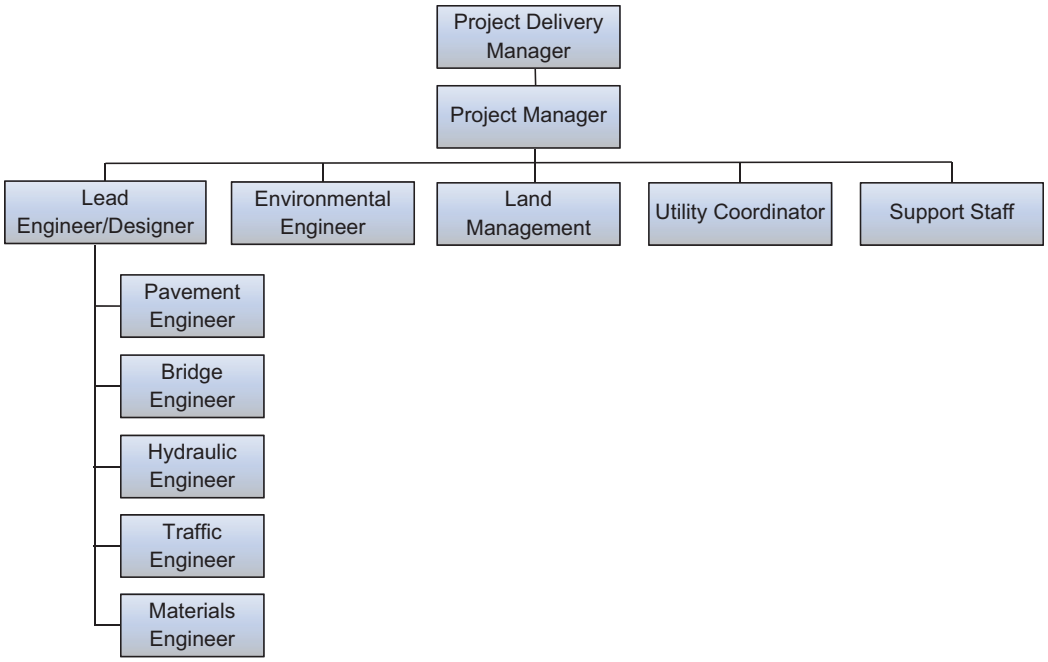


Figure A113-1. Typical project organizational chart.

Outcomes of This Action

- **Organizational chart with roles and responsibilities**—at the end of this activity, the PSP team members should have a clear idea about their roles and expectations. The same should also be reflected in the organizational chart. A typical project organization chart is shown in Figure A113-1. It should be noted that a team member shown on the project organization chart does not necessarily signify that the team member is working full time on the project. Team effort depends on the project definition, its characteristics, and its location.

A12 Conduct Site Visit

Sometimes actual project site conditions are unknown, and a site visit at the beginning of the PSP may significantly enhance the ability of the project to meet its project budgetary constraints and objectives. The objectives of the site visit are to ascertain the available project information or physical parameters, assess the need for additional investigations critical to the PSP, and determine any sensitive issues that may later affect the project cost and schedule.

The four major activities performed to conduct a site visit (Figure A12) are:

- **A121: Prepare for site visit**—The objective of this activity is to prepare for the site visit. The site visit is intended for each key team member and representatives from critical outside agencies. It begins with a team kickoff meeting.
- **A122: Confirm project information**—The objective of this activity is to collect all possible project information during the site visit and to confirm it with the information from the planning phase. This activity should also include identifying critical areas that may require further investigation solely for the purpose of the PSP.
- **A123: Identify required investigations for PSP**—Critical inputs or data required for performing the PSP may not always be available from the planning phase or may not be obtained during the site visit. In these situations, additional investigation may be necessary. The objective of

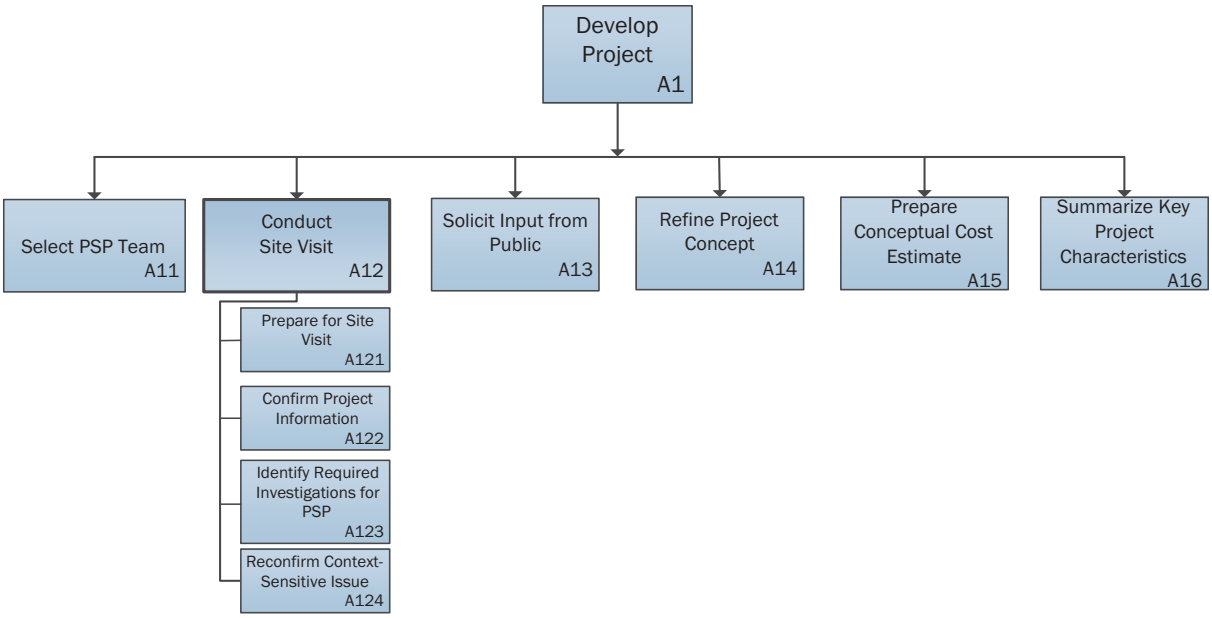


Figure A12. The second step in developing the project is conducting the site visit.

this activity is to identify the feasible investigations to obtain these critical inputs and to resolve any discrepancies between the available and observed parameters.

- **A124: Reconfirm context–sensitive issues**—The objective of this activity is to reconfirm project context–sensitive issues considered during the site visit and verify all site-related information.

A121 Prepare for Site Visit

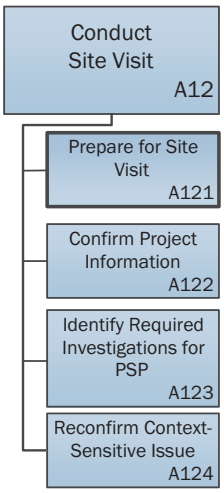


Figure A121. The first step in conducting the site visit is preparing for the site visit.

The objective of this activity is to prepare for the site visit. The site visit is intended for each key team member and representatives from critical outside agencies. It begins with a team kickoff meeting.

The three actions performed in this activity (Figure A121) are:

- **Collect information about the project**—project-specific information should be collected from all the possible sources. The idea is to gather and develop the project information so as to identify the project requirements.
- **Prepare the list of participants**—key team members should be invited to the site visit.
- **Prepare the agenda**—a comprehensive agenda, along with a schedule, for the site visit should be prepared covering details of actions required and expected outcomes of the visit.

Data Requirements and Information Needed to Initiate the Activity

- **Capacity improvement needs**—existing levels of traffic service and estimates of future traffic demands.
- **Community concerns and issues**—including but not limited to cultural concerns, historical artifacts, adjacent facilities, and land use.
- **Social, environmental, and economic factors**—including current and future economic development needs; geographic, political, and political restraints; environmental drivers; safety improvement needs; existing infrastructure conditions; and suggestions of needs from operations and maintenance, planners, local elected officials, and the public.

- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **Geographic information systems (GIS)**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.
- **2D/CD CAD**—existing design and as-built files of previous projects either within or adjacent to the project boundaries.
- **PSP Team**—as identified at the end of activity A113.

Outcomes of This Action

- **List of participants**—including key team members, representatives of each discipline, and outside agencies.
- **Agenda**—including the purpose of the site visit, expected outcomes from the site visit, and the action plan for the site visit.

A122 Confirm Project Information

The objective of this activity is to collect all possible project information during the site visit and to confirm it with the information from the planning phase. This activity should also include identifying critical areas that may require further investigation solely for the purpose of the PSP.

The three actions performed in this activity (Figure A122) are:

- **Collect project information**—during the site visit, all the available project information related to physical parameters, ROW, environmental issues, and project conflicts like existing structures, utilities, etc. should be collected.
- **Assess the need for investigation**—the PSP team should assess all the critical aspects of the project and assess the need for any investigations like surveys, geotechnical investigation, field

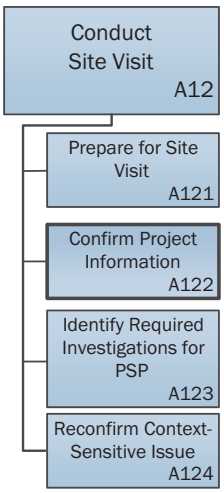


Figure A122. The second step in conducting the site visit is confirming the project information.

investigations to address environmental issues, etc. to generate an adequate level of inputs for performing the PSP.
- **Confirm project information**—toward the end of the site visit, the PSP team should verify the available information with the actual site conditions and record any discrepancies. Additional investigation may be called for to resolve these discrepancies.

Data Requirements and Information Needed to Initiate the Activity

- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.
- **List of participants**—including key internal participants and external stakeholders.
- **Agenda**—including the purpose of the site visit, the expected outcome of the site visit, and the action plan for the site visit.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **PSP team**—as identified at the end of activity A113.
- **Communication tools**—including a stakeholder contact information list, flowcharts that show communication channels for different issues, and file management software.

Outcomes of This Action

- **Verified project parameters**—resulting from the site visit and including confirmed project information.
- **Identified critical areas for further investigation**—including identified unavailable critical inputs required for performing an effective PSP, as well as proposed investigations for obtaining these inputs and resolving any discrepancies between available and collected project information.

A123 Identify Required Investigations for PSP

Critical inputs or data required for performing the PSP may not always be available from the planning phase or may not be obtained during the site visit. In these situations, additional

investigation may be necessary. The objective of this activity is to identify the feasible investigations to obtain these critical inputs and to resolve any discrepancies between the available and observed parameters.

The four actions performed in this activity (Figure A123) are:

- **Review required inputs**—the inputs for which investigations are proposed should be reassessed for their importance for performing the PSP.
- **Identify required investigations**—the PSP team should consider all the possible methods of investigation and choose the most efficient and effective method based on budget and time constraint. The team should also ascertain that further investigation is the only way to obtain the required inputs.
- **Prepare a list of investigations**—the final list of investigations should be based on required completion time and cost of the investigations.
- **Prepare a schedule and objectives for the investigations**—conducting investigations will be a challenge in terms of cost and schedule. The schedule should be worked out for these investigations along with the objectives of the investigations.

Data Requirements and Information Needed to Initiate the Activity

- **Verified project parameters**—resulting from the site visit effort and including confirmed project information that can be further used for the PSP.
- **Identified critical areas for further investigation**—including identified unavailable critical inputs required for performing an effective PSP, as well as proposed investigations for obtaining these inputs and resolving any discrepancies between available and collected project information.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **PSP team**—as identified at the end of activity A113.

Outcomes of This Action

- **Details of investigations to be carried out**—including investigations to be carried out, the schedule for investigations, and the objectives of investigations.

A124 Reconfirm Context–Sensitive Issues

The objective of this activity is to reconfirm project context–sensitive issues considered during the site visit and verify all site related information.

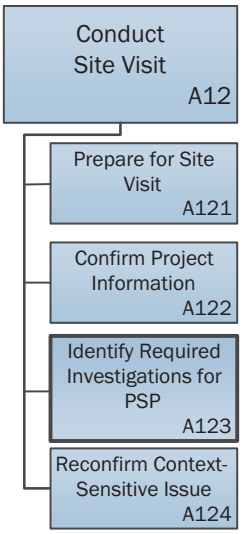


Figure A123. The third step in conducting the site visit is identifying required investigations for the PSP.

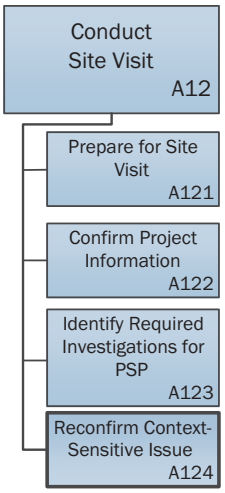


Figure A124. The fourth step in conducting the site visit is reconfirming context-sensitive issues.

The two actions performed in this activity (Figure A124) are:

- **Review sensitive issues**—the PSP team should review all the sensitive issues covering design, environmental, ROW, utilities, public involvement, etc.
- **Update project information**—based on the information collected or observed during the site visits, the project parameters should be updated.

Data Requirements and Information Needed to Initiate the Activity

- **Verified project parameters**—resulting from the site visit effort and including confirmed project information that can be further used for the PSP.
- **Details of investigation to be carried out**—including investigations to be carried out, the schedule for investigations, and the objectives of investigations.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **PSP team**—as identified at the end of activity A113.

Outcomes of This Action

- **Updated physical parameters**—including verified and developed project parameters.

A13 Solicit Input from Public

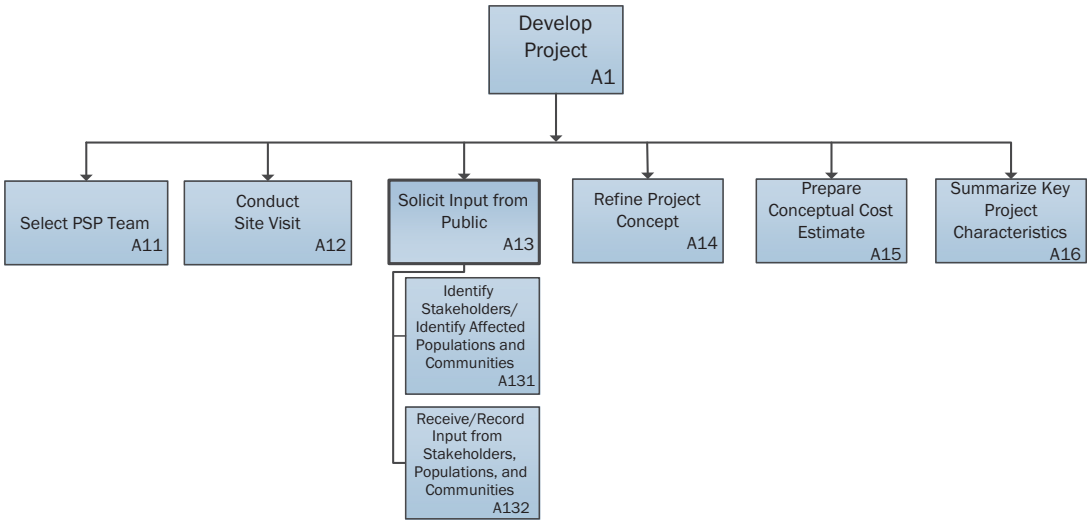


Figure A13. The third step in developing the project is soliciting input from the public.

Every project has to consider some level of public involvement. The agency must inform the public of issues associated with the project and measure public opinions about the development process.

The two major activities performed to solicit input from the public (Figure A13) are:

- **A131: Identify stakeholders/identify affected populations and communities**—The objective of this activity is to identify and document transportation stakeholders and the communities and populations directly affected by project activities.
- **A132: Receive/record inputs from stakeholders, populations, and communities**—The objective of this activity is to document the planning and public involvement activities that contribute to the administrative record. The administrative record serves to demonstrate due diligence to resource agencies, reviewers, and the public that a hard look was conducted.

A131 Identify Stakeholders/Identify Affected Populations and Communities

The objective of this activity is to identify and document transportation stakeholders and the communities and populations directly affected by project activities.

The five actions performed in this activity (Figure A131) are:

- **Identify project-specific stakeholders**—identify and document responsible parties, local and resource agencies, and key project requirements including their location, footprint (limits), and descriptions of key work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Identify project-specific populations**—identify at-risk, environmental justice (EJ) communities in the project area of influence.
- **Identify project-specific communities**—identify affected communities in the project area.
- **Identify project-specific natural communities**—identify the impacts on affected natural and biotic communities.
- **Revise project scope and planning documents**—as needed to reflect the presence and characteristics of individual populations, communities, or biotic and natural communities that may be affected; the project scope and planning documents may be revised.

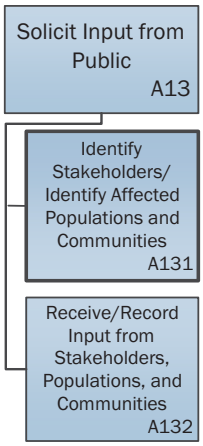


Figure A131. The first step in soliciting input from the public is identifying stakeholders/ identifying affected populations and communities.

Data Requirements and Information Needed to Initiate the Activity

- **Community information and plans**—identified stakeholders, affected populations, community impacts, the public involvement plan, metropolitan transportation plan (MTP), long-range plans, and other affected plans. Consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **Long-range plans**—including the statewide transportation plan (SWP), MTP, and public involvement plan [part of the MTP or a stand-alone metropolitan planning organization (MPO)–produced plan]. Air quality conformity, state and federal public involvement requirements, and plan consistency requirements, etc. should also be considered.

Tools and Resources

- **Public outreach, notification, and education**—meetings, mailings, education of the public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and state department of transportation (DOT) staff, and public leaders.
- **PSP team**—relevant team members as identified at the end of activity A1113.

Outcomes of This Action

- **Record of key stakeholders, partners, agencies, affected populations, and their input.**

A132 Receive/Record Input from Stakeholders, Populations, and Communities

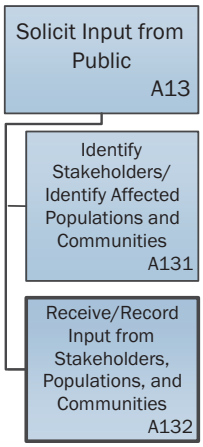


Figure A132. The second step in soliciting input from the public is receiving/ recording input from stakeholders, populations, and communities.

The objective of this activity is to document the planning and public involvement activities that contribute to the administrative record. The administrative record serves to demonstrate due diligence to resource agencies, reviewers, and the public that a hard look was conducted.

The four actions performed in this activity (Figure A132) are:

- **Document stakeholders**—the roles and responsibilities of participating agencies, local jurisdictions, and resource agencies involved in the proposed project studies and management plans, including jurisdictions for key project requirements, location, and footprint (limits).
- **Document populations**—broadly identifies and records the potential presence of at-risk EJ communities in the potential area of influence of the proposed project. The purpose is to avoid potential disproportionate impacts on protected populations.
- **Document communities**—communities of all makes and compositions that may be affected or have interests in a project. These may be geographically based communities (neighborhoods, historic districts, or business districts) or interest-based communities (e.g., cycling, preservation, or economic development) within the project area of influence.
- **Document natural communities**—the locations and characteristics of biotic and natural communities and receptors such as floodplains, streams/wetlands, habitats, parks, public lands, and conservation areas. Particular attention should be paid to identify sensitive receptors to avoid future mitigation.

Data Requirements and Information Needed to Initiate the Activity

- **Community information and plans**—a record of community impacts, the public involvement plan, MTP, long-range plans, and other affected plans. Consistency with other local, regional, and statewide plans is necessary.
- **Record of key stakeholders, partners, agencies, affected populations, and their input.**

Restrictions

- **Long-range plans**—including the SWP, MTP, and public involvement plan (part of the MTP or a stand-alone MPO-produced plan). Air quality conformity, state and federal public involvement requirements, and plan consistency requirements, etc. should also be considered.

Tools and Resources

- **Public outreach, notification, and education**—meetings, mailings, education of public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and state DOT staff, and public leaders.
- **PSP team**—relevant team members as identified at the end of activity A113.

Outcomes of This Action

- **Administrative record of key stakeholders, partners, agencies, affected populations, and their input.**

A14 Refine Project Concept

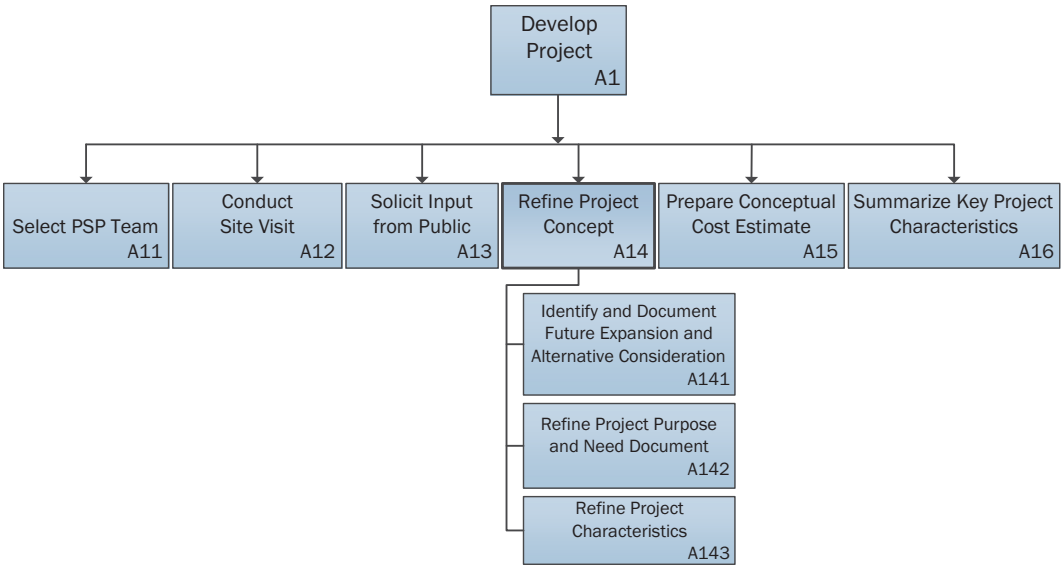


Figure A14. The fourth step in developing the project is refining the project concept.

The objective of this activity is to refine the project concept and make sure it is in line with the agency's strategic goals, based on the outcome of the site visit and public input to the project.

The three major activities performed to refine the project concept (Figure A14) are:

- **A141: Identify and document future expansion and alternative considerations**—The objective of this activity is to identify and document future expansions needed and considerations to be included when soliciting input from internal and external participants.
- **A142: Refine project purpose and need document**—The objective of this activity is to refine the project purpose and need document to a significant level and to serve as the basis for identifying, comparing, and selecting the best alternative.
- **A143: Refine project characteristics**—Given the time and knowledge/information gap between the planning and current PSP phase, it is possible that the project characteristics need

further updating. The objective of this activity is to update the project characteristics based on knowledge/information acquired during the site visit and public input on the project.

A141 Identify and Document Future Expansion and Alternative Consideration

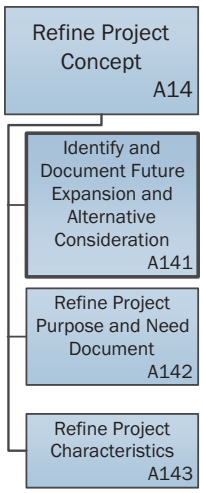


Figure A141. The first step in refining the project concept is identifying and documenting future expansion and alternative considerations.

The objective of this activity is to identify and document future expansions needed and considerations to be included when soliciting input from internal and external participants.

The four actions performed in this activity (Figure A141) are:

- **Identify potential alternatives**—the PSP team produces a list of all possible alternatives to fulfill the purpose and needs identified in the previous activity.
- **Compare/assess alternatives**—the PSP team preliminarily evaluates alternatives using general knowledge about transportation project development and anticipated input from stakeholders and the public.
- **List identified alternatives**—the list includes all information and data associated with each alternative, explanations of how the agency derived and assessed alternatives, and reasons why each alternative is kept for further consideration or dropped.
- **Document future expansion and alternative considerations**—expansions and alternatives should be properly documented for future reference to help the PSP team stay aligned while moving forward.

Data Requirements and Information Needed to Initiate the Activity

- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Updated physical parameters**—including verified and developed project parameters.
- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Documented major alternatives**—comprehensive collection of all information and data associated with each alternative, explanations of how the agency derived and assessed alternatives, and reasons why each alternative is kept for further consideration or dropped.
- **Stakeholders' input on project**—the administrative record of key stakeholders, partners, agencies, affected populations, and their input.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public input, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **PSP team**—as identified at the end of activity A113.

Outcomes of This Action

- **Future expansion and alternatives consideration**—at the end of this activity, the PSP team should have a clear idea of what efforts need to be made to expand the alternatives for further assessment and what kind of information is needed from the stakeholders and the public.

A142 Refine Project Purpose and Need Document

The objective of this activity is to refine the project purpose and need document to a significant level and to serve as the basis for identifying, comparing, and selecting the best alternative. The document should:

- Be based on objective and factual information reflecting both current and future conditions.
- Clearly identify the rationale for pursuing the project.

The four actions performed in this activity (Figure A142) are:

- **Review the federal and state laws and regulations**—review the laws and regulations pertaining to a project purpose and need statement, e.g., the NEPA of 1969, etc.
- **Gather or develop an adequate level of the proposed project details**—details like the proposed project location, length, limits, long-range plan, current and future plan, roadway deficiencies, and so on.
- **Write and review purpose and need statement**—statement should focus on transportation problems, advance the proposed project efficiently, provide a clear basis for evaluating alternatives, and should be legally defensible.
- **Finalize the purpose and need document**—the PSP should create a factual and objective statement of the current conditions and a clear rationale for pursuing the project.

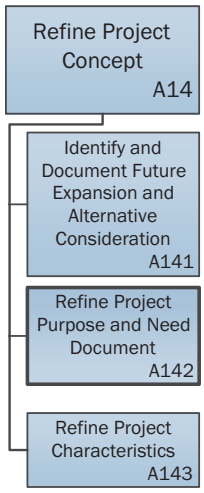


Figure A142. The second step in refining the project concept is refining the project purpose and need document.

Data Requirements and Information Needed to Initiate the Activity

- **Future expansion and alternatives consideration**—the PSP team should have a clear idea of what efforts need to be made to expand the alternatives for further assessment and what kind of information is needed from the stakeholders and the public.
- **Capacity improvement needs**—existing levels of traffic service and an estimate of future traffic demands.
- **Social, environmental, and economic factors**—including current and future economic development needs; geographic, political, and political restraints; environmental drivers; safety improvement needs; existing infrastructure conditions; and suggestions of needs from operations and maintenance, planners, local elected officials, and the public.
- **Updated physical parameters**—including verified and developed project parameters.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Stakeholders' inputs on project**—the administrative record of key stakeholders, partners, agencies, affected populations, and their input.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state law and regulations.**

Tools and Resources

- **PSP team**—as identified at the end of activity A113.
- **FHWA Environmental Review Tool Kit**—http://environment.fhwa.dot.gov/projdev/index.asp.
- **FHWA Public Involvement Techniques for Transportation Decision Making**—http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/.
- **FHWA Planning and Environment**—http://environment.fhwa.dot.gov/integ/index.asp.
- **Transportation Planning Capacity Building**—http://www.planning.dot.gov/.
- American Association of State Highway and Transportation Officials (AASHTO) Center for Environmental Excellence—http://environment.transportation.org/.
- **Appendix A**—T13: Project Purpose and Need Statement.

Outcomes of This Action

- **Updated purpose and need statement**—clear rationale for pursuing the project.

A143 Refine Project Characteristics

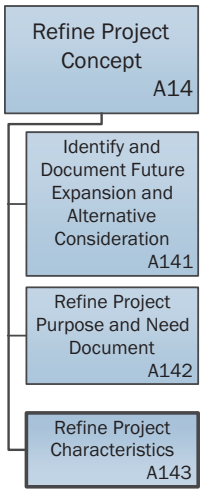


Figure A143. The third step in refining the project concept is refining the project characteristics.

Given the time and knowledge/information gap between the planning and current PSP phase, it is possible that the project characteristics need further updating. The objective of this activity is to update the project characteristics based on knowledge/information acquired during the site visit and public input on the project.

The three actions performed in this activity (Figure A143) are:

- **Identify possible sources of information**—the process of developing the purpose and need document usually involves site visits and inputs from individuals and state agencies with relevant knowledge of the existing conditions.
- **Collect information about the project**—the document should be developed to the level of detail that is sufficient to be used as the basis for comparing and selecting alternatives.
- **Finalize the project characteristics and definition**—the PSP team should develop the project characteristics and definition based on the available project information from all sources.

Data Requirements and Information Needed to Initiate the Activity

- **Future expansion and alternative considerations**—the PSP team should have a clear idea of what efforts need to be made to expand the alternatives for further assessment and what kind of information is needed from the stakeholders and the public.
- **Capacity improvement needs**—existing levels of traffic service and an estimate of future traffic demands.

- **Social, environmental, and economic factors**—including current and future economic development needs; geographic, political, and political restraints; environmental drivers; safety improvement needs; existing infrastructure conditions; and suggestions of needs from operations and maintenance, planners, local elected officials, and the public.
- **Physical parameters**—including verified and developed project parameters.
- **Project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Updated project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Stakeholders' input on project**—the administrative record of key stakeholders, partners, agencies, affected populations, and their input.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.

Tools and Resources

- **PSP team**—as identified at the end of activity A113.

Outcomes of This Action

- **Refined project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Refined project parameters**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

A15 Prepare Conceptual Cost Estimate

The agency must prepare relatively accurate cost estimates based on data available to the project team at this point. The time and effort required for estimate preparation varies with project complexity and the level of definition related to project requirements.

The five major activities performed to prepare the conceptual cost estimate (Figure A15) are:

- **A151: Determine basis for conceptual cost estimate**—The objective of this activity is to collect and document all information required to serve as a basis for preparing a base conceptual estimate in the next activity (A152).

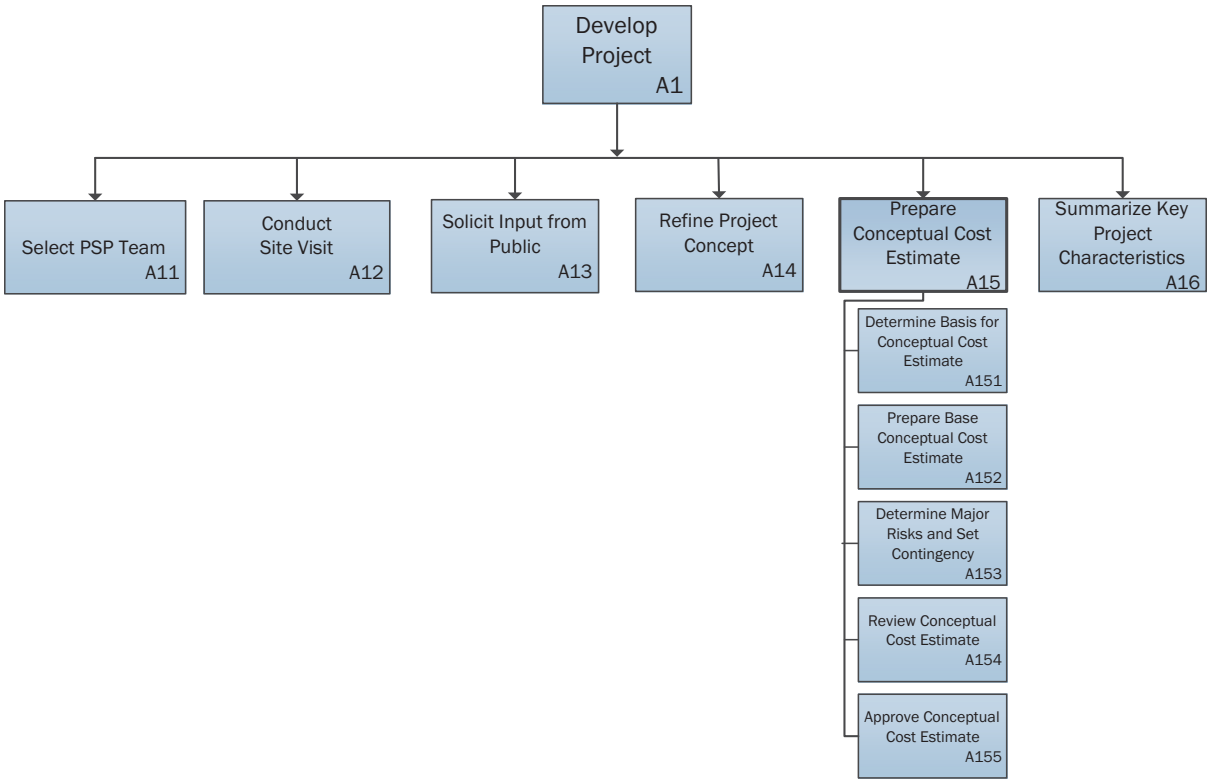


Figure A15. The fifth step in developing the project is preparing the conceptual cost estimate.

- **A152: Prepare base conceptual cost estimate**—The objective of this activity is to prepare the most likely conceptual cost estimate based on what is known, without including contingency dollars to cover estimate uncertainty or risks. An estimate of contingency is covered in the next activity (A153).
- **A153: Determine major risks and set contingency**—The objective of this activity is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate.
- **A154: Review conceptual cost estimate**—The objective of this activity is to review the conceptual estimate to ensure that it is as complete and accurate as possible based on the project requirements as described in the refined project concept (A14).
- **A155: Approve conceptual cost estimate**—The objective of this activity is to approve the final conceptual estimate package before the estimate is released to both internal and external project stakeholders.

A151 Determine Basis for Conceptual Cost Estimate

The objective of this activity is to collect and document all information required to serve as a basis for preparing a base conceptual estimate in the next activity (A152).

The five actions performed in this activity (Figure A151) are:

- **Review the concept definition**—the proposed project studies and management plans, unknowns, and key project requirements, including their locations and parameters (e.g., boundaries/limits) and descriptions of key work (e.g., widen existing roadway, mill and resurface roadway, or construct new project) should be reviewed. Once the material is reviewed,

a plan will be made for how the estimate will be prepared, what other input will be required, and what deadlines should be set.

- **Determine an alternative to the estimate**—identify which alternative solution developed for the project in previous steps should be estimated first.
- **Review site characteristics**—understand the project site characteristics and possible impacts they might have on ROW, utility, environmental, and construction costs.
- **Determine if clarification is needed**—confirm that the project definition (project requirements and site characteristics) is complete and, if necessary, requests additional information for clarifying existing documentation of the project requirements or ensuring that certain requirements are needed.
- **Determine the scoping estimate basis**—begins with documentation of trail that supports a project estimate and prepares an estimating file with documentation of the estimate basis, including scoping worksheets, schematics or other preliminary drawings, design criteria, and other specific project requirements.

Data Requirements and Information Needed to Initiate the Activity

- **Refined project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Refined project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating; NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf]; and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).
- **Risk management procedure**—guidance on the approach to identify risks, quantify their impact on cost, and take actions to mitigate the impact of risks as the project scope is developed; a tool available for risk management (*NCHRP Report 658: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf]).

Tools and Resources

- **Cost estimators**—the members of the PSP team responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.

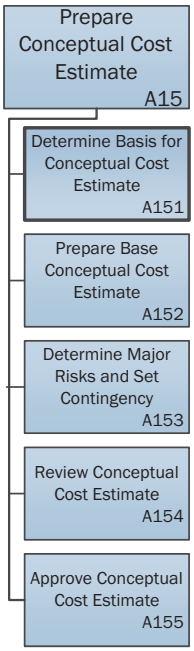


Figure A151. The first step in preparing the conceptual cost estimate is determining the basis for the conceptual cost estimate.

Outcomes of This Action

- **Location characteristics**—comprehensive collection of all information about the project site and location including urban versus rural type, labor wage rates, potential environmental conditions that must be mitigated, ROW requirements, utility relocations requirements, and detour and haul route requirements.
- **Updated project definition**—comprehensive collection of all information and data including scoping worksheets, schematics or other preliminary drawings, design criteria, and other specific project requirements organized in a systematic manner for easy review.

A152 Prepare Base Conceptual Estimate

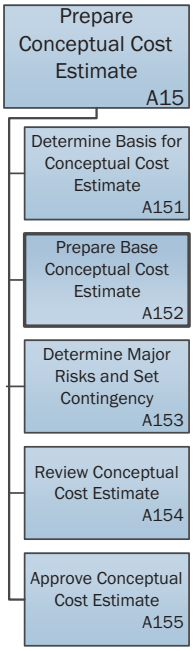


Figure A152. The second step in preparing the conceptual cost estimate is preparing the base conceptual cost estimate.

The objective of this activity is to prepare the most likely conceptual cost estimate based on what is known, without including contingency dollars to cover estimate uncertainty or risks. An estimate of contingency is covered in the next activity (A153).

The six actions performed in this activity (Figure A152) are:

- **Select the appropriate approach**—determine the types of estimating techniques that can be used. The techniques used depend on the level of project definition and the knowledge of the project type and project characteristics, as defined by the estimate basis in the previous activity (A151).
- **Determine estimate components and quantify**—produce:
  - A list of major items to be estimated.
  - Any quantities needed to prepare the base estimate (e.g., the number of lane miles or square feet of a bridge deck).
- **Develop estimate data**—use the list of major items and quantities to do one of the following:
  - Derive the cost data needed to convert the major quantity into costs.
  - Derive costs from a historical percentage.
- **Calculate the cost estimate**—convert quantities or percentages into costs using a cost-estimating program such as a spreadsheet.
- **Document estimate assumptions**—create a project estimate file that contains the following items used to prepare the base cost estimate:
  - Estimate basis from (A151).
  - Estimate calculations.
  - Estimate assumptions.
- **Prepare an estimate package**—create a package, including a cost summary that will be included in the project estimate file.

Data Requirements and Information Needed to Initiate the Activity

- **Estimate basis**—including the accumulated information on the project requirements, such as:
  - Project location.
  - Project limits.
  - Description of the proposed scope.
- **Refined project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

- **Historical data**—cost data from previous projects used as a basis for pricing different components of the total project cost.
- **Functional group input**—cost estimates provided by different functional groups (e.g., traffic operations).

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the members of the PSP team responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- ***AASHTO Practical Guide to Cost Estimating***—Chapter 2.
- **Cost-estimating techniques**—including:
  - Historical cost per driving parameter (e.g., dollars per lane mile).
  - Similar projects.
  - Historical percentages.
- **Appendix A**—T01: Cost/Parameter Using Similar Projects; T02: Cost/Parameter Using Typical Sections; and T05: Historical Percentage.
- **Cost-estimating spreadsheet**—spreadsheet that includes:
  - Scope items.
  - Quantities.
  - Unit costs.
  - Cost extensions.

Outcomes of This Action

- **Conceptual project cost estimate file**—comprehensive collection of all information and data used to prepare the cost estimate, organized in a systematic manner for easy review. The file includes a cost estimate value.

A153 Determine Major Risks and Set Contingency

The objective of this activity is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate.

The six actions performed in this activity (Figure A153) are:

- **Review risk information**—estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate. This action reviews the estimating assumptions made by the estimator and the project definition assumptions made by the planner. Next, risk checklists and risk analyses from similar projects are reviewed.

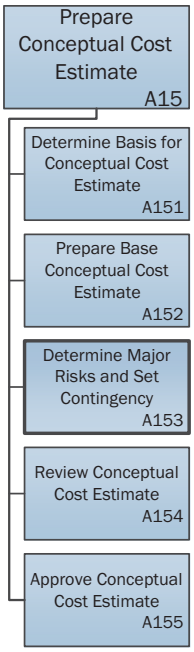


Figure A153. The third step in preparing the conceptual cost estimate is determining major risks and setting the contingency.

- **Determine the level of risk analysis**—categorize the project as minor, moderately complex, or major with respect to its complexity using estimate basis. If this is not the first estimate for the project, then the conceptual cost estimate must be reconciled against the previous estimate.
- **Identify risks**—identify and categorize risks that could affect the project, and document these risks. Based on the level of complexity identified in the previous step, one of the following types of analysis is performed to identify project risks:
  - Type I risk analysis—risk identification and percentage contingency for minor projects.
  - Type II risk analysis—qualitative risk analysis and identified contingency items for moderately complex projects.
  - Type III risk analysis—quantitative risk analysis and contingency management for major projects.
- **Estimate contingency**—begin with determining likelihood and magnitude of impact of each risk and use this information as the basis for estimating contingency. Based on the level of complexity, this action may use historical data, the estimator's judgment, and a stochastic model of cost and schedule.
- **Document the risk and contingency basis**—document a transparent list of risks and uncertainties, and keep it in the project estimate file for communication of the cost estimate.
- **Prepare the total project cost estimate**—the contingency amount is added to the base cost estimate to arrive at a total project cost.

Data Requirements and Information Needed to Initiate the Activity

- **Conceptual project cost estimate basis**—all known costs categorized by different types of estimate elements and excluding contingency to cover uncertainties.
- **Conceptual project cost estimate file**—comprehensive collection of all information and data used to prepare the cost estimate, organized in a systematic manner for easy review. The file includes a cost estimate value.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).
- **Risk management procedure**—guidance on the approach to identify risks, quantify their impact on cost, and take actions to mitigate the impact of risks as the project scope is developed; a tool available for risk management (*NCHRP Report 658: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf]).

Tools and Resources

- **Cost estimators**—the members of the PSP team responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.

- **Cost-estimating spreadsheet**—spreadsheet that includes scope items, quantities, unit costs, and cost extensions.
- **Risk analyst**—the member of the PSP team and/or an external consultant who creates a stochastic model of cost and schedule in complex projects.
- **Appendix A**—T07: Risk Checklists and T09: Contingency Percentage.

Outcomes of This Action

- **Preliminary base estimate with contingencies**—including:
  - Total project cost expressed as a range.
  - Supporting documentation related to the estimate basis, assumptions, and backup calculations.
- **Major project risks**—a risk register can be used to record and communicate the following information:
  - A detailed description of the risks.
  - Their probability of occurrence.
  - Their impact if they occur.
  - Strategies to manage the risks.
  - An assignment of ownership for the risks.
  - A schedule for risk resolution. A risk management plan generally documents the structure of risk management for each project. The risk management plan includes, at a minimum, the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking.
- **Initial risk management plan narrative**—the risk management plan generally documents the structure of risk management for each project such as:
  - The approach to managing the risks.
  - Roles and responsibilities.
  - Budgeting, timing, reporting formats, and tracking.

A154 Review Conceptual Cost Estimate

The objective of this activity is to review the conceptual estimate to ensure that it is as complete and accurate as possible based on the project requirements as described in the refined project concept (A14).

The two actions performed in this activity (Figure A154) are:

- **Determine the level of review**—select the appropriate tools for review, and develop a review plan that contains a schedule for the review and a listing of people who will participate.
- **Review/verify and reconcile the estimate**—review, verify, and reconcile the estimate to determine if the correct assumptions, calculations, and conclusions were made about the project. Based on the level of complexity, one of the following review methods can be used:
  - Estimate checklist.
  - Roundtable estimate review.
  - In-house peers.
  - Formal committee.

If this is not the first estimate for the project, then the conceptual cost estimate must be reconciled against the previous estimate.

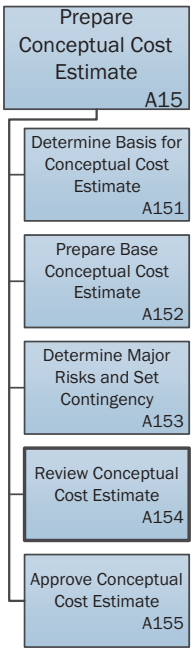


Figure A154. The fourth step in preparing the conceptual cost estimate is reviewing the conceptual cost estimate.

Data Requirements and Information Needed to Initiate the Activity

- **Preliminary base estimate with contingencies**—including:
  - Total project cost expressed as a range.
  - Supporting documentation related to the estimate basis, assumptions, and backup calculations.
- **Major project risks**—a risk register can be used to record and communicate the following information:
  - A detailed description of the risks.
  - Their probability of occurrence.
  - Their impact if they occur.
  - Strategies to manage the risks.
  - An assignment of ownership for the risks.
  - A schedule for risk resolution. A risk management plan generally documents the structure of risk management for each project. The risk management plan includes, at a minimum, the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking.
- **Initial risk management plan narrative**—the risk management plan generally documents the structure of risk management for each project such as:
  - The approach to managing the risks.
  - Roles and responsibilities.
  - Budgeting, timing, reporting formats, and tracking.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the members of the PSP team responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating spreadsheet**—a spreadsheet that includes scope items, quantities, unit costs, and cost extensions.

Outcomes of This Action

- **Final conceptual cost estimate package**—containing the base cost (summary and details) and contingency, all supporting documentation related to the estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty. Noting any changes that have been made or need to be made is essential to the cost management process.

A155 Approve Conceptual Cost Estimate

The objective of this activity is to approve the final conceptual estimate package before the estimate is released to both internal and external project stakeholders.

The two actions performed in this activity (Figure A155) are:

- **Prepare the estimate package**—the objective of this action makes sure that that no important items are overlooked, all documentation is clear and concise, and it easily allows the retrieval of key information to facilitate the final review and approval.
- **Approve the estimate package**—input the reviewed conceptual cost estimate package and give it a final formal approval. This approval is twofold:
  - Approval that the estimate was prepared using the appropriate procedure, tools, and knowledge.
  - Approval of the estimate amount.

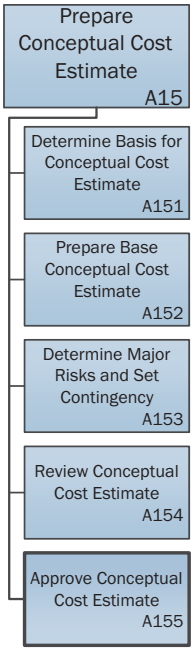


Figure A155. The fifth step in preparing the conceptual cost estimate is approving the conceptual cost estimate.

Data Requirements and Information Needed to Initiate the Activity

- **Final conceptual cost estimate package**—containing the base cost (summary and details) and contingency, all supporting documentation related to the estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty. Noting any changes that have been made or need to be made is essential to the cost management process.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the staff members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Project development/delivery manage**—the staff member responsible for managing the project development activities and the PSP team in charge of performing different actions.

Outcomes of This Action

- **Approved conceptual cost estimate package**—once the estimate is approved, it can be communicated. Approving the conceptual cost estimate includes the following two approvals:
  - Approval that the estimate was prepared using the appropriate procedure, tools, and knowledge.
  - Approval of the estimate amount.

A16 Summarize Key Project Characteristics

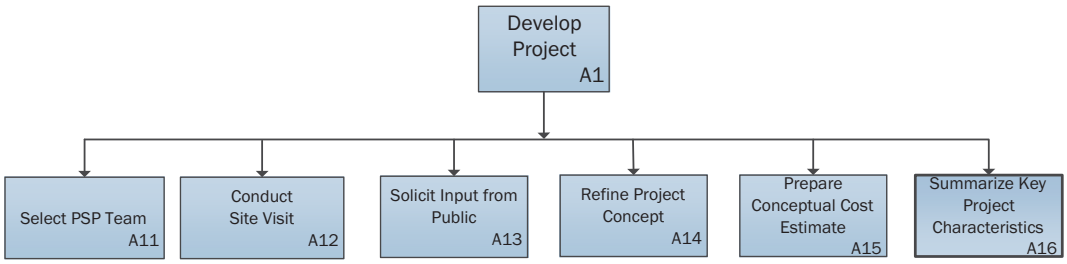


Figure A16. The sixth step in developing the project is summarizing key project characteristics.

After finalizing the conceptual cost estimate and before analyzing the alternative and documenting findings, all the key project characteristics are reviewed thoroughly and summarized for further use in the PSP. The objective of this activity is to develop updated project definitions, project parameters, and project purpose and need.

The three actions required to perform this activity (Figure A16) are:

- **Identify possible sources of information**—the process of developing the purpose and need document usually involves site visits and inputs from individuals and state agencies with relevant knowledge of the existing conditions.
- **Collect information about the project**—the document should be developed to the level of detail that is sufficient to be used as the basis for comparing and selecting alternatives.
- **Update the project definition, project parameters, and project purpose and need**—review and develop the project definition, project parameters, and project purpose and need based on the available project information from all sources.

Data Requirements and Information Needed to Initiate the Activity

- **Conceptual cost estimate**—all known costs categorized by different types of estimate elements and excluding contingency to cover uncertainties.
- **Updated project purpose and need statement**—factual and objective data and information on the statement of the current conditions and why the project is being pursued.
- **Refined project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.
- **Refined project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Refined project parameters**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for project teams, site visits, public inputs, conceptual definition, cost estimating, and reporting.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **PSP team**—should work together to ensure all important information is included in the summary.
- **Project development/delivery manager**—the staff member responsible for managing the project development activities and the project scoping process team in charge of performing different PSP activities.
- **Appendix A**—T13: Project Purpose and Need Statement and T15: Scoping Worksheets/Scoping Checklists.

Outcomes of This Action

- **Updated project characteristics**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.
- **Updated project definition**—including typical project requirements, such as:
  - Project parameters (project boundaries such as length and width).
  - Narrative descriptions of the key project work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
  - Alterative solutions to support purpose and need identified (if any).
- **Updated project parameters**—including:
  - A description of the type of project (e.g., preservation versus rehabilitation).
  - A description of the project's complexity related to the concept scope, including site location information (e.g., urban versus rural), potential access issues, and other data relevant to preparing the cost estimate.

A2 Analyze Alternatives and Document Findings

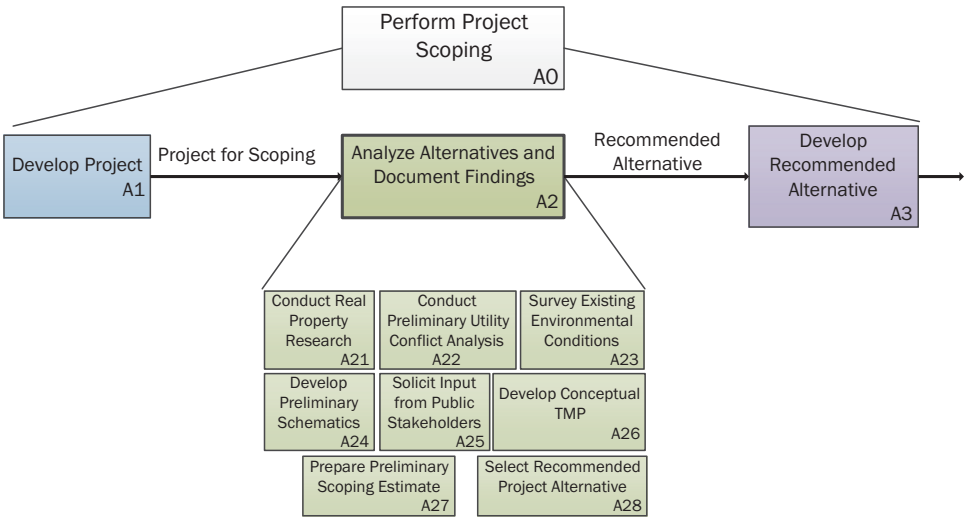


Figure A2. The second step in the PSP is analyzing alternatives and documenting findings.

Purpose: *To explore possible alternatives for performing the project and to select the most preferred alternative.*

To meet this purpose: *The agency should perform various studies at this stage, including ROW research, traffic analysis, survey of existing conditions covering environmental and utility issues, and hydraulic studies. The project team uses preliminary schematics and these studies to update the project cost estimate.*

The objective of the second activity (A2) (Figure A2) of the PSP is to analyze the alternatives and document the findings in order to assess, prioritize, and recommend an alternative for further detailing in the next step of the PSP. This includes performing various studies for each alternative, such as ROW research, traffic analysis, survey of existing conditions covering environmental and utility issues, and development of a conceptual TMP and preliminary scoping estimates.

The eight major activities performed to analyze alternatives are:

- **A21: Conduct real property research**—A high-level assessment of proposed project ROW requirements is required at this step to identify properties that need to be acquired and restrictions such as the existing ROW limit, easement, and real property owners from records maintained by local public entities.
- **A22: Conduct preliminary utility conflict analysis**—Infrastructure projects often necessitate the adjustment of utilities to accommodate the design and construction of proposed transportation facilities. Failure to mitigate utility conflicts in the design process or to relocate facilities in a timely manner can result in unwarranted delays and increased project costs. This

activity schedules and conducts district-level and division-level coordination meetings with utility owners.

- **A23: Survey existing environmental conditions**—This activity includes identifying environmental issues and determining the appropriate environmental document/project classification based on the type of project (e.g., road widening, bridge, or shoulder improvements). Environmental documentation should provide a brief summary of the results of analysis and coordination with resource agencies, as well as information about the social, economic, and environmental impacts of a project.
- **A24: Develop preliminary schematics**—Developing preliminary schematics includes activities such as refining alignments and geometrics, preparing preliminary plans and layouts, developing preliminary pavement design reports, conducting hydraulic studies, and conducting preliminary planning for bridges. This activity could also involve preliminary coordination with other stakeholders.
- **A25: Solicit input from public stakeholders**—The agency should keep the public informed of issues associated with the project and measure public opinions about the development process. The level of public involvement is dependent upon a number of social, economic, and environmental factors, along with the type and complexity of the project. Public involvement efforts may include meetings with key stakeholders including affected real property owners, public meetings, and public hearings.
- **A26: Develop conceptual TMP**—The objective of this activity is to develop the conceptual TMPs for the identified alternatives in an attempt to minimize potential traffic impacts to the traveling public. At this stage, traffic plans and strategies for the identified alternatives are conceptually developed and compared. The estimate of cost that includes provisions for contingencies should be proposed. This activity is particularly important since the TMP has become part of the programming document and a major TMP can easily cost several million dollars.
- **A27: Prepare preliminary scoping estimate**—The preliminary cost estimate at this stage includes estimating costs for preliminary engineering, construction, ROW acquisition, utility adjustment, environmental/mitigations, and other project expenses. Estimates are prepared for each identified alternative solution.
- **A28: Select recommended project alternative**—Selecting the preferred alternative is performed according to the extent to which each alternative meets design, operation, and maintenance requirements extracted from long-range and intermediate-range transportation plans. Comparing preliminary cost estimates developed for each alternative is an important part of this activity. The project team then selects the preferred alternative. This activity also involves securing approval of the preliminary schematics and associated studies before the project proceeds to Develop Recommended Alternative (A3).

Project Scalability Considerations

A complex project will typically have ROW, utility relocation, and potential alternatives. If the project does not have potential alternative solutions to achieving the purpose and need, then the activities in A2 are not required. The recommended alternative becomes the final output of A1: Develop Project, and the project moves to A3: Develop Recommended Alternative. If the project scope does not include ROW requirements, then A21 is not performed. If the project scope does not include utility relocation, then A22 is not performed.

The project may have different environmental requirements so those activities related to environmental assessment may be performed at different levels of detail depending on the specific requirements for a project. A category exclusion is much less effort than an environmental impact statement.

The level of design effort, traffic management, and public involvement will vary as well depending on the project type and its characteristics including location. Adjustments to the PSP in these activity areas might require reduction in the estimated level of effort to complete these activities.

The guidelines in A2 do not cover interaction with railroads. The user should review the *SHRP 2 Report S2-R16-RR-1: Strategies for Improving the Project Agreement Process between Highway Agencies and Railroads* for a comprehensive treatment of this topic area (see Appendix B).

A21 Conduct Real Property Research

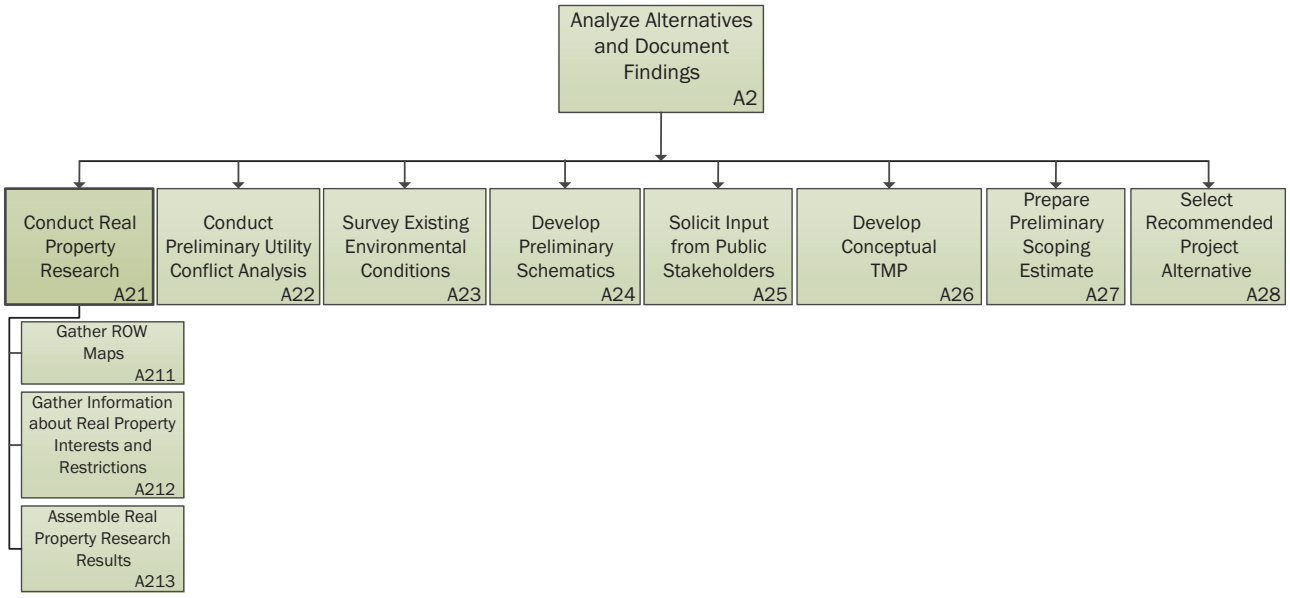


Figure A21. The first step in analyzing alternatives and documenting findings is conducting real property research.

A high-level assessment of proposed project ROW requirements is required at this step to identify properties that need to be acquired and restrictions such as the existing ROW limit, easement, and real property owners from records maintained by local public entities.

The three major activities performed to conduct real property research (Figure A21) are:

- **A211: Gather ROW maps**—The objective of this activity is to gather and compile existing ROW maps as well as information about existing real property interests and restrictions that exist at the agency along the proposed project of interest. Subsequent activities involve searches at external entities (e.g., the city, county, or appraisal district office).
- **A212: Gather information about real property interests and restrictions**—The objective of this activity is to gather and compile available records about existing real property interests and restrictions that exist along the proposed project of interest from external entities such as the tax assessor's office, the county appraisal district, or a similar office.
- **A213: Assemble real property research results**—The objective of this activity is to assemble and consolidate information about existing real property interests and restrictions along the proposed project. This includes information that already exists at the agency, along with information received from external entities such as the tax assessor's office, the county appraisal district, or a similar office.

A211 Gather ROW Maps

The objective of this activity is to gather and compile existing ROW maps as well as information about existing real property interests and restrictions that exist at the agency along the proposed project of interest. Subsequent activities involve searches at external entities (e.g., the city, county, or appraisal district office).

The four actions performed in this activity (Figure A211) are:

- **Gather project limits**—gather and display potential project limits using appropriate CAD software to determine the anticipated extent of real property interest acquisitions. One or more overlays may be necessary depending on the number of alternative alignments under consideration.
- **Gather and review existing ROW information**—compile the ROW maps as well as information about existing real property interests and restrictions that exist at the agency.
- **Scan or digitize existing ROW information**—overlay scanned images (or digitized versions) of existing ROW maps on project alignments.
- **Document real property interests**—compile real property interest information associated with the existing ROW maps.

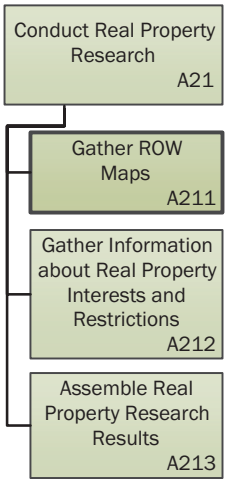


Figure A211. The first step in conducting real property research is gathering ROW maps.

Data Requirements and Information Needed to Initiate the Activity

- **Project information**—including general information about the project.
- **Project limits**—including alternative alignments and their corresponding ROW lines.

Restrictions

- **ROW manual**—document that provides general procedures for the acquisition of real property interests. It might contain information about preliminary engineering-level activities, although not necessarily (typically, ROW manuals describe activities beginning with the development of the ROW map, once the approved alignment has been selected).
- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.

Tools and Resources

- **Paper or digitized ROW maps**—old ROW maps typically exist in paper (sheet or roll) format. Scanned or digitized versions might also exist.
- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.
- **ROW information system**—information system that contains data about real property interests the agency has acquired in the past.

Outcomes of This Action

- **ROW maps**—one or more layers that contain information about existing ROW maps at the agency.

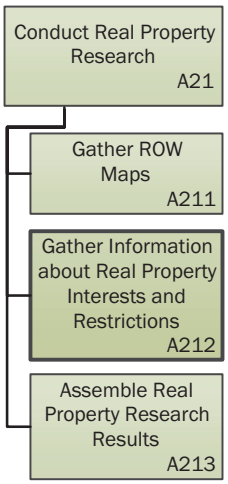


Figure A212. The second step in conducting real property research is gathering information about real property interests and restrictions.

A212 Gather Information about Real Property Interests and Restrictions

The objective of this activity is to gather and compile available records about existing real property interests and restrictions that exist along the proposed project of interest from external entities such as the tax assessor's office, the county appraisal district, or a similar office.

The five actions performed in this activity (Figure A212) are:

- **Gather project limits**—gather and display potential project limits using appropriate CAD or GIS software to determine the anticipated extent of real property interest acquisitions. One or more overlays may be necessary depending on the number of alternative alignments under consideration.
- **Gather project information**—compile relevant project information that might have bearing on the determination of property interests that need to be acquired.
- **Gather and review documentation about real property interests at the agency**—use layers that contain information about existing ROW maps at the agency.
- **Gather and review existing information about real property interests and restrictions**—compile existing records (e.g., deeds and easements) from relevant public offices to identify real property interests and restrictions along the proposed project.
- **Document deed, easement, and other real property records**—document and overlay relevant real property owner information on existing ROW maps.

Data Requirements and Information Needed to Initiate the Activity

- **Project information**—including general information about the project.
- **Project limits**—including alternative alignments and their corresponding ROW lines.
- **ROW maps**—including information about existing real property interests at the agency.

Restrictions

- **Laws and regulations**—governing the levels of authority that keep track of relevant property tax, deed, and easement information, e.g., the tax assessor office or appraisal district.

Tools and Resources

- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.
- **Tax assessor or appraisal district records**—records and information systems that contain information about real property interests and restrictions.

Outcomes of This Action

- **Information about real property interests and restrictions**—information about existing real property interests and restrictions along the proposed project.

A213 Assemble Real Property Research Results

The objective of this activity is to assemble and consolidate information about existing real property interests and restrictions along the proposed project. This includes information that already exists at the agency, along with information received from external entities such as the tax assessor's office, the county appraisal district, or a similar office.

The three actions performed in this activity (Figure A213) are:

- **Gather and review documentation about real property interests at the agency**—use layers that contain information about existing ROW maps at the agency.
- **Gather and review deed, easement, and other real property records**—overlay relevant real property interest and restriction information on existing ROW maps.
- **Consolidate information**—develop consolidated information about real property interests and restrictions along the proposed project.

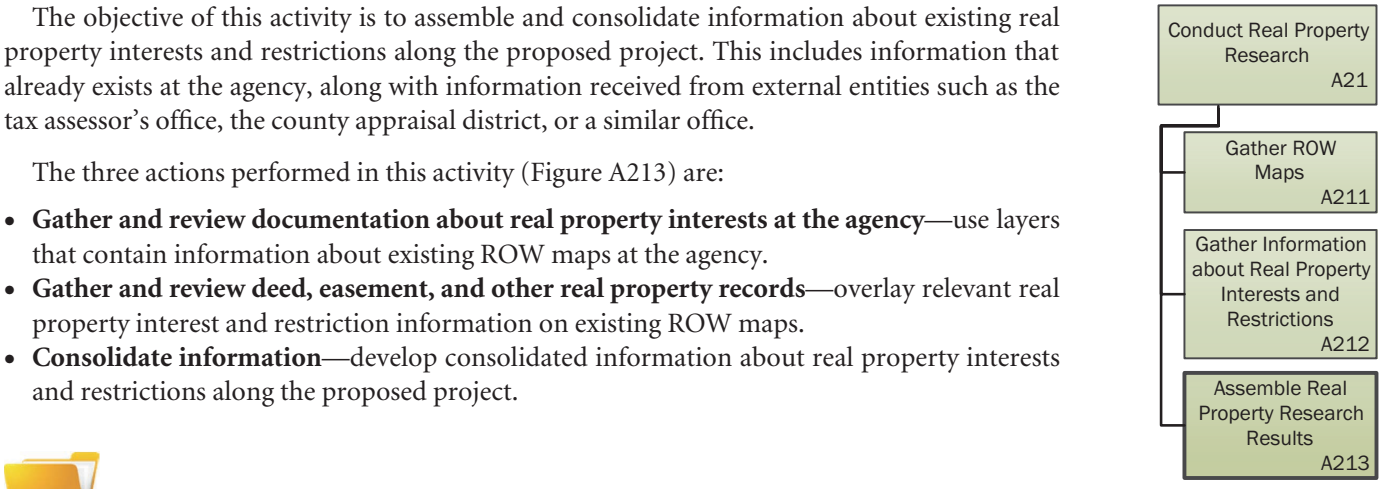


Figure A213. The third step in conducting real property research is assembling real property research results.

Data Requirements and Information Needed to Initiate the Activity

- **ROW maps**—one or more layers that contain information about existing ROW maps at the agency.
- **Information about real property interests and restrictions**—information about existing property interests and restrictions along the proposed project.

Restrictions

- **ROW manual**—document that provides general procedures for the acquisition of real property interests. It might contain information about preliminary engineering-level activities, although not necessarily (typically, ROW manuals describe activities beginning with the development of the ROW map, once the approved alignment has been selected).
- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.

Tools and Resources

- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.

Outcomes of This Action

- **Real property interests and restrictions**—maps and other information documenting existing property interests and restrictions along the proposed project.

A22 Conduct Preliminary Utility Conflict Analysis

Infrastructure projects often necessitate the adjustment of utilities to accommodate the design and construction of proposed transportation facilities. Failure to mitigate utility conflicts in the design process or to relocate facilities in a timely manner can result in unwarranted delays and

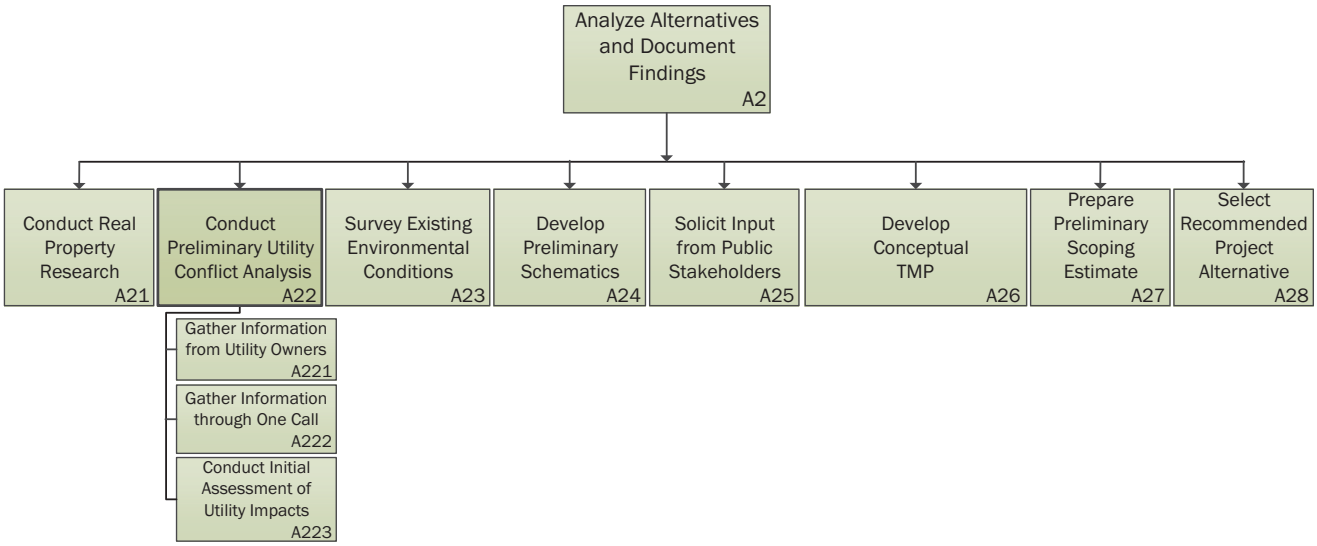


Figure A22. The second step in analyzing alternatives and documenting findings is conducting the preliminary utility conflict analysis.

increased project costs. This activity schedules and conducts district-level and division-level coordination meetings with utility owners.

The three major activities performed to conduct the preliminary utility conflict analysis (Figure A22) are:

- **A221: Gather information from utility owners**—The objective of this activity is to gather information from utility owners about existing utility installations within the project limits. Typically, the agency sends project drawings to utility owners with a request to mark up those drawings with relevant utility information.
- **A222: Gather information through One Call**—The objective of this activity is to gather information about existing utility installations within the project limits through One Call notification centers. This activity depends on whether One Call laws and regulations enable the use of design tickets to mark existing utility installations on the ground without an actual excavation being planned in the short term.
- **A223: Conduct initial assessment of utility impacts**—The objective of this activity is to conduct an initial assessment of utility impacts based on existing utility as-builts and records, as well as data gathered through One Call notification centers. Although it is common to collect this type of information at the beginning of the design phase, it is increasingly common to complete this activity in conjunction with other data collection activities while developing alternative alignments at the beginning of the scoping phase. After collecting preliminary utility data, the agency conducts an initial assessment of utility impacts. The outcome of this activity is an early assessment of utility facilities that potentially need to be adjusted or a determination that additional information is needed.

A221 Gather Information from Utility Owners

The objective of this activity is to gather information from utility owners about existing utility installations within the project limits. Typically, the agency sends project drawings to utility owners with a request to mark up those drawings with relevant utility information.

The four actions performed in this activity (Figure A221) are:

- **Gather project limits**—gather and display potential project limits using appropriate CAD or GIS software to determine the anticipated extent of real property interest acquisitions. One or more overlays may be necessary depending on the number of alternative alignments under consideration.
- **Gather project information**—compile relevant project information that might have a bearing on the identification of utility facilities that may be in conflict with the project.
- **Send project drawings to utility owners**—send project drawings to utility owners with a request to mark up those drawings with relevant utility information.
- **Document existing utility installations**—compile information provided by utility owners.

Data Requirements and Information Needed to Initiate the Activity

- **Project information**—including general information about the project.
- **Project limits**—including alternative alignments and their corresponding ROW lines.

Restrictions

- **Utility manual**—procedure document that provides general information about utility accommodation and utility relocation procedures at the agency.
- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Environmental process**—this process guides and drives much of what happens during the project scoping.

Tools and Resources

- **Project manager/design engineer**—the staff member who manages the project.
- **Utility coordinator**—the staff member responsible for providing coordination between the agency, utility owners, consultants, and other related stakeholders.

Outcomes of This Action

- **Marked-up drawings/files**—files in the appropriate format that show the location of existing utility installations in relation to the transportation project.

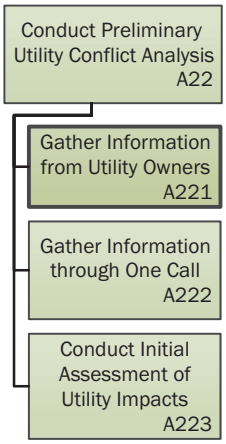


Figure A221. The first step in conducting the preliminary utility conflict analysis is gathering information from utility owners.

A222 Gather Information through One Call

The objective of this activity is to gather information about existing utility installations within the project limits through One Call notification centers. This activity depends on whether One Call laws and regulations enable the use of design tickets to mark existing utility installations on the ground without an actual excavation being planned in the short term.

The five actions performed in this activity (Figure A222) are:

- **Gather project limits**—gather and display potential project limits using appropriate CAD or GIS software to determine the anticipated extent of real property interest acquisitions. One

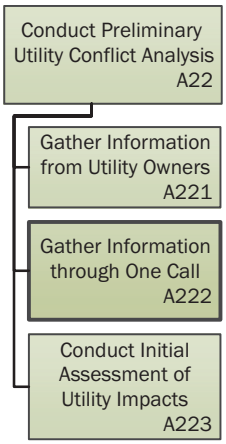


Figure A222. The second step in conducting the preliminary utility conflict analysis is gathering information through One Call.

or more overlays may be necessary depending on the number of alternative alignments under consideration.

- **Gather project information**—compile relevant project information that might have bearing on the identification of utility facilities that may be in conflict with the project.
- **Place a One Call request**—send project drawings to utility owners with a request to mark up those drawings with relevant utility information.
- **Survey One Call**—compiles information provided by utility owners.
- **Document utility**—transcribes survey data into project files (usually in CAD format).

Data Requirements and Information Needed to Initiate the Activity

- **Project information**—including general information about the project.
- **Project limits**—including alternative alignments and their corresponding ROW lines.
- **Marked-up drawings/files**—files in the appropriate format that show the location of existing utility installations in relation to the transportation project (as provided by utility owners).

Restrictions

- **Utility manual**—procedure document that provides general information about utility accommodation and utility relocation procedures at the agency.
- **One Call laws and regulations**—laws and regulations that govern the process to request utility locates through One Call notification centers.

Tools and Resources

- **Design engineer**—the staff member who uses the information collected to identify utility conflicts.
- **Utility coordinator**—the staff member responsible for providing coordination between the agency, utility owners, consultants, and other related stakeholders.
- **One Call notification center**—entity that receives, processes, and forwards One Call requests to utility owners.

Outcomes of This Action

- **Surveyed utility location**—drawing or file (usually in CAD format) that shows the location of One Call utility locates.

A223 Conduct Initial Assessment of Utility Impacts

The objective of this activity is to conduct an initial assessment of utility impacts based on existing utility as-builts and records, as well as data gathered through One Call notification centers. Although it is common to collect this type of information at the beginning of the design phase, it is increasingly common to complete this activity in conjunction with other data collection activities while developing alternative alignments at the beginning of the scoping phase. After collecting preliminary utility data, the agency conducts an initial assessment of utility

impacts. The outcome of this activity is an early assessment of utility facilities that potentially need to be adjusted or a determination that additional information is needed.

The three actions performed in this activity (Figure A223) are:

- **Gather marked-up drawings/files**—gather and display potential project limits using appropriate CAD or GIS software to determine the anticipated extent of real property interest acquisitions. One or more overlays may be necessary depending on the number of alternative alignments under consideration.
- **Document utility information**—compile relevant project information that might have a bearing on the identification of utility facilities that may be in conflict with the project.
- **Initial assessment of utility impacts**—send project drawings to utility owners with a request to mark up those drawings with relevant utility information.

Data Requirements and Information Needed to Initiate the Activity

- **Marked-up drawings/files**—files in the appropriate format that show the location of existing utility installations in relation to the transportation project.
- **Surveyed utility location**—drawing or file (usually in CAD format) that shows the location of One Call utility locations.

Restrictions

- **Utility manual**—procedure guidance document that provides general information about utility accommodation and utility relocation procedures at the agency.
- **Utility accommodation policies and rules**—guidance and requirement document that describes utility accommodation policies within the ROW, as well as procedures for utility relocations.

Tools and Resources

- **Design engineer**—the staff member who uses the information collected to identify utility conflicts.
- **Utility coordinator**—the staff member responsible for providing coordination between the agency, utility owners, consultants, and other related stakeholders.
- **Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data, Standard CI/ASCE 38-02**—American Society of Civil Engineers, Reston, Virginia, 2002.

Outcomes of This Action

- **Preliminary assessment of impacts**—early assessment of utility facilities that potentially need to be adjusted or a determination that additional information is needed.

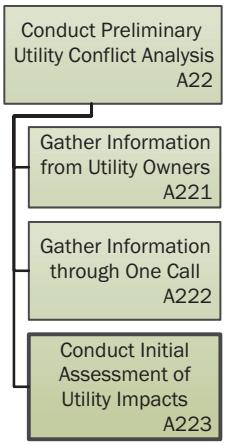


Figure A223. The third step in conducting the preliminary utility conflict analysis is conducting the initial assessment of utility impacts.

A23 Survey Existing Environmental Conditions

This activity includes identifying environmental issues and determining the appropriate environmental document/project classification based on the type of project (e.g., road widening, bridge, or shoulder improvements). Environmental documentation should provide a brief

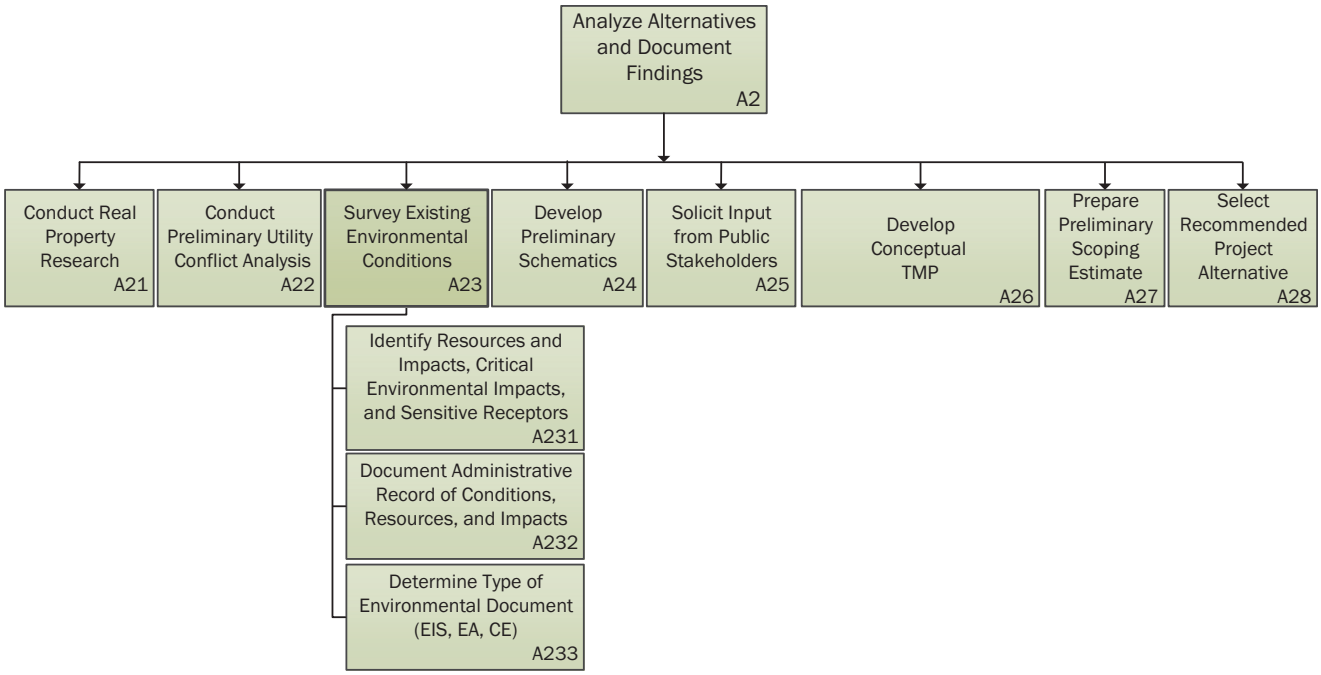


Figure A23. The third step in analyzing alternatives and documenting findings is surveying existing environmental conditions.

summary of the results of analysis and coordination with resource agencies, as well as information about the social, economic, and environmental impacts of a project.

The three major activities performed to survey existing environmental conditions (Figure A23) are:

- **A231: Identify resources and impacts, critical environmental impacts, and sensitive receptors**—The objective of this activity is to conduct a preliminary assessment of the direct impacts on the social and physical environment and to identify critical impacts as the preliminary assessment of the direct impacts on the social and physical environment is conducted. The preliminary assessment also identifies the anticipated type of NEPA document to be prepared (categorical exclusion [CE], environmental assessment [EA], or environmental impact statement [EIS]), permitting requirements, and potential environmental commitments, and results in the equivalent of an environmental scoping document. Critical impacts and sensitive receptors should be identified to be addressed early in the assessment process.
- **A232: Document administrative record of conditions, resources, and impacts**—The objective of this activity is to document, as part of the administrative record, the preliminary assessment of the direct impacts on the social and physical environment. The purpose of the administrative record is to provide evidence that due diligence (the hard-look doctrine) was conducted.
- **A233: Determine type of environmental document (EIS, EA, CE)**—The objective of this activity is to prepare and submit the appropriate environmental document based on the preliminary assessment (CE, EA, or EIS).

A231 Identify Resources and Impacts, Critical Environmental Impacts, and Sensitive Receptors

The objective of this activity is to conduct a preliminary assessment of the direct impacts on the social and physical environment and to identify critical impacts as the preliminary assessment of the direct impacts on the social and physical environment is conducted. The preliminary

assessment also identifies the anticipated type of NEPA document to be prepared (CE, EA, or EIS), permitting requirements, and potential environmental commitments, and results in the equivalent of an environmental scoping document. Critical impacts and sensitive receptors should be identified to be addressed early in the assessment process.

The two actions performed in this activity (Figure A231) are:

- **Identify various types of resources and impacts**—gather information regarding the impact of each alternative on various resources:
  - Identify natural, physical, and biological resources and potential direct impacts.
  - Identify human, social, and community resources and potential direct impacts.
  - Identify parks and public lands and potential direct impacts.
- **Identify relevant jurisdictions and coordinate with participating agencies**—identify resource agencies' jurisdictions for resources and coordinate with them to obtain required state and federal permits.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; and the Endangered Species Act.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **GIS**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.
- **Checklists**—environmental requirements in the form of checklists and decision trees to ensure compliance.
- **Planners**—the staff responsible for funding and plan consistency.
- **Engineers**—the design staff responsible for project limits, ROW, footprint, and potential construction impacts.

Outcomes of This Action

- **Resources and impacts**—preliminary environmental scoping document with the administrative record of potential direct impacts.

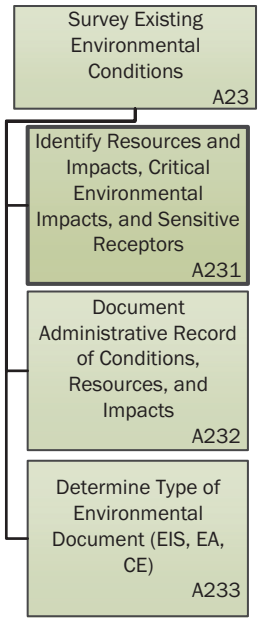


Figure A231. The first step in surveying existing environmental conditions is identifying resources and impacts, critical environmental impacts, and sensitive receptors.

- **List of critical (fatal flaw) environmental impacts and sensitive receptors**—project impacts that are likely to directly impact the natural, physical, biological, human, social, and community resources to a significant degree or that require avoidance or mitigation.

A232 Document Administrative Record of Conditions, Resources, and Impacts

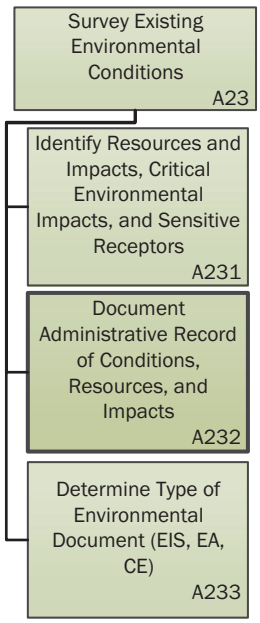


Figure A232. The second step in surveying existing environmental conditions is document the administrative record of conditions, resources, and impacts.

The objective of this activity is to document, as part of the administrative record, the preliminary assessment of the direct impacts on the social and physical environment. The purpose of the administrative record is to provide evidence that due diligence (the hard-look doctrine) was conducted.

The two actions performed in this activity (Figure A232) are:

- **Document various types of resources and impacts**—gather information regarding the impact of each alternative on various resources:
  - Document natural, physical, and biological resources and potential direct impacts.
  - Document human, social, and community resources and potential direct impacts.
  - Document parks and public lands and potential direct impacts.
- **Document relevant jurisdictions and coordinate with participating agencies**—document resource agency jurisdictions for resources and coordinate with them to obtain required state and federal required permits.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **GIS**—geospatial information on existing site conditions. Data would ideally be not only from the STAs but also other state and federal agencies with interests in the project's proximity.
- **Checklists**—environmental requirements in the form of checklists and decision trees to ensure compliance.

- **Planners**—the staff responsible for funding and plan consistency.
- **Engineers**—the design staff responsible for project limits, ROW, footprint, and potential construction impacts.

Outcomes of This Action

- **Environmental scoping document**—determines the scope of issues to be addressed, identifying key environmental issues related to a proposed action, and delineating roles and responsibilities in the environmental review process. The environmental scoping document serves as a management tool to guide environmental activities during project development, including public participation and resource agency coordination activities. The scoping process helps scale the environmental effort to the context and intensity of a project's anticipated impacts. The project scope is kept up to date throughout project development via amendments when or if there are changes to the project or when or if there is new environmental information requiring changes in scoped activities.

A233 Determine Type of Environmental Document (EIS, EA, CE)

The objective of this activity is to prepare and submit the appropriate environmental document based on the preliminary assessment (CE, EA, or EIS).

The three actions performed in this activity (Figure A233) are:

- **Prepare environmental documents**—develop environmental documents according to the 23 CFR 771.117 (c) and (d) list. A CE involves minimal public impact, has little or no ROW to acquire, and does not involve significant social, economic, or environmental impacts.
- **Describe indirect and cumulative impacts as part of an EA**—an EA is prepared for each action that is not a CE and does not clearly require the preparation of an EIS, or in situations to determine if an EIS is needed. The outcome of an EA is a finding of no significant impact (FONSI). Direct impacts happen when the project is implemented; the action causes these impacts that occur at the same time and place as the action. Indirect impacts happen after project implementation but are caused by the project; the action causes these impacts to occur later or farther from the action, but the impacts are still reasonably foreseeable. An example is gradual change in the land use next to the freeway from induced growth.
- **Determine if an EIS is required**—an EIS concludes with a record of decision (ROD). Projects or actions that may significantly affect the quality of the human environment require an EIS.

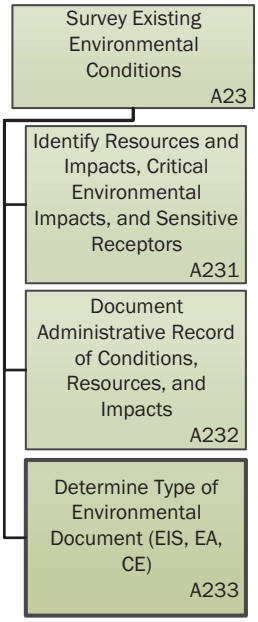


Figure A233. The third step in surveying existing environmental conditions is determining the type of environmental document (EIS, EA, CE).

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive

Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **GIS**—geospatial information on existing site conditions. Data would ideally be not only from the STAs but also other state and federal agencies with interests in the project's proximity.
- **Checklists**—environmental requirements in the form of checklists and decision trees to ensure compliance.
- **Planners**—the staff responsible for funding and plan consistency.
- **Engineers**—the design staff responsible for project limits, ROW, footprint, and potential construction impacts.

Outcomes of This Action

- **Environmental requirements**—a record of environmental permits, commitments, and actions that were identified during the assessment process such as resource agency concurrence and approvals.
- **Preliminary draft environmental document**—a complete assessment document (CE, EA, or EIS) made available for review by appropriate agencies and the DOT.

A24 Develop Preliminary Schematics

Developing preliminary schematics includes activities such as refining alignments and geometrics, preparing preliminary plans and layouts, developing preliminary pavement design reports, conducting hydraulic studies, and conducting preliminary planning for bridges. This activity could also involve preliminary coordination with other stakeholders.

The four major activities performed to develop the preliminary schematics (Figure A24) are:

- **A241: Determine schematic layout**—The objective of this activity is to determine the format and layout of the schematic designs in order to best tailor them to the intended audience.
- **A242: Align horizontal and vertical elements**—The objective of this activity is to identify the roadway's horizontal and vertical alignment in accordance with the project's design speed, existing and future roadway conditions, subsurface conditions, and topography. Development of horizontal and vertical alignments should take into consideration: context–sensitive issues (e.g., social/political constraints and historical concerns in proximity to the project); river, lake or ocean crossings; existing above- and below-grade utilities; and constraints due to ROW boundaries.
- **A243: Develop cross-sectional elements**—The objective of this activity is to develop the cross-sectional elements, which will affect the width of the proposed ROW and utility relocation requirements.
- **A244: Determine access limits during construction and operation**—The objective of this activity is to develop traffic control plans that address the concerns of controlled access limits to and from adjacent property or facilities.

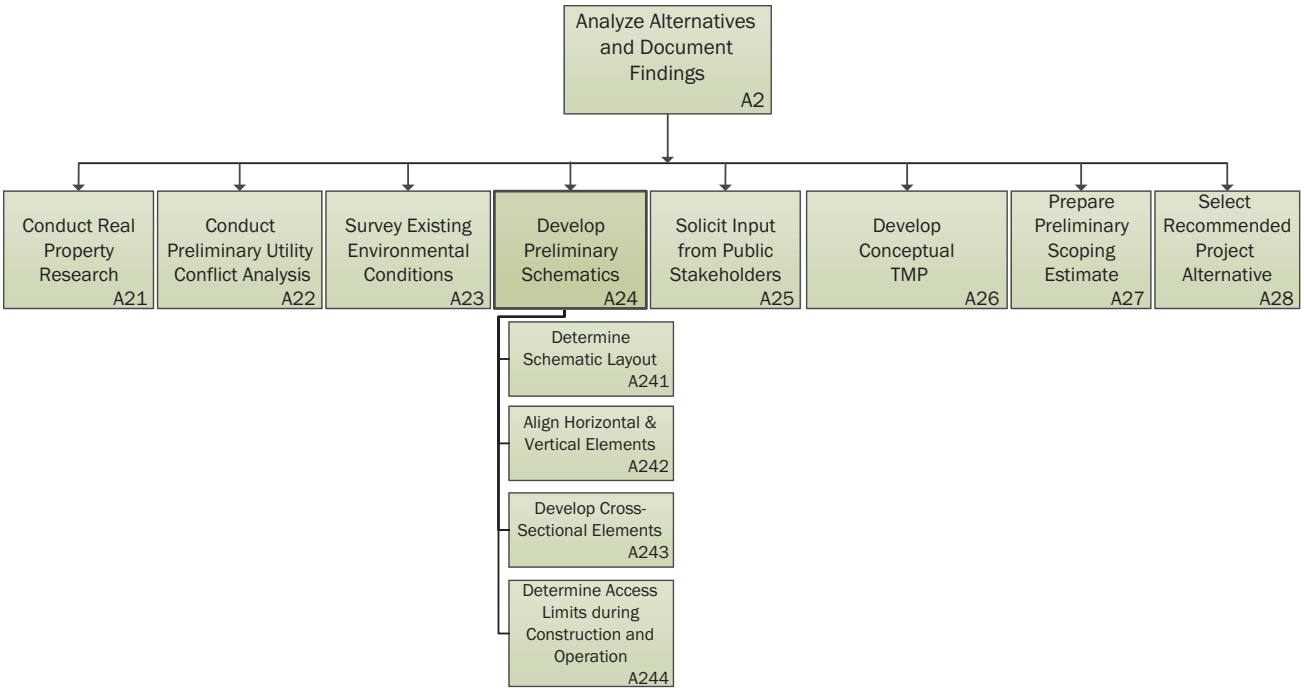


Figure A24. The fourth step in analyzing alternatives and documenting findings is developing the preliminary schematics.

A241 Determine Schematic Layout

The objective of this activity is to determine the format and layout of the schematic designs in order to best tailor them to the intended audience.

The three actions performed in this activity (Figure A241) are:

- **Identify information needed for earthwork requirements**—project-specific requirements should be determined regarding the necessary soils maps, estimated cut and fill balances from the earthwork mass diagrams, and watershed/water basin delineation.
- **Establish design controls and criteria**—design controls and criteria help establish explicit goals that a project needs to achieve in order to be successful. The controls and criteria need to be established in consideration of the following: general project information (e.g., location, project boundary limits, speed, and annual average daily traffic); location of existing structures (e.g., interchanges, main lanes, frontages, ramps, ditches, utilities, and drainage structures); project future capacity needs; preliminary (or anticipated) ROW limits; location of retaining and noise abatement walls; control of access both during and after construction; master plan zoning maps; anticipated detours or bypasses; and above- and below-grade ROW.
- **Establish schematic formats**—design formats need to be identified to facilitate the development of signage schematics, profiles, horizontal and vertical alignments, and all other geometric alignments.

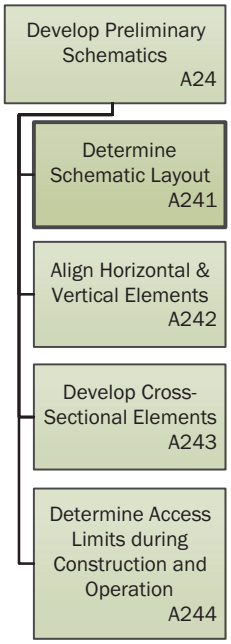


Figure A241. The first step in developing the preliminary schematics is determining the schematic layout.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well.

- **Preliminary assessment of impacts**—early assessment of utility facilities that potentially need to be adjusted or a determination that additional information is needed.
- **Environmental Requirements**—a record of environmental permits, commitments, and actions that were identified during the assessment process such as resource agency concurrence and approvals.
- **Hydraulic considerations**—a list of possible hydraulic issues that may have an impact on the schematic layout.
- **Property interests and restrictions**—maps and other information documenting existing property interests and restrictions along the proposed project.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **State and federal regulation requirements**—refer to pertinent sections in state and federal regulations for any restrictions regarding the schematic layout.

Tools and Resources

- **GIS**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.
- **2D/CD CAD/civil integrated model**—existing design and as-built files of previous projects either within or adjacent to the project boundaries.
- **Design engineer**—the design expert within the agency or a consultant.
- **Project manager**—the staff member who manages the project.

Outcomes of This Action

- **Schematic layout**—used for horizontal and vertical alignments along with cross-sectional elements.

A242 Align Horizontal and Vertical Elements

The objective of this activity is to identify the roadway's horizontal and vertical alignment in accordance with the project's design speed, existing and future roadway conditions, subsurface conditions, and topography. The horizontal and vertical alignments need to be developed in consideration of: context–sensitive issues (e.g., social/political constraints and historical concerns in proximity to the project); river, lake or ocean crossings; existing above- and below-grade utilities, and constraints due to ROW boundaries.

The two actions performed in this activity (Figure A242) are:

- **Develop horizontal alignment**—the project-specific horizontal alignment should be established in accordance to the project design controls and criteria in addition to specific horizontal

geometry and sight distances. The alignment should be in reference to the project's survey control system.

- **Develop vertical alignment**—the project-specific vertical alignment should also be established in accordance to the project design controls and criteria in addition to specific vertical geometry and sight distances. The vertical alignment should include crossover grades and profiles. The alignment should be in reference to the project's survey control system.

Data Requirements and Information Needed to Initiate the Activity

- **Schematic layout**—used for horizontal and vertical alignments along with cross-sectional elements.
- **Preliminary assessment of impacts**—early assessment of utility facilities that potentially need to be adjusted or a determination that additional information is needed.
- **Environmental requirements**—a record of environmental permits, commitments, and actions that were identified during the assessment process such as resource agency concurrence and approvals.
- **Property interests and restrictions**—maps and other information documenting existing property interests and restrictions along the proposed project.
- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **State and federal regulation requirements**—refer to pertinent sections in state and federal regulations for any restrictions regarding horizontal and vertical alignment.
- **Environmental laws and regulations**—affecting transportation project development.

Tools and Resources

- **GIS**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.
- **2D/CD CAD/civil integrated model**—existing design and as-built files of previous projects either within or adjacent to the project boundaries.
- **Design engineer**—the design expert within the agency or a consultant.
- **Project manager**—the staff member who manages the project.

Outcomes of This Action

- **Identification of horizontal and vertical elements**—general and project-specific considerations for horizontal and vertical alignment identified and documented.

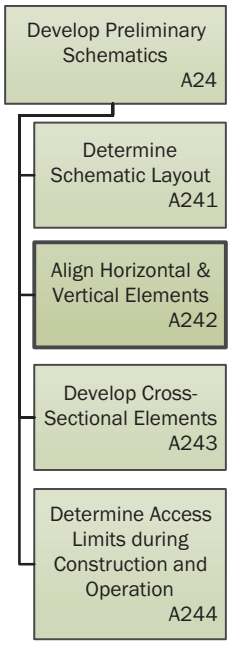


Figure A242. The second step in developing the preliminary schematics is aligning horizontal and vertical elements.

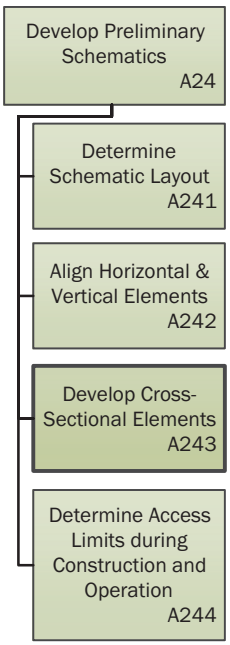


Figure A243. The third step in developing the preliminary schematics is developing cross-sectional elements.

A243 Develop Cross-Sectional Elements

The objective of this activity is to develop the cross-sectional elements, which will affect the width of the proposed ROW and utility relocation requirements.

There are two actions in this activity (Figure A243), and they include:

- **Develop roadway cross sections**—elements to be included in the roadway cross section include: cut or fill slopes; existing and proposed easements; pavement cross slopes; frontage roads and ramp radii; existing and proposed sidewalks, bicycle lanes, and other pedestrian elements; noise abatement (e.g., walls and structures); number and width of road lanes; width of median; width of shoulder; and maintenance access requirements.
- **Develop drainage cross sections**—elements to be included in the drainage cross sections include ditch cross-sections, cross-drainage structures (e.g., culverts), and extent of side slopes and ditches, including levees and dams.

Data Requirements and Information Needed to Initiate the Activity

- **Schematic layout**—used for horizontal and vertical alignments along with cross-sectional elements.
- **Identified horizontal and vertical elements**—general and project-specific considerations for horizontal and vertical alignment identified and documented at the end of activity A242.
- **Environmental requirements**—a record of environmental permits, commitments, and actions that were identified during the assessment process such as resource agency concurrence and approvals.
- **Hydraulic considerations**—a list of possible hydraulic issues that may have an impact on the schematic layout.
- **Property interests and restrictions**—maps and other information documenting existing property interests and restrictions along the proposed project.
- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **State and federal regulation requirements**—refer to pertinent sections in state and federal regulations for any restrictions regarding horizontal and vertical alignment.
- **Environmental laws and regulations**—affecting transportation project development.

Tools and Resources

- **GIS**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.
- **2D/CD CAD/civil integrated model**—existing design and as-built files of previous projects either within or adjacent to the project boundaries.

- **Design engineer**—the design expert within the agency or a consultant.
- **Project manager**—the staff member who manages the project, assigned during activity A15.

Outcomes of This Action

- **Design of cross-sectional elements**—preliminary drawings of cross-sectional elements (e.g., roadway, median area, bicycle and pedestrian facilities, utility and landscape areas, and drainage channels and side slopes).

A244 Determine Access Limits during Construction and Operation

The objective of this activity is to develop TMPs that address the concerns of controlled access limits to and from adjacent property or facilities.

The two actions performed in this activity (Figure A244) are:

- **Determine vehicular access limits**—the project-specific vehicular access limits should consider the following: ROW acquisition (including access deeds and restrictions); entrance/exit locations and length; and access limit, which takes into account frontage road requirements, driveway access requirements, and emergency vehicle access requirements.
- **Determine special access limits**—the project needs to establish requirements to maintain special access lanes, including bicycle and pedestrian lanes, high-occupancy vehicle lanes, truck-only lanes, and crossover lanes.

Data Requirements and Information Needed to Initiate the Activity

- **Schematic layout**—used for horizontal and vertical alignments along with cross-sectional elements.
- **Identified horizontal and vertical elements**—general and project-specific considerations for horizontal and vertical alignment identified and documented at the end of activity A242.
- **Design of cross-sectional element**—preliminary drawings of cross-sectional elements (e.g., roadway, median area, bicycle and pedestrian facilities, utility and landscape areas, and drainage channels and side slopes).

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **GIS**—geospatial information on existing site conditions. Data would ideally be from not only the STAs but also other state and federal agencies with interests in the project's proximity.

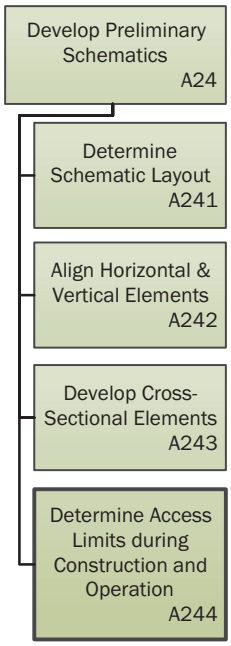


Figure A244. The fourth step in developing the preliminary schematics is determining access limits during construction and operation.

- **2D/CD CAD/civil integrated model**—existing design and as-built files of previous projects either within or adjacent to the project boundaries.
- **Design engineer**—the design expert within the agency or a consultant.
- **Project manager**—the staff member who manages the project.
- **District resident engineer**—the individual familiar with local conditions.
- **Traffic engineer**—the individual familiar with traffic control during construction.

Outcomes of This Action

- **Schematic drawings**—including horizontal and vertical elements, cross-sectional elements, construction access limits, and the traffic control plan.

A25 Solicit Input from Public Stakeholders

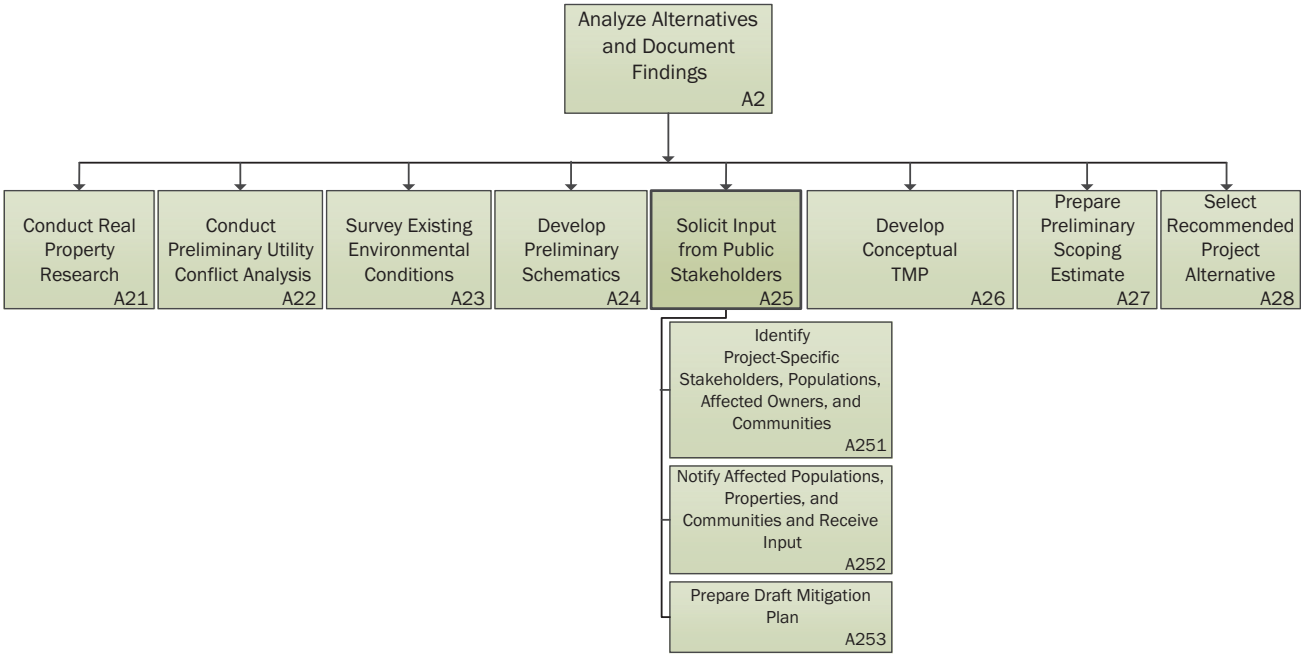


Figure A25. The fifth step in analyzing alternatives and documenting findings is soliciting input from public stakeholders.

The agency should keep the public informed of issues associated with the project and measure public opinions about the development process. The level of public involvement is dependent upon a number of social, economic, and environmental factors, along with the type and complexity of the project. Public involvement efforts may include meetings with key stakeholders including affected property owners, public meetings, and public hearings.

The three major activities performed to solicit input from public stakeholders (Figure A25) are:

- **A251: Identify project-specific stakeholders, populations, affected owners, and communities**—The objective of this activity is to identify stakeholders, populations, affected owners, and communities directly affected by the proposed project.

- **A252: Notify affected populations, properties, and communities and receive input**—The objective of this activity is to notify stakeholders, populations, affected owners, and communities that may be directly affected by the proposed project.
- **A253: Prepare draft mitigation plan**—If needed and impacts from the proposed project are anticipated, the objective of this activity is to finalize a mitigation plan to address impacts to stakeholders, populations, affected owners, and communities that are directly affected by the proposed project. Mitigation should follow the following sequence: avoid, minimize, repair/rehabilitate/restore, reduce, and compensate.

A251 Identify Project-Specific Stakeholders, Populations, Affected Owners, and Communities

The objective of this activity is to identify stakeholders, populations, affected owners, and communities directly affected by the proposed project.

The two actions performed in this activity (Figure A251) are:

- **Identify project-specific stakeholders, populations, affected property owners, and communities:**
  - Identify stakeholders, affected populations, and communities.
  - Identify EJ and limited English proficiency (LEP) populations.
  - Identify affected property owners.
  - Identify public lands.
  - Identify community features/impacts.
- **Identify potential impacts, if any, to affected populations.**

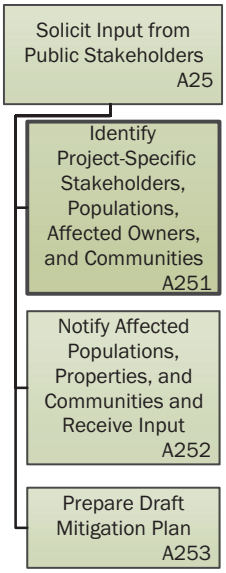


Figure A251. The first step in soliciting input from public stakeholders is identifying project-specific stakeholders, populations, affected owners, and communities.

Data Requirements and Information Needed to Initiate the Activity

- **Project description, limits, footprint, and work activities**—resources and communities in the project area, including resource agency databases, etc.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Resource agency databases**—with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.
- **FHWA environmental review Tool Kit**—http://environment.fhwa.dot.gov/projdev/index.asp.

- **FHWA public involvement techniques for transportation decision making**—http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/.
- **FHWA community impact assessment**—http://www.fhwa.dot.gov/environment/cia/.

Outcomes of This Action

- **Preliminary environmental scoping document with the administrative record of potential direct impacts.**

A252 Notify Affected Populations, Properties, and Communities and Receive Input

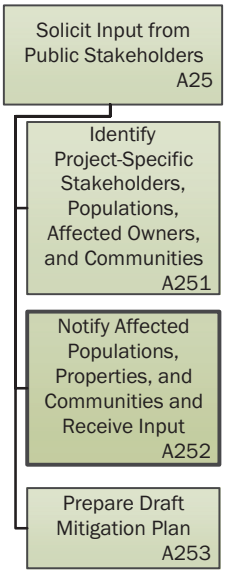


Figure A252. The second step in soliciting input from public stakeholders is notifying affected populations, properties, and communities and receiving input.

The objective of this activity is to notify stakeholders, populations, affected owners, and communities that may be directly affected by the proposed project.

The three actions performed in this activity (Figure 252) are:

- **Describe the nature and characteristics of impacts to affected communities, if any.**
- **Notify affected property owners, populations, and communities, as required.**
- **Conduct outreach with those affected, and receive and record inputs.**

Data Requirements and Information Needed to Initiate the Activity

- **Project description, limits, footprint, and work activities**—resources and communities in the project area, including resource agency databases, etc.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Resource agency databases**—with previously identified sensitive receptors, stream and wetland inventories, and ecological data at region planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.

Outcomes of This Action

- **Preliminary environmental scoping document with the administrative record of potential direct impacts.**
- **An administrative record of affected communities and populations.**

A253 Prepare Draft Mitigation Plan

If needed and impacts from the proposed project are anticipated, the objective of this activity is to finalize a mitigation plan to address impacts to stakeholders, populations, affected owners, and communities that are directly affected by the proposed project. Mitigation should follow the following sequence: avoid, minimize, repair/rehabilitate/restore, reduce, and compensate.

The three actions performed in this activity (Figure A253) are:

- **Meet state and federal requirements**—provide a description of proposed mitigation actions or permits as needed to meet state and federal requirements.
- **Record actions**—to avoid, minimize repair/rehabilitate/restore, reduce, or compensate for impacts.
- **Notify stakeholders**—affected property owners, populations, communities, or resource agencies about actions, permits, and commitments as required by state and federal requirements.

Data Requirements and Information Needed to Initiate the Activity

- **Project description, limits, footprint, and work activities**—resources and communities in the project area, including resource agency databases, etc.
- **Record of identified stakeholders, affected populations, community impacts, public involvement plan, MTP, long-range plans, and other affected plans**—consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Resource agency databases**—with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.
- **Record of public outreach, notification, and education**—meetings, mailings, education of public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and state DOT staff, and public leaders.

Outcomes of This Action

- **An administrative record of affected individuals, populations, or communities that require compensatory or restorative mitigation.**

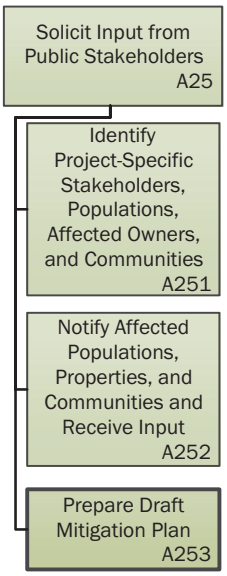


Figure A253. The third step in soliciting input from public stakeholders is preparing the draft mitigation plan.

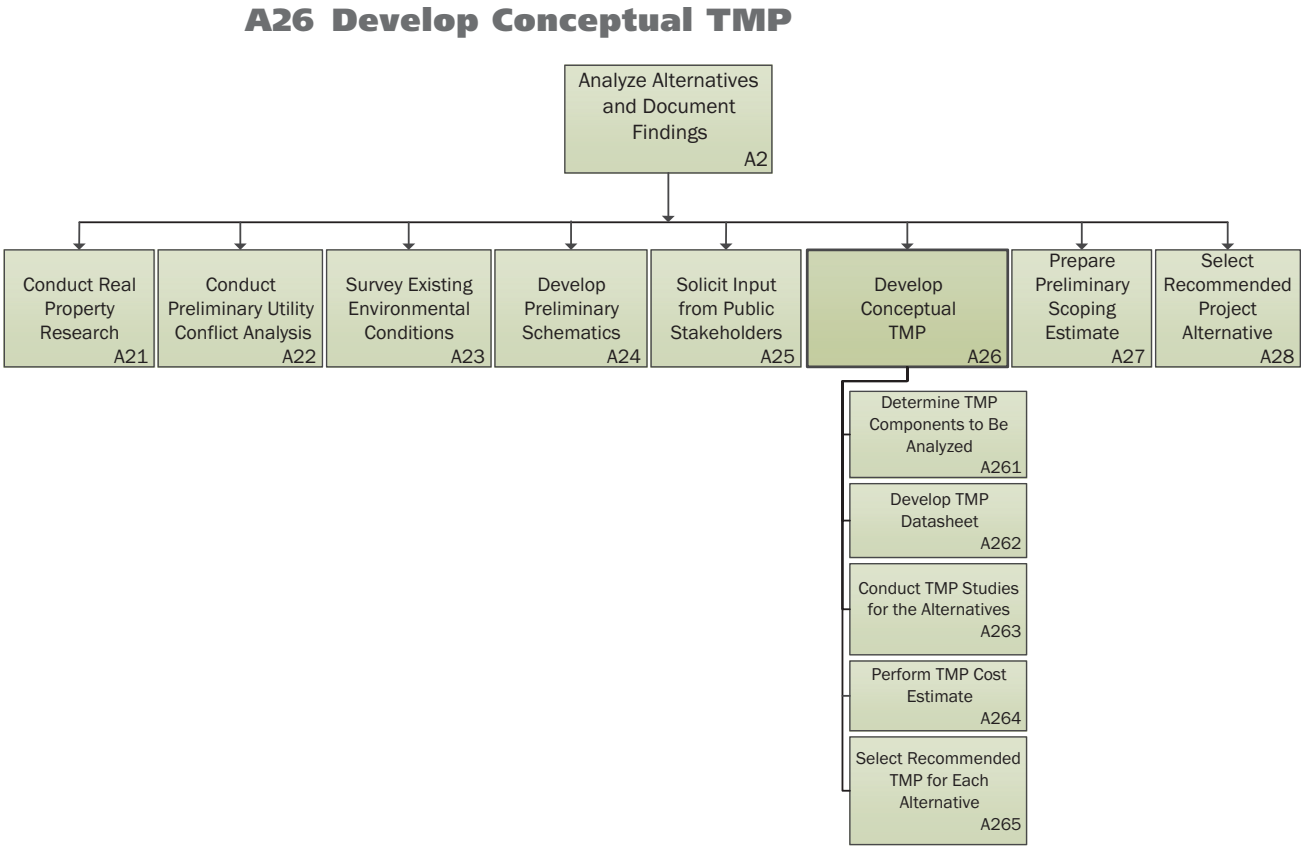


Figure A26. The sixth step in analyzing alternatives and documenting findings is developing the conceptual TMP.

The objective of this activity is to develop the conceptual TMPs for the identified alternatives in an attempt to minimize potential traffic impacts to the traveling public. At this stage, traffic plans and strategies for the proposed alternatives are conceptually developed and compared. The estimate of cost that includes provisions for contingencies should be proposed. This activity is particularly important since the TMP has become part of the programming document and a major TMP can easily cost several million dollars.

The five major activities performed to develop the conceptual TMP (Figure A26) are:

- **A261: Determine TMP components to be analyzed**—The objective of this activity is to determine the type of TMP that will be developed and compared for the proposed project's alternatives. In general, there are three types of TMPs—basic, intermediate, and major—each of which documents work zone impact management strategies and how they will be implemented. Once a specific type of TMP is chosen, its TMP components are subsequently determined.
- **A262: Develop TMP datasheet**—The objective of this activity is to prepare a TMP datasheet that includes information about proposed work, work areas, and traffic patterns and levels.
- **A263: Conduct TMP studies for the alternatives**—The objective of this activity is to conduct preliminary TMP studies that assess work zone impacts and management strategies. A temporary traffic control (TTC) plan should be included. A major TMP should include a traffic operations (TO) plan, along with a public information and outreach (PIO) plan.
- **A264: Perform TMP cost estimate**—The objective of this activity is to estimate the cost of each TMP alternative. A TMP cost estimate should be developed for each alternative being considered and should not be based solely on the project cost.

- **A265: Select recommended TMP for each alternative**—The objective of this activity is to further evaluate the analyzed TMP alternatives, geared to selecting the most appropriate alternative. Cooperation among all involved in the conceptual TMP development process becomes crucial at this stage to develop the most economical and realistic TMP strategies that blend design, construction, and work zone management.

A261 Determine TMP Components to Be Analyzed

The objective of this activity is to determine the type of TMP that will be developed and compared for the proposed project's alternatives. In general, there are three types of TMPs—basic, intermediate, and major—each of which documents work zone impact management strategies and how they will be implemented. Once a specific type of TMP is chosen, its TMP components are subsequently determined.

The four actions performed in this activity (Figure A261) are:

- **Create a cross-functional TMP team**—create an interdisciplinary TMP team that is comprised of a variety of disciplines. It is imperative that all offices be involved in the team to provide feedback and review the TMP.
- **Collect project information**—compile project information and materials. These include project scope, roadway characteristics, work zone capacity and traffic level, local issues, ROW maps, and preliminary public outreach strategies.
- **Identify existing barriers and potential obstacles**—identify any existing barriers and potential obstacles that can affect work zone mobility and safety.
- **Determine TMP components**—determine the type of TMP that will be pursued and compared for the proposed project's alternatives.

Data Requirements and Information Needed to Initiate the Activity

- **Construction alternatives**—defined with respect to the duration and occurrence of four construction alternatives (nighttime, weekday, weekend, and 24/7 around the clock), each of which can be executed under three standard lane closure scenarios (single lane, double lane, and full lane closure).
- **Lane closure alternatives**—defined by the number of lanes to be closed for construction.
- **Work zone demand-capacity information**—capacity is defined as the maximum possible traffic service flow, which is quantifiable from the latest *Highway Capacity Manual* (2010). Demand is defined as the 24-hour hourly distribution of vehicles passing through the work zone in a single direction under normal operating conditions.
- **Comments on potential TMP alternative solutions**—including feedback from the general public as a factor in sound decision making to be reflective of changing construction and traffic management plans.

Restrictions

- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed, pertinent to the development and implementation of TMPs.
- **Conceptual cost estimate**—it is extremely important to develop TMPs within the identified cost range of the TMP activities.
- **Construction phasing/staging**—defines the length of construction work zone closures and describes how the entire project will be split.

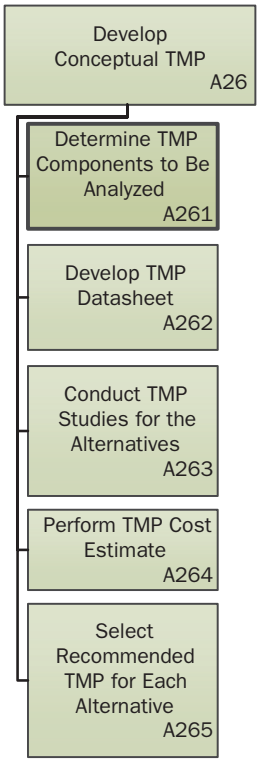


Figure A261. The first step in developing the conceptual TMP is determining the TMP components to be analyzed.

Tools and Resources

- **TMP team**—cross-functional TMP team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Integrated TMP analysis tool**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures. Use of macro- and microscopic simulations can enable STAs to conduct a more sophisticated traffic analysis.

Outcomes of This Action

- **Identified type of TMP.**

A262 Develop TMP Datasheet

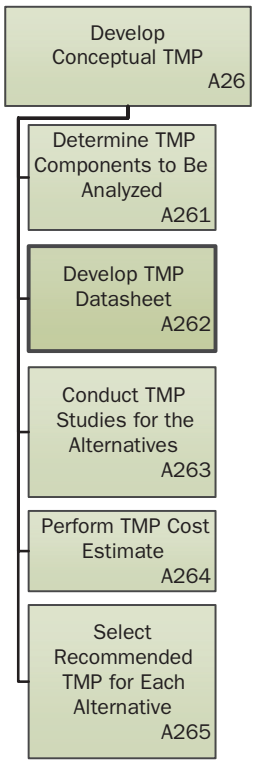


Figure A262. The second step in developing the conceptual TMP is developing a TMP datasheet.

The objective of this activity is to prepare a TMP datasheet that includes key information about proposed work, work areas, and traffic patterns and levels.

The two actions performed in this activity (Figure A262) are:

- **Compile project information and materials**—compile materials and information related to the project. These include the identified preliminary TMP elements and respective costs.
- **Develop a TMP datasheet**—develop a TMP datasheet that can be used to identify the proposed TMP strategies that may be included to improve mobility and safety at the construction work zone during lane closures.

Data Requirements and Information Needed to Initiate the Activity

- **Identified type of TMP**—determines what information needs to be included in the datasheet.

Restrictions

- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed, pertinent to the development and implementation of TMPs.
- **Conceptual cost estimate**—extremely important to develop TMPs within the identified cost range of the TMP activities.
- **Construction phasing/staging**—defines the length of construction work zone closures and describes how the entire project will be split.

Tools and Resources

- **TMP team**—cross-functional TMP team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.

- **Integrated TMP analysis tool**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures. Use of macro- and microscopic simulations can enable STAs to conduct a more sophisticated traffic analysis.

Outcomes of This Action

- **Preliminary TMP elements and costs**—For all TMPs, itemized TMP elements along with respective cost estimates of the proposed strategies may be included.

A263 Conduct TMP Studies for the Alternatives

The objective of this activity is to conduct preliminary TMP studies that assess work zone impacts and management strategies. A TTC plan should be included. A major TMP should include a TO plan, along with a PIO plan.

The three actions performed in this activity (Figure A263) are:

- **Identify and evaluate potential construction staging approaches and plans**—identify and evaluate the alternatives that may include construction phasing and project design options.
- **Identify and evaluate preliminary work zone management strategies**—evaluate the most effective alternative combination of preliminary traffic control and operation strategies, with the identification of potential public outreach and involvement strategies.
- **Assess anticipated work zone impacts for the proposed project's alternatives**—perform preliminary work zone impact assessments for the proposed project's alternatives, which address how traffic control and safety can be handled during lane closures. This action identifies the level of impacts in order to allocate more appropriate resources. This action includes the identification of significant projects according to an FHWA requirement in the new mobility and safety rule.

Data Requirements and Information Needed to Initiate the Activity

- **Preliminary TMP elements and costs**—itemized TMP elements along with respective cost estimates of the proposed strategies.

Restrictions

- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed, pertinent to the development and implementation of TMPs.
- **Conceptual cost estimate**—extremely important to develop TMPs within the identified cost range of the TMP activities.
- **Construction phasing/staging**—defines the length of construction work zone closures and describes how the entire project will be split.

Tools and Resources

- **TMP team**—cross-functional TMP team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.

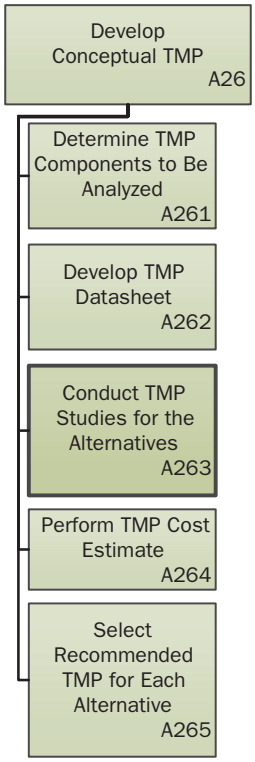


Figure A263. The third step in developing the conceptual TMP is conducting TMP studies for the identified project's alternatives.

- **Integrated TMP analysis tool**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures. Use of macro- and microscopic simulations can enable STAs to conduct a more sophisticated traffic analysis.
- **Appendix A**—T12: Scheduling and Work Zone Impact Analysis.

Outcomes of This Action

- **Analyzed what-if alternatives of TMP strategies**—including the assessments of work zone impacts for the proposed alternatives. Levels of impacts at the construction work zone are identified. Benefits and costs of each alternative are identified and compared.

A264 Perform TMP Cost Estimate

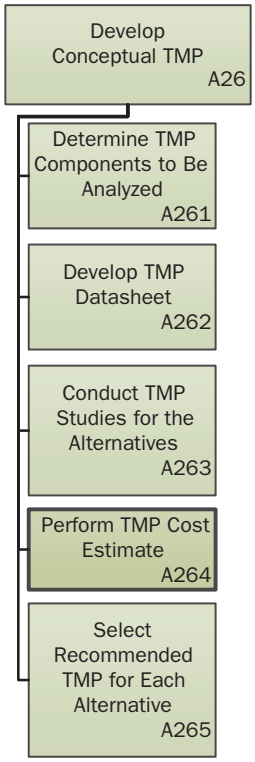


Figure A264. The fourth step in developing the conceptual TMP is performing the TMP cost estimate.

The objective of this activity is to estimate the cost of each TMP alternative. A TMP cost estimate should be developed for each alternative being considered and should not be basely solely on the project cost.

The three actions performed in this activity (Figure A264) are:

- **Identify elements and the type of TMP**—evaluate all elements of the TMP to conduct the cost estimate of each identified TMP element.
- **Itemize the cost of each TMP element**—perform itemized cost estimates of each TMP elements, depending on the type of TMP.
- **Perform the cost estimate for implementing TMP**—depending on the type of TMP, this may include the costs of implementing the following work zone management strategies: TTC plan, TO, and public outreach.

Data Requirements and Information Needed to Initiate the Activity

- **Analyze what-if alternatives of TMP strategies**—the assessments of work zone impacts for the proposed alternatives.
- **Preliminary TMP elements and costs**—for all TMPs, itemized TMP elements along with respective cost estimates of the proposed strategies may be included.

Restrictions

- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed, pertinent to the development and implementation of TMPs.
- **Conceptual cost estimate**—extremely important to develop TMPs within the identified cost range of the TMP activities.
- **Construction phasing/staging**—defines the length of construction work zone closures and describes how the entire project will be split.

Tools and Resources

- **TMP team**—cross-functional TMP team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.

- **Integrated TMP analysis tool**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures. Use of macro- and microscopic simulations can enable STAs to conduct a more sophisticated traffic analysis.

Outcomes of This Action

- **Cost estimate of TMPs for each alternative**—including preliminary estimates of traffic-handling costs, public outreach costs, incentives, contingencies, road user delay costs, and equipment rental costs, e.g., quick-change moveable barrier and automated work zone information system (AWIS).

A265 Select Recommended TMP for Each Alternative

The objective of this activity is to further evaluate the analyzed TMP alternatives, geared to select the most appropriate alternative. Cooperation among all involved in the conceptual TMP development process becomes crucial at this stage to develop the most economical and realistic TMP strategies that blend design, construction, and work zone management.

The three actions performed in this activity (Figure A265) are:

- **Develop a qualitative summary of anticipated work zone impacts for each alternative**—by developing an intuitive summary table that can facilitate a decision-making process by demonstrating how road users are impacted by the project and how traffic patterns are expected to change.
- **Review impact assessment based on the summary**—evaluate impacts assessment based on the summary in order to select an alternative.
- **Select the TMP alternative**—choose the most appropriate alternative for the project. An integrated approach that concurrently captures anticipated work zone impacts (e.g., probable queue length and delay), construction phasing/staging strategies, and road user delay costs is desired. Comparing the cost to implement the work zone impact management strategies to the reduction in road user delay costs would help make better-informed decisions.

Data Requirements and Information Needed to Initiate the Activity

- **Cost estimate of TMPs for alternative**—including preliminary estimates of traffic-handling costs, public outreach costs, incentives, contingencies, road user delay costs, and equipment rental costs (e.g., quick-change moveable barrier and AWIS).
- **Analyzed what-if alternatives of TMP strategies**—the assessments of work zone impacts for the proposed alternatives.

Restrictions

- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed, pertinent to the development and implementation of TMPs.
- **Conceptual cost estimate**—extremely important to develop TMPs within the identified cost range of the TMP activities.
- **Construction phasing/staging**—defines the length of construction work zone closures and describes how the entire project will be split.

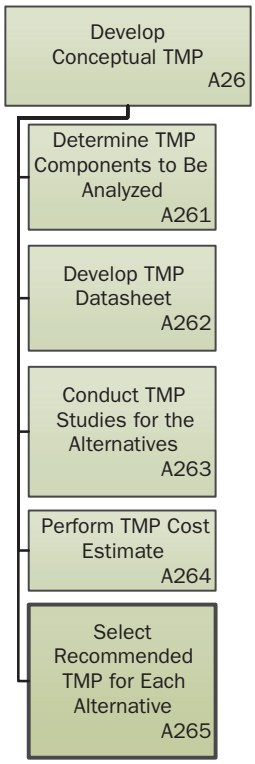


Figure A265. The fifth step in developing the conceptual TMP is selecting the recommended TMP for each identified project's alternative.

Tools and Resources

- **TMP team**—cross-functional TMP team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Integrated TMP analysis tool**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures. Use of macro- and microscopic simulations can enable STAs to conduct a more sophisticated traffic analysis.

Outcomes of This Action

- **Selected recommended TMP for the alternatives.**

A27 Prepare Preliminary Scoping Estimate

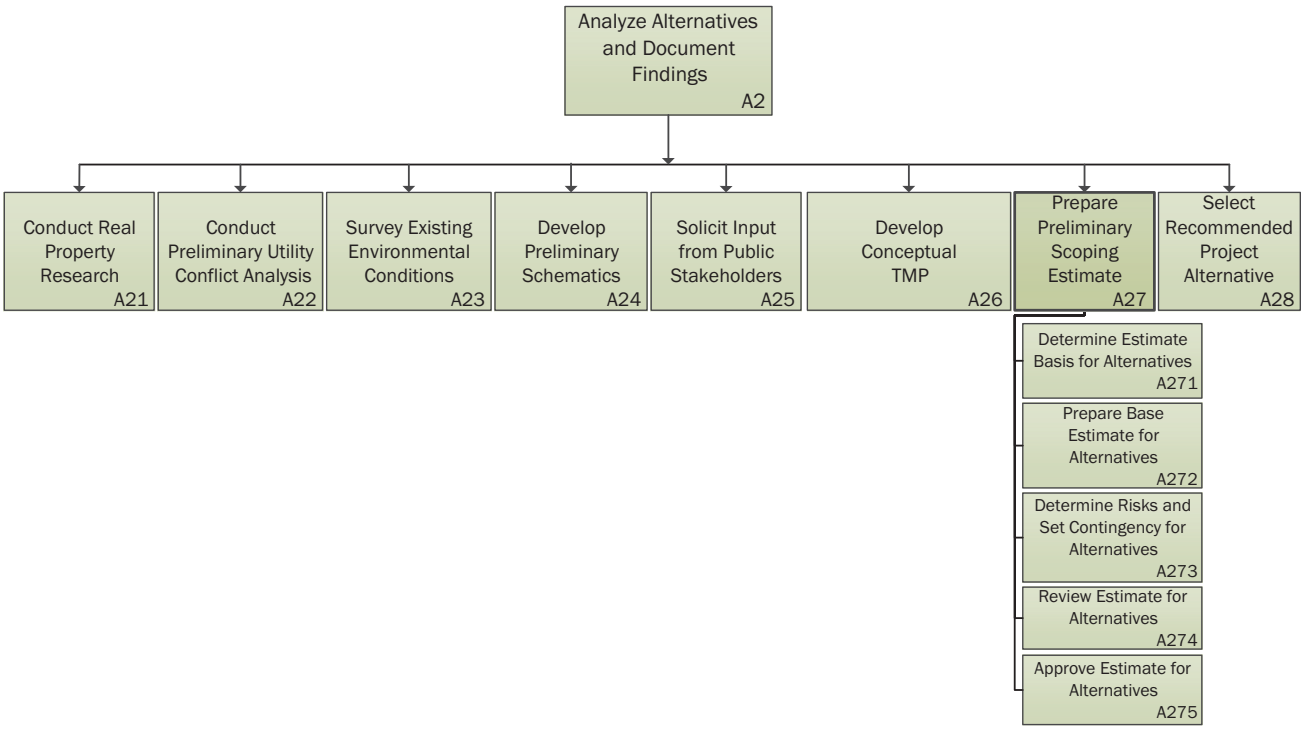


Figure A27. The seventh step in analyzing alternatives and documenting findings is preparing the preliminary scoping estimate.

The preliminary scoping estimate at this stage includes estimating costs for preliminary engineering, construction, ROW acquisition, utility adjustment, environmental/mitigations, and other project expenses. Estimates are prepared for each identified alternative solution.

The five major activities performed to prepare the preliminary scoping estimate (Figure A27) are:

- **A271: Determine estimate basis for alternatives**—The objective of this activity is to collect and document all information required to serve as a basis for preparing a preliminary scoping estimate (base estimate) for alternatives in the next activity (A272).

- **A272: Prepare base estimate for alternatives**—The objective of this activity is to prepare the most likely base cost estimate for each alternative based on what is known without including contingency dollars to cover estimate uncertainty or risks. An estimate of contingency for each alternative is covered in the next activity (A273).
- **A273: Determine risks and set contingency for alternatives**—The objective of this activity is to characterize the estimate uncertainty for each alternative and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate for each alternative.
- **A274: Review estimate for alternatives**—The objective of this activity is to review the cost estimate for each alternative to ensure that it is as complete and accurate as possible based on the project information collected in activity A271.
- **A275: Approve estimate for alternatives**—The objective of this activity is to approve the final estimate package for each alternative before the estimate is released for selecting the recommended alternative.

A271 Determine Estimate Basis for Alternatives

The objective of this activity is to collect and document all information required to serve as a basis for preparing a preliminary scoping estimate (base estimate) for alternatives in the next activity (A272).

The four actions performed in this activity (Figure A271) are:

- **Review project information**—including the schematic drawings, environmental requirements, property interests and restrictions, traffic models, construction staging, preliminary assessment of utility impacts, and utility relocation. Once this information is reviewed, a plan is made for how the estimate will be prepared, what other inputs will be required, and what deadlines should be set.
- **Review site characteristics for each alternative**—understand the project site characteristics for each alternative and possible impacts they might have on the ROW, utility, environmental, and construction costs associated with each one.
- **Determine if clarification is needed**—confirm that the information collected for each alternative is complete and, if necessary, request additional information for clarifying existing documentation.
- **Determine scoping estimate basis**—the purpose of this step is to begin the documentation trail that supports a project estimate and to prepare an estimating file with documentation of the estimate basis. The file should include scoping worksheets, schematics or other preliminary drawings, environmental requirements, property interests and restrictions, traffic models, preliminary utility impacts and utility relocation, and other specific project requirements.

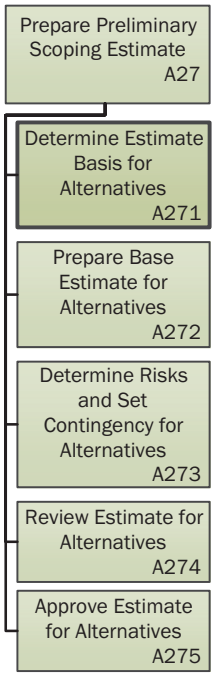


Figure A271. The first step in preparing the preliminary scoping estimate is determining the estimate basis for alternatives.

Data Requirements and Information Needed to Initiate the Activity

- **Schematic drawings**—roadway, bridges, etc.
- **Environmental requirements.**
- **Property interests and restrictions.**
- **TMPs, construction staging, etc.**
- **Preliminary assessment of utility impacts and utility relocation.**

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and*

Management for Highway Projects during Planning, Programming, and Preconstruction [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Other disciplines PSP team members**—representing other disciplines like design, ROW, TO, environmental, construction, etc.

Outcomes of This Action

- **Location characteristics for alternatives**—comprehensive collection of all information about the project site and location including urban versus rural type, labor wage rates, potential environmental conditions that should be mitigated, ROW requirements, utility relocation requirements, and detour and haul route requirements.
- **Project scope for alternatives**—comprehensive collection of all information and data for each alternative including scoping worksheets, schematics or other preliminary drawings, environmental requirements, property interests and restrictions, TMPs, preliminary utility impacts and utility relocation, and other specific project requirements.

A272 Prepare Base Estimate for Alternatives

The objective of this activity is to prepare the most likely base cost estimate for each alternative based on what is known without including contingency dollars to cover estimate uncertainty or risks. An estimate of contingency for each alternative is covered in the next activity (A273).

The six actions performed in this activity (Figure A272) are:

- **Select an appropriate approach**—determine the types of estimating techniques that can be used commensurate with the level of project definition, size, and complexity, as well as knowledge of the project type and project characteristics as defined by the estimate basis (activity A271).
- **Determine estimate components and quantify them**—develop a list of major items to be estimated and any quantities needed to prepare the base estimate for each alternative.
- **Develop estimate data**—use the list of major items and quantities to determine the various cost data that are applied to the elements and major items of each alternative, or to derive costs from a historical percentage.
- **Calculate the cost estimate**—convert quantities or percentages to cost for each alternative.
- **Document estimate assumptions**—add to the project estimate file, estimate calculations and estimate assumptions made to prepare the base cost estimate for each alternative.
- **Prepare the estimate package**—create a package that provides a cost summary for each alternative to be included in the project estimate file. It also includes a cost comparison showing all the alternatives summarized in a single table.

Data Requirements and Information Needed to Initiate the Activity

- **Location characteristics for alternatives**—comprehensive collection of all information about the project site and location including urban versus rural type, labor wage rates, potential

environmental conditions that should be mitigated, ROW requirements, utility relocation requirements, and detour and haul route requirements.
- **Project scope for alternatives**—comprehensive collection of all information and data for each alternative including scoping worksheets, schematics or other preliminary drawings, environmental requirements, property interests and restrictions, TMPs, preliminary utility impacts and utility relocation, and other specific project requirements.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based and historical techniques, while permitting ad hoc data entry if historical data are not present. Examples include AASHTOWare Project Estimator software and TRACER.
- Appendix A: T01: Cost/Parameter Using Similar Projects; T02: Cost/Parameter Using Typical Sections; T03: Cost-Based Estimating; T04: Historical Bid-Based Estimating; and T05: Historical Percentage.

Outcomes of This Action

- **Project estimation file for alternatives**—all required information related to the base cost estimate for each alternative, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, backup calculations, and cost basis for the estimate.
- **Base cost estimate package for alternatives**—all known costs for each alternative categorized by different types of estimate elements and excluding contingency to cover uncertainties. The estimate package should include updates in project definition, assumptions, quantity and price calculations, and supporting data.
- **Cost comparison table**—a side-by-side comparison of the cost of each alternative.

A273 Determine Risks and Set Contingency for Alternatives

The objective of this activity is to characterize the estimate uncertainty for each alternative and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate for each alternative.

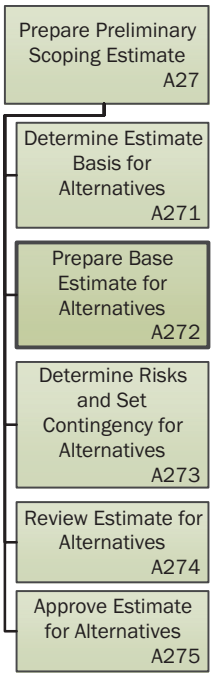


Figure A272. The second step in preparing the preliminary scoping estimate is preparing the base estimate for alternatives.

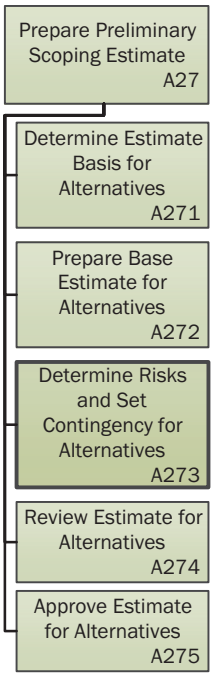


Figure A273. The third step in preparing the preliminary scoping estimate is determining the risks and setting the contingency for alternatives.

The six actions performed in this activity (Figure A273) are:

- **Review risk information**—for each alternative the estimating assumptions made by the estimator and the project definition assumptions made by other PSP team members.
- **Determine level of risk analysis**—use estimate basis documents (activity A271) and a project complexity assessment evaluation for categorizing each alternative as minor, moderately complex, or major with respect to its complexity.
- **Identify risks**—identify, categorize, and document risks that could affect each alternative. Based on the level of complexity identified in the previous action, one of the following types of analysis should be performed:
  - Type I risk analysis—risk identification and percentage contingency for minor projects.
  - Type II risk analysis—qualitative risk analysis and identified contingency items for moderately complex projects.
  - Type III risk analysis—quantitative risk analysis and contingency management for major projects.
- **Estimate the contingency for each alternative**—the likelihood and magnitude of impact of each risk associated with each alternative, and use this information as the basis for estimating the contingency for each alternative. Based on the level of complexity, this action may use historical data, the estimator's judgment, and a stochastic model of cost and schedule.
- **Document the risk and contingency basis for each alternative**—a transparent list of risks and uncertainties that are maintained in the project estimate file for communication of the cost estimate.
- **Prepare the total project cost estimate for each alternative**—the contingency amount is added to the base cost estimate to arrive at a total cost for each alternative.

Data Requirements and Information Needed to Initiate the Activity

- **Project estimation file for alternatives**—all required information related to the base cost estimate for each alternative, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, backup calculations, and cost basis for the estimate.
- **Base cost estimate package for alternatives**—all known costs for each alternative categorized by different types of estimate elements and excluding contingency to cover uncertainties. The estimate package should include updates in project definition, assumptions, quantity and price calculations, and supporting data.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).
- **Risk management procedure**—guidance on the approach to identify risks, quantify their impact on cost, and take actions to mitigate the impact of risks as the project scope is developed; and a tool available for risk management (*NCHRP Report 658: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based and historical techniques, while permitting ad hoc data entry if historical data are not present. Examples include the AASHTOWare Project Estimator software.
- **Risk analyst**—the PSP team member or an external consultant who creates a stochastic model of cost and schedule in complex projects (*NCHRP Report 658* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf]).
- **Appendix A**—T06: Expert Interviews; T07: Risk Checklists; T08: Probability × Impact (P×I) Matrix; T09: Contingency Percentage; T10: Contingency Identified; and T11: Estimate Ranges—Monte Carlo Analysis.

Outcomes of This Action

- **Base estimate with contingencies for alternatives**—in base estimates, the total cost of each alternative should be expressed as a single number. It also contains supporting documentation related to the estimate basis, assumptions, and backup calculations.
- **Project risks for alternatives**—a list of potential major risks for each alternative.

A274 Review Estimate for Alternatives

The objective of this activity is to review the base cost estimate for each alternative to ensure that it is as complete and accurate as possible based on the project information collected in activities A271 through A273.

The three actions performed in this activity (Figure A274) are:

- **Determine the level of review**—perform a careful review of the project details, choose the appropriate tools for review, and develop a review plan that contains a schedule for the review and a listing of people who will participate. The level of review is tied to the project type and complexity determined during the risk and contingency process (activity A273).
- **Review/verify and reconcile the estimate**—an appropriate review level used to review, verify, and reconcile the estimate to determine if the correct assumptions, calculations, and conclusions were made about each alternative. Based on the level of complexity, one of the following review methods can be used:
  - Roundtable estimate review.
  - In-house peers.
  - Formal committee.
- **Reconcile with the latest estimate**—review the current estimate for each alternative and the conceptual cost estimate in order to reconcile the differences between the two.

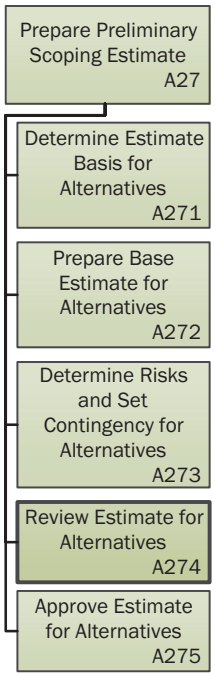


Figure A274. The fourth step in preparing the preliminary scoping estimate is reviewing the estimate for alternatives.

Data Requirements and Information Needed to Initiate the Activity

- **Base estimate with contingencies for alternatives**—the total cost of each alternative should be expressed as a single number. It also contains supporting documentation related to the estimate basis, assumptions, and backup calculations.
- **Project risks for alternatives**—a list of major risks for each alternative.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based and historical techniques, while permitting ad hoc data entry if historical data are not present. Examples include the AASHTOWare Project Estimator software and TRACER.
- **Other disciplines as necessary based on the project type and complexity.**

Outcomes of This Action

- **Final cost estimate package for alternatives**—containing the summary of scope, including key scope items, major cost elements, risk items, base cost (summary and details) and contingency, all supporting documentation, and backup calculations for each alternative.

A275 Approve Estimate for Alternatives

The objective of this activity is to approve the final estimate package for each alternative before the estimates are released to both internal and external project stakeholders.

The two actions performed in this activity (Figure A275) are:

- **Prepare the estimate package for alternatives**—review the total project cost estimate for each alternative, the project assumptions, and the estimate changes to prepare a final estimate package for each alternative that is ready for review.
- **Approve the estimate package for alternatives**—obtain final formal estimate approval. The purpose of this approval is to show that the estimates were prepared using the appropriate procedure, tools, and knowledge, and also to approve the estimate amount for each alternative. Cost estimates should be approved by district management before they are communicated to external audiences. Therefore, this step should include approval by a member of district management or someone with the authority to do so prior to conveying any of this information to external sources.

Data Requirements and Information Needed to Initiate the Activity

- **Final cost estimate package for alternatives**—containing the summary of scope, including key scope items, major cost elements, risk items, base cost (summary and details) and contingency, all supporting documentation, and backup calculations.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the staff responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Project manager**—the staff member who manages the project.
- **Project development/delivery manager and district management**—those individuals who are accountable for the alternative scope and cost estimate analysis.

Outcomes of This Action

- **Approved cost estimate package for alternate solutions**—approval that the estimate was completed using the appropriate procedure, tools, and knowledge, and approval of the estimate amount.

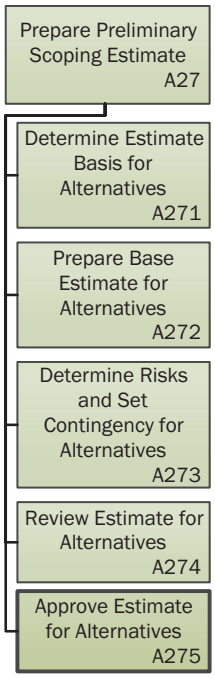


Figure A275. The fifth step in preparing the preliminary scoping estimate is approving the estimate for alternatives.

A28 Select Recommended Project Alternative

Selecting the preferred alternative is performed according to how each alternative meets design, operation, and maintenance requirements extracted from long-range and intermediate-range transportation plans. Comparing preliminary cost estimates developed for each alternative is an important part of this activity. The project team then selects the preferred alternative. This activity also involves securing approval of the preliminary schematics and associated studies before the project proceeds to Develop Recommended Alternative (A3).

The four major activities performed to select the recommended alternative (Figure A28) are:

- **A281: Summarize alternatives analyses**—The objective of this activity is to gather all information from the analysis performed for the identified alternatives so that a feasible preferred alternative can be identified.
- **A282: Conduct ranking analysis**—The objective of this activity is to rank the alternatives based on alternative ranking criteria and in order to identify the preferred alternative.
- **A283: Select project alternative**—The objective of this activity is to select the preferred alternative for further evaluation and scoping.
- **A284: Evaluate project definition completeness**—The objective of this activity is to evaluate project definition completeness by using the appropriate tool to identify areas needing further scoping.

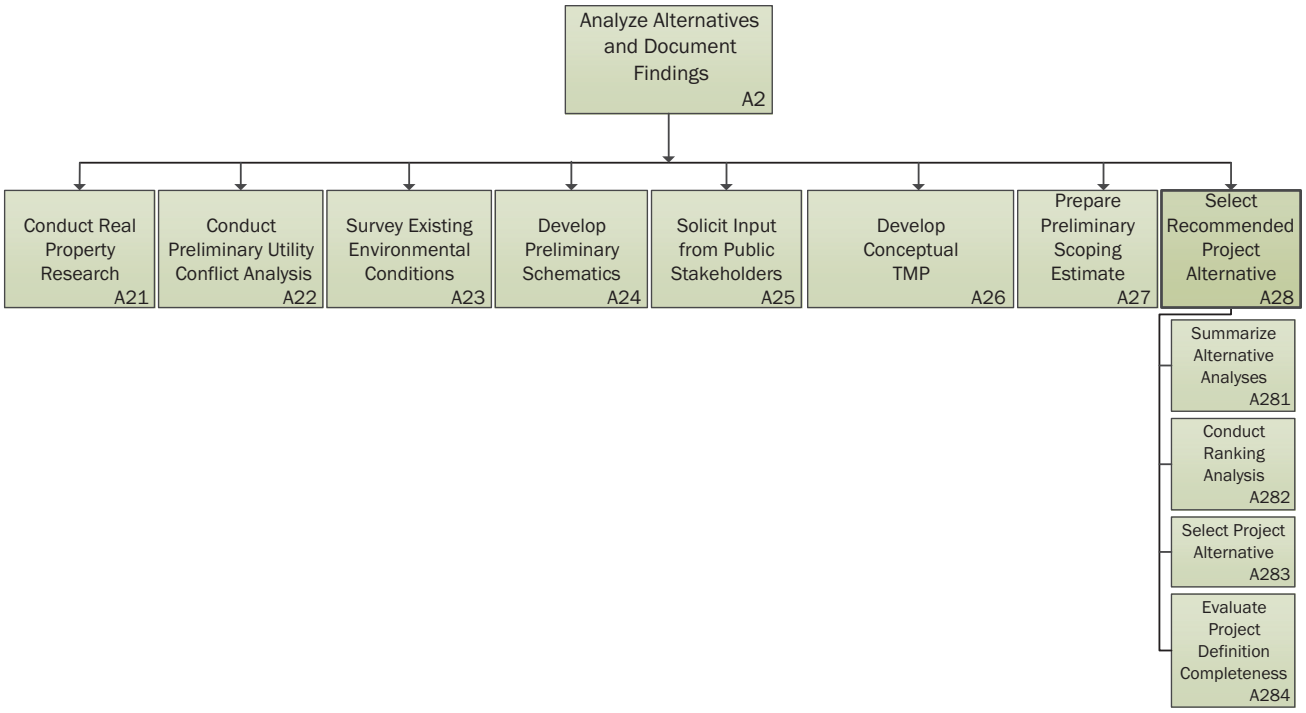


Figure A28. The eighth step in analyzing alternatives and documenting findings is selecting the recommended project alternative.

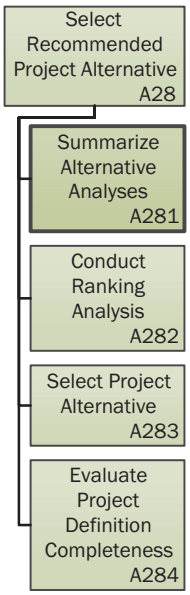


Figure A281. The first step in selecting the recommended project alternative is summarizing the alternative analyses.

A281 Summarize Alternative Analyses

The objective of this activity is to gather all information from the analysis performed for the identified alternatives so that a feasible preferred alternative can be identified.

The two actions performed in this activity (Figure A281) are:

- **Collect documented analysis results for each alternative.**
- **Summarize analysis results on each alternative in a format whereby comparing alternatives is easy.**

Data Requirements and Information Needed to Initiate the Activity

- **Schematic drawings**—schematic layout, horizontal and vertical elements, cross-sectional designs, and traffic control plans (output from activity A24).
- **TMPs**—containing information on traffic flows, facility capacities, etc.
- **Construction staging**—staging plans for people, vehicles, equipment, and materials.
- **Property interests and restrictions**—output from activity A21.
- **Environmental requirements and impacts**—output from activity A23.
- **Public Inputs**—comments on potential alternative solutions.
- **Preliminary assessment of utility impacts and utility relocations**—output from activity A22.
- **Transportation goals**—purpose of the project.
- **Social community goals**—how can the alternatives benefit social communities?
- **Schedule requirements**—time frame for milestone events.
- **Funding availabilities and preliminary estimates**—are the alternatives affordable?

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **PSP team**—in charge of putting together the summary.
- **Project development/delivery manager**—approves feasible alternatives.
- **Scoping worksheet**—facilitates data summary.
- **Constructability reviews**—reviews of construction processes from start to finish in order to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns. *NCHRP Report 391: Constructability Review Process for Transportation Facilities Workbook* and AASHTO's *Constructability Review Best Practices Guide* provide assistance in executing the constructability review (see Appendix B).

Outcomes of This Action

- **Selection and documentation of feasible alternatives**—feasible alternatives are selected for ranking. Documentation includes how and why a certain alternative is selected or dropped.

A282 Conduct Ranking Analysis

The objective of this activity is to rank the alternatives based on alternative ranking criteria in order to identify the preferred alternative.

The two actions performed in this activity (Figure A282) are:

- **Determine the ranking criteria**—determine what aspects are to be considered when comparing alternatives and which aspects are the priorities.
- **Rank alternatives according to the ranking rules.**

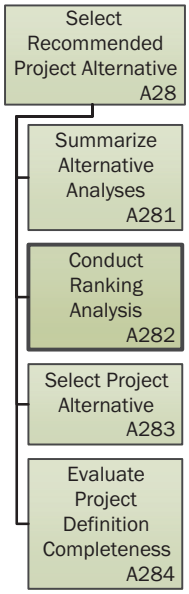


Figure A282. The second step in selecting the recommended project alternative is conducting the ranking analysis.

Data Requirements and Information Needed to Initiate the Activity

- **Summary of analysis performed on feasible alternatives**—output from activity A281.
- **Ranking rules**—which aspects are to be considered and which aspects are priorities for specific projects.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.

- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **PSP team**—the team of personnel in charge of project scoping.
- **Ranking criteria and tools**—forms or some type of scoring sheets, etc.
- **Benefit/cost analysis tools.**

Outcomes of This Action

- **Alternatives ranked and properly documented.**

A283 Select Project Alternative

The objective of this activity is to select the preferred alternative for further evaluation and scoping.

The action performed in this activity (Figure A283) is:

- **Recommend alternative**—the preferred alternative according to the output of the previous activity (activity A282) and report the selection for approval.

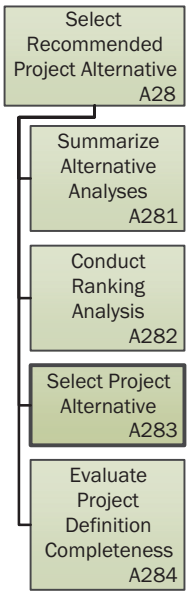


Figure A283. The third step in selecting the recommended project alternative is selecting the project alternative.

Data Requirements and Information Needed to Initiate the Activity

- **Ranked feasible alternatives and detailed ranking information**—output from activity A282.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **PSP team**—the team of personnel identified during activity A11 to be in charge of project scoping.
- **Project development/delivery manager**—someone that has the authority to approve the preferred alternative.

Outcomes of This Action

- **The preferred alternative selected for further evaluation (see A3: Develop Recommended Alternative).**

A284 Evaluate Project Definition Completeness

The objective of this activity is to evaluate project definition completeness by using the appropriate tool to identify areas needing further scoping.

The three actions performed in this activity (Figure A284) are:

- **Evaluate project definition**—using tools such as the Texas Department of Transportation's (TxDOT's) APRA tool.
- **Identify areas needing further scoping.**
- **Recommend improvements**—recommend ways to improve scoping completeness for the next stage of the scoping process (A3: Develop Recommended Alternative).

Data Requirements and Information Needed to Initiate the Activity

- **All available analysis reports on the preferred alternative**—including environmental analysis, constructability review, benefit-cost analysis, a utility research report, preliminary schematics, and a conceptual Transportation Management Plan.

Restrictions

- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Local, state, and federal regulations.**

Tools and Resources

- **PSP team**—the team of personnel identified during activity A113 to be in charge of project scoping.
- **Project definition evaluation tools**—such as the TxDOT's APRA tool.
- **Appendix A**—T14: Project Scope/Definition Completeness Evaluation Tools (TxDOT APRA).

Outcomes of This Action

- **Project definition rating index score for the recommended alternative.**
- **Recommendations on how to improve project definition completeness in the next step for the preferred alternative (A3: Develop Recommended Alternative).**

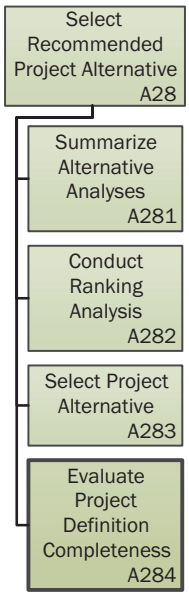


Figure A284. The fourth step in selecting the recommended project alternative is evaluating project definition completeness.

A3 Develop Recommended Alternative

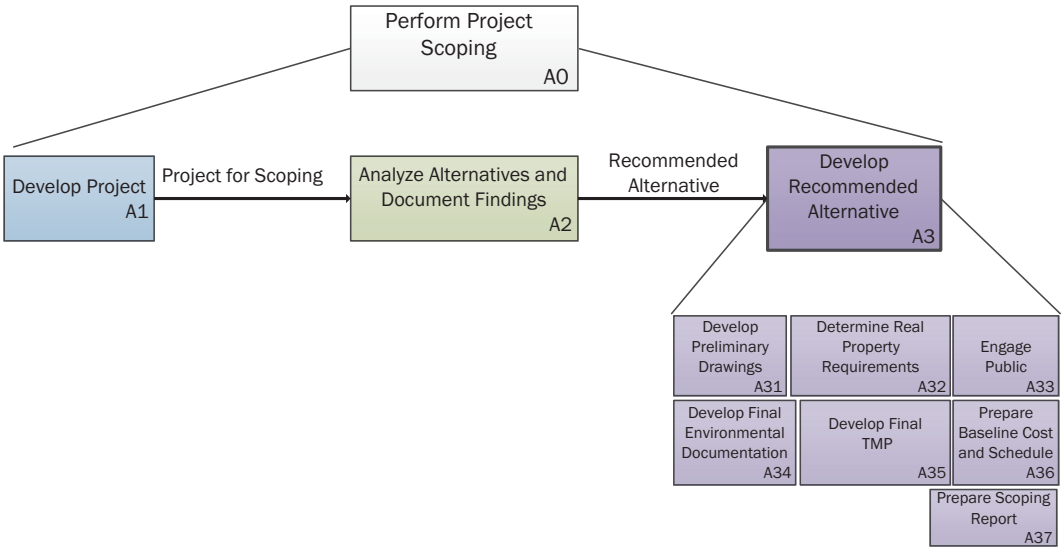


Figure A3. The third step in the PSP is developing the recommended alternative.

Purpose: *To develop and document the preferred alternative for readiness for programming the project.*

To meet this purpose: *A baseline budget and letting date should be set. The preferred alternative should be documented in an approved scoping report signed by appropriate management.*

The objective of the last activity (A3) (Figure A3) of the PSP is to develop and document the recommended alternative for readiness for programming the project. This includes developing preliminary drawings, final environmental documentation, and the final transportation management plan; determining real property requirements; engaging the public; preparing the baseline cost and schedule; and preparing the project scoping report.

The seven major activities performed to develop the recommended alternative are:

- **A31: Develop preliminary drawings**—Preliminary drawings should include basic information necessary for the proper review and evaluation of the proposed improvement. Developing preliminary drawings should take into account design considerations (e.g., design life, safety, aesthetics, compatibility with long-range transportation goals, environmental sustainability, access management, and community image), operating considerations (e.g., daily level of service requirements, directional volume and lane change requirements, operating timetable, technological needs assessment, and flexibility to change layout), and maintenance considerations (e.g., scheduled shut-down frequencies and durations, traffic-monitoring requirements, equipment access needs and provisions,

TMPs and detour availability, environmental conservation programs, and selection of materials for design and construction).

- **A32: Determine real property requirements**—This activity takes place at the beginning of the preliminary design phase, along with other data collection activities, in preparation for the development of alternative alignments. Later in the preliminary design phase, it also involves conducting data-gathering activities needed to refine preferred alignments to minimize ROW impacts to properties. ROW mapping is a major component of this activity. A ROW map is a compilation of internal data, property descriptions (which include field notes and parcel plats), appraisal information, and improvements related to the transportation project. ROW maps are recognized as internal plans and management documents, with significant impact on the project development process. Preparation of these maps normally begins after obtaining schematic design approval.
- **A33: Engage public**—The agency should keep the public informed of issues associated with the project and measure public opinions about the development process. Similar to previous steps, public involvement efforts may include meetings with key stakeholders including affected property owners, public meetings, and public hearings to provide public access to the decision-making process and to provide an avenue for public inputs. For projects that involve added capacity or public lands, a public hearing is generally required. Public meetings before a formal public hearing are common in situations where a large amount of ROW is needed for the project, the roadway function changes substantially, controversy about the project is substantial, or the project is high profile. In practice, most projects at transportation agencies are CE projects. For these projects, a written notification usually satisfies the requirement for a meeting with affected property owners. As a result, a public hearing is not required. Public hearings are typically advertised in newspapers and other media in accordance with FHWA and state regulations. Regulations govern a variety of other requirements regarding public meetings, including geographic location, room size, agenda, protocol, and procedures.
- **A34: Develop final environmental documentation**—Final environmental documents describe the project's impacts and mitigation, if any, on the various resources and communities based on the proposed project's construction, location, and design. In addition, the document should describe early interagency coordination and preliminary public involvement, including estimates of time required for milestones.
- **A35: Develop final TMP**—Depending on the complexity of the work or magnitude of anticipated traffic impacts, a TMP may provide lane requirement charts, standard special provisions for maintaining traffic, and, for a major project, a separate comprehensive report. In developing the TMP, the project team should consider the following strategies for alleviating or minimizing work-related traffic delays:
  - Public awareness campaigns.
  - Motorist information.
  - Demand management.
  - Incident management.
  - System management.
  - Construction methods and staging.
  - Alternate route planning.
- **A36: Prepare baseline cost and schedule**—Based on the information developed in the previous activities, the project team will determine preliminary work activities and establish the schedule baseline. Then, based on the available resources, the project budget is allocated across the scheduled activities and across time. Cost estimate is prepared based on the time-phased allocation of resources and baseline cost is established. The baseline is what cost and schedule performance is measured against.
- **A37: Prepare scoping report**—The scoping report should provide documentation of the need for the project and disclose information about alternatives and impacts. More specifically, the scoping report should explain where the project is located, why the project is needed,

what the objectives and purposes of the project are, and what alternatives were considered. Environmental, ROW, and utility impact reviews are an important part of the project scoping report. Finally, the project cost and schedule baseline, as well as traffic, safety, and maintenance operations, should be included in the report.

Project Scalability Considerations

A complex project will typically have ROW requirements and utility relocations. However, if the project scope does not include ROW requirements, then A32 is not performed. If the project does not have potential alternative solutions to achieving the purpose and need, but still includes utility relocation, then A22 is performed before A31. Additional effort around utility relocations beyond A22 is not required and the scope of this activity is sufficiently defined for developing the preferred alternative in A3.

The project may have different environmental requirements so those activities related to environmental assessment may be performed at different levels of detail depending on the specific requirements for a project, that is, whether a CE, an EA or an EIS is needed.

The level of design effort, traffic management, and public involvement will vary as well depending on the project type and its characteristics. Adjustments in these activity areas might require a reduction in the estimated level of effort to complete these activities. The PSP team should make this determination based on project definition, characteristics, and location.

The guidelines in A3 do not cover interaction with railroads. The user should review *SHRP 2 Report S2-R16-RR-1: Strategies for Improving the Project Agreement Process Between Highway Agencies and Railroads* for a comprehensive treatment of this topic area (see Appendix B).

A31 Develop Preliminary Drawings

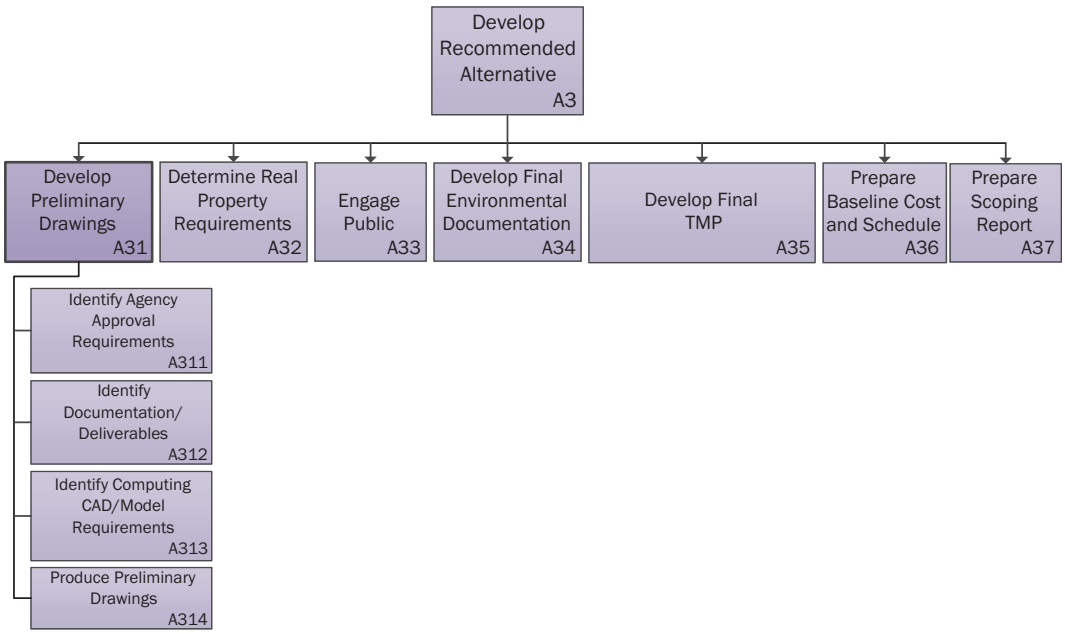


Figure A31. The first step in developing the recommended alternative is developing preliminary drawings.

Preliminary drawings should include basic information necessary for the proper review and evaluation of the proposed improvement. Developing preliminary drawings should take into account design considerations (e.g., design life, safety, aesthetics, compatibility with long-range transportation goals, environmental sustainability, access management, and community image), operating considerations (e.g., daily level of service requirements, directional volume and lane change requirements, operating timetable, technological needs assessment, and flexibility to change layout), and maintenance considerations (e.g., scheduled shut-down frequencies and durations, traffic-monitoring requirements, equipment access needs and provisions, traffic control plans and detour availability, environmental conservation programs, and selection of materials for design and construction).

The four major activities performed to develop preliminary drawings (Figure A31) are:

- **A311: Identify agency approval requirements**—The objective of this activity is to identify any requirements the agency may have for approving the preliminary drawings. Doing so may help reduce agency-induced changes during design and shorten project delivery.
- **A312: Identify documentation/deliverables**—The objective of this activity is to identify what drawings and documentation should be produced and what elements and level of detail should be included in the preliminary drawings.
- **A313: Identify computing CAD/model requirements**—The objective of this activity is to find out what available computerized design platform (2D CAD, 3D CAD, etc.) should be used to produce preliminary drawings.
- **A314: Produce preliminary drawings**—The objective of this activity is to produce a set of preliminary drawings (roadway, bridges, drainage, ROW, etc.) of the recommended alternative for further evaluation and project permitting.

A311 Identify Agency Approval Requirements

The objective of this activity is to identify any requirements the agency may have for approving the preliminary drawings. Doing so may help reduce agency-induced changes during design and shorten project delivery.

The two actions performed in this activity (Figure A311) are:

- **Refer to federal, state, and local regulations to find general requirements**—depending on the funding stream for the proposed project, there are likely varying requirements in regards to the review and approval process, including estimated timelines. In addition to each state maintaining its own review and approval process, the FHWA also maintains drawing standards for various design elements.
- **Document agency approval requirements**—considering that agency approval requirements may originate in different sources, the requirements should be synthesized into a single source, which can then be referenced by both internal and outside consultants through the project's development process.

Data Requirements and Information Needed to Initiate the Activity

- **Agency's requirements**—include detail requirements of types of drawings to be produced, elements to be included in the drawings, and others.

Restrictions

- **Budget and time**—required for identifying and documenting agency approval requirements.
- **Federal, state, and local regulations**—may contain requirements for agency approval.

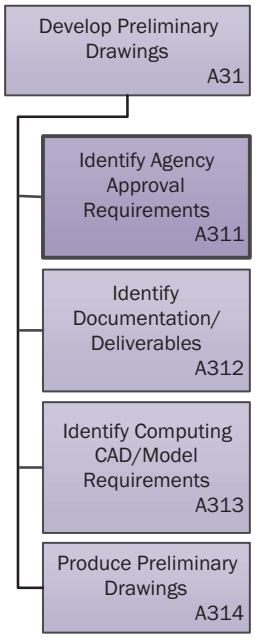


Figure A311. The first step in developing preliminary drawings is identifying the agency approval requirements.

Tools and Resources

- **Project manager and the PSP team**—responsible for collecting information on agency approval requirements.
- **Agency**—involved in this activity.

Outcomes of This Action

- **Identification of Agency's Requirements.**

A312 Identify Documentation/Deliverables

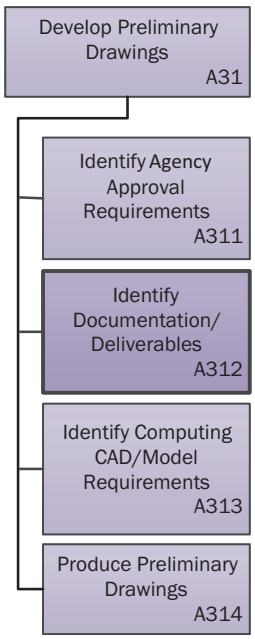


Figure A312. The second step in developing preliminary drawings is identifying documentation/ deliverables.

The objective of this activity is to identify what drawings and documentation should be produced and what elements and level of detail should be included in the preliminary drawings.

The three actions performed in this activity (Figure A312) are:

- **Refer to federal, state, and local regulations for requirements on preliminary drawings**—depending on the funding stream for the proposed project, there are likely varying requirements in regards to the drawing elements and format of the project drawings/models before they can be reviewed and approved by the involved agencies. In addition to each state maintaining its standard drawing requirements, the FHWA also maintains drawing standards for various design elements for the eastern, central, and western lands.
- **Refer to state manuals**—the project development manual, project scoping manual, and design manual for requirements on preliminary drawings. The FHWA maintains a list of the different state standard plan requirements.
- **Determine and document required documentation/deliverables**—the various drawing requirements need to be synthesized into a single source. Considering that A311 (Identify Agency Approval Requirements) synthesizes the approval and review process, the drawing requirements documented here should be appended to the same synthesis.

Data Requirements and Information Needed to Initiate the Activity

- **Type of drawings**—drawings required at this stage of the develop process including details of plan, elevation, cross section, and other elements.
- **Elements to be included in the drawings**—location map, utilities, ROW marks, etc.
- **Level of detail**—the drawings should contain sufficient detail to support project permitting.

Restrictions

- **Budget and time**—required for identifying and documenting agency approval requirements.

Tools and Resources

- **Project manager and the PSP team**—responsible for collecting information on agency approval requirements.

Outcomes of This Action

- **List of required deliverables.**

A313 Identify Computing CAD/Model Requirements

The objective of this activity is to find out what available computerized design platform (2D CAD, 3D CAD, etc.) should be used to produce preliminary drawings.

The two actions performed in this activity (Figure A313) are:

- **Identify available modeling platforms available for the project**—different transportation agencies have differing requirements as to the drawing and model formats, with most specifying the format in either a MicroStation design file or an AutoCAD drawing. The specified formats do periodically change, so the required format should be confirmed for each project. Furthermore, it should be clarified whether the units are to be in U.S. customary, metric, or both.
- **Identify any computing requirements**—with the advancements of civil integrated management (CIM) systems, data content in the project models has important significant implications of supporting different functions throughout a project's lifecycle. For example, incorporation of survey control data in the geometric design model can be used to support automated machine guidance during construction. This activity should identify data requirements in order to be incorporated into the CAD model.

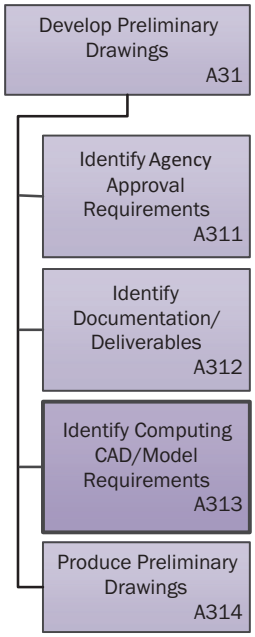


Figure A313. The third step in developing preliminary drawings is identifying computing CAD/model requirements.

Data Requirements and Information Needed to Initiate the Activity

- **Project information**—although most transportation projects use 2D CAD for producing drawings, some large, complex projects (e.g., large bridges) may benefit from using 3D CAD or Building Information Modeling (BIM) technology.
- **Available platforms**—advantages and disadvantages of all possible available technology for the project.
- **Agency guidebooks**—some agencies do possess guidebooks regarding CAD/model standards and should be referred to when identifying the requirements.

Restrictions

- **Funding for the project**—determines what is affordable.
- **Regulations and design manual**—information on required types of drawings based on project type.

Tools and Resources

- **Project manager**—the staff member who decides what computer platform to use.
- **Lead design engineer**—the staff member who provides expert opinion on what design platform is best for the project.
- **IT experts**—CAD technicians, BIM technicians, and other required professionals.
- **Design platforms**—2D CAD, 3D CAD, BIM, and other.

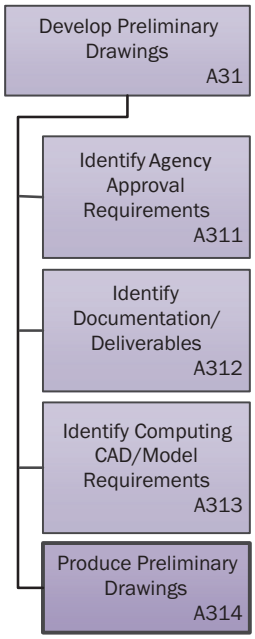


Figure A314. The fourth step in developing preliminary drawings is producing the preliminary drawings.

Outcomes of This Action

- **Determination of which computer platform(s) should be used for producing preliminary drawings.**

A314 Produce Preliminary Drawings

The objective of this activity is to produce a set of preliminary drawings (roadway, bridges, drainage, ROW, etc.) of the recommended alternative for further evaluation and project permitting.

The four actions performed in this activity (Figure A314) are:

- **Produce the title sheet**—the title sheet should be developed in accordance to the governing agency requirements. The content of the title sheet should include, but is not limited to: project title, associated project numbers, project location information and map, index to sheets, project quantities, revision block, contact information block, and associated approval signatures and stamps.
- **Produce the plan sheets**—in addition, the plan sheets should be developed in accordance to the governing agency requirements. The plan sheets should include, but are not limited to: existing and proposed topography, existing ROW, horizontal alignment data, entrance locations, construction limits, drawing scale, sheet number, existing below-grade and above-grade utilities, and associated approval signatures and stamps.
- **Produce the profile sheets**—the profile sheets should be developed in accordance to the governing agency requirements and include, but are not limited to, the following: vertical alignment data, entrance locations, drawing scale, sheet number, existing below-grade and above-grade utilities, and associated approval signature and stamps.
- **Draw the typical cross sections**—the cross sections should be developed in accordance to the governing agency requirements and include, but are not limited to, the following: pavement design; prime, tack, and seal coat locations dimensions; dimension widths and labels; cross-slopes; cut and fill slopes; drawing scale; sheet number; and associated approval signatures and stamps.

Data Requirements and Information Needed to Initiate the Activity

- **Requirements for agency approval**—output from activity A311.
- **Required deliverables**—output from activity A312.
- **Recommended alternative**—information on the location of the project, type of project, basic design requirements from A2.
- **Geographic data of the project location.**

Restrictions

- **Budget**—cost constraints for producing preliminary drawings.
- **Time**—schedule constraints for producing preliminary drawings.
- **Design manuals**—requirements for preliminary drawings.

Tools and Resources

- **Lead design engineer**—the staff member who provides expert opinion on what design platform is best for the project.

- **Modeling technicians**—CAD technicians or BIM technicians to support computerized **drawing.**
- **Design platforms**—2D CAD, 3D CAD, BIM, etc.
- **GIS**—provides geographic information on the project site.
- **Constructability reviews**—*NCHRP Report 391: Constructability Review Process for Transportation Facilities: Workbook.*

Outcomes of This Action

- **A set of preliminary drawings for review and project permitting.**

A32 Determine Real Property Requirements

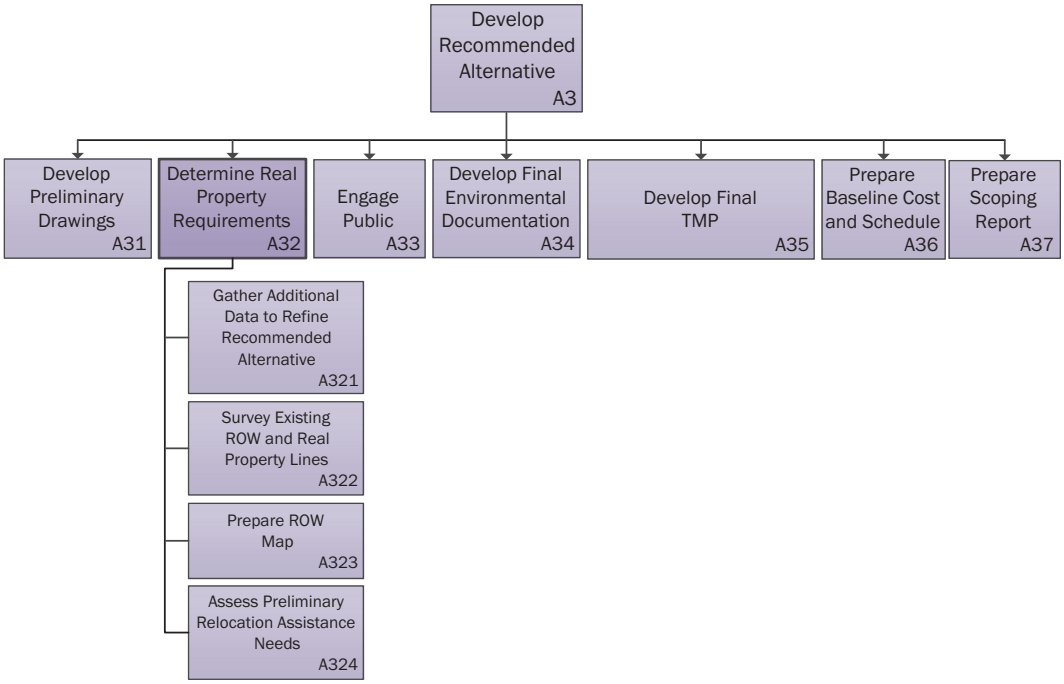


Figure A32. The second step in developing the recommended alternative is determining real property requirements.

This activity takes place at the beginning of the preliminary design phase, along with other data collection activities in preparation for the development of alternative alignments. Later in the preliminary design phase, it also involves conducting data-gathering activities needed to refine preferred alignments to minimize ROW impacts to properties. ROW mapping is a major component of this activity. A ROW map is a compilation of internal data, real property descriptions (which include field notes and parcel plats), appraisal information, and improvements related to the transportation project. ROW maps are recognized as internal plans and management documents, with significant impact on the project development process. Preparation of these maps normally begins after obtaining schematic design approval.

The four major activities performed to determine real property requirements (Figure A32) are:

- **A321: Gather additional data to refine recommended alternative**—This activity gathers additional data to refine the preferred alignments and minimize real property impacts.

- **A322: Survey existing ROW and real property lines**—This activity conducts a survey of existing ROW and real property lines following appropriate survey standards, laws, and regulations. This survey is necessary for developing the ROW map and real property descriptions.
- **A323: Prepare ROW map**—This activity prepares the ROW map. A ROW map is a compilation of internal data, real property descriptions (which include field notes and parcel plats), and other information related to the transportation project. ROW maps are recognized as internal plans and management documents, with significant impact on the project development process. Preparation of these maps normally begins after obtaining schematic design approval.
- **A324: Assess preliminary relocation assistance needs**—This activity conducts a preliminary assessment of relocation assistance needs. According to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (also known as the Uniform Act and codified as 42 U.S. Code [USC] 4601 et seq.), determining relocation assistance eligibility can start early by providing a written notice of intent to acquire real property. The act encourages early planning to anticipate displacements and provide for the resolution of problems in order to minimize adverse impacts on displaced persons and expedite project completion.

A321 Gather Additional Data to Refine Recommended Alternative

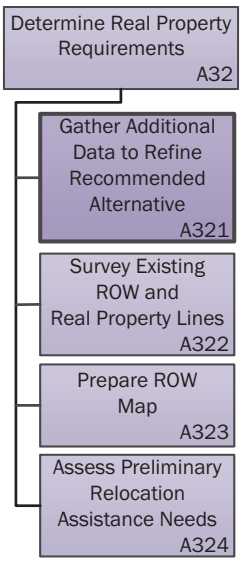


Figure A321. The first step in determining real property requirements is gathering additional data to refine the recommended alternative.

The purpose of this activity is to gather additional data to refine the preferred alignments and minimize real property impacts.

The five actions performed in this activity (Figure A321) are:

- **Gather the recommended alternative geometric schematic**—the geometric schematic and other information associated with the recommended alternative.
- **Gather results from the value engineering study**—the relevant results and recommendations from the value engineering study.
- **Gather copies of federal, state, and local agreements**—agreements with federal, state, and local agencies that document levels of responsibility that each agency has agreed to in relation to the project. These agreements typically outline funding contributions and other responsibilities for each party.
- **Gather information about ROW limits, temporary easements, drainage easements, and control of access lines**—more specific information as it becomes available, such as ROW limits, temporary and drainage easements, and control of access lines.
- **Process and document additional datasets**—the additional datasets that will be needed to conduct a survey of existing ROW and real property lines.

Data Requirements and Information Needed to Initiate the Activity

- **Recommended alternative geometric schematic**—depicts the geometric alignment associated with the recommended alternative.
- **Value engineering study**—including recommendations from subject matter experts about project alignment and other features.
- **State and local agreements**—document levels of responsibility that each agency has agreed to in relation to the project. These agreements typically outline funding contributions and other responsibilities for each party.
- **ROW limits, temporary easements, drainage easements, and control of access lines**—more specific information as it becomes available. Examples include ROW limits, temporary and drainage easements, and control of access lines.

Restrictions

- **ROW manual**—document that provides guidance on general procedures for the acquisition of real property interests. It might contain information about preliminary engineering-level activities, although not necessarily (typically, ROW manuals describe activities beginning with the development of the ROW map, once the approved alignment has been selected).
- **Project development process manual**—procedure document that provides general information about the project development process for ROW, utility relocation, public inputs, environmental requirements, preliminary design, transportation management plan, preliminary cost estimating, and alternative analysis.

Tools and Resources

- **Project manager**—the staff member who provides general guidance on what data needs to be acquired and compiled.
- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.

Outcomes of This Action

- **Additional datasets**—datasets gathered to refine the preferred alignments and minimize real property impacts.

A322 Survey Existing ROW and Real Property Lines

This activity conducts a survey of existing ROW and real property lines following appropriate survey standards, laws, and regulations. This survey is necessary for developing the ROW map and real property descriptions.

The three actions performed in this activity (Figure A322) are:

- **Gather the recommended alternative geometric schematic**—the geometric schematic and other information associated with the recommended alternative.
- **Gather information about ROW limits, temporary easements, drainage easements, and control of access lines**—gather more specific information as it becomes available, for example, ROW limits, temporary and drainage easements, and control of access lines.
- **Gather additional datasets**—any additional datasets that will be needed to conduct a survey of existing ROW and real property lines.

Data Requirements and Information Needed to Initiate the Activity

- **Recommended alternative geometric schematic**—depicts the geometric alignment associated with the recommended alternative.
- **ROW limits, temporary easements, drainage easements, and control of access lines**—more specific information as it becomes available. Examples include ROW limits, temporary and drainage easements, and control of access lines.
- **Additional datasets**—datasets gathered to refine the preferred alignments and minimize real property impacts.

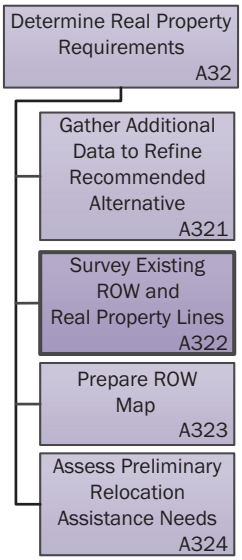


Figure A322. The second step in determining real property requirements is surveying existing ROW and real property lines.

Restrictions

- **Surveying standards, laws, and regulations**—guidance and requirements on applicable surveying standards and protocols.

Tools and Resources

- **Licensed surveyor**—the person in charge of conducting, overseeing, and certifying all survey work and results.

Outcomes of This Action

- **Survey files**—files in the appropriate format that contain all the necessary information to identify, locate, and document real property interests that will need to be acquired. They also contain detailed information about existing real property restrictions.

A323 Prepare ROW Map

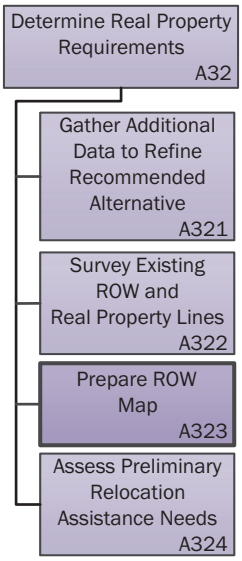


Figure A323. The third step in determining real property requirements is preparing the ROW map.

This activity prepares the ROW map. A ROW map is a compilation of internal data, real property descriptions (which include field notes and parcel plats), and other information related to the transportation project. ROW maps are recognized as internal plans and management documents, with significant impact on the project development process. Preparation of these maps normally begins after obtaining schematic design approval.

The three actions performed in this activity (Figure A323) are:

- **Gather recommended alternative geometric schematic**—the geometric schematic and other information associated with the recommended alternative.
- **Gather information about row limits, temporary easements, drainage easements, and Control of access lines**—more specific information as it becomes available, such as ROW limits, temporary and drainage easements, and control of access lines.
- **Gather additional datasets**—any additional datasets that will be needed to conduct a survey of existing ROW and real property lines.

Data Requirements and Information Needed to Initiate the Activity

- **Survey files**—files in the appropriate format that contain all the necessary information to identify, locate, and document real property interests that will need to be acquired. They also contain detailed information about existing real property restrictions.

Restrictions

- **ROW manual**—document that provides guidance on general procedures for the acquisition of real property interests.
- **Surveying standards, laws, and regulations**—guidance and requirements on applicable surveying standards and protocols.

Tools and Resources

- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.
- **Licensed surveyor**—the person in charge of conducting, overseeing, and certifying all survey work and results.

Outcomes of This Action

- **ROW map and real property descriptions**—compilation of internal data, real property descriptions (which include field notes and parcel plats), and other information related to the transportation project.

A324 Assess Preliminary Relocation Assistance Needs

This activity conducts a preliminary assessment of relocation assistance needs. According to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (also known as the Uniform Act and codified as 42 USC 4601 et seq.), determining relocation assistance eligibility can start early by providing a written notice of intent to acquire real property. The act encourages early planning to anticipate displacements and provide for the resolution of problems in order to minimize adverse impacts on displaced persons and expedite project completion.

The two actions performed in this activity (Figure A324) are:

- **Gather additional datasets**—additional information about potential relocation assistance needs in connection with the transportation project.
- **Document preliminary relocation assistance needs**—compile preliminary relocation assistance needs.

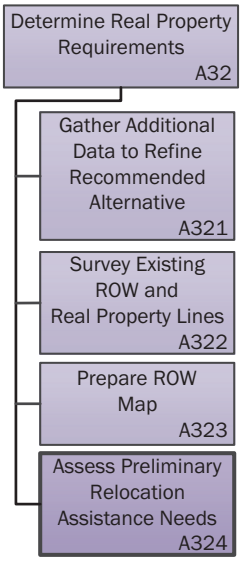


Figure A324. The fourth step in determining real property requirements is assessing preliminary relocation assistance needs.

Data Requirements and Information Needed to Initiate the Activity

- **Additional datasets**—datasets gathered to refine the preferred alignments and minimize real property impacts.

Restrictions

- **Uniform Act**—federal legislation that provides basic standards and requirements for real property interest acquisitions and relocation assistance services.
- **Federal and state regulations**—federal and state regulations that govern the acquisition of real property interests, eminent domain powers, and relocation assistance services.
- **ROW manual**—document that provides guidance on general procedures for the acquisition of real property interests.

Tools and Resources

- **Project manager**—the staff member who provides general guidance on what data need to be acquired and compiled.
- **ROW coordinator/agent**—the staff member responsible for the acquisition of real property interests.

Outcomes of This Action

- **Preliminary relocation assistance needs.**

A33 Engage Public

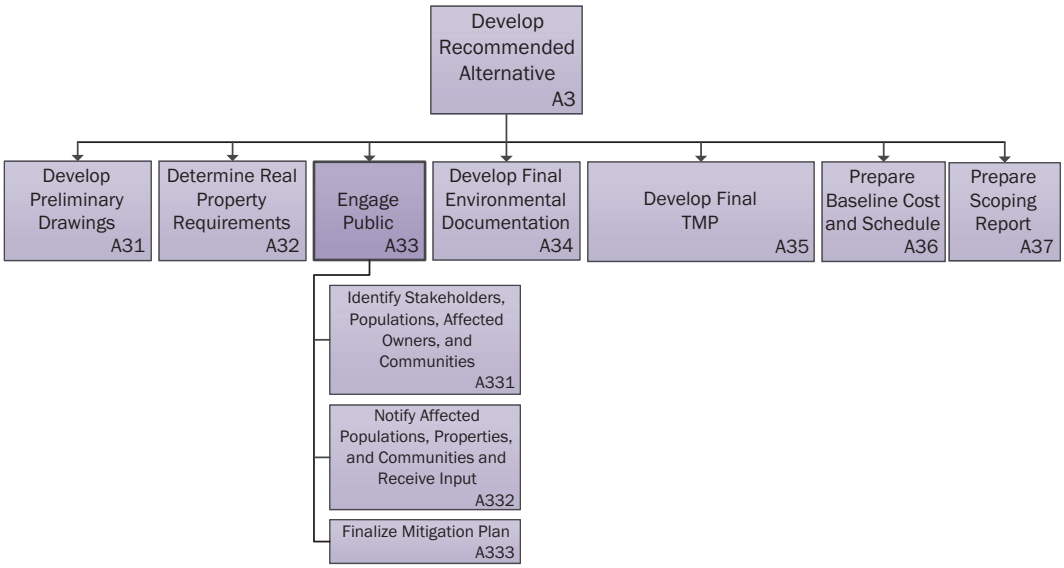


Figure A33. The third step in developing the recommended alternative is engaging the public.

The agency should keep the public informed of issues associated with the project and measure public opinions about the development process. Similar to previous steps, public involvement efforts may include meetings with key stakeholders including affected property agencies, public meetings, and public hearings to provide public access to the decision-making process and to provide an avenue for public inputs. For projects that involve added capacity or public lands, a public hearing is generally required. Public meetings before a formal public hearing are common in situations where a large amount of ROW is needed for the project, the roadway function changes substantially, controversy about the project is substantial, or the project is high profile. In practice, most projects at transportation agencies are CE projects. For these projects, a written notification usually satisfies the requirement for a meeting with affected property agencies. As a result, a public hearing is not required. Public hearings are typically advertised in newspapers and other media in accordance with FHWA and state regulations. Regulations govern a variety of other requirements regarding public meetings, including geographic location, room size, agenda, protocol, and procedures.

The three major activities performed to engage the public (Figure A33) are:

- **A331: Identify stakeholders, populations, affected owners, and communities**—The objective of this activity is to identify and document project-specific transportation stakeholders, and communities and populations directly affected by project activities. It refines and provides details started in activity A121.
- **A332: Notify affected populations, properties, and communities and receive input**—The objective of this activity is to notify individual stakeholders, communities, and populations directly affected by project activities.
- **A333: Finalize mitigation plan**—The objective of this activity is to revise mitigation plans, if any are required, for potential community impacts.

A331 Identify Stakeholders, Populations, Affected Owners, and Communities

The objective of this activity is to identify and document project-specific transportation stakeholders, and communities and populations directly affected by project activities. It refines and provides details started in activity A131.

The five actions performed in this activity (Figure A331) are:

- **Identify project-specific stakeholders**—identify and document responsible parties, local and resource agencies, and key project requirements including their location, footprint (limits), and descriptions of key work (e.g., widen existing roadway, mill and resurface roadway, or construct new project).
- **Identify project-specific populations**—at-risk, EJ communities in the project area of influence. Previous steps (activities A13 and A25) should be estimated first.
- **Identify project-specific communities**—affected communities within the project area.
- **Identify project-specific natural impacts**—on affected natural and biotic communities.
- **Revise the project scope and specification as needed**—they should reflect the presence and characteristics of individual populations, communities, or biotic and natural communities that may be affected.

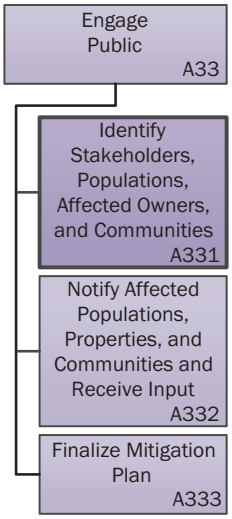


Figure A331. The first step in engaging the public is identifying stakeholders, populations, affected owners, and communities.

Data Requirements and Information Needed to Initiate the Activity

- **Record of identified stakeholders, affected populations, community impacts, public involvement plan, MTP, long-range plans, and other affected plans**—consistency with other local, regional, and statewide plans.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Public outreach, notification, and education**—meetings, mailings, education of public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and SDOT staff, and public leaders.
- **Resource agency databases**—with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.
- **FHWA Environmental Review Tool Kit**—http://environment.fhwa.dot.gov/projdev/index.asp.
- **FHWA public involvement techniques for Transportation Decision Making**—http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/.
- **FHWA Community Impact Assessment**—http://www.fhwa.dot.gov/environment/cia/.

Outcomes of This Action

- **List of identified affected populations and description of types of potential impacts.**
- **Record of key stakeholders, partners, agencies, affected populations, and their inputs.**

A332 Notify Affected Populations, Properties, and Communities and Receive Input

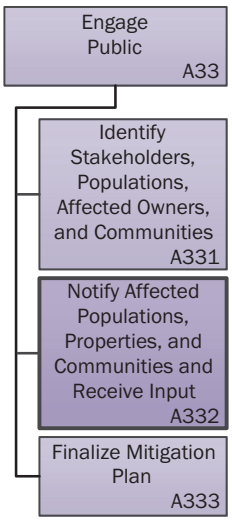


Figure A332. The second step in engaging the public is notifying affected populations, properties, and communities and receiving input.

The objective of this activity is to notify individual stakeholders, communities, and populations directly affected by project activities.

The six actions performed in this activity (Figure A332) are:

- **Notify project-specific stakeholders individually**—per the notification requirements to responsible parties and local and resource agencies.
- **Notify project-specific individuals**—at-risk, EJ communities and individuals in the project area of influence. The previous steps are activities A13 and A25.
- **Notify project-specific communities**—perform to notify the affected communities within the project area.
- **Notify resource agencies responsible for project-specific natural communities**—generally is conducted to meet resource agency regulations for permits.
- **Receive input, if any, from above notifications of affected individuals.**
- **Include mitigation plans in the scope and specification as needed.**

Data Requirements and Information Needed to Initiate the Activity

- **Record of identified stakeholders, affected populations, community impacts, public involvement plan, MTP, long-range plans, and other affected plans**—consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Public outreach, notification, and education**—meetings, mailings, education of public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and SDOT staff, and public leaders.
- **Resource agency databases**—previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.

Outcomes of This Action

- **Draft mitigation plans.**
- **Record of key stakeholders, partners, agencies, affected populations, and their inputs.**

A333 Finalize Mitigation Plan

The objective of this activity is to revise mitigation plans, if any are required, for potential community impacts.

The three actions performed in this activity (Figure A333) are:

- **Provide a description of proposed mitigation actions or permits**—as needed to meet state and federal requirements.
- **Record proposed actions**—to avoid, minimize, or compensate for impacts.
- **Notify affected parties**—property owners, populations, communities, or resource agencies on actions, permits, and commitments as required by state and federal requirements.

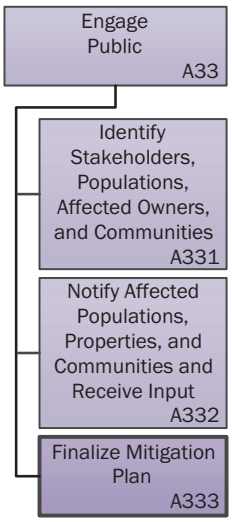


Figure A333. The third step in engaging the public is finalizing the mitigation plan.

Data Requirements and Information Needed to Initiate the Activity

- **Project description, limits, footprint, and work activities**—resources and communities in the project area, including resource agency databases, etc.
- **Record of identified stakeholders, affected populations, community impacts, public involvement plan, MTP, long-range plans, and other affected plans**—consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Resource agency databases**—previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies. Planners and subject matter experts, environmental scientists, biologists, archeologists, etc. assess potential impacts.
- **Record of public outreach, notification, and education**—meetings, mailings, education of public and local officials, and identification of stakeholders using public involvement coordinators, planners, engineers, MPO and SDOT staff, and public leaders.
- **FHWA environmental review tool kit**—http://environment.fhwa.dot.gov/projdev/index.asp.

- **FHWA public involvement techniques for transportation decision making**—http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/.
- **FHWA community impact assessment**—http://www.fhwa.dot.gov/environment/cia/.

Outcomes of This Action

- **Environmental permits and commitments for the proposed project.**
- **Preliminary environmental scoping document with the administrative record of potential direct impacts.**

A34 Develop Final Environmental Documentation

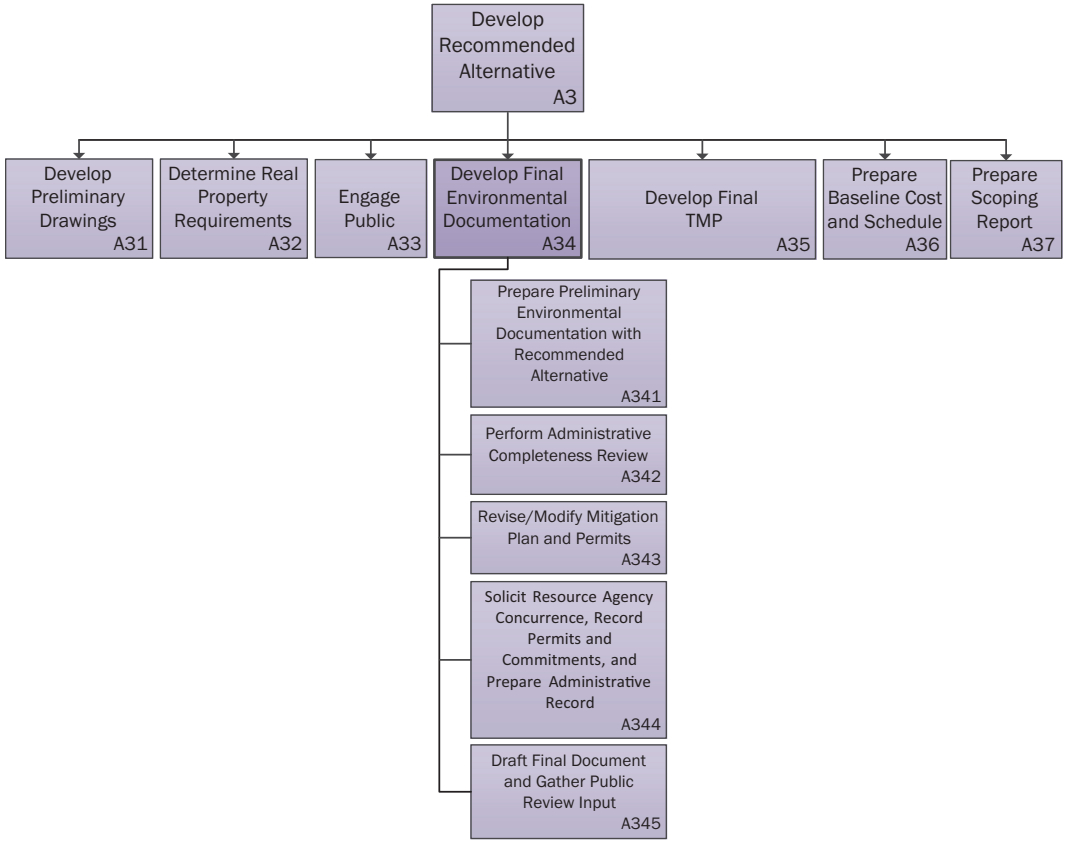


Figure A34. The fourth step in developing the recommended alternative is developing final environmental documentation.

Final environmental documents describe the project's impacts and mitigation, if any, on the various resources and communities based on the proposed project's construction, location, and design. In addition, the document should describe early interagency coordination and preliminary public involvement, including estimates of time required for milestones.

The five major activities performed to develop final environmental documentation (Figure A34) are:

- **A341: Prepare preliminary environmental documentation with recommended alternative**—The objective of this activity is to prepare and submit the appropriate environmental document based on the preliminary assessment (CE, EA, or EIS).

- **A342: Perform administrative completeness review**—The objective of this activity is to review the final draft of the environmental document for completeness and compliance (CE, EA, or EIS).
- **A343: Revise/modify mitigation plan and permits**—The objective of this activity is to revise the mitigation plan (if needed) based on early review from resource agencies to address impacts to stakeholders, populations, affected owners, and communities that are directly affected by the proposed project. Mitigation should follow the following sequence: avoid, minimize, repair/rehabilitate/restore, reduce, and compensate.
- **A344: Solicit resource agency concurrence, record permits and commitments, and prepare administrative record**—The objective of this activity is to finalize the mitigation plan (if needed) from resources agencies.
- **A345: Draft final document and gather public review input**—The objective of this activity is to finalize the environmental document, permits, and commitments as required by state and federal laws.

A341 Prepare Preliminary Environmental Documentation with Recommended Alternative

The objective of this activity is to prepare and submit the appropriate environmental document based on the preliminary assessment (CE, EA, or EIS).

The three actions performed in this activity (Figure A341) are:

- **Prepare the environmental document**—in accordance with the 23 CFR 771.117 (c) and (d) list. CE involves minimal public impact, has little or no ROW to acquire, and does not involve significant social, economic, or environmental impacts.
- **Describe indirect and cumulative impacts as part of the EA**—an EA is prepared for each action that is not a CE and does not clearly require the preparation of an EIS, or in situations to determine if an EIS is needed. The outcome of an EA is a FONSI. Impacts are described as follows:
  - Direct impacts occur at the same time and place as the action.
  - Indirect impacts happen after project implementation but are caused by the project. The action causes these impacts to occur later in time or farther removed in distance from the action, but the impacts are still reasonably foreseeable.
  - Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
- **Determine if an EIS is required**—an EIS concludes with an ROD. Projects or actions that may significantly affect the quality of the human environment require an EIS.

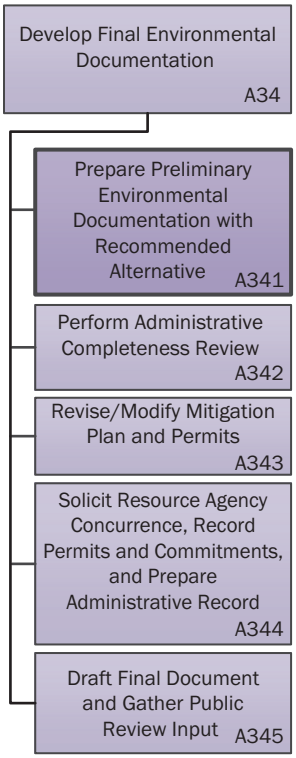


Figure A341. The first step in developing final environmental documentation is preparing preliminary environmental documentation with the recommended alternative.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially resource agency databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive

Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **FHWA environment topics website**—http://www.fhwa.dot.gov/environment/.
- **FHWA environmental review tool kit**—http://environment.fhwa.dot.gov/projdev/index.asp.

Outcomes of This Action

- **Preliminary Environmental Documentation**—environmental document with the administrative record of potential direct, indirect, and cumulative impacts.

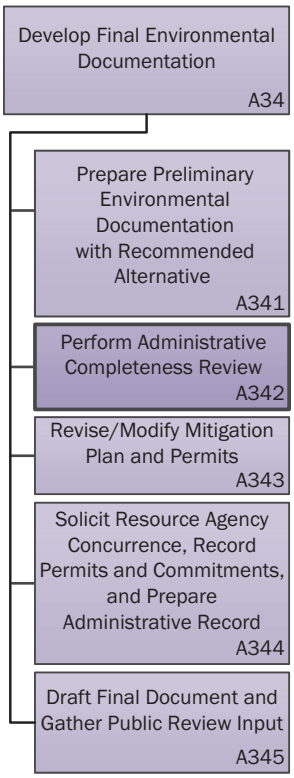


Figure A342. The second step in developing final environmental documentation is performing the administrative completeness review.

A342 Perform Administrative Completeness Review

The objective of this activity is to review the final draft of the environmental document for completeness and compliance (CE, EA, or EIS).

The three actions performed in this activity (Figure A342) are:

- **Conduct review of the environmental document**—determine if all requirements are met. See Council on Environmental Quality (CEQ) state and federal requirements, and the 23 CFR 771.117 (c) and (d) list.
- **Correct deficiencies resulting from the review, if any**—address comments and corrections based on the resource agency and DOT reviews.
- **Submit the final draft document to the appropriate authorities and agencies for approval**—corrected document is submitted to the DOT and is available for public review.

Data Requirements and Information Needed to Initiate the Activity

- **Preliminary environmental documentation**—environmental document with the administrative record of potential direct, indirect, and cumulative impacts.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **Constructability reviews**—*NCHRP Report 391: Constructability Review Process for Transportation Facilities: Workbook.*

Outcomes of This Action

- **Administrative completeness status**—environmental document with the administrative record of potential direct, indirect, and cumulative impacts.

A343 Revise/Modify Mitigation Plan and Permits

The objective of this activity is to revise the mitigation plan (if needed) based on early review from resource agencies to address impacts to stakeholders, populations, affected owners, and communities that are directly affected by the proposed project. Mitigation should follow this sequence: avoid, minimize, repair/rehabilitate/restore, reduce, and compensate.

The three actions performed in this activity (Figure A343) are:

- **Describe mitigation actions**—provide a description of proposed mitigation actions or permits as needed to meet state and federal requirements.
- **Record actions**—to avoid, minimize, repair/rehabilitate/restore, reduce, or compensate for impacts.
- **Notify affected parties**—notify affected property owners, populations, communities, or resource agencies on actions, permits, and commitments as required by state and federal requirements.

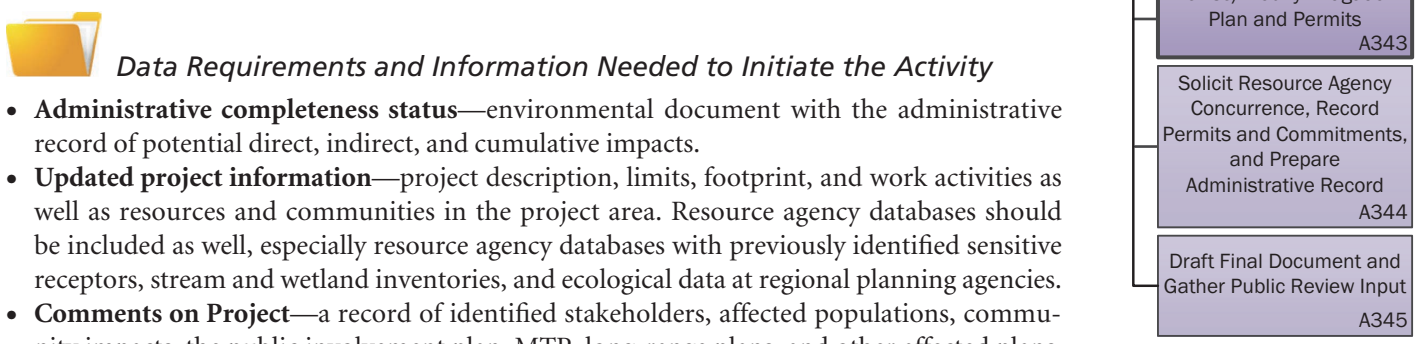


Figure A343. The third step in developing final environmental documentation is revising/modifying mitigation plan and permits.

Data Requirements and Information Needed to Initiate the Activity

- **Administrative completeness status**—environmental document with the administrative record of potential direct, indirect, and cumulative impacts.
- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially resource agency databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.
- **Comments on Project**—a record of identified stakeholders, affected populations, community impacts, the public involvement plan, MTP, long-range plans, and other affected plans. Consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **FHWA environment topics**—http://www.fhwa.dot.gov/environment/.
- **FHWA environmental review tool kit**—http://environment.fhwa.dot.gov/projdev/index.asp.

Outcomes of This Action

- **Revised mitigation plan**—environmental permits and commitments for the proposed project.

A344 Solicit Resource Agency Concurrence, Record Permits and Commitments, and Prepare Administrative Record

The objective of this activity is to finalize the mitigation plan (if needed) for resource agencies.

The three actions performed in this activity (Figure A344) are:

- **Finalize mitigation actions**—provide a description of proposed mitigation actions or permits as needed to meet state and federal requirements.
- **Record actions**—record actions to avoid, minimize, repair/rehabilitate/restore, reduce, or compensate for impacts.
- **Notify affected parties**—notify affected property owners, populations, communities, or resource agencies on actions, permits, and commitments as required by state and federal requirements.

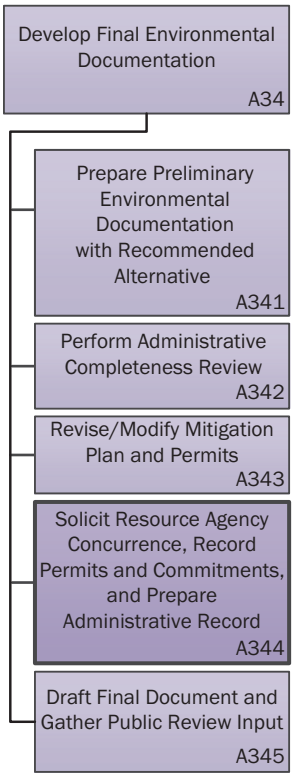


Figure A344. The fourth step in developing final environmental documentation is soliciting resource agency concurrence, recording permits and commitments, and preparing the administrative record.

Data Requirements and Information Needed to Initiate the Activity

- **Revised mitigation plan**—environmental permits and commitments for the proposed project.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **Constructability reviews**—*NCHRP Report 391: Constructability Review Process for Transportation Facilities: Workbook.*

Outcomes of This Action

- **Finalized mitigation plan.**

A345 Draft Final Document and Gather Public Review Input

The objective of this activity is to finalize the environmental document, permits, and commitments as required by state and federal laws.

The three actions performed in this activity (Figure A345) are:

- **Finalize the environmental document**—the documents as needed to meet state and federal requirements.
- **Finalize all permits and commitments as required.**
- **Complete the administrative record**—the administrative record including the final environmental document and supporting documentation for public review.

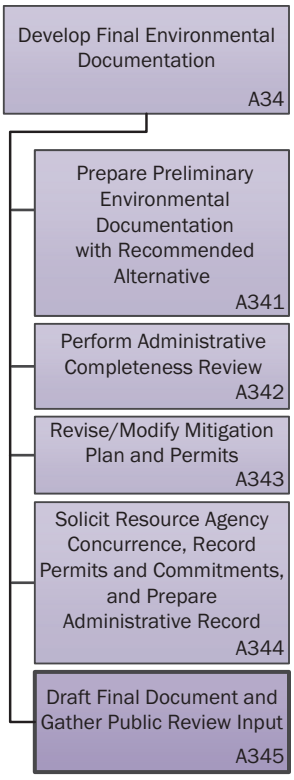


Figure A345. The fifth step in developing final environmental documentation is drafting the final document and gathering public review input.

Data Requirements and Information Needed to Initiate the Activity

- **Revised mitigation plan**—environmental permits and commitments for the proposed project.
- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially resource agency databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.
- **Comments on project**—a record of identified stakeholders, affected populations, community impacts, the public involvement plan, MTP, long-range plans, and other affected plans. Consistency with other local, regional, and statewide plans is necessary.

Restrictions

- **State and federal rules and requirements**—NEPA; Title VI of the Civil Rights Act of 1964; Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970; Executive Order 12898; Section 4(f) of USDOT; the Clean Air Act; the Clean Water Act; the Farmland Protection Policy Act; the National Historic Preservation Act; economic, social, and environmental effects; public hearing requirements; the Archaeological and Historic Preservation Act; Executive Order 11990; Executive Order 11988; the Endangered Species Act; and various state requirements related to environmental protection.

Tools and Resources

- **Environmental coordinator**—the staff member responsible for providing coordination between the agency, environmental resource agencies, consultants, and other related stakeholders.
- **Constructability reviews**—*NCHRP Report 391: Constructability Review Process for Transportation Facilities: Workbook.*

Outcomes of This Action

- **Approved environmental document and complete administrative record**—complete and final draft of the environmental document, environmental permits, and commitments for the proposed project.
- **CE clearance, FONSI, or ROD.**
- **NEPA requirements met**—a letter from the appropriate approving agency reviewer such as FHWA.

A35 Develop Final TMP

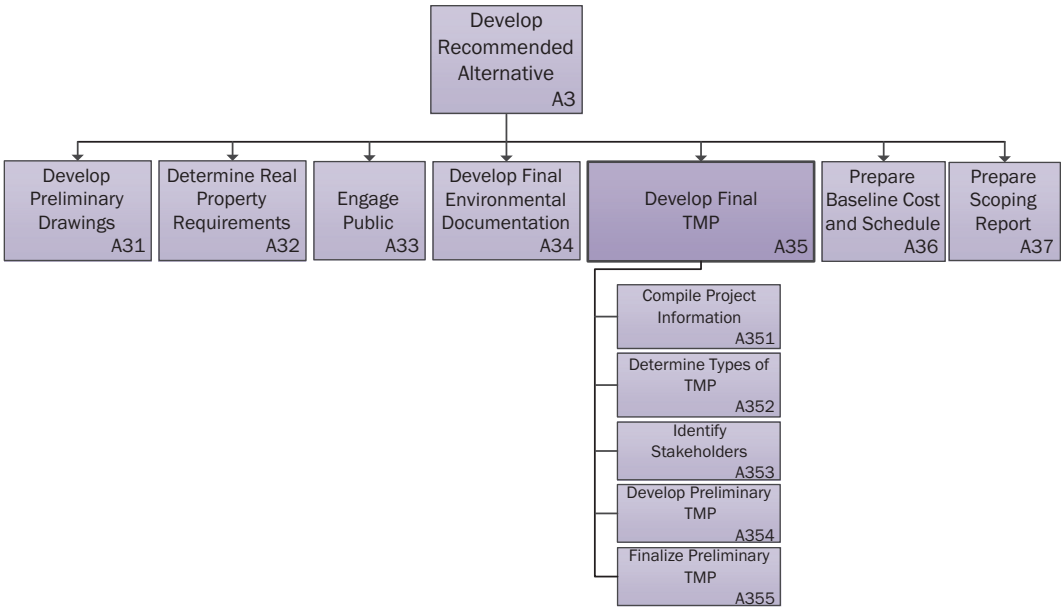


Figure A35. The fifth step in developing the recommended alternative is developing the final TMP.

Depending on the complexity of the work or magnitude of anticipated traffic impacts, a TMP may provide lane requirement charts, standard special provisions for maintaining traffic, and, for a major project, a separate comprehensive report. In developing the TMP, the project team should consider the following strategies for alleviating or minimizing work-related traffic delays:

- Public awareness campaigns.
- Motorist information.
- Demand management.
- Incident management.
- System management.
- Construction methods and staging.
- Alternate route planning.

The five major activities performed to develop the final TMP (Figure A35) are:

- **A351: Compile project information**—The objective of this activity is to compile all information and materials necessary for the project, including a work description, lists of work areas, traffic volumes and patterns, traffic levels, and so on.

- **A352: Determine types of TMP**—The objective of this activity is to determine the types of the TMP that will be pursued for the project among three choices (basic, intermediate, and major). A minor TMP should include a TTC plan and a major TMP should include TO and PI plans.
- **A353: Identify stakeholders**—The objective of this activity is to identify major stakeholders of implementing work zone management strategies based on the project's selected TMP type and components.
- **A354: Develop preliminary TMP**—The objective of this activity is to develop a preliminary TMP that combines design and construction phasing with work zone management strategies.
- **A355: Finalize preliminary TMP**—The objective of this activity is to re-review the preliminary TMP, revise it as necessary, and develop the final TMP that mirrors the results of quantitative analysis. Comments and opinions from subcommittees and task forces are reflected to ensure that all TMP requirements are addressed.

A351 Compile Project Information

The objective of this activity is to compile all information and materials necessary for the project, including a work description, lists of work areas, traffic volumes and patterns, traffic levels, and so on.

The two actions performed in this activity (Figure A351) are:

- **Review project information**—all information already collected through the earlier conceptual TMP development stage. Project requirements, TMP datasheet, and applicable policies are reviewed.
- **Compile traffic and construction information**—further compile all information necessary for the project in order to determine the appropriate type of TMP (i.e., basic, intermediate, and major TMP). Based on information for the selected alternative, the team creates an integrated approach that concurrently captures anticipated work zone impacts, construction phasing/staging, and management strategies as needed.

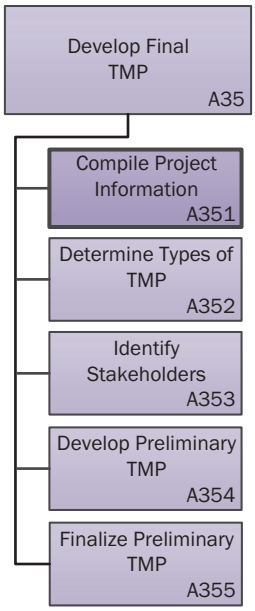


Figure A351. The first step in developing the final TMP is compiling project information.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project information**—project description, limits, footprint, and work activities as well as resources and communities in the project area. Resource agency databases should be included as well, especially resource agency databases with previously identified sensitive receptors, stream and wetland inventories, and ecological data at regional planning agencies.
- **Project schedule and budget**—duration of the project and total project cost. It is extremely important to identify the proper scope and cost of the TMP activities.
- **Preliminary construction staging plan**—plan for construction staging/phasing with a project layout.
- **Preliminary management strategies**—including contingency plans, traffic management strategies, accelerated construction strategies, public outreach strategies, and demand-oriented/capacity-oriented management strategies.

Restrictions

- **Project requirement**—FHWA's requirements concerning work zone safety and mobility as well as states' requirements for work zone activities, depending on the complexity of the work or magnitude of anticipated traffic impacts.

- **TMP datasheet**—project programming generates a request for a TMP datasheet that includes information about a work description, and lists the work areas and traffic patterns and levels.
- **Applicable policies**—including lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed.

Tools and Resources

- **PSP team**—cross-functional sub-team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Decision support tools**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures.
- **Macro-/micro-traffic simulations**—enables a more detailed traffic analysis, including potential work zone delay estimate, impact analysis on traffic diversion to the alternate routes, intersections that would be affected, etc.

Outcomes of This Action

- **Compiled traffic and construction information**—all necessary Information is collected for conducting a TMP study.

A352 Determine Types of TMP

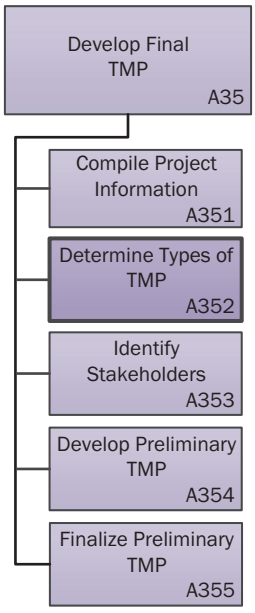


Figure A352. The second step in developing the final TMP is determining the types of TMP.

The objective of this activity is to determine the types of the TMP that will be pursued for the project among three choices (basic, intermediate, and major). A minor TMP should include a TTC plan and a major TMP should include TO and PI plans.

The three actions performed in this activity (Figure A352) are:

- **Determine the level of TMP implementation**—the level of potential traffic disruption caused by construction work being performed under lane closure situations. This action also involves determining whether the project is significant based upon an FHWA requirement on the new rule concerning motorists' mobility and safety. Lane closure policies, work procedures, and anticipated work zone impacts need to be reviewed.
- **Identify the type of TMP**—any existing barriers and potential obstacles that can affect work zone mobility and safety. The types of TMP that will be pursued are determined based on the compiled information.
- **Determine the main components of the identified TMP.**

Data Requirements and Information Needed to Initiate the Activity

- **Compiled traffic and construction information**—serves as the cornerstone to identify necessary components of the TMP to determine types of TMP.

Restrictions

- **Project requirement**—FHWA's requirements concerning work zone safety and mobility as well as states' requirements for work zone activities, depending on the complexity of the work or magnitude of anticipated traffic impacts.

- **TMP datasheet**—project programming generates a request for a TMP datasheet that includes information about a work description, and lists the work areas and traffic patterns and levels.
- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed.

Tools and Resources

- **PSP team**—cross-functional sub-team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Appendix A**—T12: Scheduling and Work Zone Impact Analysis.

Outcomes of This Action

- **Identified TMP:**
  - Basic TMP—available for projects with minimal anticipated impacts. It includes only the TTC plan.
  - Intermediate TMP—intended for projects that are anticipated to have more than minimal disruption but that have not been identified as a significant project. The TMP includes more detailed work zone impact analysis and management strategies than the basic TMP. It includes a TTC and TO plans.
  - Major TMP—intended for significant projects that impact road users, commercial enterprises, and communities. It should include TTC, TO, and PI plans.

A353 Identify Stakeholders

The objective of this activity is to identify major stakeholders of implementing work zone management strategies based on the project's selected TMP type and components.

The two actions performed in this activity (Figure A353) are:

- **Re-review the identified TMP components**—re-review the identified TMP components based on the level of project significance.
- **Identify major stakeholders for the TMP**—major stakeholders for implementing TMP work zone management strategies in order to streamline the implementation of the strategies among major project participants and vendors. In general, intermediate and major TMPs may need to include the following stakeholders: FHWA, public agencies, construction work zone enhanced enforcement agencies, railroad agencies, trucking associations, community groups, schools, emergency services, businesses, local public works, and technology implementation vendors.

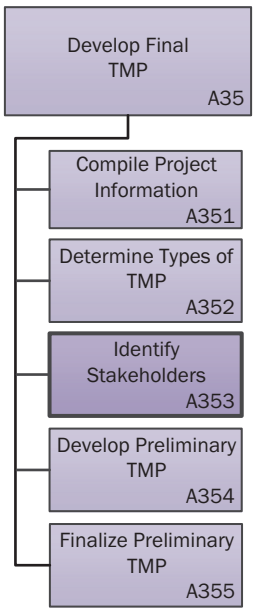


Figure A353. The third step in developing the final TMP is identifying stakeholders.

Data Requirements and Information Needed to Initiate the Activity

- **Identified type of TMP**—among three choices: basic TMP, intermediate TMP, and major TMP.

Restrictions

- **Project requirement**—FHWA's requirements concerning work zone safety and mobility as well as states' requirements for work zone activities, depending on the complexity of the work or magnitude of anticipated traffic impacts.
- **TMP datasheet**—project programming generates a request for a TMP datasheet that includes information about a work description, and lists the work areas and traffic patterns and levels.

Tools and Resources

- **PSP team**—cross-functional sub-team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.

Outcomes of This Action

- **Identified stakeholders for TMP**—important to streamline the implementation of work zone management strategies.

A354 Develop Preliminary TMP

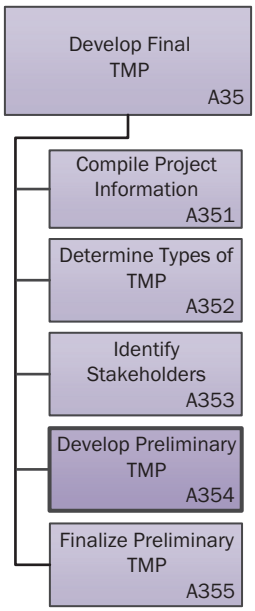


Figure A354. The fourth step in developing the final TMP is developing the preliminary TMP.

The objective of this activity is to develop a preliminary TMP that combines design and construction phasing with work zone management strategies.

The six actions performed in this activity (Figure A354) are:

- **Develop the TTC plan**—determine the limitations of operations during lane closures and thus to control traffic, based on applicable policies. This action designs the lane widths, number of lanes, and directions of travel; sets the work zone speed limits; sets types, locations, and spacing of traffic control devices.
- **Quantify impacts of the TTC plan to be implemented**—quantifies expected queue length and estimates costs of TTC plans.
- **Develop the TO plan**—the requirements that involve TTC during lane closures while coordinating with other projects and agencies. In general, TO plans include demand management, proposed project/network management, work zone safety management, incident management, and so on.
- **Quantify impacts of the TO plan to be implemented**—estimate traffic patterns and rates to determine anticipated work zone impacts while appropriately improving traffic operations on alternate routes and estimating the costs of the TO strategies.
- **Develop the PI plan**—determine the types of PI strategies to use (e.g., Internet-based information system and real-time travel information [e.g., AWIS]) by coordinating with stakeholders.
- **Quantify impacts of the PI plan to be implemented**—estimate traffic volumes that would be impacted by the project to meet the public needs while estimating the costs of the PIO strategies.

Data Requirements and Information Needed to Initiate the Activity

- **Identified stakeholders for TMP**—important to streamline the implementation of work zone management strategies.

Restrictions

- **Project requirement**—FHWA's requirements concerning work zone safety and mobility as well as states' requirements for work zone activities, depending on the complexity of the work or magnitude of anticipated traffic impacts.
- **TMP datasheet**—project programming generates a request for a TMP datasheet that includes information about a work description, and lists the work areas and traffic patterns and levels.
- **Applicable policies**—include lane closure policies in determining daily permitted lane closure times and maximum work zone queue lengths allowed.

Tools and Resources

- **PSP team**—cross-functional sub-team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Decision support tools**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures.
- **Macro-/micro-traffic simulations**—enables a more detailed traffic analysis, including potential work zone delay estimate, impact analysis on traffic diversion to the alternate routes, intersections that would be affected, and so on.
- **Appendix A**—T12: Scheduling and Work Zone Impact Analysis.

Outcomes of This Action

- **Developed work zone management strategies**—TTC, TO, and PI plans.

A355 Finalize Preliminary TMP

The objective of this activity is to re-review the preliminary TMP, revise it as necessary, and develop the final TMP that mirrors the results of quantitative analysis. Comments and opinions from subcommittees and task forces are reflected to ensure that all TMP requirements are addressed.

The two actions performed in this activity (Figure A355) are:

- **Identify and evaluate TTC, TO, and PI needs**—reflect comments and opinions from subcommittees and task forces about the developed work zone management strategies (i.e., TTC, TO, and PI plans) in order to ensure all the TMP requirements are met.
- **Finalize the preliminary TMP**—approval by agencies and thus initiates plans for comprehensive work zone management. This action prepares the baseline cost and schedule for the recommended alternative.

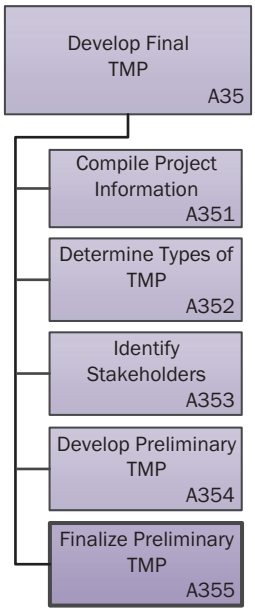


Figure A355. The fifth step in developing the final TMP is finalizing the preliminary TMP.

Data Requirements and Information Needed to Initiate the Activity

- **Developed work zone management strategies**—include appropriate TTC, TO, and PI Plans.

Restrictions

- **Project requirement**—FHWA's requirements concerning work zone safety and mobility as well as states' requirements for work zone activities, depending on the complexity of the work or magnitude of anticipated traffic impacts.
- **TMP datasheet**—project programming generates a request for a TMP datasheet that includes information about a work description, and lists the work areas and traffic patterns and levels.

Tools and Resources

- **PSP team**—cross-functional sub-team members based on the project's proposed TMP type and anticipated traffic impacts. In general, the divisions of design, project management, construction, and TO are involved.
- **Decision support tools**—like the FHWA-endorsed CA4PRS, decision support tools can help STAs develop sounder, more feasible TMP strategies by balancing schedule and cost while minimizing traffic inconvenience incurred by lane closures.

Outcomes of This Action

- **Approved plans for comprehensive work zone management**—coordinated and compiled document describing how proposed strategies work together to manage the work zone impacts.
- **Traffic control and construction staging**—recommended approach for the project.

A36 Prepare Baseline Cost and Schedule

Based on the information developed in the previous activities, the project team will determine preliminary work activities and establish the schedule baseline. Then, based on the available resources, the project budget is allocated across the scheduled activities and across time. Cost estimate is prepared based on the time-phased allocation of resources and baseline cost is established. The baseline is what cost and schedule performance is measured against.

The six major activities performed to prepare the baseline cost and schedule (Figure A36) are:

- **A361: Determine estimate basis for recommended alternative**—The objective of this activity is to collect and document all information required to prepare the estimate basis for the recommended alternative (activity A362).
- **A362: Prepare base estimate for recommended alternative**—The objective of this activity is to prepare the most likely cost estimate without contingency.
- **A363: Determine risk and set contingency for recommended alternative**—The objective of this activity is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate.
- **A364: Review estimate for recommended alternative**—The objective of this activity is to ensure that the estimate is as complete and accurate as possible, based on the project requirements.
- **A365: Approve estimate for recommended alternative**—The objective of this activity is to obtain district management acceptance and buy-in of the total project cost that will become

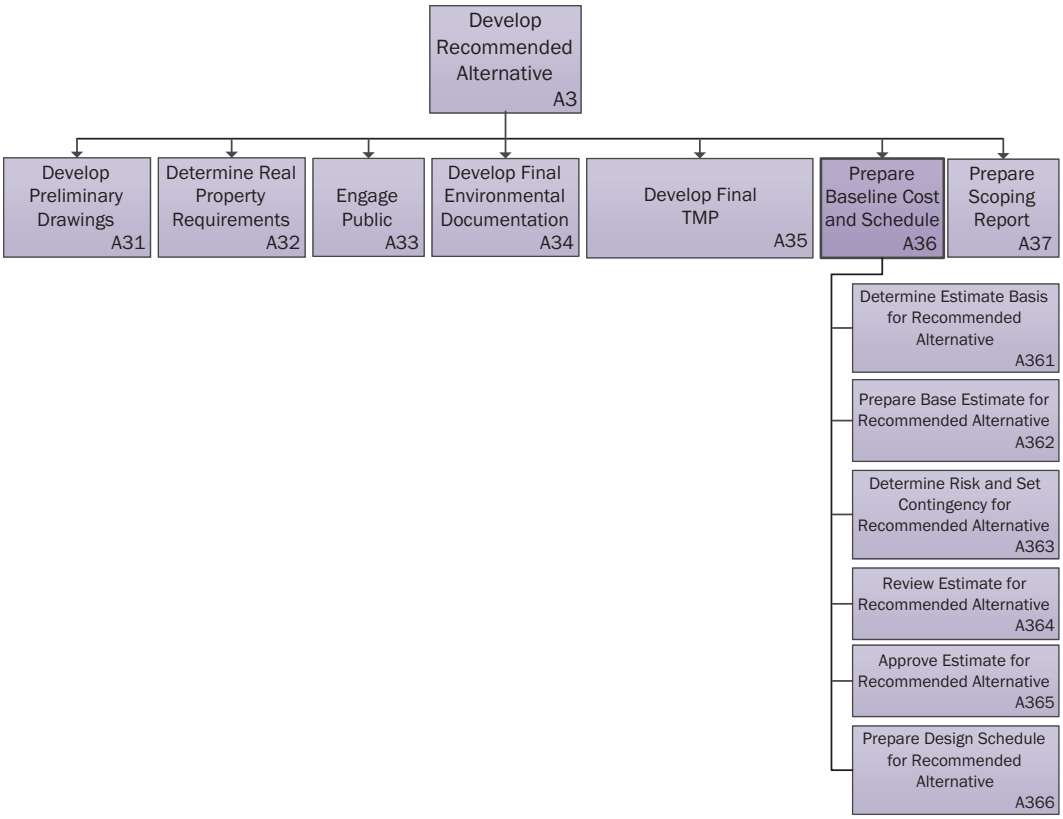


Figure A36. The sixth step in developing the recommended alternative is preparing the baseline cost and schedule.

the baseline for managing cost during design and before the estimate is released to both internal and external project stakeholders.

- **A366: Prepare design schedule for recommended alternative**—The objective of this activity is to prepare a baseline schedule, including high-level milestones, for the recommended alternative.

A361 Determine Estimate Basis for Recommended Alternative

The objective of this activity is to collect and document all information required to prepare the estimate basis for the recommended alternative (activity A362).

The four actions performed in this activity (Figure A361) are:

- **Review the project information**—review typical project requirements including project parameters (project boundaries such as length and width), preliminary drawings (plans, typical cross sections, and details), and narrative description of the key project work.
- **Review site characteristics**—include attributes of a project site that can significantly impact ROW, utility, environmental, and construction costs. Specific actions include reviewing video logs and/or aerial photographs to visualize the project and walking the project site.
- **Determine if clarification is needed**—confirm that the project definition is complete and, if necessary, obtain additional information regarding the project requirements.
- **Determine the scoping estimate basis**—begin the documentation trail that supports a project estimate. Documentation of project requirements is critical in preparing the base cost estimate and determining risks and setting contingency.

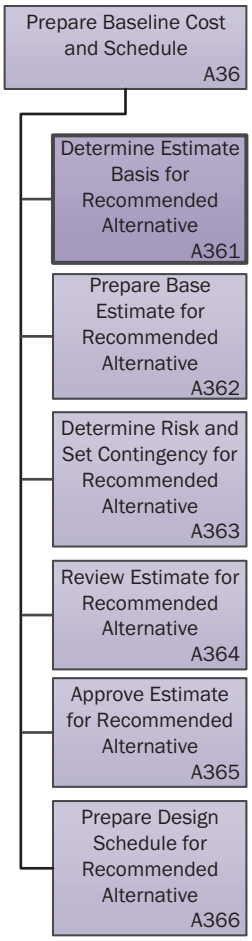


Figure A361. The first step in preparing the baseline cost and schedule is determining the estimate basis for the recommended alternative.

Data Requirements and Information Needed to Initiate the Activity

- **Preliminary drawings**—project requirements including EA, topographic surveys, metes and bounds survey, geotechnical investigations, hydrologic analysis, hydraulic analysis, utility engineering, traffic studies, and hazardous materials assessment (further provided in FHWA Order 6640.1A—FHWA Policy on Permissible Project Related Activities during the NEPA Process).
- **Preliminary relocation assistance needs**—compiled preliminary relocation assistance needs.
- **ROW map and real property descriptions**—compilation of internal data, real property descriptions (which include field notes and parcel plats), and other information related to the transportation project.
- **Approved environmental document and complete administrative record**—complete and final draft of the environmental document, environmental permits, and commitments for the proposed project.
- **NEPA requirements met**—a letter from the appropriate approving agency reviewer such as FHWA.
- **CE clearance, FONSI, or ROD.**
- **Approved plans for comprehensive work zone management**—coordinated and compiled document describing how proposed strategies work together to manage the work zone impacts.
- **Traffic control and construction staging**—recommended approach for the project.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team member responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Other disciplines**—inputs required on the project definition for design and other disciplines involved in the project based on the project's characteristics.

Outcomes of This Action

- **Location characteristics for recommended alternative**—comprehensive collection of all information about the project site and location including urban versus rural type, labor wage rates, potential environmental conditions that should be mitigated, ROW requirements, utility relocations requirements, and detour and haul routes requirements for the recommended alternative

- **Project scope for recommended alternative**—comprehensive collection of all information and data including scoping worksheets, schematics or other preliminary drawings, design criteria, and other specific project requirements organized in a systematic manner for easy review.

A362 Prepare Base Estimate for Recommended Alternative

The objective of this activity is to prepare the most likely cost estimate without contingency.

The six actions performed in this activity (Figure A362) are:

- **Select the appropriate approach**—it is the foundation for quality and accurate estimate. The estimator should be aware of the project definition, size, and complexity. The estimating approach/tool should be determined in conjunction with the unique characteristics of the project.
- **Quantify estimate elements**—categories and elements of the total project cost estimate are required to estimate all project costs. Once the elements are determined, the estimator determines the appropriate quantity measure and calculates quantities for each element dictated by the estimating tool. Calculations of quantities including assumptions should be documented in detail.
- **Develop estimate data**—determines the various cost data that are applied to elements and major items.
- **Calculate the cost estimate**—ensure that all work elements and major items are covered. The estimator inputs historical estimate data into the estimating system.
- **Document estimate assumptions**—assumptions behind the decisions that were used to estimate the project. Backup calculations and assumptions are critical to ensure consistency and are also used to justify any changes in the cost of the project.
- **Prepare the estimate package**—collating all details, summaries, and assumptions into a single document. The estimate package represents the total project cost without the contingency.

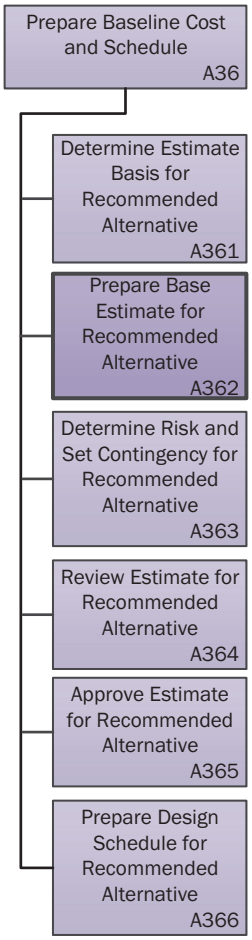


Figure A362. The second step in preparing the baseline cost and schedule is preparing base estimate for the recommended alternative.

Data Requirements and Information Needed to Initiate the Activity

- **Location characteristics for recommended alternative**—comprehensive collection of all information about the project site and location including urban versus rural type, labor wage rates, potential environmental conditions that should be mitigated, ROW requirements, utility relocations requirements, and detour and haul routes requirements for the recommended alternative.
- **Project scope for recommended alternative**—comprehensive collection of all information and data including scoping worksheets, preliminary drawings, design criteria, and other specific project requirements organized in a systematic manner for easy review.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based, bid-based, and historical percentage, while permitting ad hoc data entry if historical data are not present. Examples include the AASHTOWare Project Estimator software and TRACER.
- **Tools**—Appendix A: T03: Cost-Based Estimating; T04: Historical Bid-Based Estimating; and T05 Historical Percentage.

Outcomes of This Action

- **Project estimation file for recommended alternative**—all required information related to the base cost estimate, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, backup calculations, and cost basis for the estimate.
- **Base cost estimate package for recommended alternative**—project cost, without contingency, and all supporting information such as details, summaries, and assumptions collated into a single, logical volume in a way that is easy to understand and well organized for reviewers. Summary-level information is often prepared for later estimate reviews and management approvals. The estimate package should include updates in project definition, assumptions, quantity and price calculations, and supporting data.

A363 Determine Risk and Set Contingency for Recommended Alternative

All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management planning. The objective of this activity is to characterize the estimated uncertainty and develop a contingency amount to add to the base estimate to arrive at the total project cost estimate.

The six actions performed in this activity (Figure A363) are:

- **Review risk information**—estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate. This action views the estimating assumptions made by the project estimator and the design assumptions made by the discipline groups in the previous stages. After conducting a thorough review of the estimating and design assumptions, risk checklists and risk analyses from similar projects might be used as well.
- **Determine the level of risk analysis**—using estimate basis documents to determine the level of risk analysis based on project complexity. A project complexity evaluation categorizes the project as major, moderately complex, or minor. These three complexity ratings correlate to a Type I, Type II, and Type III level of risk analysis:
  - Type I risk analysis—risk identification and percentage contingency for minor projects (development of a list of risks and the use of a percentage of the project cost to estimate the contingency.)
  - Type II risk analysis—qualitative risk analysis and identified contingency items for moderately complex projects—including a risk register containing a Probability and Impact (P×I) matrix analysis to rank the risks.
  - Type III risk analysis—quantitative risk analysis and contingency management for major projects (risk analysis workshop and a stochastic estimate of cost and schedule).

- **Identify risks**—identify and categorize risks that could affect the project and document them. On minor, low-cost projects with little uncertainty (few risks), the risks can simply be kept as a list of red-flag items. On major projects that are by nature uncertain, the risks are entered into a rigorous analysis process and stochastic estimate that form the basis for risk monitoring and control throughout the process. Moderately complex projects can use a combination of these methods. Risk identification and risk assessment might be completed in a single step, and this process can be called risk assessment.
- **Estimate the contingency**—an appropriate contingency for the project using a list of risks, along with any historical information concerning cost growth. On minor projects employing a Type I risk analysis, contingency can be assigned through a simple percentage from historical data and the estimator's judgment. On major projects using a Type III risk analysis, contingency can be assigned through a stochastic model of cost and schedule using an external consultant to assist in building the model. Type II risk analyses can use a combination of percentages and probabilistic estimates to estimate the contingency.
- **Document the risk and contingency basis**—requires the estimator and project team to document a transparent list of risks and uncertainties. Maintenance of a risk register is a requirement for Type II and III documentation. It is also a good practice for Type I documentation. A formal risk management plan is a requirement for Type III documentation, but it is also good practice for Type II documentation.
- **Prepare the total project cost estimate**—require adding the base cost estimate and contingency estimate to arrive at a total project cost. Inflation is added to the estimate, in addition to any identified contingency. Inflation is applied to the sum of the base and contingency estimates for the overall project.

Data Requirements and Information Needed to Initiate the Activity

- **Project estimation file for recommended alternative**—all required information related to the base cost estimate, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, backup calculations, and cost basis for the estimate.
- **Base cost estimate package for recommended alternative**—project cost, without contingency, and all supporting information such as details, summaries, and assumptions collated into a single, logical volume in a way that is easy to understand and well organized for reviewers. Summary-level information is often prepared for later estimate reviews and management approvals. The estimate package should include updates in project definition, assumptions, quantity and price calculations, and supporting data.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).
- **Risk management procedure**—guidance on the approach to identify risks, quantify their impact on cost, and take actions to mitigate the impact of risks as the project scope is developed; and a tool available for risk management (*NCHRP Report 658: Guidebook on Risk Analysis Tools*

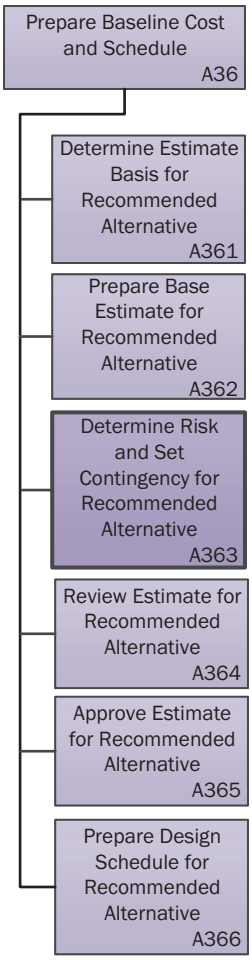


Figure A363. The third step in preparing the baseline cost and schedule is determining the risk and setting the contingency for the recommended alternative.

and Management Practices to Control Transportation Project Costs [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based and historical techniques, while permitting ad hoc data entry if historical data are not present. Examples include the AASHTOWare Project Estimator software and TRACER.
- **Risk analyst**—the PSP team member and/or an external consultant who creates a stochastic model of cost and schedule in complex projects.
- **Appendix A:** T06: Expert Interviews, T07: Risk Checklists, T08: Probability × Impact (P×I) Matrix, T09: Contingency Percentage, T10: Contingency Identified, and T11: Estimate Ranges—Monte Carlo Analysis.

Outcomes of This Action

- **Base estimate with contingencies for recommended alternative**—contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs. In the contingency estimate, include the greatest level of detail that the contingency estimate can support. For example, a Type I analysis using a percentage contingency may include only one item for contingency based on a percentage of the total project cost. A Type I contingency estimate cannot support separate contingency estimates for the categories in the total project cost estimate summary. A Type II or III analysis may support contingency for various categories of the total project cost estimate calculations (e.g., separate contingencies for ROW, utilities, etc.).
- **Project risk management plan for recommended alternative**—the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking. A risk register should provide a detailed description of the risks, their probability of occurrence, their impact if they occur, the strategies to manage the risks, an assignment of ownership for the risks, and a schedule for risk resolution.

A364 Review Estimate for Recommended Alternative

The objective of this activity is to ensure that the estimate is as complete and accurate as possible, based on the project requirements.

The four actions performed in this activity (Figure A364) are:

- **Determine the level of review**—perform a careful review of the project details and use the appropriate tools for review. The level of review correlates directly to the project complexity definitions determined in the previous activity (A363). Based on the level of complexity, estimate checklists, in-house peer review, round table estimate reviews, formal committees, or expert teams might be employed. The review plan containing a schedule for the review and a listing of people who will participate needs to be prepared as well.

- **Review estimate assumptions**—require a review of the estimate assumptions and list of risks identified in the previous activity (A363) in order to determine if the necessary assumptions and conclusions were made about the project.
- **Verify completeness and cost data**—review the base estimate with contingencies for the recommended alternative using the applicable tools to determine if the data are complete and correct. The output of this step should result in a confirmation of the completeness of the data and a verified estimate.
- **Reconcile with the latest estimate**—review of the current estimate and the previous estimate in order to attempt to reconcile the differences between the two. In addition to looking at key differences in cost, it should be determined why these differences exist.

Data Requirements and Information Needed to Initiate the Activity

- **Base estimate with contingencies for recommended alternative**—contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs. In the contingency estimate, include the greatest level of detail that the contingency estimate can support. For example, a Type I analysis using a percentage contingency may include only one item for contingency based on a percentage of the total project cost. A Type I contingency estimate cannot support separate contingency estimates for the categories in the total project cost estimate summary. A Type II or III analysis may support contingency for various categories of the total project cost estimate calculations (e.g., separate contingencies for ROW, utilities, etc.).
- **Project risk management plan for recommended alternative**—the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking. A risk register should provide a detailed description of the risks, their probability of occurrence, their impact if they occur, the strategies to manage the risks, an assignment of ownership for the risks, and a schedule for risk resolution.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate, including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost estimators**—the PSP team members responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Cost-estimating program**—PC-based or web-based cost estimation system that automates estimation data gathering, provides the ability to manage large datasets, and supports estimation via cost-based and historical techniques, while permitting ad hoc data entry if historical data are not present. Examples include the AASHTOWare Project Estimator software and TRACER.

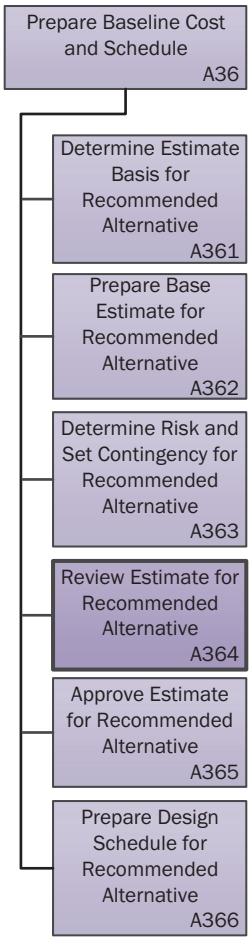


Figure A364. The fourth step in preparing the baseline cost and schedule is reviewing the estimate for the recommended alternative.

- **Other disciplines PSP team members**—representing other disciplines like design, ROW, TO, environmental, construction, etc.

Outcomes of This Action

- **Final cost estimate package for recommended alternative**—containing the summary of scope, including key scope items, major cost elements, risk items, base cost (summary and details) and contingency, all supporting documentation related to estimate basis, assumptions, risks, and backup calculations.

A365 Approve Estimate for Recommended Alternative

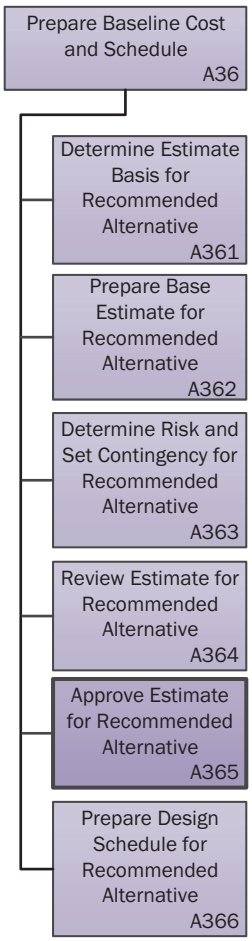


Figure A365. The fifth step in preparing the baseline cost and schedule is approving the estimate for the recommended alternative.

The objective of this activity is to obtain district management acceptance and buy-in of the total project cost that will become the baseline for managing cost during design and before the estimate is released to both internal and external project stakeholders.

The two actions performed in this activity (Figure A365) are:

- **Prepare the estimate package**—review the total project cost estimate, the project assumptions, and the estimate changes to prepare a final estimate package that is ready for approval. The final package should provide management with enough detail to understand the project yet provide a high-level picture. All project specifics should be written such that anyone who is not familiar with the project may still have a good understanding of the following:
  - What are the purpose and need of the project?
  - What does the design entail?
  - What are the associated costs?
  - What are the risks?
- **Approve the estimate package**—provide the final estimate package for approval. Approval is performed by a member of district management or someone with the authority to do so prior to conveying any of this information to external sources.

Data Requirements and Information Needed to Initiate the Activity

- **Final cost estimate package for recommended alternative**—containing the summary of scope, including key scope items, major cost elements, risk items, base cost (summary and details) and contingency, all supporting documentation related to the estimate basis, assumptions, risks, and backup calculations and contingency.

Restrictions

- **Cost-estimating procedures**—guidance on the approach to preparing the cost estimate including activities to be performed and tools available for estimating (*AASHTO Practical Guide to Cost Estimating* and *NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf], and *NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management* [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf]).

Tools and Resources

- **Cost Estimators**—the staff responsible for compiling all components of the cost estimate and preparing portions of the cost estimate.
- **Management**—district engineer and project development/delivery manager.

Outcomes of This Action

- **Approved Cost Estimate Package for Recommended Alternative**—approval that the estimate was completed using the appropriate procedure, tools, and knowledge, and approval of the estimate amount.

A366 Prepare Design Schedule for Recommended Alternative

The objective of this activity is to prepare a baseline schedule, including high-level milestones, for the recommended alternative.

The four actions performed in this activity (Figure A366) are:

- **Review project information and baseline cost estimate**—review typical project requirements including project parameters (project boundaries such as length and width), preliminary drawings (plans, typical cross sections, and details), and narrative description of the key project work and baseline cost estimate.
- **Identifying, defining, and sequencing activities related to the work breakdown structure**—identify the major activities related to the work breakdown structure required to complete the project and define them at a detailed level. The baseline project estimates can be used for this purpose. These activities are also logically sequenced to support, manage, and control the project.
- **Determining activities' duration**—determine the activities' duration based on the amount of work involved in each activity, the number and availability of resources, and, when appropriate, historical information.
- **Identifying milestones**—project milestones related to baseline control levels.

Data Requirements and Information Needed to Initiate the Activity

- **Approved cost estimate for recommended alternative**—final cost estimate package. This should also include the quantities for defined elements and major items.
- **Available resources**—the details of resources available for executing the project activities.

Restrictions

- **Scheduling procedures**—guidance on the approach to preparing the estimate baseline schedule including activities to be performed and tools available for estimating.

Tools and Resources

- **Scheduling engineer**—the PSP team member responsible for preparing the project schedule.
- **MS project/primavera**—the tools to be used for preparing the project schedule.

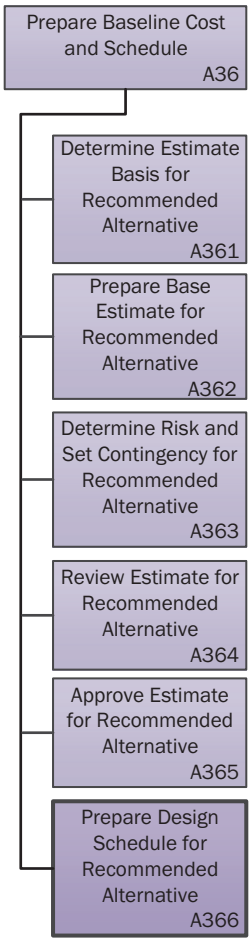


Figure A366. The sixth step in preparing the baseline cost and schedule is preparing the design schedule for the recommended alternative.

Outcomes of This Action

- **Baseline scope, cost estimate, and schedule for recommended alternative along with supporting documents and information organized and documented**—including basis, assumptions, exclusions, methodology, references, etc.

A37 Prepare Scoping Report

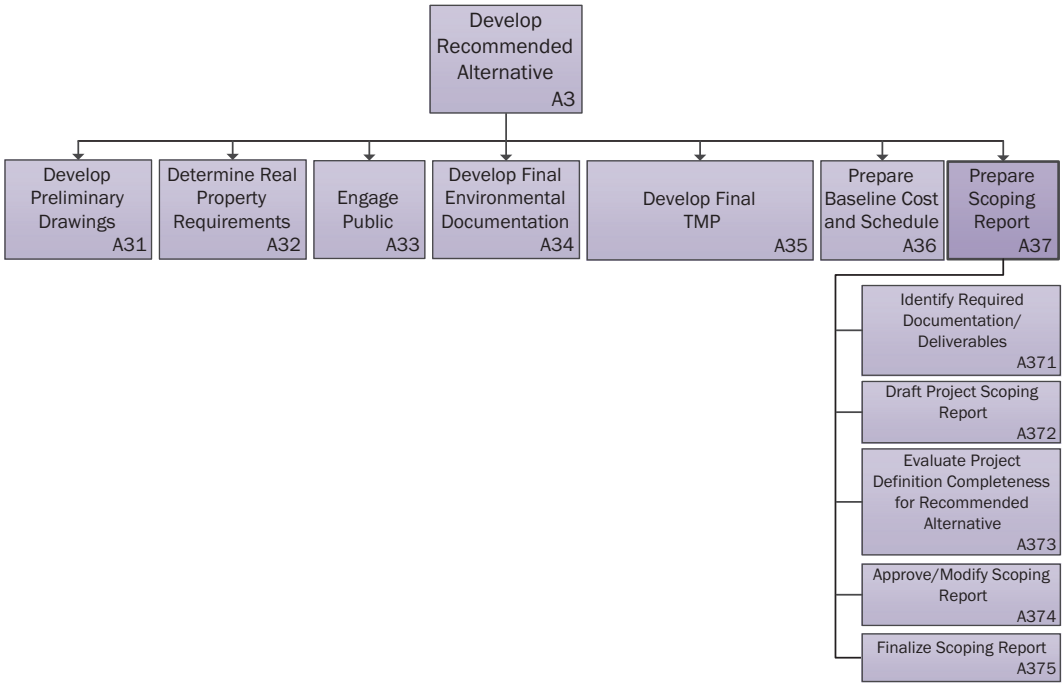


Figure A37. The seventh step in developing the recommended alternative is preparing the scoping report.

The scoping report should provide documentation of the need for the project and disclose information about alternatives and impacts. More specifically, the scoping report should explain where the project is located, why the project is needed, what the objectives and purposes of the project are, and what alternatives were considered. Environmental, ROW, and utility impact reviews are an important part of the project scoping report. Finally, the project cost and schedule baseline, as well as traffic, safety, and maintenance operations, should be included in the report.

The five major activities performed to prepare the scoping report (Figure A37) are:

- **A371: Identify required documentation/deliverables**—The objective of this activity is to identify the documentation and deliverables that are required to be included in the draft project scoping report.
- **A372: Draft project scoping report**—The objective of this activity is to draft a project scoping report in the format required by the transportation agency for final approval of the project scope.
- **A373: Evaluate project definition completeness for recommended alternative**—The objective of this activity is to evaluate project definition completeness for final scope approval.

- **A374: Approve/modify scoping report**—The objective of this activity is for the project development director to approve the scoping report or make suggestions on how to modify the scoping report for final scoping approval.
- **A375: Finalize scoping report**—The objective of this activity is to update the scoping report according to comments from the project development director and finalize the report to be used as a basis for detailed design.

A371 Identify Required Documentation/Deliverables

The objective of this activity is to identify the documentation and deliverables that are required to be included in the draft project scoping report.

The action to be performed in this activity (Figure A371) is:

- **Refer to Federal and State Regulations and the STA's Guidelines**—for preparing the project scoping report to identify the required documentation/deliverables. This would include the identification of report formatting requirements, including the detailed information that is required to be included in the scoping report. While formats will vary from state to state, at a minimum the report should have a purpose and need description, project idventifiers, available data description, funding identification, key stakeholder contact information, budgets, schedules, ROW and utility issues, and attachments as appropriate including alignments, photographs, and any required checklists.

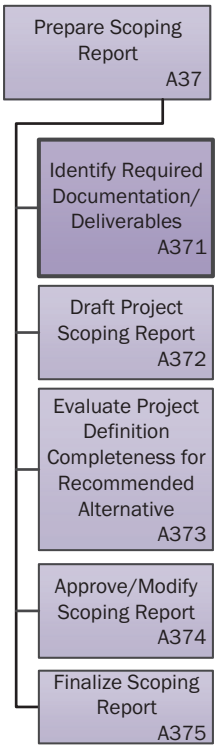


Figure A371. The first step in preparing the scoping report is identifying the required documentation/ deliverables.

Data Requirements and Information Needed to Initiate the Activity

- **Regulations**—federal and state regulations on how to prepare a project scoping report.
- **Project development process manual**—procedure for preparing a project scoping report.

Restrictions

- **Project development process manual**—procedure for preparing a project scoping report.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **Project PSP team**—the team of personnel assigned to be in charge of project scoping.
- **Scoping report templates**—templates for final scoping reports.
- **Scoping worksheet**—scoping worksheets or checklists to ensure all issues that need to be addressed during project scoping are addressed.

Outcomes of This Action

- **Identified documentation and deliverables**—including:
  - Preferred alternative including preliminary drawings and other design criteria.
  - Budget.

- Schedule.
- Environmental documentation.
- ROW requirements.
- Utility requirements.
- Public involvement documentation.

A372 Draft Project Scoping Report

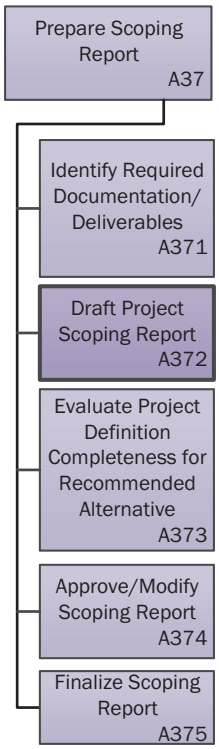


Figure A372. The second step in preparing the scoping report is drafting the project scoping report.

The objective of this activity is to draft a project scoping report in the format required by the transportation agency for final approval of the project scope.

The four actions to be performed in this activity (Figure A372) are:

- **Gather the required report information**—obtained by previous scoping activities and arrange them in the format of the scoping report. A scoping report template for the specific STA may be available in an electronic word processor template.
- **Assign report sections to project team members**—team members should be assigned report sections based on their areas of expertise. In addition to section assignment, one team member should be identified as responsible for assembling the draft sections into a single document. Section due dates should be clearly identified and timed so that the final report will be complete at the required time.
- **Draft report sections**—the assigned sections are drafted by each team member using the required format. Once completed, the draft sections are electronically sent to the person assembling the draft report by the specified due date.
- **Assemble draft sections to create comprehensive report**—the draft sections are assembled into a scoping report. This document should be seamless and edited for grammar and consistent language throughout.

Data Requirements and Information Needed to Initiate the Activity

- **Documentation from previous scoping activities**—may include an analysis report (environmental analysis, traffic analysis, benefit-cost analysis, etc.), project definition documentation, scoping worksheets, scoping checklists, and others.
- **Identified reporting requirements**—output from activity A371.

Restrictions

- **Project development process manual**—procedure for preparing a project scoping report.
- **Budget and time for scoping**—cost and schedule restraints for developing scoping documents.
- **Federal and state regulations.**

Tools and Resources

- **Project PSP team**—the team of personnel assigned to be in charge of project scoping.
- **Scoping report templates**—Some STAs may have developed templates for final scoping reports.

- **Scoping worksheet**—scoping worksheets or checklists to ensure all issues that need to be addressed during project scoping are addressed.
- **Appendix A**—T15: Scoping Worksheets/Scoping Checklists and T16: Scoping Report Templates.

Outcomes of This Action

- **Draft project scoping report**—a draft report in the appropriate format to be submitted to higher management for approval.

A373 Evaluate Project Definition Completeness for Recommended Alternative

The objective of this activity is to evaluate project definition completeness for final scope approval.

The action to be performed in this activity (Figure A373) is:

- **Evaluate project definition completeness**—this key action is used to identify any deficiencies in the project's scoping that may lead to problems during the design or construction phase. Tools such as the Construction Industry Institute's Project Definition Rating Index for Infrastructure or TxDOT's Advanced Planning Risk Analysis tool may be helpful in rating the project's level of scoping definition. STAs may have specific tools required for scoping rating and should be employed as appropriate. One critical component of this step is identifying which project team members (PSPs) will evaluate the project as industry research has demonstrated that multiple scoping evaluations tend to more accurately measure scoping completeness as opposed to a single evaluation.

Data Requirements and Information Needed to Initiate the Activity

- **Draft project scoping report**—output from activity A372.

Restrictions

- **Procedure manual for alternative selection.**
- **Schedule restraints for developing the document.**
- **Cost restraints for developing the document.**
- **Federal and state regulations.**

Tools and Resources

- **Project PSP team**—the team of personnel assigned to be in charge of project scoping.
- **Appendix A**—T14: Project Scope/Definition Completeness Evaluation Tools—TxDOT CII's PDRI for Infrastructure, a comprehensive assessment tool for measuring the completeness of project definition specially designed for infrastructure projects.

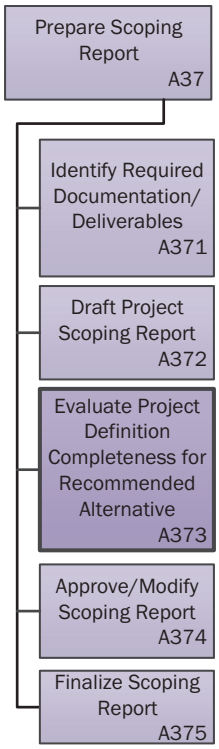


Figure A373. The third step in preparing the scoping report is evaluating the project definition completeness for the recommended alternative.

Outcomes of This Action

- **A project definition completeness index score (by the end of the scoping process).**

A374 Approve/Modify Scoping Report

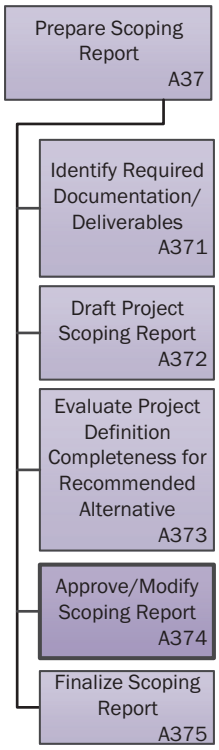


Figure A374. The fourth step in preparing the scoping report is approving/ modifying the scoping report.

The objective of this activity is for the project development director to approve the scoping report or make suggestions on how to modify the scoping report for final scoping approval.

The three actions to be performed in this activity (Figure A374) are:

- **The project development director assesses the project scope and the quality of the scoping report**—the project development director reviews the project scoping report and the scoping evaluation score to determine the adequacy of the current project scope.
- **The project development director approves the scoping report or makes recommendations on how to modify the report**—the project development director makes a decision regarding the adequacy of the project scoping definition. This decision should be based on the entire scoping report with an eye toward the specific project requirements and not simply on the scoping definition score assigned in the report. Specific deficiencies should be clearly identified to aid the project team in addressing the identified issues.
- **The project team modifies the scoping report and re-submits it for approval**—depending on the amount of modifications required the revisions may be performed by a single portion or the entire project team.

Data Requirements and Information Needed to Initiate the Activity

- **Draft project scoping report**—output from activity A372.
- **Project definition completeness scores**—output from activity A373.
- **Project development director's comments on scoping report.**

Restrictions

- **Procedure manual for alternative selection.**
- **Schedule restraints for developing the document.**
- **Cost restraints for developing the document.**
- **Federal and state regulations.**

Tools and Resources

- **Project PSP team**—the team of personnel assigned to be in charge of project scoping.
- **Project development/deliver manager**—someone who has the authority to approve the scoping report or make recommendations.
- **Appendix A**—T15: Scoping Worksheets/Scoping Checklists.

Outcomes of This Action

- **Decision or comments on scoping report**—the scoping report may be final or need modification.

A375 Finalize Scoping Report

The objective of this activity is to update the scoping report according to comments from the project development director and finalize the report to be used as a basis for detailed design.

The three actions to be performed in this activity (Figure A375) are:

- **The project team updates the scoping report and the project definition completeness index**—based on the detailed comments of the project development director, the project team repeats steps A372 and A373 to improve the scoping report and the level of scope definition.
- **The project team re-submits the report to the project development director for approval**—to aid the project develop director in re-reviewing the report, the changes made to the scoping report should be clearly identified. This could include the use of Microsoft Word's "Track Changes" feature (or similar) or the use of a separate document that clearly identifies changes to the scoping document and evaluation. This process is repeated until the project development director can approve the final scoping report.
- **The project development director approves the final project scoping report**—once the report is completed it is distributed to the required individuals to initial the detailed design phase. This specific list of people will vary among STAs but at a minimum should include the design manager, the project portfolio manager, and any design consultants retained for the project.

Data Requirements and Information Needed to Initiate the Activity

- **Updated project scoping report and updated project definition completeness scores**—after activity A374, the PSP team may need to revise the scoping report and complete the PDRI once more to obtain an updated project definition completeness score.
- **Project development director's comments on scoping report.**

Restrictions

- **State transportation agency's scoping manual.**
- **Schedule restraints for developing the document.**
- **Cost restraints for developing the document.**
- **Federal and state regulations.**

Tools and Resources

- **Project PSP team**—the team of personnel assigned to be in charge of project scoping.
- **Project development/delivery manager**—someone who has the authority to approve the scoping report or make recommendations.
- **Appendix A**—T15: Scoping Worksheets/Scoping Checklists and T16: Scoping Report Templates.

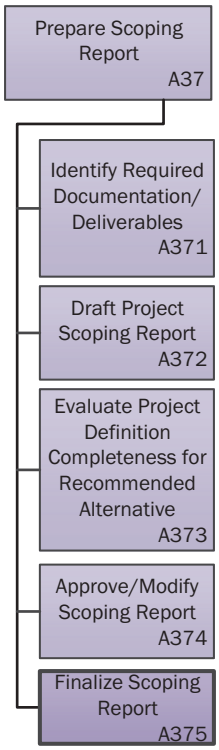


Figure A375. The fifth step in preparing the scoping report is finalizing the scoping report.

Outcomes of This Action

- **Approved final project scoping report**—including the following in finalized form:
  - Preferred alternative including preliminary drawings and other design criteria.
  - Budget.
  - Schedule.
  - Environmental documentation.
  - ROW requirements.
  - Utility requirements.
  - Public involvement documentation.
  - Project narrative.

APPENDIX A

PSP Tools and Techniques

Introduction

This research identified a number of tools that can be used while performing different activities in the PSP. Many of these tools are different techniques that have been developed in other related research. The purpose of this appendix is to summarize key tools used in the PSP.

The structure used for describing a tool is divided in the followings parts:

1. **What is it?**—provides an introduction to the tool.
2. **When to use it?**—links the tool to the activities(s) of the PSP.
3. **Why use it?**—describes the purpose and advantages of using the tool in the PSP.
4. **What does it do?**—explains the set parameter that can be achieved by using the tool.
5. **How to use it?**—describes the procedure or steps to be followed when using the tool in the PSP.
6. **Example**—provides a reference to similar tools or procedures adopted in other related research.
7. **Tips**—provides tips to improve the outcomes of using the tool.

The tools are developed to support the Level 4 activities. A tool applicability matrix is shown in Table 3. The users of this guidebook should use this matrix to identify the tool(s) to perform the corresponding activity.

T01: Cost/Parameter Using Similar Projects

What Is It?

During the early stages of a project's development process, a project has a limited scope definition concerning how a transportation need should be addressed. Often the current need is similar to a recently programmed, designed, or completed project such that a recent project can serve as a relative cost basis for estimating the future program area (a project or group of projects).

This tool uses the cost of one or more similar projects, which have a known cost and definition, to develop the estimate. The similar project's cost is converted into some reasonable cost parameter, such as dollars per centerline mile or dollars per square foot of deck area. This cost parameter is then used with an order of magnitude quantity parameter derived from the project being estimated, such as the number of centerline miles, to provide a basis for approximating the total cost of the facility.

When to Use It?

This tool is used for preparing conceptual estimates during the planning phase of project development. This tool is used in performing the activity—A152: Prepare Base Conceptual Estimate.

Table 3. Tools applicability matrix.

Tools #	Description	Use for Level—4
T01:	Cost/Parameter Using Similar Projects	A152
T02:	Cost/Parameter Using Typical Sections	A152
T03:	Cost-Based Estimating	A272, A362
T04:	Historical Bid-Based Estimating	A272, A362
T05:	Historical Percentage	A152, A272, A362
T06:	Expert Interviews	A273, A363
T07:	Risk Checklists	A153, A273, A363
T08:	Probability × Impact (P×I) Matrix	A273, A363
T09:	Contingency Percentage	A153, A363
T10:	Contingency Identified	A273, A363
T11:	Estimate Ranges—Monte Carlo Analysis	A273, A363
T12:	Scheduling and Work Zone Impact Analysis	A263, A352, A354
T13:	Project Purpose and Need Statement	A111, A112, A16, A142
T14:	Project Scope/Definition Completeness Evaluation Tools (TxDOT APRA)	A284, A373
T15	Scoping Worksheets/Scoping Checklists	A111-A113, A16, A372, A374, A375
T16	Scoping Report Templates	A372, A374, A375

Why Use It?

The purpose of this tool is to rapidly assess the approximate costs for addressing a transportation need based on limited design information.

What Does It Do?

This tool provides an easy way to quickly approximate the conceptual cost of a potential transportation program. The concept is based on identifying an existing project that is *almost identical* in scope to the project that is being estimated. The tool relies on historical cost data, which are modified to fit any differences in definition, location, and other project characteristics that might exist between the previous and the new project. The time of the reference project is important because cost data from the reference project may require adjustment for inflation.

How to Use It?

The agency retains cost data from previously completed projects. When the agency needs a conceptual estimate for an early approximation of a transportation project, the estimator collects the cost data from similar completed project(s). The estimator must review the previous project(s) and cost data to determine the best way of relating the costs of the past project(s) to the new one. Usually, this is performed using the lane mile method or by using the square foot of deck area for certain items such as bridges. The estimator should consider the size of the project, location, and definition of the work.

Sometimes data from more than one previous project are used to estimate the new project. For example, one highway project may be built in a similar location, such as an urban area, but not have any bridges, whereas another project may have similar bridges but be built in a rural area.

All of the data from the past projects must be inflated to current-day dollars before any cost values are calculated for the new project. After the inflation adjustment, the cost per lane mile or square foot of deck area of the past project(s) can be applied to the new project.

In summary, the typical steps for developing this type of estimate are:

1. Define key parameters used for the basis estimate (e.g., centerline miles or bridge deck area).
2. Calculate the total quantity of parameters (e.g., lane miles for the project based on proposed limits).
3. Find similar project(s) and cost history.
4. Adjust the cost history to current-day dollars.
5. Calculate the cost per parameter for the past project (e.g., lane mile).
6. Apply the historical cost per parameter (e.g., lane mile) to the current project quantity parameters.
7. Adjust the cost history for the current project definition, conditions, and characteristics.

Example

See the AASHTO *Practical Guide to Cost Estimating,* Chapter 2: "Conceptual Estimating."

For cost inflation, refer to the National Highway Construction Cost Index at http://www.fhwa.dot.gov/policyinformation/nhcci/pt1.cfm

Tips

Applying this tool requires the user to match basic project definition elements to projects that are deemed similar in definition to the transportation program or project being estimated. The user must ensure that all elements are covered in relation to the similar project. If there is not a perfect match, the user should make appropriate adjustments in cost. For example, if the similar project has fewer structures than the transportation need being estimated, the user should make an appropriate adjustment in the cost estimate to account for fewer structures. Location differences may also be present and must be accounted for when using costs of similar projects.

This tool is useful for developing quick estimates for a program or project, *provided the level of project definition similarity is very high.* The cost of the similar project should include all elements including engineering costs, ROW, utility adjustments, construction engineering, and construction. If one of these elements is not in the scope of the new transportation need, then the cost for this element must be deleted. Alternatively, the cost for elements could be added to adjust for differences between a similar past project and a new transportation need. Contingencies should be included as a separate element to cover uncertainties related to project definition and the cost-estimating technique used. The user can use simple spreadsheets to summarize cost estimate elements when using this tool.

T02: Cost/Parameter Using Typical Sections

What Is It?

Due to limited project definition during the early project development process, a proposed facility is often described in terms of a parameter, such as centerline miles of roadway improvement, additional lanes, the type of construction (new or reconstruction), or the number of

bridges. For example, types of typical pavement sections are used as the basis for estimating pavement construction cost for a given or standard pavement length and thickness and for a typical shoulder width.

Historical cost data are provided in terms of cost factors (e.g., dollars per centerline mile) and percentages for certain scope categories. The costs per parameter are often built using specific items from historical bid data. Historical data may reflect average costs and are not necessarily specific to any one area within a state. However, data can be used for a specific district to provide a location-specific cost parameter.

This tool uses typical sections/components representing common types of facilities and historical cost data to derive key cost parameters. These cost parameters, such as dollars per centerline mile or dollars per square foot of deck area, are used with gross quantities to provide a basis for approximating the partial cost of the facility.

When to Use It?

This tool is used for preparing a transportation program (project) conceptual estimate during the planning phase of program (project) development. This tool is used in performing the activity—A152: Prepare Base Conceptual Estimate.

Why Use It?

The purpose of this tool is to develop approximate total project costs for a transportation need or needs so that estimates of funds required for long-range plans can be determined.

What Does It Do?

This tool is easy to use and provides a quick approximation of the conceptual cost for addressing a transportation need or correcting a deficiency. The concept is based on identifying those cost elements that are likely to be a substantial portion of a project's total cost. The tool relies on historical bid data for developing standardized or typical configurations that represent types of transportation facilities.

How to Use It?

Applying this tool requires the estimator to match basic definition elements to typical configurations and/or sections representing different types of transportation need solutions. The user must also ensure that all scope items are covered and that the database provides sufficient information to estimate all pertinent elements or typical items that comprise an element for the proposed solution, such as a pavement section, ROW, engineering, and utility relocation. Cost adjustments may also be necessary when the definition of a current project is different than that of the past project. Other cost adjustments may be necessary for existing project conditions and characteristics.

Since agencies generally do not have a published cost per parameter based on typical sections, the estimator can develop these data for a specific application. Typically steps are:

1. Create a typical section for an element over a common parameter (e.g., a 1-mile pavement section including the structure, sub-grade materials, etc.).
2. Identify typical item costs that reflect the items that make up the element.
3. Find historic cost data for the items.
4. Develop quantities for the standard section and apply the item cost data.
5. Summarize the cost for the total parameter (e.g., lane mile).

6. Calculate the parameter quantity for the current project.
7. Apply the cost per parameter factor to the current quantity.

Example

See the AASHTO *Practical Guide to Cost Estimating,* Chapter 2: "Conceptual Estimating."

For cost inflation, refer to the National Highway Construction Cost Index at http://www.fhwa.dot.gov/policyinformation/nhcci/pt1.cfm

Tips

Applying this tool requires the estimator to match basic items to typical configurations and/or sections representing different types of transportation need solutions. The estimator must also ensure that all project definition elements are covered and that the database provides sufficient information to estimate all pertinent elements for the proposed solution. The estimate must cover all categories of total project costs that apply, such as ROW, engineering, and utility relocation. Cost adjustments may also be necessary when the project definition is different from that used to make the estimate or when unique conditions exist. The user can use simple spreadsheets to make calculations and summarize cost estimate elements.

T03: Cost-Based Estimating

What Is It?

Cost-based estimating is a tool to compute the unit cost for items of work based on estimating the cost of each component to complete the work and then adding a reasonable amount for a contractor's overhead and profit. A schedule of items and their quantities is required to use this tool. These quantities can then be used to estimate costs for such construction components as labor, materials, and equipment in order to arrive at a realistic unit cost for an item.

When to Use It?

This tool is used for developing cost estimates while performing activity A36: Prepare Baseline Cost and Schedule.

Why Use It?

The unique character of projects, geographical influences, and market factors, as well as the volatility of material prices, often make historical pricing an unreliable method of estimating project costs. Cost-based estimating may provide more accurate and defendable costs to support the development of the baseline cost estimate and further support the decision for contract award/rejection during the letting phase. While preparing the baseline cost estimate during A272: Prepare Base Estimate for Alternatives and A362: Prepare Base Estimate for Recommended Alternative, work items are so well defined that the construction operations involved with a work item can be visualized to support the development of cost-based estimates.

What Does It Do?

Cost-based estimates contain six basic elements: time, equipment, labor, material, overhead, and profit. Generally, a work statement and set of drawings or specifications are used to determine material quantities required for each discrete task performed in accomplishing a

given construction operation. From these quantities, direct labor, materials, and equipment are derived. Contractor overhead and profit are then added. The total cost divided by the quantity gives the unit price for the work item.

How to Use It?

Using cost-based estimating begins with identifying the source of cost data. Several STAs maintain previous project cost data. For example, the Minnesota DOT has templates or catalogs loaded in the cost estimating system (CES) software, and tables are available to estimate production rates and equipment requirements for items.

Example

See the AASHTO *Practical Guide to Cost Estimating,* Chapter 4: "Cost-Based Estimates."

For cost inflation, refer to the National Highway Construction Cost Index at http://www.fhwa.dot.gov/policyinformation/nhcci/pt1.cfm

Tips

The estimator needs to locate sources of information related to production rates and crews for line items estimated using this approach. This may require contacting local contractors or using a database such as RS Means Heavy Construction Cost Data.

The estimator has to call suppliers of materials to obtain unit costs for materials and similar resources for determining equipment production and rental rates. The estimator should have construction experience so a line item can be visualized in terms of the operations needed to construct the work.

T04: Historical Bid-Based Estimating

What Is It?

Historical bid-based estimating is used for certain items that are not critical items in terms of cost. This approach relies heavily on good historical bid data for estimating item cost. The historical data normally are based on bids from recent projects. Under this approach, bid data are summarized and adjusted for project conditions (e.g., project location, size, and quantities) and general market conditions. This approach requires the least amount of time and personnel to develop the estimate and produces a good estimate, as long as noncompetitive bid prices are excluded from the database and appropriately adjusted data are used to build the estimate.

When to Use It?

This tool is used for developing cost estimates while performing the activities—A272: Prepare Base Estimate for Alternatives and A362: Prepare Estimate Basis for Recommended Alternative.

Why Use It?

Historical bid-based estimating is typically the most efficient method for developing an estimate for items when adequate historical pricing data are available. Implementing a bid-history-based estimating process enables STAs to estimate the cost of proposed work using a minimum

of resources. Similar projects with similar line items, quantities, and locations can generally be estimated quickly using historical bid data from previous projects and engineering judgment.

A bid history is essential for analysis of contract bids. Maintaining a strong bid history can discourage undesirable bidding practices. A bid history is also valuable for use in evaluating contractor-proposed changes, such as value engineering/analysis proposals.

What Does It Do?

This method uses data from recently bid contracts as a basis for the unit prices on the project being estimated. Data from previous projects are typically stored in a bid tabulation database for three to five years to provide the historical data to the estimator. The more data that are available and organized by project type, size, and location, the better resource the estimator has to produce an estimate that reflects the known scope and site conditions of the new project. Unit prices are adjusted for the specific project conditions in comparison to the previous projects. Adjustments are generally made based on the project location, project size, project risks, quantities, general market conditions, and other factors. The estimator has to rely on engineering judgment and experience to make these adjustments.

Example

See the AASHTO *Practical Guide to Cost Estimating,* Chapter 3: "Bid-Based Estimates."

For cost inflation, refer to the National Highway Construction Cost Index at http://www.fhwa.dot.gov/policyinformation/nhcci/pt1.cfm

How to Use It?

The process of historical bid-based estimation starts with the identification of the elements/items of historical bid cost data that can be calculated using this approach. The database is scanned to find a project with similar data as required for the current project. The bid data, unit price data, and other relevant information are then studied, analyzed, and related to the unit prices of the current project by considering the characteristics of the project. Feasible unit rates are selected and applied to the current project to calculate the cost estimate. A spreadsheet can be used to calculate the cost estimate and to apply the cost inflation factors. The local, political, regional, and material factors are considered and applied to the estimate of the project. At the end, a final check is given to the estimate, and extra costs are added to the estimated values. Some of the advantages of using this method are that it uses minimum resources, is an easy and efficient method, and quickly prepares estimates. The disadvantages include the maintenance and update of a database to support the estimates, and that details for new and unique items are not available in the database.

Tips

Several historical databases are available that provide current values for estimating the costs of the various units of work for a project. The databases are compiled from records of actual project costs, as well as ongoing price quotations from suppliers, and are published annually in the form of books, CDs, and computer-based extranets. There is, however, a danger of applying any historical database pricing without first adjusting the data for the particular aspects of the project under consideration. In construction, every project is unique, with a distinct set of local factors (e.g., the size of the project, desirability, level of competition, flexibility of specifications, work site, and hour restrictions) that come into play in bidding. When an estimating system that

is attached to a price database is used, the estimator should still review each line item price to determine if it is applicable to the project being estimated. Blindly applying database prices can lead to inaccurate estimates.

Location factors should also be applied but only after first considering the project size and particular nature to determine where the bidders will come from. If it is a large project in a small town, the location factor for that town will likely not apply because the bidders will be coming from elsewhere. The bids may as a result be much higher than the factor would indicate because the wages will be based on another location and the bidders may have to pay accommodation and travel costs for some of their workers.

T05: Historical Percentage

What Is It?

Historical percentages are used to estimate costs for items that are not typically defined early. A percent is developed based on historical cost information from past projects to cover certain items. This percentage is based on a relationship between the selected items and a total cost category such as direct construction. Contractor mobilization, construction engineering, and preliminary design (often referred to as preliminary engineering) are often estimated based on a historical percent of construction.

During the early phases of project development not all line items can be identified sufficiently to be quantified. Estimating quantities and unit prices for these line items are difficult due to this lack of definition in the design. One tool often used to estimate known but not quantified line items is developing historical percentages to cover those items.

When to Use It?

Historical percentages are best applied when there are many small items that cannot be quantified due to lack of design. This tool can also be used when time to prepare the estimate is a constraint. Historical percentages are commonly used for estimating contractor mobilization, construction engineering and preliminary engineering costs. This tool is most applicable in the programming and early design phases of project development.

This tool is used for developing cost estimates while performing these activities—A152: Prepare Base Conceptual Estimate; A272: Prepare Base Estimate for Alternatives; and A362: Prepare Estimate Basis for Recommended Alternative.

Why Use It?

There are circumstances when the estimator simply does not have sufficient time and information to detail all line items and develop quantities for these line items. With a good database of historical bid prices used on past projects combined with standard line items for reference, developing percentages for a group of similar line items may take less time and be just as accurate as trying to estimate quantities for these line items.

What Does It Do?

Cost estimates contain many line items when fully detailed through the Engineers' Estimate at the end of Final Design. However, early in project development, identifying and quantifying all line items is difficult at best. This tool provides a methodology for estimating costs for these unidentified line items.

How to Use It?

Historical percentages can be developed using projects that are relatively similar in scope and complexity. This tool relies on an agency having standard line item numbers to aid in preparing such percentages. Historical percentages are typically developed for estimating contractor mobilization, construction engineering and preliminary engineering costs.

Example

On a recent Washington State Department of Transportation (WSDOT) project that was early in the preliminary engineering stage, a historical percent was used to determine the estimated costs for erosion control and planting. This category of work has a set of standard line items under Section 17 of WSDOT's Standard Item Table. In this case, several similar projects, both completed and recently estimated, were used to develop a percent range for the erosion control and planting component of the estimate. The percentages were based on a ratio of costs for this section to total direct construction costs without mobilization. The range varied from two percent to nine percent.

WSDOT provides guidance on some historical percentages. For example, mobilization, and construction engineering, and preliminary engineering (PE) costs are estimated typically using this approach. Mobilization is a percent of direct construction cost. Suggested percentages based on construction cost are provided in the (WSDOT) Plans Preparation Manual, Division 8. Typical percentages used on recent projects have varied from seven to 12 percent. Typically ranges for construction engineering costs are also shown in the Plans Preparation Manual, Division 8. These ranges are based on program type (preservation and improvement) and construction cost. The range for PE cost is typically between seven and 15 percent.

Tips

The project from which historical percentages are developed should be very similar in scope and complexity to the project being estimated. The following approach to developing and applying this tool may be useful:

- Identify components or project elements that can be estimated using a percentage.
- Find several different projects that are similar.
- Identify line items and actual cost for those items.
- Calculate the sum cost of these items and determine percent of sum to total costs for several projects (e.g., percent of construction).
- Select percent that best fits project being estimated.
- Apply to project and incorporate item into cost estimate.

The percent selected must be consistent with the scope, complexity, and schedule for the project being estimated. As the dollar size of the project increases, historical percentages normally decrease. Construction execution can also impact mobilization and construction engineering costs.

T06: Expert Interviews

What Is It?

Expert interviews are simply the solicitation of expert opinions. Interview questions are generally open ended, and the discussion can cover all areas that the expert may be knowledgeable about. Documentation of the discussion is important because the discussion may reveal a

number of different risks, and the expert may provide information beyond the identification of the risk, such as probability and impact. The WSDOT has important guidelines (*A Policy for Risk Assessment,* published in 2008) to follow when selecting a subject matter expert:

> Subject matter experts (SMEs) are people who are qualified in their fields to make reasonable subjective assessments on project costs and schedules without bias; subject matter experts provide relevant technical, management, and political insight to the project and critically examine the project estimate to validate cost and quantity components. Subject matter experts use their real-world construction, risk analysis, and cost estimating knowledge to identify and quantify uncertainties. Subject matter experts must not have personal agendas and must be willing to work as part of a team. Subject matter experts can be internal or external and can be local or national.

When to Use It?

SMEs should be brought in early in the process but generally not until sufficient scope has been defined to warrant their expert opinions. Experts can be used during risk identification, risk assessment, planning, or any other point where the project team would appreciate additional opinions.

This tool is used for developing cost estimates while performing these activities—A273: Determine Risk and Set Contingency for Alternatives and A363: Determine Risk and Set Contingency for Recommended Alternative.

Why Use It?

Simply put, expert interviews provide additional informed minds to generate a comprehensive list of risks. As experts, they can provide knowledge and experience in specific fields that may not be available to the project team.

What Does It Do?

The expert interviews provide risks that are well developed and informed. The interviews also provide a way to begin describing, whether qualitatively or quantitatively, the probability and impact of risks.

How to Use It?

SMEs should be brought in early in the process but generally not until sufficient scope has been defined to warrant their expert opinions. The experience of SMEs can be used for risk identification, risk assessment, planning, or any other point where the project team would appreciate additional opinions.

Example

National Highway Institute (2006). *Risk Management Instructor Guide.* NHI Course 134065, National Highway Institute, Washington, D.C.

Washington State Department of Transportation (2008). *A Policy for Cost Risk Assessment* at http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment.

Tips

While reviewing the expert interview documentation, make sure not to include any of the team's own biases. Let the information speak for itself, and, if necessary, talk to the expert about his or her opinion and clarify any confusion.

T07: Risk Checklists

What Is It?

Risk checklists are a historic list of risks identified or realized on past projects. Risk checklists are meant to be shared between estimators and discipline groups on all projects.

Risk checklists are a tool for risk identification that can be used at the earliest stages of risk identification to learn from past projects and past team member experience. The list helps estimators better understand the required contingency and helps managers more effectively control scope growth throughout the project development process. The use of a risk checklist is the final step of risk identification to ensure that common project risks are not overlooked.

When to Use It?

Risk checklists should be used only after the team has identified risks on its own (e.g., through an examination of scope and estimating assumptions, the brainstorming of issues and concerns, or the creation of a red-flag list). Risk checklists should not be used as the first step in risk identification because they may not contain important project-specific risks. If a project team relies too heavily on a risk checklist, it could easily overlook project-specific risks, and the risks may not be phased correctly for the unique aspects of the project.

This tool should be used while performing these activities—A153: Determine Major Risks and Set Contingency; A273: Determine Risks, and Set Contingency for Alternatives; and A363: Determine Risk and Set Contingency for Recommended Alternative.

Why Use It?

The benefit of maintaining risk checklists is to capture corporate knowledge within a state highway agency and ensure that common risks are not overlooked in the estimating or risk management process. Risk checklists are simple to maintain if the agency has a central estimating or risk management function. Risk checklists can also be maintained by individual estimators or project managers.

What Does It Do?

Risk checklists serve as a final step in the risk identification process to ensure that common risks are not overlooked.

How to Use It?

A risk checklist should be reviewed at the start of a project and potentially several more times throughout the project. The list should be reviewed by a project team, and the risks that may have impacts should be documented and added to the risk register and possibly marked for quantitative analysis.

Example

The California Department of Transportation (Caltrans) has developed a sample list of risks in its *Project Risk Management Handbook.* This sample list of risks can be used as the basis for creating a list of red-flag items for an individual project. The Caltrans list is quite comprehensive, and any single project's list of risks should not include all of these elements. The sample risks are listed in Appendix C of the *Project Risk Management Handbook: Threats*

and Opportunities (2nd ed., May 2007, Caltrans, Sacramento, CA). The handbook is available at http://www.dot.ca.gov/hq/projmgmt/documents/prmhb/archive/caltrans_project_risk_management_handbook_20070502.pdf.

Tips

This method is only useful when the project team members think about every item on the list as a jumping-off point for further risks. Each item must be thought about in detail to ensure that the risk is truly a project risk. The thought process should be documented in order to build on this in future discussions of the risks.

T08: Probability × Impact (P×I) Matrix

What Is It?

A P×I matrix is used for qualitative analysis of risks on a project (Figure 11). It is formed using each project risk's probability and its corresponding impact. These matrices can take many forms, but a simple illustration is shown in Figure 12. For each of the project objectives, the combinations could fall into one of these three categories:

- **Black**—indicates that the activity is high risk. High-risk events are so classified either because they have a high likelihood of occurrence coupled with, at least, a moderate impact, or they have a high impact with, at least, moderate likelihood. In either case, specific directed management action is warranted to reduce the probability of occurrence or reduce the risk's negative impact.
- **White**—indicates that the activity is moderate risk. Moderate-risk events are either high-likelihood/low-consequence events, or they are low-likelihood/high-consequence events. An individual high-likelihood/low-consequence event by itself would have little impact on project cost or schedule outcomes. However, most projects contain a myriad of such risks (e.g., material prices, schedule durations, and installation rates); the combined effect of numerous high-likelihood/low-consequence risks can significantly alter project outcomes. Commonly, risk management procedures accommodate these high-likelihood/low-consequence risks by determining their combined effect and developing cost and/or schedule contingency allowances to manage their influence. Low-likelihood/high-consequence events, on the other hand, usually warrant individualized attention and management. At a minimum, low-likelihood/high-consequence events should be periodically monitored for changes in either their probability of occurrence or in their potential impacts. Some events with very large, albeit unlikely, impacts may be actively managed to mitigate the negative consequences should the unlikely event occur.
- **Blue**—indicates that the activity is low risk. Risks that are characterized as low risk can usually be disregarded and eliminated from further assessment. As risk is periodically reassessed in the future, these low risks are resolved with minimal effort, retained, or elevated to a higher risk category.

The assessment guide in Figure 12 also illustrates the key elements of a probability and impact analysis.

When to Use It?

A P×I matrix can be used when evaluating project risks in any phase of the project. It is typically used in conjunction with the risk register. The P×I matrix can be used as the sole tool for ranking risks in a qualitative analysis. In a quantitative risk analysis, the P×I matrix can be used for an initial assessment of risks before a more precise measure of probability and impact is made for probabilistic calculations.

	Very Low	Low	Moderate	High	Very High
Cost Impact	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Schedule Impact	Insignificant slippage	<5% project slippage	5-10 % project slippage	10-20% project slippage	>20% project slippage
Scope Impact	Change is barely noticeable	Minor areas are affected	Change requires TBPOC approval	Change not acceptable to TBPOC	Material termination of project
Probability	1–19%	20–39%	40–59%	60–79%	80–99%

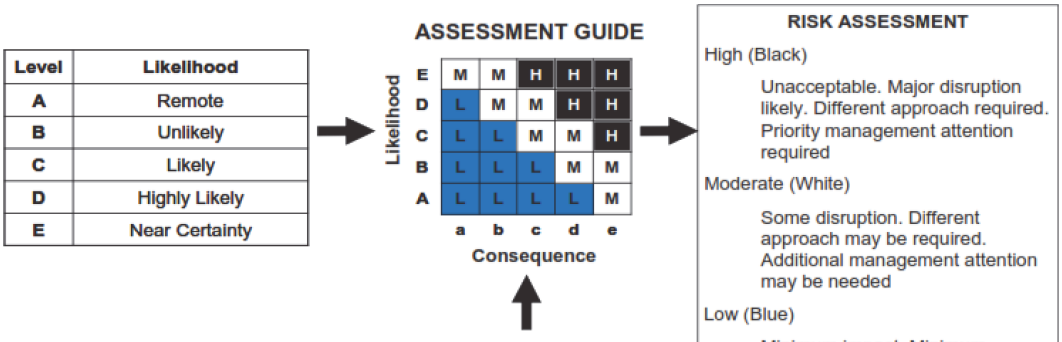
Note: TBPOC stands for the Toll Bridge Program Oversight Committee.

Figure 11. Sample P×I matrix.

This tool should be used while performing these activities—A273: Determine Risk and Set Contingency for Alternatives and A363: Determine Risk and Set Contingency for Recommended Alternative.

Why Use It?

Each risk is likely to have a different probability of occurrence and a corresponding impact on the project. Therefore, the project team members need to consider the interaction between the probability and the impact when evaluating the risks. The P×I matrix facilitates such evaluation.



Level	Schedule	and/or	Cost
a	Minimal or no impact		Minimal or no impact
b	Additional resources required; able to meet		<5%
c	Minor slip in key milestones; not able to meet need date		5-7%
d	Major slip in key milestone or critical path impacted		7-10%
e	Can't achieve key team or major program milestone		>10%

Figure 12. Definition of impact and probability levels.

What Does It Do?

The P×I matrix helps a project team rank the myriad risks faced by a project so that the project manager can direct the majority of the available resources to the high- and medium-impact items.

How to Use It?

The estimator, project team member, or appropriate subject matter expert uses his or her professional judgment to determine the probability of occurrence and the corresponding likely impact for each risk. This is typically done using adjectives (e.g., high, medium, or low) rather than direct probabilities (e.g., 10 percent or 25 percent) or impacts (e.g., $1 million or three months). The adjectives correspond to color coding for graphical presentation. This information is used to prioritize the risks so that the project team can effectively allocate the resources to the risks that have the highest potential to adversely affect the project.

Example

Figure 11 shows a sample P×I matrix with brief descriptions for the various combinations of probabilities of occurrence and impact. This example was taken from the Caltrans *Risk Management Handbook*.

Figure 12 shows a color-coded assessment guide that project teams can use for rank-ordering project risks. This example is taken from the U.S. Department of Energy.

Tips

The P×I matrix is most effective when used to prioritize the limited resources at a project team's disposal. A key requirement of successful use of this tool is the involvement of SMEs who can provide informed judgments about the probabilities of occurrence and the likely impact based on past experience, as well as data when available.

T09: Contingency Percentage

What Is It?

Recognizing that cost estimation is inherently difficult because estimators are trying to predict the future, it is prudent to provide contingency in cost estimates. The contingency amount can be set as a percentage of the project's base cost estimate with the percentage being established by analysis of historical cost experience from past projects.

On non-complex projects using a Level I risk analysis, add a contingency as a percentage of the base estimate to arrive at the total project cost estimate. While estimators must include a contingency with each estimate, non-complex projects do not warrant a detailed risk analysis and contingency development.

When to Use It?

The contingency percentage added to an estimate is a valid means of reflecting the uncertainties that remain in the project as design progresses. Include a contingency percentage in every project estimate from the early PSP; however, the magnitude of the contingency decreases as the scope is defined further in the process.

This tool should be used while performing these activities—A153: Determine Major Risks and Set Contingency and A363: Determine Risk and Set Contingency for Recommended Alternative.

Why Use It?

At any stage in the development of a project, cost estimates will be composed of three components for which there are differing amounts of information:

- Known and quantifiable costs.
- Known but not quantified costs.
- Costs that are unknown and therefore cannot be quantified in advance.

The base estimate includes the known and quantifiable costs. The contingency percentage is intended to include both the known but not quantified and the unknown costs.

What Does It Do?

A contingency percentage in an estimate is meant to provide funds for cost growth resulting from necessary but unforeseeable items, such as project scope changes, underestimation of real project costs, or errors in projecting the rate of inflation. Increases in the prices for construction services due to inflation are not to be considered covered by the contingency amount. Inflation should be handled by applying an appropriate inflation rate to the calculated project cost.

How to Use It?

The contingency percentage is the most prevalent approach that project teams use when resources for more sophisticated risk and contingency analysis are limited or unavailable. In its simplest form, a reference table or graph is provided to the project teams for estimating contingency as a percentage of the base estimate. Based on the project's level of design completion or other factors such as development milestones, the estimator or the project manager determines the corresponding contingency percentage to include in the cost estimate. For example, the Ohio DOT provides a relationship between the contingency and the state of design completion as shown in Figure 13.

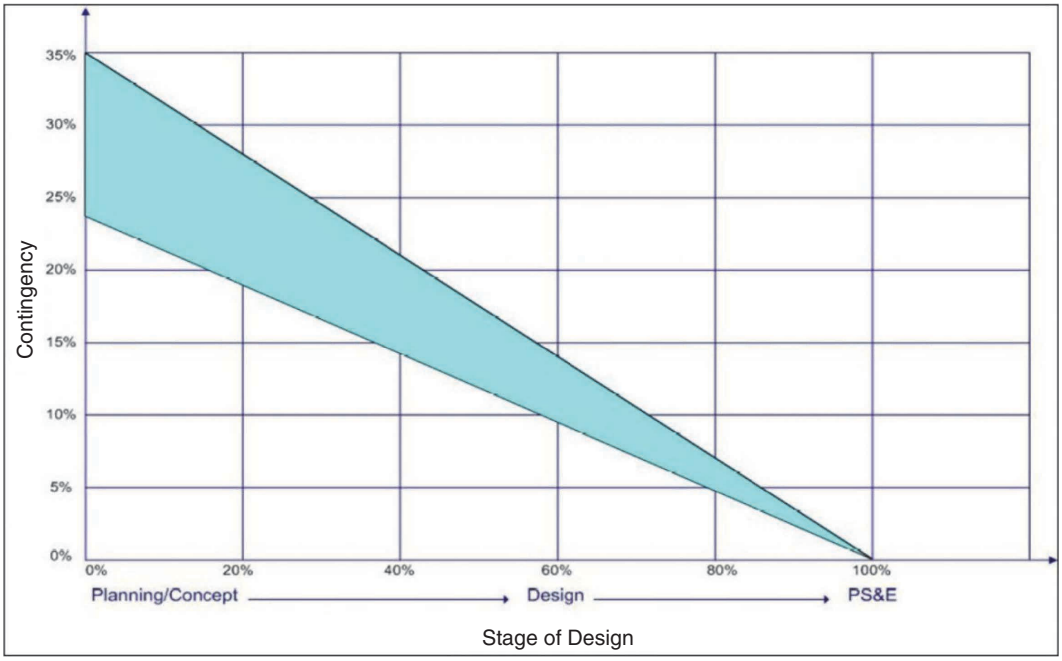


Figure 13. Ohio DOT design completion contingency guidelines for cost-estimating major projects.

Example

The following resources can be referred to for preparing the contingency percentage:

- Caltrans (2015). *Project Development Procedures Manual,* Chapter 20. www.dot.ca.gov/hq/oppd/pdpm/pdpmn.htm.
- Caltrans Office of Statewide Project Management Improvement (2007). *Project Risk Management Handbook: Threats and Opportunities,* 2nd ed. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.
- Caltrans (1998). *State Administrative Manual,* Chapter 6000, Section 6854: Construction.
- FHWA (2004). Contingency Fund Management for Major Projects.
- FHWA (2004). Major Project Program Cost Estimating Guidance.
- Ohio DOT (2007). *Ohio Procedure for Budget Estimating.*
- Uppal, Kul B. (ed.) (2005). *Professional Practice Guide #8: Contingency* (CD). Association for the Advancement of Cost Engineering (AACE) International. Tips.

When using a contingency percentage, two steps are needed to make the process work effectively:

1. Define the purpose of the contingency amount carefully. Estimators and management must understand that the contingency is intended to account for specific unforeseen, unexpected, unidentified, or undefined costs. The project risks that cause the occurrence of these costs must be delineated in the state highway agency's estimation manual with the percentages.
2. Establish contingency percentages based on actual experience (i.e., historical data). It is important for both estimators and management to know the level of accuracy achieved with the prescribed contingency.

T10: Contingency Identified

What Is It?

This tool creates a process whereby the contingency amount included in an estimate is set on the basis of identified risks and the probability of their occurrence. This contingency identified tool should ideally be used in conjunction with a comprehensive risk management process. When used in conjunction with a qualitative risk assessment or expected values for the risk items, the contingency is set using the cost estimator's judgment with the information generated from the risk identification and analysis process and in accordance with STA policy. The specific identified contingency items can then be used for contingency management and resolution throughout the project development process. In other words, as the risks are realized or resolved, the identified contingency amount can be added to the base estimate or removed from the total project cost estimate, respectively.

On moderately complex projects using a Level II risk analysis, add a contingency based on identified line items to the base estimate to arrive at the total project cost estimate.

When to Use It?

In case of moderately complex projects and using a Level II risk analysis, this tool should be used while performing these activities—A273: Determine Risk and Set Contingency for Alternatives and A363: Determine Risk and Set Contingency for Recommended Alternative.

Why Use It?

The identification of project risks gives the estimator a much firmer basis for developing a reliable contingency amount than the typical top-down assignment of a percentage based on the

estimated direct cost of the project. It also provides for a sound contingency resolution process to manage the total project cost.

What Does It Do?

Because risks are specifically delineated as a project is developed, specific strategies can be implemented to mitigate, transfer, or avoid significant risks. In addition, with the risks identified and quantified, control and tracking procedures can be implemented to monitor risk items on an ongoing basis.

How to Use It?

Researchers used the identified contingency as an overarching principle of contingency estimation. At every stage of the project, risks must be identified and contingency extracted. This extraction leads to greater understanding of the cost and uncertainty in a project. When choosing the appropriate contingency percentage in a Type II risk analysis, consult the range of contingency from the percentage contingency tool and then review the top 20 percent of the prioritized risks to ensure that the contingency is adequate. Use an expected value estimate for estimating the top-ranked risks. Calculate the expected value by multiplying the product of the impact should the risk occur by the probability of the occurrence (e.g., $\$1{,}000{,}000 \times 0.50 = \$500{,}000$). Use additional contingency if warranted by the expected value analysis.

Example

The Cost Estimating Validation Procedure® (CEVP) developed by the WSDOT is a peer-level review of the scope, schedule, and cost estimate for transportation projects throughout the state of Washington. The objective of the CEVP is to evaluate the quality and completeness, including anticipated uncertainty and variability, of the projected cost and schedule.

The outcomes of the CEVP include the following:

- An estimate validation statement in the form of a CEVP Project Summary Sheet that more accurately represents the project cost ranges and the uncertainty involved.
- Findings and recommendations that allow WSDOT project teams and senior management to better understand the basis, content, and variability of cost estimates.
- Identification and characterization of the high-risk project elements, which will enable project teams to address appropriate mitigation strategies.

The Caltrans *Risk Management Handbook* (2007) (http://www.dot.ca.gov/hq/projmgmt/documents/prmhb/archive/caltrans_project_risk_management_handbook_20070502.pdf) calls for a quantitative assessment of project risk items representing the highest degree of exposure. This quantification is important for adjusting/updating the contingency amount to be included in the project estimate.

Tips

To successfully attack the effects of project risk, risk analysis must take a broad view of risk; concentration on the technical risks can lead to oversights in other project dimensions. The analysis should consider local authority/agency impacts, industry and market risks, elements of political uncertainty, and public and/or permit approval processes that might impact timing.

Scope changes must also be considered from a broad perspective. Identification of risk goes beyond the internal project risks, such as pile-driving depth, and includes exogenous factors,

such as market conditions, business environment, global construction activities/demand, macroeconomic environment, and weather. Namely, any major uncertainties that might influence the primary project outcomes of cost, schedule, or quality should be included.

T11: Estimate Ranges—Monte Carlo Analysis

What Is It?

Monte Carlo analysis is a computerized probabilistic simulation modeling technique that uses random number generators to draw samples from probability distributions. Monte Carlo analysis uses repetitive trials to generate overall probability distributions for project cost or schedule. It relies upon multiple inputs of probabilities for risk events and for uncertainty in cost and duration of line items. A trial consists of the simulation engine selecting a value for each of the line items based on their probabilities and generating a final estimate based on that trial. This process is repeated many times (usually several thousand) to generate a distribution for the total cost or schedule.

Monte Carlo analysis is part of a sophisticated probabilistic modeling process that can be used to generate a range estimate through simulation methods. The use of Monte Carlo analysis is typically facilitated by experts in this field who work closely with estimators, project team members, and SMEs.

When to Use It?

Monte Carlo analysis is applied on complex projects and is used as the basis for a Type III risk analysis. The tool can be used for A273: Determine Risk and Set Contingency for Alternatives, and A363: Determine Risk and Set Contingency for Recommended Alternative.

This tool can be used while performing the activities—A273: Determine Major Risks and Set Contingency for Alternatives, and A363: Determine Major Risks and Set Contingency for Recommended Alternative.

Why Use It?

Monte Carlo analysis has many advantages. It can determine risk effects for cost and schedule models that are too complex for common analytical methods. The output of a Monte Carlo simulation can provide a graphical distribution of project cost or schedule. This distribution can be used to generate an estimate range. It can also be used to calculate a contingency. Monte Carlo analysis can explicitly incorporate the risk knowledge and judgment of the estimators, project team, and SMEs for both cost and schedule risk events. It has the ability to reveal, through sensitivity analysis, the impact of specific risk events on the project cost and schedule.

What Does It Do?

The tool allows the project team to visualize the uncertainty relating to the total project cost and schedule. Monte Carlo analysis can be used to determine project cost and schedule ranges and the most likely values for each activity. Figure 14 shows typical probability outputs from a Monte Carlo analysis. The histogram is useful for understanding the mean and dispersion of the results. The cumulative chart is useful for determining project budgets and contingency values at specific levels of certainty or confidence. In addition to graphically conveying information, Monte Carlo analyses produce numerical values for common statistical parameters, such as the mean, standard deviation, distribution range, and skewness.

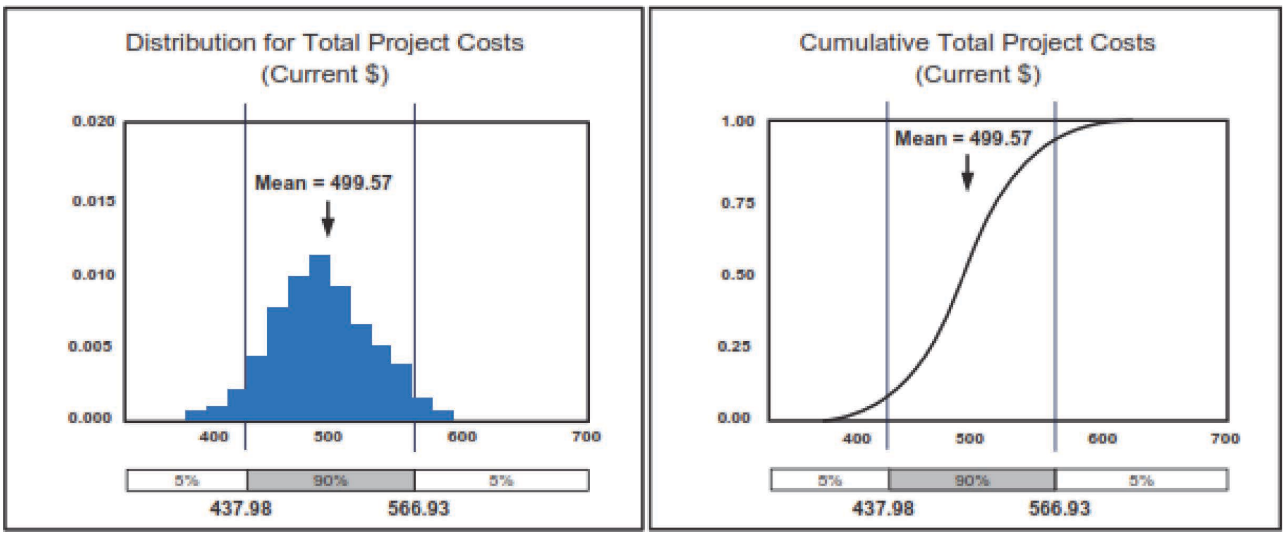


Figure 14. Typical Monte Carlo output for total costs.

How to Use It?

Monte Carlo analysis can be used to generate a number of different decision-making tools for the project team. In order to produce these tools, the inputs must be assessed to accurately model project risks. Each risk can be given a different risk profile indicating where the most likely and least likely values are. Among these different distributions are triangular, uniform, normal, BetaPert, BetaPert modified, lognormal, discrete, trigen, and any custom-defined distribution.

In addition to the total cost ranges, an additional output of a Monte Carlo analysis is a tornado diagram. The tornado diagram is a graphic depiction of a sensitivity analysis. The tornado diagram can be used to show which risks will have the greatest positive or negative effect on project cost and schedule. Figure 15 indicates the correlation that project risks have to the total project schedule. The risks with the longest bars have the largest impact on the overall cost or schedule variability.

Several commercial software packages exist to help teams run Monte Carlo analyses. The two most commonly used are @Risk and Crystal Ball. As well as software that integrates within existing spreadsheet programs, spreadsheet macros can be developed to produce simple Monte

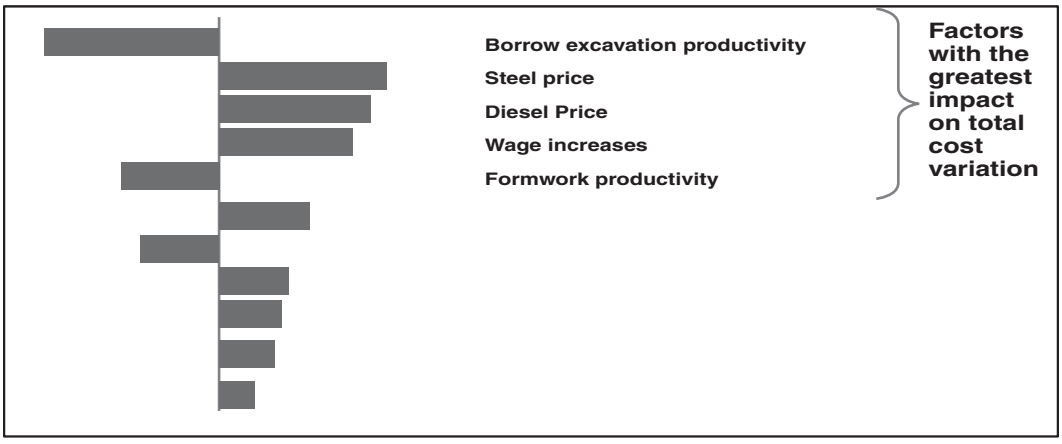


Figure 15. Example tornado diagram output from a Monte Carlo analysis.

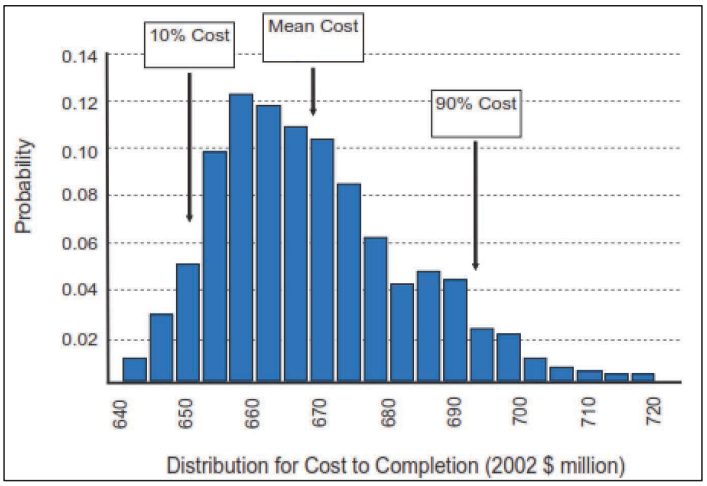


Figure 16. Example of an estimate range.

Carlo analyses. For example, WSDOT has developed its own Monte Carlo analysis package in Microsoft Excel using macros. Additionally, some stand-alone software exists to generate cost and schedule Monte Carlo simulations. The most common stand-alone software is Pertmaster.

Example

WSDOT has developed a risk-based approach to cost estimating in CEVP. CEVP is used to convey project cost through estimate ranges. Figure 16 provides an example of how CEVP is used to convey an estimate range. The project represented has a 10 percent chance of being completed for $651 million or less, while there is a 90 percent chance that the project will cost $693 million or less. The project can cost as little as $640 million and as much as $720 million.

Tips

Monte Carlo analysis can provide insights into complex projects that might not be apparent through conventional estimating and scheduling techniques. It can provide cost and schedule ranges with graphical outputs. It can also provide insights into which risks have the greatest influence on these ranges. All too often, however, the output is used only for go/no-go decisions or a one-time generation of a baseline cost.

Monte Carlo analyses should only be conducted or facilitated by trained professionals. It is important to understand that the output of the model is only as accurate as the assumptions used to generate the output and the ability of the model to represent the actual project.

T12: Scheduling and Work Zone Impact Analysis

What Is It?

Agency efforts to deliver projects in a timely manner have been furthered by use of innovative software analysis programs and scheduling techniques such as the CPM or PERT. A more recent tool arising from these efforts is a state-of-the-art tool called Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS), which has come into use because of its integrative ability to analyze schedules, costs, and work zone traffic impacts.

CA4PRS was developed under FHWA pooled fund research with a multistate consortium (California, Minnesota, Texas, and Washington). CA4PRS software is a scheduling and work zone impact analysis tool used to select the most economical strategies for highway rehabilitation or reconstruction given various project constraints.

When to Use It?

This tool is used for preparing TMPs during the planning phase of program (project) development. The use of CA4PRS is especially beneficial for transportation agencies when it is implemented during the planning and design stages of highway project development in order to balance schedule (construction production), inconvenience (traffic delay), and affordability (agency budget).

This tool should be used while performing these activities—A263: Conduct TMP Studies for the Alternatives; A352: Determine Types of TMP; and A354: Develop Preliminary TMP.

Why Use It?

FHWA updated federal regulations governing safety and mobility in work zones: Rule 23 CFR Part 630 Subpart J. All state and local governments that receive federal aid highway funding must now implement the rule. CA4PRS is software that can perform the majority of the analyses required for compliance with the new federal rule. Currently, the other available tools lack the capacity to perform these analyses and/or possess additional limitations, such as the following:

- They are too complicated for routine DOT analyses.
- Group license acquisition is too expensive.
- Too much time is needed to obtain the required inputs information.

States are willing to use tools such as CA4PRS, which has already been widely used in California and in four other states. Validation studies on several major highway rehabilitation projects in states including California, Washington, and Minnesota have proven the reliability and accuracy of the software. As a result, there has been nationally growing acceptance of the program including recent arrangements by FHWA for free group licenses for all 50 states.

What Does It Do?

CA4PRS is very easy to use due to its user-friendly interface. The CA4PRS scheduling module calculates the duration of the project in terms of the total number of closures and closure hours required for each rehabilitation alternative. Using a demand-capacity model based on the *Highway Capacity Manual,* the CA4PRS traffic module quantifies the impact on the traveling public of work zone closures in terms of time spent in the closure and road user cost.

How to Use It?

CA4PRS can play a pivotal role in developing sound TMPs that account for the integration of schedule and traffic impact that the work zone will have on the traveling public. Since the scheduling reliability and accuracy of CA4PRS were validated with numerous highway renewal projects, it is assumed that the program's use will provide reliable baseline data. Typical analysis procedures in CA4PRS are as follows:

- Input the scope (lane miles) of the rehabilitation project.
- Select a rehabilitation strategy: PCC reconstruction, CSOL rehabilitation, or FDAC replacement analysis modules.

- Define a new pavement cross section: slab and base thickness (PCC) or layer profile (AC).
- Set concrete curing time (PCC) or AC cooling time (or let the MultiCool software calculate cooling times interactively).
- Choose a construction window (closure timing and length): for example, 10-hour nighttime closure only, 55-hour weekend closure, or 72-hour weekday closure.
- Select rehabilitation sequences and lane closure tactics.
- Input the contractor's logistical resources (crew, equipment, and plants) for major operations.
- Perform a schedule analysis.
- Input the duration of the project in the traffic analysis module.
- Set the traffic parameters including closure length, construction year, lane closure tactic, speed limit, traveler's value of time, truck percentage, average traffic volume, etc.
- Perform a traffic analysis.

For more detailed information about its usage, please refer to FHWA's CA4PRS training page at http://ops.fhwa.dot.gov/wz/p2p/ca4prs/presentations/training/index.htm.

Example

See the Caltrans CA4PRS website at http://www.dot.ca.gov/newtech/roadway/ca4prs.

Tips

CA4PRS helps agencies, contractors, and consultants prepare strategies (including the PS&E package) for highway projects by:

- Estimating working days and CPM schedules.
- Developing construction staging plans.
- Supplementing TMPs.
- Outlining incentives and cost (A) + schedule (B) contracts.

Because FHWA has purchased a group license of CA4PRS, all 50 state DOTs have an unlimited free license for the CA4PRS software for their internal use. It is downloadable at http://www.dot.ca.gov/newtech/roadway/ca4prs/protected/index.htm.

T13: Project Purpose and Need Statement

What Is It?

The purpose and need statement is intended to clarify the expected outcome of public expenditure and to justify that expenditure—what you are trying to accomplish and why you think it is necessary. As such, it should be the first step in the project development process. It will be used to guide the development of alternatives, and it will be a fundamental element when developing criteria for selection between alternatives.

When to Use It?

This tool should be used while performing these activities—A111: Identify Discipline Needs to Be Addressed; A112: Identify Key Internal Participants and External Stakeholders; A142: Refine Project Purpose and Need Document; and A16: Summarize Key Project Characteristics.

Why Use It?

A purpose and need statement is a fundamental requirement when developing a proposal that will require future NEPA documentation, an EIS or EA. In addition, some other federal

processes, such as granting a 404 permit, also require the generation of a purpose and need statement in order to apply for the permit. Clarity of purpose and confirmation of need are in themselves sound practices when developing large scale proposals requiring public expenditure.

What Does It Do?

Purpose and need has been and continues to be a challenge. This tool will provide a uniform approach and facilitates in developing and establishing the need and purpose statement for the project.

How to Use It?

The fundamental legal guidance on purpose and need statements comes from the NEPA CEQ regulation, Section 1502.13; the purpose and need statement, "shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." Each federal agency has their own guidance on NEPA products. FHWA Technical Advisory T 6640.8A and 40 CFR 1502.13 direct state DOTs to "identify and describe the proposed action and the transportation problem(s) or other needs which it is intended to address." The advisory goes on to list nine factors that may be helpful in establishing the need for a proposed action. Eight of those are relevant to this discussion and include: system linkage, capacity, transportation demand, legislation, social demands or economic development, modal interrelationships, safety, and roadway deficiencies. The ninth addresses project status and is not relevant to this discussion.

Example

See the WSDOT purpose and need statement for the project, I-90—Cross Lake Washington Tolling, at http://www.wsdot.wa.gov/Projects/I90/CrossLakeWATolling/PurposeAndNeed.htm.

Tips

Purpose:

- The purpose is analogous to the problem. It is the "what" of the proposal.
- The purpose should "focus on the State's transportation system." Other important issues to be addressed by the project such as local transportation systems, livability, and the environment should be identified as goals and objectives.
- The purpose should be stated in a single sentence.
- The purpose should be stated as the positive outcome that is expected. For example, the purpose is to reduce congestion in the Interstate corridor.
- It should avoid stating a solution as a purpose, as in the purpose of the project is to build a bypass. Rather, it should indicate what transportation problem(s) are being addressed.
- Where appropriate, it should be stated broadly enough so that more than one mode can be considered and multi-modal solutions are not dismissed prematurely. This should tie back to the "MPO strategy" in terms of modal options.
- Where appropriate, it should be stated broadly enough so that more than one alternative can be considered and alternatives are not dismissed prematurely. It should also be stated generically as to not eliminate a bundled set of mobility options or a "menu" of options.
- The purpose should be stated in a manner so that a suite of intermediate steps could be posed as the solution, scaled to the needs of the community, if appropriate. For example, sometimes the project is simply the implementation of some "No Build" strategies, for example.
- TDM, bus expansion, etc. The purpose should develop from an MPO strategy, which is grounded in the region's performance goals.

Need:

- Should establish the evidence that the problem exists, or will exist if projected population and planned land use growth are realized
- Should be factually and numerically based, i.e., performance measures, latest planning assumptions, crash data, VMT, etc.
- Should support the assertion made in the purpose statement. For example, if the purpose statement is based on safety improvements, the need statement should support the assertion that there is or will be a safety problem to be corrected which would be supported by crash data/analysis.

T14: Project Scope/Definition Completeness Evaluation Tools (TxDOT APRA)

What Is It?

Transportation project scoping is a comprehensive process that may require multiple stages. STAs that have established formal scoping procedures usually also have clearly defined milestone activities, for example, when a project is selected or a preferred alternative is determined. When these milestone activities are completed, project scoping may move on to the next stage. At the conclusion of each milestone activity, the PSP team should know what they have accomplished in developing the project scope, how complete the project scoping is, and what areas may require the most attention when moving on to the next stage.

Although each transportation development project is unique, there are generic characteristics and concerns to all projects, which make it possible to develop a project scope completeness evaluation tool that is able to work on most projects and compare across projects. The Construction Industry Institute has come up with several versions of the Project Definition Rating Index tool that are tailored toward different types of construction development projects. Some STAs are also developing their own tools that best fit their needs. TxDOT has introduced its APRA tool.

When to Use It?

Ideally the PSP team should evaluate the completeness of the project scope after each milestone activity is accomplished.

This tool should be used while performing these activities—A284: Evaluate Project Definition Completeness and A373: Evaluate Project Definition Completeness for Recommended Alternative.

Why Use It?

Using the APRA tool when certain milestones are reached helps the PSP team understand where the project is in the overall development process. If the evaluation results show the project definition is not ready to proceed to the next stage, the PSP team may decide to put more effort into it before rushing into the succeeding activities.

The APRA evaluation results help identify the areas in which project definition is most complete as well as areas that require additional attention. The project manager can use the evaluation results to best allocate the PSP team's time and resources.

The APRA tool covers the most common elements in TxDOT's project development process, which help prevent the PSP team from making omissions.

What Does It Do?

The APRA tool developed under TxDOT Research Project 0-5478 offers a method to measure project scope definition for completeness and identify potential risks early in the project. It is a weighed scoring system that covers all commonly considered elements in TxDOT's typical PDP. Elements are broken down into three sections, with each section containing several categories (see Table 4 for sections, categories, and weights).

The PSP team evaluates each element to determine the definition of completeness for each element. Completeness is scored from 0 to 5, with 1 being "complete definition," 5 being "incomplete or poor definition," and 0 being "non-applicable."

At the end of the evaluation, the project team obtains an overall score of project definition completeness, as well as the scores for each section and category, so that the team can compare project definition completeness to other projects or the desired level, and direct the team's focus to the elements that need further attention.

How to Use It?

There are generally three steps for using the APRA tool: prepare for assessment, assess the project, and develop an action plan. When preparing for assessment, necessary information and materials are distributed to participants and facilitators. Before the meeting to assess the project, participants should be allowed enough time to familiarize themselves with the material. During the assessment meeting, participants discuss the elements one by one and determine the score for each element. Facilitators take notes and record the scores. A facilitated meeting usually takes two to three hours. Finally, when the evaluation results are ready, the PSP team identifies weak areas in the project scope and determines the actions that need to be taken to strengthen them.

Example

For more information about the TxDOT APRA tool, see TxDOT Report 0-5478-1: *Identifying Right-of-Way Requirements during the Project.*

Table 4. APRA sections, categories, and weights for elements considered in the PDP.

SECTION and Category	Weight
SECTION I – BASIS OF PROJECT DECISION	**300**
Category A - Project Strategy	122
Category B - Owner/Operator Philosophies	76
Category C - Project Requirements	102
SECTION II – BASIS OF DESIGN	**359**
Category D - Site Information	173
Category E - Location & Geometry	79
Category F - Structures	48
Category G - Design Parameters	29
Category H - Installed Equipment	30
SECTION III – EXECUTION APPROACH	**341**
Category I - Acquisition Strategy	137
Category J - Deliverables	23
Category K - Project Control	98
Category L - Project Execution Plan	83
TOTAL	**1000**

The APRA computer tool is available for download at http://onlinemanuals.txdot.gov/txdotmanuals/pdp/preliminary_design.htm.

Tips

How to assess the completeness of project scope should be included in the curriculum of the agency's training programs. However, since project scoping may involve parties outside of the transportation agency, there is no guarantee that everyone knows how the assessment tools should be used. The person in charge of the assessment should distribute all relevant guidelines and documents before the assessment meeting and make sure all team members have enough time to understand the material.

It may be necessary to assign a facilitator who understands the assessment tool to run the process.

The honesty of all parties is important. Make it clear that the purpose of assessing the completeness of the project scope is to identify issues, rather than obtaining a good score.

T15: Scoping Worksheets/Scoping Checklists

What Is It?

Several STAs have developed their set of scoping worksheets/checklists as a tool to help identify items to be included in the project scope. Different worksheets/checklists are designed for functional groups responsible for different areas (design, construction, environmental, ROW, etc.). These worksheets/checklists ensure an organized and consistent scoping process while minimizing the chance of errors and omissions during project scoping.

Scoping worksheets/checklists are usually a series of forms to be completed by personnel overseeing areas (e.g., community impact, construction, environmental impact, or ROW) involved in project scoping. The worksheets list work items that are commonly included in each area and provide a good starting point for deciding what items may or may not be included in the project scope. The worksheets may also include some preliminary cost and duration estimates of the work items, as well as information that is specific to each project.

When to Use It?

Initial completion of the scoping worksheets/checklists generally takes place when a preferred alternative is selected. Depending on the specific area, the worksheets/checklists may be completed on different dates by different functional groups. In the later stages of the scoping process, the PSP team may need to modify the worksheets/checklists as the project scope is being refined. STAs that have developed their scoping worksheet/checklists generally require that they be included in the final scoping report.

This tool should be used while performing these activities—A111: Identify Discipline Needs to Be Addressed; A112: Identify Key Internal Participants and External Stakeholders; A113: Prepare Organizational Chart; A16: Summarize Key Project Characteristics; A372: Draft Project Scoping Report; A374: Approve/Modify Scoping Report; and A375: Finalize Scoping Report.

Why Use It?

Completing scoping worksheets/checklists is an efficient way of identifying most work items that should be included in the project scope. While the list of work items may not be exhaustive, it provides a good starting point for the PSP team to quickly identify most of the work items.

Using scoping worksheets/checklists reduces the chance of errors and omissions since the worksheets/checklists should be developed using previous project experience within the organization and should already include the commonly occurring work items.

Requiring PSP teams to complete a set of scoping worksheets/checklists helps ensure the consistency of the project scoping process throughout the organization.

What Does It Do?

The scoping worksheet/checklists usually include a list of commonly occurring work items with which the PSP team can identify what items may or may not have an impact on the scope of the project. The work items may be broken down into various areas: community impact, construction, environmental impact, ROW, roadway design, bridge design, landscape, traffic, utilities, etc. The worksheets/checklists are distributed to functional groups responsible for each area and filled out. Completed worksheets/checklists may also contain comments regarding certain work items, which the PSP team can refer to while the scope of the project is being developed and refined.

How to Use It?

STAs that have developed scoping worksheets also provide guidance on how to complete the worksheets. For example, the Minnesota Department of Transportation (MnDOT) requires a set of scoping worksheets to be completed when a preferred alternative is selected. MnDOT's scoping checklists cover 16 areas, as listed in Table 5.

MnDOT provided the following guidance on completing the worksheet:

> In general, the scoping worksheets should be sent to the person that oversees each functional area (principal engineer or above). In many districts, multiple worksheets may be sent to one person, since they may oversee more than one functional area. District should complete the above table with the name of the person that will receive each worksheet so that it is done consistently across the district. The person that completes each worksheet should fill in the 'Date Completed' box when it is finished.
>
> Most items have check boxes associated with them in the worksheets. Below is guidance to aid in determining how to complete the checkboxes.

Table 5. List of MnDOT's scoping worksheets.

Worksheet	Title	Name	Date Completed
Project Manager	Project Manager		
Business Impact Assessment	Project Manager		
Planning Section	District Planning Director		
State Aid	District State Aid Engineer		
Land Management	District Land Management Engineer		
Surveys	District Principal Surveyor		
State Patrol	District State Patrol Office		
Environmental Documentation	District Preliminary Design Engineer		
Access Management	Chair of District Access Management Committee		
Bridge	District Bridge Engineer		
Construction	District Construction Engineer		
Design	District Design Engineer		
Hydraulics	District Hydraulic Engineer		
Maintenance	Area Maintenance Engineer		
Materials	District Materials Engineer		
Traffic	District Traffic Engineer		

'Yes'—There is a known issue that needs to be addressed
'No'—As the project currently stands, the item is not an issue
'Not Needed'—The task is not needed
'Maybe'—The potential for an issue exists, but more information is needed to determine specifics
'Need'—The item is required because it currently does not meet standards, is required by law, must be included to accomplish purpose of the project, etc.
'Want'—The item is not required, but it would be ideal to address as part of the project
'Not'—The item is not applicable to this project

The list of items in the worksheets is not an exhaustive list, but merely guidance to help functional groups scope individual projects. Districts should feel free to make changes to the scoping worksheets as they see fit.

There are also section-specific guidance and tips on each worksheet. For example, the "Business Impact" section of MnDOT's worksheets states that "the purpose of this form is to record notes on potential business impacts associated with the project." This section also suggests certain documents and a project map showing the location of construction and businesses identified as potentially impacted may be helpful.

The Virginia Department of Transportation (VDOT) requires a set of scoping worksheets to be included in the final project scoping report. Similar to the worksheets developed by MnDOT, VDOT's scoping worksheets cover 14 areas that are usually involved in the scoping process. Each of the 14 areas (community impact, construction, environmental, hydraulics, landscape and architecture, materials, planning and investments, ROW, roadway design, structures and bridges, survey, traffic design, traffic engineering, and utilities) has its own scoping worksheet. In addition to the items that may impact the project scope, VDOT's scoping worksheets also require information such as estimated cost, estimated activity duration, and potential risks associated with the areas.

Example

MnDOT's scoping worksheets are available at http://www.dot.state.mn.us/pm/documents/scoping-worksheets.doc.

VDOT's scoping worksheets are available at http://vdotforms.vdot.virginia.gov/Default.aspx. Under "Search by Form Name," look for the scoping worksheets.

Tips

Develop a set of scoping worksheets that best suit your agency's scoping process. Divide work items into categories that match the functional groups that participate in project scoping, and assign a specific person (or the person who occupies a specific position in a project team) to complete the scoping worksheets.

Provide both general and section-specific instructions for completing the worksheets.

Incorporate the scoping worksheets into the staff training programs.

T16: Scoping Report Templates

What Is It?

Transportation project scoping is a comprehensive task that involves various types of personnel in the STAs. To ensure alignment within the PSP team and avoid confusion about the project scope, documentation is critical. Regardless of whether an STA has a formal PSP, some form of a report is necessary to document the outcomes of any scoping effort. A scoping report template is a document that lays out the format and required information of the scoping report.

When to Use It?

Depending on the scoping process, different STAs may require the project team to complete scoping reports at different stages. For example, a project team may complete an initial scoping report when an alternative is selected for a proposed project and a final scoping report when the scoping process is complete and all necessary evaluations are performed. A small and simple project may only require one comprehensive scoping report, while a large, complex project may need interim reports when important milestones are achieved.

This tool should be used while performing these activities—A372: Draft Project Scoping Report; A374: Approve/Modify Scoping Report; and A375: Finalize Scoping Report.

Why Use It?

Various parties could be involved in the transportation PSP. At the end of the scoping process, reading the project scoping report should be an efficient way for all parties to understand what issues were considered and what decisions were made. In order for all parties to be familiar with the structure of the report, it is important to keep a consistent layout for the scoping reports.

Summarizing the outcomes of all scoping activities in an organized manner can be time consuming, and omissions may occur when time is of the essence. Having the formatting and contents clearly outlined can help save time and avoid errors and omissions at the same time.

What Does It Do?

A template for a project scoping report should provide an organized way to summarize the efforts and outcomes of the PSP. It should clearly define required information and the level of detail to maintain data consistency throughout the transportation agency.

How to Use It?

VDOT has developed a standard form (Form PM-100) for the project team to fill out at the end of the scoping process. At the final project scope milestone, the project manager finalizes the scoping report and submits it to the required individual(s) for approval. The project manager ensures that the final project scope accomplishes and documents the following:

1. Determine the delivery method (design-build, design-bid-build, or public-private partnership).
2. Refine project limits.
3. Preliminarily identify project issues that may affect scheduling and the construction budget, such as environmental issues, ROW, design, utilities, etc.
4. Finalize the purpose and need for the project.
5. Refine the pre-scoping (programming) estimate to develop the initial construction cost estimate.
6. Consider opportunities (cost, quality, safety, etc.), identify project risk, and develop risk mitigation strategies.
7. Refine the schedule (each team milestone should be clarified with all team members and reviewed to ensure commitment).
8. Determine if a citizen information meeting should be held.
9. Define participation of each discipline and identify a project team member.

The Kentucky Transportation Cabinet requires two documents that contain comprehensive project information to be completed during the PSP, the project identification form (PIF) and the data need analysis (DNA):

- The PIF is prepared when the transportation need is first noted, and the information is entered into the Unscheduled Project List database and is updated periodically. The PIF contains the problem statement, project description, specific geometric and analytical data, cost estimates, and assumptions for the project. Maps and pictures for the project may also be attached. PIFs are prepared by district offices and submitted to the central office. The central office then evaluates and ranks potential projects.
- The DNA comes at a later stage in the scoping process. It is a study completed prior to the design phase of a project to identify the purpose and need for the project through the analysis of existing conditions and available data. DNAs are used to better define the project scope, identify potential environmental concerns, and determine if the funds allocated in the highway plan are adequate for the project.

Example

VDOT's Project Scoping Report (PM-100) is available at http://vdotforms.vdot.virginia.gov/SearchResults.aspx?filename=PM_100.doc.

APPENDIX B

Online Links to Various Resources and Tools to Support the PSP as Referenced in This Guidebook

Level 3 Activity No.	Link	Reference	Description
A14, A25, A33, and A34	http://environment.fhwa.dot.gov/projdev/index.asp	FWHA Environmental Review Toolkit	The FHWA Environmental Review Toolkit website provides guidance and examples for the various compliance areas relating to preparing and reviewing NEPA documents.
A14, A25, and A33	http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/	FHWA *Public Involvement Techniques for Transportation Decision Making*	This FHWA document presents numerous techniques and practices that can be used for public involvement. This report gives agencies access to a wide variety of tools to involve the public in developing specific plans, programs, or projects through their public involvement processes.
A14	http://www.planning.dot.gov/	Transportation Planning Capacity Building	The Transportation Planning Capacity Building (TPCB) Program is designed to help decision makers, transportation officials, and staff resolve the increasingly complex issues they face when addressing transportation needs in their communities. This comprehensive program for training, technical assistance, and support targets state, local, regional, and Tribal governments, transit operators, and community leaders.
A14	http://environment.fhwa.dot.gov/integ/index.asp	FHWA Planning and Environment Linkages	Planning and Environment Linkages (PEL) represents a collaborative and integrated approach to transportation decision making that considers environmental, community, and economic goals early in the transportation planning process; and uses the information, analysis, and products developed during planning to inform the environmental review process.
A14, A25, and A33	http://environment.transportation.org/	AASHTO Center for Environmental Excellence	The AASHTO Center for Environmental Excellence, developed in cooperation with FHWA, offers a wide range of products and services to assist transportation agencies in achieving environmental excellence in delivering their transportation programs and projects. Through its information exchange, technical assistance, and partnership-building and training resources, the center helps transportation agencies incorporate environmental compliance, sustainability, and stewardship into transportation planning, project development, construction, maintenance, and operations.
A25, and A33	http://www.fhwa.dot.gov/environment/cia/	FHWA Community Impact Assessment	The Community Impact Assessment (CIA) website serves as an information clearinghouse for transportation officials, regional-development professionals, and the general public interested in evaluating the effects of transportation planning and project implementation on a community and its quality of life.
A14, A25, and A33	http://www.fhwa.dot.gov/planning/public_involvement/	FHWA Public Involvement/Public Participation	This site provides links to relevant information and exemplary case studies and examples on public involvement processes and strategies.

Level 3 Activity No.	Link	Reference	Description
A25, A33, and A34	http://www.fhwa.dot.gov/environment/	FHWA Environment	Three offices within FHWA focus on environmental protection and enhancement. Information regarding the full range of FHWA environmental programs can be found on this website. The Subject Index may be helpful in finding information.
A15, A27, and A36	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf	*NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction*	This report provides strategies, methods, and tools to prepare cost estimates during all preconstruction project phases including the scoping phase. The report proposes a six-step estimating process for developing accurate and consistent estimates. The estimating methods are tied to the relevant step in the process.
A15, A27, and A36	Purchase from AASHTO at https://bookstore.transportation.org/collection_detail.aspx?ID=122	AASHTO *Practical Guide to Cost Estimating*	Part I covers cost estimating. Specific techniques covered include conceptual estimating, bid-based estimating, cost-based estimating, and risk-based estimating. All four techniques can be used in the scoping phase of a project.
A15, A27, and A36	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_625-2.pdf	*NCHRP Report 625: Procedures Guide for Right-of-Way Cost Estimation and Cost Management*	This report provides a how-to guide to preparing cost estimates related to ROW following a six-step estimating process (see *NCHRP Report 574*). The cost-estimating methods and tools presented relate specifically to ROW and are also tied to preconstruction phases including scoping.
A15, A27, and A36	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf	*NCHRP Report 658: Guidebooks on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*	This report identifies the risk management process in five steps. The report provides tools to identify risks, analyze risks, develop mitigation plans, allocate risk, and then monitor and control risks. The risk process is tied to preconstruction phases including scoping.
A21 and A32	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_771.pdf	*NCHRP Report 771: Strategies to Optimize Real Property Acquisition, Relocation Assistance, and Property Management Practices*	This report provides (a) improved, integrated real property procedures and business practices in the project development and delivery process; and (b) suggestions to improve property management practices. An online survey, follow-up interviews, and a peer exchange meeting were used to determine which business practices are critical to the mission of the project development and delivery process and real property management. This report will be of interest to ROW administrators and real property managers.
A24 and A31	Archived—request from Transportation Research Board	*NCHRP Report 391: Constructability Review Process for Transportation Facilities: Workbook*	This report provides a process to perform constructability reviews during different phases of the PDP including the scoping phase. The report identifies key constructability concepts. Constructability review tools are also provided that are tied to each project delivery phase.
A35	http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R16-RR-1.pdf	*SHRP 2 Report S2-R16-RR-1: Strategies for Improving the Project Agreement Process Between Highway Agencies and Railroads*	This report for SHRP 2 Renewal Project R16 provides a comprehensive collection of recommended practices that promote cooperation between railroads and transportation agencies on highway projects that cross or lie alongside railways. The report presents standard processes and successful practices that can help both sides reduce the time and cost of project reviews. The report also includes a series of model agreements that both parties can use and amend as needed.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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