CONTRACT TIME DETERMINATION TOOLKIT FOR HIGHWAY PROJECTS

Quick Start Manual

VERSION II
October 2020

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1 General Instructions

This quick start tutorial is designed to help users become familiar with the ***Contract Time Determination Toolkit for Highway Projects*** **(CTD4HP)**. This user-friendly toolkit helps highway agencies establish and maintain a systematic approach to determine credible and defensible contract times for projects using conventional and alternative contracting methods.

CTD4HP consists of five toolsets covering five main topics of contract time determination (CTD):

1. CTD for design-bid-build (DBB) projects.
2. CTD for urban projects with incentive provisions.
3. CTD for projects using alternative project delivery methods (APDMs).
4. Relationship of contract time to risk management.
5. Post-construction contract time evaluation and feedback loop.

Each toolset contains tools that support a step-by-step procedure for its corresponding topic (e.g., DBB projects, urban projects with incentive provisions, APDM projects, risk management, or post-construction feedback). Depending upon a specific step, the supporting tools can be automated tools, semiautomated tools, templates, or checklists. A tool description accompanies each tool to provide detailed information for usage.

1.1. Getting Started

To use the tool, the user should click the **Enable Content, Enable Editing,** or **Enable Macros** button that appears when the tool is first opened (depending on operating systems) (Figure 1). If a user's computer is set up to enable macros automatically in advance, the user will not see the Security Warning Dialogue Box.

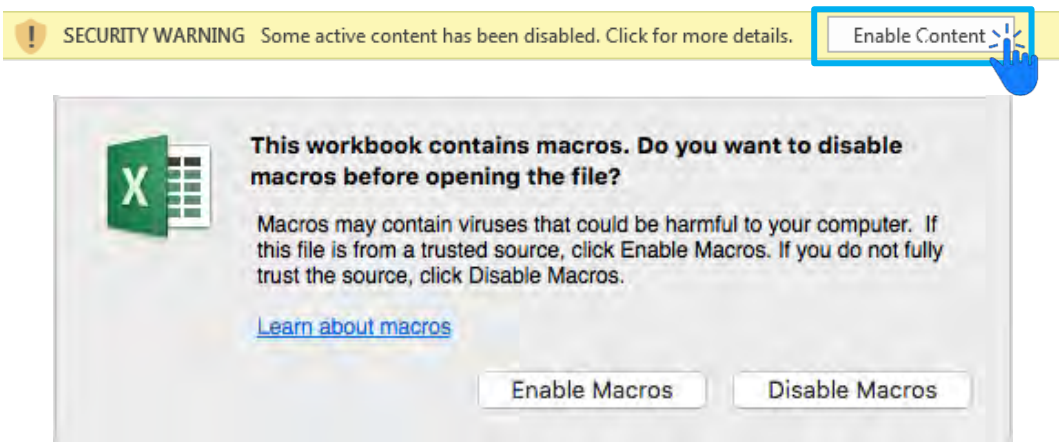


Figure 1. Security Warning Dialogue Box.

1.2. Launching CTD4HP

Once the tool is opened, the user can see the **Main Page**, as shown in Figure 2. The user is provided with a brief introduction to the tool. The toolkit includes five toolsets corresponding to the five main topics (e.g., DBB projects, urban projects with incentive, APDM projects, risk management, or post-

construction feedback). Five buttons represent the topics. To go to a specific toolset, the user should click on the associated button.

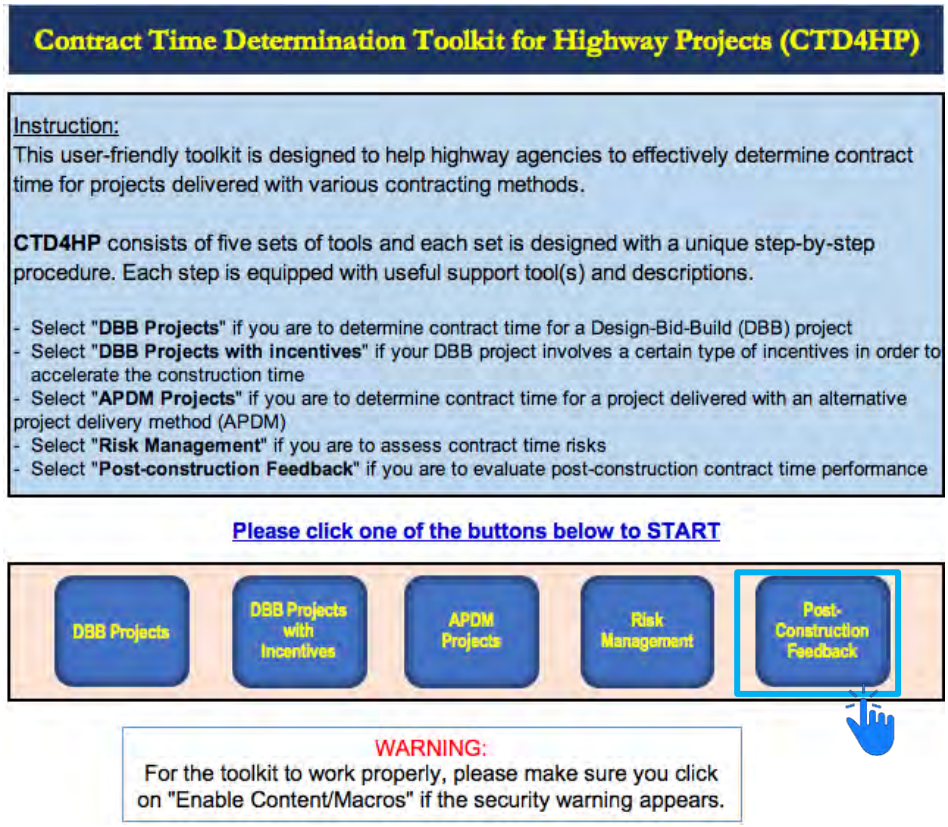


Figure 2. Main Page of CTD4HP.

Each of the following sections provides detailed instructions for one of the five toolsets:

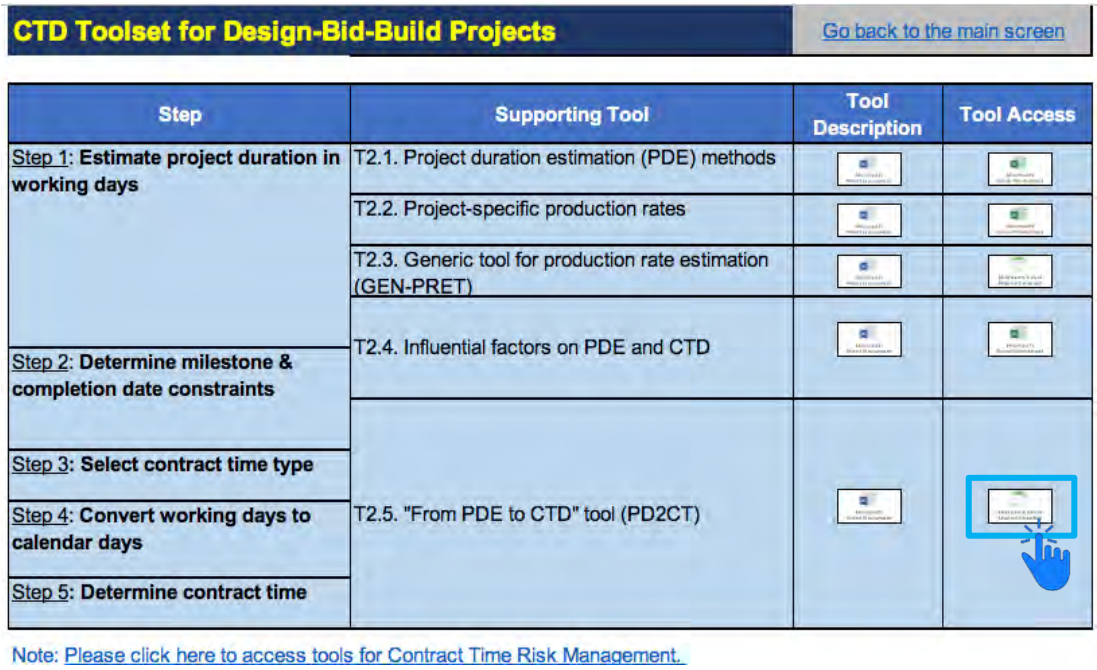
- Section 2: CTD Toolset for Design-Bid-Build Projects.
- Section 3: CTD Toolset for Design-Bid-Build Projects with Incentive Provisions.
- Section 4: CTD Toolset for Projects Using Alternative Project Delivery Methods.
- Section 5: CTD Toolset for Risk Management.
- Section 6: CTD Toolset for Post-Construction Contract Time Evaluation and Feedback Loop.

2 CTD Toolset for Design-Bid-Build Projects

Figure 3 shows the summary page of the **CTD Toolset for Design-Bid-Build Projects**. The toolset contains five supporting tools, as shown in the second column:

- T2.1. Project duration estimation (PDE) methods.
- T2.2. Project-specific production rates.
- T2.3. Generic tool for production rate estimation.
- T2.4. Influential factors on PDE and CTD.
- T2.5. "From PDE to CTD" tool.

Each tool supports one or more steps in the proposed CTD procedure for DBB projects (see the “Step” column). The third and fourth columns contain icons to access tool descriptions and tools. Users should double-click on the icons to access the corresponding files.



CTD Toolset for Design-Bid-Build Projects | Go back to the main screen

Step	Supporting Tool	Tool Description	Tool Access
Step 1: **Estimate project duration in working days**	T2.1. Project duration estimation (PDE) methods		
	T2.2. Project-specific production rates		
	T2.3. Generic tool for production rate estimation (GEN-PRET)		
Step 2: **Determine milestone & completion date constraints**	T2.4. Influential factors on PDE and CTD		
Step 3: **Select contract time type**	T2.5. "From PDE to CTD" tool (PD2CT)		
Step 4: **Convert working days to calendar days**			
Step 5: **Determine contract time**			

Note: Please click here to access tools for Contract Time Risk Management.

Figure 3. CTD Toolset for DBB Projects.

T2.1. Project Duration Estimation Methods

This tool serves as a comprehensive guide for existing and potential PDE methods. The home page lists the PDE methods (see Figure 4). To learn more about a method, click on it.

Project Duration Estimation Methods

Please click on the method to see more detailed information

Code	Method
M1	Bar Charts/Gantt Charts
M2	Critical Path Method
M3	Extended applications of CPM: Last Planner® System of Production Control
M4	Extended applications of CPM: 4D Scheduling using Building Information Modeling
M5	Program Evaluation and Review Technique
M6	Estimated Cost Method
M7	Multiple Regression
M8	Linear Scheduling
M9	Artificial Neural Network
M10	Case-Based Reasoning
M11	Monte-Carlo Simulation

Figure 4. Home Page of the PDE Method Tool.

To go back to the home page, click on "Back to home page," located at the top left corner of each worksheet (see Figure 5).

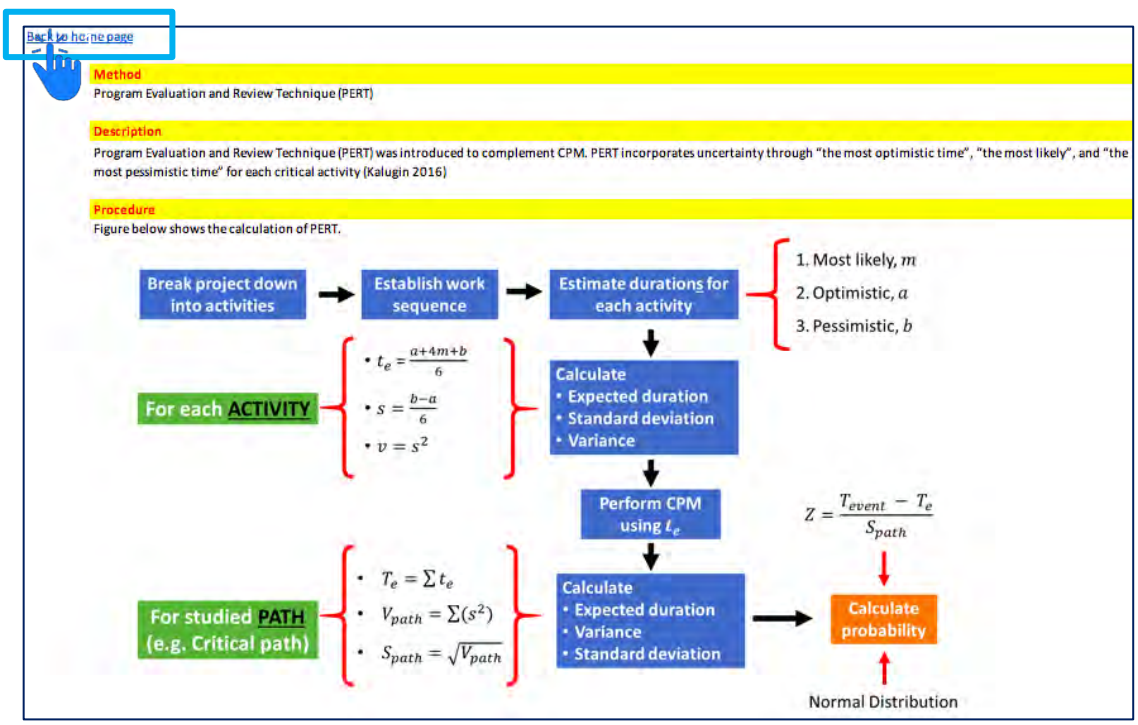


Figure 5. Screenshot of a PDE Method.

T2.2. Project-Specific Production Rates

This tool summarizes how 12 major influential factors on production rate are considered by state departments of transportation (DOTs) in the United States. For each factor, the tool briefly mentions the method currently used by some state DOTs and provides links to access the original DOT sources (see

Figure 6). To learn more about the practice of a specific DOT, click the link or the icon in the rightmost column, which will open the source of the information (e.g., table, tool, etc.).

Project-Specific Production Rates (PRs)

How do highway agencies currently consider influential factors on production rate estimation?

No.	Factor	State	Tool	Method	Source
1	Maintenance of traffic	FL	PR table	Three categories of production rates (i.e., low, average, and high) for different levels of traffic.	
		MO	PR table	Different PRs for heavy & light traffic	
		TX	PR table	Different PRs for heavy & light traffic	
		VA	PR table	PR adjustment factors for ligh, moderate, and high traffic conditions Light = 1.0, Moderate = 0.88, High = 0.70	
		WI	PR estimation tool	Different PRs for low, moderate, and high traffic	
2	Project complexity	VA	PR table	PR adjustment factors for low, medium, and high complexity Light = 1.0, Moderate = 0.85, High = 0.70	Click here
3	Coordination with utilities & relocation of utilities	FL	PR table	Different PRs for different levels of existing facilities	Click here
		WI	PR estimation tool	Different PRs for few utilities, some utilities, and significant utilities	Click here

Figure 6. Screenshot of the Home Page of the Project-Specific Production Rate Tool.

T2.3. Generic Tool for Production Rate Estimation

This generic tool for production rate estimation (GEN-PRET) can be applied by any DOTs that maintain or are willing to calculate production rates of historical projects to establish a state-specific automated tool for estimating production rates. A DOT can use GEN-PRET to define its own factors influencing a specific construction activity and input corresponding historical data of the activity into the tool. Given the information of a new project, the tool can output the number of past projects that have similar characteristics with the new project, statistical measures of production rates (e.g., mean, median, first quartile, and third quartile), and two production rate estimates using two methods: linear regression and case-based reasoning.

Since GEN-PRET allows DOTs to establish a DOT-specific tool, the tool involves two phases:

- Tool development using historical data.
- Tool application for a new project.

Steps for the tool development phase are as follows:

Step 1: In the "Historical Data" sheet, input the highway agency name, activity description, and unit of measurement (see Figure 7). Each Excel file corresponds to a construction activity. Subsequently, identify the factors that influence the production rate of the activity, including factor name, variable name, and variable coding (e.g., 1 = urban project and 0 = rural project).

Generic Tool for Production Rate Estimation

Tool Development Using Historical Data

Input

Provide input for orange cells

Highway agency: ABC DOT

Activity description: TOPSOIL-SALVAGING AND PLACING

Unit of measurement: CUYD

Step 1. Identify the factors that influence the production rate of the activity

1. Apart from "Quantity", please identify at most 10 CATEGORICAL factors that the agency wants to consider.
2. For each factor, please input "Factor Name", "Variable Name", and "Variable Coding".

No.	Factor Name	Variable Name	Variable Coding
1	Project work type	Work_Type	E.g., 110 = Reconstruction/New Construction
2	District location of the project	District	1=District 1, 2=District 2, 3 = District , 4 = District 4, and 5 = District 5
3	Large project (>= $2M) or small projet (< $2M)	Budget	1 = Large project and 0 = Small project
4	Urban or rural area	Urban	1 = Urban project and 0 = Rural project
5	Season of work (e.g., construction season or winter season)	Season	1= Winter Season and 0 = Construction Season
6			
7			
8			
9			
10			

Figure 7. GEN-PRET—Step 1 of Tool Development Using Historical Data.

Step 2: Input the corresponding historical data of the activity (see Figure 8). To go to the application phase, click on "Go to 'New Project Screen.'"

Step 2. Input the agency's historical data of the activity

1. Please input the historical data of the activity according to the variables defined in Step 1.
2. The tool allows at most 1,000 projects.
3. If there is a missing value of an input variable, please keep the corresponding cell blank. Do not input 0.

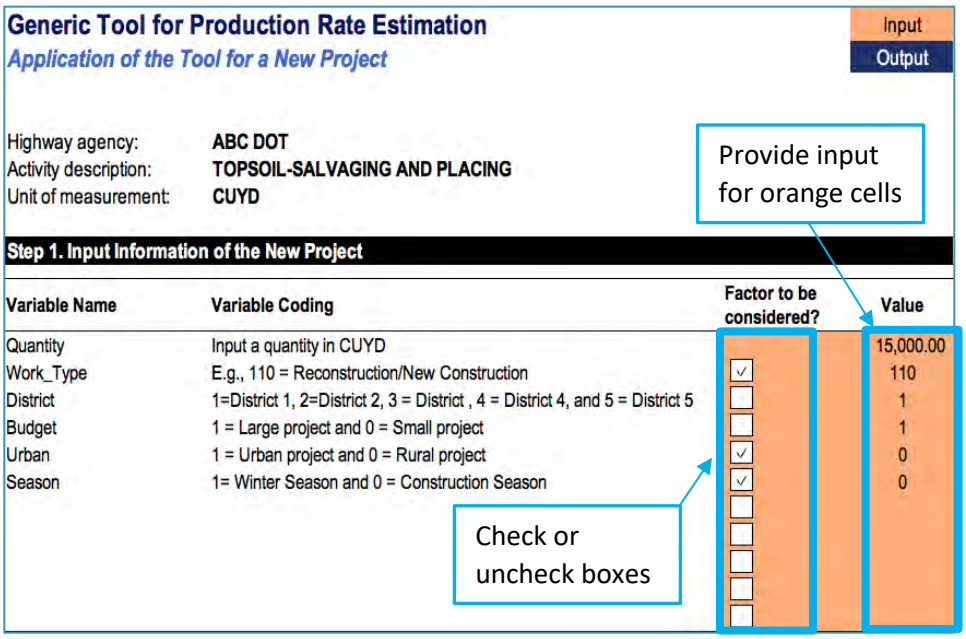
Go to "New Project Screen"

No.	Project_ID (Optional)	Influential factor										Quantity	Production Rate
		Work_Type	District	Budget	Urban	Season	N/A	N/A	N/A	N/A			
1	0920009000	110	5	1	0	1						65,290.3	10,881.7
2	1016005000	110	5	1	0	0						7,981.1	1,140.2
3	1016013000	110	5	1	0	1						14,491.4	2,415.2
4	1027021000	510	1	0	0	0						1,308.0	654.0
5	1027039000	510	1	0	0	1						723.0	120.5
6	1027079000	110	1	1	0	0						24,963.9	1,313.9
7	1027089000	650	1	1	0	1						10,516.7	3,505.6
8	1233020000	150	1	1	0	0						7,199.6	2,399.9
9	1289011000	110	1	1	0	0						48,479.7	5,386.6
10	1420044000	110	2	1	0	0						24,484.6	3,060.6
11	1420053000	110	2	1	0	0						32,183.3	10,727.8
12	1744030000	110	1	1	0	0						42,099.7	3,827.2
13	2015094000	110	1	1	0	0						32,304.8	3,230.5
14	2015114003	110	1	1	0	0						14,568.7	7,284.4
15	2015115000	110	1	1	0	1						9,995.1	1,999.0
16	2015116000	110	1	0	0	1						9,401.6	2,350.4
17	2016117000	110	1	1	0	0						11,246.0	2,811.5
18	2016118000	110	1	1	0	0						15,296.5	3,059.3
19	2019027000	150	2	1	0	0						18,809.7	3,134.9
20	2024011000	150	4	1	0	0						44,269.0	4,918.8
21	2024020000	150	4	1	0	0						28,902.8	2,627.5
22	2038073000	110	1	1	1	0						18,751.4	2,343.9

Figure 8. GEN-PRET—Step 2 of Tool Development Using Historical Data.

Steps for applying the tool to a new project are as follows:

Step 1: Type in the values of the input variables for a new project and decide whether an input variable is considered in the estimation by checking or unchecking the corresponding box (see Figure 9).



Generic Tool for Production Rate Estimation

Application of the Tool for a New Project

Input
Output

Highway agency: **ABC DOT**
Activity description: **TOPSOIL-SALVAGING AND PLACING**
Unit of measurement: **CUYD**

Provide input for orange cells

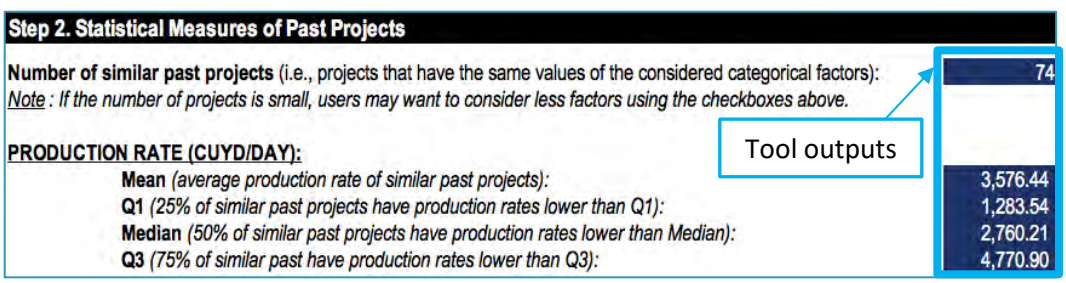
Step 1. Input Information of the New Project

Variable Name	Variable Coding	Factor to be considered?	Value
Quantity	Input a quantity in CUYD		15,000.00
Work_Type	E.g., 110 = Reconstruction/New Construction	✓	110
District	1=District 1, 2=District 2, 3 = District , 4 = District 4, and 5 = District 5	☐	1
Budget	1 = Large project and 0 = Small project	☐	1
Urban	1 = Urban project and 0 = Rural project	✓	0
Season	1= Winter Season and 0 = Construction Season	✓	0
		☐	
		☐	
		☐	
		☐	
		☐	

Check or uncheck boxes

Figure 9. GEN-PRET—Input Information of the New Project.

Step 2: Based on the provided input, the tool will output the number of similar projects and the production rate range of those projects in blue cells (see Figure 10). If the number of similar projects is small, consider unchecking some of the factors in Step 1.



Step 2. Statistical Measures of Past Projects

Number of similar past projects (i.e., projects that have the same values of the considered categorical factors): 74
Note : If the number of projects is small, users may want to consider less factors using the checkboxes above.

Tool outputs

PRODUCTION RATE (CUYD/DAY):

Mean *(average production rate of similar past projects):*	3,576.44
Q1 *(25% of similar past projects have production rates lower than Q1):*	1,283.54
Median *(50% of similar past projects have production rates lower than Median):*	2,760.21
Q3 *(75% of similar past have production rates lower than Q3):*	4,770.90

Figure 10. GEN-PRET—Statistical Measures of Past Similar Projects.

Step 3: GEN-PRET will also output the estimated production rates for the activity using linear regression and case-based reasoning (see Figure 11). For the case-based reasoning method, users can change the number of top similar projects used for the production rate calculation.

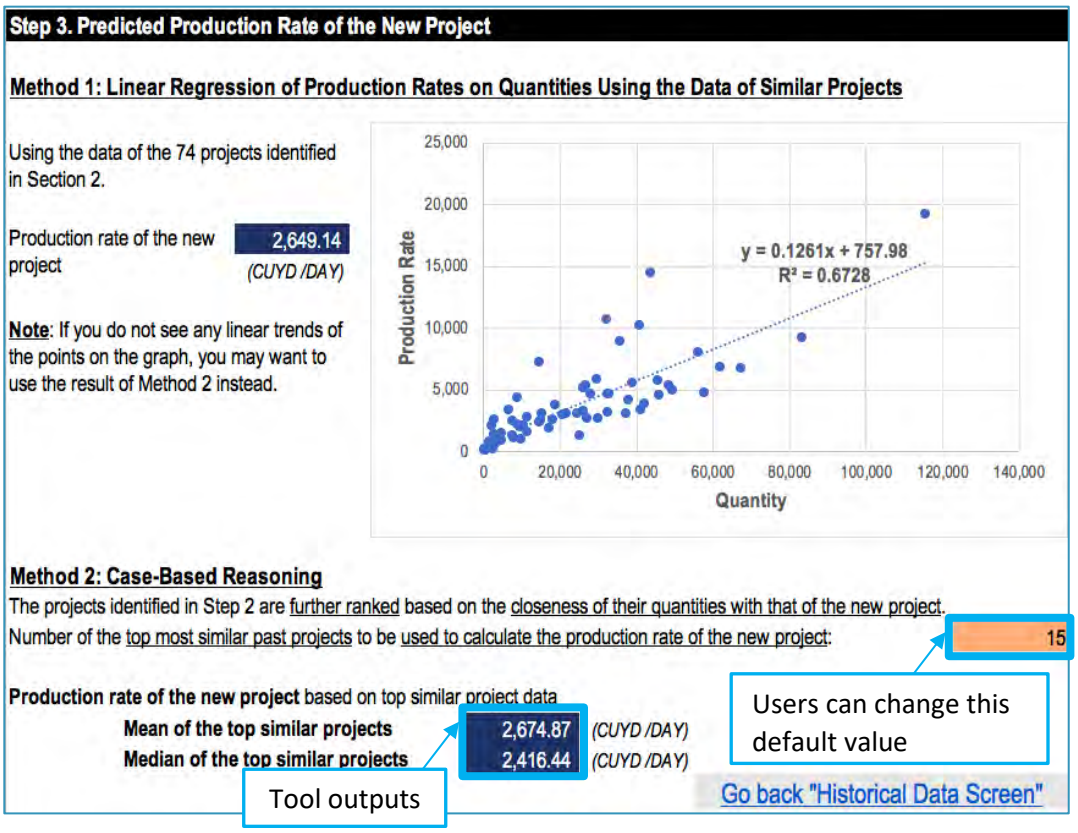
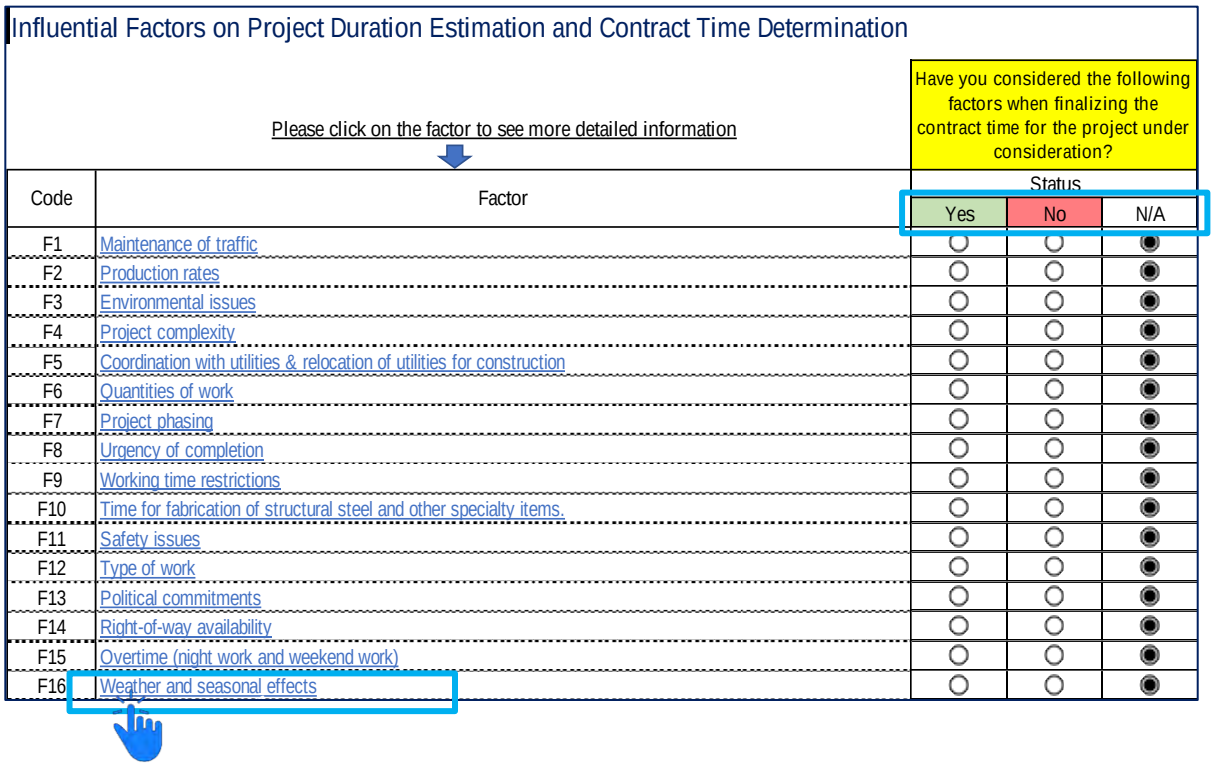


Figure 11. GEN-PRET—Predict the Production Rate of the New Project.

T2.4. Influential Factors on PDE and CTD

This tool offers a comprehensive list of influential factors on PDE or CTD and a detailed description of each factor.

The home page lists 42 factors influencing PDE/CTD. To learn more about a factor, click the factor on the home page (see Figure 12), and the tool will open the corresponding worksheet that contains detailed information on the selected factor.



Influential Factors on Project Duration Estimation and Contract Time Determination

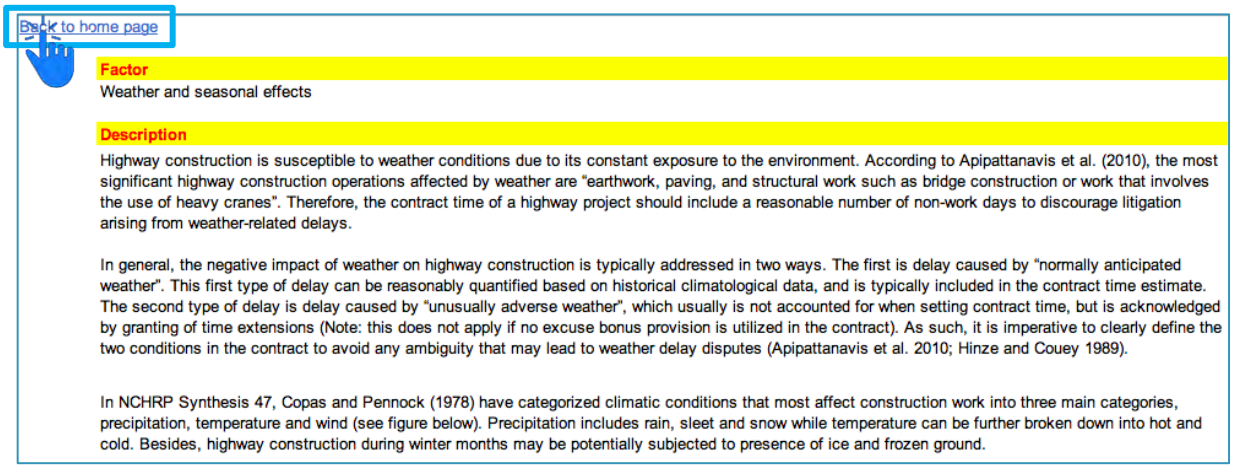
Please click on the factor to see more detailed information

Have you considered the following factors when finalizing the contract time for the project under consideration?

Code	Factor	Status: Yes	Status: No	Status: N/A
F1	Maintenance of traffic	○	○	◉
F2	Production rates	○	○	◉
F3	Environmental issues	○	○	◉
F4	Project complexity	○	○	◉
F5	Coordination with utilities & relocation of utilities for construction	○	○	◉
F6	Quantities of work	○	○	◉
F7	Project phasing	○	○	◉
F8	Urgency of completion	○	○	◉
F9	Working time restrictions	○	○	◉
F10	Time for fabrication of structural steel and other specialty items.	○	○	◉
F11	Safety issues	○	○	◉
F12	Type of work	○	○	◉
F13	Political commitments	○	○	◉
F14	Right-of-way availability	○	○	◉
F15	Overtime (night work and weekend work)	○	○	◉
F16	Weather and seasonal effects	○	○	◉

Figure 12. Screenshot of the Tool Home Page.

To view another factor, click on "Back to home page" (see Figure 13), and then click on the factor of interest.



Back to home page

Factor

Weather and seasonal effects

Description

Highway construction is susceptible to weather conditions due to its constant exposure to the environment. According to Apipattanavis et al. (2010), the most significant highway construction operations affected by weather are "earthwork, paving, and structural work such as bridge construction or work that involves the use of heavy cranes". Therefore, the contract time of a highway project should include a reasonable number of non-work days to discourage litigation arising from weather-related delays.

In general, the negative impact of weather on highway construction is typically addressed in two ways. The first is delay caused by "normally anticipated weather". This first type of delay can be reasonably quantified based on historical climatological data, and is typically included in the contract time estimate. The second type of delay is delay caused by "unusually adverse weather", which usually is not accounted for when setting contract time, but is acknowledged by granting of time extensions (Note: this does not apply if no excuse bonus provision is utilized in the contract). As such, it is imperative to clearly define the two conditions in the contract to avoid any ambiguity that may lead to weather delay disputes (Apipattanavis et al. 2010; Hinze and Couey 1989).

In NCHRP Synthesis 47, Copas and Pennock (1978) have categorized climatic conditions that most affect construction work into three main categories, precipitation, temperature and wind (see figure below). Precipitation includes rain, sleet and snow while temperature can be further broken down into hot and cold. Besides, highway construction during winter months may be potentially subjected to presence of ice and frozen ground.

Figure 13. Screenshot of an Influential Factor.

To use this tool as a checklist, evaluate whether each factor has been considered in the CTD procedure for the specific project and perform the following on the home page (Figure 12):

- Select "yes" to indicate the factor has been accounted for. The factor will then be highlighted in green.

- Select “no” if this factor is applicable to the project under consideration but has not been considered. The factor will be highlighted in red, indicating further action is required.
- Select “n/a” if this factor does not apply to the project under consideration. Use this option only if confident that it is not applicable.

T2.5. “From PDE to CTD” Tool

The “From PDE to CTD” tool (PD2CT) helps determine contract time given a project duration estimate in working days. The primary function of PD2CT is to help DOTs perform the conversion systematically and accurately with consideration of multiple factors that influence contract time. The tool also helps DOTs determine constraints, select contract time type, and determine contract time.

Step 1: Enter the following information: the earliest contract (construction) start date and project duration in working days (see Figure 14).

Step 2: To use the constraint checking function, enter the required completion date (i.e., the date the agency wants the project finished by) for each applicable category (see Figure 14).

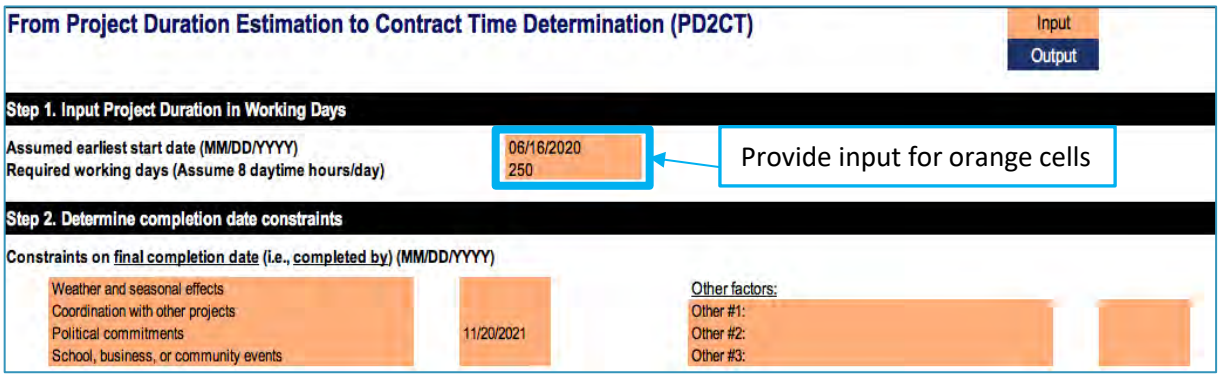


Figure 14. PD2CT—Steps 1 and 2.

Step 3: Answer some relevant questions to select the contract time type (see Figure 15). If “working day” is the type of contract time, the conversion from working days to calendar days is unnecessary. Otherwise, continue with these steps.

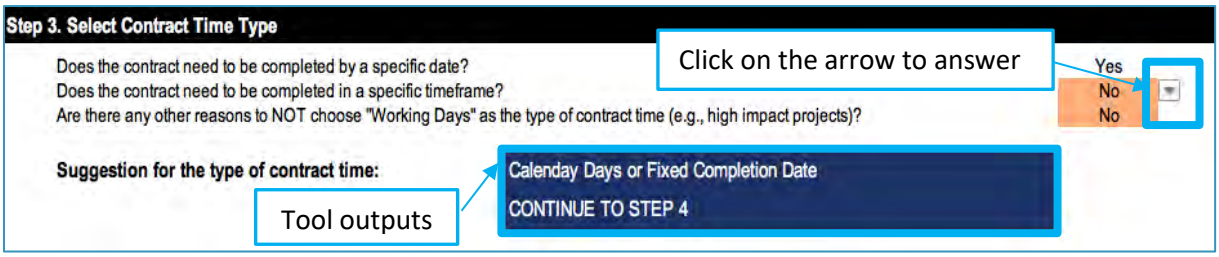


Figure 15. PD2CT—Select Contract Time Type.

Step 4: Convert working days to calendar days as follows:

- Enter relevant information to describe the workday calendar(s) that applies to the project under consideration (see Figure 16). The tool can accommodate up to three different types of workday

calendars for three consecutive periods of time. For each period, enter the start date and select one type of calendar.

Step 4. Convert Working Days to Calendar Days

Workday calendar

This tool allows for choosing at most three different types of calendar for three consecutive periods of time.

1. If you need only one calendar, please do NOT type in the start dates of Periods 2&3. The start date of Period 1 is equal to the assumed earliest start date.
2. If you need two calendars, please type in the start date of Period 2 and do NOT type in the start date of Periods 3.
3. If you need three calendars, please type in the start dates of Periods 2&3.

Period 1	Period 2	Period 3
Start date of Period 1 (MM/DD/YYYY) 06/16/2020	**Start date of Period 2 (MM/DD/YYYY)**	**Start date of Period 3 (MM/DD/YYYY)**
Choose ONLY ONE CALENDAR for Period 1:	**Choose AT MOST ONE CALENDAR for Period 2:**	**Choose AT MOST ONE CALENDAR for Period 3:**

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Standard five-day weeks (Mon->Fri, 8 hours/day)		8	8	8	8	8	
Seven-day weeks (8 hours/day)	8	8	8	8	8	8	8
Night work: five-day weeks (Mon->Fri, 4 hours/day)		4	4	4	4	4	
Customized workdays (Hours/Day)		8.0	8.0	8.0	8.0	8.0	8.0

Figure 16. PD2CT—Workday Calendar.

- If necessary, enter the adjustment factor to account for reduced or increased productivity during a particular period (see Figure 17).
- Select or type in non-working days (see Figure 17):
  - Select all holidays (non-working) that are recognized by the agency.
  - Enter the monthly anticipated non-working days caused by adverse weather conditions.
  - Enter any applicable non-working periods.
  - Enter any other specific non-working days.

Adjustment factor Period 1: 1 Period 2: 1 Period 3: 1

Adjustment factor = Actual productivity/Assumed productivity used to calculate the required working days.

If you think that the actual productivity will be lower than the assumed productivity, the adjustment factor <1.

If you think that the actual productivity will be larger than the assumed productivity, the adjustment factor >1.

Provide input for orange cells

Non-working days

Holidays (check all that apply)

- [x] New Year's Day
- [x] Martin Luther King Jr. Day
- [ ] President's Day
- [ ] Memorial Day
- [x] Independence Day
- [ ] Labor Day
- [ ] Columbus Day
- [ ] Veteran's Day
- [x] Thanksgiving Day
- [x] Christmas Day

Use checkboxes to select holidays

Monthly anticipated adverse weather days (in calendar days):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12	10	5	5	4	2	4	3	4	3	2	6

Shutdown periods due to winter and other constraints such as environment and landscaping,

Period 1 (MM/DD/YYYY)	From	12/01/2020	Thru	03/15/2021
Period 2 (MM/DD/YYYY)	From	12/01/2021	Thru	03/15/2022
Period 3 (MM/DD/YYYY)	From		Thru	
Period 4 (MM/DD/YYYY)	From		Thru	

Other specific non-working days (MM/DD/YYYY)

11/27/2020					
07/03/2020					

CLICK HERE TO GO TO THE NEXT STEPS

Figure 17. PD2CT—Adjustment Factors and Non-working Days.

- Click on "CLICK HERE TO GO TO THE NEXT STEPS" to obtain the project duration in fixed completion date or calendar days, as shown in Figure 18.

From Project Duration Estimation to Contract Time Determination (PD2CT) GO BACK TO THE START

Step 4. Convert Working Days to Calendar Days

Assumed start day (MM/DD/YYYY)	06/16/2020	06/23/2020	06/30/2020	07/07/2020	07/14/2020	07/21/2020	07/28/2020	08/04/2020	08/11/2020
Completion date (MM/DD/YYYY)	11/01/2021	11/08/2021	11/15/2021	11/19/2021	11/29/2021	03/21/2022	03/28/2022	04/04/2022	04/11/2022
Number of calendar days	504	504	504	501	504	609	609	609	609

Figure 18. PD2CT—Completion Date or the Number of Calendar Days.

Step 5: The tool checks the constraints and outputs the contract time (see Figure 19). The tool also produces a bar graph illustrating the effect of the start date on the number of calendar days (see Figure 20).

Step 5. Determine Contract Time

Check constraints on final completion date	Satisfied	Satisfied	Satisfied	Satisfied	Not satisfied	Not satisfied	Not satisfied	Not satisfied	Not satisfied
Contract time in fixed completion date	11/01/2021	11/08/2021	11/15/2021	11/19/2021	Reconsider Input	Reconsider Input	Reconsider Input	Reconsider Input	Reconsider Input
Contract time in calendary days	504	504	504	501	Reconsider Input	Reconsider Input	Reconsider Input	Reconsider Input	Reconsider Input
Detail:									
Weather and seasonal effects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									
Coordination with other projects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									
Political commitments	Satisfied	Satisfied	Satisfied	Satisfied	Not satisfied	Not satisfied	Not satisfied	Not satisfied	Not satisfied
Constraint on completion date	11/20/2021	11/20/2021	11/20/2021	11/20/2021	11/20/2021	11/20/2021	11/20/2021	11/20/2021	11/20/2021
Diff. (days) = Constraint - Completion date	19	12	5	1	-9	-121	-128	-135	-142
Diff. / # Calendar days	3.8%	2.4%	1.0%	0.2%	-1.8%	-19.9%	-21.0%	-22.2%	-23.3%
School, business, or community events	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									
Other #1:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									
Other #2:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									
Other #3:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Constraint on completion date									
Diff. (days) = Constraint - Completion date									
Diff. / # Calendar days									

Figure 19. PD2CT—Check Constraints and Determine Contract Time.

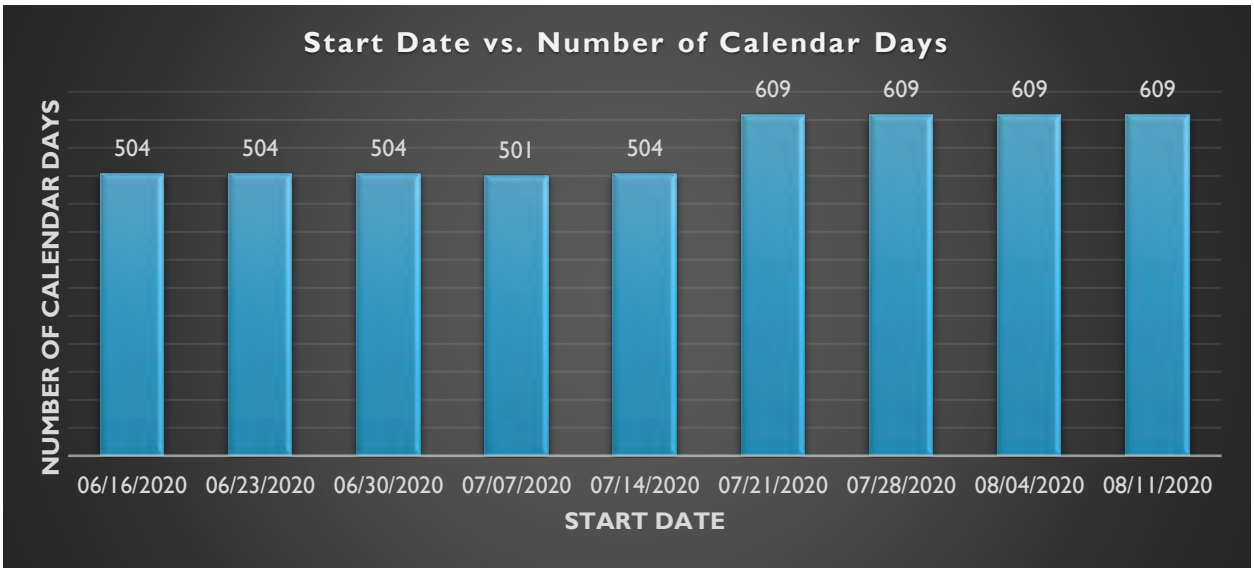


Figure 20. PD2CT—Start Date vs. Number of Calendar Days.

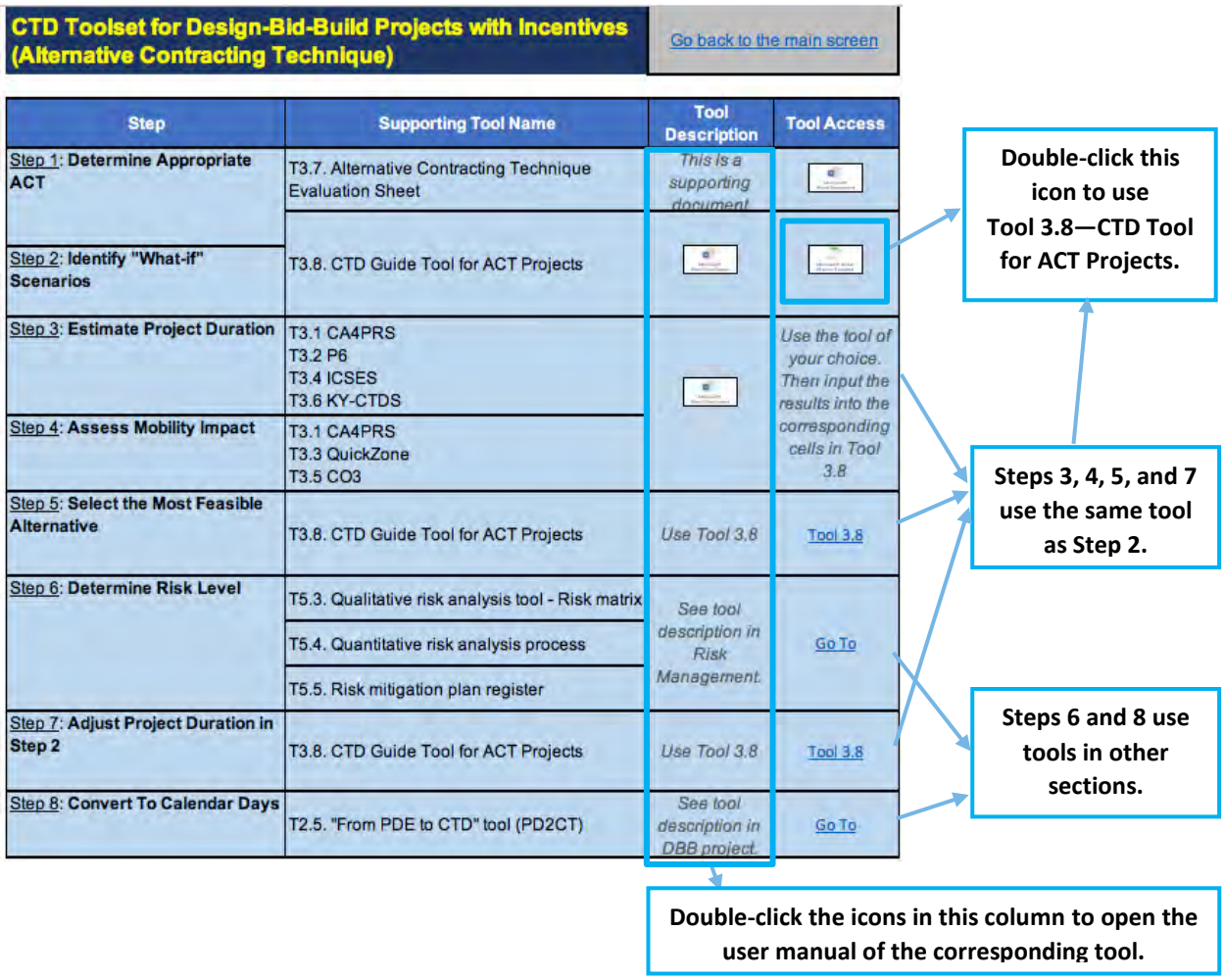
3 CTD Toolset for Design-Bid-Build Projects with Incentives

Figure 21 shows the summary page of the **CTD Toolset for Design-Bid-Build Projects with Incentives**. This toolset contains several supporting tools, as shown in the second column, labeled "Supporting Tool Name."

- Tools 3.1–3.6: Several existing tools that can be used in Steps 2 and 3.
- Tool 3.7: Alternative Contracting Technique Evaluation Sheet.
- Tool 3.8: CTD Guide Tool for ACT Projects.

Tool 3.7 is a document with detailed descriptions of several typical alternative contracting techniques (ACTs) used to incentivize a project, with their benefits, limitations, and best-use scenarios.

Tool 3.8 is an integrated CTD tool designed for DBB projects with incentives. These projects typically have high traffic volume. Thus, mobility impact is important to the CTD process of these projects.



CTD Toolset for Design-Bid-Build Projects with Incentives (Alternative Contracting Technique)

Go back to the main screen

Step	Supporting Tool Name	Tool Description	Tool Access
Step 1: **Determine Appropriate ACT**	T3.7. Alternative Contracting Technique Evaluation Sheet	*This is a supporting document*	
Step 2: **Identify "What-if" Scenarios**	T3.8. CTD Guide Tool for ACT Projects		
Step 3: **Estimate Project Duration**	T3.1 CA4PRS T3.2 P6 T3.4 ICSES T3.6 KY-CTDS		*Use the tool of your choice. Then input the results into the corresponding cells in Tool 3.8*
Step 4: **Assess Mobility Impact**	T3.1 CA4PRS T3.3 QuickZone T3.5 CO3		
Step 5: **Select the Most Feasible Alternative**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 6: **Determine Risk Level**	T5.3. Qualitative risk analysis tool - Risk matrix	*See tool description in Risk Management.*	Go To
	T5.4. Quantitative risk analysis process		
	T5.5. Risk mitigation plan register		
Step 7: **Adjust Project Duration in Step 2**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 8: **Convert To Calendar Days**	T2.5. "From PDE to CTD" tool (PD2CT)	*See tool description in DBB project.*	Go To

Figure 21. CTD Toolset for Design-Bid-Build Projects with Incentives (ACTs).

T3.7. Alternative Contracting Technique Evaluation Sheet

This supporting document helps users select the most appropriate ACT for the project. It assists users in developing a better understanding of the benefits, limitations, and best-use scenarios of each ACT.

T3.8. CTD Guide Tool for ACT Projects

Tool 3.8 is the main tool used to conduct the CTD for projects with incentives (i.e., ACTs). The main purpose of the tool is to provide the user with a clear and well-structured CTD framework consisting of eight steps (see Figure 22). Users still need external tools to complete several tasks and input the results of these tasks into this tool to continue the workflow of the framework.

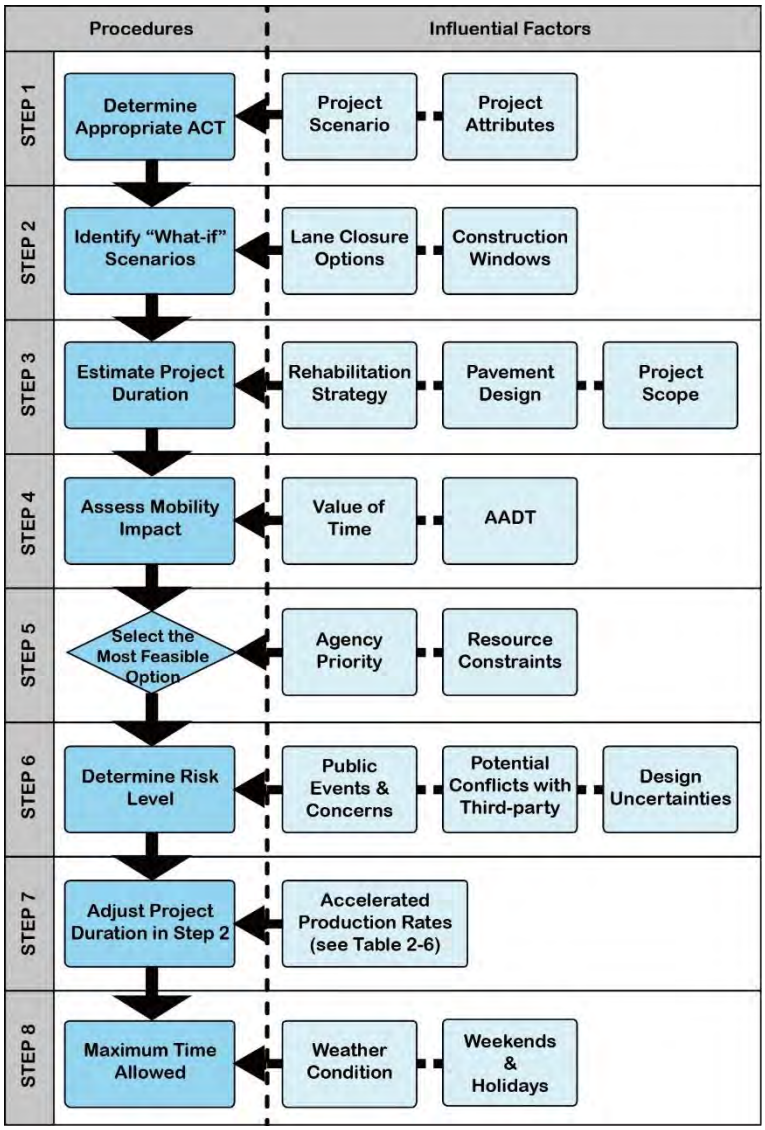
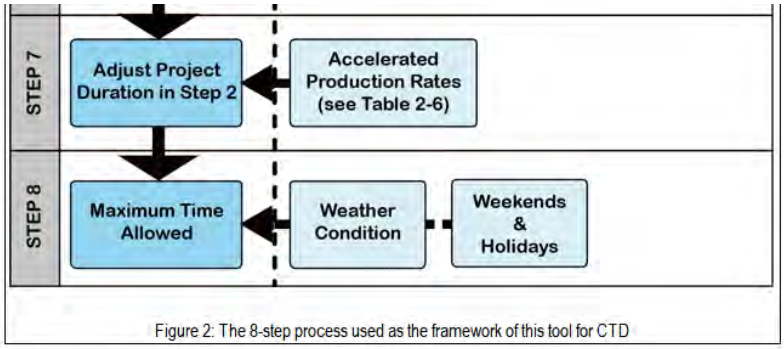


Figure 22. The Eight-Step CTD Process for Projects with ACTs.

General Instructions

The opening sheet of Tool 3.8 briefly introduces the framework (see Figure 22) of this tool and provides general instructions on how to find input cells and output cells. After reading the instructions, the user can proceed to Step 1 by clicking the button at the end of the instructions, as shown in Figure 23.



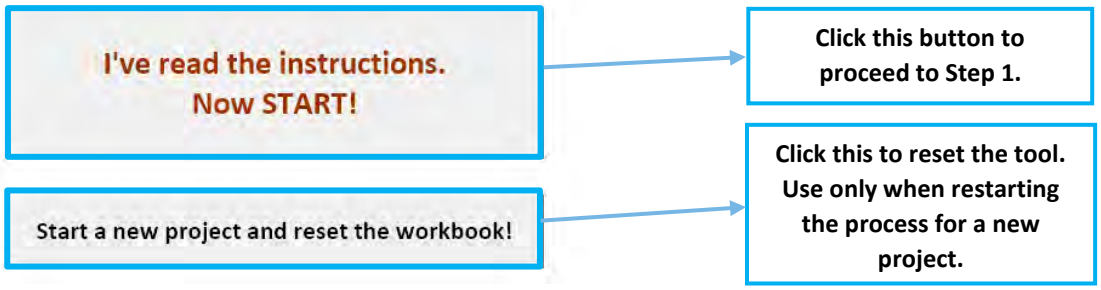


Figure 23. Proceed to Step 1 after Reading the General Instructions of Tool 3.8.

Step 1: Determine Appropriate ACT

In this step, the user goes through a checklist to determine the appropriate ACT for the current project. Tool 3.7 (supporting document on ACTs) can also help the user select the best ACT for the project. The process is shown in Figure 24.

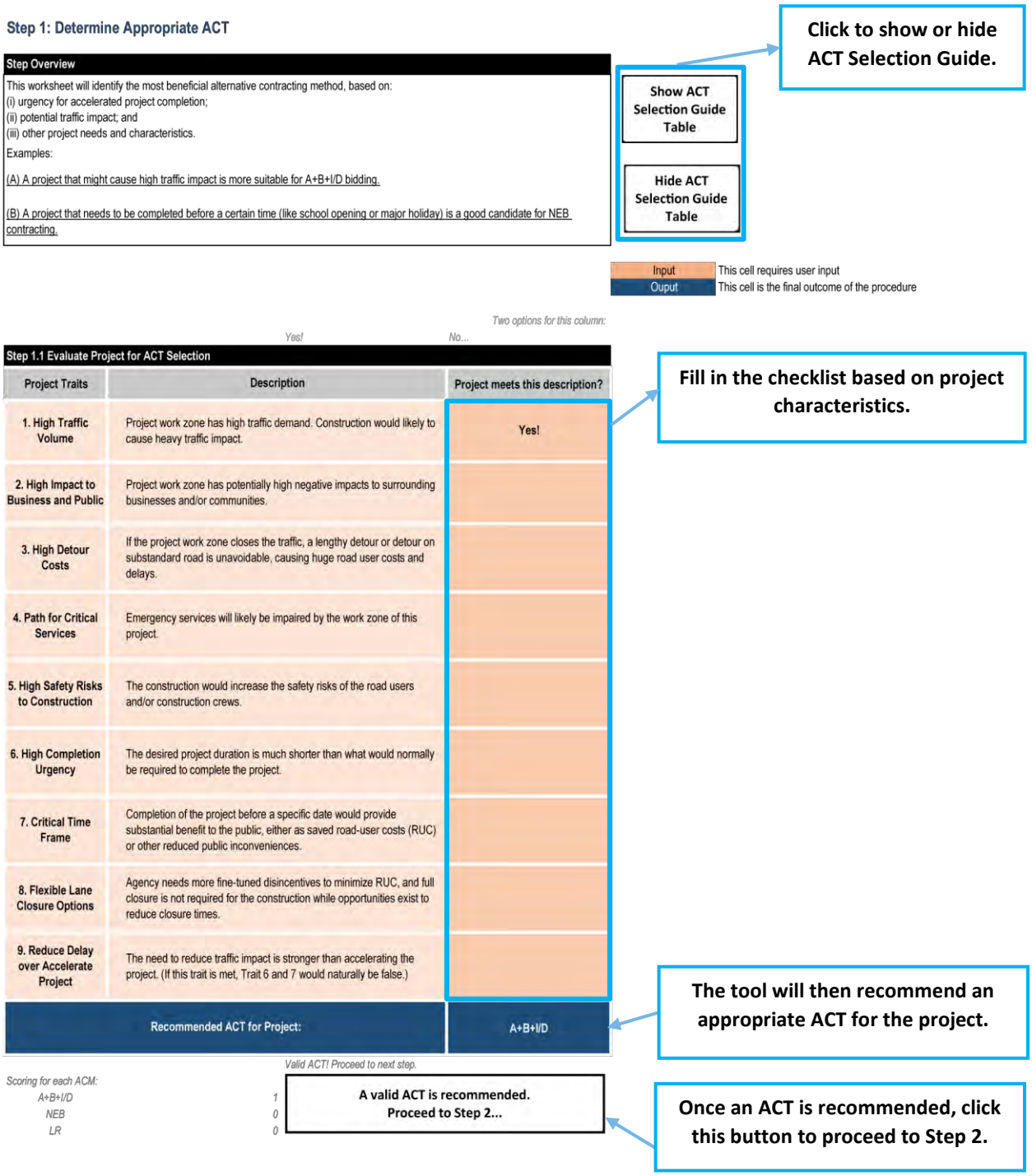


Figure 24. ACT Selection Procedure in the Integrated CTD Tool for Projects with Incentives.

Step 2: Identify an Alternative Construction Scenario

In this step, the user defines key project constraints and identifies an applicable construction time window for a construction alternative. The process is shown in Figure 25.

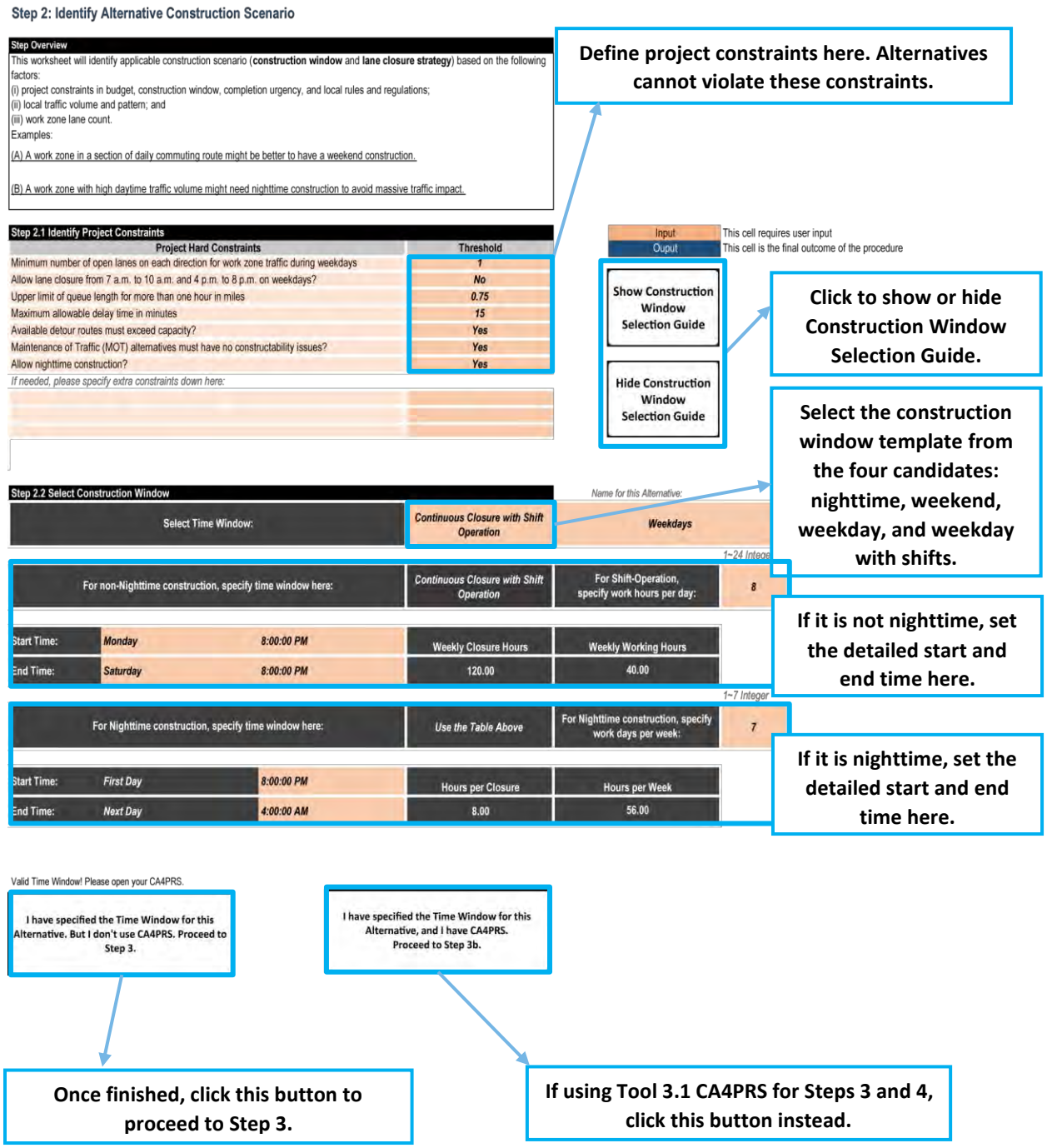


Figure 25. Define Construction Alternative.

Step 3: Estimate Project Duration

In this step, the user employs an external tool or method to estimate the project duration needed to complete the project with the identified construction alternative in Step 2 and then inputs the results into this tool in the form of the construction windows needed. If the user chooses to use CA4PRS in the last step, a detailed step-by-step guide is available to demonstrate how the user can get the estimated project duration with CA4PRS.

The procedure in Step 3 (or Step 3 with CA4PRS workflow) is shown in Figure 26.

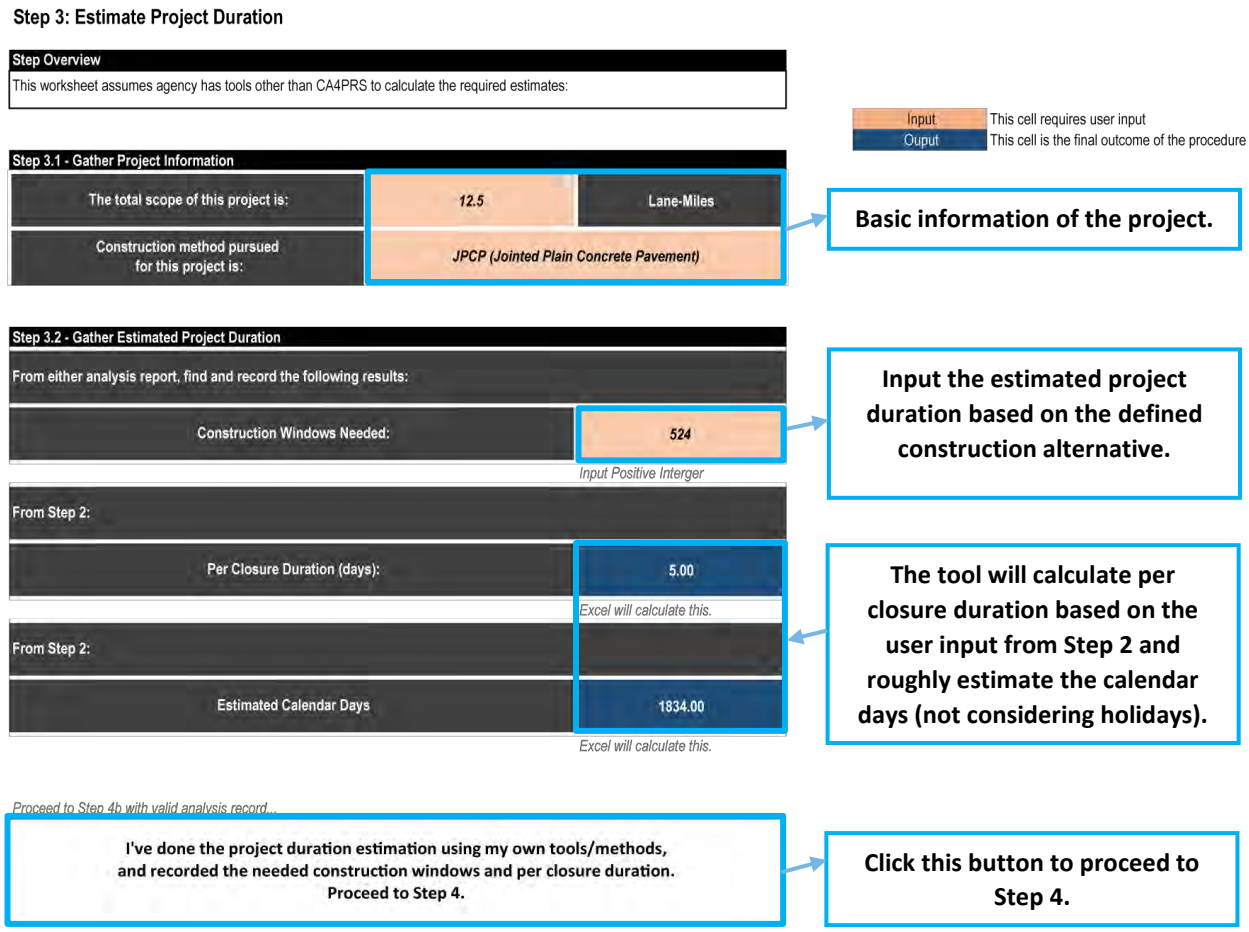


Figure 26. Fill in Project Duration Estimates.

If the user chooses the CA4PRS workflow in Step 2, the detailed guidelines shown in Figure 27 on how to use CA4PRS to acquire the needed results are available.

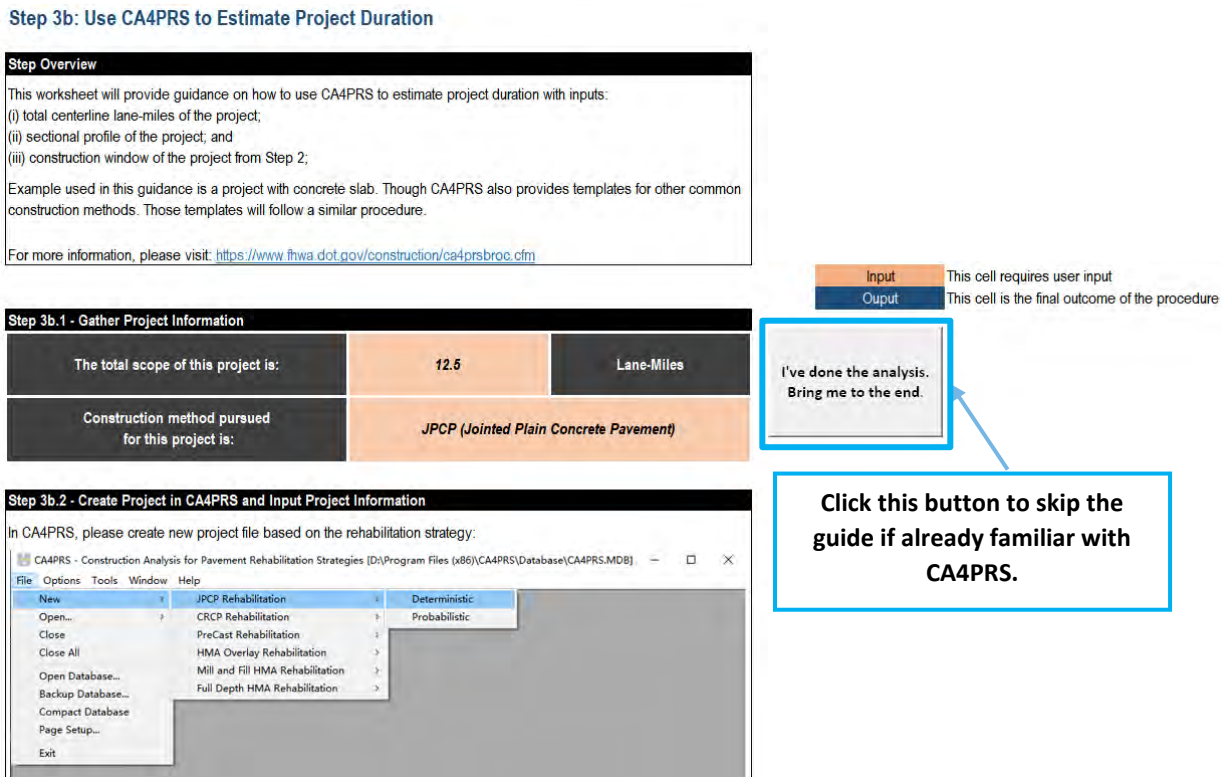


Figure 27. Fill in Project Scope Information.

At the end of this step, the user needs to fill in the estimated project duration based on the CA4PRS analysis, as shown in Figure 28.

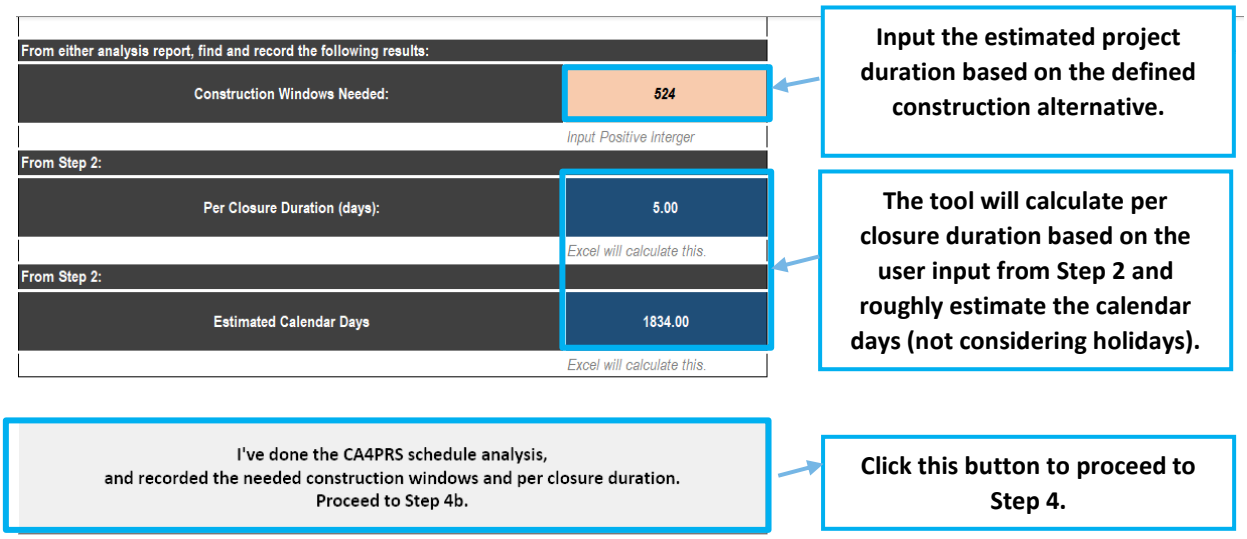


Figure 28. Fill in CA4PRS Schedule Analysis Results.

Step 4: Assess Mobility Impact

In this step, the user utilizes an external tool or method to estimate the mobility impact measured by road user cost and maximum delay for the identified construction alternative in Step 2 and then inputs the results into this tool. If the user chooses to use CA4PRS in Step 2, a detailed step-by-step guide is available to explain how to conduct traffic analysis with CA4PRS to get the results needed.

The procedure for Step 4 (or Step 4 with CA4PRS workflow) is shown in

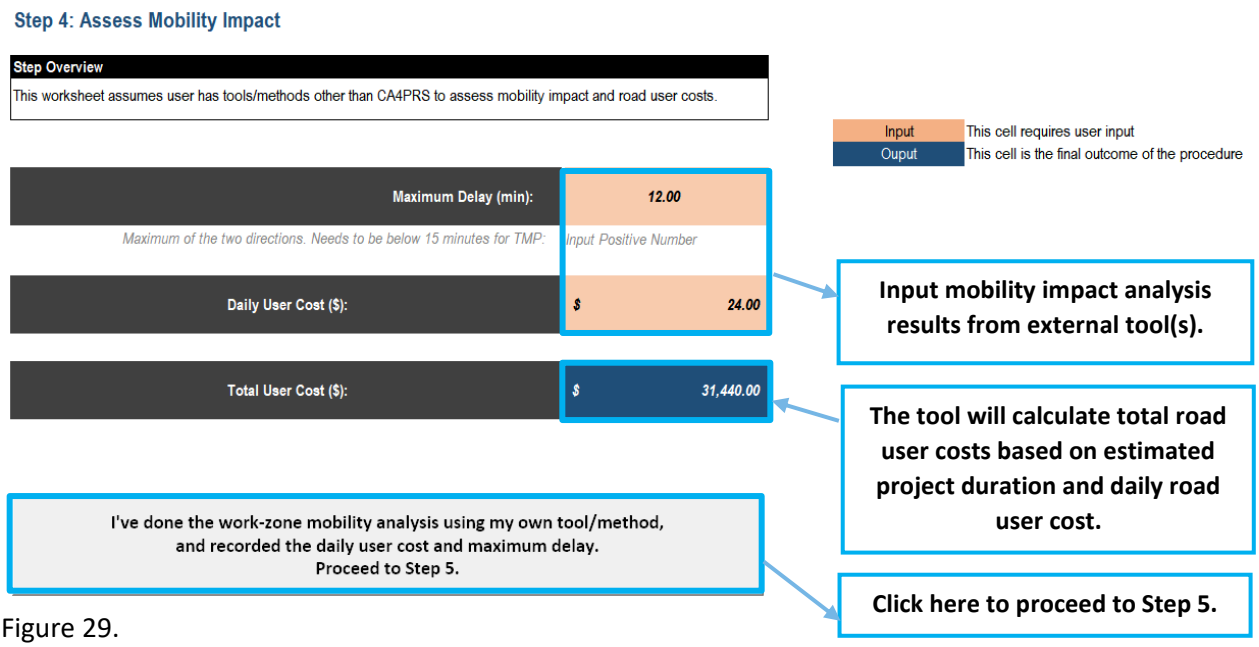


Figure 29.

Figure 29. Fill in Mobility Impact Results.

If the user chooses the CA4PRS workflow in Step 2, the detailed guidelines shown in Figure 30 on how to use CA4PRS to acquire the needed results are available.

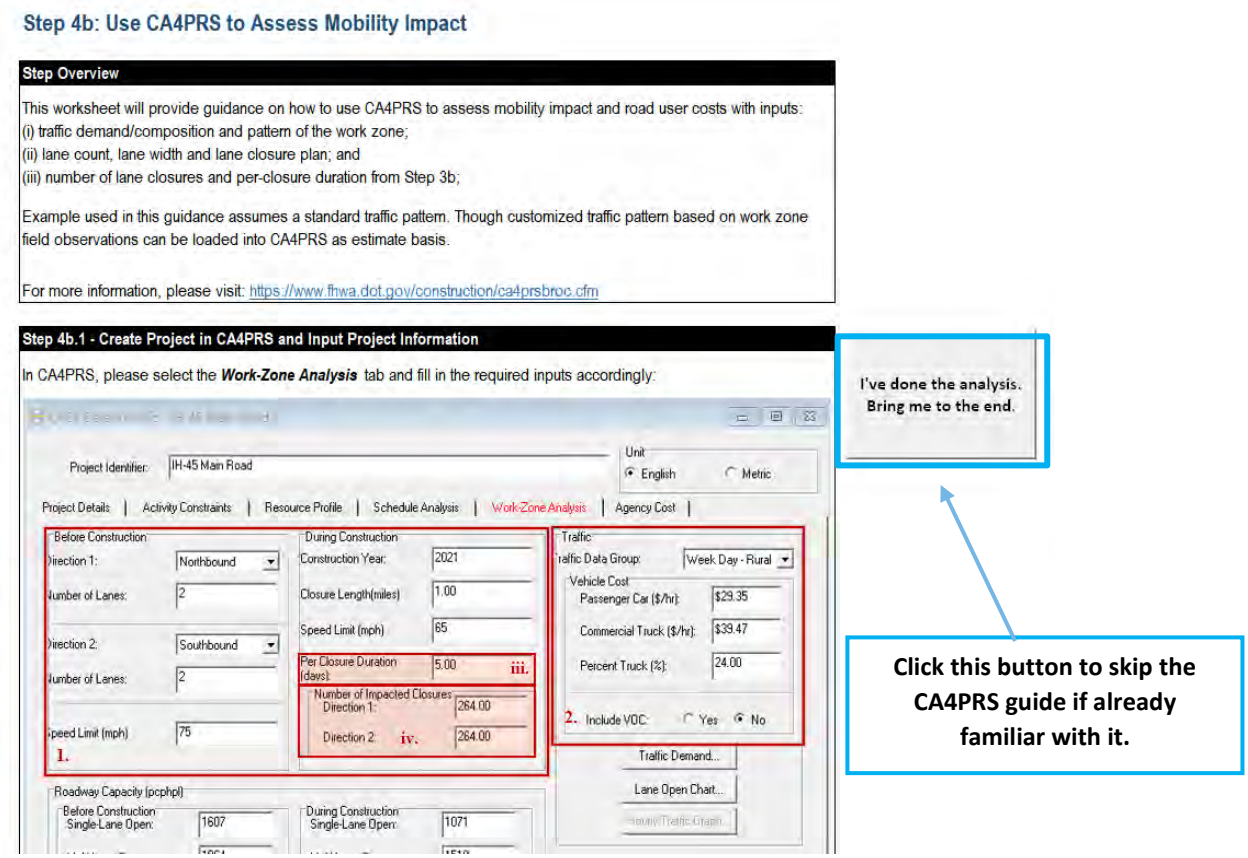


Figure 30. Fill in Work Zone Information.

At the end of this step, the user needs to fill in the traffic impact results based on the CA4PRS analysis, as Figure **31** illustrates.

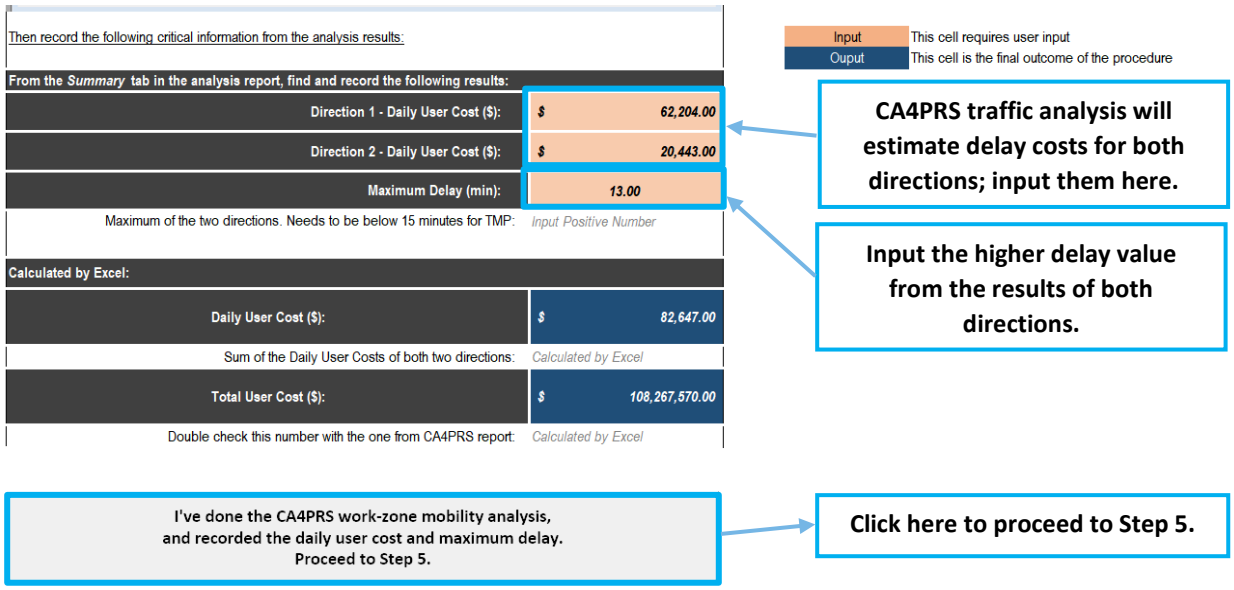


Figure 31. Fill in CA4PRS Mobility Analysis Results.

Step 5: Select the Best Alternative

In this step, the tool collects results from Steps 3 and 4 for each alternative, and the user defines project alternative evaluation criteria (such as project priority and rubrics) and evaluates each alternative based on these criteria. The first part of the procedure is to define project soft constraints and collect information on all alternatives, as shown in Figure 32.

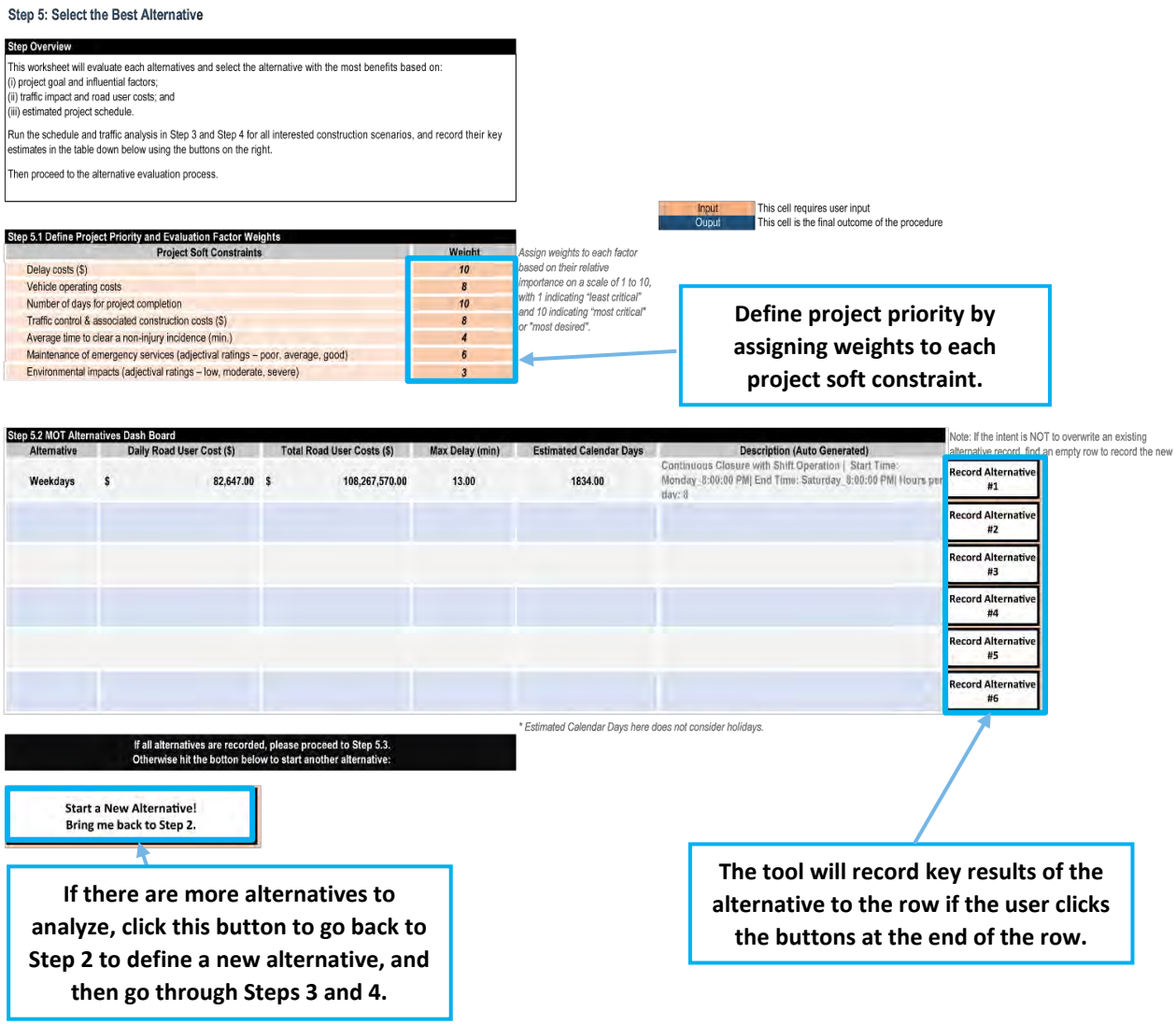


Figure 32. Part A of Step 5—Fill in Alternative Analysis Results.

Steps 2, 3, and 4 are repeated for all construction alternatives of the project.

Once the procedure is completed for all alternatives, the user goes through Steps 5.3 and 5.4 to select the best-value alternative. The procedure is shown in Figure 33.

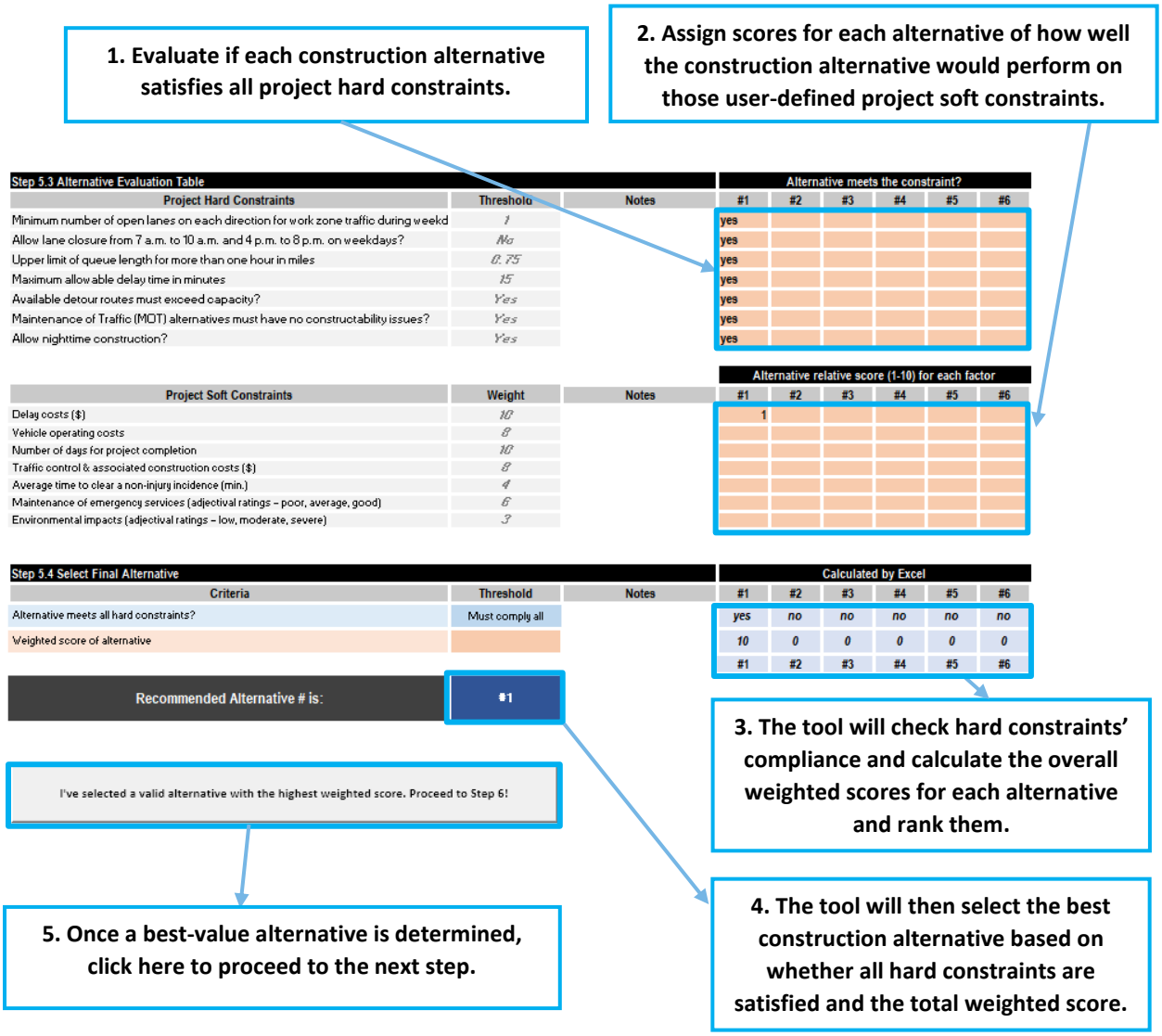


Figure 33. Part B of Step 5—Evaluate Each Alternative and Select the Best Alternative.

Step 6: Assess Risk Factors

This step uses the risk analysis tool discussed in more detail in Section 5. The user begins by going back to the main CTD toolset, as shown in Figure 34.

CTD Toolset for Design-Bid-Build Projects with Incentives (Alternative Contracting Technique)

Go back to the main screen

Step	Supporting Tool Name	Tool Description	Tool Access
Step 1: **Determine Appropriate ACT**	T3.7. Alternative Contracting Technique Evaluation Sheet	*This is a supporting document*	
Step 2: **Identify "What-if" Scenarios**	T3.8. CTD Guide Tool for ACT Projects		
Step 3: **Estimate Project Duration**	T3.1 CA4PRS T3.2 P6 T3.4 ICSES T3.6 KY-CTDS		*Use the tool of your choice. Then input the results into the corresponding cells in Tool 3.8*
Step 4: **Assess Mobility Impact**	T3.1 CA4PRS T3.3 QuickZone T3.5 CO3		
Step 5: **Select the Most Feasible Alternative**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 6: **Determine Risk Level**	T5.3. Qualitative risk analysis tool - Risk matrix	*See tool description in Risk Management.*	Go To
	T5.4. Quantitative risk analysis process		
	T5.5. Risk mitigation plan register		
Step 7: **Adjust Project Duration in Step 2**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 8: **Convert To Calendar Days**	T2.5. "From PDE to CTD" tool (PD2CT)	*See tool description in DBB project.*	Go To

In the CTD toolset, click this cell to access the risk analysis tool.

Figure 34. Access Risk Analysis Tool in the Unified CTD Toolset.

The user then goes back to Tool 3.8 and proceeds as shown in Figure 35.

Step 6: Assess Risk Factors

Step Overview

This worksheet will help you assess various risk factors for the final MOT alternative:

Please use the project risk analysis tool develop by NCHRP 08-114 team.

I've already evaluated all risk factors and assigned risk levels. Proceed to Step 7!

The Risk Level is too high. I want to modify my alternatives or start new one. Back to Step 2!

If the risk level is acceptable, click this button to proceed.

If the risk analysis indicates the risk is too high for the alternative, click this button to go back to Step 2 and start a new alternative.

Figure 35. Determine Risk Level in Tool 3.8.

Step 7: Adjust Project Duration and Incentive/Disincentive (I/D) Valuation

In this step, the user determines the I/D discount factor and acceleration factor based on the selected ACT and the agency's own practice and policy. The procedure is shown in Figure 36.

Step 7: Adjust Project Duration and I/D Valuation

Step Overview

Since ACM is expected to accelerate project schedule, this sheet will adjust final project duration of the final alternative based on:
(i) ACM type; and
(ii) project type and scope;

This sheet will also help determine the daily incentive/disincentive amount for A+B+I/D contracting by applying a discount factor (DF).

This section contains the user guidelines and some rules of thumb to determine an appropriate discount factor for I/D valuation.

Determine Discount Factor for Incentives

Incentive/Disincentive (I/D) valuation should be greater than contractor's acceleration costs (CA), but no more than the agency savings, represented by the Daily Road User Cost (DRUC). The daily I/D rate (A) equals to the DRUC listed above multiplied by a discount factor (DF) as follows:

A = DRUC x DF and **AC < A < DRUC**

Thus, determine the value of ***DF*** is critical for the accuracy of the CTD. Too high, contractors would be overpaid, which could be very politically controversial and likely fail to protect the benefit of the public; too low, contractors might not have much motivation to accelerate contract, as well as much less deterrance against schedule delay (since in most cases the incentive and disincentive amounts are the same).

However, there is very little well-established practice to calculate an accurate value of ***DF***. Here are some rules of thumb based on existing literature:

1. Generally, DF value should be between **0.25** and **0.5**.
2. Total incentive amount should be less than **5% of the total project cost** (FHWA guide).
3. Contract time should be expected to be an accelerated schedule (usually **15% faster**) for A+B+I/D contracting when contractors submit their biddings.
4. For NEB contracting, there is usually a desired project duration for the agencies that is often much shorter than normal project duration. The fix-amount bonus then should be based on the accelerated days.
5. For LR contracting, contractor usually will have some flexibility over project schedule. Lane rental fee should be based on CA4PRS traffic simulation for a single lane closure.

Input	This cell requires user input
Ouput	This cell is the final outcome of the procedure

Step 7.1 - Determine Discount Factor (DF) and Acceleration Factor

Discount Factor for I/D Valuation:	0.50
Acceleration Factor (for A+B+I/D & NEB):	15%

Input the determined discount factor and acceleration factor here.

Click the button below to get the adjusted final alternative snapshot...

Get Adjusted Final Alternative Snapshot

Click this button to command the tool to conduct the calculation.

Final Alternative Snapshot (Calculated by Excel)

Selected ACM for Final Alternative is:	A+B+I/D
Estimated Calendar Days for Final Alternative is:	1834
Accelerated Calendar Days for Final Alternative is:	1595
Daily Road User Cost (DRUC) for Final Alternative is:	$ 82,647
Daily Incentive/Disincentive (I/D) Rate:	$ 41,324

This is the final alternative CTD output calculated by the tool.

The Final Alternative is Adjusted. Proceed to Step 8...

Click this button to proceed to the next step.

Figure 36. Adjust Project Duration and Determine ACT Incentive Values.

Step 8: Convert to Final Calendar Days for Contract Time

This step uses the working days to calendar days conversion tool described in Section 2. The user begins by going back to the main CTD toolset (see Figure 37).

CTD Toolset for Design-Bid-Build Projects with Incentives (Alternative Contracting Technique) | Go back to the main screen

Step	Supporting Tool Name	Tool Description	Tool Access
Step 1: **Determine Appropriate ACT**	T3.7. Alternative Contracting Technique Evaluation Sheet	*This is a supporting document*	
Step 2: **Identify "What-if" Scenarios**	T3.8. CTD Guide Tool for ACT Projects		
Step 3: **Estimate Project Duration**	T3.1 CA4PRS T3.2 P6 T3.4 ICSES T3.6 KY-CTDS		*Use the tool of your choice. Then input the results into the corresponding cells in Tool 3.8*
Step 4: **Assess Mobility Impact**	T3.1 CA4PRS T3.3 QuickZone T3.5 CO3		
Step 5: **Select the Most Feasible Alternative**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 6: **Determine Risk Level**	T5.3. Qualitative risk analysis tool - Risk matrix	*See tool description in Risk Management.*	Go To
	T5.4. Quantitative risk analysis process		
	T5.5. Risk mitigation plan register		
Step 7: **Adjust Project Duration in Step 2**	T3.8. CTD Guide Tool for ACT Projects	*Use Tool 3.8*	Tool 3.8
Step 8: **Convert To Calendar Days**	T2.5. "From PDE to CTD" tool (PD2CT)	*See tool description in DBB project.*	Go To

In the CTD toolset, click this cell to access the calendar day conversion tool.

Figure 37. Access Calendar Days Conversion Tool in the Main Toolset.

Back in Tool 3.8, the user then enters the results from the calendar days conversion tool, as shown in Figure 38.

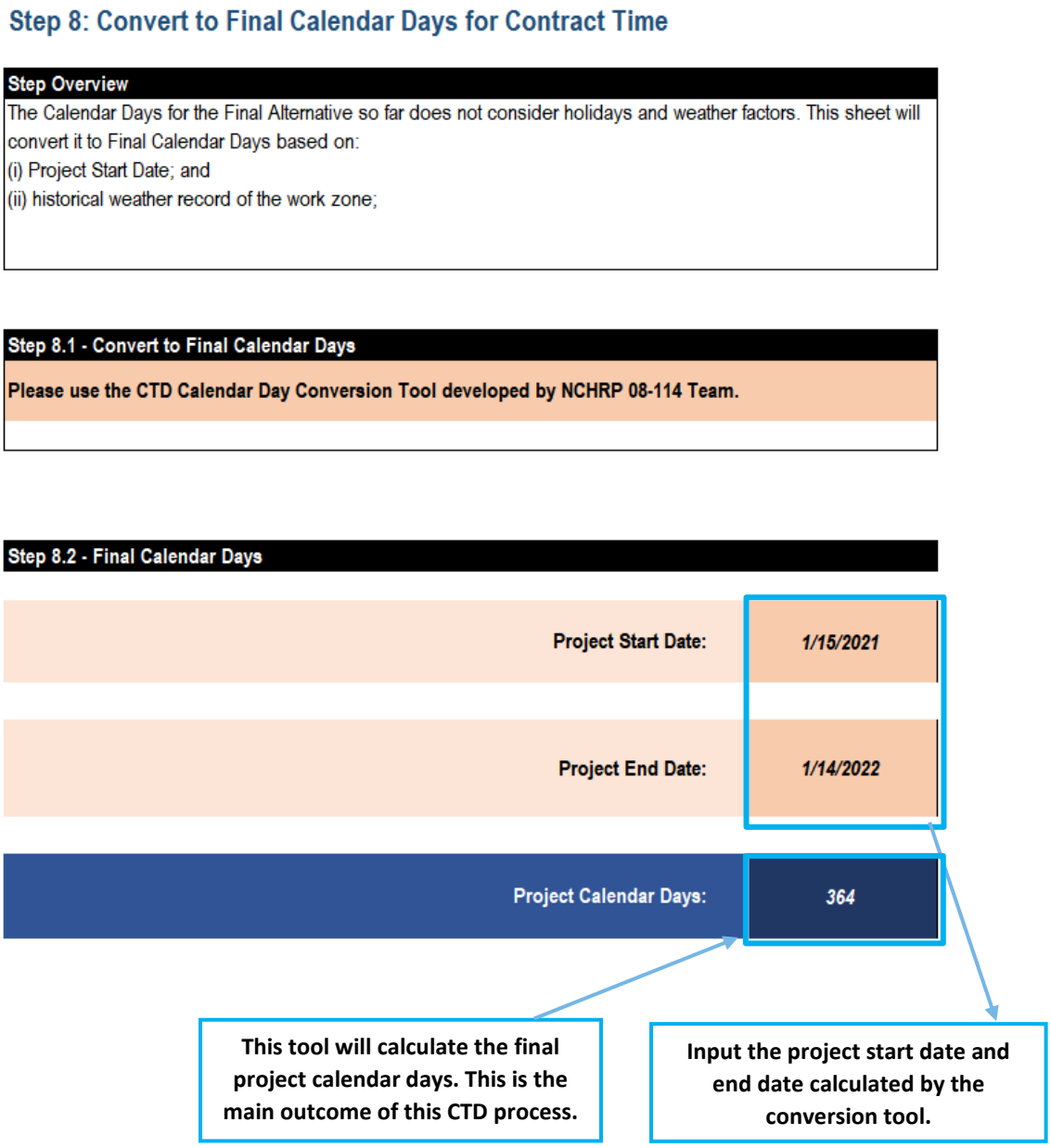


Figure 38. Final Step—Determine Final Contract Time Duration.

4 CTD Toolset for Alternative Project Delivery Method Projects

Figure 39 shows the summary page of the **CTD Toolset for Alternative Project Delivery Method Projects**. This toolset contains two supporting tools, as shown in the second column.

- Tool 4.1. Preconstruction activity duration checklist.
- Tool 4.2. Preconstruction period estimation tool (PRECON-PET).

Both Tool 4.1 and Tool 4.2 support the second step in the proposed CTD procedure for APDM projects. The third and fourth columns contain icons to access the tool descriptions and the tools themselves. Users can double-click on the icons to access the corresponding files.

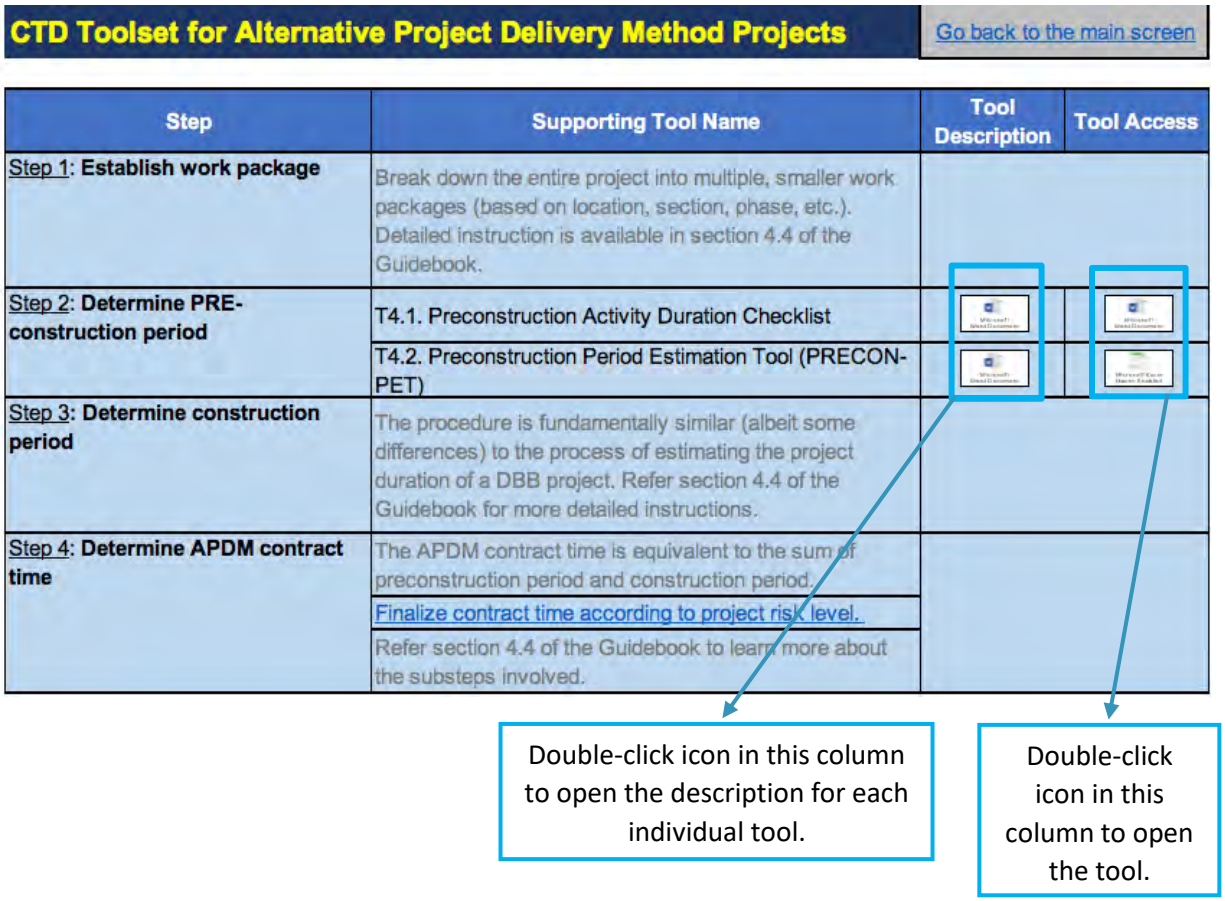


Figure 39. CTD Toolset for APDM Projects.

T4.1. Preconstruction Activity Duration Checklist

This checklist (see Figure 40) contains a list of questions (and some tips) regarding the status, requirements, and risks associated with the preconstruction period. Users should review each item listed (if applicable) and adjust the duration estimate of the corresponding preconstruction activity accordingly.

Preconstruction Activity Duration Checklist

1. Will the project require an accelerated schedule?
2. Will you allow construction to start before the design is complete?
3. Consider how project phasing/staging may affect the preconstruction duration.
    - E.g., certain project segment/phase can proceed to construction much earlier than other segments/phases
4. Consider how certain project milestones may affect the start of design of certain components/segments of the project.
    - E.g., Earlier opening of certain segment
5. Will the NEPA clearance be complete by the time the APDM contract is awarded?
6. Will the project require design exceptions from FHWA?
7. What is the magnitude of impact on existing utilities?
    - Relocation anticipated
    - Coordination effort

Figure 40. Screenshot of Preconstruction Activity Duration Checklist.

T4.2. Preconstruction Period Estimation Tool (PRECON-PET)

Launching PRECON-PET

Once the tool is opened, the user will see the "READ ME—General Instructions" sheet shown in Figure 41. The user is provided with important assumptions that this tool makes regarding the preconstruction period, as well as a general overview of the procedure to determine the preconstruction period.

The user should select the "Click to START" button (Figure 41) to advance to the first step.

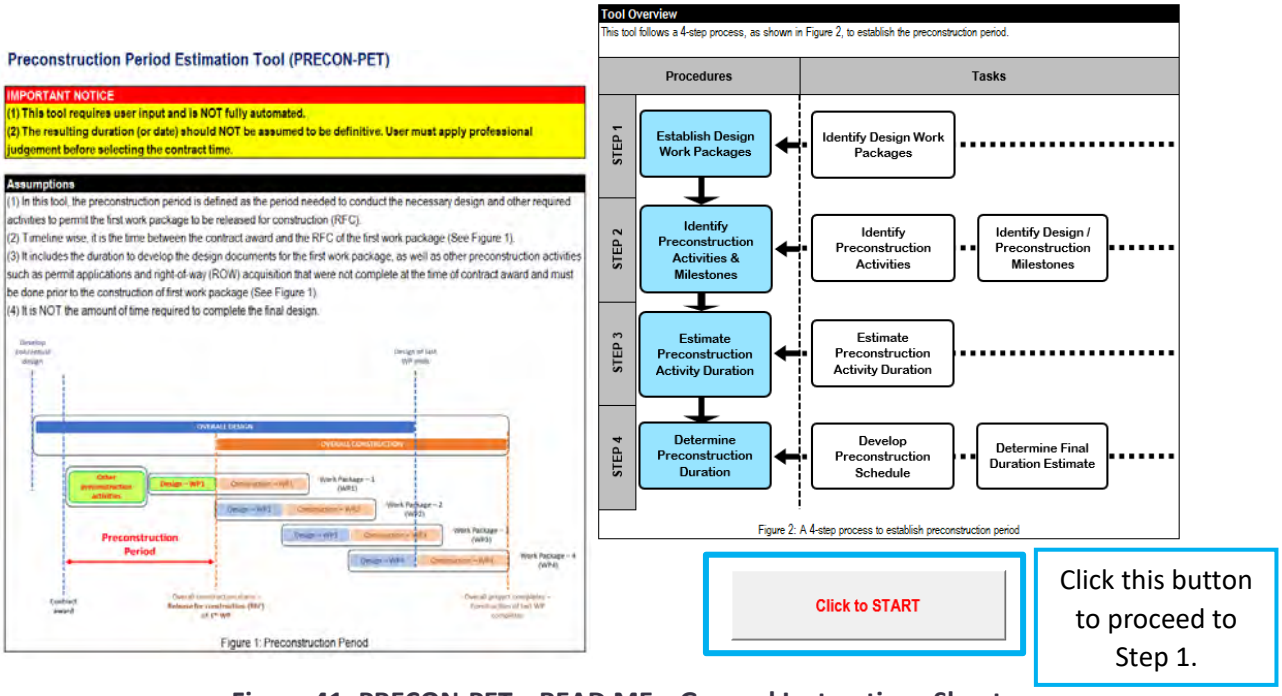


Figure 41. PRECON-PET—READ ME—General Instructions Sheet.

Step 1: Establish Design Work Packages

After selecting “Click to START,” the user sees the “1-Design Work Packages” sheet, as shown in Figure 42.

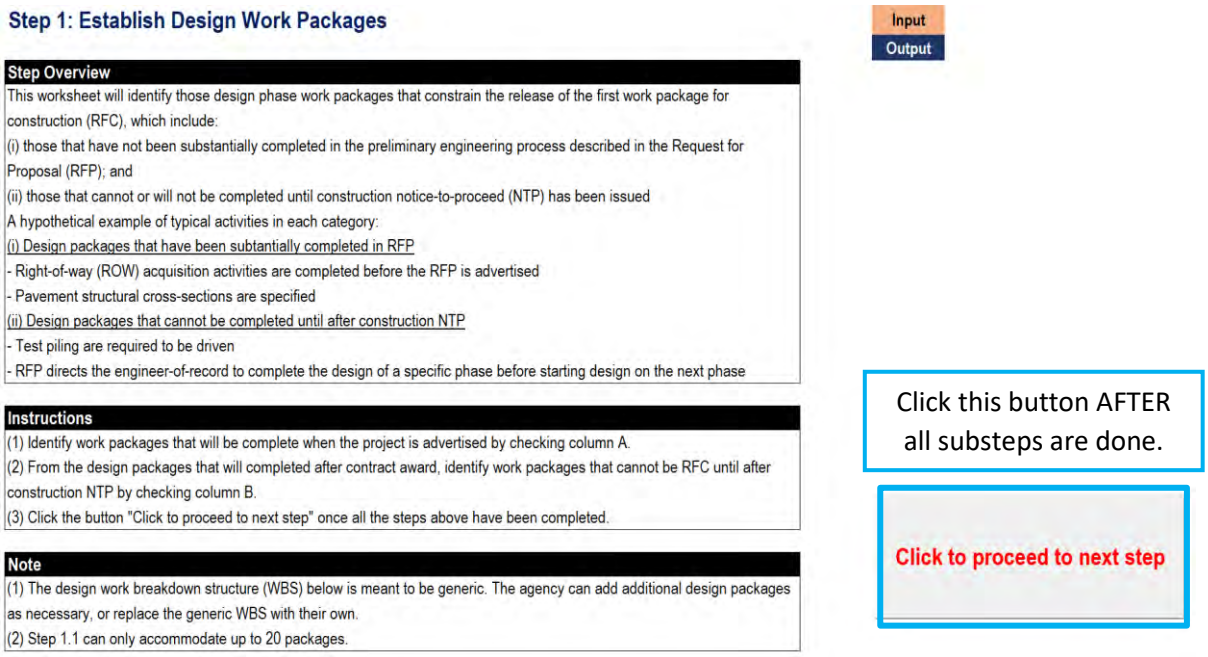


Figure 42. PRECON-PET—1-Design Work Packages Sheet.

In Step 1.1, the user should first list the design phase work packages involved in the project of interest (see Figure 43). A generic list of design phase work packages is provided in Step 1.1, but the user can replace any of them or include additional design packages, as necessary.

Step 1.1: Design Phase Work Package
Context - Economic / business / abutting properties
Planning - Meeting project goals / Identify purpose & need
Local Agency / Stakeholder (State Aid) - Local/stakeholder interests & needs as defined with community engagement & outreach
Right-of-way / Land Management (acquisitions, temporary construction easements, permanent easements, public land leasing / agreements)
Environmental / Natural Resources - Permits, consents, commitments, etc.
Utilities - Existing, relocation, future (prior rights, agreements, negotiations)
Design - Bridges & other structures
Design - Mobility / Other assets (roadway geometrics, assets within ROW)
Design - Drainage / Hydraulics (stormwater management, NPDES, drainage assets, etc.)
Design - Traffic (maintenance & protection of traffic, signage, striping, lighting, signals, etc.)
Construction (constructability, staging, seqeuncing, phasing)

List of design work packages. The ones currently shown are generic (user replaceable) and may not be exhaustive.

Add additional required work package(s) here.

Figure 43. PRECON-PET—Step 1.1.

For each listed work package, the user should do the following (as shown in Figure 44):

- Check the "A" column if the work package will be complete when the project is advertised.
- Check the "B" column if the work package cannot be released for construction (RFC) until after the notice-to-proceed (NTP) of the overall construction.
- Leave both A and B options unchecked if neither statement applies.

Check this column if the work package will be complete when project is advertised.

Step 1.1: Design Phase Work Package	A	B
Context - Economic / business / abutting properties	☑	☐
Planning - Meeting project goals / Identify purpose & need	☐	☑
Local Agency / Stakeholder (State Aid) - Local/stakeholder interests & needs as defined with community engagement & outreach	☐	☐

Check this column if the work package cannot be RFC until after the NTP of overall construction.

Figure 44. PRECON-PET—Determine Preconstruction Work Packages.

After completing this step, the user should select the "Click to proceed to next step" button (Figure 42) to access the "2-Precon Activities & Milestones" sheet shown in Figure 45.

Step 2: Estimate Preconstruction Activity and Milestones

In this step, the user should begin by clicking the “Show Preconstruction Period Work Packages” button (Figure 45). The “Preconstruction Work Packages” table will only show work packages that were determined by the tool to be included in the preconstruction period based on user input in Step 1.

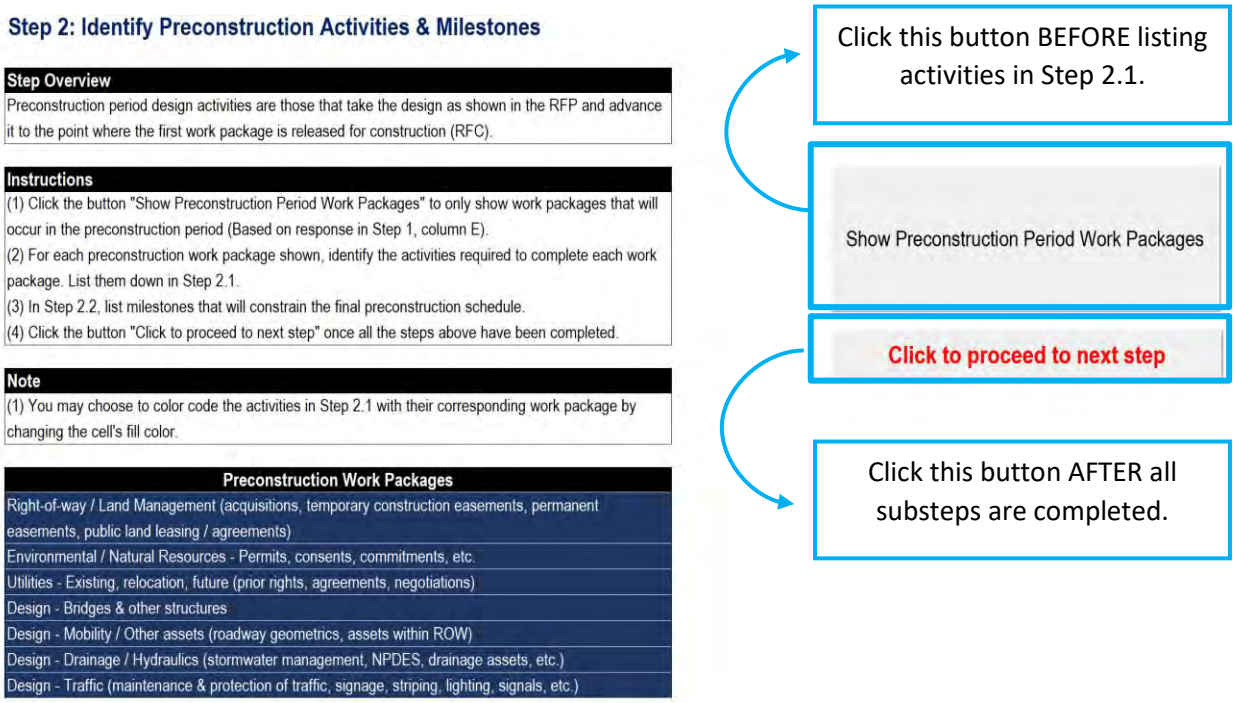


Figure 45. PRECON-PET—2-Precon Activities & Milestones Sheet.

In Step 2.1, the user lists the activities required to complete each preconstruction work package shown (Figure 46). The user may choose to color code the activities with their corresponding work package by changing the cell's fill color. For example, "Complete SUE study" and "Negotiate utilities agreements" are two activities associated with the work package "Utilities—Existing, relocation, future (prior rights, agreements, negotiations)."

In Step 2.2, the user lists all milestones that are anticipated to constrain the preconstruction schedule (Figure 46).

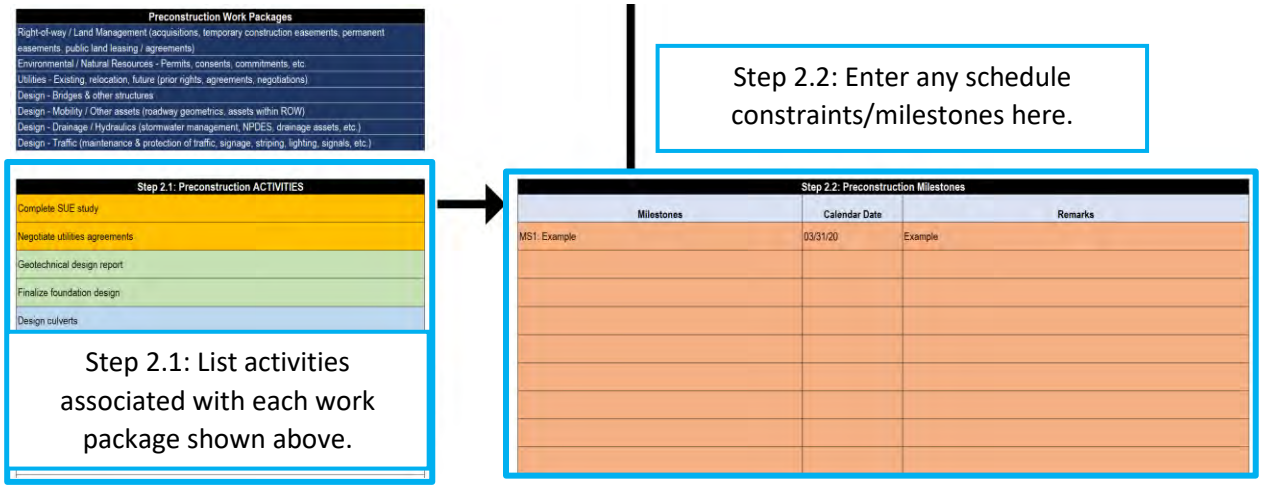


Figure 46. PRECON-PET—Step 2.1 and Step 2.2.

Once Step 2.1 and Step 2.2 are completed, the user should select "Click to proceed to next step" (Figure 45) to be taken to the "3-Precon Activity Duration" sheet shown in Figure 47.

Step 3: Estimate Preconstruction Activity Duration

In this step, the user begins by selecting the “Copy Activities from Step 2” button (Figure 47), which will populate Column B in Step 3.1 with the activities identified in Step 2.1.

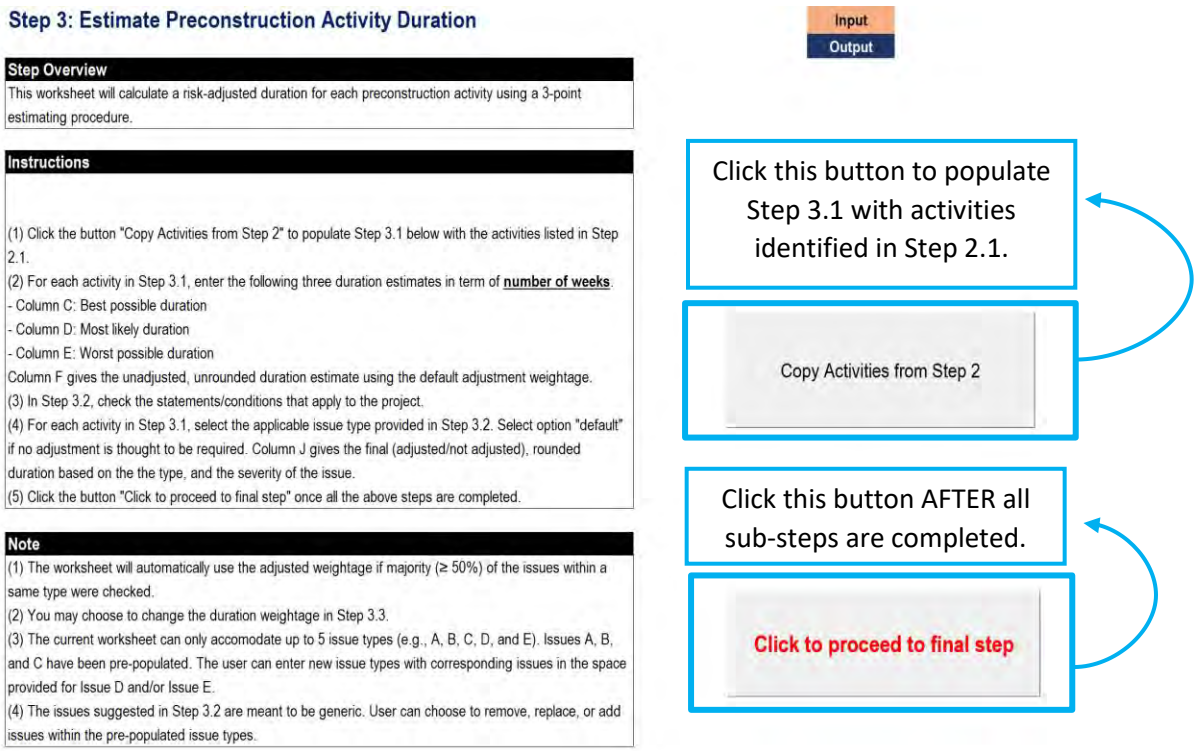


Figure 47. PRECON-PET—3-Precon Activity Duration sheet.

For each preconstruction activity shown, the user should enter the following three duration estimates in terms of number of weeks (Figure 48).

- Column C: Best possible duration.
- Column D: Most likely duration.
- Column E: Worst possible duration.

Step 3.1: Preconstruction Activities						
Preconstruction Activities (From Table 2.1)	Best scenario (Shortest)	Most likely duration	Worst scenario (Longest)	Default duration (Unadjusted, unrounded)	Issue Type	Final estimated duration
Complete SUE study	2	4	8	4.333	A	4.3
Negotiate utilities agreements	1	3	6	3.167	A	3.2
Geotechnical design report	4	6	12	6.667	B	11.7
Finalize foundation design	2	3	4	3.000	B	4.5
Design culverts	1	2	3	2.000	B	3.2
Grading plans	1	2	4	2.167	B	3.8
Develop construction phasing plans	1	2	3	2.000	C	2.0
Develop MOT plan	1	2	5	2.333	C	2.3
				0.000	Default	0.0
				0.000	Default	0.0

Enter estimated durations in WEEKS.

Assign issue type AFTER completing Step 3.2 to enable duration adjustment.

Figure 48. PRECON-PET—Step 3.1.

Next, in Step 3.2, the user checks the issues that apply to the project of interest (Figure 49). Note that the issue types (e.g., third party/ROW, design issue, construction issue) and accompanying issues currently displayed are generic. Users can add additional issue types (e.g., D and E) or replace/add any issue within the pre-populated issue types.

Step 3.2: APDM Issues Impact Checklist

Issue Type	Issue	Applies
(A) Third Party/ROW		
A	ROW acquisition is not complete before APDM contract award	☑
	NEPA clearance will not be complete before APDM contract is awarded	☑
	Level of effort to obtain remaining necessary permits greater than normal	☐
	Number of third parties (i.e., railroads, utilities, environmental, etc.) is higher than normal	☐
	The magnitude of impact on existing utilities is greater than normal	☐
	Utility coordination responsibilities will not assigned to the private sector	☐
		☐
		☐
(B) Design Issue		
B	Project design is expected to be more than 30% complete at the time of advertisement	☑
	The project requires design exceptions from FHWA	☑
	At least one project milestone will constrain the start of design of certain components/segments of the project	☐
	In-house design resources will constrain design submittal review time	☐
		☐

Issue type and name (replaceable by user)

Step 3.2: Check issue(s) that is applicable to the project of interest

Add new issue here

Figure 49. PRECON-PET—Step 3.2.

Once Step 3.2 is completed, the user assigns an issue type for each preconstruction activity (Figure 48). Users should select the "default" option if no adjustment to duration is thought to be needed.

In Step 3.3 (Figure 50), the user can choose to alter the adjustment weightage that is used by the tool to calculate the risk-adjusted duration tabulated in Column J.

Step 3.3: Duration Adjustment Weightage			
Duration Adjustment Weightage	Best possible case	Most likely case	Worst possible case
Default	1	4	1
Adjusted (Applies to all issue types)	1	3	4

Change weightage here (OPTIONAL)

Figure 50. PRECON-PET—Step 3.3.

Once the above steps are completed, the user should select the “Click to proceed to final step” button (Figure 47) to access the “4-Precon Schedule” sheet described in Step 4.

Step 4: Determine Preconstruction Duration

In this step, the user should first select the “Copy Activities and Durations from Step 3” button (see Figure 51) to populate the bar chart (Column B and C) with activities and their adjusted duration.

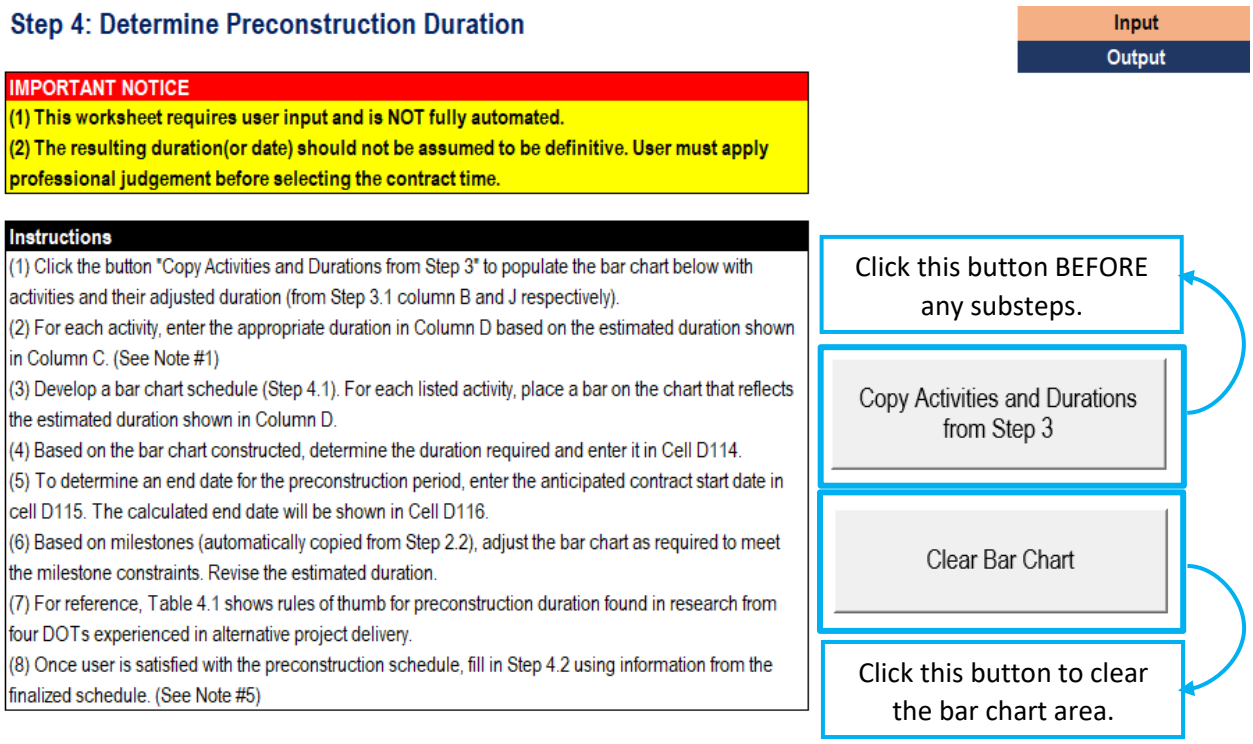


Figure 51. PRECON-PET—4-Precon Schedule Sheet.

For each activity, the user needs to input the appropriate duration (e.g., round up, round down, or no change) in Column D of the bar chart (Figure 52) based on the estimated duration shown in Column C.

Based on the duration displayed in Column D, the user then develops a bar chart schedule by changing the cell’s fill color. The user also needs to consider the activity relationship. Figure 52 shows an example.

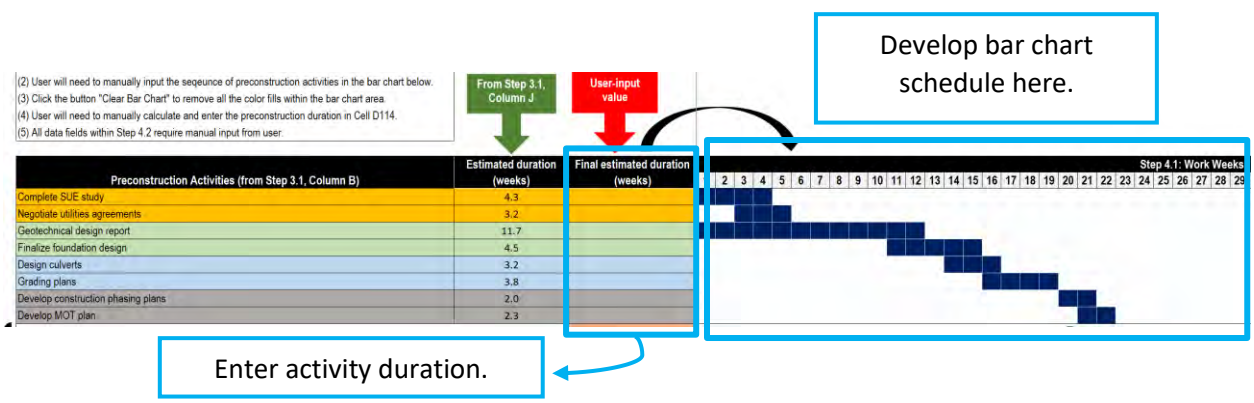


Figure 52. PRECON-PET—Step 4.1.

The user can click the “Clear Bar Chart” button (Figure 51) if needed to erase and redevelop the entire bar chart schedule.

Once the bar chart schedule is developed, the user determines the total duration and enters it into Cell D114. The user also needs to input the anticipated contract start date in Cell D115 (Figure 53).

Based on the user-input start date (Cell D115) and tool-calculated end date (Cell D116), the user can examine whether the current preconstruction schedule meets all constraints listed in the "Preconstruction Milestones" table (from Step 2.2).

The user can adjust the schedule, as necessary. Whenever a change is made, the user must remember to revise the activity duration (Column D), the bar chart schedule, and/or the estimated total duration (Cell D114), if applicable.

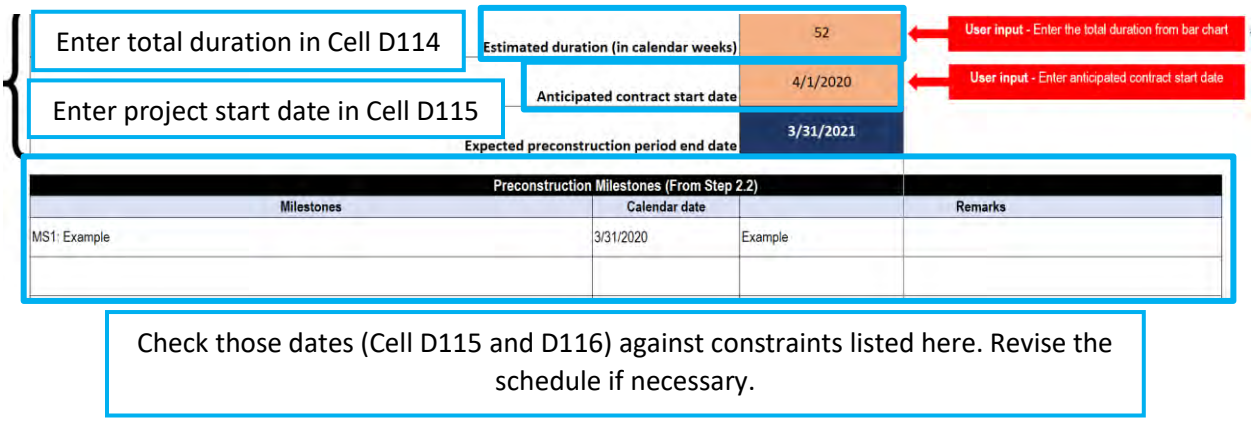


Figure 53. PRECON-PET—Calculating Preconstruction Period End Date.

Once satisfied with the revised schedule, the user manually enters all three required parameters in Step 4.2 (Figure 54), which concludes the preconstruction period estimation process.

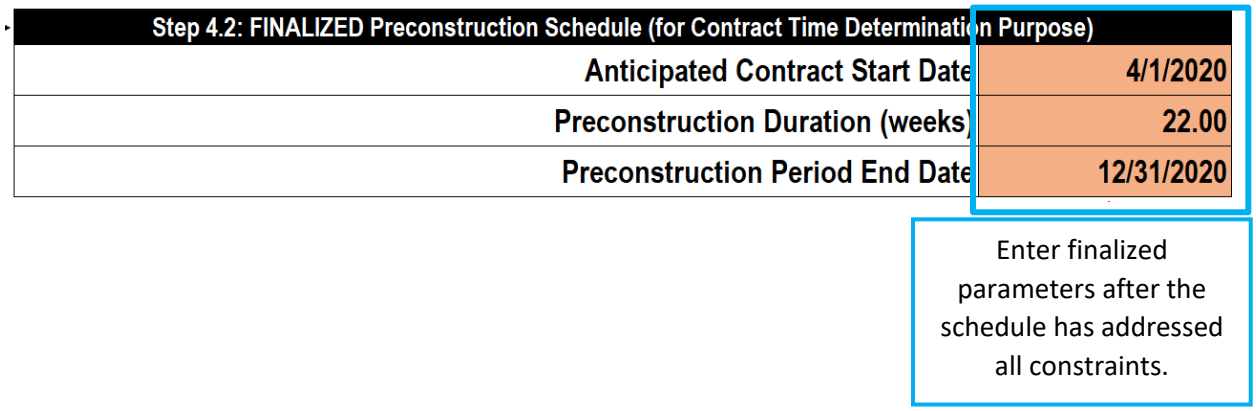


Figure 54. PRECON-PET—Finalize Preconstruction Schedule.

5 CTD Toolset for Risk Management

The **schedule risk management tool** is an MS Excel-based tool that provides templates for use in the major schedule risk management steps as follows:

- Tool 5.1. Risk breakdown structure template for risk identification.
- Tool 5.2. Risk register template for qualitative risk analysis.
- Tool 5.3. Risk mitigation plan register for risk mitigation and monitor.

Figure 55 shows the summary page of the tool. Users can double-click on the icons to access the corresponding files.

CTD Toolset for Risk Management | Go back to the main screen

Step	Supporting Tool	Tool Description	Tool Access
Step 1: **Risk identification**	Use influential factors as risk checklist		
	T5.1. Risk breakdown structure		
Step 2: **Select risk analysis method**	Selecting risk analysis method mainly bases on project size/complexity. The detailed criteria for selection are at Section 5.2.2 of the Guidebook.		
Step 3: **Risk analysis**	T5.2. Qualitative risk analysis tool		Tool 5.1
	Quantitative risk analysis process		
Step 4: **Risk mitigation & monitor**	T5.3. Risk mitigation plan register		Tool 5.1
Step 5: **Utilize output in CTD**	Utilizing output in CTD is more a method rather than a tool. The detailed method instruction is at Section 5.2.5 of the Guidebook.		

Double-click icon to access the corresponding files.

Figure 55. CTD Toolset for Risk Management.

T5.1. Risk Breakdown Structure Template

The risk breakdown structure (RBS) tool is used for identifying and categorizing risks through a hierarchical structure. It is a multilevel breakdown table that shows potential risk source and category. The RBS is an effective tool for organizing and mitigation planning of risks in a project.

Level 1: Risk Categories/Sources

- Users can use their own classification of risk sources by editing text in this row.
- Add columns to the right to address more categories.

Level 0	Project Schedule Risk			
Level 1	Technical	Organizational	Environmental	Social and Economic
Level 2	TECH 10 Inappropriate design and poor engineering	ORG 10 Poor project phasing	ENV 10 Unexpected geotechnical issues	SE 10 Stakeholders request late changes
	TECH 20 Unstable supply of critical construction materials	ORG 20 Coordination with utilities & relocation of utilities for construction	ENV 20 Obtain permits	SE 20 High-volume traffic
	TECH 30 Equipment availability	ORG 30 Resource/personnel availability	ENV 30 Inclement weather	SE 30 Political commitments
	TECH 40 Poor construction site surveys	ORG 40 Coordination with adjacent projects		
	TECH 50 Prolonged time for fabrication of structural steel and other specialty items	ORG 50 Right-of-way availability		
		ORG 60 Contractor qualifications		
		ORG 70 Mobilization & assembly time		
		ORG 80 Communications among contract parties		

Level 2: RBS ID and Risk Subcategories

- RBS ID is composed of an alphanumeric code of the Level 1 category (e.g., Technical [TECH], Environmental [ENV], etc.) and the order of the subcategories (e.g., the first listed subcategory is TECH 10).
- Listed are some common risk subcategories as a reference; users may delete, add, or modify the subcategories.
- Add rows to the bottom to address more subcategories.

T5.2. Risk Register Template

The qualitative risk analysis involves (1) assessing the likelihood and impact of risk factors in terms of subjective ratings; (2) ranking risk factors by calculating risk scores (the product of risk likelihood and impact); and (3) assessing total potential schedule delay and adding it to CTD results.

RBS ID is assigned based on the categorization code in RBS sheet

When the user clicks each cell in C**olumns 5, 6, 11, and 12,** a pop-up message will appear to provide a short explanation of input

Columns 7, 8, and 9 are generated automatically.

	Risk Identification			Qualitative Analysis					Output for CTD		
RBS ID	Status	RBS Categor	Risk Description	Likelihood (1-5)	Impact (1-5)	Risk Matrix	Risk Score (Likelihood × Impact)	Ranking	Is risk on Critical Path?	Potential Delay of Top Risk Factor before Mitigation	Combined Total Potential Delay
	2	3	4	5	6	7	8	9	10	11	12
ENV 20.01	Active	Environmental	Conservation Commission approval as a Limited Project is not received.	2	5	Risk 1	10	1	Yes	3 months	5 months
ENV 20.02	Active	Environmental	Obtaining NEPA approval - need FHWA approval for a CE checklist in order for ROW process to commence. The risk is that the FHWA doesn't agree that project is a CE and/or info needed for CE completion is not available in a timely manner.	1	5	Risk 2	5	4	Yes		
ORG 50.01	Active	Organizational	ROW process - ROW plans under review and not approved for taking yet. Risk is the length of ROW process and obtaining ROW Certificate for advertising.	3	3	Risk 3	9	2	Yes	2 months	
SE 20.01	Active	Social and Economic	Due to high traffic volumes proposed staging to maintain two lanes in each direction of roadway, limiting any additional lane closure/ramp closure to off-peak hours/weekends. Restriction to off-peak lane closures limits the contractor's flexibility/options to maintain the schedule.	3	3	Risk 4	9	2	Yes	2 months	
ORG 40.01	Active	Organizational	Coordination during design with adjacent projects' designers.	3	1	Risk 5	3	5	No		

Impact of Occurence
Very Low = 1
Low = 2
Moderate = 3
High = 4
Very High = 5

Columns 7 and 9: Both a risk matrix and risk ranking are used to help the project team select and focus on significant risks. A risk matrix gives a general idea about the significant levels (high, medium, low), while a risk ranking helps to make a choice inside the significant level.

Column 11: After ranking the risks, it would be prudent to concentrate on the top-ranked risks (fewer than five risk factors) and estimate the potential delay caused by each. In this template, the potential delays caused by the top three risks are evaluated.

Column 12: To evaluate the combined total potential delay before mitigation, the user needs to decide if the potential delays due to these risk factors are additive (affecting sequential activities in the CPM) or concurrent (affecting parallel activities in the CPM). For concurrent cases, the user needs to further decide what portions are additive. The combined effect of delay will be added to the base project duration.

T5.3. Risk Mitigation Plan Register Template

The risk mitigation plan (RMP) register is an expanded section of the risk register that summarizes the contents of the RMP report. The RMP register should focus on the top risk factors. Based on the 80/20 Rule, 80% of the effects are due to 20% of the causes. The user can decide on the number of risks to be dealt with in the RMP, but there should generally be fewer than five risks. For example, in this tool, the top three risks in the risk register go to the RMP.

When the user clicks each cell in C**olumns 15 and 16,** a pop-up message will appear to provide a short explanation of input

			Mitigation - Response Action			Monitor and Control	Output for CTD		
RBS ID	Status	RBS Categor	Strategy	Action Plan	Risk Manager	Date and Review Comments	Is risk on Critical Path?	Potential Delay of Top Risk Factor after Mitigation	Combined Total Potential Delay
1	2	3	10	11	12	13	14	15	16
ENV 20.01	Active	Environmental	REDUCE	Conduct additional pre-application meetings with Conservation agency and modify 75% and/or 100% accordingly.	John, PM office	Last status update 3.20.2020. Action is being taken to expedite meetings with regulatory agencies.	Yes	1 months	3 months
ORG 50.01	Active	Organizational	ACCEPT	Continue working with the DOT to satisfy the requiremensts to receive certification.	John, PM office	Last status update 3.20.2020. Update at the next QPR meeting.	Yes	2 months	
SE 20.01	Active	Social and Economic	REDUCE	Identify potential conflicts and construction issues. Prepare CTD schedule per the DOT guidelines which incorporates all duration assumptions.	Contractor	Last status update 3.20.2020. No action taken yet.	Yes	1 months	

It would be prudent to concentrate on the top-ranked risks (less than 5 risk factors) and estimate the potential delay caused by each. In this tool, top 3 is selected.

Column 10: Risk mitigation strategies generally include:

- Avoid the risk, for example, through design changes or policy actions.
- Reduce the potential impact of the risk by similar actions used in eliminating the risk.
- Transfer/share all or part of the risks to other parties by instruments such as insurance or contract clauses.
- Accept the risk, possibly without further actions by using schedule contingency.

The user can select the most effective plan to alleviate the impact of risk from the dropdown menu.

Column 11: The user can write a brief but detailed plan of action to deal with each of the top risks.

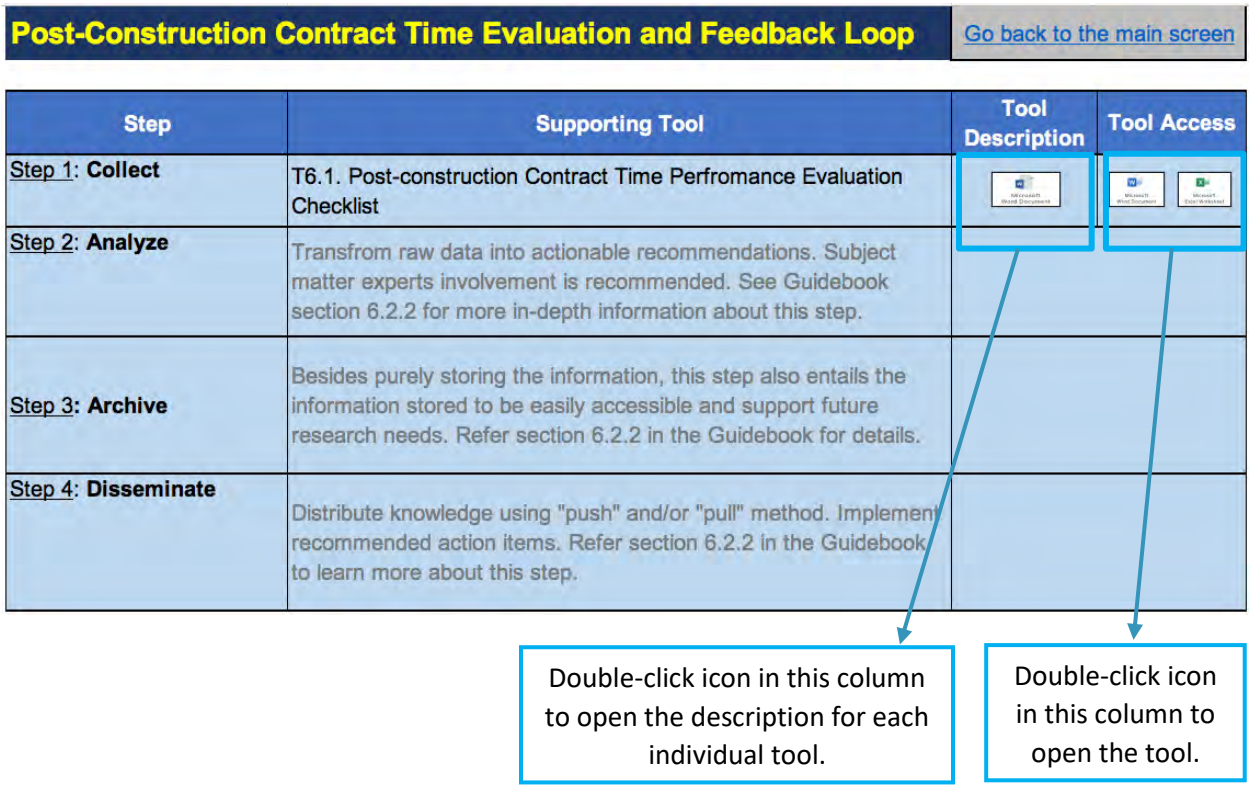
Column 12: The risk manager is the person responsible for action, implementation, and follow-up.

6 CTD Toolset for Post-Construction Contract Time Evaluation and Feedback Loop

Figure 56 shows the summary page of the **CTD Toolset for Post-Construction Contract Time Evaluation and Feedback Loop**. This toolset contains one supporting tool, which is:

- Tool 6.1. Post-construction contract time performance evaluation checklist.

Tool 6.1 supports the first step in the proposed procedure for an effective contract time-related lessons learned program. The third and fourth columns contain icons to access the tool descriptions and the actual tools, respectively. Users can double-click on the icons to access the corresponding files.



Post-Construction Contract Time Evaluation and Feedback Loop | Go back to the main screen

Step	Supporting Tool	Tool Description	Tool Access
Step 1: **Collect**	T6.1. Post-construction Contract Time Perfromance Evaluation Checklist		
Step 2: **Analyze**	Transfrom raw data into actionable recommendations. Subject matter experts involvement is recommended. See Guidebook section 6.2.2 for more in-depth information about this step.		
Step 3: **Archive**	Besides purely storing the information, this step also entails the information stored to be easily accessible and support future research needs. Refer section 6.2.2 in the Guidebook for details.		
Step 4: **Disseminate**	Distribute knowledge using "push" and/or "pull" method. Implement recommended action items. Refer section 6.2.2 in the Guidebook to learn more about this step.		

Figure 56. CTD Toolset for Post-Construction Contract Time Evaluation and Feedback Loop.

T6.1. Post-Construction Contract Time Performance Evaluation Checklist

This checklist (Figure 57) helps DOTs assess their performance in establishing and executing the contract time of a project. It should be used during the post-construction meeting or during interim project performance meetings (for multiphase, longer projects). Through the use of influential factors to categorize its content, this checklist also serves as a template to capture lessons learned in a consistent and systematic manner. For maximum effectiveness, users should gather as many inputs for each question as possible from project team members.

Post-Construction Contract Time Performance Evaluation Checklist

Contract Time Overview	
What was the original number of contract days? (What was the original scheduled completion date?)	
Was this duration in A. Working days, or B. Calendar days	
What was the adjusted (i.e., time extension included) number of contract days/completion date?	
What was date of the first working day? (mm/dd/yyyy)	
What was the date the project was accepted (the final working day)? (mm/dd/yyyy)	
Did the project complete earlier or later than expected?	
By how many days?	
Compute schedule growth.	
Schedule Extensions/Suspensions	
How were time extensions/suspensions request evaluated?	
Was there adequate written documentation on file to support the additional time granted?	
List extensions/suspensions and reasons for approving.	

Extensions/Suspensions	No. of days granted	Reasons

Gather as many inputs as possible from project participants or subject matter experts for each question.

Figure 57. Screenshot of Post-Construction Contract Time Performance Evaluation Checklist.