

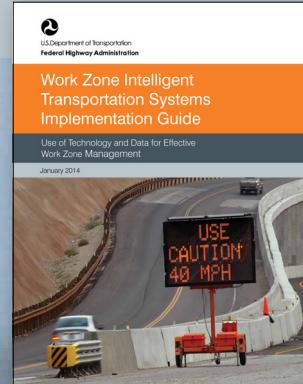


U.S. Department of Transportation
Federal Highway Administration

Work Zone Intelligent Transportation Systems (WZITS) Implementation Tool

User Guide for Prototype Software Implementation of the FHWA Work Zone Intelligent Transportation System Implementation Guide FHWA-HOP-14-008

September 2017



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1 INTRODUCTION

This practitioner-friendly user guide describes the Work Zone Intelligent Transportation Systems (WZITS) Implementation Tool, prepared for the Federal Highway Administration (FHWA), and provides step-by-step instructions for its use.

The WZITS Implementation Tool implements the logic and methodology described in the [FHWA Work Zone Intelligent Transportation Systems Implementation Guide](#) (1); users should refer to the guide for information about the underlying methods incorporated into the tool. The tool creates and manages a project file that provides users with (a) guidance during the WZITS decision-making process, and (b) a place to document the decisions made, along with relevant supporting information. The user guide includes four case studies that illustrate the use of the tool.

1.1 OVERVIEW

ITS is the use of a broad range of communications-based information and electronics technologies to enhance transportation (1). Work zone ITS is the use of ITS to improve safety and mobility in and around work zones. Information provided by work zone ITS may be in the form of real-time traffic conditions, such as travel delays through a work zone, or recommended diversion routes. This information can be used by motorists to alter their travel behavior, and by contractors and transportation agencies to alter traffic control strategies, traveler information, or work schedules. A work zone ITS deployment can be focused solely around safety or mobility, but it often supports both goals and can also help enhance productivity.

The WZITS Implementation Tool provides three core types of inputs, guidance, and documentation:

1. *Project Information*
2. *Project Wizards*
3. *Project Documentation*

Project Information inputs provide project reference information for the work zone and allow the user to add customized project documentation in addition to the standard inputs. General information about the overall roadway facility and the work zone scenario can also be specified using these inputs.

Project Wizards aggregate user inputs according to the guidance of the *Work Zone ITS Implementation Guide*. The wizards also provide decision-support through recommendations relating to project goals, ITS feasibility, team members and stakeholders, and potential ITS applications. The user can then combine the tool's recommendations with their own knowledge about a specific roadway and work zone when making decisions.

Lastly, *Project Documentation* questions reflect the guidance of the *Work Zone ITS Implementation Guide*. These questions are intended to ensure that the user has considered particular steps or aspects of the implementation process. This section of the tool also provides a place to document the decisions made over the course of the project.

1.2 JAVA™ REQUIREMENTS

The WZITS Implementation Tool has been developed using the Java programming language and version 8 or newer of the Java SE Runtime Environment (JRE) is required to run the tool. Any version of Java 8 will be sufficient, but it is generally preferable to have the most up-to-date version whenever possible. There are a number of ways to check if the installed version of Java is sufficient or up-to-date, as described in Section 1.2.1 below. The most recent version of Java can be obtained at the Java SE home page by selecting the JRE download (<http://www.oracle.com/technetwork/java/javase/downloads/index.html>). At the time this user guide was written, the most recent version of Java JRE 8 could be found at <http://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html>.

1.2.1 CHECKING THE JAVA VERSION

1.2.1.1 WINDOWS USERS

The Java Control Panel provides information about the version of the JRE installed on the computer. To find the Java Control Panel in Windows 7 and earlier, open the Windows Control Panel and enter “java” in the search bar. In Windows 10, type “java” in the search bar located with the taskbar at the bottom of the window and select the “Configure Java” desktop app. Once the Java Control Panel is open, click the “About...” button in the “General” tab to display a window displaying the version number, as shown in Figure 1.

If the search does not return any results, it is likely that the JRE is not installed on the computer. An alternative way to check is to open a Command Prompt window and type the command “java-version”. If this command returns an error or the output does not say “java version 1.8.0_xx” (xx can be any number), then the JRE will need to be installed or updated.



Figure 1: Example “About Java” dialog showing the currently installed version.

1.2.1.2 MAC OS OR LINUX USERS

On Mac OS computers, the Java Control Panel provides information about the version of the JRE installed on the computer. To find it, open System Preferences from the Apple menu, and click the Java icon at the bottom of the window. A message will appear stating that the Java Control Panel will open in a new window; click to continue. Once the Java Control Panel is open, click the “About...” button in the “General” tab to display a window displaying the version number, similar to that shown in Figure 1. If the Java icon cannot be found in System Preferences, Java is likely not installed on the computer (Java must be reinstalled each time the Mac OS is updated).

An alternative way to check the installed version of Java on either a Mac OS or Linux computer is to use the “Terminal” application. On a Macintosh, Terminal can be found using the Launchpad or by performing a Spotlight search. Once in the terminal, type the “java –version” command. If this command returns an error or the output does not say “java version 1.8.0_xx” (xx can be any number), then the JRE will need to be installed or updated.

1.3 INSTALLATION AND RUNNING

To install the WZITS Implementation Tool, download or copy the WZITS_Tool.zip file to the desired location on the computer. Next, extract the contents of the zip archive. **This is a key step because the tool cannot be run while in an archived state.** Some computers will extract the files from the archive automatically if the .zip file is double-clicked, but on many Windows computers the extraction must be done explicitly.

To extract the contents of the archive, right-click on the .zip file and select the “Extract” option. Alternatively, if the .zip file has been opened, choose the Extract tab and select the “Extract All” option. In either case, the user will be asked to specify a location for the extracted files.

Once the files have been extracted, the WZITS Implementation Tool can be run immediately by double-clicking on the WZITS_Tool.jar icon—no further installation is required.

1.4 USER GUIDE ORGANIZATION

Section 0 of this user guide focuses on how to use the software. First, Sections 2.1 through 2.3 outline the tool’s basic structure and features, including how to navigate through the software, how to start a new work zone ITS assessment, and how to save and reopen projects. Next, Section 2.4 provides a detailed discussion of the tool’s outputs. Finally, Section 2.5 describes the outputs produced by the tool.

Section 0 provides four case studies demonstrating how to use the tool; the appendix in Section 5 provides detailed output reports for each case study. Finally, Section 5 provides a reference to the *Work Zone ITS Implementation Guide*.

2 WZITS IMPLEMENTATION TOOL USER GUIDE

This section presents an overview of the WZITS Implementation Tool and provides step-by-step descriptions on how to interact with the tool's various components. Screenshots are used extensively to illustrate key points. The focus is on user interaction with the tool, as opposed to a discussion of the individual steps of a WZITS assessment and their respective inputs. Section 2.4 provides a brief overview of these steps and their underlying logic; more detailed information can be found in the *Work Zone ITS Implementation Guide* (1).

2.1 NAVIGATING THE TOOL

The general layout of the tool's main window is shown in Figure 2. This window contains five key components, as indicated by the numbers in Figure 2:

1. Project Menubar
2. Project Workflow Toolbar
3. Step Navigator
4. Main Input Window
5. Project Dashboard

The screenshot shows the WZITS Implementation Tool interface. A red box highlights the main input window area. Numbered callouts point to specific parts of the interface:

- 1**: Project Menubar (File, Edit, Results, Templates, Help) located at the top.
- 2**: Project Workflow Toolbar (Step 1, Step 2, Step 3, Step 4, Step 5, Step 6, Back, Forward, Home) located at the top right.
- 3**: Step Navigator (WZITS Project, Step 1, General Info, User Needs, Goals Selection, Selected Goals, Feasibility Assessment, Stakeholder Assessment, Stakeholders & Team Members, Back, Forward, Step 3, Step 4, Step 5, Step 6) located on the left.
- 4**: Main Input Window (General Information, Facility and Work Zone Configuration, Project Limits) highlighted by a red box.
- 5**: Project Dashboard (Ready!, Project Info, Project Information and Summary, Applications) located at the bottom.

The Main Input Window (4) contains the following sections:

- General Information** (State Agency: FHWA, Analyst: John Doe, Date: 07/22/2017, Project Name: WZITS Project, Project Description: This space can provide a brief reference description of the WZITS project, Link to Project Website, Upload Project Photo (Optional), Browse).
- Facility and Work Zone Configuration** (Facility and Base Conditions: Functional Class of Roadway: [dropdown], Maintaining Agency: [dropdown], Area Type: [dropdown], Annual Average Daily Traffic (Bidirectional AADT): 50000, Number of Roadway Lanes (1 Direction): 3, Shoulder Width (ft): 10, Posted Speed Limit (mph): 55, Width: 12, of a Signalized Corridor? [checkbox], Is National Highway System? [checkbox]).
- Project Limits** (Work Zone Length (mi): 2, Work Zone Type (MUTCD Designation): [dropdown], Work Zone Speed Limit: 45, Number of Lanes to be Closed: 1, Work Zone Lane Width: 12, Shoulder Closure: [checkbox], Federal-Aid Project: [checkbox]).

Figure 2: General Layout of the WZITS Implementation Tool.

The *Project Menubar* (#1 in Figure 2) provides access to various commands and options, similar to the menus provided in any other application. The usage of these menu commands will be described as needed throughout Section 2.

The *Project Workflow Toolbar* (#2 in Figure 2) is located just below the menubar. The toolbar serves as both the primary navigational control for the tool and as a visual reference to where the user is in the WZITS assessment process. Section 2.1.1 discusses the use of the toolbar.

The *Step Navigator* (#3 in Figure 2) is located on the left side of the window. The steps involved in a WZITS assessment are displayed in the navigator in an expandable/collapsible tree format. Double-clicking any item in the tree will navigate directly to the corresponding step or sub-step in the assessment process.

The *Main Input Window* (#4 in Figure 2) occupies the center of the window. This area provides the inputs and outputs relevant to a specific step or sub-step of a WZITS assessment and its content changes as different steps are selected in the Project Workflow Toolbar or Step Navigator. The screenshot in Figure 2 shows the introduction screen that is displayed in the main input window each time the tool is launched.

Finally, the *Project Dashboard* (#5 in Figure 2) is hidden until the bar at the bottom of the window is clicked, thereby expanding the dashboard into the bottom section of the window. The dashboard displays the progress made in the WZITS assessment and provides key assessment milestones. Section 2.1.2 describes the dashboard in more detail.

2.1.1 PROJECT WORKFLOW TOOLBAR

Figure 3 displays views of the Project Workflow Toolbar in its collapsed and expanded states. In the toolbar's collapsed state (Figure 3a), only the top-level steps in the process are shown. In the toolbar's expanded state (Figure 3b), a selected step (in this case, Step 1) is expanded to display all the substeps associated with that step.

One function of the toolbar is to visually indicate the progress made in the WZITS assessment. The step currently being worked on is highlighted. In Figure 3a, the tool has just been opened with a new project and the "Intro" step is highlighted. None of the steps in the process have been worked on yet; these are displayed in a light blue color. In Figure 3b, Step 1 has been opened to reveal all the sub-steps associated with Step 1. The user has already worked on all the sub-steps in Step 1, as the light blue color has been replaced with brighter colors in each sub-step. Sub-steps shown with a brown background are ones where the user provides input to the tool or views tool output via the Main Input Window; these sub-steps turn orange when selected (for example, the Team Members sub-step is currently being worked on in Figure 3b). Sub-steps shown with a dark green background have an associated wizard for providing input, as described in Section 2.4.2; these sub-steps turn light green when selected.

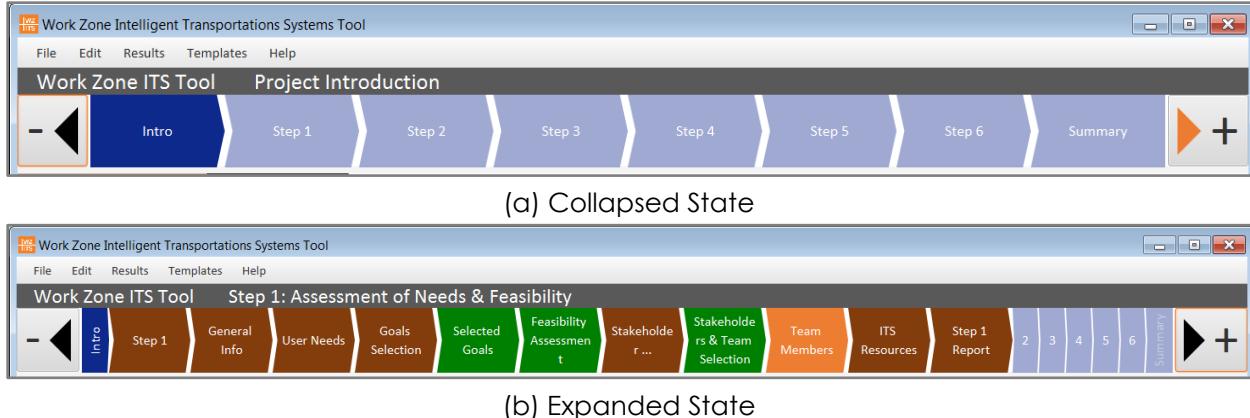


Figure 3: Close-up View of the Project Workflow Toolbar.

The toolbar's second function is to serve as the tool's main navigational control. The arrow buttons on the right and left sides of the toolbar allow the user to step forward and backward through the WZITS assessment. The individual step icons expand and collapse as the user navigates through them and the sub-step currently being worked on is highlighted. In addition, the name of the current step being worked on is displayed in the grey bar at the top of the toolbar. The step and sub-step icons also double as buttons that can be used to jump directly to a specific step or sub-step.

2.1.2 PROJECT DASHBOARD

The Project Dashboard provides real-time feedback about project progress made and key assessment conclusions. By default, the project dashboard is collapsed, but it can be expanded by clicking the bar at the bottom of the window. In its collapsed state (Figure 4), the dashboard provides progress bars denoting progress toward the four key assessment milestones: Goals Selection, Feasibility Assessment, Stakeholders, and Applications. The progress bars are displayed in orange while the assessment is in process. The bars change to green once the all the requirements to reach the milestone have been completed.



Figure 4: Example of the Project Dashboard in its Collapsed State.

In its expanded state (Figure 5), the Project Dashboard provides more detailed information about the progress of the WZITS assessment. Five tabs are provided: one for each of four assessment milestones, and a fifth with general project information. Indicators next to each tab show progress toward completing a milestone in orange with percent complete, changing to green and "Ready!" once the milestone is reached. In Figure 5, the user has selected the Goals tab. This tab shows the top goal that the user has selected out of each category of goals. The dashboard tabs can be a useful way to view important information from previous steps without having to navigate back to the step or sub-step in the Main Input Window.

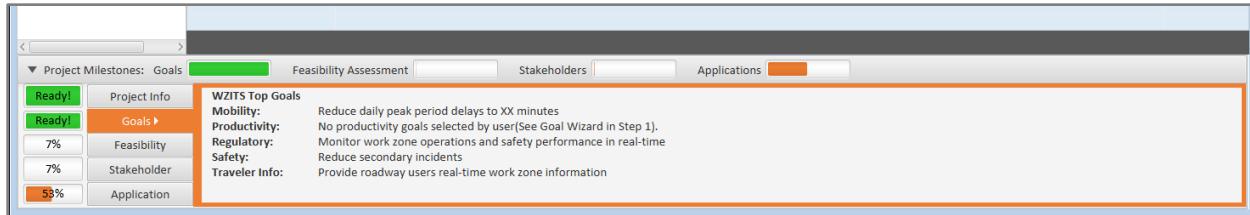


Figure 5: Example of the Project Dashboard in its Expanded State.

2.2 STARTING A NEW WORK ZONE ITS ASSESSMENT

After starting the program, the user can create a new project or open an existing project. Opening an existing project is described next in Section 2.3. To begin a new WZITS assessment, press the large blue button at the bottom of the introduction screen, or navigate to Step 1 using the forward arrow in the Project Workflow Toolbar.

The first screen of each step provides a title card displaying the name of the corresponding step in the *Work Zone ITS Implementation Guide*, along with the names of the sub-steps associated with that step. While the tool's six main steps are consistent with the six steps presented in the *Work Zone ITS Implementation Guide*, the tool makes some changes to selected sub-steps to better facilitate the use of the guidance for design and decision-making purposes. For example, the feasibility assessment has been moved earlier in the process to provide a more timely assessment of when to proceed to use the tool.

Figure 6 shows an example of the title card for Step 1. The sub-steps shown in orange correspond directly to sections in the *Work Zone ITS Implementation Guide*; the specific section number is shown for reference in a dark gray box below each of the orange sub-steps. For example, guidance for the User Needs sub-step can be found in Section 1.1 of the implementation guide. Sub-steps shown in light grey indicate inputs unique to the tool (general project information in this case). Finally, sub-steps shown in green are decision-support "wizards" that aggregate information from previous sub-steps to provide actionable items and interim outputs. These "wizards" are not explicitly described in the implementation guide; rather, they provide helpful structure to the guide's decision-making process.

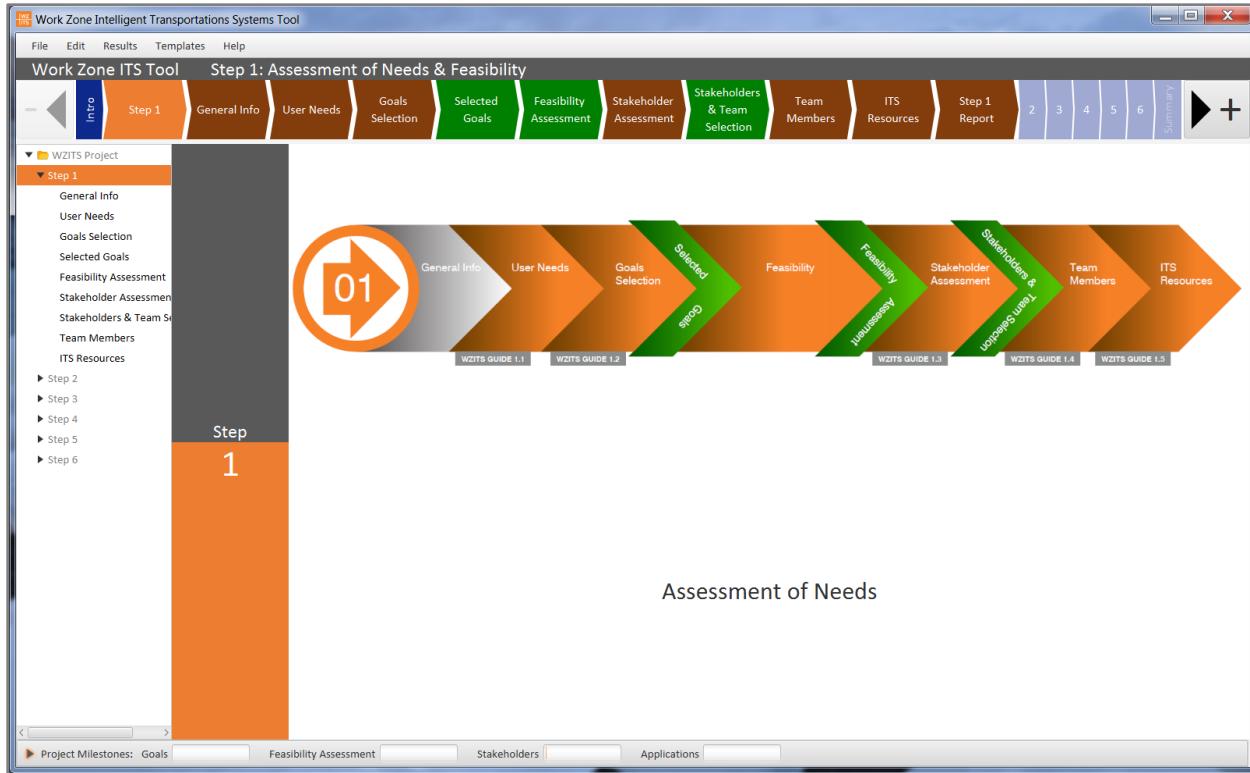


Figure 6: Title Card for Step 1: Assessment of Needs.

2.3 SAVING AND OPENING PROJECTS

The tool saves projects files in a custom .wzp format. To save a file, select either “Save Project” or “Save Project As” from the File menu. “Save Project As” can be used to save the file in a new location, with a new name, or both. If the active project has been saved previously, “Save Project” will write any new changes to the existing file. If the project has not yet been saved, “Save Project” will function the same as the “Save Project As” option.

To open a project file, select “Open Project” from the File menu and use the file explorer to select the desired .wzp file.

2.4 WORK ZONE ITS TOOL INPUTS

The tool's inputs can be divided into three categories: project information, wizard inputs, and project documentation. The majority of the tool's inputs fall into one of the two latter categories. The following subsections describe how to interact with each of the three input types.

2.4.1 PROJECT INFORMATION AND FACILITY CONFIGURATION

The tool's initial step, Introduction, is a new step that is not explicitly described in the *Work Zone ITS Implementation Guide*. This step allows the user to input general project reference information and to describe the overall roadway facility and work zone configuration. Inputs for this step are entered through a combination of text fields, drop-down choice boxes, and direct numerical inputs, as shown in Figure 7. General project information inputs are entered in the

left-hand column within the Main Input Window, while facility and work zone configuration inputs are entered in the right-hand column.

Figure 7: Project Information and Facility Configuration Inputs.

The user can optionally specify the following information about each project:

- State Agency
- Analyst
- Project Name
- Project Description
- Project Limits
- Project Website Link
- Project Photo

These inputs are used solely for record-keeping and documentation purposes, and it is up to the user's discretion as to how much (or how little) information to provide.

Next, the user should provide a set of inputs relating to the facility and work zone configuration. These inputs are not meant to provide an exhaustive description of the facility and work zone. Rather, they are a subset of commonly used information that the tool uses to facilitate project documentation and the tool's decision-making logic. Many of the inputs are used to preemptively provide answers to questions where possible in later steps of the assessment. Where available, more information about a particular input can be viewed by clicking on an orange “?” next to the input name (see Work Zone Type in Figure 7).

As these inputs may not provide a complete picture of particular aspects of the facility or work zone, the user can optionally provide additional notes for an input by clicking the “Add Comment” link directly to the right of that input. Doing so will launch a small popup window with space for entering additional comments. These comments will be displayed later on in the documentation for the step. Figure 8 shows an example of the popup window for roadway functional class.

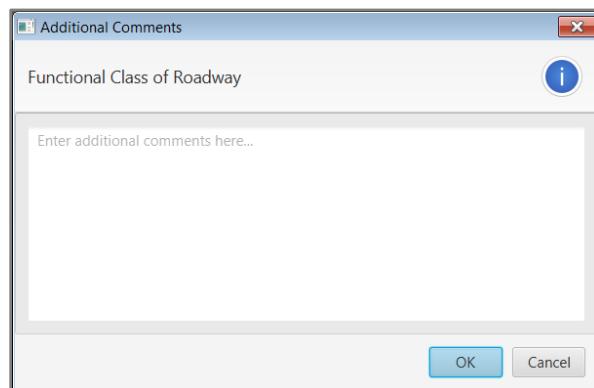


Figure 8: Example of an “Additional Comments” Popup Window.

2.4.2 WIZARD-STYLE INPUTS

Four decision-support “wizards” have been incorporated into the tool to provide guidance and decision-making support. The four wizards facilitate:

1. Selecting project **goals** for the use of work zone ITS,
2. Assessing the **feasibility** of using work zone ITS strategies for the project,
3. Selecting the **stakeholders** and team members most likely to be affected, and
4. Identifying the WZITS **applications** or technologies most likely to be effective for the project.

The Goals, Feasibility, and Stakeholder wizards are completed during Step 1 (as shown previously in Figure 6), while the Applications wizard is completed as the first activity in Step 2.

Using the wizard largely consists of answering a series of yes-or-no questions, although some wizards require additional inputs in the form of drop-down choice boxes. Figure 9 shows an example of the questions asked by the Goals wizard. The user should answer these questions to the best of their ability. In the event that a question is not applicable to a particular project, answering “No” will generally remove the question from consideration in scoring. Questions that are “greyed out” have been answered previously or are considered to be not applicable based on previous inputs.

WZITS Project	Step 1	User Needs				
		#	Input Question	User Response	Yes	No
General Info	General Info	1	Do you expect congestion impacts to be noticeable to drivers?		<input type="checkbox"/>	<input type="checkbox"/>
User Needs	Goals Selection	2	Is driver diversion expected onto alternate routes?		<input type="checkbox"/>	<input type="checkbox"/>
Goals Selection	Selected Goals	3	Do you anticipate significant queuing as a result of this work zone?		<input type="checkbox"/>	<input type="checkbox"/>
Selected Goals	Feasibility Assessment	4	Will this work zone have reduced lane widths?		<input type="checkbox"/>	<input type="checkbox"/>
Feasibility Assessment	Stakeholder Assessment	5	Will this work zone result in reduced sight distances that impact roadway users?		<input type="checkbox"/>	<input type="checkbox"/>
Stakeholder Assessment	Stakeholders & Team Selection	6	Will transit vehicles need to travel through the work zone?		<input type="checkbox"/>	<input type="checkbox"/>
Stakeholders & Team Selection	Team Members					
Team Members	ITS Resources					
ITS Resources						

Figure 9: Example of Inputs Required for the Goals Wizard.

Each question is linked to a scoring matrix that is used to quantify an aspect of the assessment and to provide the user with a recommendation. These scoring matrices have been pre-determined, drawing from the Work Zone ITS Implementation Guide, in combination with the beta testing and outreach performed for the implementation tool. If desired, users can customize the scoring matrices by directly editing the tool's source code.

After all of a wizard's questions have been answered, the wizard will use the scoring matrices to quantify its assessment. In the case of the Feasibility wizard, this process results in an immediate score and recommendation, as shown in Figure 10.

Work Zone ITS Tool Step 1: Assessment of Needs & Feasibility																	
Intro	Step 1	General Info	User Needs	Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary
WZITS Project	Step 1	General Info	User Needs	Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary
Step 1	General Info	User Needs	Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary	
General Info	User Needs	Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary		
User Needs	Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary			
Goals Selection	Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary				
Selected Goals	Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary					
Feasibility Assessment	Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary						
Stakeholder Assessment	Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary							
Stakeholders & Team Selection	Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary								
Team Members	ITS Resources	Step 1 Report	2	3	4	5	6	Summary									
ITS Resources	Step 1 Report	2	3	4	5	6	Summary										
Step 1 Report	2	3	4	5	6	Summary											
2	3	4	5	6	Summary												
3	4	5	6	Summary													
4	5	6	Summary														
5	6	Summary															
6	Summary																

Feasibility Assessment

#	Input Question	User Response	Contributed Score
1	What is the duration of long-term stationary work?	> 1 Construction Seasons	8
2	To what extent will users be impacted for the duration of the work zone?	Moderate	5
3	During which time periods are noticeable traffic impacts expected to occur?	During most of the morning or afternoon peaks hours	5
4	How long are queues expected to extend?	1-2 miles for 1-2 hours per day	5

Mark All That Apply

#	Input Question	User Response	Contributed Score
1	Is traffic speed variability expected to occur?	Yes	1
2	Do you expect back of queue and other sight distance issues?	Yes	3
3	Are high speeds/chronic speeding expected to occur?	Yes	2
4	Is driver diversion expected onto alternate routes? (See User Needs #2)	Yes	1
5	Are merging conflicts and hazards at work zone tapers expected to occur?	Yes	3
6	Do you expect the work zone layout to cause driver confusion or trouble wayfinding?	Yes	3
7	Will frequently changing operating conditions for traffic be used?	Yes	3
8	Will variable work activities occur?	Yes	3
9	Are oversize vehicles expected?	Yes	3
10	Do you expect a construction vehicle entry/exit speed differential relative to traffic?	Yes	2

Feasibility Score: 53

30 or more: ITS is likely to provide significant benefits and should be considered as a treatment to mitigate impacts.

Figure 10: Example of the Outputs from a Feasibility Wizard Assessment.

In the case of the other three wizards, the tool provides a set of scored recommendations from which the user must make selections.

For example, the Goals wizard provides a set of recommended project goals, and the user is then asked to select the most important goals, drawing from the user's knowledge of the particulars of the project. An example is shown in Figure 11. Use the checkboxes in the right-most column to mark a specific goal for inclusion in the project. When provided, use an "edit" link to specify an aspect of a goal (e.g., to specify a maximum delay in the "Reduce daily peak period delays to XX minutes" goal).

Note that while the priorities listed for the goals are based on the *Work Zone ITS Implementation Guide*, **these priorities are not intended to be the sole factors in the decision-making process**; rather, they should supplement the user's knowledge and be used to provide an initial assessment.

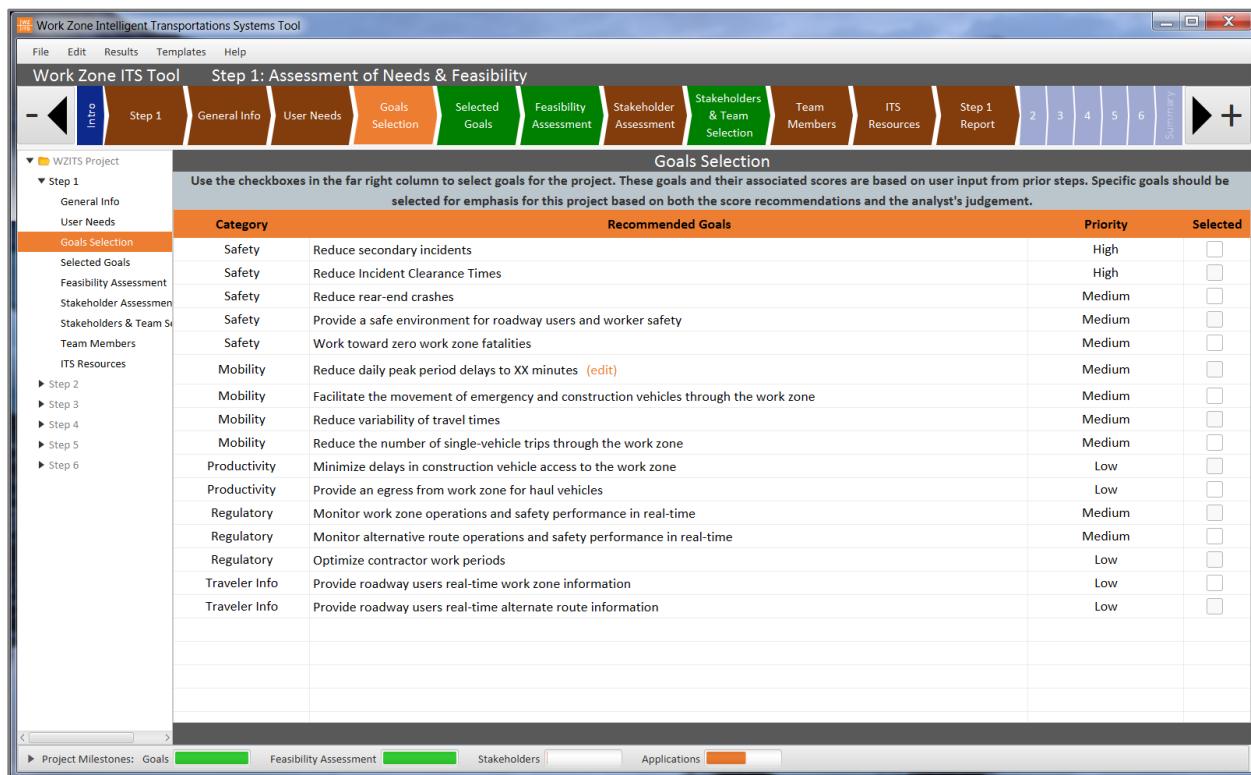


Figure 11: Example of the Goals Selection Step of the Goals Wizard.

Once the desired project goals have been selected from the list of recommended goals, the wizard's final step summarizes the selected goals, as shown in Figure 12. The selected goals will also appear in the fact sheet output for Step 1 (described in Section 2.5). In addition, the user can return to this sub-step at any time for reference.

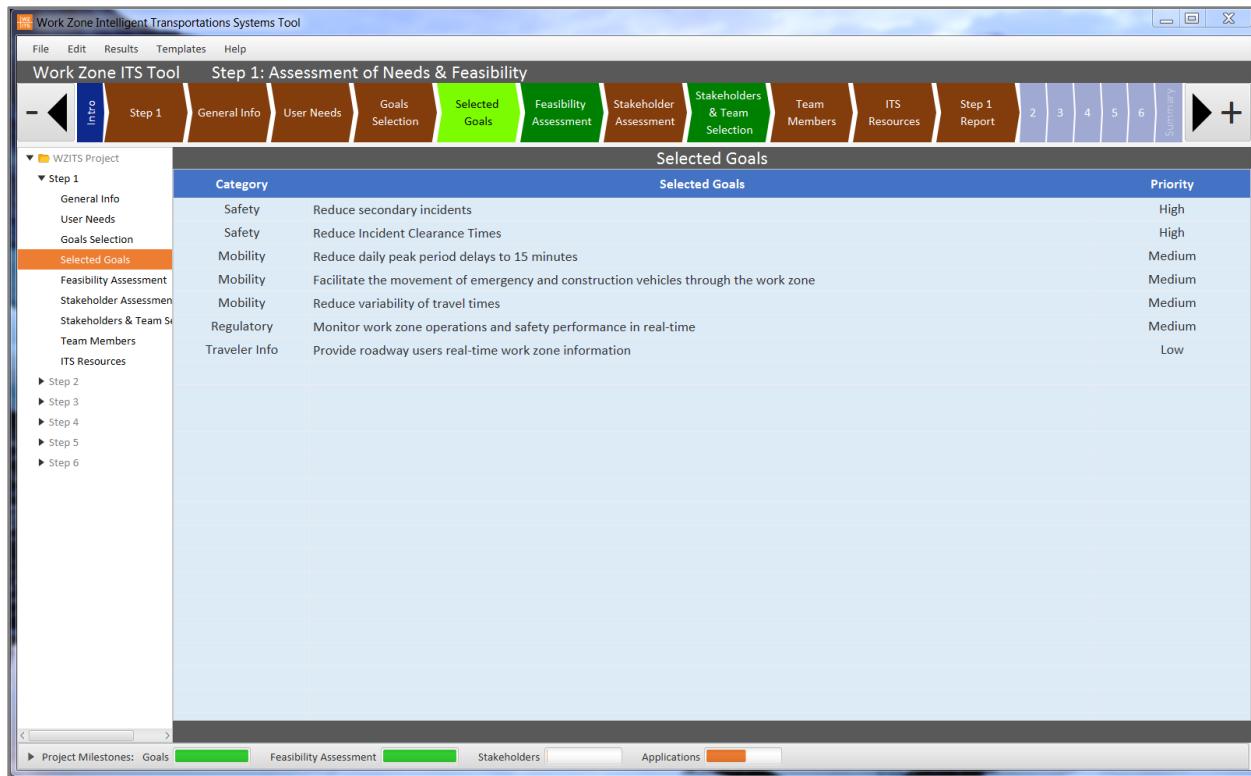


Figure 12: Example of Selected Goals Step of the Goals Wizard.

The Stakeholder wizard follows a similar three-step process of answering input questions, selecting project stakeholder and team members from a set of recommendations, and displaying a summary of the user's selections. Figure 13 shows an example of the Stakeholder wizard's input questions window, while Figure 14 shows an example of the team member recommendations produced by the wizard, along with their relative priorities. The user can mark agencies and groups as *core team members*, *stakeholders*, or *parties with little to no interest* (represented by the "N/A" column). Agencies or groups for which no selection is made are automatically placed into the "little to no interest" category.

Figure 15 shows an example of the Stakeholder wizard's summary results screen. The "edit" links next to each team member, stakeholder, and other organizations can be used to specify contact information and other relevant information, such as organization names. When clicked, these links open a pop-up window similar to the example shown in Figure 16 for a city transportation agency. The information entered in these pop-up windows will be stored in the project file for reference and will be displayed in an abbreviated manner in the fact sheet outputs.

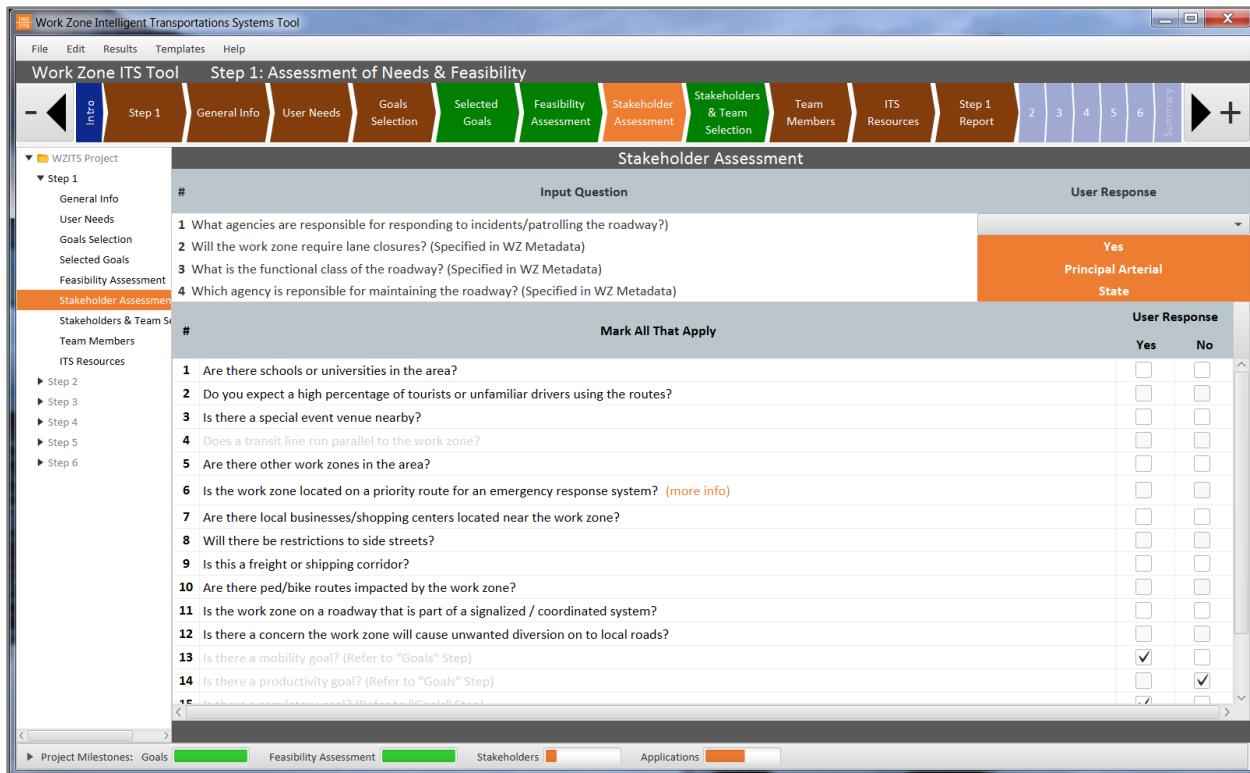


Figure 13: Example of Stakeholder Wizard Inputs.

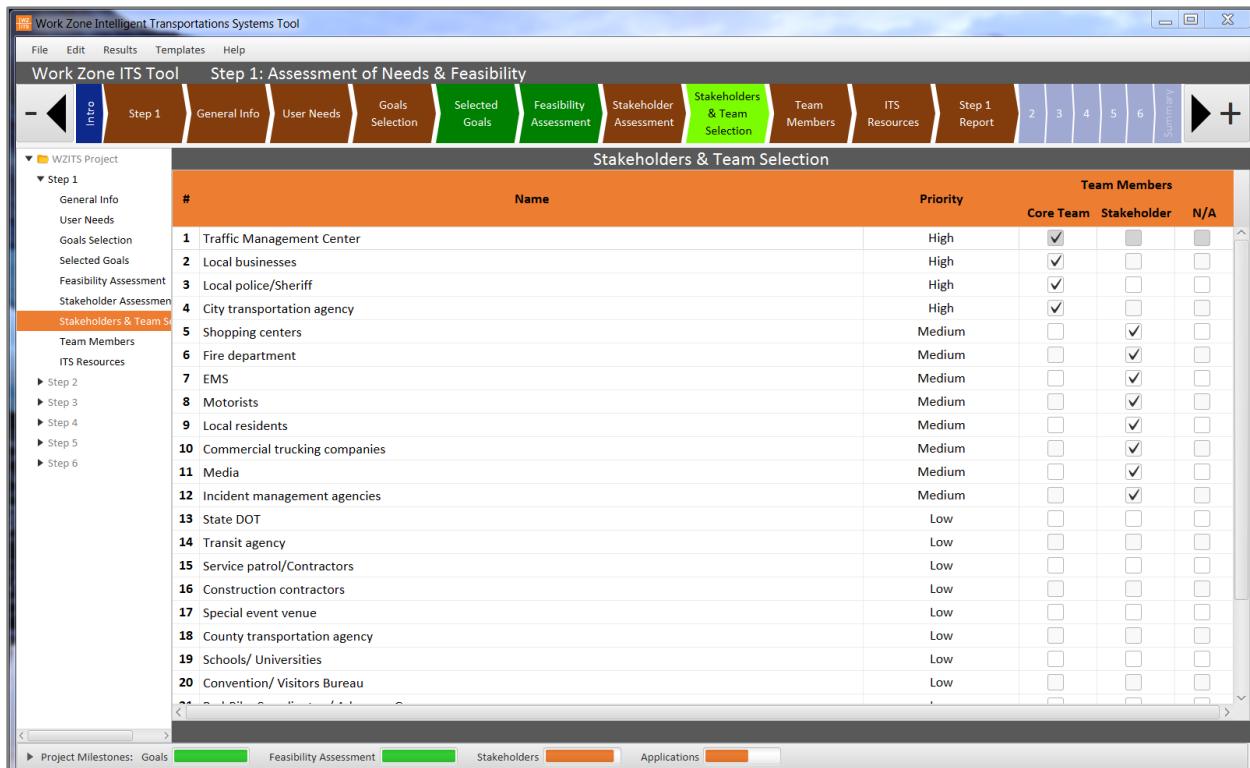


Figure 14: Example of Stakeholder Wizard Team Member Selection.

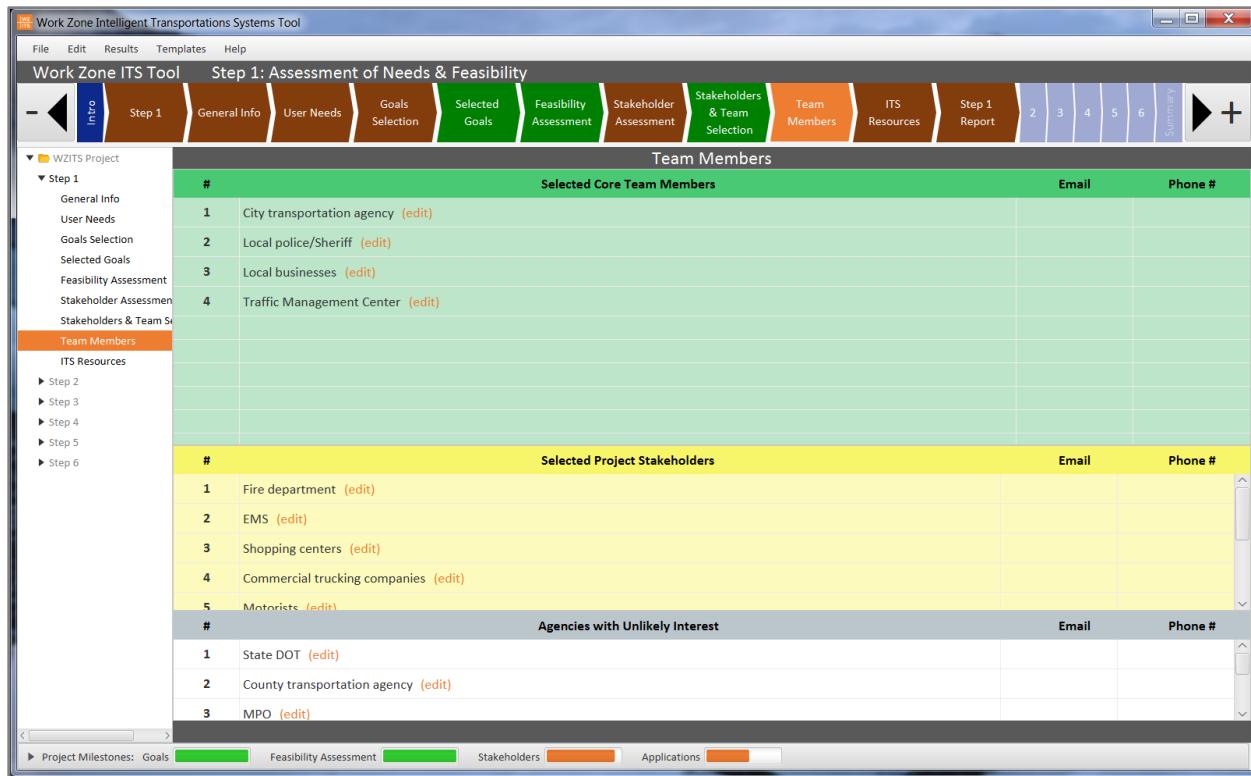


Figure 15: Example of the Stakeholder Wizard Summary Step.

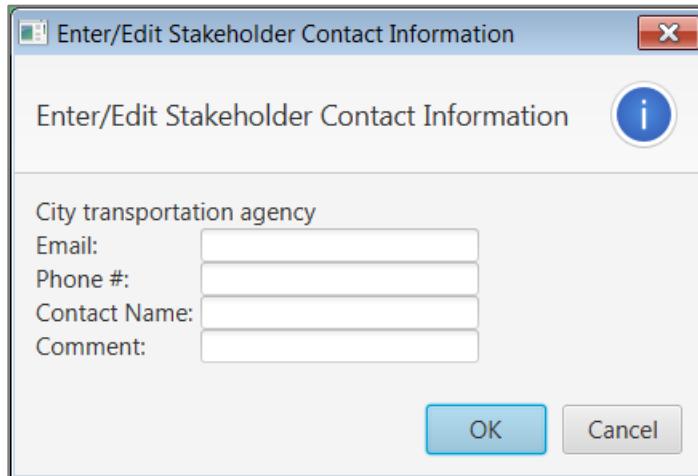


Figure 16: Example of the Stakeholder Contact Information Pop-up Window.

2.4.3 PROJECT DOCUMENTATION INPUTS

The final type of input used by the tool are project documentation inputs. These inputs are not scored or used directly in the tool's decision-making guidance; instead, they provide records of the assessment steps that were taken along with all information relevant to the decisions that were made. This information is stored in the project file for future reference, and appears in the fact sheet outputs.

Project documentation inputs are presented in the form of questions and comment areas. The questions include yes-or-no questions, multiple-choice questions, and open-ended questions requiring the user to fill out a comment field with the relevant information and/or justification. Each question should be answered to the best of one's ability. The comments boxes can be used to indicate questions that are not applicable to a particular project. Figure 17 shows an example of the project documentation inputs related to costs.

The screenshot shows the WZITS Tool interface. The title bar reads "Work Zone Intelligent Transportations Systems Tool". The menu bar includes "File", "Edit", "Results", "Templates", and "Help". The main title "Work Zone ITS Tool" and "Step 2: Concept Development" are displayed. A progress bar at the top shows Step 2 completed, with sub-steps 1 through 6 listed below it. The left sidebar shows a tree view of the project structure under "WZITS Project", including "Step 1" and "Step 2" sections with various sub-items like "General Info", "User Needs", "Goals Selection", etc. The "Costs" section is currently selected in the sidebar. The main content area is titled "Costs" and contains the following questions:

- 1: Will any sensors be deployed?
How many / what type? Additional comments... Yes No
- 2: Will portable variable message signs will be deployed?
How many / what type? Additional comments... Yes No
- 3: Will cameras will be deployed?
How many / what type? Additional comments... Yes No
- 4: Which ITS devices will be rented/leased?
Describe...
- 5: Which ITS devices will be purchased?
Describe...
- 6: Who will maintain and calibrate the system?
Describe...
- 7: Have system goals, objectives and a concept of operations been defined?
Additional comments... Yes No
- 8: How much time is scheduled for smart work zone set-up?
Additional comments...
- 9: What type of software will be to manage the smart work zone?
Additional comments...

At the bottom, there is a "Project Milestones" section with four green progress bars labeled "Goals", "Feasibility Assessment", "Stakeholders", and "Applications".

Figure 17: Example of Project Documentation Inputs.

2.5 WZITS IMPLEMENTATION TOOL OUTPUTS

The tool generates eight fact sheet outputs over the course of the work zone ITS assessment. Steps 1 and 2 generate two fact sheets each, while Steps 3–6 generate one fact sheet each. These fact sheets aggregate the information input into the tool and the guidance determined from these inputs into a set of concise reference sheets.

The fact sheets can be accessed from the “Step Report” sub-step once all of the other sub-steps associated with that step have been completed. Figure 18 shows an example of the first fact sheet generated in Step 1. Fact sheets can also be exported as PDF files by selecting “Export to PDF” from the Results menu, as shown in Figure 19.

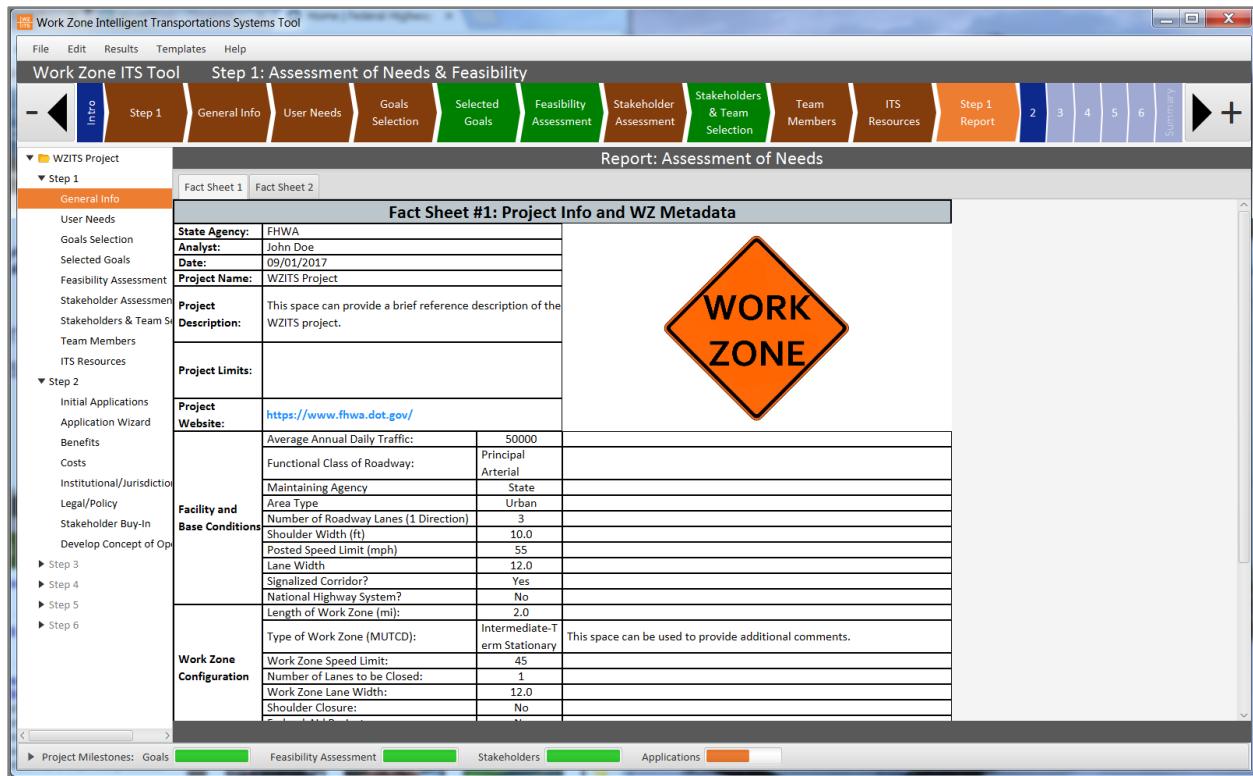


Figure 18: Example of the First Fact Sheet of Step 1.

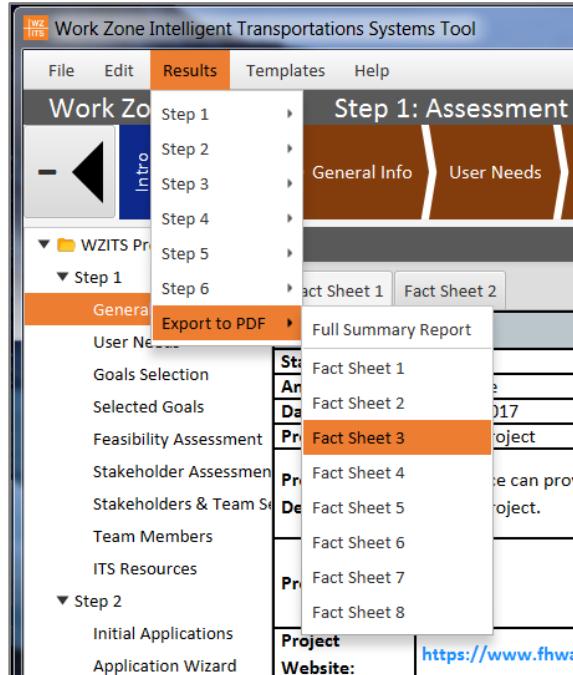


Figure 19: Demonstration of Exporting a Fact Sheet in PDF Format.

3 CASE STUDIES

This section presents a set of four case studies that demonstrate example usages of the WZITS Implementation Tool. The focus of these case studies is largely on the early stages of the WZITS process, because some of the projects had not actually gone through ConOps, procurement, deployment, and WZITS system evaluation at the time of writing. Therefore, the case studies are intended to illustrate how an agency can use the *Work Zone ITS Implementation Guide* and implementation tool to assist in evaluating WZITS feasibility, goal setting, application, and stakeholder involvement. The case studies are introduced below and documented further in the appendix in Section 5.

3.1 CASE STUDY 1: ROAD WIDENING IN RALEIGH, NC

The North Carolina Department of Transportation (NCDOT) completed a roadway widening project along Interstate I-40 in Raleigh, NC in 2011. This case study assumes that the implementation tool had been applied to the project prior to construction.

The project widened 6.2 miles of I-40 from west of Wade Avenue (State Road 1728) to east of the Jones Franklin Road (S.R. 5039) bridge. The project's stated goal was to reduce congestion and improve traffic flow in one of the most heavily congested areas in the Research Triangle. An overview map of the project is shown in Figure 20.

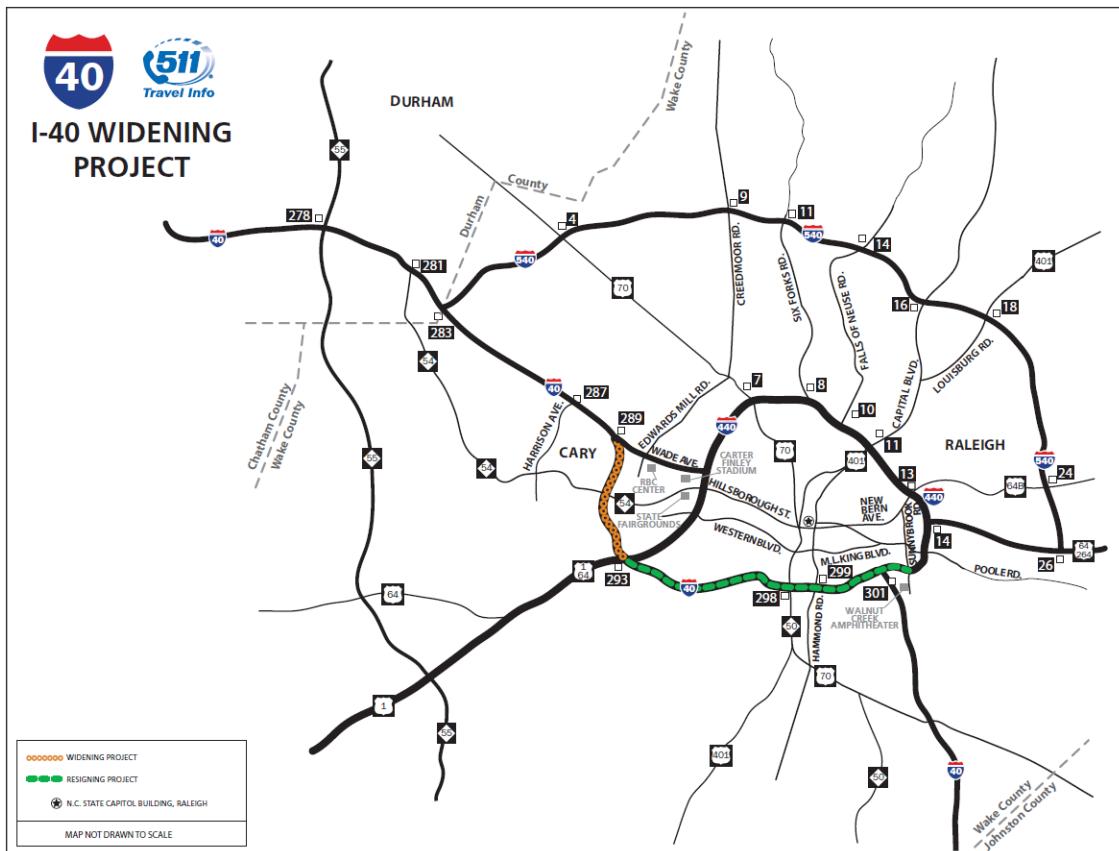


Figure 20: Raleigh, NC Case Study Overview (Source: NCDOT)

Lane closures were allowed between 9 p.m. and 6 a.m. Monday through Friday, until 9 a.m. on Saturday, and until 10 a.m. on Sunday. One extended weekend lane closure was allowed to occur from 9 p.m. Friday to 6 a.m. Monday in the eastbound lanes between Harrison Avenue and Wade Avenue.

The project was constructed using the design-build method. Design-build is an innovative procedure that allows NCDOT to conduct a project's design, environmental permitting, right-of-way acquisition, utility relocation, and construction concurrently under one contract. These steps help reduce construction time and help the department avoid cost inflation.

To minimize impact from construction vehicles, the contractor installed two conveyer belt systems near the N.C. 54 interchange to transport stone and asphalt to the median area. The contractor estimated that the use of the conveyors eliminated 237 lane closures and nearly 12,000 truck trips that otherwise would have been needed to haul the materials from the I-40 travel lanes. The conveyer belt system is shown in Figure 21.



Figure 21: Photos of the Raleigh, NC Case Study Conveyer Belt System

Following the guidance in *Work Zone ITS Implementation Guide* and the implementation tool's wizards, information about the I-40 widening project was used to complete Steps 1 and Step 2 of the work zone assessment process to determine the following:

- System goals;
- Feasibility of the project as a Smart Work Zone;
- Most applicable Smart Work Zone applications; and
- List of stakeholders.

Starting with the Goal Wizard, a series of twenty questions were answered related to the roadway geometry, expected congestion and queuing, and performance targets. Based on these responses, the wizard recommended a number of goals in the mobility, safety, productivity, regulatory, and traveler information categories and provided a ranking for each of these recommended goals (see Table 1). For the I-40 case study, the highest-ranked goals were:

- Mobility: reduce variability of travel times,
- Safety: reduce rear-end crashes, and

- Regulatory: Monitor work zone operations and safety in real-time.

Additional mobility goals included reducing delays and single-vehicle trips through the work zones. Additional safety goals included reducing secondary crashes and incident clearance times. These recommendations matched well with NCDOT's focus and policy for this work zone.

Table 1: Goal Wizard Output for the Raleigh, NC Case Study

Category	Recommended User Goals by WZITS Tool	Score
Mobility Goals	Reduce variability of travel times	High
	Reduce daily peak period delays to XX minutes	Medium
	Reduce the number of single-vehicle trips through the work zone	Medium
	Facilitate the movement of emergency and construction vehicles through the work zone	Medium
Safety Goals	Reduce rear-end crashes	High
	Reduce secondary incidents	Medium
	Reduce Incident Clearance Times	Medium
	Provide a safe environment for roadway users and worker safety	Medium
	Work toward zero work zone fatalities	Medium
Productivity Goals	Minimize delays in construction vehicle access to the work zone	Low
	Provide an egress from work zone for haul vehicles	Low
Regulatory Goals	Monitor work zone operations and safety performance in real-time	High
	Reduce work zone delays to within XX minutes	Medium
	Monitor alternative route operations and safety performance in real-time	Medium
	Optimize contractor work periods	Medium
Traveler Information Goals	Provide roadway users real-time work zone information	Medium
	Provide roadway users real-time alternate route information	Medium

Next, the Feasibility Wizard was used to answer a series of questions related to work zone duration, impacts, and delays, along with specific issues affecting the work zone. Based on the answers to these questions, an ITS feasibility score was generated for the project. The Feasibility Wizard will provide one of three outcomes: (1) WZITS is recommended and will provide benefits, (2) WZITS may provide benefits, and (3) WZITS may not provide benefits. For this case study, the feasibility score was 36 points, which results in a recommendation that WZITS be designed and implemented for this project.

The Application Wizard was then applied to generate a recommendation for the type of WZITS to implement. A series of questions were answered that were based on the goal categories but related to the construction project. The answers to these questions were used to recommend WZITS applications, as shown in Table 2. For the I-40 case study, the top two recommended applications were:

- Queue warning system, and
- Real-time traveler information system.

Table 2: Application Wizard Output for the Raleigh, NC Case Study

Recommended WZITS Applications	Score
Queue Warning	High
Real-time Traveler Information	High
Incident Management	Medium
Variable Speed Limit	Medium
Performance Measurement	Medium
Dynamic Lane Merge	Medium
Temporary Ramp Metering	Low
Construction Vehicle Entrance/ Exit Warning	Low

The Stakeholder Wizard was applied to the case study to assist the NCDOT project designer with determining the project stakeholders. This wizard asks a series of questions related to the project and the land use surrounding the work zone. Based on the answers to the questions, the wizard recommended a list of potential stakeholders for the project, as shown below in Table 3.

Table 3: Recommended Stakeholder List for the Raleigh, NC Case Study

Recommended Stakeholders by WZITS Tool	Score
FHWA Division Office	High
Local police	High
Motorists	Medium
Traffic Management Center	Medium
Local businesses	Medium
EMS	Medium
Commercial trucking companies	Medium
Incident management agencies	Medium
State DOT	Medium
Transit agency	Medium
Fire department	Medium
Media	Medium
City transportation agency	Low
Shopping centers	Low
Local residents	Low
Special event venue	Low
County transportation agency	Low
MPO	Low
Service patrol/ contractors	Low
Construction contractors	Low
Public officials	Low
Schools/ Universities	Low
Convention/ Visitors Bureau	Low
State police	Low

Detailed case study results are provided in Section 5.

3.2 CASE STUDY 2: BRIDGE REPLACEMENT IN ANDOVER, MA

In this case study, the Massachusetts Department of Transportation (MassDOT) plans to replace a bridge on Interstate 495 that crosses over Route 28 in Andover, MA. Figure 22 shows an aerial view of the project location.



Figure 22: Overview of the Bridge Replacement Case Study in Andover, MA

The project will take place over a four-year staged construction project. The construction project will have the following four stages:

- Stage 1 (6 months) — Construct a temporary bridge in the existing median.
- Stage 2 (18 months) — Move I-495 northbound traffic to the temporary bridge, demolish the existing I-495 northbound bridge and reconstruct a new I-495 northbound bridge.
- Stage 3 (18 months) — Move I-495 northbound traffic to the new bridge, shift I-495 southbound traffic to the temporary bridge, demolish the I-495 southbound bridge and reconstruct a new I-495 southbound bridge.
- Stage 4 (6 months) – Shift traffic to the newly constructed I-495 southbound bridge and remove the temporary bridge in the median.

Various traffic characteristics are known about the roadway and about the temporary bridge that will be constructed. Following the guidance in *Work Zone ITS Implementation Guide* and the implementation tool's wizards, the information about the bridge replacement project was used to complete Steps 1 and Step 2 of the work zone ITS assessment process and determine the following:

- System goals,
- Feasibility of the project as a Smart Work Zone,
- Most applicable Smart Work Zone applications, and

- List of stakeholders.

Starting with the Goal Wizard, a series of twenty (20) questions were answered related to the roadway geometry, expected congestion and queuing, and performance targets. Based on the responses, the goal wizard output matrix provided a number of goals in the mobility, safety, productivity, regulatory, and traveler information categories and also provided a ranking for each of the associated goals (see Table 6).

The Goal Wizard assists agencies in determining goals for their projects. For the I-495 case study, the highest ranked goal is in the safety category: reduce rear-end crashes. Additional goals include reducing secondary crashes and incident clearance times. In the mobility category, it is recommended that delays are reduced to within MassDOT's adopted 12-minute rule and to reduce travel time variability.

Table 4: Goal Wizard Output for the Andover, MA Case Study.

Category	Recommended User Goals by WZITS Tool	Score
Mobility Goals	Reduce daily peak period delays to 12 minutes	Medium
	Reduce variability of travel times	Medium
	Facilitate the movement of emergency and construction vehicles through the work zone	Medium
	Reduce the number of single-vehicle trips through the work zone	Medium
Safety Goals	Reduce rear-end crashes	High
	Reduce secondary incidents	Medium
	Reduce Incident Clearance Times	Medium
	Provide a safe environment for roadway users and worker safety	Medium
	Work toward zero work zone fatalities	Medium
Productivity Goals	Minimize delays in construction vehicle access to the work zone	Low
	Provide an egress from work zone for haul vehicles	Low
Regulatory Goals	Monitor work zone operations and safety performance in real-time	Medium
	Reduce work zone delays to within XX minutes	Medium
	Monitor alternative route operations and safety performance in real-time	Low
	Optimize contractor work periods	Low
Traveler Information Goals	Provide roadway users real-time work zone information	Low
	Provide roadway users real-time alternate route information	Low

Next, the Feasibility Wizard was used to answer a series of questions related to the work zone duration, impacts, and delays, along with specific issues affecting the work zone. Based on the answers to these questions, an ITS feasibility score was generated for the project. The Feasibility Wizard will provide one of three outcomes: (1) WZITS is recommended and will provide benefits, (2) WZITS may provide benefits, and (3) WZITS may not provide benefits. For this case study, the feasibility score was 37 points, which results in a recommendation that WZITS be designed and implemented for this project.

The Application Wizard was then applied to generate a recommendation for the type of WZITS to implement. A series of questions were answered that were based on the goal categories but related to the construction project. The answers to these questions were used to recommend WZITS applications, as shown in Table 5. For the I-495 case study, the top two recommended applications to be implemented are:

- Real-time traveler information system, and
- Queue warning system.

Table 5: Application Wizard Output for the Andover, MA Case Study.

Recommended WZITS Applications	Score
Real-time Traveler Information	High
Queue Warning	Medium
Incident Management	Low
Variable Speed Limit	Low
Performance Measurement	Low
Dynamic Lane Merge	Low
Automated Enforcement	Low
Construction Vehicle Entrance/ Exit Warning	Low
Temporary Ramp Metering	Low

The Stakeholder Wizard was applied to the case study to assist the MassDOT project designer with determining the project stakeholders. The stakeholder wizard asks the user a series of questions related to the project and the land use surrounding the work zone. Based on the answers to the questions, the wizard recommends a list of potential stakeholders for the project, as shown below in Table 6.

Table 6: Recommended Stakeholder List for the Andover, MA Case Study.

Recommended Stakeholders by WZITS Tool	Score
Traffic Management Center	High
Commercial trucking companies	Medium
Motorists	Medium
Local businesses	Medium
State DOT	Low
Service patrol/ contractors	Low
Construction contractors	Low
EMS	Low
Media	Low
Incident management agencies	Low
Local police	Low
County transportation agency	Low
MPO	Low
FHWA Division Office	Low
Fire department	Low
Public officials	Low
City transportation agency	Low
State police	Low
Shopping centers	Low
Local residents	Low
Special event venue	Low

Detailed case study results are provided in Section 5.

3.3 CASE STUDY 3: NORTH WASHINGTON BRIDGE IN BOSTON, MA

The Massachusetts Department of Transportation (MassDOT), in conjunction with the City of Boston, plans to replace the North Washington Street Bridge between Boston's North End and Charlestown neighborhoods. Figure 23 shows the project limits. Detailed evaluation results and reports generated with the WZITS tool are shown in the Appendix.



Figure 23: North Washington Street Bridge Project (Source: MassDOT).

The project will take place over a three-year staged construction project. The construction project will have the following four stages (and sub-stages):

- Stage 1A — Closes the sidewalk on the east side of the bridge and establishes the work zone. Shared bicycle lane markings (sharrows) are added.
- Stage 1B — Reduces the bridge capacity from four lanes to two lanes with all travel on the west side of the bridge. Detours are put in place.
- Stage 2 — Provides an additional travel lane for a total of three lanes: one inbound into the North End and two outbound exiting the North End.
- Stage 3 — Shifts the three lanes of traffic to the east side of the bridge.
- Stage 4A — Reopens all four lanes for travel and provides a one-way buffered bicycle lane and sidewalk on the west side of the bridge.

- Stage 4B — Maintains the travel lanes provided in Stage 4A but the transition areas entering and exiting the bridge structure shift the work zones to allow the final stages of the project to tie into the existing City streets.

Various traffic characteristics are known about the roadway and the planned work zone. Using the implementation tool, the following information was completed for the project:

- Assessment of Needs;
- Concept Development and Feasibility;
- Detailed System Planning and Design;
- Procurement;
- System Deployment; and
- System Operation, Maintenance, and Evaluation.

The Goal Wizard provided recommended user goals, as shown in Table 7. The WZITS feasibility score generated by the Feasibility Wizard was 35. A score of 30 or more suggests that ITS is likely to provide significant benefits and should be considered as a treatment to mitigate impacts. Based on the project goals and the overall WZITS feasibility, the Application Wizard then provided a set of recommended work zone ITS applications, as shown in Table 8.

Table 7: Goal Wizard Output for the Boston, MA Case Study.

Category	Recommended User Goals by WZITS Tool	Priority
Safety Goals	Work toward Zero work zone fatalities	Medium
	Reduce rear-end crashes	Medium
	Provide safe environment for roadway users and worker safety	Low
Mobility Goals	Reduce variability of travel times	Medium
	Reduce the number of single-vehicle trips through the work zone	Medium
Regulatory Goals	Optimize contractor work periods	Low
Traveler Info Goals	Provide roadway users real-time work zone information	Medium
	Provide roadway users real-time alternative route information	Medium

Table 8: Application Wizard Output for the Boston, MA Case Study.

Recommended WZITS Applications	
Queue Warning	Medium
Real-time Traveler Information	High
Incident Management	Low
Dynamic Lane Merge	Low
Variable Speed Limit	Medium
Automated Enforcement	Low
Construction Vehicle Entrance/ Exit Warning	Not Recommended
Temporary Ramp Metering	Low
Performance Measurement	Medium

The WZITS tool recommended that one or more ITS solutions be incorporated into the project, along with a number of identified goals for the deployment. The tool further identified a number of potential strategies to consider for the project. Detailed case study results are provided in Section 5.

3.4 CASE STUDY 4: ROADWAY WIDENING IN ASHE COUNTY, NC

The North Carolina Department of Transportation (NCDOT) is widening U.S. 221 from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, NC. The 16.1-mile project will widen the main corridor into Ashe County for commuters and commercial vehicles into a four-lane median-divided highway. **Error! Reference source not found.** provides an overview map of the project.

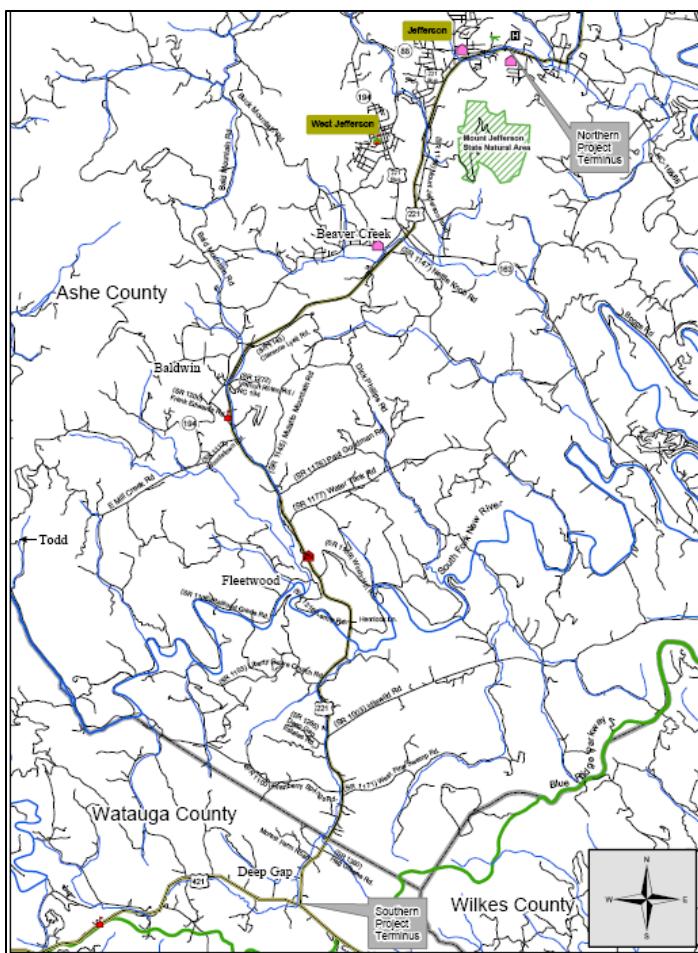


Figure 24: NCDOT US 221 Case Study Overview (Source: NCDOT).

As planned, the project work includes the following five sections:

- Section A — U.S. 421 to Idlewild Road in Watauga and Ashe counties (2.8 miles)
- Section B — Idlewild Road to North of South Fork New River in Ashe County (1.8 miles)
- Section C — South Fork New River to South of N.C. 194 in Ashe County (4 miles)
- Section D — South of N.C. 194 to North of N.C. 163 in Ashe County (4 miles)
- Section E — N.C. 163 to U.S. 221 Business/N.C. 88 in Jefferson (3.5 miles)

Various traffic characteristics are known about the roadway and the planned work zone. Using the implementation tool, the following information was completed for the project:

- Assessment of Needs;

- Concept Development and Feasibility;
- Detailed System Planning and Design;
- Procurement;
- System Deployment; and
- System Operation, Maintenance, and Evaluation.

Applying the Goal Wizard generated the set of recommended user goals shown in Table 9. The WZITS feasibility score generated by the Feasibility Wizard was 20. This score suggests that ITS may provide some benefits on the predominantly rural facility, and should be considered as a treatment to mitigate impacts. Based on the project goals, the Application Wizard then provided a set of recommended WZ ITS applications, which are summarized in Table 10.

Table 9: Goal Wizard Output for the US 221 Case Study.

Category	Recommended User Goals by WZITS Tool	Priority
Safety Goals	Reduce secondary incidents	Medium
	Reduce incidence clearance times	Medium
	Work towards zero work zone fatalities	Medium
	Provide a safe environment for roadway users and worker safety	Medium
Productivity Goals	Provide an egress from work zone for haul vehicles	Low
Regulatory Goals	Optimize contractor work periods	Low

Table 10: Application Wizard Output for the US 221 Case Study.

Recommended WZITS Applications	
Queue Warning	Low
Real-time Traveler Information	Low
Incident Management	Low
Dynamic Lane Merge	Not Recommended
Variable Speed Limit	Low
Automated Enforcement	Low
Construction Vehicle Entrance/ Exit Warning	Low
Temporary Ramp Metering	Low
Performance Measurement	Medium

The implementation tool recommended that one or more ITS solutions should be considered for the project, and identified a number of potential goals for the deployment. The tool further identified a number of potential strategies to consider for the project, although they generally scored low compared to the previous case studies. Detailed case study results are provided in Section 5.

4 REFERENCES

Federal Highway Administration, Work Zone Intelligent Transportation Systems Implementation Guide, January 2014

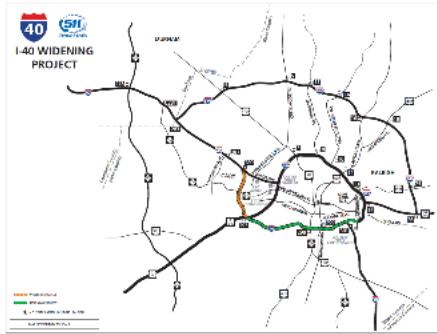
Massachusetts Department of Transportation. 2017.

North Carolina Department of Transportation. 2017.

5 APPENDIX - DETAILED CASE STUDY TOOL REPORTS

The following pages contain the output reports for the four case studies generated using the WZITS Implementation Tool. Each report consists of eight pages, formatted to contain the most pertinent inputs and outputs generated from the WZITS tool.

Fact Sheet #1: Project Info and WZ Metadata		
State Agency:	NCDOT	
Analyst:	JLT	
Date:	10/03/2017	
Project Name:	Case Study 1 - Road Widening in Raleigh, NC	
Project Description:	The North Carolina Department of Transportation (NCDOT) completed a roadway widening project of Interstate I-40 in Raleigh, NC in 2011. This case study ...	
Project Limits:	The project included widening 6.2 miles of I-40 from west of Wade Avenue (State Road 1728) to east of the Jones Franklin Road (S.R. 5039) bridge. The	
Project Website:		
Facility and Base Conditions	Average Annual Daily Traffic:	125000
	Functional Class of Roadway:	Interstate
	Maintaining Agency	State
	Area Type	Urban
	Number of Roadway Lanes (1 Direction)	3
	Shoulder Width (ft)	10.0
	Posted Speed Limit (mph)	60
	Lane Width	12.0
	Signalized Corridor?	No
Work Zone Configuration	National Highway System?	Yes
	Length of Work Zone (mi):	6.2
	Type of Work Zone (MUTCD):	Long-Term Stationary
	Work Zone Speed Limit:	50
	Number of Lanes to be Closed:	1
	Work Zone Lane Width:	12.0
	Shoulder Closure:	Yes
Category	Selected Work Zone ITS Goals	
	Reduce rear-end crashes	
	Reduce secondary incidents	
	Reduce Incident Clearance Times	
	Reduce daily peak period delays to 25 minutes	
	Reduce variability of travel times	
	Monitor work zone operations and safety performance in real-time	
	Monitor alternative route operations and safety performance in real-time	
	Provide roadway users real-time work zone information	
Feasibility Score:		36
30 or more: ITS is likely to provide significant benefits and should be considered as a treatment to mitigate impacts.		



Fact Sheet #2: WZITS Stakeholders			
State Agency:	NCDOT		
Analyst:	JLT		
Date:	10/03/2017		
Project Name:	Case Study 1 - Road Widening in Raleigh, NC		
Project Description:	The North Carolina Department of Transportation (NCDOT) completed a roadway widening project of Interstate I-40 in Raleigh, NC in 2011. This case study assumes that the WZITS wizards had been applied to the project prior to construction.		
Project Limits:	The project included widening 6.2 miles of I-40 from west of Wade Avenue (State Road 1728) to east of the Jones Franklin Road (S.R. 5039) bridge. The		
Project Website:			
Selected Team and Stakeholders			
#	Core Team Members	Email	Phone
1	State DOT		
2	City transportation agency		
3	MPO		
4	FHWA Division Office		
#	Stakeholders	Email	Phone
6	Local police/Sheriff		
7	EMS		
8	Motorists		
9	Incident management agencies		
10	Special event venue		
11	Traffic Management Center		
ITS Resources			
#	Type	Response	Comment
1	Weather Monitoring Stations	No	
2	TMC Monitoring Roadway	Yes	
3	Website/Traveler Information System	Yes	
4	ITS On-Call Contract(s) Available	No	
5	Accessed to Leased Devices	No	

Fact Sheet #3: WZITS Applications and Refinement				
#	Application	High	Selected	
1	Queue Warning	Medium	Yes	
2	Real-time Traveler Information	High	Yes	
3	Incident Management	Low	Yes	
4	Dynamic Lane Merge	Low	No	
5	Variable Speed Limit	Medium	No	
6	Automated Enforcement	Low	No	
7	Construction Vehicle Entrance/ Exit Warning	Low	No	
8	Temporary Ramp Metering	Low	No	
9	Performance Measurement	Medium	No	
Application Refinement				
Category	Application Refinement	Response	Comment	
Benefits	Reducing traffic volumes	Yes		
	Reducing speed variance	Yes		
	Reducing queue-related crashes	No		
	Reducing vehicle conflicts	No		
	Reducing/eliminating dangerous merges	Yes		
	Reducing travel time	Yes		
	Reducing incident response time	No		
	Reducing speeds/increasing motorist speed compliance	No		
Institutional/ Jurisdictional	Has sufficient funding been provided in the construction contract for the work zone?	Yes		
	Is your agency reluctant to adopt smart work zone ITS?	No		
	Do your agency ITS experts interact with road design and construction experts in relation to work zones?	No		
	Does your agency have staff with experience in smart work zone ITS?	Yes		
	Do long standing operational procedures (SOPs) need to be adopted?	No		
Legal/ Policy	Is the type of system being implemented permitted under the current laws and regulations?	Yes		
	Are there any liability issues for placing ITS equipment in a work zone?	No		
	Are there restrictions regarding the archiving of data in your state?	Yes		
	Are there any liability issues regarding the posting of warning messages?	No		
Stakeholder Buy-in	Have inter-agency relationships been established between stakeholders?	Yes		
	Are regular meetings held with stakeholders to keep them apprised of the project?	Yes		
	Is there a champion for the project?	Yes		
	Have the estimated benefits of the project been documented?	Yes		

Fact Sheet #4: WZITS Concept of Operations	
State Agency:	NCDOT
Analyst:	JLT
Date:	10/03/2017
Project Name:	Case Study 1 - Road Widening in Raleigh, NC
Project Description:	The North Carolina Department of Transportation (NCDOT) completed a roadway widening project of Interstate I-40 in Raleigh, NC in 2011. This case study assumes that the WZITS wizards had been applied to the project prior to construction.
Project Limits:	The project included widening 6.2 miles of I-40 from west of Wade Avenue (State Road 1728) to east of the Jones Franklin Road (S.R. 5039) bridge. The
Project Website:	

Fact Sheet #5: WZITS Project Documentation			
System Planning & Design			
Category	Question	Response	Comment
Document Concept of Operations	Is there data flow between system components?	No	
	Is there information flow between the agency and the public?	No	
	Do you have communication flow charts?	No	
	How will the system ultimately operate?	-	
	Is there an overall strategy for the system?	No	
	How does the work zone fit into the overall construction project?	-	
Requirements	Have physical requirements been defined?	No	
	Have functional requirements been defined?	No	
	Have system requirements been defined?	No	
	Has a traceability matrix been established?	No	
	Has interoperability or connectivity been established with other ITS equipment in the region?	No	
	Has connectivity been established with the traffic management center (TMC) in the region?	No	
	Will changes in the work zone environment be addressed over time?	No	
	Has a contingency plan been included with the design to address delays in the project?	No	
Testing Strategy	Has a test plan for the project been developed?	No	
Operations & Maintenance	Are there requirements for response times when there are equipment failures?	No	
	Is there a procedure for enforcing penalties for system downtime?	No	
Staff Training Needs	Where will training be held?	-	
	Has staff been trained on contractor notification procedures?	No	
System Security	Is access to the smart work zone ITS application protected from unauthorized users?	No	
	Has protection and recovery from vandalism and stolen system components such as batteries been addressed?	No	
Evaluation	Is a system evaluation of the project planned?	No	
	Were the system goals and objectives explicitly stated?	No	
	Is there a mechanism in place for the public to offer feedback on the smart work zone system?	No	
	Should changes be made to optimize the system or improve performance?	No	
Benefit/Cost	Have the benefits that the system will have on mobility been considered?	No	
	Have the benefits that the system will have on safety been considered?	No	
	Has the cost estimate been re-examined now that the system requirements have been defined?	No	

Fact Sheet #6: WZITS Procurement			
Procurement			
Category	Question	Response	Comment
Direct/Indirect	Does the agency want control over the work zone setup, operation and management? If yes, please describe the extent below.	No	
Award Mechanism	What type of award mechanism do you plan to use?	-	
RFP Requirements	Is your agency issuing a request for proposals (RFP)?	No	
	Have clear specifications for the system been defined?	No	
	Will the agency hire an independent evaluator for the system?	No	
Selected Vendor	Has a selection committee been formed?	No	
	Have the proposal review evaluation criteria been specified?	No	

Fact Sheet #7: WZITS System Deployment			
System Deployment			
Category	Question	Response	Comment
Implementing System Plans	Will the system be operated as a stand-alone system?	No	
	What is the level of agency involvement?	-	
Scheduling Decisions	Has sufficient lead time to deploy the smart work zone ITS system been included in the construction project schedule?	No	
	Has sufficient testing and calibration time and effort been included in the construction project schedule?	No	
	Has the evaluation process been included in the schedule?	No	
System Acceptance Testing	Has system acceptance testing been conducted using the test plan?	No	
	Is the smart work zone ITS system flexible enough to incorporate construction design changes and delays?	No	
	Has the system been verified from a drivers' expectation?	No	
	Has the system deployment been field verified by agency personnel?	No	
Handling Deployment Issues	Is there a contingency plan for addressing communication issues with the equipment?	No	
	Are there any weather related issues that need to be considered with the smart work zone ITS deployment?	No	
	Has an experienced/qualified contractor been selected?	No	
	Is regular communication with the stakeholders continuing during the deployment phase?	No	
	Is there a way to incorporate user feedback into the system?	No	

Fact Sheet #8: WZITS Operations and Maintenance			
State Agency:	NCDOT		
Analyst:	JLT		
Date:	10/03/2017		
Project Name:	Case Study 1 - Road Widening in Raleigh, NC		
Project Description:	The North Carolina Department of Transportation (NCDOT) completed a roadway widening project of Interstate I-40 in Raleigh, NC in 2011. This case study assumes that the WZITS wizards had been applied to the project prior to construction.		
Project Limits:	The project included widening 6.2 miles of I-40 from west of Wade Avenue (State Road 1728) to east of the Jones Franklin Road (S.R. 5039) bridge. The		
Project Website:			
System Operation, Maintenance & Evaluation			
Category	Question	Response	Comment
Changing Work Zone	Has support for changing work zone requirements been considered?	No	
	Is the agency or contractor personnel prepared to make changes to the work zone?	No	
	Is coordination between construction team, agency personnel and ITS operators clearly defined?	No	
Using/Sharing ITS Info	Is data being collected on the project?	No	
	Has the agency considered making the data available through an XML feed?	No	
	Will camera images be made available to the public through the agency website?	No	
	Are performance measures being collected through the smart work zone ITS data?	No	
Maintaining Adequate Staff	Will consistent personnel be available through the duration of the project?	No	
Leveraging Public Support	Is there public support for the project?	No	
	Has the public been adequately prepared for the project?	No	
	Have elected officials been adequately briefed on the project?	No	
	Has the media and public affairs office been adequately briefed on the project?	No	
System Monitoring/Evaluation	Has a system been put in place for ongoing monitoring and evaluation of the project?	No	
	Are there provisions in place to modify or recalibrate the smart work zone ITS set-up throughout the project?	No	
	Is a final evaluation of the project planned?	No	

Fact Sheet #1: Project Info and WZ Metadata		
State Agency:	MassDOT	
Analyst:	JLT	
Date:	10/03/2017	
Project Name:	Case Study 2: I-495 Bridge Replacement	
Project Description:	The Massachusetts Department of Transportation (MassDOT) plans to replace a bridge on Interstate 495 that crosses over Route 28 in Andover, MA.	
Project Limits:	The project will take place over a four year staged construction project. The construction project will have the following four stages:...	
Project Website:		
Facility and Base Conditions	Average Annual Daily Traffic:	65000
	Functional Class of Roadway:	Interstate
	Maintaining Agency	State
	Area Type	Urban
	Number of Roadway Lanes (1 Direction)	2
	Shoulder Width (ft)	10.0
	Posted Speed Limit (mph)	65
	Lane Width	12.0
	Signalized Corridor?	No
	National Highway System?	Yes
Work Zone Configuration	Length of Work Zone (mi):	1.0
	Type of Work Zone (MUTCD):	Long-Term Stationary
	Work Zone Speed Limit:	45
	Number of Lanes to be Closed:	1
	Work Zone Lane Width:	12.0
	Shoulder Closure:	Yes
	Federal-Aid Project:	Yes
Category	Selected Work Zone ITS Goals	
Safety	Reduce rear-end crashes	High
	Reduce secondary incidents	High
	Reduce Incident Clearance Times	High
	Work toward zero work zone fatalities	Medium
Mobility	Reduce daily peak period delays to 12 minutes	Medium
	Facilitate the movement of emergency and construction vehicles through the work zone	High
Regulatory	Monitor work zone operations and safety performance in real-time	High
Traveler Info	Provide roadway users real-time work zone information	Medium
Feasibility Score:		37
30 or more: ITS is likely to provide significant benefits and should be considered as a treatment to mitigate impacts.		

Fact Sheet #2: WZITS Stakeholders			
State Agency:	MassDOT		
Analyst:	JLT		
Date:	10/03/2017		
Project Name:	Case Study 2: I-495 Bridge Replacement		
Project Description:	The Massachusetts Department of Transportation (MassDOT) plans to replace a bridge on Interstate 495 that crosses over Route 28 in Andover, MA.		
Project Limits:	The project will take place over a four year staged construction project. The construction project will have the following four stages: - Stage 1 (6 months) – Construct a temporary bridge in the existing median. - Stage 2 (18 months) – Move I-495 NB traffic to the temporary bridge, demolish existing I-495 NB bridge and reconstruct a new ...		
Project Website:			
Selected Team and Stakeholders			
#	Core Team Members	Email	Phone
1	State DOT		
2	FHWA Division Office		
3	Traffic Management Center		
#	Stakeholders	Email	Phone
5	Local police/Sheriff		
6	Shopping centers		
7	Commercial trucking companies		
8	Motorists		
9	Local residents		
10	Incident management agencies		
ITS Resources			
#	Type	Response	Comment
1	Weather Monitoring Stations	No	
2	TMC Monitoring Roadway	Yes	
3	Website/Traveler Information System	Yes	
4	ITS On-Call Contract(s) Available	No	
5	Accessed to Leased Devices	No	

Fact Sheet #3: WZITS Applications and Refinement			
#	Application	High	Selected
1	Queue Warning	Medium	Yes
2	Real-time Traveler Information	High	Yes
3	Incident Management	Medium	Yes
4	Dynamic Lane Merge	Low	No
5	Variable Speed Limit	Medium	No
6	Automated Enforcement	Low	No
7	Construction Vehicle Entrance/ Exit Warning	Low	No
8	Temporary Ramp Metering	Low	No
9	Performance Measurement	Medium	No
Application Refinement			
Category	Application Refinement	Response	Comment
Benefits	Reducing traffic volumes	Yes	
	Reducing speed variance	Yes	
	Reducing queue-related crashes	No	
	Reducing vehicle conflicts	No	
	Reducing/eliminating dangerous merges	No	
	Reducing travel time	Yes	
	Reducing incident response time	No	
	Reducing speeds/increasing motorist speed compliance	No	
Institutional/ Jurisdictional	Has sufficient funding been provided in the construction contract for the work zone?	Yes	
	Is your agency reluctant to adopt smart work zone ITS?	No	
	Do your agency ITS experts interact with road design and construction experts in relation to work zones?	No	
	Does your agency have staff with experience in smart work zone ITS?	Yes	
	Do long standing operational procedures (SOPs) need to be adopted?	No	
Legal/ Policy	Is the type of system being implemented permitted under the current laws and regulations?	Yes	
	Are there any liability issues for placing ITS equipment in a work zone?	No	
	Are there restrictions regarding the archiving of data in your state?	No	
	Are there any liability issues regarding the posting of warning messages?	No	
Stakeholder Buy-in	Have inter-agency relationships been established between stakeholders?	Yes	
	Are regular meetings held with stakeholders to keep them apprised of the project?	Yes	
	Is there a champion for the project?	Yes	
	Have the estimated benefits of the project been documented?	Yes	

Fact Sheet #4: WZITS Concept of Operations	
State Agency:	MassDOT
Analyst:	JLT
Date:	10/03/2017
Project Name:	Case Study 2: I-495 Bridge Replacement
Project Description:	The Massachusetts Department of Transportation (MassDOT) plans to replace a bridge on Interstate 495 that crosses over Route 28 in Andover, MA.
Project Limits:	The project will take place over a four year staged construction project. The construction project will have the following four stages: - Stage 1 (6 months) – Construct a temporary bridge in the existing median. - Stage 2 (18 months) – Move I-495 NB traffic to the temporary bridge, demolish existing I-495 NB bridge and reconstruct a new ...
Project Website:	

Fact Sheet #5: WZITS Project Documentation			
Category	Question	Response	Comment
Document Concept of Operations	Is there data flow between system components?	No	
	Is there information flow between the agency and the public?	No	
	Do you have communication flow charts?	No	
	How will the system ultimately operate?	-	
	Is there an overall strategy for the system?	No	
	How does the work zone fit into the overall construction project?	-	
Requirements	Have physical requirements been defined?	No	
	Have functional requirements been defined?	No	
	Have system requirements been defined?	No	
	Has a traceability matrix been established?	No	
	Has interoperability or connectivity been established with other ITS equipment in the region?	No	
	Has connectivity been established with the traffic management center (TMC) in the region?	No	
	Will changes in the work zone environment be addressed over time?	No	
	Has a contingency plan been included with the design to address delays in the project?	No	
Testing Strategy	Has a test plan for the project been developed?	No	
Operations & Maintenance	Are there requirements for response times when there are equipment failures?	No	
	Is there a procedure for enforcing penalties for system downtime?	No	
Staff Training Needs	Where will training be held?	-	
	Has staff been trained on contractor notification procedures?	No	
System Security	Is access to the smart work zone ITS application protected from unauthorized users?	No	
	Has protection and recovery from vandalism and stolen system components such as batteries been addressed?	No	
Evaluation	Is a system evaluation of the project planned?	No	
	Were the system goals and objectives explicitly stated?	No	
	Is there a mechanism in place for the public to offer feedback on the smart work zone system?	No	
	Should changes be made to optimize the system or improve performance?	No	
Benefit/Cost	Have the benefits that the system will have on mobility been considered?	No	
	Have the benefits that the system will have on safety been considered?	No	
	Has the cost estimate been re-examined now that the system requirements have been defined?	No	

Fact Sheet #6: WZITS Procurement			
Procurement			
Category	Question	Response	Comment
Direct/Indirect	Does the agency want control over the work zone setup, operation and management? If yes, please describe the extent below.	No	
Award Mechanism	What type of award mechanism do you plan to use?	-	
RFP Requirements	Is your agency issuing a request for proposals (RFP)?	No	
	Have clear specifications for the system been defined?	No	
	Will the agency hire an independent evaluator for the system?	No	
Selected Vendor	Has a selection committee been formed?	No	
	Have the proposal review evaluation criteria been specified?	No	

Fact Sheet #7: WZITS System Deployment			
System Deployment			
Category	Question	Response	Comment
Implementing System Plans	Will the system be operated as a stand-alone system?	No	
	What is the level of agency involvement?	-	
Scheduling Decisions	Has sufficient lead time to deploy the smart work zone ITS system been included in the construction project schedule?	No	
	Has sufficient testing and calibration time and effort been included in the construction project schedule?	No	
	Has the evaluation process been included in the schedule?	No	
System Acceptance Testing	Has system acceptance testing been conducted using the test plan?	No	
	Is the smart work zone ITS system flexible enough to incorporate construction design changes and delays?	No	
	Has the system been verified from a drivers' expectation?	No	
	Has the system deployment been field verified by agency personnel?	No	
Handling Deployment Issues	Is there a contingency plan for addressing communication issues with the equipment?	No	
	Are there any weather related issues that need to be considered with the smart work zone ITS deployment?	No	
	Has an experienced/qualified contractor been selected?	No	
	Is regular communication with the stakeholders continuing during the deployment phase?	No	
	Is there a way to incorporate user feedback into the system?	No	

Fact Sheet #8: WZITS Operations and Maintenance			
State Agency:	MassDOT		
Analyst:	JLT		
Date:	10/03/2017		
Project Name:	Case Study 2: I-495 Bridge Replacement		
Project Description:	The Massachusetts Department of Transportation (MassDOT) plans to replace a bridge on Interstate 495 that crosses over Route 28 in Andover, MA.		
Project Limits:	The project will take place over a four year staged construction project. The construction project will have the following four stages: - Stage 1 (6 months) – Construct a temporary bridge in the existing median. - Stage 2 (18 months) – Move I-495 NB traffic to the temporary bridge, demolish existing I-495 NB bridge and reconstruct a new ...		
Project Website:			
System Operation, Maintenance & Evaluation			
Category	Question	Response	Comment
Changing Work Zone	Has support for changing work zone requirements been considered?	No	
	Is the agency or contractor personnel prepared to make changes to the work zone?	No	
	Is coordination between construction team, agency personnel and ITS operators clearly defined?	No	
Using/Sharing ITS Info	Is data being collected on the project?	No	
	Has the agency considered making the data available through an XML feed?	No	
	Will camera images be made available to the public through the agency website?	No	
	Are performance measures being collected through the smart work zone ITS data?	No	
Maintaining Adequate Staff	Will consistent personnel be available through the duration of the project?	No	
Leveraging Public Support	Is there public support for the project?	No	
	Has the public been adequately prepared for the project?	No	
	Have elected officials been adequately briefed on the project?	No	
	Has the media and public affairs office been adequately briefed on the project?	No	
System Monitoring/Evaluation	Has a system been put in place for ongoing monitoring and evaluation of the project?	No	
	Are there provisions in place to modify or recalibrate the smart work zone ITS set-up throughout the project?	No	
	Is a final evaluation of the project planned?	No	

Fact Sheet #1: Project Info and WZ Metadata		
State Agency:	MassDOT	
Analyst:	EMM	
Date:	10/03/2017	
Project Name:	Case Study 3 - N. Washington Street Bridge	
Project Description:	The project includes replacement of the North Washington Street Bridge between Charlestown and the North End in the City of Boston. It has been determined ...	
Project Limits:	The project spans Rutherford Avenue between Causeway Street to the south and Chelsea Street to the north.	
Project Website:	http://www.massdot.state.ma.us/highway/HighlightedProjects/NorthWashingtonStreetBridgeReplacement.aspx	
Facility and Base Conditions	Average Annual Daily Traffic:	80000
	Functional Class of Roadway:	Principal Arterial
	Maintaining Agency	City/Town
	Area Type	Urban
	Number of Roadway Lanes (1 Direction)	2
	Shoulder Width (ft)	1.0
	Posted Speed Limit (mph)	25
	Lane Width	11.0
	Signalized Corridor?	Yes
Work Zone Configuration	National Highway System?	No
	Length of Work Zone (mi):	0.4
	Type of Work Zone (MUTCD):	Long-Term Stationary
	Work Zone Speed Limit:	20
	Number of Lanes to be Closed:	1
	Work Zone Lane Width:	11.0
	Shoulder Closure:	No
Category	Federal-Aid Project:	Yes
	Selected Work Zone ITS Goals	
	Reduce rear-end crashes	
	Work toward zero work zone fatalities	
	Provide a safe environment for roadway users and worker safety	
	Reduce the number of single-vehicle trips through the work zone	
	Reduce variability of travel times	
	Optimize contractor work periods	
	Provide roadway users real-time work zone information	
Feasibility Score:		35
30 or more: ITS is likely to provide significant benefits and should be considered as a treatment to mitigate impacts.		



Fact Sheet #2: WZITS Stakeholders			
State Agency:	MassDOT		
Analyst:	EMM		
Date:	10/03/2017		
Project Name:	Case Study 3 - N. Washington Street Bridge		
Project Description:	The project includes replacement of the North Washington Street Bridge between Charlestown and the North End in the City of Boston. It has been determined that the span must be replaced to ensure safety, accessibility, and long-term serviceability. The proposed design will provide improved vehicle, pedestrian, cycling, transit, and boat navigation facilities, while visually complementing...		
Project Limits:	The project spans Rutherford Avenue between Causeway Street to the south and Chelsea Street to the north.		
Project Website:	http://www.massdot.state.ma.us/highway/HighlightedProjects/NorthWashingtonStreetBridgeReplacement.aspx		
Selected Team and Stakeholders			
#	Core Team Members	Email	Phone
1	State DOT	Michael.O'Dowd@dot.state.m...	857-888-8888
2	City transportation agency	para.jayasinghe@cityofboston....	617-888-8888
3	FHWA Division Office	fhwa@fhwa.gov	617-888-8888
4	Construction contractors	contractor@myproject.com	617-888-8888
5	Local police/Sheriff	chief@bostonpolice.com	617-888-8888
6	Public officials		
7	Traffic Management Center	don.burgess@cityofboston.gov	617-888-8888
#	Stakeholders	Email	Phone
9	MPO		
10	Transit agency	mbta@mbta.com	617-888-8888
11	Fire department	bfd@cityofboston.gov	617-888-8888
12	Special event venue	tdgarden@tdgarden.com	617-888-8888
13	Ped-Bike Coordinator / Advocacy Group	bikeboston@cyclistsunion.com	617-888-8888
ITS Resources			
#	Type	Response	Comment
1	Weather Monitoring Stations	No	
2	TMC Monitoring Roadway	Yes	Boston Transportation Department
3	Website/Traveler Information System	Yes	MassDOT provides online realtime traffic monitoring through their website.
4	ITS On-Call Contract(s) Available	No	
5	Accessed to Leased Devices	No	

Fact Sheet #3: WZITS Applications and Refinement			
State Agency:	MassDOT		
Analyst:	EMM		
Date:	10/03/2017		
Project Name:	Case Study 3 - N. Washington Street Bridge		
Project Description:	The project includes replacement of the North Washington Street Bridge between Charlestown and the North End in the City of Boston. It has been determined that the span must be replaced to ensure safety, accessibility, and long-term serviceability. The proposed design will provide improved vehicle, pedestrian, cycling, transit, and boat navigation facilities, while visually complementing...		
Project Limits:	The project spans Rutherford Avenue between Causeway Street to the south and Chelsea Street to the north.		
Project Website:	http://www.massdot.state.ma.us/highway/HighlightedProjects/NorthWashingtonStreetBridgeReplacement.aspx		
WZITS Selected Applications			
#	Application	High	Selected
1	Queue Warning	Medium	No
2	Real-time Traveler Information	High	Yes
3	Incident Management	Low	Yes
4	Dynamic Lane Merge	Low	No
5	Variable Speed Limit	Medium	No
6	Automated Enforcement	Low	No
7	Construction Vehicle Entrance/ Exit Warning	Not Recommended	No
8	Temporary Ramp Metering	Low	No
9	Performance Measurement	Medium	No
Application Refinement			
Category	Application Refinement	Response	Comment
Benefits	Reducing traffic volumes	Yes	This corridor is a heavily traveled transit corridor. Reducing travel times for vehicles is important.
	Reducing speed variance	No	
	Reducing queue-related crashes	No	
	Reducing vehicle conflicts	No	
	Reducing/eliminating dangerous merges	No	
	Reducing travel time	Yes	
	Reducing incident response time	No	
	Reducing speeds/increasing motorist speed compliance	No	
Institutional/Jurisdictional	Has sufficient funding been provided in the construction contract for the work zone?	Yes	
	Is your agency reluctant to adopt smart work zone ITS?	Yes	Smart work zone is an added project cost that the agency is sensitive to.
	Do your agency ITS experts interact with road design and construction experts in relation to work zones?	No	
	Does your agency have staff with experience in smart work zone ITS?	Yes	
	Do long standing operational procedures (SOPs) need to be adopted?	No	
Legal/ Policy	Is the type of system being implemented permitted under the current laws and regulations?	Yes	
	Are there any liability issues for placing ITS equipment in a work zone?	No	
	Are there restrictions regarding the archiving of data in your state?	No	
	Are there any liability issues regarding the posting of warning messages?	No	
Stakeholder Buy-in	Have inter-agency relationships been established between stakeholders?	Yes	Yes. The project is a joint effort between FHWA, MassDOT, and the City of Boston.
	Are regular meetings held with stakeholders to keep them apprised of the project?	Yes	
	Is there a champion for the project?	Yes	MassDOT
	Have the estimated benefits of the project been documented?	Yes	Replace Structurally Deficient Bridge Provide Multi-Modal Bridge as a Complete City Street over Water Improve Deficient Bike and Pedestrian Accommodations Improve Intersections Safety and Functionality Improve Navigation Channel Provide Context Sensitive Bridge Design in an Important Waterfront and Historic Bridge Location Provide Visually Appealing Bridge Design Complementing the Zakim Bridge Maintain Traffic, Residential and Economical Needs during Construction

Fact Sheet #4: WZITS Concept of Operations	
State Agency:	MassDOT
Analyst:	EMM
Date:	10/03/2017
Project Name:	Case Study 3 - N. Washington Street Bridge
Project Description:	The project includes replacement of the North Washington Street Bridge between Charlestown and the North End in the City of Boston. It has been determined that the span must be replaced to ensure safety, accessibility, and long-term serviceability. The proposed design will provide improved vehicle, pedestrian, cycling, transit, and boat navigation facilities, while visually complementin...
Project Limits:	The project spans Rutherford Avenue between Causeway Street to the south and Chelsea Street to the north.
Project Website:	http://www.massdot.state.ma.us/highway/HighlightedProjects/NorthWashingtonStreetBridgeReplacement.aspx

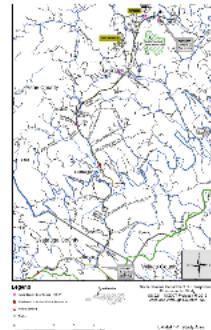
Fact Sheet #5: WZITS Project Documentation			
System Planning & Design			
Category	Question	Response	Comment
Document Concept of Operations	Is there data flow between system components?	Yes	
	Is there information flow between the agency and the public?	Yes	MassDOT is maintaining a project website.
	Do you have communication flow charts?	No	
	How will the system ultimately operate?	-	
	Is there an overall strategy for the system?	Yes	
	How does the work zone fit into the overall construction project?	-	Team currently assessing which opportunities are beneficial and cost effective for the project.
Requirements	Have physical requirements been defined?	No	
	Have functional requirements been defined?	No	
	Have system requirements been defined?	No	
	Has a traceability matrix been established?	No	
	Has interoperability or connectivity been established with other ITS equipment in the region?	No	
	Has connectivity been established with the traffic management center (TMC) in the region?	Yes	System is functioning on Boston Transportation Department's central monitoring system.
	Will changes in the work zone environment be addressed over time?	Yes	
	Has a contingency plan been included with the design to address delays in the project?	No	
	Have operation, maintenance, and calibration requirements been defined?	No	
Testing Strategy	Has a test plan for the project been developed?	Yes	MassDOT plans to test this system the week of X thru X to determine impacts.
Operations & Maintenance	Are there requirements for response times when there are equipment failures?	No	
	Is there a procedure for enforcing penalties for system downtime?	No	
Staff Training Needs	Where will training be held?	-	n/a
	Has staff been trained on contractor notification procedures?	Yes	All notifications will be processed by MassDOT's project manager.
System Security	Is access to the smart work zone ITS application protected from unauthorized users?	Yes	
	Has protection and recovery from vandalism and stolen system components such as batteries been addressed?	No	
Evaluation	Is a system evaluation of the project planned?	Yes	
	Were the system goals and objectives explicitly stated?	Yes	
	Is there a mechanism in place for the public to offer feedback on the smart work zone system?	Yes	Comments can be emailed to MassDOT's project manager or contact the City of Boston through the Mayor's hotline or City project manager.
	Should changes be made to optimize the system or improve performance?	Yes	Boston Transportation Department will monitor traffic signal operations on either end of the bridge and have the ability to adjust timings from their control center in real-time.
Benefit/Cost	Have the benefits that the system will have on mobility been considered?	Yes	
	Have the benefits that the system will have on safety been considered?	Yes	
	Has the cost estimate been re-examined now that the system requirements have been defined?	Yes	

Fact Sheet #6: WZITS Procurement			
Procurement			
Category	Question	Response	Comment
Direct/Indirect	Does the agency want control over the work zone setup, operation and management? If yes, please describe the extent below.	Yes	The City of Boston will be responsible for site visits to ensure that the management plan is being executed in accordance with contract documents. The City will also monitor and adjust signal timings from the central control center as needed.
Award Mechanism	What type of award mechanism do you plan to use?	-	
RFP Requirements	Is your agency issuing a request for proposals (RFP)?	Yes	
	Have clear specifications for the system been defined?	No	
	Will the agency hire an independent evaluator for the system?	No	
Selected Vendor	Has a selection committee been formed?	Yes	
	Have the proposal review evaluation criteria been specified?	Yes	

Fact Sheet #7: WZITS System Deployment			
System Deployment			
Category	Question	Response	Comment
Implementing System Plans	Will the system be operated as a stand-alone system?	Yes	
	What is the level of agency involvement?	-	City of Boston will monitor on a daily basis.
Scheduling Decisions	Has sufficient lead time to deploy the smart work zone ITS system been included in the construction project schedule?	No	
	Has sufficient testing and calibration time and effort been included in the construction project schedule?	Yes	
	Has the evaluation process been included in the schedule?	Yes	
System Acceptance Testing	Has system acceptance testing been conducted using the test plan?	No	
	Is the smart work zone ITS system flexible enough to incorporate construction design changes and delays?	Yes	
	Has the system been verified from a drivers' expectation?	Yes	
	Has the system deployment been field verified by agency personnel?	Yes	
Handling Deployment Issues	Is there a contingency plan for addressing communication issues with the equipment?	Yes	Boston Transportation Department has on-call signal contractors available to address communication issues.
	Are there any weather related issues that need to be considered with the smart work zone ITS deployment?	No	
	Has an experienced/qualified contractor been selected?	Yes	
	Is regular communication with the stakeholders continuing during the deployment phase?	No	
	Is there a way to incorporate user feedback into the system?	Yes	

Fact Sheet #8: WZITS Operations and Maintenance			
System Operation, Maintenance & Evaluation			
Category	Question	Response	Comment
Changing Work Zone	Has support for changing work zone requirements been considered?	Yes	
	Is the agency or contractor personnel prepared to make changes to the work zone?	Yes	
	Is coordination between construction team, agency personnel and ITS operators clearly defined?	Yes	
Using/Sharing ITS Info	Is data being collected on the project?	No	
	Has the agency considered making the data available through an XML feed?	No	
	Will camera images be made available to the public through the agency website?	Yes	
	Are performance measures being collected through the smart work zone ITS data?	No	
Maintaining Adequate Staff	Will consistent personnel be available through the duration of the project?	Yes	MassDOT and the City of Boston have assigned project managers who will be the leads during the duration of the project.
Leveraging Public Support	Is there public support for the project?	Yes	
	Has the public been adequately prepared for the project?	Yes	Numerous public meetings have been held in advance of the project.
	Have elected officials been adequately briefed on the project?	Yes	
	Has the media and public affairs office been adequately briefed on the project?	Yes	
System Monitoring/Evaluation	Has a system been put in place for ongoing monitoring and evaluation of the project?	Yes	
	Are there provisions in place to modify or recalibrate the smart work zone ITS set-up throughout the project?	Yes	The Boston Transportation Department is able to make modifications as needed.
	Is a final evaluation of the project planned?	No	

Fact Sheet #1: Project Info and WZ Metadata			
State Agency:	NC Division 11		
Analyst:	EMM		
Date:	10/03/2017		
Project Name:	Case Study 4 - US 221		
Project Description:	Work is underway to widen U.S. 221, from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, into a four-lane median-divided highway. The 16.1-mile ...		
Project Limits:	The widening project is being completed in five sections: U.S. 421 to Idlewild Road in Watauga and Ashe counties...		
Project Website:	https://www.ncdot.gov/projects/us221widening/		
Facility and Base Conditions	Average Annual Daily Traffic:	50000	
	Functional Class of Roadway:	Minor Arterial	
	Maintaining Agency	State	
	Area Type	Rural	
	Number of Roadway Lanes (1 Direction)	1	Typical. Varies
	Shoulder Width (ft)	3.0	Varies
	Posted Speed Limit (mph)	55	
	Lane Width	12.0	
	Signalized Corridor?	Yes	
Work Zone Configuration	National Highway System?	Yes	
	Length of Work Zone (mi):	13.0	
	Type of Work Zone (MUTCD):	Mobile	
	Work Zone Speed Limit:	40	
	Number of Lanes to be Closed:	0	
	Work Zone Lane Width:	12.0	
	Shoulder Closure:	Yes	
	Federal-Aid Project:	Yes	
Category	Selected Work Zone ITS Goals		Priority
Safety	Reduce secondary incidents		Medium
	Reduce Incident Clearance Times		Medium
	Work toward zero work zone fatalities		Medium
	Provide a safe environment for roadway users and worker safety		Medium
Productivity	Provide an egress from work zone for haul vehicles		Low
Regulatory	Optimize contractor work periods		Low
Feasibility Score:		20	
10 to 29: ITS may provide some benefits and should be considered as a treatment to mitigate impacts.			



Fact Sheet #2: WZITS Stakeholders			
State Agency:	NC Division 11		
Analyst:	EMM		
Date:	10/03/2017		
Project Name:	Case Study 4 - US 221		
Project Description:	Work is underway to widen U.S. 221, from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, into to four-lane median-divided highway. The 16.1-mile project is designed to improve traffic flow, increase capacity reduce the number of crashes and increase regional connectivity along this highly traveled corridor. U.S. 221 is key to the High Country and connecting Boone with ...		
Project Limits:	The widening project is being completed in five sections: U.S. 421 to Idlewild Road in Watauga and Ashe counties (referred to as Section A) is 2.8-miles. ...		
Project Website:	https://www.ncdot.gov/projects/us221widening/		
Selected Team and Stakeholders			
#	Core Team Members	Email	Phone
1	State DOT	tbeaver@nc.state.gov	336-903-9117
2	County transportation agency	county@nc.state.gov	888-888-8888
3	City transportation agency	city@nc.city.gov	888-888-8888
4	Construction contractors	contractor@private.com	888-888-8888
5	Local police/Sheriff	police@nc.state.gov	888-888-8888
6	Public officials	official@nc.state.gov	888-888-8888
#	Stakeholders	Email	Phone
8	MPO	mpo@nc.state.gov	888-888-8888
9	FHWA Division Office	FHWA@government.gov	888-888-8888
10	Service patrol/Contractors	Patrol@state.gov	888-888-8888
11	State police	police@state.nc.gov	888-888-8888
12	Fire department	fire@nc.gov	888-888-8888
13	EMS		
14	Commercial trucking companies		
15	Motorists		
16	Media		
17	Local residents		
18	Incident management agencies		
19	Special event venue		
20	Traffic Management Center		
ITS Resources			
#	Type	Response	Comment
1	Weather Monitoring Stations	No	
2	TMC Monitoring Roadway	Yes	
3	Website/Traveler Information System	Yes	www.testlink.com
4	ITS On-Call Contract(s) Available	No	
5	Accessed to Leased Devices	Yes	

Fact Sheet #3: WZITS Applications and Refinement	
State Agency:	NC Division 11
Analyst:	EMM
Date:	10/03/2017
Project Name:	Case Study 4 - US 221
Project Description:	Work is underway to widen U.S. 221, from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, into to four-lane median-divided highway. The 16.1-mile project is designed to improve traffic flow, increase capacity reduce the number of crashes and increase regional connectivity along this highly traveled corridor. U.S. 221 is key to the High Country and connecting Boone with ...
Project Limits:	The widening project is being completed in five sections: U.S. 421 to Idlewild Road in Watauga and Ashe counties (referred to as Section A) is 2.8-miles. ...
Project Website:	https://www.ncdot.gov/projects/us221widening/

WZITS Selected Applications

#	Application	High	Selected
1	Queue Warning	Low	No
2	Real-time Traveler Information	Low	Yes
3	Incident Management	Low	Yes
4	Dynamic Lane Merge	Not Recommended	No
5	Variable Speed Limit	Low	No
6	Automated Enforcement	Low	No
7	Construction Vehicle Entrance/ Exit Warning	Low	Yes
8	Temporary Ramp Metering	Low	No
9	Performance Measurement	Medium	No

Application Refinement

Category	Application Refinement	Response	Comment
Benefits	Reducing traffic volumes	No	
	Reducing speed variance	Yes	
	Reducing queue-related crashes	No	
	Reducing vehicle conflicts	No	
	Reducing/eliminating dangerous merges	No	
	Reducing travel time	No	
	Reducing incident response time	No	
	Reducing speeds/increasing motorist speed compliance	Yes	
Institutional/Jurisdictional	Has sufficient funding been provided in the construction contract for the work zone?	Yes	
	Is your agency reluctant to adopt smart work zone ITS?	Yes	
	Do your agency ITS experts interact with road design and construction experts in relation to work zones?	Yes	
	Does your agency have staff with experience in smart work zone ITS?	Yes	
	Do long standing operational procedures (SOPs) need to be adopted?	No	
Legal/ Policy	Is the type of system being implemented permitted under the current laws and regulations?	Yes	
	Are there any liability issues for placing ITS equipment in a work zone?	No	
	Are there restrictions regarding the archiving of data in your state?	No	
	Are there any liability issues regarding the posting of warning messages?	No	
Stakeholder Buy-in	Have inter-agency relationships been established between stakeholders?	Yes	
	Are regular meetings held with stakeholders to keep them apprised of the project?	Yes	
	Is there a champion for the project?	Yes	
	Have the estimated benefits of the project been documented?	Yes	

Fact Sheet #4: WZITS Concept of Operations	
State Agency:	NC Division 11
Analyst:	EMM
Date:	10/03/2017
Project Name:	Case Study 4 - US 221
Project Description:	Work is underway to widen U.S. 221, from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, into to four-lane median-divided highway. The 16.1-mile project is designed to improve traffic flow, increase capacity reduce the number of crashes and increase regional connectivity along this highly traveled corridor. U.S. 221 is key to the High Country and connecting Boone with ...
Project Limits:	The widening project is being completed in five sections: U.S. 421 to Idlewild Road in Watauga and Ashe counties (referred to as Section A) is 2.8-miles. ...
Project Website:	https://www.ncdot.gov/projects/us221widening/

Fact Sheet #5: WZITS Project Documentation			
System Planning & Design			
Category	Question	Response	Comment
Document Concept of Operations	Is there data flow between system components?	Yes	
	Is there information flow between the agency and the public?	Yes	
	Do you have communication flow charts?	No	
	How will the system ultimately operate?	-	Test
	Is there an overall strategy for the system?	Yes	
	How does the work zone fit into the overall construction project?	-	Test
Requirements	Have physical requirements been defined?	Yes	
	Have functional requirements been defined?	No	
	Have system requirements been defined?	Yes	
	Has a traceability matrix been established?	No	
	Has interoperability or connectivity been established with other ITS equipment in the region?	Yes	
	Has connectivity been established with the traffic management center (TMC) in the region?	Yes	
	Will changes in the work zone environment be addressed over time?	No	
	Has a contingency plan been included with the design to address delays in the project?	Yes	
Testing Strategy	Have operation, maintenance, and calibration requirements been defined?	Yes	
Operations & Maintenance	Has a test plan for the project been developed?	Yes	
	Are there requirements for response times when there are equipment failures?	Yes	Set in contractor documents.
Staff Training Needs	Is there a procedure for enforcing penalties for system downtime?	Yes	In contract documents
	Where will training be held?	-	Location TBD County, NC
System Security	Has staff been trained on contractor notification procedures?	No	Yes
	Is access to the smart work zone ITS application protected from unauthorized users?	Yes	
Evaluation	Has protection and recovery from vandalism and stolen system components such as batteries been addressed?	Yes	
	Is a system evaluation of the project planned?	Yes	
	Were the system goals and objectives explicitly stated?	Yes	
	Is there a mechanism in place for the public to offer feedback on the smart work zone system?	No	
Benefit/Cost	Should changes be made to optimize the system or improve performance?	No	
	Have the benefits that the system will have on mobility been considered?	Yes	
	Have the benefits that the system will have on safety been considered?	Yes	
	Has the cost estimate been re-examined now that the system requirements have been defined?	Yes	

Fact Sheet #6: WZITS Procurement			
Procurement			
Category	Question	Response	Comment
Direct/Indirect	Does the agency want control over the work zone setup, operation and management? If yes, please describe the extent below.	No	
Award Mechanism	What type of award mechanism do you plan to use?	-	
RFP Requirements	Is your agency issuing a request for proposals (RFP)?	No	
	Have clear specifications for the system been defined?	Yes	
	Will the agency hire an independent evaluator for the system?	No	
Selected Vendor	Has a selection committee been formed?	No	
	Have the proposal review evaluation criteria been specified?	No	

Fact Sheet #7: WZITS System Deployment			
System Deployment			
Category	Question	Response	Comment
Implementing System Plans	Will the system be operated as a stand-alone system?	Yes	
	What is the level of agency involvement?	-	Agency will be provided with weekly update from project team.
Scheduling Decisions	Has sufficient lead time to deploy the smart work zone ITS system been included in the construction project schedule?	Yes	
	Has sufficient testing and calibration time and effort been included in the construction project schedule?	Yes	
	Has the evaluation process been included in the schedule?	Yes	
System Acceptance Testing	Has system acceptance testing been conducted using the test plan?	Yes	
	Is the smart work zone ITS system flexible enough to incorporate construction design changes and delays?	Yes	
	Has the system been verified from a drivers' expectation?	Yes	
	Has the system deployment been field verified by agency personnel?	Yes	
Handling Deployment Issues	Is there a contingency plan for addressing communication issues with the equipment?	Yes	
	Are there any weather related issues that need to be considered with the smart work zone ITS deployment?	No	
	Has an experienced/qualified contractor been selected?	Yes	
	Is regular communication with the stakeholders continuing during the deployment phase?	No	
	Is there a way to incorporate user feedback into the system?	No	

Fact Sheet #8: WZITS Operations and Maintenance			
State Agency:	NC Division 11		
Analyst:	EMM		
Date:	10/03/2017		
Project Name:	Case Study 4 - US 221		
Project Description:	Work is underway to widen U.S. 221, from U.S. 421 in Deep Gap to U.S. 221 Business/N.C. 88 in Jefferson, into to four-lane median-divided highway. The 16.1-mile project is designed to improve traffic flow, increase capacity reduce the number of crashes and increase regional connectivity along this highly traveled corridor. U.S. 221 is key to the High Country and connecting Boone with ...		
Project Limits:	The widening project is being completed in five sections: U.S. 421 to Idlewild Road in Watauga and Ashe counties (referred to as Section A) is 2.8-miles. ...		
Project Website:	https://www.ncdot.gov/projects/us221widening/		
System Operation, Maintenance & Evaluation			
Category	Question	Response	Comment
Changing Work Zone	Has support for changing work zone requirements been considered?	Yes	
	Is the agency or contractor personnel prepared to make changes to the work zone?	Yes	
	Is coordination between construction team, agency personnel and ITS operators clearly defined?	Yes	
Using/Sharing ITS Info	Is data being collected on the project?	No	
	Has the agency considered making the data available through an XML feed?	No	
	Will camera images be made available to the public through the agency website?	Yes	
	Are performance measures being collected through the smart work zone ITS data?	No	
Maintaining Adequate Staff	Will consistent personnel be available through the duration of the project?	Yes	
Leveraging Public Support	Is there public support for the project?	Yes	
	Has the public been adequately prepared for the project?	Yes	
	Have elected officials been adequately briefed on the project?	Yes	
	Has the media and public affairs office been adequately briefed on the project?	Yes	
System Monitoring/Evaluation	Has a system been put in place for ongoing monitoring and evaluation of the project?	Yes	
	Are there provisions in place to modify or recalibrate the smart work zone ITS set-up throughout the project?	Yes	
	Is a final evaluation of the project planned?	No	