



**CIVIL ENGINEERING STUDIES**

Illinois Center for Transportation Series No. 23-024

UILU-ENG-2023-2024

ISSN: 0197-9191

# **Results of Work Zone Queue Analysis Training Classes**

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Research Report No. FHWA-ICT-23-018

A white paper of the findings of

**ICT PROJECT R27-256**

**Work Zone Queue Analysis Training Classes**

<https://doi.org/10.36501/0197-9191/23-024>

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**Illinois Center for Transportation**

**November 2023**



**TECHNICAL REPORT DOCUMENTATION PAGE**

<b>1. Report No.</b> FHWA-ICT-23-018		<b>2. Government Accession No.</b> N/A		<b>3. Recipient's Catalog No.</b> N/A	
<b>4. Title and Subtitle</b> Results of Work Zone Queue Analysis Training Classes				<b>5. Report Date</b> November 2023	
				<b>6. Performing Organization Code</b> N/A	
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<b>9. Performing Organization Name and Address</b> Illinois Center for Transportation Department of Civil and Environmental Engineering University of Illinois at Urbana-Champaign 205 North Mathews Avenue, MC-250 Urbana, IL 61801				<b>10. Work Unit No.</b> N/A	
				<b>11. Contract or Grant No.</b> R27-256	
<b>12. Sponsoring Agency Name and Address</b> Illinois Department of Transportation (SPR) Bureau of Research 126 East Ash Street Springfield, IL 62704				<b>13. Type of Report and Period Covered</b> White Paper 4/16/22–11/30/23	
				<b>14. Sponsoring Agency Code</b>	
<b>15. Supplementary Notes</b> Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. <a href="https://doi.org/10.36501/0197-9191/23-024">https://doi.org/10.36501/0197-9191/23-024</a>					
<b>16. Abstract</b> This white paper summarizes the results from three training classes on queue analysis in work zones. Accurately predicting the mobility impacts of work zones will enable designers to identify effective countermeasures to improve mobility and safety in work zones. The course provides hands-on training on basic analytical methods (queue analysis methods) to compute work zone performance measures such as capacity, speed, queue length, delay, and users' costs. The capabilities and limitations of WorkZoneQ-Pro and the Highway Capacity Manual procedure for work zones are discussed, and basic guidance on how to use them is presented. The first and second courses were in-person and lasted 1.5 days. The third course was virtual and lasted only one day with reduced content. The evaluation results indicate that the participants very much liked the trainings and learned a lot. The in-person classes had slightly higher scores than the virtual class. The average scores were 4.4–4.9 (out of 5) for the in-person classes and 4.2–4.9 (out of 5) for the online class.					
<b>17. Key Words</b> Work Zone Congestion, Delay, Speed, Capacity, User Cost, Queue Analysis, WorkZoneQ-Pro Training, Queue Length, HCM Work Zone Procedure, Work Zone Capacity			<b>18. Distribution Statement</b> No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161.		
<b>19. Security Classif. (of this report)</b> Unclassified		<b>20. Security Classif. (of this page)</b> Unclassified		<b>21. No. of Pages</b> 8	<b>22. Price</b> N/A



## **ACKNOWLEDGMENT, DISCLAIMER, MANUFACTURERS' NAMES**

This publication is based on the results of **ICT-R27-256: Work Zone Queue Analysis Training Classes**. ICT-R27-256 was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation; and the U.S. Department of Transportation, Federal Highway Administration.

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## EXECUTIVE SUMMARY

This white paper summarizes the results from three training classes on queue analysis in work zones. Accurately predicting the mobility impacts of work zones will enable designers to identify effective countermeasures to improve mobility and safety in work zones. The course provides hands-on training on basic analytical methods (queue analysis methods) to compute work zone performance measures (WZPMs) such as capacity, speed, queue length, delay, and users' costs. The capabilities and limitations of WorkZoneQ-Pro and the Highway Capacity Manual (HCM) procedure for work zones are discussed and basic guidance on how to use them is presented. The first and second courses were in-person and lasted 1.5 days. The third course was virtual and lasted only one day with reduced content. The evaluation results indicate that the participants very much liked the training and learned a lot. The average scores were 4.4–4.9 (out of 5) for the in-person classes and 4.2–4.9 (out of 5) for the online class. The in-person classes had slightly higher scores than the virtual class.

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# CHAPTER 1: INTRODUCTION

This white paper summarizes the results from three training classes conducted in this study. The focus of the training was queue analysis in work zones, which is an important task for the safe and efficient operation of traffic through work zones. The goal of this project is to provide training on work zone impact analysis programs to designers, allowing them to more accurately predict the mobility impacts caused by construction activities. Determining potential backups and delays is essential to identify what safety countermeasures and alternatives for traffic management are needed during construction. By being able to accurately predict the mobility impacts of work zones, designers will be able to identify and implement countermeasures to improve mobility and safety in work zones.

The course provides hands-on training on basic analytical methods (queue analysis methods) to compute work zone performance measures (WZPMs). WZPMs include the following factors: capacity, speed, queue length, delay, and users' costs. The capabilities and limitations of the analytical tools are discussed and basic guidance on how to use them is presented. The first and second courses were in-person and lasted 1.5 days. The third course was virtual and lasted only one day. It was also recorded on Zoom. The 1.5-day classes had five modules. Module 1 briefly reviewed the necessary background material for this course. It presented basic principles of traffic flow in work zones, transportation management plans, and other topics. Modules 2 through 4 covered three analytical methods and step-by-step procedures for computing WZPMs. Module 2 covered spreadsheets such as QDAT and MoDOT. Module 3 covered the work zone capacity estimation procedures of the Highway Capacity Manual (HCM 2016 and HCM7). Module 4 covered WorkZoneQ-Pro procedures for queue analysis. These modules complement each other, enabling the participants to analyze more complex work zone conditions. Module 5 discusses how to select and use the appropriate methods to evaluate various traffic management strategies in their impacts on WZPMs. In the one-day class, Module 1 was shortened, Module 2 was not included, and Module 5 was modified.

## CHAPTER 2: RESEARCH OBJECTIVE

The objectives of the work zone queue analysis training classes are listed below:

1. Work zone traffic management analysis using analytical methods.
2. Computation of work zone performance measures (capacity, speed, queue length, delay, and users' costs).
3. Hands-on experience with solving example problems that demonstrate how the tools can be used for evaluation of traffic management strategies or implementation of Intelligent Transportation Systems (ITS) in managing back-of-queue and delay.
4. Freeway (WorkZoneQ-Pro, HCM, QDAT, and MoDOT [not included in the one-day class]).

Participants will learn how to do queue analysis for the following facilities:

1. Arterial midblock (WorkZoneQ-Pro)
2. One-lane operation on a two-lane highway (HCM, WorkZoneQ-Pro)
3. Intersections (HCM, WorkZoneQ-Pro uses HCS and gives user cost)

## **CHAPTER 3: COURSE CONTENTS**

The 1.5-day course is composed of five main modules, but the one-day course did not have Module 2 and Modules 1 and 5 were modified.

### **MODULE 1: PRINCIPLES OF WORK ZONE TRAFFIC FLOW AND TMP**

Module 1 covered a brief introduction to the following topics: traffic flow concepts, transportation management plan (TMP), temporary traffic control, WZ capacity and its influencing factors, WZ analysis procedures, and queue concepts.

For the one-day course, Modules 1 was modified. The modified Module 1 shortened the coverage of most topics and excluded TMP development information.

### **MODULE 2: INPUT-OUTPUT SUCH AS QDAT AND MODOT SPREADSHEETS**

Module 2 provides hands-on training on how to use two input-output methods (such as QDAT and MoDOT spreadsheets). Participants solve in-class example problems using the programs and learn how to use tools for making decisions on construction and contracting methods or how to plan and evaluate mitigation strategies. For the one-day course, Module 2 was not included due to time constraints.

### **MODULE 3: CAPACITY CALCULATION METHODS IN HCM 2016 AND HCM7**

In Module 3, participants learn the work zone capacity analysis methods in the Highway Capacity Manual (HCM 2016 and HCM7). They receive hands-on training on how to use the updated procedures for freeways, urban streets, and one-lane two-way operations.

### **MODULE 4: WORK ZONE Q-PRO**

In Module 4, participants compute WZPMs (capacity, speed, queue length, delay, and users' costs) for a dynamic queue where congestion grows and shrinks, the speed of moving queue, and the extent of congestion in time and space. They receive hands-on training on how to use Work ZoneQ-Pro for freeways, one-lane two-way operations, and arterials with mid-block work zones.

### **MODULE 5: TRAFFIC MANAGEMENT STRATEGIES USING THE TOOLS**

Module 5 allows participants to learn how to compare, select, and use tools to evaluate traffic management strategies such as the number of lanes closed, lane closure time, effects of diversion, or implementation of ITS in managing back of queue and delay. Several work zone scenarios are discussed, and example problems are presented. For the one-day course, Module 5 was modified by excluding materials related to QDAT and MODOT spreadsheets since those spreadsheet were not covered in the course.

## SUMMARY AND EVALUATION RESULTS

### Training Class #1

Training class #1 was conducted on May 18–19 in Springfield, Illinois. There were 28 class participants (about 3 participants per district and a few from the Central Office), and they were actively engaged in the 1.5-day class (12 hours). Class notes were distributed to the participants. The electronic files needed for this training were sent to IDOT prior to the class, and the participants downloaded them to their PC from an IDOT site. At the end of the class, a course evaluation form was distributed to the class and their assessments were sought. The evaluation forms were processed, and a summary of the evaluation results was sent to IDOT. A summary of the results is given in the next paragraph. Also, PDH (professional development hour) certificates were distributed to the participants.

Table 1 gives a summary of the evaluation results. The high scores seem to indicate that participants liked the content and delivery of the course very much.

**Table 1. Evaluation Results for Training Class #1**

<b>Questions</b>	<b>Average score (out of 5)</b>
<b>GENERAL</b>	
(1) The course was well organized.	4.82
(2) The various points on the course were well developed.	4.75
(3) There was adequate opportunity and encouragement for participants to express ideas or ask questions	4.89
(4) Information presented was applicable to my job.	4.46
(5) The knowledge and skills developed on this course will be useful.	4.54
<b>INSTRUCTOR</b>	
(1) Instructor was knowledgeable and effective in conveying his/her knowledge.	4.86
(2) Instructor related course content to work situation.	4.79
(3) Instructor was interesting and enthusiastic.	4.82
(4) Instructor used visual aids and handouts effectively.	4.93
(5) Instructor used individual or group exercises effectively.	4.61

## Training Class #2

Training class #2 was conducted on January 18–19 in Schaumburg, Illinois. There were 36 class participants (all were from District 1, except two people from the Central Office), and they were actively engaged in the 1.5-day class (12 hours). Class notes were distributed to the participants. The electronic files needed for this training were sent to IDOT prior to the class, and IT staff had downloaded them from an IDOT site to the PCs in the training room. There were 18 computers, each with two monitors. Two participants shared one PC to maximize the number of participants. At the end of the class, a course evaluation form was distributed to the class and their assessments were sought. The evaluation forms were processed, and a summary of the evaluation results was sent to IDOT. A summary of the results is given in the next paragraph. Also, PDH certificates were distributed to the participants.

Table 2 gives a summary of the evaluation results. Even though the training room was crowded and warm, the high scores seem to indicate that participants liked the contents and delivery of the course very much.

**Table 2. Evaluation Results for Training Class #2**

Questions	Average score (out of 5)
<b>GENERAL</b>	
(1) The course was well organized.	4.64
(2) The various points on the course were well developed.	4.64
(3) There was adequate opportunity and encouragement for participants to express ideas or ask questions.	4.85
(4) Information presented was applicable to my job.	4.42
(5) The knowledge and skills developed on this course will be useful.	4.52
<b>INSTRUCTOR</b>	
(1) Instructor was knowledgeable and effective in conveying his/her knowledge.	4.88
(2) Instructor related course content to work situation.	4.66
(3) Instructor was interesting and enthusiastic.	4.66
(4) Instructor used visual aids and handouts effectively.	4.69
(5) Instructor used individual or group exercises effectively.	4.63

### Training Class #3

IDOT suggested making the third training a one-day (8 hour) online class and recording it. The outline of the one-day class was sent to IDOT staff and the coverage of the course was agreed upon. The outline is given in Figure 1 for reference.

Suggested topics for one day (8 hours) WZ queue analysis class	
Module 1:	1.0 Hr
Traffic Flow Concepts	
WZ capacity, WZ Analysis and Queue	
Module 3:	2.0 Hr
HCM Capacity Methods:	
Freeways, intersections, and one-lane two way operations	
Module 4:	3 Hr
WorkZoneQ Pro:	
Freeways, midblock arterials, and one-lane two way operations	
UI spreadsheet for Intersections	
Module 5:	2.0 Hr
Traffic Management Strategies using the Tools	
Wrap up: discussion, Q&A, evaluation, PDH	

**Figure 1. Suggested topics for the one-day (8 hour) work zone queue analysis class.**

Training class #3 was conducted virtually on July 19. There were 36 online participants (about 4 participants per district), and they seem to be engaged in the training. The electronic files needed for this training were sent to the IDOT Central office about one week prior to the class. IDOT staff put the files on an IDOT site, and the participants downloaded them to their PC.

After the class was over, a course evaluation form was mailed to all participants to get feedback. Fourteen participants completed the evaluation form. The evaluation forms were processed, and a summary of the evaluation results is given in the next paragraph. The PDH certificates were mailed directly to the participants.

Table 3 gives a summary of the evaluation results. The high scores seem to indicate that participants liked the contents and delivery of the course very much.

**Table 3. Evaluation Results for Training Class #3**

<b>Questions</b>	<b>Average score (out of 5)</b>
<b>GENERAL</b>	
(1) The course was well organized.	4.50
(2) The various points on the course were well developed.	4.36
(3) There was adequate opportunity and encouragement for participants to express ideas or ask questions	4.57
(4) Information presented was applicable to my job.	4.21
(5) The knowledge and skills developed on this course will be useful.	4.36
<b>INSTRUCTOR</b>	
(1) Instructor was knowledgeable and effective in conveying his/her knowledge.	4.86
(2) Instructor related course content to work situation.	4.43
(3) Instructor was interesting and enthusiastic.	4.43
(4) Instructor used visual aids and handouts effectively.	4.57
(5) Instructor used individual or group exercises effectively.	4.36

## **CHAPTER 4: CONCLUSIONS AND SUGGESTIONS**

These courses provided hands-on training on basic queue analysis methods to compute work zone performance measures such as capacity, speed, queue length, delay, and users' costs. Accurately predicting the impacts of construction zones on travelers' mobility and determining the potential backups and delays would help in identifying the proper traffic management plans and safety countermeasures during construction.

The trainings generated strong interest. All three classes were full, and there were people on the waiting list to take the course. The evaluation results indicate that the participants very much liked the training and learned from them. The average scores were 4.4–4.9 (out of 5) for the in-person classes and 4.2–4.9 (out of 5) for the online class. The in-person classes had slightly higher scores than the virtual class, which is understandable. The virtual class has advantages, but the interaction with the participants is not as good as the in-person classes. Shortening the class to one day made taking the class easier, but several participants suggested it could be beneficial to have a longer training course or divide it into two days.





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