Proof-of-Concept Integrated Work Zone Mapping Toolset

Interface Control Document (ICD)

www.its.dot.gov/index.htm

Final Report – July 13, 2020
Prepared for: FHWA-XXX-XX-XXX: V2X Work Zone Mapping Toolset

U.S. Department of Transportation

Produced by ICF
U.S. Department of Transportation
ITS Joint Program Office – HOIT

Notice

Technical Report Documentation Page

1. Report No. FHWA-XXX-XX-XXX	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Interface Control Document For Proof-of-Concept of Integrated Work Zone Mapping Toolset		5. Report Date 07/13/2020 6. Performing Organization Code
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12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Office of Operation R&D 1200 New Jersey Avenue, S.E., Washington, DC 20590		13. Type of Report and Period Covered Draft Report 9/2017-6/2020 14. Sponsoring Agency Code HOIT-1
15. Supplementary Notes Work performed for: Deborah Curtis (TOCOR), Harry Crump (COR)		
16. Abstract This report provides system engineering support for a project to develop, test and demonstrate a proof of concept (POC) system for efficiently capturing a digital map of a work zone and its features, including lane closures and workers present in the work zone. These data are combined with other work zone configuration data to form a work zone map message that is published to disseminate to infrastructure owner-operator traveler information systems, third-party traveler information systems, and automated driving systems (ADS) such as the FHWA CARMA3 vehicle. The work zone map message is to be published in WZDx V2, SAE J2945/4 RSM (XML), and SAE J2945/4 RSM (binary) formats. This document summarizes system engineering architecture and requirements for the POC system as well as a testing plan.		
17. Key Words Connected Vehicle Technology, System Architecture, System Engineering, Testing Plan, Work Zone Mapping	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 89	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Table of Contents

List of Figures

List of Tables

Chapter 1. Introduction

The Interface Control Document (ICD) describes all interfaces and data flows shown in the System Engineering Report. Legacy Interfaces that are not being modified for the Vehicle to Everything (V2X) Work Zone proof of concept (POC) application suite, are not defined with extensive details in this ICD and rely primarily on external document references.

1.1 Purpose of the Interface Control Document

This ICD captures the necessary information required to define the V2X Work Zone POC interfaces. The purpose of this ICD is to clearly communicate all inputs and outputs for each action whether they are internal to the system or transparent to system users. The audience for this document is intended to be developers. In addition to this ICD, a System Engineering and Testing Report as well as a Testing Results document have been created for the POC Work Zone Mapping Toolset. The System Engineering report defines the engineering architecture and requirements for the toolset. The Testing Results document explains the testing requirements and results of the testing that was conducted.

1.2 Document Overview

The document describes the purpose of each interface between system entities within the system of interest or between the system of interest and an external interface, message structure and protocol, size and frequency of transmission of data, security, timing and sequencing.

1.3 Assumptions

Key assumptions pertaining to external components for the implementation of the V2X Work Zone proof of concept include:

1. The Azure Cloud platform will be continuously available during the proof of concept.
2. The project team will have access to demo this solution in collaboration of WDOT using an active work zone.
3. COVID will reduce in intensity to allow testing and demonstration and testing of this project.

1.4 Risks and Constraints

The key risk associated with the interfaces described here is that the COVID-19 epidemic halts or slows development efforts.

As for constraints, the V2X Work Zone proof of concept is designed with the following:

1. The system is built to rely upon existing test facilities at TFHRC and TFHRC staff capabilities to setup and operate an actual or simulated work zone.

2. The TFHRC data communications for wireless internet and TMC communications are needed to support this deployment.

3. If V2X Hub will be used, TFHRC will support the hardware and software for this suite of applications in the TMC, roadside and vehicle.

Chapter 2. Terms, Acronyms, Standards and References

Table 2-1 provides a glossary of terms used in this document.

Table 2-1. Glossary of Terms

Term	Definition
Roadside Safety Message (RSM)	This message contains information useful to connected and automated vehicles when navigating work zones, mostly following the upcoming Society of Automotive Engineers (SAE) J2945/4 standard.
Work Zone Data Exchange (WZDx)	The Work Zone Data Exchange (WZDx) Specification aims to make harmonized work zone data provided by infrastructure owners and operators (IOOs) available for third party use, making travel on public roads safer and more efficient through ubiquitous access to data on work zone activity.[1]
Work Zone Data Collection (WZDC) Tool	POC laptop-based tool created for collecting work zone data and building relevant work zone messages.
Transportation Management Center (TMC) Website	The website that is used to generate the configuration files for a work zone, visualization of an RSM and WZDx file.

Table 2-2 presents a list of acronyms used in this document.

Table 2-2. Table of acronyms

Acronym	Definition
ADS	Automated Driver System
ASN.1	Abstract Syntax Notation One
DSRC	Dedicated Short Range Communications
CARMA	Cooperative Automation Research Mobility Applications
IOO	Independent Owner Operator
ITS	Intelligent Transportation Systems
JSON	JavaScript Object Notation
SDX	Situational Data Exchange

[1] USDOT jpo-wzdx github: https://github.com/usdot-jpo-ode/jpo-wzdx

TIM	Traveler Information Message
TMC	Traffic Management Center
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
WZDC	Work Zone Data Collection (Tool)

Table 2-3 lists the major standards bodies referenced in this document.

Table 2-3. Standards Bodies

Abbreviation	Organization Name
AASHTO	American Association of State Highway and Transportation Officials
FHWA	Federal Highway Administration
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
SAE	SAE International
USDOT	United States Department of Transportation

Table 2-4 lists the standards documents and other resources used and referenced to develop the concepts in this document.

Table 2-4. Reference Sources

#	Document (Title, source, version, date, location)
1.	*ASN.1:2015*, International Telecommunications Union. (Consists of: X.680-X.693), August 13, 2015 https://www.itu.int/rec/T-REC-X/e
2.	SAE J2735_201603 - Dedicated Short Range Communications (DSRC) Message Set Dictionary™, SAE International, March 30, 2016 http://standards.sae.org/j2735_201603/
3.	SAE J2945/1_201603 - On-Board System Requirements for V2V Safety Communications, SAE International, March 30, 2016 http://standards.sae.org/j2945/1_201603/
4.	SAE J2945/4 – Road Safety Applications – UNPUBLISHED http://standards.sae.org/j2945/1_201603/
5.	Work Zone Data Exchange (WZDx) - v2.0 https://github.com/usdot-jpo-ode/jpo-wzdx
6.	*ISO* 8601 – Date and Time Format https://www.iso.org/iso-8601-date-and-time-format.html
7.	WZDC Tool and TMC Website https://github.com/TonyEnglish/V2X-manual-data-collection
8.	Google Maps Zoom Levels

	https://developers.google.com/maps/documentation/javascript/overview#:~:text=As%20a%20result%2C%20map%20images,and%20cover%20a%20smaller%20area.
9.	Google Maps Maps Static API https://developers.google.com/maps/documentation/maps-static/overview
12.	Task 6 – POC System Engineering Report
13.	Task 6 – Test Case Result Report

Chapter 3. Background

The objective of Task 6 of the V2X Mapping Project is to develop, test and demonstrate a proof of concept (POC) system for efficiently capturing a digital map of a work zone and its features, including lane closures and workers present in the work zone. These data are combined with other work zone configuration data to form a work zone map message that is published to disseminate to IOO traveler information systems, third-party traveler information systems, and automated driving systems (ADS) such as the FHWA CARMA vehicle. For further details and information review the POC System Engineering Report for the V2X Task 5-6 summary.

3.1 Physical System Overview

The physical view in Figure 3-1 represents the block diagram of the systems and interfaces, numbered for reference and discussion here and in following sections. This provides a detailed graphical view of the physical architecture of the Infrastructure and V2X Mapping Needs Assessment and Development Support Task 6 and interactions that occurs within and between the different entities. Refer to the System Engineering Document for a detailed review and full explanation of the Simulated TMC Data Collection Website (Azure Cloud), WZDC tool, 3rd Party Traveler Info and CARMA.

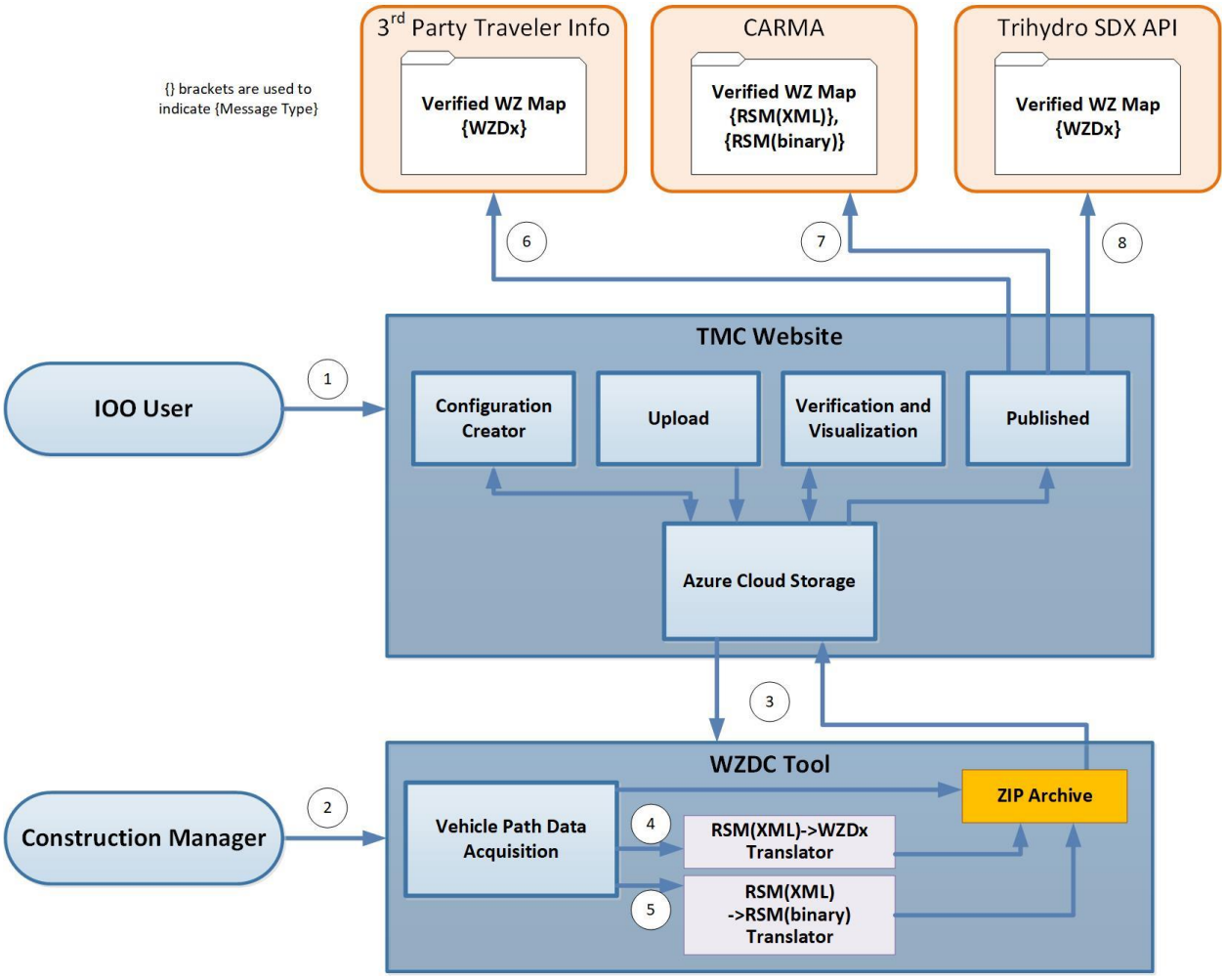


Figure 3-1. Physical View of Infrastructure and V2X Mapping Needs Assessment and Development Support Task 6 System Architecture with Numbered Interfaces.
(Source: ICF)

3.2 List of Interfaces

This section lists the interfaces that are being defined in **Chapter 4.**

Heading Descriptions for Table 3-1:

1. Interface Number: The interface number from Physical View, Figure 3-1
2. Source Element: The device which provides data for the flow
3. Destination Element: The device which consumes the data for the flow
4. Communication Profile: Communication protocol(s) used
5. Application Information Standard: Key standard(s) governing this information exchange

Table 3-1 - List of Interfaces

Interface #	Source Element	Destination Element	Communication Profile	Application Information Standard
1	IOO User	TMC Website	Human Web Interface WWW Browser	NA
2	IOO User	WZDC Tool	Human user Interface	NA
3	TMC Website (Azure Storage)	WZDC Tool	JSON, ZIP, CSV, UPER, XML, GeoJSON	Custom JSON, Custom ZIP archive, XML RSM (J2735, J2945/4), WZDx GeoJSON
4	WZDC Tool (Data Acquisition)	WZDC Tool (RSM XML to WZDx Translator)	XML, GeoJSON	XML RSM (J2735, J2945/4), WZDx GeoJSON
5	WZDC Tool (Data Acquisition)	WZDC Tool (RSM XML to WZDx Translator)	ASN.1, UPER, XML	J2735, J2945/4
6	TMC Website	3rd Party Traveler Info	GeoJSON	WZDx GeoJSON
7	TMC Website	CARMA	UPER, XML	XML RSM (J2735, J2945/4)
8	TMC Website	Trihydro SDX	GeoJSON	WZDx GeoJSON

Chapter 4. Interfaces

This part of the ICD includes all the separate Physical Object to Physical Object flows shown in the POC System Engineering Report, with each Physical Object to Physical Object pair mapping to its own Device to Device Section.

Existing standards and protocols are referenced within the document and additional context is provided if there is room for interpretation of the referenced standard or protocol. Based on this ICD, a developer or other stakeholder can successfully develop an interface or develop interoperable interfaces based on its content that meet the proof of concept work zone mapping requirements. Any deviation from a published standard or protocol, or use of optional fields, or known deficiencies in clarity within the publish standard or protocol, are documented here.

4.1 IOO User <-> TMC Website

This section describes the Independent Owner Operator (IOO) user to TMC Website interface. This includes interactions with the configuration creator, upload, verification and visualization, and published pages.

This user can enter, update, load, save, publish, and verify work zone information.

4.1.1 IOO User Enters Information into Configuration Creator

Users enter work zone information into the Configuration Creator page of the TMC Website. This page allows a user to create, edit and publish configuration files.

4.1.1.1 External References

- azure cloud storage
- azure blob storage (containers)

4.1.1.2 Covered Information Flows

An IOO user enters work zone information int the TMC website Configuration Creator.

The TMC website Configuration Creator uploads and downloads files from TMC Cloud Storage.

4.1.1.3 Dialogs

4.1.1.3.1 Dialog: User enters information into Config Creator web interface

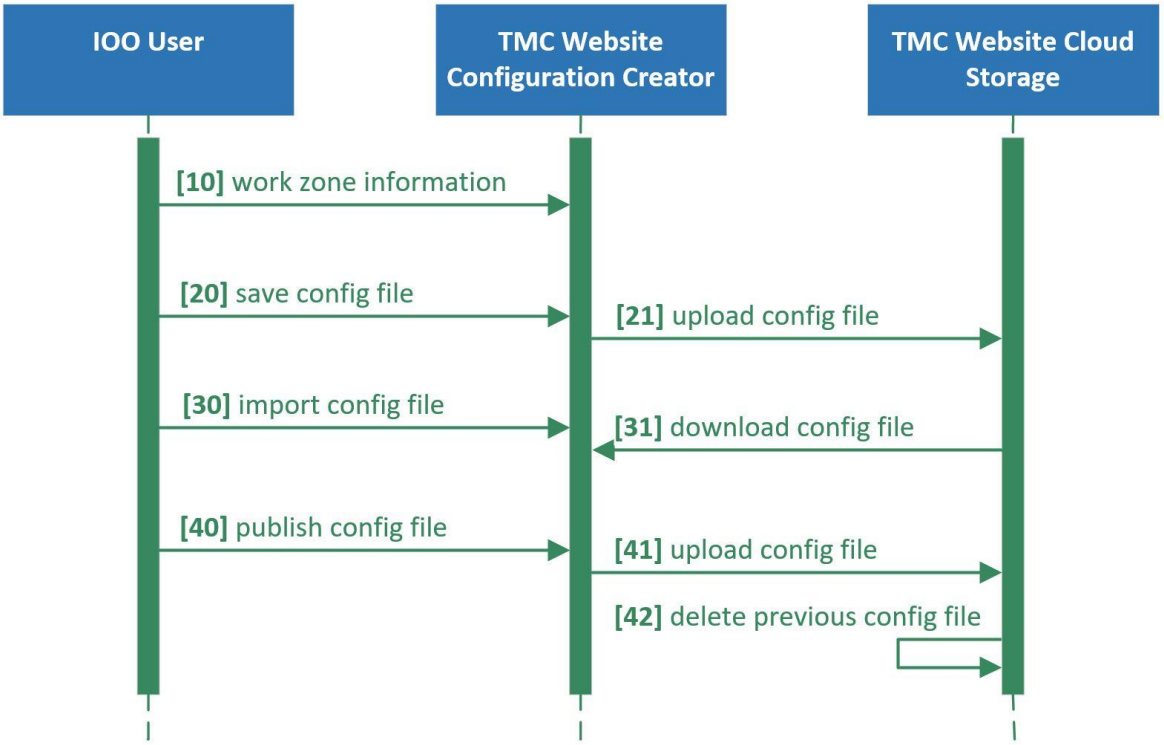


Figure 4-1. Sequence Diagram: User enters work zone information
Source: ICF

[10] Enter work zone information

User enters work zone information into WZ Config Creator web interface. This includes work zone description, road name, number of lanes, begin/end location, and many more fields (described in Messages 4.1.1.4). These fields are used to create a Configuration File, described in Section 5.1.

[20-21] Save configuration file

User saves entered data to a configuration file. The data entered in is validated for type, length and required content before the data is saved or published. Required data is not needed for files that are in-progress. The generated configuration file is uploaded to TMC Cloud Storage.

[30-31] Import configuration file

User imports selected TMC cloud configuration file and it is downloaded to the TMC Configuration Creator and loaded into the user interface.

[40-42] Publish configuration file

User publishes configuration file. The selected file is uploaded to a published container in the TMC Cloud Storage and the in-progress configuration file is removed.

4.1.1.4 Messages

- WZ description
- Road name
- Road number (optional)
- Number of lanes
- Vehicle path data lane
- Average lane width (optional)
- Approach and WZ lane padding (optional)
- Speed limits (normal speed, start of WZ speed, workers present speed)
- Cause code and sub cause code
- WZ start date/time and end date/time
- WZ days of week (optional)
- Beginning and ending locations
- Beginning/ending cross streets and mileposts (optional)
- WZ status (optional)
- Road direction (optional)
- Beginning/ending location and date accuracies (optional)
- Types of work (optional)
- Lane restrictions (optional)
- Lane types (optional)
- Issuing organization (required)
- WZ Location Method (defaulted to channel-device-method – required)
- Lrs Type (required)
- Location verify method
- Data feed frequency update
- Contact name (required)
- Contact email (required)

4.1.1.5 Data Elements

The fields used in the Configuration file are defined in

Table 5-1.

4.1.2 IOO User Uploads Work Zone Data

After a work zone is mapped, the data is exported as a ZIP archive. This archive can be uploaded automatically by the WZDC Tool or manually by an IOO User.

4.1.2.1 External References

- azure cloud storage
- azure blob storage (containers)
- azure functions

4.1.2.2 Covered Information Flows

A work zone data ZIP archive is transferred from the IOO user to the TMC Uploads page.

The TMC Upload Page uploads the work zone data ZIP archive to TMC Cloud Storage.

4.1.2.3 Dialogs

4.1.2.3.1 Dialog: User uploads work zone data archive

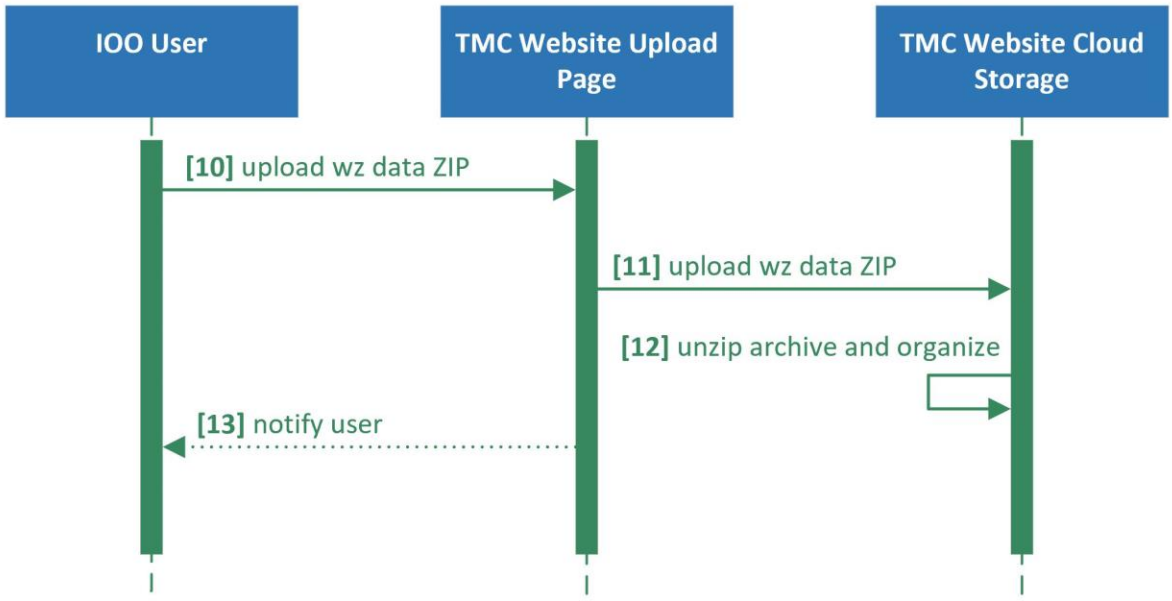


Figure 4-2. Sequence Diagram: User uploads data.
Source: ICF

[10-11] Upload work zone data

User selects and uploads work zone data ZIP file, which is uploaded to the work-zone-data-uploads TMC Cloud Storage container.

[12] Unzip uploaded work zone data

Uploaded data triggers an Azure Function, which unzips the archive and organizes the data files into folders in TMC Cloud Storage.

[13] Notify user

Notification is displayed for either success or failure.

4.1.2.4 Messages

Work Zone Data ZIP Archive (Section 5.5).

4.1.2.5 Data Elements

There are no optional data elements in this flow.

4.1.3 IOO User Verifies Work Zone

An IOO user will verify and visualize a mapped work zone before publishing the work zone. This is done by utilizing the TMC website Verification and Visualization page. A user will select a work zone, view visualizations of the mapped work zone, and then has the option to publish the work zone if it is accurate.

Two visualizations are generated. The first is created from data used to generate the RSM (XML) message (Section 5.3), while the second is a direct visualization of the GeoJSON WZDx v2.0 message (Section 5.4).

4.1.3.1 External References

- azure cloud storage
- azure blob storage (containers)
- Road Safety Message: SAE J2945/4
- WZDx v2.0 Message: https://github.com/usdot-jpo-ode/jpo-wzdx/

4.1.3.2 Covered Information Flows

The TMC website Verification and Visualization page displays work zone visualizations to the user.

4.1.3.3 Dialogs

4.1.3.3.1 Dialog: User loads work zone visualization

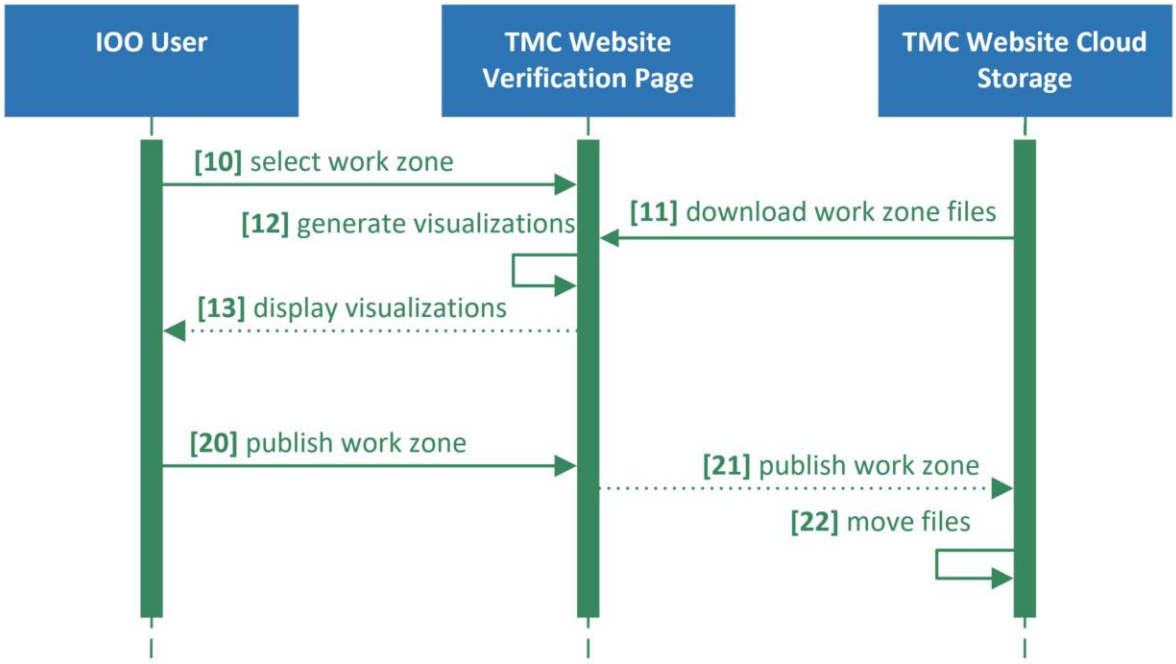


Figure 4-3. Sequence Diagram: User visualizes work zone.
Source: ICF

[10-11] Work zone selected

User selects work zone from list and website downloads work zone data. Creation of visualizations begins.

[12-13] Visualization creation

TMC website creates both visualizations using downloaded work zone data. Generated visualizations are displayed to the user.

[20-22] Publish work zone

User presses “Verify and Publish” button, which triggers the application to publish the work zone. The work zone data is copied from the Notifications are returned to the user for success/failure.

4.1.3.4 Messages

- Work Zone Configuration File (Section 5.1)
- Vehicle Path History File (Section 5.2)

- WZDx v2.0 (Section 5.4)

4.1.3.5 Data Elements

- The fields used in the Configuration file are defined in

- Table 5-1.
- The fields used in the WZDx v2.0 file are defined in Section 5.4**.**

4.1.4 IOO User Views Published Work Zone Data

After a work zone has been mapped and verified, the messages are made available for download. This is done through the Published page of the TMC website. A user will select a work zone and which associated messages they would like to download, and download those files. These messages include the WZDx, RSM xml and RXM binary messages.

4.1.4.1 External References

- Road Safety Message: SAE J2945/4
- WZDx Message: https://github.com/usdot-jpo-ode/jpo-wzdx/

4.1.4.2 Covered Information Flows

User retrieves published work zone data from the TMC website Published page.

4.1.4.3 Dialogs

4.1.4.3.1 Dialog: User download published work zone data

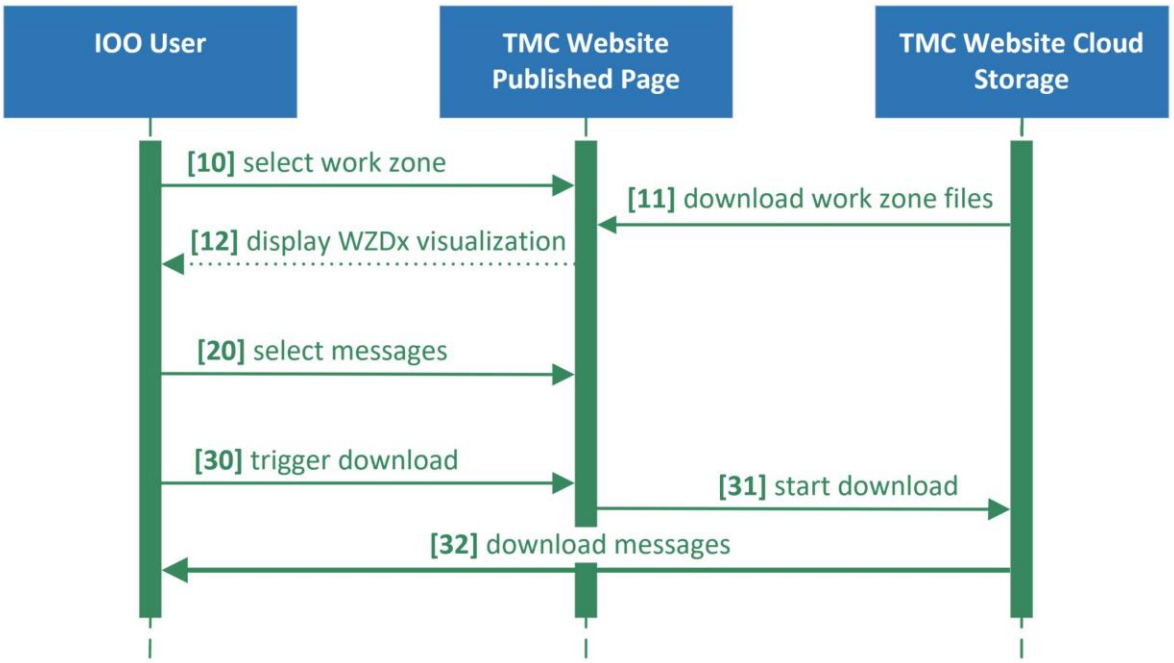


Figure 4-4. Sequence Diagram: User downloads published work zone data.
Source: ICF

[10-12] Work zone selected

User selects work zone from list and website downloads work zone files (WZDx and config file). loads visualization of WZDx message).

[20] message selection

User selects which of the three available message types they want to download (WZDx, RSM xml or RSM binary).

[30-32] Download requested

User requests download and the website initiates the zipping and download of selected messages.

4.1.4.4 Messages

- Work Zone Configuration File (Section 5.1)
- RSM (XML) (Section 5.35.2)
- RSM (binary) (Section 5.3)
- WZDx v2.0 (Section 5.4)

4.1.4.5 Data Elements

- The fields used in the Configuration file are defined in

- Table 5-1
- The fields used in the RSM files are defined in Table 5-4
- The fields used in the WZDx v2.0 file are defined in Section 5.4

4.2 IOO User <-> WZDC Tool

This section describes the interface between an IOO User and the WZDC Tool running on a laptop/portable computer.

4.2.1 IOO User Initializes WZDC Tool

The WZDC Tool requires a configuration file, a valid java installation, and a GPS connection. Upon initiation, the application will verify the installed java version and GPS connection. A user will select a configuration file, either from the cloud or from a local directory. If all requirements are satisfied, the user may initiate data collection.

4.2.1.1 External References

None.

4.2.1.2 Covered Information Flows

User selects configuration file on WZDC tool UI.

WZDC tool displays information and sends on-screen notifications to user.

4.2.1.3 Dialogs

4.2.1.3.1 Dialog: User initializes WZDC tool

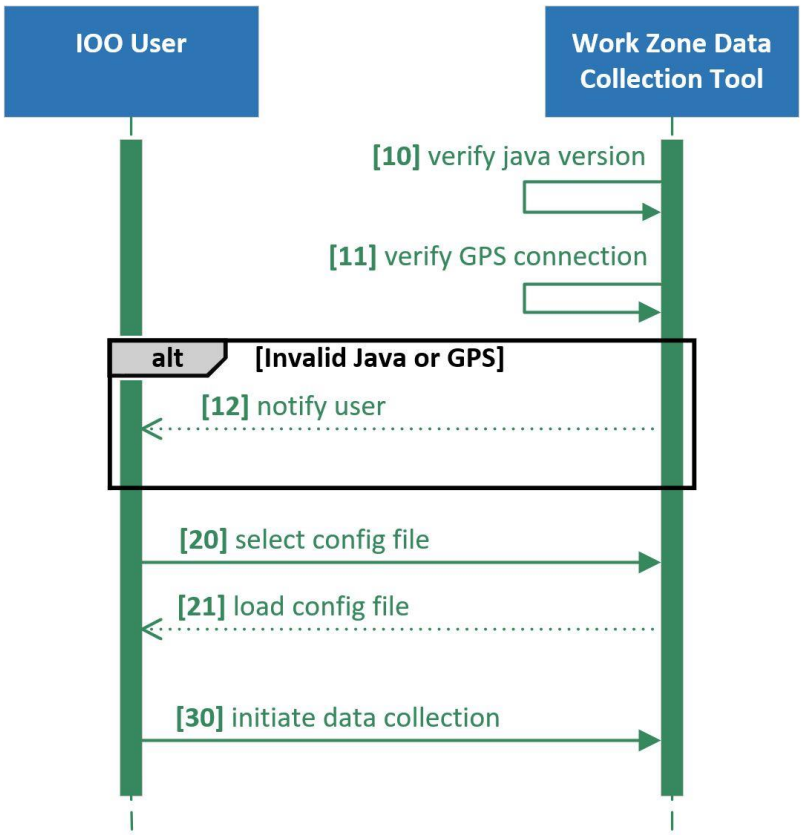


Figure 4-5. Sequence Diagram: User initializes WZDC tool.
Source: ICF

[10-12] WZDC tool verifies Java and GPS

Application verifies Java version and GPS connection. If an issue is found, the user is notified.

[20-21] User selects config file

User selects configuration file to load. If an internet connection is detected, the user may select a file from the cloud, otherwise a local config file must be selected. The selected configuration file is loaded into the WZDC tool.

[30] User initiates data collection

When the application registers a valid Java version, GPS connection and configuration file, the Initiate Data Collection button is enabled. A user can press this button to begin mapping the physical work zone.

4.2.1.4 Messages

Configuration File (Section 5.1)

4.2.1.5 Data Elements

The fields used in the Configuration file are defined in

Table 5-1.

4.2.2 IOO User Marks Work Zone Elements

A user will mark locations of lane closures and the presence of workers in the WZDC Tool. The tool will automatically begin data collection and allow the user to mark locations when the work zone starting location is reached (retrieved from config file). The user interface will show the current state of the work zone. Data collection will automatically terminate when the work zone ending location is reached.

4.2.2.1 External References

None

4.2.2.2 Covered Information Flows

User marks work zone events on the WZDC tool user interface.

4.2.2.3 Dialogs

4.2.2.3.1 Dialog: User marks work zone elements

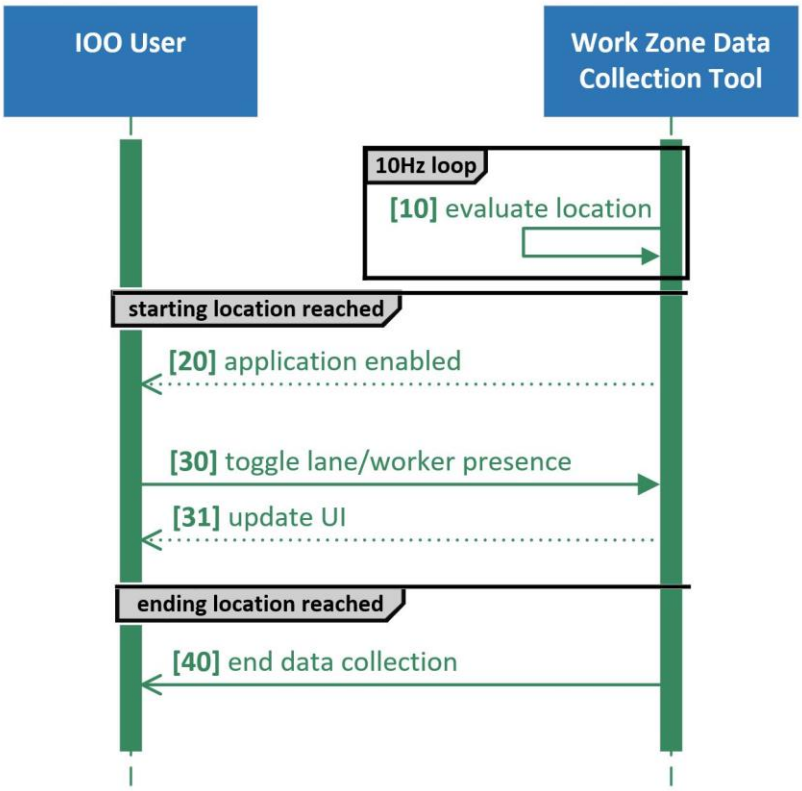


Figure 4-6. Sequence Diagram: User marks work zone elements.
Source: ICF

[10] Application evaluates GPS location (10Hz loop)

WZDC tool constantly evaluates location using high accuracy GPS at 10Hz.

[20] Data collection begins

When starting location is reached, the application enables user input and begins data collection.

[30-31] User marks work zone elements

User marks lane closures and the presence of workers in the application as they drive the work zone. The UI updates with the current state of the work zone.

[40] Data collection ends

When the ending location is reached, the application disables user input, ends data collection and begins the message generation. The user is notified of the ending of data collection.

4.2.2.4 Messages

- User toggles lane closure and worker presence values

4.2.2.5 Data Elements

There are no optional data elements for this message flow.

4.2.3 IOO User Uploads Work Zone Data

After work zone data collection is complete, messages are generated and uploaded. If this process is successful, the user is notified of the location of this work zone data and where to verify it. If the message generation fails, the user is notified of the error that occurred.

4.2.3.1 External References

None

4.2.3.2 Covered Information Flows

User initiates upload in WZDC tool UI.

WZDC tool sends on-screen notifications to user.

4.2.3.3 Dialogs

4.2.3.3.1 Dialog: User uploads ZIP archive

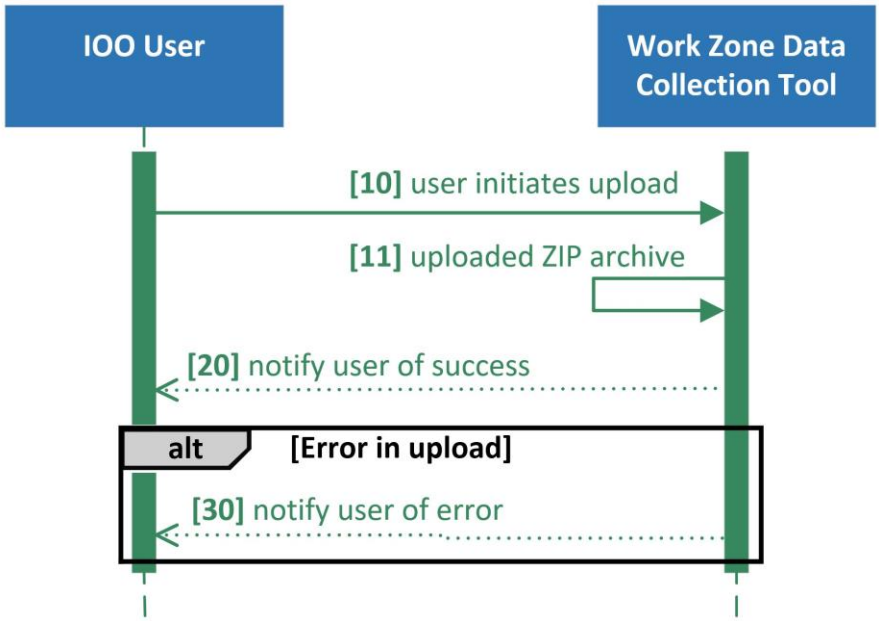


Figure 4-7. Sequence Diagram: User uploads ZIP archive.
Source: ICF

[10-11] ZIP archive uploaded

User initiates upload in WZDC tool UI. WZDC tool uploads generated ZIP archive to Azure Cloud Storage (Section 4.3.2).

[20] User notified successful upload

The user is notified of the successful upload and where to verify/visualize the mapped work zone.

[30] Error in upload

If the upload process fails, the user is notified of the error that occurred.

4.2.3.4 Messages

- Notification containing directions to verify work zone and publish

4.2.3.5 Data Elements

There are no optional data elements for this message flow.

4.3 WZDC Tool <-> TMC Website (Cloud Storage)

This section describes an interface between the WZDC tool and the TMC Website.

4.3.1 WZDC Tool Downloads Published Configuration File

When the WZDC tool is initialized, a configuration file must be loaded. This can be done from a local directory, or from the TMC Cloud Storage. If a cloud config file is requested, it will be downloaded and loaded into the WZDC tool.

4.3.1.1 External References

- azure cloud storage
- azure blob storage (containers)

4.3.1.2 Covered Information Flows

The WZDC tool receives a list of Azure Blobs from TMC Cloud Storage.

The WZDC tool downloads a Configuration File from TMC Cloud Storage.

4.3.1.3 Dialogs

4.3.1.3.1 Dialog: WZDC tool download config file

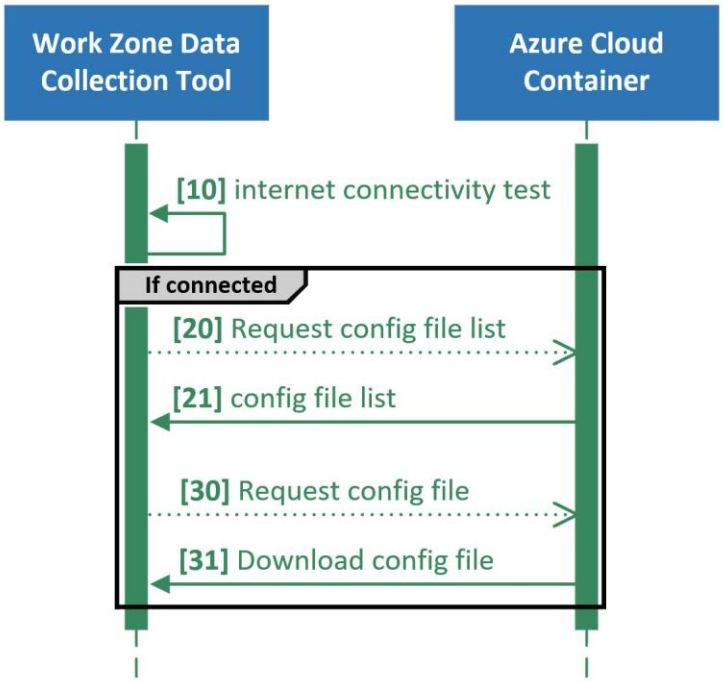


Figure 4-8. Sequence Diagram: WZDC tool downloads configuration file.
Source: ICF

[10] Verify internet connectivity

WZDC tool automatically verifies internet connection on load. If an internet connection is detected, then step [20] will begin.

[20-21] Retrieve config list from Azure blob storage

WZDC tool retrieves a list of configuration files from published-config-files TMC Cloud Storage container. These configuration files are displayed in the application.

[30-31] Download configuration file

After a config file is selected, the application downloads a configuration file from published-config-files TMC Cloud Storage container.

4.3.1.4 Messages

- List of Azure blobs (files)
- Configuration File (Section 5.1)

4.3.1.5 Data Elements

- The fields used in the Configuration file are defined in

- Table 5-1.

4.3.2 WZDC Tool Uploads Work Zone Data

After the WZDC tool has generated the messages and created the work zone data ZIP archive (), it uploads that ZIP archive to TMC Cloud Storage where it is unzipped and organized for use by the TMC Verification and Visualization page.

4.3.2.1 External References

- azure cloud storage
- azure blob storage (containers)
- azure functions

4.3.2.2 Covered Information Flows

WZDC tool uploads ZIP archive to TMC website Cloud Storage

4.3.2.3 Dialogs

4.3.2.3.1 Dialog: Work Zone Data Uploaded by WZDC Tool

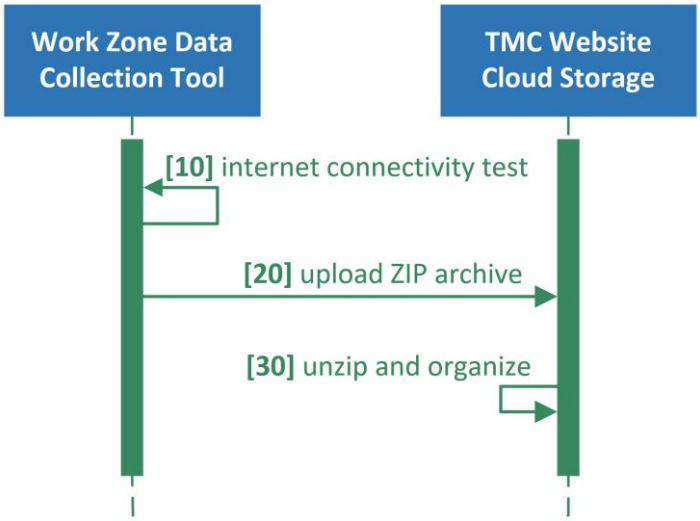


Figure 4-9. Sequence Diagram: WZDC tool uploads ZIP archive.
Source: ICF

[10] connectivity test

RSM binary converter is called with the RSM XML file location and the output RSM (binary) name/location

[20] upload ZIP archive

WZDC tool uploads ZIP archive to raw-uploads TMC Cloud Storage container.

[30] upload ZIP archive

Uploaded data triggers an Azure Function which unzips the archive and organizes the data files into folders in TMC Cloud Storage.

4.3.2.4 Messages

- Work zone data ZIP archive (Section 5.5)

4.3.2.5 Data Elements

There are no optional data elements for this message flow.

4.4 WZDC Tool <-> RSM XML to RSM Binary Converter

The WZDC tool utilizes an RSM (XML) to RSM (binary) converter (compiled java file) to convert RSM (XML) files to RSM (binary) files.

4.4.1 RSM XML Converted to RSM Binary

After the WZDC tool has generated the RSM (XML) message, this will be used to create the RSM (binary) message. This is done using a java-based converter. This converter has a significant amount of error checking and field validation.

4.4.1.1 External References

- Road Safety Message: SAE J2945/4

4.4.1.2 Covered Information Flows

WZDC tool passes RSM (XML) file information to RSM (XML) to RSM (binary) Converter.

4.4.1.3 Dialogs

4.4.1.3.1 Dialog: RSM XML to binary conversion

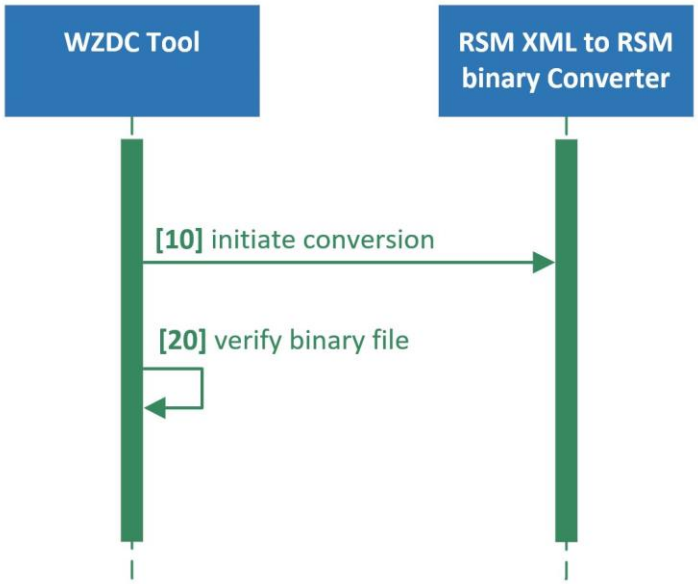


Figure 4-10. Sequence Diagram: RSM XML to binary conversion.
Source: ICF

[10] initiate conversion

RSM binary converter is called with the RSM XML file location and the output RSM (binary) name/location

[20] verify binary file

WZDC tool verifies output RSM (binary) file to ensure that no errors occurred in the conversion process. If errors occurred, the message generation will terminate, and the user will be notified.

4.4.1.4 Messages

- RSM (XML) file name and location
- Output RSM (binary) file name and location

4.4.1.5 Data Elements

There are no optional data elements for this message flow.

4.5 WZDC Tool <-> RSM to WZDx Translator

This section describes the interface between the WZDC tool and the RSM to WZDX translator.

4.5.1 WZDC Tool Sends RSM to Translator

After the RSM (XML) message has been generated by the WZDC tool, this message is used to create a WZDX message. If multiple RSM (XML) files are generated, they are all converted to a single WZDx message.

4.5.1.1 External References

- Road Safety Message: SAE J2945/4
- WZDx Message: https://github.com/usdot-jpo-ode/jpo-wzdx/

4.5.1.2 Covered Information Flows

WZDC tool sends RSM (XML) message to Translator.

Translator sends WZDx message to WZDC tool.

4.5.1.3 Dialogs

4.5.1.3.1 Dialog: Translator translates RSM message to WZDx

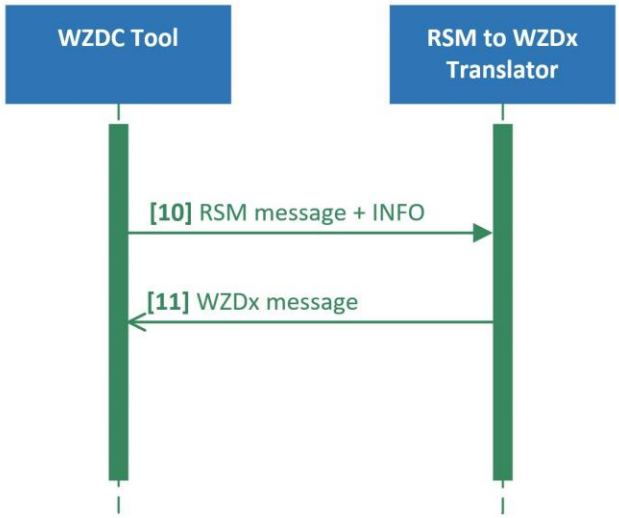


Figure 4-11. Sequence Diagram: Translator translates RSM message to WZDx.
Source: ICF

[10-11] translator called on RSM message

The WZDC tool calls the RSM to WZDx translator with the RSM (XML) message in a dictionary format, and the translator returns the WZDx message in dictionary format.

4.5.1.4 Messages

- RSM (XML) (Section 5.3)
- WZDx (Section 5.4)

4.5.1.5 Data Elements

- The fields used in the RSM files are defined in Table 5-4
- The fields used in the WZDx v2.0 file are defined in section 5.4

4.6 3rd Party Traveler Info <-> TMC Website

This section describes an interface between a 3rd party user and the TMC Website. The 3rd party user can download WZDx, RSM (xml) and RSM (binary) messages.

4.6.1 3rd Party User Downloads Published Work Zone Data

After a work zone has been mapped, verified and published, the messages from that work zone are made available for download by 3rd party users, through the TMC website Published page. The 3rd party user can download WZDx, RSM (xml) and RSM (binary) messages.

4.6.1.1 External References

- Road Safety Message: SAE J2945/4
- WZDx Message: https://github.com/usdot-jpo-ode/jpo-wzdx/

4.6.1.2 Covered Information Flows

A 3rd party user downloads work zone messages from the TMC website cloud storage through the TMC website Published page user interface.

4.6.1.3 Dialogs

4.6.1.3.1 Dialog: 3rd party downloads published work zone data

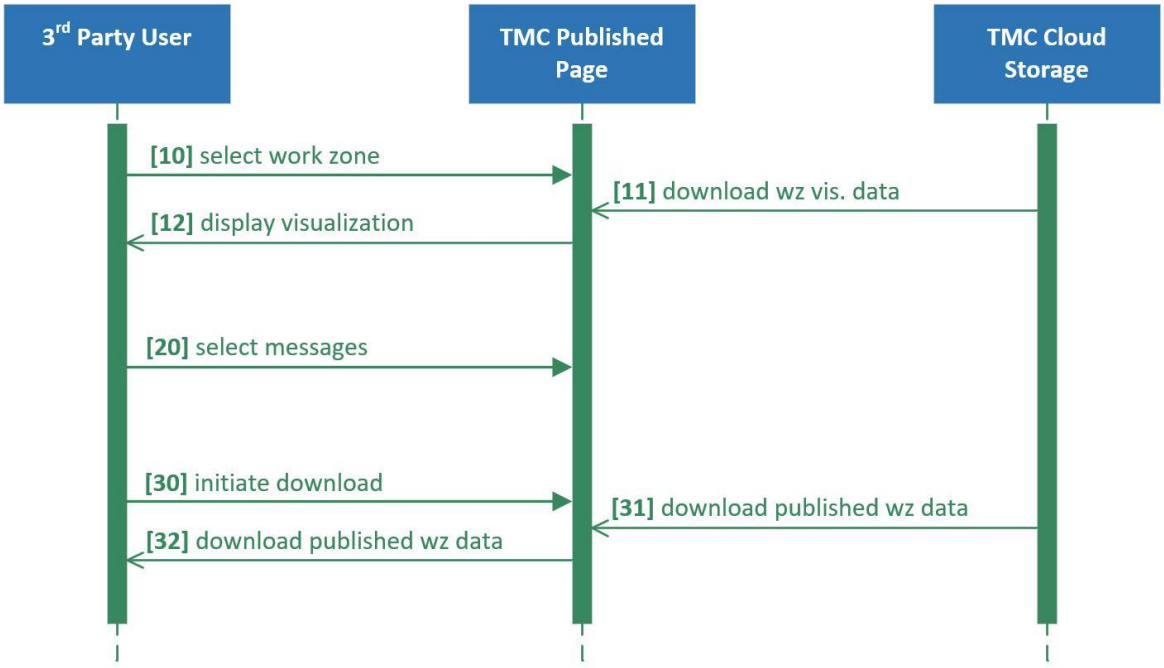


Figure 4-12. Sequence Diagram: 3rd party downloads published work zone data.
Source: ICF

[10-12] User loads work zone

User selects work zone and TMC Website loads visualization (WZDx GeoJSON)

[20] User selects message types

User selects which messages they would like to download on the TMC website user interface

[30-32] User downloads messages

User presses download button, TMC Website zips and downloads requested messages.

4.6.1.4 Messages

- Configuration File (Section 5.1)
- WZDx v2.0 (Section 5.4)

4.6.1.5 Data Elements

There are no requirements for this interface as this occurs outside of TMC environment.

- The fields used in the Configuration file are defined in

- Table 5-1
- The fields used in the WZDx v2.0 file are defined in section 5.4

4.7 CARMA <-> TMC Website

After a work zone is mapped, it is made available to CARMA users to download. The messages available for download include WZDx, RSM (xml) and RSM (binary) messages.

4.7.1 CARMA User Downloads Published Work Zone Data

After a work zone has been mapped, verified and published, the messages from that work zone are made available for download by 3rd party users, through the TMC website Published page. The 3rd party user can download WZDx, RSM (xml) and RSM (binary) messages.

4.7.1.1 External References

- Road Safety Message: SAE J2945/4
- WZDx Message: https://github.com/usdot-jpo-ode/jpo-wzdx/

4.7.1.2 Covered Information Flows

A CARMA user downloads work zone messages from the TMC website cloud storage through the TMC website Published page user interface.

4.7.1.3 Dialogs

4.7.1.3.1 Dialog: CARMA user downloads published work zone data

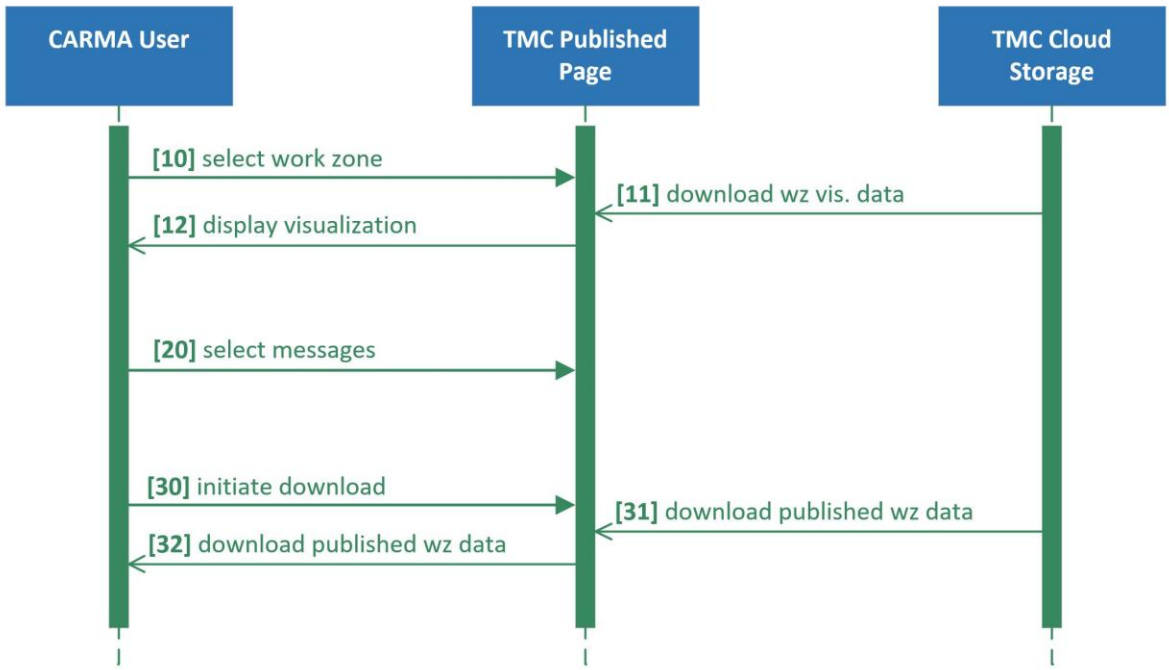


Figure 4-13. Sequence Diagram: CARMA user downloads published work zone data.
Source: ICF

[10-12] User loads work zone

User selects work zone and TMC Website loads visualization (WZDx GeoJSON)

[20] User selects message types

User selects which messages they would like to download on the TMC website (Published page) user interface

[30-32] User downloads messages

User presses download button, TMC Website zips and downloads requested messages.

4.7.1.4 Messages

- Configuration File
- WZDx
- RSM (xml)

- RXM (binary)

4.7.1.5 Data Elements

- The fields used in the Configuration file are defined in

- Table 5-1
- The fields used in the RSM files are defined in Table 5-4
- The fields used in the WZDx v2.0 file are defined in Section 5.4

4.8 TMC Website <-> Trihydro Situational Data Exchange

This section describes an interface between the TMC Website and the Trihydro Situational Data Exchange (SDX). The TMC Website utilizes the Trihydro SDX API to transfer WZDx messages.

4.8.1 TMC Website Sends WZDx Message to Trihydro SDX

After a work zone has been mapped, verified and published, the WZDx message from that work zone is sent to the Trihydro SDX.

4.8.1.1 External References

- WZDx Message: https://github.com/usdot-jpo-ode/jpo-wzdx/
- Trihydro SDX: https://sdxbeta.trihydro.com/
- Trihydro SDx API: https://sdxbeta-service.trihydro.com/index.html

4.8.1.2 Covered Information Flows

The TMC Website utilizes an HTTP request (POST and PUT) to send WZDx messages to the Trihydro SDx API

4.8.1.3 Dialogs

4.8.1.3.1 Dialog: TMC sends WZDx message to SDX API

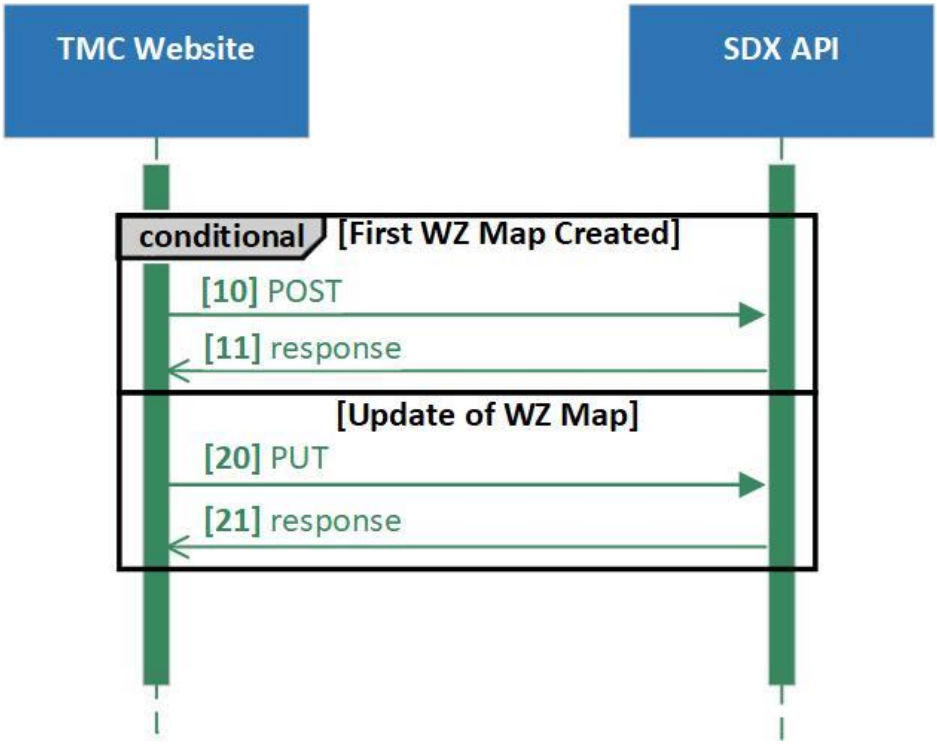


Figure 4-14. Sequence Diagram: TMC sends WZDx message to SDX API.
Source: ICF

[10-11] TMC pushes WZDx to API (First time)

The first time a unique work zone is mapped, the TMC website utilizes the POST SDX API.

[20-21] TMC pushes WZDx to API (Update)

When a work zone is re-mapped/updated, the TMC website utilizes the PUT SDX API.

4.8.1.4 Messages

- WZDx v2.0 (Section 5.4)
- feed_info_id (

- Table 5-1)

4.8.1.5 Data Elements

- The fields used in the WZDx v2.0 file are defined in Section 5.4

Chapter 5. Message Spreadsheets

5.1 Work Zone Configuration File

JSON Configuration files are created by the TMC Website Configuration Creator page and used by the WZDC Tool to configure data collection and message generation.

5.1.1 Configuration File

The configuration file is in JSON format. A sample file is shown below, as well as a picture representation of the base64 ImageString. Following this are tables which define each field in detail.


```
{
  "DateCreated": "6/11/2020",
  "FeedInfoID": "2c15bb79-6a36-4f57-ad92-1fdc27cbbb60",
  "GeneralInfo": {
    "Description": "accuracy-test-1",
    "RoadName": "Prairie Center Cir",
    "RoadNumber": "",
    "Direction": "eastbound",
    "BeginningCrossStreet": "HR Ranch Road",
    "EndingCrossStreet": "Laramie County Public Works",
    "BeginningMilePost": 0,
    "EndingMilePost": 0,
    "EventStatus": "planned"
  },
  "TypesOfWork": [
    {
```

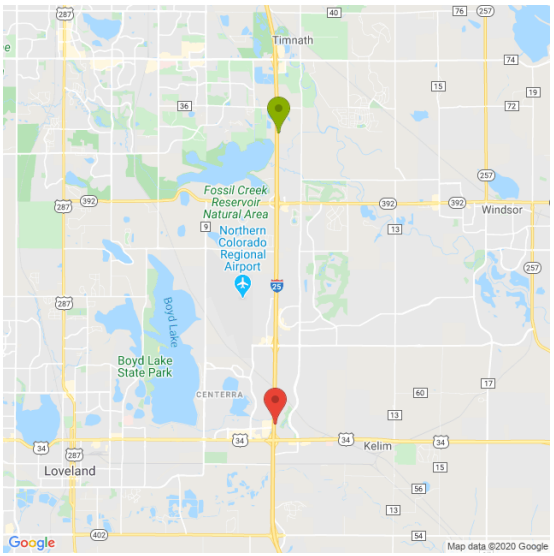
```
    "Is_Architectural_Change": false,
    "WorkType": "maintenance"
   }
 ],
 "LaneInfo": {
  "NumberOfLanes": 2,
  "AverageLaneWidth": 3.6,
  "ApproachLanePadding": 0.0,
  "WorkzoneLanePadding": 0.0,
  "VehiclePathDataLane": 2,
  "Lanes": [
   {
    "LaneNumber": 1,
    "LaneType": "left-lane",
    "LaneRestrictions": [
     {
      "RestrictionValue": null,
      "RestrictionType": "no-trucks",
      "RestrictionUnits": null
     }
    ]
   },
   {
    "LaneNumber": 2,
    "LaneType": "right-lane",
```

```
      "LaneRestrictions": [
        {
          "RestrictionValue": null,
          "RestrictionType": "towing-prohibited",
          "RestrictionUnits": null
        }
      ]
    }
  ]
},
"SpeedLimits": {
  "NormalSpeed": 25,
  "ReferencePointSpeed": 20,
  "WorkersPresentSpeed": 15
},
"CauseCodes": {
  "CauseCode": 3,
  "SubCauseCode": 0
},
"Schedule": {
  "StartDate": "2020-06-15T06:00:00Z",
  "StartDateAccuracy": "estimated",
  "EndDate": "2020-06-22T11:57:00Z",
  "EndDateAccuracy": "estimated",
  "DaysOfWeek": [
```

```
      "Mon",
      "Tues",
      "Wed",
      "Thurs",
      "Fri"
    ]
  },
  "Location": {
    "BeginningLocation": {
      "Lat": 41.146949089427,
      "Lon": -104.655958174084,
      "Elev": null
    },
    "BeginningAccuracy": "estimated",
    "EndingLocation": {
      "Lat": 41.1504290591271,
      "Lon": -104.644421993111,
      "Elev": null
    },
    "EndingAccuracy": "estimated"
  },
  "metadata": {
    "wz_location_method": "channel-device-method",
    "lrs_type": "interpolative",
    "location_verify_method": "GPS equipment accurate to 2 m",
```

```
    "datafeed_frequency_update": "",
    "timestamp_metadata_update": "2020-06-11T05:04:03Z",
    "contact_name": "Jacob Frye",
    "contact_email": "jfrye@neaeraconsulting.com",
    "issuing_organization": "Neaera Consulting"
  },
  "ImageInfo": {
    "Zoom": 12,
    "Center": {
      "Lat": 40.456381543613148,
      "Lon": -104.99186130175801,
      "Elev": null
    },
    "ImageString": "iVBORw0KGgoAAAANSUhEUgAAAoAAAAKACAMAAAA7EzkR…",
  }
}
```

5.1.1.1 Configuration File Image (From ImageString)



External References Used Below:

- jpo-wzdx github: https://github.com/usdot-jpo-ode/jpo-wzdx

Table 5-1 JSON Configuration Fields

JSON Tag	Field Type	Description	External Reference	Valid Range	Sample JSON Value
DateCreated	DateTime	Date and time of file creation in UTC	ISO 8601 [6]	-	“2020-06-15T12:00:00Z”
feed_info_id	String (GUID)	Unique WZDx feed identifier	jpo-wzdx(feed_info_id)	-	“78e357d4-27de-4fc1-a6e2-d099c62588ae”
GeneralInfo	Sequence	General information	-	-	-
Description	String	Work zone description	jpo-wzdx(description)	(a-z, no special charactoers) 20 char limit	“workzone description”
RoadName	String	Road name	jpo-wzdx(road_name)	(a-z, no special charactoers) 20 char limit	“road name”
Roadnumber	String	Road Number	jpo-wzdx(road_number)	-	“I-100”
Direction	Enumeration	Direction	jpo-wzdx (direction)	See Enum	“northbound”
BeginningCrossStreet	String (optional)	Beginning cross street	jpo-wzdx(beginning_cross_street)	-	“Street 1”
EndingCrossStreet	String (optional)	Ending cross street	jpo-wzdx(ending_cross_street)	-	“Street 2”
BeginningMilePost	Decimal (optional)	Beginning milepost	jpo-wzdx(beginning_mile_post)	-	“1.1”
EndingMilePost	Decimal (optional)	Ending milepost	jpo-wzdx(ending_mile_post)	-	“2.5”
EventStatus	Enumeration (optional)	Event status	jpo-wzdx(event_status)	See Enum	“planned”
TypesOfWork	List	Types of work list		-	
WorkType	Enumeration (optional)	Type of work	jpo-wzdx(work_type)	See Enum	“maintenance”

Is_Architectural_Change	Boolean (optional)	Will result in structural change?	jpo-wzdx(is_architectural_change)	-	False
LaneInfo	Sequence	Lane-based information	-	-	-
NumberOfLanes	Integer	Number of lanes	-	0-8	3
AverageLaneWidth	Decimal	Average lane width (meters)	-	-	3.6
ApproachLanePadding	Decimal (optional)	Lane padding of approach region (meters)	-	-	0
WorkzoneLanePadding	Decimal (optional)	Lane padding of wz (meters)	-	-	0
VehiclePathDataLane	Integer	Driven lane	-	0-8	3
Lanes	List	List of lanes		-	-
LaneNumber	Integer	Lane number	jpo-wzdx(lane_number)	0-8	1
LaneType	Enumeration	Lane type	jpo-wzdx(lane_type)	See Enum	“left-lane”
LaneRestrictions	List	Lane restrictions list		-	-
RestrictionType	Enumeration (optional)	Type of restriction	jpo-wzdx(restriction_type)	See Enum	“reduced-height”
RestrictionValue	Decimal (optional)	Value of restriction	jpo-wzdx(restriction_value)	-	12.0
RestrictionUnits	Enumeration (optional)	Units of restriction value	jpo-wzdx(restriction_units)	See Enum	“feet”
SpeedLimits	Sequence	Speed limits	-	-	-
NormalSpeed	Integer	Normal speed limit (mph)	-	0-85	75
ReferencePointSpeed	Integer	Speed limit at start of work zone (mph)	-	0-85	65
WorkersPresentSpeed	Integer	Speed limit when workers present (mph)	-	0-85	55
CauseCodes	Sequence		-	-	-
CauseCode	Integer	Cause code	RSM CauseCode	0-99	3
SubCauseCode	Integer	Sun cause code	RSM SubCauseCode	0	0
Schedule	Sequence				
StartDate	DateTime	Date and time of file creation in UTC	ISO 8601 [6]	-	“2020-06-15T12:00:00Z”
StartDateAccuracy	Enumeration	Accuracy of start date	jpo-wzdx(start_date_accuracy)	See Enum	“estimated”

EndDate	DateTime	Date and time of file creation in UTC	ISO 8601 [6]	-	“2020-06-15T12:00:00Z”
EndDateAccuracy	Enumeration	Accuracy of end date	jpo-wzdx(end_date_accuracy)	See Enum	“estimated”
DaysOfWeek	List	Days of the week that the work zone is active	-	Enum [“mon”, “Tues”, “Wed”, Thurs”, “Fri”, “Sat”, “Sun”]	["Mon", "Tues", "Wed", "Thurs", "Fri"]
Location	Sequence		-	-	-
BeginningLocation	Sequence	Location of beginning of wz	-	-	-
Lat	Decimal	Latitude (Deg.)	-	-90..90	40.0610154535084
Lon	Decimal	Longitude (Deg.)	-	-180..180	-105.211646909321
Elev	Decimal (optional)	Elevation (meters, WGS-84)	-	-4096.. 61439	null
BeginningAccuracy	Enumeration	jpo-wzdx(beginning_accuracy)	-	See Enum	“estimated”
EndingLocation	Sequence	Location of end of wz	-	-	-
Lat	Decimal	Latitude	-	-90..90	40.0591849898534
Lon	Decimal	Longitude	-	-180..180	-105.216069847308
Elev	Decimal (optional)	Elevation (meters, WGS-84)	-	-4096.. 61439	null
EndingAccuracy	Enumeration	jpo-wzdx(ending_accuracy)	-	See Enum	“estimated”
metadata	Sequence	Metadata for WZDx	jpo-wzdx(metadata)	-	-
wz_location_method	Enumeration	Wz location verification method	jpo-wzdx(wz_location_method)	See Enum	“channel-device-method”
lrs_type	String	Linear referencing method	jpo-wzdx(wz_location_method)	-	“interpolative”
location_verify_method	String	Method used to verify accuracy of locations	jpo-wzdx(wlocation_verify_method)	-	“Example Survey accurate GPS equipment accurate to 0.1 cm”
datafeed_frequency_update	String	WZDx feed update frequency	jpo-wzdx(wz_location_method)	-	“24h”

timestamp_metadata_update	DateTime	Medatata update timestamp	jpo-wzdx(wz_location_method)	-	“2020-06-05T05:48:42Z”
contact_name	String	WZDx feed contact name	jpo-wzdx(contact_name)	-	“test name”
contact_email	String	WZDx feed contact email	jpo-wzdx(contact_email)	-	“test@gmail.com”
issuing_organization	String	WZDx feed issuing organization	jpo-wzdx(issuing_organization)	-	“test org”
ImageInfo	Sequence	Information about map image	-	-	-
Zoom	Integer	Google Maps zoom level of image	Google Maps Zoom Level [8]	0..21	10
Center	Sequence	Center location of image	-	-	-
Lat	Decimal	Latitude	-	-90..90	40.0591849898534
Lon	Decimal	Longitude	-	-180..180	-105.216069847308
Elev	Decimal (optional)	Elevation (meters, WGS-84)	-	-4096..61439	null
ImageString	Base64 String	Base64 string conversion of PNG image[2]	-	640x640[3]	"iVBORw0KGg…”

[2] The image is generated from the Google Maps Maps Static API [**9**]

[3] Image size before conversion to base64 string

5.2 Vehicle Path History File

This Path and Features file is generated by the WZDC tool. It contains the vehicle path data along with work zone element markers.

5.2.1 WZ Path and Features File

The path and features file is in CSV format. An example file (screenshot) is shown below, along with a table defining all of the fields.

GPS Date & Time	# of Sats	HDOP	Latitude	Longitude	Altitude(m)	Speed(m/s)	Heading(I	Marker	Value
2020/05/28-21:37:08:40	11	0.84	40.06102767	-105.2104952	1588.1	7.850936667	268.58	Data Log	TRUE
2020/05/28-21:37:08:50	11	0.84	40.06102767	-105.2104952	1588.1	7.850936667	268.58		
2020/05/28-21:37:08:60	11	0.84	40.06102767	-105.210504	1588.2	7.696088889	269.01		
2020/05/28-21:37:08:70	11	0.84	40.06102767	-105.2105132	1588.2	7.650303333	269.66		
2020/05/28-21:37:08:80	11	0.84	40.0610275	-105.2105228	1588.2	8.047454444	268.78		
2020/05/28-21:37:08:90	11	0.84	40.06102767	-105.2105317	1588.2	7.741874444	270.55		
2020/05/28-21:37:09:00	11	0.84	40.0610275	-105.2105407	1588.2	7.642072222	269.39		
2020/05/28-21:37:09:10	11	0.84	40.06102767	-105.2105502	1588.2	7.919872222	270.77		
2020/05/28-21:37:09:20	11	0.84	40.06102733	-105.2105583	1588.2	7.467161111	269.04		
2020/05/28-21:37:09:30	11	0.84	40.06102733	-105.2105672	1588.3	7.633326667	269.66		
2020/05/28-21:37:09:40	11	0.84	40.061027	-105.210576	1588.3	7.564905556	268.37		
2020/05/28-21:37:09:50	11	0.84	40.06102667	-105.2105848	1588.4	7.670366667	268.21		
2020/05/28-21:37:09:60	11	0.84	40.06102633	-105.2105937	1588.4	7.542784444	267.62		
2020/05/28-21:37:09:70	11	0.91	40.06102617	-105.2106027	1588.5	7.600916667	268.44		
2020/05/28-21:37:09:80	11	0.84	40.061026	-105.2106115	1588.5	7.549472222	268.17		
2020/05/28-21:37:09:90	11	0.91	40.061026	-105.2106203	1588.4	7.44967	268.66		
2020/05/28-21:37:10:00	11	0.91	40.06102583	-105.2106292	1588.4	7.429606667	268.27		
2020/05/28-21:37:10:10	11	0.91	40.06102567	-105.2106378	1588.5	7.524778889	268.89		
2020/05/28-21:37:10:20	11	0.91	40.06102533	-105.2106468	1588.5	7.610691111	268.11		
2020/05/28-21:37:10:30	11	0.91	40.061025	-105.2106552	1588.5	7.329804444	267.52		

Figure 5-1 Path and features file contents

Table 5-2 CSV Path and Features Fields

CSV Field	Field Type	Units	Description	Valid Range	Sample Value
GPS Date & Time	DateTime	-	Date and time of	-	2020/05/28-21:37:08:40
# of Sats	Integer	-	Number of satellites visible to GPS	Integer(0..24)	11
HDOP	Percent (decimal)	-	Horizontal degree of prevision	Decimal(0..1)	0.84
Latitude	Decimal	Degrees latitude	Latitude of GPS	Decimal(-90..90)	40.06102767
Longitude	Decimal	Degrees longitude	Longitude of GPS	Decimal(-180..180)	-105.2105132
Altitude(m)	Decimal	meters	Altitude of GPS	-4096..61439	1588.2
Speed(m/s)	Decimal	meters/second	Speed of GPS	Decimal(0..163)	7.650303333

Heading(deg)	Decimal	deg	Heading of GPS	Decimal(0..360)	269.66
Marker	See Table (**7-3**)	-	Marker indicating event	-	LC
Value	See Table (**7-3**)	-	Value of marker	-	1

Table 5-3 Valid Marker and Values

Marker	Value
Data Log	Boolean
RP	
WP+RP	Integer (1-8)
LC+RP	Integer (1-8)
WP	Boolean
LC	Integer (1-8)
LO	Integer (1-8)

5.3 Roadside Safety Message (RSM)

The RSM message is divided into 3 containers:

- commonContainer: contains general information about the event including start/end date, event recurrence and the approach region geometry.
- rszContainer: contains detailed lane-by-lane information for the main event region, including lane geometry, presence of workers and lane closures.
- curveContainer: contains information to describe curved road geometry, including advisory speed, presence of obstacles and roadway geometry.

5.3.1 ASN.1 Structure of Road Safety Message (RSM)

The following table shows the fields from the J2945, Message: MSG_RoadSafetyMessage (RSM). Heading Descriptions for Table 5-4:

1. Usage: Indicates if the field is used by WZDC tool.
2. Field Name: Field name from SAE J2945/4.
3. Field Type: Field type from SAE J2945/4.
4. ASN.1 Structural Type: ASN.1 structural type: Ex. OPTIONAL, Sequence, Choice, etc.
5. ASN.1 Primitive Type: ASN.1 primitive data type.

Table 5-4 RSM Message Fields

Usage	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type
yes	RoadsideSafetyMessage		SEQUENCE	
yes	version	Version		INTEGER (0..255)
yes	commonContainer		SEQUENCE	
yes	eventInfo		SEQUENCE	
yes	eventID	TemporaryID		OCTET STRING (SIZE(4))
yes	msgSegmentInfo	MsgSegmentInfo	SEQUENCE	
yes	totalMsgSegments	SegmentCount		INTEGER (1..127)
yes	thisSegmentNum	SegmentCount		INTEGER (1..127)
yes	startDateTime	DDateTime	SEQUENCE	
yes	year	DYear		INTEGER (0..4095)
yes	month	DMonth		INTEGER (0..12)
yes	day	DDay		INTEGER (0..31)
yes	hour	DHour	OPTIONAL	INTEGER (0..31)
yes	minute	DMinute	OPTIONAL	INTEGER (0..60)
no	second	DSecond	OPTIONAL	INTEGER (0..65535)
yes	offset	DOffset	OPTIONAL	INTEGER(-840..840)
yes	endDateTime	DDateTime	SEQUENCE	
yes	year	DYear		INTEGER (0..4095)
yes	month	DMonth		INTEGER (0..12)
yes	day	DDay		INTEGER (0..31)
yes	hour	DHour	OPTIONAL	INTEGER (0..31)
yes	minute	DMinute	OPTIONAL	INTEGER (0..60)
no	second	DSecond	OPTIONAL	INTEGER (0..65535)
no	offset	DOffset	OPTIONAL	INTEGER(-840..840)
yes	eventRecurrence []	EventRecurrence	OPTIONAL SEQUENCE	
yes	EventRecurrence			
yes	startTime	DTime	OPTIONAL SEQUENCE	
yes	hour	DHour		INTEGER (0..31)
yes	minute	DMinute		INTEGER (0..60)

no	second	DSecond		INTEGER (0..65535)
no	offset	DOffset	OPTIONAL	INTEGER(-840..840)
yes	endTime	DTime	OPTIONAL SEQUENCE	
yes	hour	DHour		INTEGER (0..31)
yes	minute	DMinute		INTEGER (0..60)
no	second	DSecond		INTEGER (0..65535)
no	offset	DOffset	OPTIONAL	INTEGER(-840..840)
yes	startDate	DDate	OPTIONAL SEQUENCE	
yes	year	DYear		INTEGER (0..4095)
yes	month	DMonth		INTEGER (0..12)
yes	day	DDay		INTEGER (0..31)
yes	endDate	DDate	OPTIONAL SEQUENCE	
yes	year	DYear		INTEGER (0..4095)
yes	month	DMonth		INTEGER (0..12)
yes	day	DDay		INTEGER (0..31)
yes	monday			BOOLEAN
yes	tuesday			BOOLEAN
yes	wednesday			BOOLEAN
yes	thursday			BOOLEAN
yes	friday			BOOLEAN
yes	saturday			BOOLEAN
yes	sunday			BOOLEAN
yes	exclusion		OPTIONAL	BOOLEAN
yes	causeCode	CauseCode		INTEGER (0..255)
yes	subCauseCode	SubCausecode		INTEGER (0.. 255)
yes	regionInfo		SEQUENCE	
yes	applicableHeading	ApplicableHeading	SEQUENCE	
yes	heading	Heading		INTEGER (0..360)
yes	tolerance	Tolerance		INTEGER (0..360)
yes	referencePoint	Position3D	SEQUENCE	
yes	lat	Latitude		INTEGER (-900000000..900000001)
yes	long	Longitude		INTEGER (-1799999999..1800000001)
yes	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)

yes	referencePointType	ReferencePointType	SEQUENCE	ENUMERATED
yes	descriptiveName	DescriptiveName		IA5String (SIZE(1..63))
yes	speedLimit	RSMSpeedLimit	OPTIONAL SEQUENCE	
yes	type	SpeedLimitType		ENUMERATED
yes	speed	Speed		INTEGER (0..8191)
yes	speedUnits	SpeedUnits		ENUMERATED
yes	eventLength	EventLength	OPTIONAL	INTEGER (0..65535)
yes	approachRegion		SEQUENCE	
yes	roadwayGeometry		SEQUENCE	
yes	scale	RsmScale		INTEGER (1..100)
yes	rsmLanes []		SEQUENCE	
yes	RSMLane			
yes	laneID	LaneID		INTEGER (0..255)
yes	lanePosition	LanePosition		INTEGER (0..255)
yes	laneName	DescriptiveName		IA5String (SIZE(1..63))
yes	laneWidth	LaneWidth		INTEGER (0..32767)
yes	laneGeometry		SEQUENCE	
yes	nodeSet []		SEQUENCE	
yes	nodeLLE			
yes	nodePoint		SEQUENCE	
yes	Node-3Dabsolute		SEQUENCE	
yes	lat	Latitude		INTEGER (-900000000..900000001)
yes	long	Longitude		INTEGER (-1799999999..1800000001)
yes	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)
no	nodeAttributes			
no	speedLimit	RSMSpeedLimit	OPTIONAL SEQUENCE	
no	type	SpeedLimitType		ENUMERATED
no	speed	Speed		INTEGER (0..8191)
no	speedUnits	SpeedUnits		ENUMERATED
no	width	LaneWidth	OPTIONAL	INTEGER (0..32767)
no	taperLeft	TaperLeft	OPTIONAL	BOOLEAN
no	taperRight	TaperRight	OPTIONAL	BOOLEAN
no	laneClosed	LaneClosed	OPTIONAL	BOOLEAN

no	PeoplePresent	PeoplePresent	OPTIONAL	BOOLEAN
yes	connectsTo []		OPTIONAL SEQUENCE	
yes	laneID	LaneID		INTEGER (0..255)
yes	rszContainer		SEQUENCE	
no	laneStatus []		OPTIONAL SEQUENCE	
no	laneInfo		SEQUENCE	
no	lanePosition	LanePosition		INTEGER (0..15)
no	laneClosed	LaneClosed		BOOLEAN
no	laneClosedOffset	ObstacleDistance	OPTIONAL	INTEGER (0..32767)
no	peoplePresent	PeoplePresent	OPTIONAL	BOOLEAN
yes	speedLimit	RSMSpeedLimit	OPTIONAL SEQUENCE	
yes	type	SpeedLimitType		ENUMERATED
yes	speed	Speed		INTEGER (0..8191)
yes	speedUnits	SpeedUnits		ENUMERATED
no	roadclosureDescription	ITIS.ITIScodes(769..895)	OPTIONAL	ENUMERATED
no	roadWorkDescription	ITIS.ITIScodes(1025..1061)	OPTIONAL	ENUMERATED
no	flagman	PubnlicSafetyDirectingTrafficSubType	OPTIONAL	BIT STRING
no	trucksEnteringhighway		OPTIONAL	BOOLEAN
yes	rszRegion		SEQUENCE	
yes	roadwayGeometry		SEQUENCE	
yes	scale	RsmScale		INTEGER (1..100)
yes	rsmLanes []		SEQUENCE	
yes	RSMLane			
yes	laneID	LaneID		INTEGER (0..255)
yes	lanePosition	LanePosition		INTEGER (0..255)
yes	laneName	DescriptiveName		IA5String (SIZE(1..63))
yes	laneWidth	LaneWidth		INTEGER (0..32767)
yes	laneGeometry		CHOICE	
no	referenceLane		OPTIONAL	
yes	nodeSet []		OPTIONAL	

yes	nodeLLE			
yes	nodePoint		SEQUENCE	
yes	Node-3Dabsolute		SEQUENCE	
yes	lat	Latitude		INTEGER (-900000000..900000001)
yes	long	Longitude		INTEGER (-1799999999..1800000001)
yes	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)
yes	nodeAttributes		OPTIONAL SEQUENCE	
yes	speedLimit	RSMSpeedLimit	OPTIONAL SEQUENCE	
yes	type	SpeedLimitType		ENUMERATED
yes	speed	Speed		INTEGER (0..8191)
yes	speedUnits	SpeedUnits		ENUMERATED
no	width	LaneWidth	OPTIONAL	INTEGER (0..32767)
yes	taperLeft	TaperLeft	OPTIONAL	BOOLEAN
yes	taperRight	TaperRight	OPTIONAL	BOOLEAN
yes	laneClosed	LaneClosed	OPTIONAL	BOOLEAN
no	PeoplePresent	PeoplePresent	OPTIONAL	BOOLEAN
yes	connectsTo []		OPTIONAL SEQUENCE	
yes	laneID	LaneID		INTEGER (0..255)
no	curveContainer			
no	advisorySpeed	SpeedAdvice		INTEGER (0..500)
no	frictCoef	FrictCoef		INTEGER (0..100)
no	surfaceCondition	SurfaceCondition		ENUMERATION
no	material	Material		ENUMERATION
no	minRadius	Radius		INTEGER (0..1023)
no	bankAngle	BandAngle		INTEGER (-63..64)
no	obstaclePresent	Activity		BOOLEAN
no	reducedVisibility	Activity		BOOLEAN
no	curveRegion		SEQUENCE	
no	roadwayGeometry		SEQUENCE	
no	scale	RsmScale		INTEGER (1..100)
no	rsmLanes []		SEQUENCE	
no	RSMLane			
no	laneID	LaneID		INTEGER (0..255)

no	lanePosition	LanePosition		INTEGER (0..255)
no	laneName	DescriptiveName		IA5String (SIZE(1..63))
no	laneWidth	LaneWidth		INTEGER (0..32767)
no	laneGeometry		CHOICE	
no	referenceLane		OPTIONAL	
no	nodeSet []		OPTIONAL	
no	nodeLLE			
no	nodePoint		SEQUENCE	
no	Node-3Dabsolute		SEQUENCE	
no	lat	Latitude		INTEGER (-900000000..900000001)
no	long	Longitude		INTEGER (-1799999999..1800000001)
no	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)
no	nodeAttributes		OPTIONAL SEQUENCE	
no	speedLimit	RSMSpeedLimit	OPTIONAL SEQUENCE	
no	type	SpeedLimitType		ENUMERATED
no	speed	Speed		INTEGER (0..8191)
no	speedUnits	SpeedUnits		ENUMERATED
no	width	LaneWidth	OPTIONAL	INTEGER (0..32767)
no	peoplePresent	TaperLeft	OPTIONAL	BOOLEAN
no	taperLeft	TaperRight	OPTIONAL	BOOLEAN
no	taperRight	LaneClosed	OPTIONAL	BOOLEAN
no	laneClosed	PeoplePresent	OPTIONAL	BOOLEAN
no	connectsTo []		OPTIONAL SEQUENCE	
no	laneID	LaneID		INTEGER (0..255)

5.4 Work Zone Data Exchange (WZDx)

The Work Zone Data Exchange message (Version 2.0) [**5**] is defined in the usdot-jpo-ode github located at https://github.com/usdot-jpo-ode/jpo-wzdx.

5.5 Work Zone Data ZIP Archive

Work Zone Data ZIP Archives are created by the WZDC Tool and utilized by the TMC Website Verification and Published pages.

5.5.1 Work Zone Data Files

The work zone data ZIP archive will be a collection of five or more files, depending on the size of the work zone. An example file is shown below, as well as a table describing the contained files and their file types.

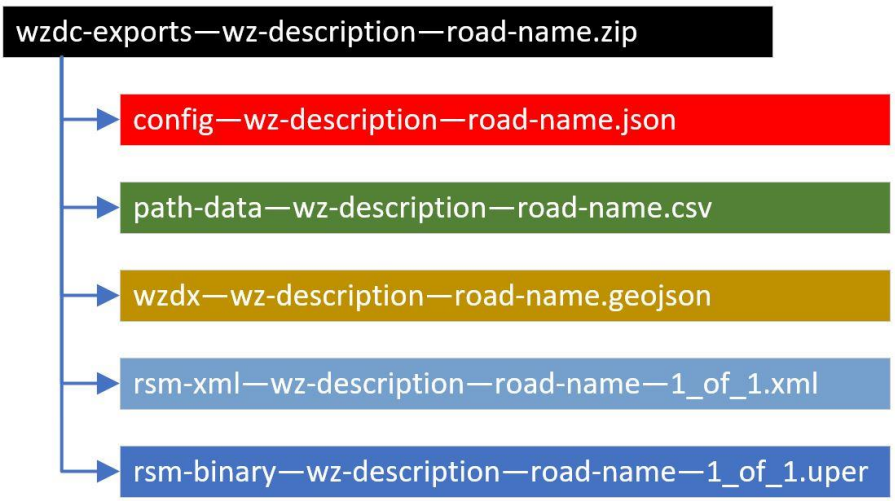


Figure 5-2 Work Zone data files

Table 5-5 Work Zone Data ZIP Archive Files

File Name	File Type	File Extension	Description
wzdc-exports--**WZID**	ZIP archive (ZIP)	zip	Archive containing files
config--**WZID**	Configuration file (JSON)	json	Configuration file
path-data--**WZID**	Path data file (CSV)	csv	Path history file
wzdx--**WZID**	WZDx (GeoJSON)	geojson	WZDx message
rsm-xml--**WZID**--**x_of_n**	RSM xml (may contain multiple) (XML)	xml	RSM message in xml

rsm-binary--**WZID**--**x_of_n**	RSM binary (may contain multiple) (Binary)	binary	RSM message in binary

WZID: Combination of the work zone road name and description (wz_description--road_name)

x_of_n: Notation describing end of RSM filenames, current_segment_num)_**of**_(total_num_segments)

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