

# REVISION OF SECTION 630 SMART WORK ZONE (SWZ) DEVICES

## NOTICE

This Project Special Provision revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. These are the official instructions for its use on CDOT construction projects, and the Construction Engineering Services Branch has reviewed, approved, and issued it. Use as written without change. Other than the instructions given, do not modify this PSP on CDOT construction projects. Do not use this special provision on CDOT projects in a manner other than specified in the instructions without approval by CDOT's Standards and Specifications Unit. The instructions for use appear below.

Other agencies using the CDOT *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision appropriately and at their own risk.

### Instructions for use on CDOT construction projects:

Review this guidance and make revisions as needed throughout the Spec. Delete this page when incorporating into the project special provisions package.

All projects deploying Smart Work Zone devices, for use in conjunction with the Standard 630 Specification, Construction Zone Traffic Control.

It is recommended for all Smart Work Zone devices to be connected and managed with an SWZ Data Processing Software in order to provide real-time traffic information monitoring and furnish a WZDx Device Feed.

If connectivity is not feasible, the designer shall:

1. Utilize cost items from the Standard 630 Specification instead of the SWZ cost items described herein.
2. Remove subsections D, E, and F from the *Materials* section.
3. Remove SWZ Data Processing Software item from the *Method of Measurement* and *Basis of Payment* sections.

If connectivity is feasible but an SWZ Data Processing Software is not utilized, the designer shall:

1. Remove subsections E and F from the *Materials* section.
2. Remove SWZ Data Processing Software item from the *Method of Measurement* and *Basis of Payment* sections.

If a SWZ System is deployed, the designer shall:

1. Remove SWZ Data Processing Software item from the *Method of Measurement* and *Basis of Payment* sections. The SWZ System pay items shall cover all setup and integration of devices in the SWZ data processing software.
2. The SWZ Data Processing Software requirements in the *Materials* section shall not be removed.

## REVISION OF SECTION 630 SMART WORK ZONE (SWZ) DEVICES

All potential devices to be deployed in a Smart Work Zone are listed alphabetically in subsection G (Additional SWZ Devices) in the *Materials* section. The designer shall remove all device sections (#1-16) in subsection G that are not applicable for the project. The designer shall also remove all associated pay items for non-utilized devices from the *Basis of Payment* section table.

For all projects that are more than 6 months in duration, the designer shall:

1. Change the device measurement from Each or Day to Month in the *Method of Measurement* section, including changing all references to daily measurement to monthly.
2. Change the device payment from Each or Day to Month in the *Basis of Payment* section, including changing all references to daily payment to monthly.

The Smart Work Zone Traffic Control Management item shall always be measured and paid daily. Non-operational devices shall always be corrected within 24 hours of notification, regardless of the device measurement.

The designer shall coordinate with the CDOT Engineer to waive or shorten the 5-day operational test, outlined in the *Construction Requirements* section, for all projects that are less than 30 days in duration.

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Text highlighted in blue may be deleted or revised based on the SWZ configuration. All other text shall never be revised or omitted from the specification.

Revise Section 630 of the Standard Specifications for this project to include the following:

Revise Section 630.01 to include:

### DESCRIPTION

A Smart Work Zone (SWZ) comprises standalone or connected devices that assess real-time traffic conditions to generate actionable intelligence for improving safety and mobility in a work zone. An SWZ shall consist of a combination of portable, temporary Intelligent Transportation System (ITS) devices and other hardware and software elements required to detect, store, and disseminate real-time traffic conditions. All SWZ devices shall be in operation 24 hours per day, seven days per week during the designated construction period.

This work consists of furnishing, installing, relocating, operating, maintaining, servicing, removing, and reporting SWZ devices per the requirements of this special provision, throughout the duration of the project. This work shall include submission and approval of an SWZ Plan to meet the deployment requirements in the Plans.

The Contractor shall be responsible for meeting all requirements outlined. The Contractor may employ an experienced Vendor to meet these requirements. A Vendor is defined as the supplier of SWZ devices and, if applicable, SWZ data processing software.

Revise Section 630.09 to include:

### MATERIALS

This work includes all potential SWZ devices, related licenses and fees, and all work necessary to install these devices.

All materials shall be compliant with the National Transportation Communications for ITS Protocol (NTCIP - <https://www.ntcip.org/document-numbers-and-status/>) and Colorado Information Security Policies (CISPs - <https://oit.colorado.gov/standards-policies-guides/technical-standards-policies>), as applicable. All materials shall be compliant with the most recent version of the Manual on Uniform Traffic Control Devices (MUTCD), as applicable. The majority of SWZ devices are Category IV work zone devices, as defined by the FHWA, and are exempt from crash testing standards. All non-Category IV devices shall satisfy standards as defined by the National Cooperative Highway Research Program (NCHRP) Report 350 and the Manual for Assessing Safety Hardware (MASH). The Contractor shall perform due diligence to determine which SWZ devices shall be crashworthy. The Contractor shall protect non-compliant devices with a MASH-approved device if placed within the clear zone.

(a) *Security*. All SWZ devices shall be physically and digitally secured to prevent tampering or damage. The Contractor shall meet the following minimum requirements:

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1. Secure devices with a padlock, chain, or other physical security measure.
2. Change all default passwords. Passwords shall have a minimum length of 8 characters with at least 1 uppercase, 1 lowercase, 1 number, and 1 special character. Passphrases are preferred and encouraged over passwords.
3. Utilize devices with field hardened components that prohibit, disable, or restrict unused physical ports, as applicable.
4. Use the most recent firmware, operating system and software patches for all materials. Document all vulnerabilities, so risks are known.

*(b) Device Mounting.* All SWZ devices shall be mounted on a field device trailer or portable MASH-tested cart system, unless otherwise documented in the SWZ Plan and approved by the respective asset owner. The Contractor may co-locate devices on a trailer, considering appropriate sizing and configuration requirements. Each field device trailer shall:

1. Have a trailer number that is visible across all lanes of traffic.
2. Be designed for 80 mile per hour wind speeds with ground anchoring.
3. Be minimally equipped with an SAE Class II, 2-inch ball-type hitch.
4. Be equipped with safety breakaway chains.
5. Have the trailer, axle, and tires rated at an appropriate Gross Vehicle Weight Rating (GVWR) for the load carried.
6. Be constructed of metal decking and equipped with four outriggers for adjustable leveling and have full-width fenders over all portions of the wheel above deck level.
7. Meet FHWA requirements for stop, tail, turn, marker lights, and reflectors.
8. Have a baked-on powder coat of CDOT fleet orange paint, unless approved by the Engineer.

*(c) Power.* All SWZ devices shall be powered for continuous operations 24 hours per day, seven days per week, during the designated construction period via solar, battery, gas or liquid, or other power supply. All SWZ devices shall be independent of all local or regional power unless otherwise documented in the SWZ Plan and approved by the Engineer. Additionally, all SWZ devices that utilize solar technology shall satisfy the following power supply requirements:

1. Display a visible real-time solar charge.
2. Be equipped with solar panels properly sized for continuous operations, excluding recharging, when there is only four hours of sun daily.
3. Have capacity to operate the device continuously for ten days during periods of darkness or inclement weather with insufficient solar coverage.

Autonomously restart in case of power failure of the device inside the construction limits.

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Delete this section if connectivity is not feasible and standalone SWZ devices are deployed.

(d) *Connectivity.* All SWZ devices shall be connected, which is defined as capable of receiving and transmitting data remotely via cellular modem, satellite, radio, or other communication method. Connected devices may receive and transmit data either to other SWZ devices, an SWZ data processing software, or both. The Contractor shall ensure data network capacity and coverage supports continuous operation for all SWZ devices. Each connected SWZ device shall:

1. Update global positioning system (GPS) coordinates within a 10-foot radius of its true location.
2. Provide current operational status with time-stamp.
3. Refresh all data in 60-second bins.
4. Contain a modem configured with internet protocol (IP) whitelisting to restrict access from unapproved parties.
5. If a cellular network is utilized, the following minimum requirements shall be satisfied:
  - A. Manage the network for firmware updates, password resets, network monitoring, and emergencies.
  - B. Have a backhaul connection from a provider with 4G accessibility at the project site. The Contractor shall use 5G connectivity whenever available.

Delete this section if connectivity is not feasible and standalone SWZ devices are deployed.

(e) *SWZ Data Processing Software.* An SWZ data processing software shall be provided for managing SWZ devices. The SWZ data processing software shall meet the following minimum requirements:

1. Maintain an uptime of 99 percent.
2. Provide a web-based graphical user interface (GUI) that complies with Google Chrome standards, meets all CISPs, and does not require software installation.
3. Allow for user account creation with specific role-based permissions to fit the authorizations required for the project. Least privileged methodology shall be used when configuring user accounts. Limit the use of built in root or administrative accounts.
4. Use a centralized authentication source with individual accounts for device access, if applicable. If centralized authentication is not possible, add general accounts such that dedicated logins can be used for system access and user access accounts can be used for configuration and maintenance.
5. Allow users to reset their username, password, and other profile settings. Multi-factor authentication shall be used for privileged accounts. Provide automatic account lockout after several failed authentication attempts.

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6. Provide a full-color map, using Google Maps or a CDOT-approved equal, with pan and zoom capabilities that depict the project area with real-time locations of all SWZ devices.
  - A. Device data shall be collected and processed in a maximum of 60-second bins.
  - B. The GUI map shall automatically refresh every 60 seconds.
  - C. The GUI map shall be supplemented by a tabular display of real-time data.
7. Communicate independently with all deployed SWZ devices to collect data.
8. Compare real-time traffic data with user-defined thresholds or historical data.
9. Display a real-time video feed for all connected cameras, current message for all connected signs, and current data for all connected sensors.
10. Assess all types of malfunctions that have occurred, such as communication disruption, improper positioning, loss or lapse in data, anomaly in data, loss of device power, or low device battery.
11. Be capable of sending real-time alerts to the Engineer and all other designated project staff of all malfunctions. Alerts shall be sent via text message, email, or both.
12. Provide a fail-safe message on all signs, such as “WORK ZONE SLOW DOWN” or dashed line, when there is insufficient data to determine real-time traffic conditions.
13. Allow appropriate staff, as designated by the Engineer, full permission to override errant messages on all units manually. Allow the ability to cancel this override and re-initiate the software’s automated messaging feature.
14. Be capable of securely absorbing data from publicly available third-party Application Programming Interfaces (APIs), such as COtrip.
15. Prohibit, disable, or restrict all unsecure and unnecessary protocols as well as physical interfaces, where applicable. The Contractor shall request any need to use unsecure protocols in writing to the Engineer with documented use cases and potential risk of system breach.

Delete this section if standalone SWZ devices are deployed or a SWZ data processing software is not used.

(f) *Work Zone Data Exchange (WZDx)*. The Contractor shall coordinate with CDOT to furnish an SWZ device data feed to CDOT per FHWA’s WZDx Device Feed Specification. The Contractor shall meet the following minimum requirements:

1. Export the Device Feed in Geographic JavaScript Object Notation (GeoJSON) format. Per the WZDx Device Feed Specification, the feed shall provide the current location, status, and any other relevant metadata about field devices deployed on the roadway in the work zone. Update the feed within 2 months of a minor WZDx Specification release and within 4 months of a major WZDx Specification release.
2. Publish the Device Feed to a CDOT-provided secure, encrypted endpoint.

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- A. If using a representational state transfer (REST) API, CDOT will provide access to a Google Cloud Storage location via a unique API key. Authentication tokens are required for additional security. The API shall be terminated upon project completion.
  - B. Include a CDOT-provided Planned Event identifier number for each device to link to CDOT's Work Zone Feed.
3. Maintain a Data Feed refresh rate of 60 seconds.

Delete any subsections (#1-16) for devices that will not be deployed on the project.

(g) *Additional SWZ Devices.* The following devices shall be included on any Method for Handling Traffic (MHT), integrated with all standard traffic control devices, and identified in an SWZ Plan. All modifications to these device specifications must be approved in writing by the Engineer. The requirements listed under each SWZ device are the minimum requirements acceptable to CDOT.

1. Advance Warning Flashing or Sequencing Arrow Panel (A/B/C Type) (SWZ). The advance warning flashing or sequencing arrow panel shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 6F.
  - B. Conform to the requirements of the Section 630 subsection, Electronic Advance Warning Signs, including panel sizing classification.
2. Automated Flagging Assistance Device (SWZ). The automated flagging assistance device shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 6E.
  - B. Conform to the requirements of the Section 630, Flagging and Pilot Car Operation.
3. Channelizing Device (SWZ). The channelizing device shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 6F.
  - B. Consist of a temporary traffic cone, drum, barricade, tubular marker, vertical panel with a GPS locator. The type of channelizing device shall be provided alongside any data transfer.
  - C. Allow for easy integration with a portable flashing beacon, portable non-intrusive traffic sensor, portable camera, or other data-collection device.
  - D. Not require mounting on a field device trailer or MASH-tested cart system.
4. Construction Traffic Sign (Panel Size A/B/C) (SWZ) . The construction traffic sign shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 6F.
  - B. Conform to the requirements of Section 630, including panel sizing classification.

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- C. Be equipped with a GPS locator.
  - D. Allow for easy integration with a portable flashing beacon, portable non-intrusive traffic sensor, portable camera, or other data-collection device.
  - E. Provide the sign legend alongside any data transfer.
  - F. Not require mounting on a field device trailer or MASH-tested cart system.
5. Portable Closed-Circuit Television (SWZ). The portable closed circuit television camera shall:
- A. Be mounted on a minimum 20-foot retractable mast.
  - B. Be capable of streaming video and still images in high efficiency video coding H264, H265, and moving picture export group (MPEG) formats.
  - C. Be able to display multiple individually configurable video streams up to 15 frames per second in high-definition resolutions from 1280 x 720 pixels.
  - D. Be capable of 360-degree pan, 180-degree tilt, and zoom adjustments to alter the field of view, with a minimum of four user-definable presets to manipulate the camera controls.
    - (1) The camera shall be able to return to a user-definable home position.
    - (2) The camera shall have a minimum of 20-times optical zoom, 12-times digital zoom, or both.
  - E. Include electronic image stabilization to maintain accuracy and functionality during inclement weather and low visibility conditions, such as precipitation, fog, darkness, excessive dust, and road debris.
6. Portable Doppler Radar (SWZ). The portable doppler radar shall:
- A. Use radar detection to gather speed and volume data of vehicles traveling within the project limits.
  - B. Be capable of collecting data immediately upon deployment and be equipped with a modem and communication package that will provide real-time data to the SWZ data processing software.
  - C. Be capable of detecting within at least 100 feet.
  - D. Include the radar detection unit with mounting hardware, manufacturer configuration software, detection unit power supply, power and communication cable, serial surge suppression, serial-to-IP converter, and all additional hardware necessary for a complete and functional installation.
  - E. Include stabilization to maintain accuracy and functionality during inclement weather and low visibility conditions, such as precipitation, fog, darkness, excessive dust, and road debris.
  - F. Be mounted on another SWZ device, if desired.



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7. Portable Flashing Beacon (SWZ). The portable flashing beacon shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 4L.
  - B. Conform to the requirements of the Section 630 subsection, General and Section 614 subsection, Highway Signs and Traffic Signals.
  - C. Be equipped with a GPS locator or other portable non-intrusive traffic sensor.
  - D. Be mounted on another SWZ device, if desired.
  
8. Portable Highway Advisory Radio Transmitter (SWZ). The portable highway advisory radio transmitter shall:
  - A. Comply with the Federal Communications Commission (FCC) Travelers' Information Station (TIS) requirements for operating broadcast band, output power, antenna height, and coverage radius.
  - B. Be installed alongside a static or dynamic portable variable message sign panel to notify travelers of the radio frequency and presence of a message.
  
9. Portable Hybrid Message Board (SWZ). The portable hybrid message board shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 2B.
  - B. Utilize a hydraulic or mechanical lift to raise and lower the sign panel to correct display height.
  - C. Consist of a static panel and a dynamic light-emitting diode (LED) insert. A full LED matrix panel may be used in place of an insert if larger messaging is desired.
  - D. Have the capability to autonomously modify display messages at various times of the day and days of the week.
  - E. Be capable of manual local operation via a hard-wired keyboard.
  
10. Portable Microwave Vehicle Radar Detector (SWZ). The portable microwave vehicle radar detector shall:
  - A. Use frequency-modulated continuous-wave radar technology to gather vehicle information, such as traffic volume, lane occupancy, individual vehicle and average vehicle speed, vehicle classification, and vehicle presence.
  - B. Be capable of collecting data immediately upon deployment and be equipped with a modem and communication package that will provide real-time data to the SWZ data processing software.
  - C. Have auto-configuration capabilities to simultaneously identify up to eight bi-directional highway lanes with the ability to detect over-center median barriers and accurately detect partially occluded vehicles.
  - D. Be capable of detecting within a ¼ mile distance.

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- E. Include the radar detection unit with mounting hardware, manufacturer configuration software, detection unit power supply, power and communication cable, serial surge suppression, serial-to-IP converter, and all additional hardware necessary for a complete and functional installation.
- F. Include stabilization to maintain accuracy and functionality during inclement weather and low visibility conditions, such as precipitation, fog, darkness, excessive dust, and road debris.
- G. Be mounted on another SWZ device, if desired.

11. Portable Ramp Meter (SWZ). The portable ramp meter shall:

- A. Comply with the most recent MUTCD, specifically Chapters 2B, 4I, and 6F.
- B. Conform to the requirements of the Section 630 subsection, Temporary Traffic Signals.
- C. Consist, at minimum, of a controller, two signal heads, and signal mounting.
  - (1) Traffic detection devices are also required for traffic-responsive metering; otherwise, pre-timed algorithms shall be used.
  - (2) Three-section signal heads (red, amber, green) are preferred over two-section signal heads (red and green only).
- D. Contain a minimum four-second light cycle, with 2 1/2 seconds of red followed by 1 1/2 seconds of green.
- E. Not exceed a max discharge rate of 900 vehicles per hour per single-metered lane. The lowest practical discharge rate shall be 240 vehicles per hour.

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12. Portable Traffic Signal (SWZ). The portable traffic signal shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 4D.
  - B. Conform to the requirements of the Section 630 subsection, Temporary Traffic Signals.
  
13. Portable Traffic Speed Monitor (SWZ). The portable traffic speed monitor shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 2B.
  - B. Utilize a hydraulic or mechanical lift to raise and lower the sign panel to its correct display height.
  - C. Include a SPEED LIMIT static panel for the desired speed throughout the SWZ.
  - D. Include a “Your Speed” radar feedback display with a self-contained radar to instantly measure traffic speeds up to 95 MPH. Speeds shall be displayed in multiples of five.
  - E. Include electronic stabilization to maintain accuracy and functionality during inclement weather and low visibility conditions, such as precipitation, fog, darkness, excessive dust, and road debris.
  - F. Be merged with a portable variable speed limit sign, if desired. In this case, all requirements for both devices shall be met.
  
14. Portable Variable Message Sign Panel (SWZ). Note that the term Portable Changeable Message Sign (PCMS) may be used interchangeably with PVMS, so long as it is referring to an SWZ device. The portable variable message sign panel shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 2L and Chapter 6F.60.
  - B. Comply with the MUTCD official ruling no. 2(09)-174(I) - Uses of and Nonstandard Syntax on Changeable Message Signs.
  - C. Utilize a hydraulic or mechanical lift to raise and lower the sign panel to its correct display height.
  - D. Have the capability to remotely modify display messages at various times of the day and days of the week.
  - E. Be capable of manual local operation via a hard-wired keyboard control.
  
15. Portable Variable Speed Limit Sign (SWZ). The portable variable speed limit sign shall:
  - A. Comply with the most recent MUTCD, specifically Chapter 2B.
  - B. Contain a static SPEED LIMIT panel with LED insert for numerical speeds. in multiples of 5 mph.
  - C. Utilize a hydraulic or mechanical lift to raise and lower the sign panel to its correct display height.

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- D. Have the capability to remotely configure different speed limits at various times of the day and days of the week.
  - E. Be a Solid-State Design (SSD) control system. The controller shall be in a weatherproof, ventilated, lockable enclosure.
  - F. Be merged with a portable traffic speed monitor, if desired. In this case, all requirements for both devices shall be met.
16. Portable Weather Monitoring Station (SWZ). The portable weather monitoring station shall:
- A. Comply with the NTCIP Environmental Sensor Station (ESS) guidelines.
  - B. Consists of an atmospheric sensor, a non-intrusive roadway sensor, a pan-tilt-zoom camera, or a combination thereof. The camera shall conform to the previous section, portable closed circuit television camera.
  - C. Collect color still-frame video images of current roadway conditions.
  - D. Operate within a minimum temperature range of -40 to 140 degrees Fahrenheit, at 0 to 100 percent relative humidity.
  - E. Meet a minimum ingress protection 66 rating.

**Revise Section 630.13 to include:**

**CONSTRUCTION REQUIREMENTS**

The Contractor shall provide equipment, supplies, materials, and labor to operationalize all SWZ devices.

*(a) SWZ Plan.* The Contractor shall submit a written and illustrated SWZ Plan to the Engineer, Staff Traffic, and CDOT ITS for approval no later than 30 days prior to setup of the SWZ devices. The Engineer, Staff Traffic, and CDOT ITS shall have no more than seven business days to review the SWZ Plan and return revisions or written approval to the Contractor. The SWZ Plan shall consist of the following items:

- (1) The locations of all SWZ devices, as shown in the Temporary Traffic Control Plans or directed by the Engineer, including relocations for traffic switches. All devices proposed to be attached to existing facilities shall be documented here to obtain approval from the respective asset owner and Engineer.
- (2) The manufacturer, make, model, and quantity for each SWZ device. The identification or serial number shall be provided if there are multiple units of the same device type.
- (3) The name and contact number for the Vendor, if applicable, and any others responsible for maintenance of the system.
- (4) The proposed messages, legends, and default messaging for all signs, including the fail-safe messages for use when there is insufficient data. The Contractor and

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Engineer shall verify posted messages do not conflict with messaging on permanent ITS devices daily. The proposed method of communication (email, virtual meeting, or other) between the Engineer and CDOT RTO/ TOC shall be documented here.

- (5) The full name and level of access for each user account authorized in the SWZ data processing software, if applicable. The type, frequency, and method of delivery (email, text, or both) for alert messages shall be described in detail.
- (6) The proposed method for publishing an SWZ Device Feed to CDOT's WZDx and for coordinating with CDOT to gather the Planned Event identifier, API key, and authentication token prior to the operational test, if applicable.
- (7) The proposed methods for satisfying all physical and digital security requirements for devices and the SWZ data processing software, if applicable. The SWZ Plan shall include verification that all CISPs have been addressed and the process for performing and confirming security checks.
- (8) The proposed process for maintaining continuous operations for each SWZ device. The process shall include, if applicable, replacing solar panels, implementing a back-up power source, managing communication failures, relocating devices, adjusting data displayed (speed limits and messages), and repairing or replacing non-operational devices. All devices proposed to rely on local or regional power shall be documented here to obtain approval from the Engineer. The Engineer shall track all utility information per Procedural Directive 90.1 "Utility Account Management".
- (9) The proposed methods for fulfilling the 5-day operational test and weekly device reports.
- (10) The proposed prorated daily unit cost of each SWZ device for pay deduction of non-operational devices.

The Contractor shall also provide written confirmation seven days in advance of all proposed changes to the SWZ Plan. Plan updates shall not be required during project progression so long as the device's location is not substantially changed.

*(b) Operational Testing Procedure.* Once all SWZ devices are installed, they shall undergo a 5-day continuous operational test. The operational test shall consist of all SWZ devices in operation with appropriate traffic control to address safety concerns while physically accessing each device. The operational test is to ensure that all SWZ devices are operating in a fully functional manner per the SWZ Plan. The Contractor shall provide for complete operations support from the Vendor, if applicable, during the operational test, and the Contractor shall provide verification that the reported data accurately reflects actual field conditions.

Delete this paragraph if connectivity is not feasible and standalone SWZ devices are deployed. The operational test shall include pushing sample device data in a WZDx-compliant Device Feed to the CDOT-provided secure, encrypted endpoint. The sample Device Feed shall include the CDOT-provided Planned Event identifier number for each device to link with CDOT's Work Zone Feed. Refer to the Materials section, subsection F, WZDx, for all integration details.

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If an SWZ device is offline or malfunctions for a cumulative period of four hours or more during this operational test on any day, no credit will be given for that day for the operational test period, and the five-day operational test will reset.

Records must be maintained for stoppages and resumptions during the operational test for submission to the Engineer. An operational test report must be submitted to provide accurate date and time of all activity, as well as:

- (1) Specific device or set of devices where work was performed.
- (2) Cause of device malfunction, if known.
- (3) Description of the type of work performed.
- (4) Time required to complete the repair.
- (5) Any issues pertaining to publishing the sample WZDx Device Feed, with resolution.

The operational test report must be submitted to the Engineer for approval no later than five days after the completion of the test. An initial payment for setup of all SWZ devices will be rendered after approval of the operational test report. No per-unit payment will be rendered for the operational testing period. No field construction activity can commence until CDOT's approval of the operational test report.

*(c) SWZ Device Installation.* All installation of the SWZ devices shall be temporary and require no drilling or excavation, unless otherwise approved by the Engineer. Whenever possible, the Contractor shall consider co-location of devices for sharing communications and power to minimize the installation cost. The SWZ shall provide full functionality when devices are relocated and shall be field adjusted as needed to provide real-time traffic data.

The Contractor shall adjust the spacing and location of the SWZ devices as needed for visibility or data capture during the various construction phases. The Contractor shall adjust spacing or relocate SWZ devices within an allowable time frame (no less than one hour) as designated by the Engineer to avoid pay deductions. The Contractor shall ensure all SWZ devices remain in place and operational until after all devices are removed from the project at the direction of the Engineer.

*(d) SWZ Device Maintenance.* The Contractor shall assume all responsibility for damaged equipment due, but not limited to, crashes, vandalism, or adverse weather which occurs during the SWZ device deployment and operation. The Contractor shall maintain an inventory of spare parts to support maintenance and repair of all SWZ devices within CDOT-defined response times.

*(e) SWZ Device Weekly Report.* The Contractor shall submit a weekly report consisting of both field observations and digital records (device health monitoring and alerting to the extent possible) for all devices, as applicable. At a minimum, weekly reports shall consist of the following items:

- (1) Relocations of all devices.
- (2) Total downtime for all devices.
- (3) All device malfunctions and, if known, cause of malfunction.

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- (4) All communication disruption between devices or the SWZ data processing software, if applicable.
  - (5) All device repair and time required to complete repair.
  - (6) All loss, lapse or anomaly in data.
  - (7) All resolution of misinformation or data inaccuracy and time required to complete resolution.
  - (8) All outstanding issues or maintenance concerns.
- (f) *Project Deliverables.* The Contractor shall submit the following to the Engineer for information, acceptance, or approval per the specified timeframes.

**Table 630-1  
PROJECT DELIVERABLES**

Deliverable	Information, Acceptance, or Approval	Schedule
SWZ Plan	Approval	30 days prior to SWZ setup
Operational Test Report	Acceptance	5 days after completion of test
Weekly Report	Acceptance	Weekly

Revise Section 630.18 to include:

**METHOD OF MEASUREMENT**

Delete this paragraph if a SWZ data processing software is not being used or a SWZ System is selected. A one-time payment will be paid for setup of the SWZ Data Processing Software, if applicable. Any additional configuration of SWZ devices with the SWZ Data Processing Software shall be incidental and not measured for payment.

Channelizing devices, construction traffic signs, and flashing beacons shall be measured per each unit deployed. All other SWZ devices shall be measured by day (Change from "day" to "month" for projects longer than 6 months in duration.). The device measurement shall include all submittals, materials, equipment, tools, labor necessary to complete the work, and support required to make the device functional and operational.

Payment will be measured for each day of Traffic Control Management required to reset or relocate any device or set of devices. Resets and relocations of non-operational devices shall not be measured for payment. This measurement shall be independent of the number of units requiring relocation in a given day.

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The Contractor shall identify and make all necessary corrections or repairs to an SWZ device that is deemed non-operational by the Engineer. A non-operational device is defined as a device that is offline, physically malfunctioning, improperly positioned, reporting inaccurate data, interfering with construction activity, or inhibiting the performance of other SWZ devices. A connected device is also considered non-operational if it is not communicating with the SWZ data processing software.

No pay deduction will occur for a non-operational device if hardware and software corrections are made within 24 hours of notification and any device relocations are made within the time frame (no less than one hour) designated by the Engineer. Otherwise, a pay deduction equal to the prorated daily unit cost of the SWZ device will be imposed for each day that it is non-operational. There shall be no limit on this penalty.

If an SWZ device is defective or damaged and unable to be repaired, the Engineer may require that a similar device from a less critical location within the project be reset to replace the defective device. No payment will be rendered for the defective device; however, the entire SWZ shall be deemed operable upon the device replacement. The Engineer reserves the right to permanently remove an SWZ device if they determine that the device is not performing per this specification, at which point no further payment will be made for the removed device.

**Revise Section 630.19 to include:**

**BASIS OF PAYMENT**

Payment is considered full compensation for all work, materials, labor, and incidentals related to SWZ devices per the Plans, Specifications, and the approved SWZ Plan.

Payment will be made under: [Remove all non-applicable items that correspond to the Materials section, subsection G \(#1-16\).](#)

<b>Pay Item</b>	<b>Pay Unit</b>
SWZ Data Processing Software	Lump Sum
Advance Warning Flashing or Sequencing Arrow Panel (_ Type) (SWZ)	Day
Advance Warning Flashing or Sequencing Arrow Panel (_ Type) (SWZ)	Month
Automated Flagging Assistance Device (SWZ)	Day
Automated Flagging Assistance Device (SWZ)	Month



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SMART WORK ZONE (SWZ) DEVICES**

<b>Pay Item</b>	<b>Pay Unit</b>
Channelizing Device (SWZ)	Each
Construction Traffic Sign (Panel Size _) (SWZ)	Each
Portable Closed-Circuit Television (SWZ)	Day
Portable Closed-Circuit Television (SWZ)	Month
Portable Doppler Radar (SWZ)	Day
Portable Doppler Radar (SWZ)	Month
Portable Flashing Beacon (SWZ)	Each
Portable Highway Advisory Radio Transmitter (SWZ)	Day
Portable Highway Advisory Radio Transmitter (SWZ)	Month
Portable Hybrid Message Board (SWZ)	Day
Portable Hybrid Message Board (SWZ)	Month
Portable Microwave Vehicle Radar Detector (SWZ)	Day
Portable Microwave Vehicle Radar Detector (SWZ)	Month
Portable Ramp Meter (SWZ)	Day
Portable Ramp Meter (SWZ)	Month
Portable Traffic Signal (SWZ)	Day

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SMART WORK ZONE (SWZ) DEVICES**

<b>Pay Item</b>	<b>Pay Unit</b>
Portable Traffic Signal (SWZ)	Month
Portable Traffic Speed Monitor (SWZ)	Day
Portable Traffic Speed Monitor (SWZ)	Month
Portable Variable Message Sign Panel (SWZ)	Day
Portable Variable Message Sign Panel (SWZ)	Month
Portable Variable Speed Limit Sign (SWZ)	Day
Portable Variable Speed Limit Sign (SWZ)	Month
Portable Weather Monitoring Station (SWZ)	Day
Portable Weather Monitoring Station (SWZ)	Month
**Smart Work Zone Devices (Setup)	Lump Sum
**Smart Work Zone Traffic Control Management	Day

\*\*These items are used for initial setup of SWZ devices and ongoing relocations for construction phasing. These items are required for all projects.

Delete this paragraph if a SWZ data processing software is not being used or a SWZ System is selected. The SWZ Data Processing Software payment shall be full compensation for furnishing the software, assigning and configuring user accounts, integrating and testing devices, operating and managing device data and control, monitoring and reporting digital device records, furnishing a WZDx-compliant SWZ device data feed, and troubleshooting software deficiencies.

The SWZ device payment shall be full compensation for operating, testing, maintaining, storing, servicing, reporting, removing, cleaning, repairing, and providing insurance for the device; for troubleshooting device deficiencies; and responding to incidents with the unit.

**REVISION OF SECTION 630  
SMART WORK ZONE (SWZ) DEVICES**

The device payment shall be limited to the number of units or **days (Change from "days" to "months" for projects longer than 6 months in duration.)** listed in the Contract, unless approved by the Engineer, and shall commence after the operational test report is approved.

The Smart Work Zone Devices (Setup) lump sum payment shall be full compensation for furnishing, installing, mobilizing, configuring, and testing all devices. This payment shall be rendered upon approval of the Operational Test Report by the Engineer.

The Smart Work Zone Traffic Control Management daily payment shall be full compensation for all resets and relocations of SWZ devices that are deemed necessary for major traffic switches or are requested by the Engineer. The payment is independent of the quantity of devices.