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GOVERNOR

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0016

Bruce A. Van Note
COMMISSIONER

September 13, 2019
Subject: Roadway Weather Information
Systems
State WIN: 024213.00
Location: Falmouth, Freeport, Richmond,
Sidney, Etna & Bangor
Amendment No. 1

Dear Sir/Ms.:

Please make the following changes to the Bid Documents:

In the Bid Book:

REMOVE pages 82 – 84, SPECIAL PROVISION – SECTION 645 – HIGHWAY SIGNING – (Solar Power System), 3 pages, dated August 26, 2019, and **REPLACE** with the attached, revised SPECIAL PROVISION – SECTION 645 – HIGHWAY SIGNING – (Solar Power System), 3 pages, dated September 10, 2019.

REMOVE pages 85 – 99, SPECIAL PROVISION – SECTION 645 – HIGHWAY SIGNING – (Road Weather Information Station (RWIS) System Equipment), 15 pages, dated August 26, 2019, and **REPLACE** with the attached, revised SPECIAL PROVISION – SECTION 645 – HIGHWAY SIGNING – (Road Weather Information Station (RWIS) System Equipment), 15 pages, dated September 13, 2019.

The following questions have been received:

Question: Would MaineDOT consider an extension the current RFP close date?

Response: No, the bids are due as indicated in the proposal.

Question: Special Provision section 104 – Utilities. Is it expected that the contractor will be responsible for any fees related to the power utilities hook up?

Response: No, MaineDOT will be responsible for utility power hook ups, including fees and service costs.

Question: Special Provision section 104 – Utilities. Can MaineDOT indicate the demarcation point for power where the contractor would be responsible to complete connections from?

Response: The Contractor shall coordinate with the Resident, but it is anticipated that the demarcation point for power service will be the power panel/breakers within the RPU cabinet.

Question: Special Provision section 645 - system integration. Where should the costs of this integration be represented? Should they be included in the cost of each RWIS station as there is no line item noted for this within the pricing schedule.

Response: The costs for system integration should be distributed across the lump sum prices for the individual RWIS sites.

Question: Multiple software is mentioned in the bid document. Can MaineDOT clarify what the flow of data is between Navigator, Compass ATMS and MaineDOT ATMS.

Response: MaineDOT's current ATMS is called New England Compass ATMS (Compass ATMS by Southwest Research Institute). MaineDOT's current Road and Weather software is Navigator (by Vaisala). The Special Provision 645 for Road Weather Information Station (RWIS) System Equipment has been revised to clarify the data flow required by this contract. The Contractor has two options:

- RWIS System data shall flow from the stations to the Compass ATMS and the Road and Weather software concurrently (in parallel); or
- RWIS System data shall flow from the stations to the Road and Weather software and then be exported to the Compass ATMS.

Question: Page 85, Paragraphs 3 and 4. These paragraphs appear to be contradictory to one another. Paragraph 3 states that the requested integration shall be the development of a live data flow using open vendor API between the RWIS equipment and ATMS where Paragraph 4 indicates that data flow must flow through navigator or alternative. Is the preference for a direct link between the equipment and ATMS?

Response: The Special Provision 645 for Road Weather Information Station (RWIS) System Equipment has been revised to clarify the data flow as noted in the previous response. MaineDOT does not have a preference between the two alternatives. It is at the Contractor's discretion as to which method best allows the Vendor's products to produce the required forecasting.

Question: Does the current Road and Weather software provide any type of weather or road weather forecasting service?

Response: The current Road and Weather software has the capability to predict weather conditions throughout the designated corridors from the information gathered at the selected RWIS sites.

Question: Section 645.02 - General. Can MaineDOT clarify what component of the RWIS System is meant to store 28 days of data? RPU, Software, etc.

Response: The intent of the RWIS System storage requirement is to store up to 28 days of data locally at the RWIS site in the event of communications failure that would discontinue the live data feed so as not to lose the collected RWIS data.

Question: Can MaineDOT confirm that the existing Road and Weather Software (Navigator) is compatible with NTCIP compliant hardware from other manufacturers?

Response: As the existing Road and Weather software is a proprietary product of a third party, MaineDOT cannot confirm what elements of the software would be considered compliant with NTCIP protocols. The Contractor is required to confirm that their products are interoperable with the current Road and Weather software or provide alternative Road and Weather software that is also interoperable with all legacy RWIS equipment.

Question: Can MaineDOT confirm that a systems integrator who is deemed qualified by MaineDOT would have permission and access to modify the configuration of the Navigator software to add the new proposed stations?

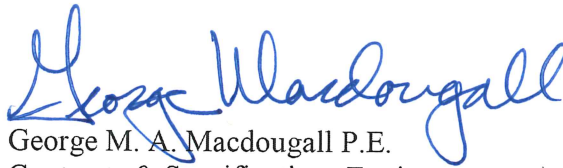
Response: As the Navigator software is a proprietary product of a third party licensed to MaineDOT as a user, MaineDOT cannot confirm who has permission to modify the software. That would be a question best posed to the owner of the software.

Question: Section 645.0245 – RWIS system equipment general. The RWIS specifications listed require heated sensors to be used. Can MaineDOT confirm if these heaters are required on the solar stations also (Sidney, Falmouth, and Richmond)? Typically, heaters are not activated on solar powered systems as they require a significant solar array which cannot be pole mounted.

Response: Where required in the Special Provisions, the proposed sensors shall include heaters. However, it is MaineDOT's intent that the RWIS stations that operate on solar power systems will have the heating units disabled upon initial installation. MaineDOT desires to have the flexibility to enable sensor heaters as needed once the system's power draw and power management has been field verified.

Consider these changes and information prior to submitting your bid on **September 18, 2019**.

Sincerely,



George M. A. Macdougall P.E.
Contracts & Specifications Engineer

SPECIAL PROVISION
SECTION 645
HIGHWAY SIGNING
(Solar Power System)

Description: This work shall consist of furnishing, installing, wiring, and testing solar power systems, mounting hardware, and associated equipment to provide power for the road weather information station (RWIS). The work shall also include calculating the power load requirements and furnishing, installing, and testing all ancillary items needed to establish a complete, functional solar power system.

General: The Contractor shall provide a solar panel array, mounting hardware, charging control equipment, batteries, battery storage cabinet, and all other associated equipment to provide the necessary power for all connected equipment. Solar panels and battery storage shall be sufficient to provide a minimum of 4 days of autonomy under no-light conditions when the batteries are fully charged, and to provide 24 hours per day of operation, seven (7) days per week, 365 days per year with no loss of operation. The batteries shall not discharge more than 50 percent of capacity at the end of the 4 days autonomy. The Contractor shall submit for approval a solar calculation which demonstrates compliance with this requirement based on the expected power draw of all connected equipment. The solar calculation shall include the manufacturer's specified loads of each piece of equipment to be powered. The solar calculation shall take into account the full required operating temperature range. The solar calculations shall take into account leaves on adjacent trees, regardless if the leaves are on the trees at the time of installation. The solar calculations recharge rate shall account for limited light levels associated with winter.

Materials: Materials provided for this contract shall comply with the following standards. If no revision date is specified, the most recent revision of the standard applies, with any published interims. Solar system hardware shall be rated for -30 degrees F to +122 degrees F. The Contractor shall submit a complete Technical Submittal for the solar power system prior to manufacturing, fabricating or constructing components of the solar power system. The Technical Submittal shall include:

- A. Solar power calculations demonstrating compliance with the autonomy requirements.
- B. Drawings, manufacturer's specifications, and applicable catalog cuts for all materials and components for this work.
 - a. Photovoltaic (PV) panels and mounting brackets
 - i. The solar panel array shall be made up of one or more PV panels along with support and mounting brackets to attach firmly and securely to a wood pole.
 - ii. The mounting bracket shall provide flexibility to aim the solar panel to maximize sun exposure.

- iii. The solar panel array shall be designed to operate over a free air temperature range of -30°F to +122°F.
 - iv. The solar power array shall be Underwriter's Laboratory (UL) approved. UL certification shall be provided with the Technical Submittal.
 - v. The solar panels, in combination with the batteries, shall provide four (4) days, minimum, autonomy under no-light conditions when the batteries are fully charged and to provide 24 hours per day, 7 days per week, 365 days per year operation with no loss of operations. The Contractor shall submit for approval a solar calculation which demonstrates compliance with this requirement. This calculation shall include the manufacturer's specified loads for each sensor, RPU, and other piece of equipment to be powered. The solar calculation shall be measured from 0°F.
- b. Control devices
- i. Control devices should include a solar controller and a battery charge controller, with all necessary connector cables and ancillary equipment.
 - ii. The control devices shall prevent the batteries from overcharging.
 - iii. The control devices shall include low voltage disconnect devices which disconnect the batteries to prevent damage in the event of a very low state of charge.
 - iv. The control devices shall include a power inverter that provides 120 VAC power to the RPU with three (3) percent or less total harmonic distortion and five (5) percent +/- output voltage regulation.
 - v. The control devices shall be temperature compensated such that the battery charging voltage is automatically adjusted based on temperature variations to maximize battery life.
 - vi. The control devices shall include a system monitoring device which allows maintenance personnel to assess critical system parameters such as battery condition and solar panel output.
 - vii. The control devices shall include overcurrent protection to ensure safe power output in the event of a malfunction of the solar power system.
- c. Batteries (AGM type and spill proof)
- d. Pole mounted battery enclosure (the batteries shall be contained in such a manner that maintenance access does not require the removal of any batteries in order to access any other battery)
- e. All other components required for a working system

The Contractor shall supply and install a grounding system at the base of the battery cabinet support pole. The grounding system shall be connected to the pole through an appropriate ground clamp. A #4 AWG copper wire shall be installed between the RPU and the battery enclosure providing a common ground system. The ground wire shall be enclosed in a minimum one-inch conduit from the RPU to the external ground rod(s). Maximum

resistance to ground shall be 25 ohms, or as recommended by the manufacturer, whichever is more stringent. Additional ground rods shall be installed to meet the required grounding.

The Contractor shall unconditionally guaranty all system modules, including all equipment and hardware as specified in the Contract Documents to be free of defects for a period of two (2) years from the date of final approval. The guaranty shall cover all materials, equipment, tools, transportation, supplies, parts, and incidentals required to facilitate response maintenance as necessary to repair and replace any defective modules, system(s) or subsystem(s) of the completed facility within the two-year time period. Acceptance of any system or subsystem during the construction contract, or any modifications to the system design proposed by the Contractor and approved by the Department shall not relieve the Contractor of the requirements of this guaranty. The guaranty period shall be considered to start concurrent with the date of final approval.

The Contractor shall perform testing in accordance with the requirements contained in Special Provision 645. Testing shall include, but not be limited to, demonstration that the solar power system will properly power the RWIS equipment for the required no-light autonomy time, while still retaining the required battery capacity after the completion of the test.

As part of the Contractor's training program for the hybrid travel time sign system, the Contractor shall include a maintenance program consisting of the furnishing of educational training in the operation and maintenance of the solar power equipment for the hybrid travel time sign system, including hardware.

Method of Measurement: Solar Power Systems will not be measured directly but shall be incidental to each RWIS equipment site using solar power.

SPECIAL PROVISION
SECTION 645
HIGHWAY SIGNING
(Road Weather Information Station (RWIS) System Equipment)

645.01 Description: This specification describes the work that shall consist of the furnishing, installing, integrating, and testing Road Weather Information Station (RWIS) systems and equipment. Work to be completed by the Contractor shall include furnishing and installing a series of environmental and weather sensors with associated equipment onto existing wood poles. Where applicable, work also includes furnishing and installing a solar power system for electrical power service. The system shall be located along the roadway pavement at locations specified in the Contract Documents or as ordered by the Resident.

Some work necessary for the Contractor to perform their work, including the installation of wood poles, trenched conduit, and maintenance of traffic control, will be completed by others. The Contractor is responsible for coordinating with the Resident to ensure that the work by others is completed in sufficient time to allow the Contractor to proceed with their responsibilities.

This specification also includes the work necessary to integrate the data obtained by the RWIS System Equipment into the Maine Department of Transportation (MaineDOT) Advanced Transportation Management System (ATMS), New England Compass ATMS (Compass ATMS). This integration effort shall include the development of a live, supported dataflow through the use of an open vendor API from the RWIS System Equipment to Compass ATMS and MaineDOT. This may be completed in conjunction with the system integration requirements, but also shall be able to be completed separately, if the system integration is not accepted.

The Contractor shall provide a System Integrator to integrate the RWIS System data into the Compass ATMS developed by the Southwest Research Institute (SwRI) for MaineDOT. This integration may be accomplished in one of two ways: the RWIS System data may be integrated directly to the Compass ATMS and the Road and Weather software in parallel; or the RWIS System data may be exported from the Road and Weather software to the Compass ATMS. The System Integrator shall be responsible for configuring the system's Road and Weather software, integrating the weather data feeds from the RWIS system equipment, and testing the communications and Road and Weather software.

The MaineDOT currently uses Navigator by Vaisala as its Road and Weather software. The Contractor shall either provide an RWIS system that is compatible with the Department's current Navigator software or shall provide an alternative Road and Weather software package that can integrate the new RWIS system equipment as well as all legacy/existing RWIS system equipment and data. If the Contractor elects to provide an

alternative Road and Weather software package, the Contractor shall be responsible for integrating all existing legacy RWIS stations (Vaisala) into the alternative Road and Weather software package at no additional cost to MaineDOT. An acceptable alternative Road and Weather software package shall accept any future RWIS equipment data, regardless of vendor, as practicable at the time of bidding. Regardless which option is selected, the Contractor's System Integrator shall ensure that the RWIS System data is available in both the Road and Weather software and the Compass ATMS.

645.02 General: The following specifications detail a typical RWIS system as currently deployed in the State of Maine. If any of the following hardware-specific requirements listed in the following sections cannot be met by a willing Bidder, but the Contractor believes that strict conformance to the given requirement is unnecessary or may be accomplished differently, the Contractor shall provide a list of the requirements that cannot be strictly met along with a justification for how the Contractor's proposed RWIS System Equipment may be considered functionally equivalent in accordance with Special Provision 103.

An acceptable RWIS system within the Road and Weather software shall predict weather conditions throughout the I-95 corridor from Mile Marker 109.0 to approximately Mile Marker 200.0 and throughout the I-295 corridor from Mile Marker 0.0 to Mile Marker 52.5 using the data obtained from the new and legacy RWIS stations along the corridor. An acceptable RWIS system within the Road and Weather software shall provide post-storm analyses up to 28 days following a weather event.

The Contractor shall provide the qualifications of the System Integrator to the Department as a condition of Contract Award as described in Special Provision 103. All work associated with system integration shall be under the direct supervision of the System Integrator. The System Integrator shall demonstrate working knowledge of the Compass ATMS and have experience working with the RWIS System data to be supplied under this project.

RWIS System data integration shall be accomplished with minimal interruption to the existing MaineDOT Traffic Management Center (TMC) operations. Any required downtime of the Compass ATMS shall be approved by the Resident at least seven (7) days in advance. The System Integrator shall use the Compass ATMS test environment to demonstrate the system operations prior to going live with the RWIS System data.

The System Integrator shall produce computer representations of the locations of the new RWIS locations within a system map as part of the Road and Weather software (GIS or other approved mapping system) for the purposes of system monitoring and operations.

The System Integrator shall prepare standard Compass ATMS reports to be displayed on the dashboard. These reports shall include:

- RWIS equipment uptime report, including the percentage of uptime during the reporting period.
- RWIS alarm and event report that provides a log of the alarms generated from the RWIS System data.
- Incorporation of RWIS data into existing reports available through the Compass ATMS.

The System Integrator shall also prepare up to three additional project-specific reports at the request of MaineDOT.

654.021 Materials: All equipment supplied under the contract shall be new. Used, refurbished, and rebuilt equipment will not be permitted.

645.025 Road Weather Information Station (RWIS) System Equipment – General

- a. All software and data interfaces shall be designed to reflect the latest NTCIP and Traffic Management Data Dictionary Standards. Specifically, the system shall support NTCIP 1204 v03.08 protocol.
- b. The RWIS System Equipment shall include a Remote Processing Unit (RPU) that shall satisfy the following requirements:
 1. The RPU shall have a modern processor, manufactured within the previous 12 months.
 2. RPU shall have a minimum of 512MB DDR3 and 2GB of NAND flash memory.
 3. RPU shall have internal/integral Ethernet communications and support direct Ethernet connections.
 4. RPU shall provide a means for real-time clock synchronization and location definition at least once daily.
 5. RPU shall have remote access capability for local maintenance purposes (WLAN, WiFi, Bluetooth or equivalent).
 6. RPU shall keep records and show calibration history of the attached sensors.
 7. The RPU shall operate in the temperature range of -40°F to +150°F.
- b. The RWIS System Equipment shall include a Sensor Interface and Power Management system that shall satisfy the following requirements:
 1. All sensor connectors shall be contact spring-cage connectors with locks to avoid use of tools in wiring and to guarantee reliable connections.
 2. RPU shall include Ethernet interfaces for sensor and peripheral connections including at least two spare ports.

3. Ethernet connections shall support Power over Ethernet (PoE) functionality.
 4. RPU shall have serial interfaces for sensor and peripheral connections without extension modules including at least two spare ports.
 5. RPU shall have centralized bus-bar for sensor grounding. The bus-bar shall be copper.
 6. Sensor cables shall be connected to bus-bar for grounding.
 7. RPU shall have built-in surge arrestors that shall be field replaceable.
 8. Where indicated on the Plans, the RPU shall have the capability to operate with solar power technology (direct current).
 9. Where indicated on the Plans, the RPU shall have a battery charger.
- c. The RWIS System shall include a Power Supply that shall satisfy the following basic requirements:
1. Where public utility power is provided, the Power Supply shall withstand an alternating current (AC) range of 89VAC to 135VAC
 2. Power shall have in-built surge protection against transients.
 3. Power shall be at least 240W to ensure sensor heating under all conditions.
 4. Power supply shall have stable output of ± 1 percent.
 5. Power supply shall allow parallel connection when additional power is required.
- d. The AC Supply shall satisfy the following requirements:
1. RPU AC supply shall have surge protection level at least 6kV/3kA. Surge protection units shall be field replaceable.
 2. AC Supply shall include a main disconnect circuit breaker for maintenance purposes.
- e. Where AC power systems are employed, the RWIS System shall include a Battery Back-Up that shall satisfy the following requirements:
1. For AC power systems, the RPU shall include a minimum of 26 amp-hours (Ah) of battery back-up to maintain measurements in case of AC power loss. The battery (or batteries) shall be installed in a dedicated battery holder to minimize movement and vibration.
 2. Back-up battery shall be sealed and spill proof and shall be considered maintenance-free.
- f. Where solar power systems are employed, the RWIS System shall include the following solar power components:
1. Photovoltaic (PV) panels with mounting brackets

- i. The solar panel array shall be made up of one or more PV panels along with support and mounting brackets to attach firmly and securely to a wood pole.
- ii. The mounting bracket shall provide flexibility to aim the solar panel to maximize sun exposure.
- iii. The solar panel array shall be designed to operate over a free air temperature range of -30°F to +122°F.
- iv. The solar power array shall be Underwriter's Laboratory (UL) approved. UL certification shall be provided with the Technical Submittal.
- v. The solar panels, in combination with the batteries, shall provide four (4) days, minimum, autonomy under no-light conditions when the batteries are fully charged and to provide 24 hours per day, 7 days per week, 365 days per year operation with no loss of operations. The Contractor shall submit for approval a solar calculation which demonstrates compliance with this requirement. This calculation shall include the manufacturer's specified loads for each sensor, RPU, and other piece of equipment to be powered. The solar calculation shall be measured from 0°F.

2. Batteries

- i. The batteries shall meet the requirements of the AC Battery Back-up system as defined above.
- ii. After four days of continuous operation under no-light conditions, the batteries shall still retain at least 50 percent of their full design capacity at 0°F.
- iii. The equipment cabinet shall include a manual generator transfer switch to allow the cabinet to be switched from solar power to provide 120 VAC generator power. The generator will be provided by MaineDOT as required. The generator transfer switch shall be mounted through the cabinet wall facing away from or downstream of the direction of traffic.

3. Control Devices

- i. Control devices should include a solar controller and a battery charge controller, with all necessary connector cables and ancillary equipment.
- ii. The control devices shall prevent the batteries from overcharging.
- iii. The control devices shall include low voltage disconnect devices which disconnect the batteries to prevent damage in the event of a very low state of charge.
- iv. If the control devices include a power inverter, the power inverter shall provide 120 VAC power to the RPU with three

- (3) percent or less total harmonic distortion and five (5) percent +/- output voltage regulation.
 - v. The control devices shall be temperature compensated such that the battery charging voltage is automatically adjusted based on temperature variations to maximize battery life.
 - vi. The control devices shall include a system monitoring device which allows maintenance personnel to assess critical system parameters such as battery condition and solar panel output.
 - vii. The control devices shall include overcurrent protection to ensure safe power output in the event of a malfunction of the solar power system.
- g. The RWIS System Equipment shall include a Communications system that shall satisfy the following requirements:
- 1. RPU shall support at least two parallel communication lines out from the station, with one communication line being a cellular modem.
 - 2. RPU Cellular communication device shall be native Ethernet.
 - 3. RPU Cellular communication shall support modern networks: 3G/4G/LTE.
 - 4. RPU Cellular communication shall support dual SIM usage for data transmission purposes.
 - 5. RPU shall support additional RS-232/485 connections for legacy device support.
 - 6. Where the RPU includes a WLAN for local remote access, the RPU shall have user definable time-out for WLAN broadcasting to prevent unintentional use of WLAN.
 - i. RPU WLAN shall have the ability to be used as a hotspot.
 - ii. RPU WLAN shall have the ability to be used as a client.
 - 7. RPU shall have two Ethernet networks: one for internal communications and second for external communications.
 - 8. RPU's internal network shall be Ethernet based.
- h. The RPU shall include a cabinet enclosure that shall satisfy the following requirements:
- 1. RPU enclosure shall not have external connectors for sensors and other equipment, which may cause excessive amount of corrosion and malfunctions.
 - 2. All entries to the RPU enclosure shall be completely encased in conduit with appropriate bushings to prevent insect and moisture entry. The sensor cable inlets shall be vandal-proof.
 - 3. RPU enclosure material shall be made of bare aluminum or stainless steel.
 - 4. RPU enclosure shall be equal to IP66 or NEMA-equivalent rating

5. RPU enclosure door shall have wind lock mechanism to maintain the door in an open position during maintenance.

645.026 RWIS System Sensors: The Contractor shall furnish, install, integrate and test environmental and weather sensors that shall measure several environmental characteristics. The following sensor equipment shall be included:

- Wind Speed and Direction Sensor
- Visibility and Present Weather Detector
- Air Temperature and Humidity Sensor
- Barometric Pressure Sensor
- Road Surface Sensors (Non-Invasive and Subsurface Probe)

1. Wind Speed and Direction Sensor

- a. The sensor shall be ultrasonic and include no external moving parts.
- b. The sensor shall be internally heated with an operational temperature of -40°F to +140°F.
- c. The sensor shall be IP66 rated.
- d. The sensor shall fully compensate for the effect of temperature, humidity and pressure.
- e. Measurement Parameters:
 - i. Wind speed shall be user selectable in units of miles per hour (mph) and knots. Wind speed resolution shall be to the whole integer for the selected unit (i.e. 5 mph or 3 knots) and accuracy shall be within two (2) percent of actual.
 - ii. Wind direction shall be measured in degrees. Wind direction resolution shall be +/- 2 degrees.
 - iii. Wind speed and direction shall be reported as instantaneous value and rolling average value to a customized average time.
 - iv. Wind speed and direction minimum and maximum values shall be available over a customized time period (i.e. 10 minutes).
 - v. Wind speed shall be available as 3-second gust values.
 - vi. All wind speed and direction values shall be available via the weather station's graphical user interface wind rose.
 - vii. Road direction shall be definable in 10 degree increments relative to the wind rose.
 - viii. RPU shall automatically calculate true north readings for wind direction.

2. Visibility and Present Weather Detector

- a. The sensor shall utilize back scatter optical technology.
- b. The sensor shall be internally heated with an operational temperature of -40°F to +131°F.
- c. The sensor shall have an operating humidity range of 0-100 percent relative humidity.

- d. The visibility and precipitation detectors shall be integrated into a single sensor unit.
- e. The sensor shall be IP66 rated.
- f. Measurement Parameters:
 - i. The sensor shall detect the following types of precipitation:
 - 1. Rain
 - 2. Freezing Rain
 - 3. Drizzle
 - 4. Freezing Drizzle
 - 5. Mixed Rain/Snow
 - 6. Snow
 - 7. Sleet/Ice Pellets
 - ii. In addition to the precipitation types described above, the sensor shall be capable of detection the following present weather conditions:
 - 1. Fog
 - 2. Mist
 - 3. Haze (from smoke or other particulates)
 - 4. Clear visibility
 - iii. The sensor shall be capable of measuring precipitation intensity. Detection threshold shall be 0.05 millimeters per hour over a 10 minute period.
 - iv. The sensor shall be capable of measuring snow accumulation and amount of new snow since previous readings.
 - v. The visibility sensor shall have a measurement range of up to 10 miles with an accuracy of +/- 10 percent.

3. Air Temperature and Humidity Sensor

- a. The sensor shall contain a radiation shield to protect the sensor from solar radiation influence and from precipitation. The radiation shield shall contain no moving parts.
- b. The sensor shall combine air temperature detector (AT), relative humidity detector (RH), and dew point detector (DP) into a single unit. Alternatively, dew point may be calculated by the RPU or via the Road and Weather software.
- c. The sensor shall have integral surge protection.
- d. The sensor shall be IP66 rated.
- e. The AT detector shall have an operational range of -40°F to +140°F.
- f. The RH detector shall have an operational range of 0-100 percent RH.
- g. Measurement Parameters:
 - i. AT detector shall provide instantaneous and rolling one minute average values. The AT detector shall hold the previous five observations.
 - ii. AT detector shall have rolling 24-hour minimum and maximum temperature values.

- iii. AT detector shall have an accuracy of 0.5°F over the range of 0°F to +100°F.
- iv. RH detector shall provide rolling one minute average values from the previous six observations.
- v. RH detector shall have an accuracy of two (2) percent and shall be reported to the nearest 0.1 percent (i.e. 90.8%).
- vi. RH detectors shall provide a means (either directly or via software) to measure dew point temperature and frost point temperature.

4. Barometric Pressure Sensor

- a. The sensor shall be a silicon capacitive absolute pressure sensor designed for barometric pressure measurement.
- b. Measurement Parameters:
 - i. The barometric pressure sensor shall conduct readings every 5 seconds and report the instantaneous readings.
 - ii. The barometric pressure sensor shall measure in units of inches of mercury (Hg).
 - iii. The barometric pressure sensor shall have an operational range of 18.0-31.0 inches Hg with a resolution of 0.03 inches Hg.
 - iv. The barometric pressure sensor shall have an accuracy of +/- 0.12 inches Hg over the temperature range of 0°F to +140°F.

5. Non-Invasive Pavement Sensors

- a. There shall be sensors that can measure the pavement surface temperature, ambient air temperature, relative humidity, pavement surface state, and friction coefficient remotely, without penetrating the roadway.
- b. These non-invasive sensors shall have no moving parts.
- c. Non-invasive sensors shall collect data samples from the road surface in accordance with the performance standards established in this specification.
- d. The data generated by the non-invasive sensors shall be compatible with the current Road and Weather software currently in operation within the MaineDOT license for New England Compass ATMS.
- e. Measurement Parameters:
 - i. The pavement surface state sensor shall have an operational range of -40°F to +140°F and 0-100 percent RH.
 - ii. The pavement surface state sensor shall be capable of remote readings at the range of 6.5 feet to 48 feet.
 - iii. The pavement surface state sensor shall identify the condition of the pavement remotely with the following surface states:
 - 1. Dry
 - 2. Moist
 - 3. Wet
 - 4. Snow/Frost
 - 5. Ice

6. Slush

- iv. The pavement surface state sensor shall measure the depth of precipitation on the pavement surface as shown below, all at a resolution of 0.01 millimeters:
 - 1. Water/Rain at 0.0 - 2.0 millimeters
 - 2. Ice at 0.0 – 2.0 millimeters
 - 3. Snow at 0.0 to 10.0 millimeters
- v. The pavement surface temperature sensor shall measure the pavement surface temperature every 60 seconds and have a resolution of 0.5°F.
- vi. The pavement surface friction sensor shall estimate the friction coefficient (grip factor) at the range 0.01 to 1.00 at a resolution of 0.01 units.

6. Subsurface Pavement Sensor

- a. The sensor shall be a probe specifically designed for outdoor use and deployment within the pavement structure.
- b. The sensor probe shall be water-tight and weather-resistant.
- c. The sensor probe shall have an operational range of -40°F to +140°F.

645.027 Closed Circuit Television (CCTV) Camera System: The Contractor shall furnish, install, integrate and test digital closed circuit television (CCTV) cameras at each RWIS System location that shall provide streaming video adjacent to the RWIS system. The CCTV camera shall be connected to the RPU and shall be remotely controlled via the RWIS communication system.

- 1. The CCTV camera shall be digital, IP addressable and Ethernet ready.
- 2. The CCTV camera shall be Underwriter's Laboratory (UL) approved. The UL certification shall be provided with the technical submittal.
- 3. The CCTV shall have the capability to be viewed, controlled and tested locally at the RPU utilizing a laptop computer with the manufacturer's software. This shall include the capability to locally retrieve operational status and fault data for the camera.
- 4. The CCTV shall have a minimum resolution of HDTV 800 x 600.
- 5. The CCTV shall be capable of streaming video with H.264 and/or Motion JPEG video compression format.
- 6. The CCTV shall be capable of time triggered FTP.
- 7. The CCTV shall be powered by an industrial grade Power Over Ethernet Injector (POEI). The POEI shall provide operating power and Ethernet data to the CCTV.
- 8. The CCTV shall be housed in an environmentally hardened enclosure suitable for continuous outdoor use. The CCTV shall have an operating range of -40°F to +100°F, minimum.
- 9. The CCTV housing shall be IP66-rated.

645.065 RWIS System Construction Requirements: The Contractor shall install the RWIS system equipment in accordance with the Plans. The equipment shall be installed on the wood poles supplied by the Department. The Contractor shall be responsible for all other work to provide a fully functional, operational, and integrated RWIS system at the locations identified in the Plans.

The Contractor shall install, configure, integrate, and test the RWIS System data into the Compass ATMS and its Road and Weather software. The RWIS System Equipment shall continuously measure and record RWIS System data. The system data shall be available to MaineDOT in the Compass ATMS mapping feature and other related internal programs.

1. Power Requirements

- a. Each RWIS location shall be supplied with adequate power to meet the site and sensor design loads. The power may be AC (public utility power as provided by others) or DC (solar power system) as required by the Plans.
- b. Where AC power is provided by others, the Contractor shall coordinate the power connections at the RPU cabinet.
- c. Where solar power is provided, the Contractor shall furnish, install, configure and test the solar power system equipment to provide the required power to the RWIS equipment.

2. Grounding System Requirements

- a. All RWIS sites shall be grounded to the manufacturer's recommended grounding requirements. If other national, state, or local grounding requirements are more stringent than those of the manufacturer, the applicable national, state, or local code shall apply.
- b. The Contractor shall install a solid copper or copper clad ground rod (minimum ¾-inch x 10-foot) along with #4 AWG ground wire and fittings at the base of the RWIS equipment pole at every location. The Contractor shall install additional ground rods as required to meet the minimum grounding required by the manufacturer.
- c. The ground wire shall be exothermically welded to each ground rod installed with all ground rods attached to every other ground rod via the ground wire.
- d. The grounding system shall be bonded to the RPU enclosure bus-bar in accordance with National Electric Code (NEC) requirements.

3. Communication Requirements

- a. The Contractor shall furnish and install a cellular modem compatible with the RWIS system and with the MaineDOT communications system.
- b. The RWIS system shall transmit weather sensor data to the MaineDOT Transportation Management Center (TMC) and its current Road and Weather software currently in operation within the MaineDOT license for New England Compass ATMS.

- c. The Contractor shall provide all necessary equipment, cables, hardware, and ancillary equipment to capture the RWIS sensor data and transmit the data to the Road and Weather software at the MaineDOT TMC.
- d. The communication system shall allow for configuration control and trouble-shooting of the RWIS equipment through both a local onsite connection and through a remote connection to the RPU.

4. Software and Integration Requirements

- a. The RWIS System shall be fully compatible with the MaineDOT current Road and Weather software currently in operation within the MaineDOT license for New England Compass ATMS.
- b. If the Contractor proposes to supply equipment that is not fully compatible with the current Road and Weather software, the Contractor shall be required to write additional software to incorporate the non-compatible equipment into the current Road and Weather software in coordination with the developer of the New England Compass ATMS. All costs associated with software development, coordination with the New England Compass ATMS developer, and for all integration services shall be the responsibility of the Contractor.
- c. The Contractor shall update the map feature and station summary pages of the Road and Weather software for each new RWIS site installed on this project.
- d. The Contractor shall ensure that the Road and Weather software reporting functions include and incorporate the new RWIS sites installed on this project.
- e. The RWIS system shall have the capability of generating alerts, watches, or warning. The user shall have the ability to set no less than two levels of alarms, both an audible and visual alarm, displayed on the operator's screen when viewing the Road and Weather software. The system shall have the ability to inform automatically via email when alarm criteria is met.
- f. The Contractor shall support the MaineDOT TMC in establishing protocols and procedures to activate portable changeable message signs (PCMS) upon alerts from the RWIS system. See Special Provision 645 Road Weather Information Station (RWIS) System Automation for additional details.

5. Sawing Bituminous Pavement

- a. Sawcutting bituminous pavement shall be with a power-driven saw with an abrasive blade of sufficient width to provide the required cuts.
- b. The sawcut shall be vertical and not exceed two inch depth.
- c. Debris from the sawing operation shall be removed and disposed of by the Contractor before reopening the roadway to traffic.

6. System Testing

- a. All RWIS sensors and equipment installed under this project shall be tested prior to final acceptance. There are three stages of tests required: Stand-Alone Testing, Central Control Testing, and Operational Testing.
- b. The Contractor shall develop test plans and procedures for each test stage for review and approval by the Department. Test plan procedures shall exercise the full functionality of each sensor and system component. Test plans shall be submitted to the Department a minimum of 21 calendar days prior to initiation of the first test.
- c. Test plans shall include the following:
 - i. Date and Time of the test
 - ii. Names of all witnesses to the test, identifying the individual executing the test plan
 - iii. Detailed, step-by-step execution plan that tests the functional requirements of all the equipment, including alarms and action plans.
 - iv. Tabular document for each test step to include:
 - 1. Description of the test step procedure;
 - 2. Expected result of the test step;
 - 3. Place to input the actual result of the test step;
 - 4. Check box indicating pass or fail; and
 - 5. Comments area for witness comments.
 - v. Location for the Resident, MaineDOT TMC representative, and test executor to sign and date the form. Signatures on the test forms only acknowledge that the test was performed in the presence of the correct witnesses. Signatures and witnesses do not signify the pass or fail of any given test.
- d. Stand-Alone testing and Central Control testing shall be completed for all sites prior to the start of the Operational testing.
- e. Upon completion of each test stage, the Contractor shall submit the final test results to the Resident within 14 calendar days.
- f. Stand-Alone Test Requirements - This test shall be performed on site at each RWIS location. The purpose of the Stand-Alone tests is to exercise all stand-alone (non-network) functional operations of the sensors and equipment installed and demonstrate compliance with the requirements for the equipment defined in the Contract Documents. If a sensor or unit fails to pass the stand-alone test, the Contractor shall correct the problem or replace the sensor or unit and retest until satisfactory results are achieved.
- g. Central Control Test Requirements – This test shall be performed at the TMC in Augusta on the MaineDOT Road and Weather software. This test shall verify that all the RWIS sensors and equipment and transmitting data to the Road and Weather software in accordance with the Contract Documents.
- h. Operational Testing – This test shall be performed through the Road and Weather software. The purpose of the Operational Testing is to operate the RWIS equipment live through the software to determine if there are any

faults or bugs that must be resolved. This test shall commence at the conclusion of the successful Central Control testing and continue for a period of 30 consecutive calendar days. All RWIS sites must demonstrate successful transmission of data and be fully integrated with the TMC operations. In the event that there is a single failure associated with any sensor at any site, the test shall be suspended while the Contractor resolves the failure (either by fixing the sensor or replacing the sensor). Upon successful repair/replacement, the test shall continue to the end of the 30 days, or a minimum of seven days, whichever is longer. Upon the failure of any second sensor or equipment, the Operational Test period shall be restarted for the full 30 days upon repair/replacement. The completion of the Operational Test period and the submission of all test reports shall be documented as the date of Final System Acceptance, provided all other work has been completed to the satisfaction of the Resident.

- i. MaineDOT reserves the right to examine and test/retest any and all test steps for the project as Quality Assurance. If MaineDOT determines that any test procedure does not show the result indicated by the final test results, the Contractor shall update and/or repair the defect at no additional cost to the Department.
- j. As part of the final testing, the Contractor shall provide to MaineDOT a complete set of maintenance and user manuals along with all the wiring and assembly schematics/diagrams, including any material safety data sheets (MSDS), prepared by the manufacturer and any toxic substances (coatings, liquids, or other) used.

645.066 Warranty and Guaranty Requirements:

1. The Contractor shall maintain and unconditionally guaranty all RWIS system equipment, including all equipment, hardware, and software for a period of not less than one year from the date of Final System Acceptance. The guaranty shall cover all labor, materials, equipment, tools, transportation, supplies, parts, and incidentals required to facilitate responsive maintenance as necessary to repair and replace any defective sensors or equipment of the completed RWIS systems within the one-year time period.
2. The Contractor shall guarantee availability of compatible replacement equipment (to the field replaceable unit level) for a ten-year time period from the date of final system acceptance. Acceptance of any system or sensors during the contract, or any modifications to the system design proposed by the Contractor and approved by the Resident shall not relieve the Contractor of the requirements of this guaranty.
3. The Contractor shall provide a warranty on all hardware furnished and installed for a period of not less than one year from the date of Final System Acceptance.
4. The warranty shall include technical support available via telephone and email 24 hours per day, 7 days per week, 365 days per year for the warranty period.

5. The warranty shall cover all parts, labor, transportation, shipping, tools, equipment, mobilization and incidentals necessary to repair or replace any system equipment, component, or sensor that fails to perform as required by the Contract Documents.
6. The Contractor shall provide warranty service within 48 hours of notification by MaineDOT of a fault or failure.
7. In the event that a component cannot be repaired within seven (7) days of notification, the Contractor shall provide a temporary replacement unit until the original can be repaired. Alternatively, the Contractor may provide a permanent replacement unit and salvage the failed component.
8. If the same component requires repair more than twice during the warranty period, the Contractor shall replace the component rather than provide a third repair at no additional cost to the Department.
9. The Contractor shall provide a log of all response maintenance and repair activities performed during the warranty period. The log shall contain the time and date of the defect notification, the technician's report of the defect and any corrective actions taken.

645.08 Method of Measurement: Road Weather Information Station (RWIS) equipment will be measured for payment by the lump sum complete in place per site, satisfactorily installed, tested, operational, and accepted.

645.09 Basis of Payment: Road Weather Information Station (RWIS) equipment will be paid for at the contract lump sum price for each location. Such price will be full compensation for furnishing and installing all materials, including but not limited to the sensors; CCTV camera; RPU and enclosure cabinets with all internal hardware; solar power service connections; communication equipment; grounding; sawcutting pavement; integration and software modifications; system testing; warranties and guaranties; and all appurtenances and incidentals required for a complete and functional installation and for furnishing all assembly hardware, tools, labor, and testing necessary for completing the installation, excepting those items explicitly indicated to be work by others.

Payment will be made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
645.53 Road Weather Information Station: (NAME/LOCATION)	LS