30.3.1 Design Process

In the RWIS design process, the designer must follow several steps to ensure successful implementation and proper operational capabilities. Many of these steps, such as power and communication requirements, must be addressed early in the design process.

1. Collect initial data required for the proposed ESS location.
2. Determine the ESS sensors required for the design location.
3. Assign name to ESS tower for proper recording.
4. Determine the location of the ESS tower and meter service pedestal.
5. Prepare the infrastructure, including tower pad and underground cabling.
6. Perform cable routing to provide hardwire interconnection between the ESS processor and any road sensors.
7. Determine the communications medium used for the proposed location.
8. Revisit steps 3 through 6 until final design is complete.
9. Begin the process to establish electrical service for the proposed location with the local power company. This should be done early in the design process to establish an acceptable electrical service location.
10. Determine the construction details needed for the proposed design, details that need to be modified, and new details that need to be created to provide a complete construction plan.
11. Determine the special provisions needed for the proposed design, special provisions that need to be modified, and new special provisions that need to be created to provide a complete construction plan.
12. Determine the standard specification bid items and procurement items that will need to be included in the estimate and miscellaneous quantities to provide a complete construction plan.

30.3.2 ESS Equipment Placement

Placement of equipment for ESS involves the controller cabinet/tower, roadway sensors, underground infrastructure, and electrical service.

30.3.3 ESS Tower and Cabinet

ESS placement is based on the requirements documented under Section 30.1.3 of this chapter. Site surveys by the WisDOT RWIS Program Manager are required. Site placement should adhere as closely as possible to standards outlined in the FHWA Road Weather Information System Environmental Sensor Station Siting Guidelines.

- **Foliage** - Whenever possible, the site survey should be done while trees are in full foliage. If this is not done, it is possible that foliage can interfere with the proper operation of the ESS equipment.

- **Right-of-way** - The ESS will always be placed in the WisDOT right-of-way.

- **Maintenance** – The ESS requires ongoing maintenance. Placement should be such that a maintenance technician has easy access to the tower location. The tower is a 30-foot foldover tower, so the orientation of the tower with regards to the direction it will fold down is critical. Proper clearance must be accounted for.

- **Permanent Structures** – It is acceptable to install the ESS cabinet on existing structures (poles, sign bridges, buildings, etc.) when power is available and stand alone options are not available, keeping in mind ease of maintenance concerns.

The controller cabinet will be located on the ESS tower. The following items will be considered in placement of the tower:

- **Distance between the controller cabinet and the roadway sensors.**
- Distance between the tower and the electrical service pedestal.
- Off-freeway accessibility for maintenance vehicles whenever possible.
- Safety/security of the cabinet location. If heavy pedestrian/all-terrain vehicle/snowmobile traffic is anticipated in the vicinity of the tower, a fence might be required around the tower.
- Grades. The ESS tower requires an eight-foot by eight-foot concrete pad. Thus, if possible, the tower should be located where the grade is minimal. The slope of the terrain for tower placement must be no steeper than 5:1.

### 30.3.4 Roadway Sensor Placement

If it is determined that roadway sensors are required, the next step is to decide the specific locations for each sensor. An ESS processor can ingest up to six sensors. The following locations should be considered, in this priority order:

- Bridge deck slow lane (if applicable)
- Roadway slow lane
- Bridge deck fast lane (if applicable)
- Roadway fast lane

Sensors can be placed in either direction of travel, but maintenance is generally easier if they are located on the same side of the highway as the ESS tower. In addition, if the proposed location is at an intersection of two state trunk highways, sensors can be placed on both.

### 30.3.5 Underground Infrastructure

When the controller cabinet, electrical service and ESS tower site have been placed, the underground conduit infrastructure can be designed. Issues to keep in mind when designing the conduit infrastructure include:

- **Pull Boxes** – Pull boxes are sometimes required between the tower and the roadway sensors.
- **Terrain** - Conduit infrastructure should be designed on relatively flat (4:1 slope or flatter) terrain. For steeper sloped terrain (3:1 or greater), conduit may be run perpendicular to (i.e., up or down) the slope to locations where the terrain is more suitable for conduit installation.
- **Conduit Size** - 1-Inch PVC conduit is typically used for roadway sensor connection. Conduit entering electrical service pedestals must be sized per pedestal requirements.
- **Conduit Fill** - The size and number of conduits along a run is dependent on percentage of fill as established by the National Electric Code (NEC). For new conduit installation, the percent fill must not exceed 31%. For installation of cable in existing conduit, 40% of the available area may be used.
- **Conduit in ESS Tower Base** - Two 2-inch conduits, and one 1-inch conduit should be placed in the ESS tower’s concrete base. This will allow one conduit for electrical wire, one conduit for communication wire, and one conduit for coaxial cable (which is sensitive to electric-magnetic fields).

### 30.3.6 Cable Routing

Cable routing for ESS sites typically involves the connection of all roadway sensors, electrical, and communications services to the ESS cabinet on the tower. Other devices such as cameras or system detector stations (Chapters 10 and 15) may be added to an RWIS site, and require cable routing as described in their respective chapters. The power distribution cable running between the ESS controller cabinet and the electrical service should be in a separate conduit. Power and communication cables should not be mixed together.

### 30.3.7 Electrical service

The power distribution wires running between the electrical service and the controller cabinet consist of stranded copper single conductors, cross-linked polyethylene (XLP), USE rated. Section 655 of the standard specifications provides guidance on additional requirements. The bid items for “Electrical Wire Lighting (gauge #) AWG will meet the requirements. The gauge of conductors must be calculated per the requirements of the National Electric Code.

### 30.3.8 Electrical Wire Routing

The conduit system for ESS sites needs to be bonded together, due to the fact that power cables are running within the system. Bonding all metallic components of the system together assures that there will be no difference in voltage potential across two points in that system. In addition, grounded conductor needs to be run with current-carrying cables (such as traffic signal conductors, power distribution wires, etc.), which returns the circuit’s current at zero voltage. The bonding/grounding wires in system typically use Electrical Wire Traffic...
Signals 10 AWG (Item 655.0515) in the State’s Standard Specifications. The gauge of grounded conductor must be calculated per the requirements of the National Electric Code. There is a distinct method required for the bonding system. Examples of this method can be found in Chapters 2 and 3.

The pull boxes do not require grounding if the total voltage encountered in the pull box is 50 volts or less. In some Districts, a policy has been made to bond and ground all conduit systems, since equipment is frequently added to various locations in the future. For assistance in bonding and grounding of underground systems, consult the State Electrical Engineer.

30.3.9 Roadway/Bridge Deck Sensor Cabling

Roadway sensors are supplied with 150 or 300 feet of Type IIA cable. When possible, this cable will be run directly into the ESS cabinet. It will be installed in the road surface in a saw kerf ½ inch wide by 1½ inches deep. This kerf will then be filled with flexible sealant once the cable has been installed.

The cable will then be run through 1-inch conduit into the ESS cabinet. If a pull box is required to extend the cable length, the sensor cable will run into the pull box, then a Type V cable will connect to the ESS cabinet.

For bridge deck installation, coordination with the State Bridge Engineer is required in order to determine whether the sensor cable will run in a saw kerf to the side of the bridge or through a hole in the deck to conduit. Once the cable is run to the side of the bridge by one of these methods, it will run through 1-inch PVC conduit to the ESS cabinet.