CHAPTER 8 – STAKING

STAKING

Correct staking of traffic control signal or lighting systems is critical to the appropriate placement of system components.

8.1 Staking Traffic Control Signal Systems

Locating the components of a traffic control signal is not an exact science; many factors influence the location of the components. These factors include: lane widths, radii, pedestrian curb ramp requirements, Accessible Pedestrian Signals (APS) pushbutton location requirements, crosswalks, cracks, and joints in the pavement on existing roads and utilities below ground and overhead. It takes an experienced person approximately two to three hours to stake a signal.

Figure 8-1: Staking

8.1.1 PRIMARY CONSIDERATIONS

On most projects, personnel from a MnDOT district traffic office will determine, in the field, the exact locations of handholes, poles, loop detectors, and the equipment pad. However, it is the contractor's responsibility to know the roadway, sidewalk and final grade elevations for proper installation of foundation elevations.

The primary considerations in staking a traffic control signal are:

Lane Widths and Radii

All through lanes and turn lanes have to be measured prior to staking. On new construction, the lanes and the radii must be determined and laid out.

Location of Crosswalks and Pedestrian Ramps

Look at the plan and determine where the crosswalks and/or stop bars are located. Lay them out on the roadway. Many of the signal components are located relative to the crosswalks and stop bars. Keep in mind, median nose locations and existing sidewalks. The crosswalks and stop bars should be laid out parallel to the adjacent road and kept in a straight line from pedestrian ramp to pedestrian ramp. It is essential that they be established and tied in so that they can be relocated during all phases of construction.

Signal Poles

They are generally located on the back edge of the crosswalk or stop bar when possible. Check for utilities above and below ground. Ensure poles are staked in accordance with the X and Y control points provided in the plan.

Loop Detectors

They are located by measuring from the back edge of the crosswalk or stop bar.

Non-Intrusive Detection
They are located on luminaire extensions, span wire, and/or mast arms as determined by the engineer.

Handholes
They are located opposite the loop detectors. Intermediate handholes are located equal distance between the loop detector handholes or conduit crossing handholes. Handholes should only be placed in the sidewalk pedestrian access route (PAR) or maintenance access route (MAR) when no other options are available.

Conduit Crossings
They are located at specific handholes.

Signal Cabinet
Signal cabinet is located as shown on the plan and within the right-of-way.

Source of Power
The source of power supplying electricity to service equipment for the signal.

8.1.2 STAKING CROSSWALKS, STOP BARS & PEDESTRIAN RAMPS

Refer to the plan to layout the crosswalks and pedestrian curb ramps where they intersect the curb. These are preliminary locations that may need to be changed. The primary things to look for are: drainage structures in the pedestrian curb ramps and the ends of median noses on a divided roadway. Keep pedestrian crossings straight to the adjacent streets. Locating the pedestrian curb ramps shall be as indicated in the contract documents or as directed by the engineer.


Figure 8-2: Crosswalk

8.1.3 STAKING SIGNAL POLES

When staking signal poles, the following key points should be considered:

1. Length of the mast arm +2 feet (for staking measurement).
2. Type of pole foundation (A or B).
3. Actual lane widths.
4. Locations of overhead signal indications relative to lane markings and curbs.
5. The size of the concrete foundation and the height of poles.
6. The minimum required overhead clearance 17 to 19 feet and the horizontal distance of shaft mounted signal heads from the face of the curb or the edge of the road or shoulder.
7. Locations of pedestrian push buttons (on the roadway side of the pole). Verify exact locations with the engineer/inspector.

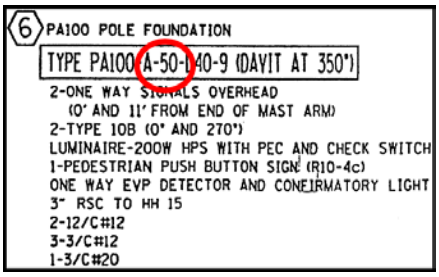

Figure 8-3: Mast Arm Length

8. Locations of crosswalks or stop bars.
9. Locations of new and existing utilities (overhead and below ground).

The length of each mast arm is listed in the pole notes on the intersection layout sheet of the plan. For example: PA100-A-50-D40-9. This means a 50-foot-long Type A arm installed at a right angle to the center line of the road.

Figure 8-4: Staking a Signal Pole

To stake the signal pole, check the plan to determine where the signal heads are to be located relative to lane lines. Place a paint mark on the pavement where the signal heads will be located. The mast arm with a signal indication installed on the end of the arm, adds approximately 15 inches to the length of the mast arm. From the pole end of the mast arm to the center of the pole shaft is approximately 6 – 8 inches. The combination of these two measurements adds an additional 2 feet of added length to the mast arm. For a 50-foot mast arm this gives an approximate length of 52 feet from center of the foundation to the center of the signal head at the end of the mast arm. Using the pole notes, determine the type of pole used (A or B). Type "A" is designed to be installed at 90 degrees to the road, Type "B" is designed to be installed at 45 degrees to the road. The two pole types are not interchangeable. From the paint on the pavement that represents the signal head at the end of the mast arm, construct a 52-foot offset line, parallel to the road that is near the location of the pole foundation.

Figure 8-5: Staking a Signal Pole

Depending on the type of bracketing, shaft mounted signal heads with visors can extend approximately 3-1/2 from the face of the pole. Add an additional 6 inches for half the diameter of the pole making the distance from the center of the pole to the end of the visors approximately 4 feet. The use of more than one head on one set of brackets (20 series) is not recommended. The MnMUTCD states the minimum allowed horizontal distance from the face of the curb or edge of shoulder to the signal head visors is 2 feet. This will place the center of the foundation at least 6 feet from the face of the curb or edge of the road. Stake the pole at the point of intersection of the 6-foot line and the 52-foot line. If the signal heads are side mounted with angle mount plumbizers, the pole can be moved closer to the edge of curb if necessary, but is not recommended.



Figure 8-6: Pedestrian Ramp Locations

Keep in mind the locations of new or existing sidewalks. The staking of pedestrian curb ramps and the placement and orientation of the pedestrian push buttons are critical. There are specific requirements in the contract documents for the installation of APS.

Figure 8-7: Required Curb Ramp Area

When approved by the engineer, move the pole location so that it lines up with the back of the crosswalk (or be as close to it as possible). Keep the 6-foot clearance and the 52-foot mast arm length in mind. According to the Americans Disability Act (ADA), pedestrian curb ramps must have a square flat area at least 4 feet by 4 feet at the end of the pedestrian curb ramp. In the example shown the APS button could not be mounted on the signal pole and the required pedestrian push button station was installed.

Figure 8-8: Check Utility Location

Check for utilities, above and below the ground. If a luminaire extension is to be installed on the pole, it will stand 40 feet above the top of the foundation. A minimum clearance from overhead wires must be maintained. The amount of clearance depends on the type of service; check with the power company. Keep in mind the underground utilities. Sewer lines can be very large and the pole foundation is required to be 12 feet or more below ground depending on the pole type. Adjust the location of the pole accordingly.

8.1.4 STAKING THE FRONT LOOPS AND CONDUIT CROSSINGS

After the crosswalks, stop-bars and poles have been located, look at the loop detector chart on the plan to get the location of the loops. The measurements given in the chart are the distances from the crosswalk (or stop bar to the front edge of the loop).

LOOP DETECTOR CHART

NUMBER	SIZE (FT)	LOCATION
D1-1, D5-1	6 X 6	40
D1-2, D5-2	6 X 6	10
D2-1, D2-2	6 X 6	475
D3-1, D7-1	2 - 6 X 6	20 & 50
D3-2, D7-2	2 - 6 X 6	5 & 35
D4-1, D8-1	6 X 6	180
D4-2, D8-2	6 X 6	180
D4-3, D8-3	6 X 6	5
D4-4, D8-1	2 – 6 X 6	5 & 20
D6-1, D6-2	6 X 6	475

ALL LOOP DETECTORS SHALL BE PVC UNLESS NOTED OTHERWISE
LOCATION: DISTANCE FROM CROSSWALK/STOP BAR IN FEET

Figure 8-9: Loop Detector Chart

8.1.5 LOCATING LOOP HANDHOLES

Place the handhole and conduit crossing at equal distance between the loops to balance the milling or saw-cuts to the loop lead-in conduit. This will prevent the placement of the conduit crossing under the loop detectors which could become damaged if the pavement cracks above the conduit crossing. In addition, it will allow room for re-cutting should that become necessary in the future. Avoid placing handholes in the PAR or MAR.

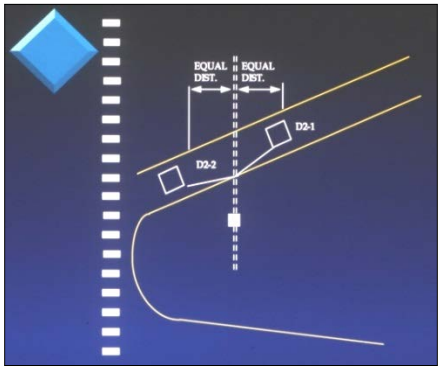

Figure 8-10: Locating Loop Handholes

8.1.6 STAKING THE BACK LOOPS AND HANDHOLES

Referring to the loop detector chart, determine the locations of the back loops. Measure the distance from the back edge of the stop bar or cross walk to the front edge of the loop detectors. Check the pavement condition and adjust the locations of the loops to avoid placing on paving joints or in cracks. The location of the back loops is not as critical as those near the crosswalk and they can be moved back and forth 5 to 10 feet without creating problems. Check with the district traffic office and note any changes on the plan.

8.1.7 STAKING THE INTERMEDIATE HANDHOLES

The intermediate handholes are located by spacing them evenly between the handhole of the back detectors and the handhole of the front detectors. The maximum distance between handholes must be less than 300 feet.

8.1.8 STAKING THE SIGNAL CABINET

When locating the signal cabinet, look for an area, within the right of way, where the cabinet will not be flooded, hit by a car going off the road or be plowed in during snow removal. Whenever possible, orient the door of the cabinet to allow workers to face traffic while working on the cabinet.

Figure 8-11: Signal Cabinet Staking

8.1.9 STAKING THE SERVICE POLE

Next, stake the service pole that provides the electric power to the traffic control signal. If the contractor is required to set a new pole, it should be located in an area that will not be flooded or be hit by traffic. It should be placed so that the conduit and handholes can be easily installed from the pole to the traffic control signal cabinet.

8.1.10 STAKING A TRAFFIC CONTROL SYSTEM ON A NEW ROADWAY

The preceding dealt with staking a traffic control signal system on an existing roadway. There are additional problems involved in staking a traffic control signal on a roadway that is under construction and they are as follows:

Figure 8-12: Signal Pole

- The characteristics of the new road are not fully developed and curbs have to be laid out before beginning to stake the signal components. It is essential to have the survey crew provide enough stakes to do this correctly. Conduit crossings have to be located and installed before the curb or pavement is placed (usually just before the gravel is placed).
- To properly locate the conduit crossings, crosswalks and loops must be located.
- In new construction areas, the curb and gutter should be installed before installing the new traffic control signal system components.
- Nearly all the components of the traffic control signal need to be located before the pavement is installed.
- Caution must be taken to avoid all structures and utilities above and below ground in the new roadway.

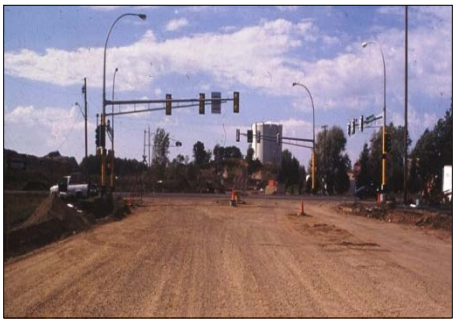

Figure 8-13: New Roadway Signal

8.1.11 FINAL CHECK

Make sure that the final locations of all the signal components are clear of all the new and existing utilities above and below ground and located within the right of way. Next, establish reference ties to the signal poles, pedestrian ramps, crosswalks and stop bars. This will ensure that they are built as staked. Detector locations, conduit crossings, and poles depend on the location of the crosswalks. They must be tied in, and/or marked, so that they can be re-established accurately.

The best way to ensure that the pedestrian ramps/crosswalks get located correctly, is to have them staked in the presence of the inspector for the curb and gutter construction and to consult with MnDOT Accessibility Office before any concrete is poured. Further information on accessibility can be found at the link below:

http://www.dot.state.mn.us/ada/index.html

8.2 Staking Roadway Lighting Systems

For conventional roadway lighting systems, there are typically three types of light poles that need to be properly staked:

1. 40-foot breakaway and non-breakaway barrier davit poles
2. 49-foot breakaway and non-breakaway barrier davit poles
3. High mast towers

8.2.1 40-FOOT BREAKAWAY AND NON-BREAKAWAY BARRIER DAVIT POLES

The 40-foot breakaway and barrier davit poles should be placed according to the assigned stationing in the light standards summary table shown on the plan. Poles are typically spaced approximately 250 feet apart which is primarily based on luminaire photometrics (visible light quantity and distribution).

- In addition to the spacing, breakaway poles will have a 19 - 23 foot set back, also called an offset measured from the right lane fog line (right edge of driving lane) as illustrated in the placement lighting unit detail shown on the plan.
- Barrier light poles should be spaced the same but will not have the 19 - 23-foot setback.

8.2.2 49-FOOT BREAKAWAY AND NON-BREAKAWAY BARRIER DAVIT POLES

49-foot breakaway and non-breakaway barrier davit poles should be placed according to the assigned stationing in the light standards summary table shown on the plan. Poles are typically spaced approximately 275 feet apart which is primarily based on lighting design calculations and luminaire type to meet the required lighting criteria.

- In addition to the spacing, breakaway poles will have a 22- 26 foot set back, also called an offset measured from the right lane fog line (right edge of driving lane) as illustrated in the placement of lighting unit type detail found on the plan.
- Barrier light poles should be spaced the same but will not have the 22-26 foot setback.

8.2.3 HIGH MAST LIGHT TOWERS

High mast lighting plans will have stationing and offset shown on the plans. High mast light tower locations should be staked by the survey crew and placed as shown on the plan.

8.2.4 LIGHT POLE LOCATIONS

The exact location of each light pole should be approved by the MnDOT district traffic office prior to any foundation excavation being started.

It is the contractor's responsibility to know final grade and sidewalk elevations to ensure pole foundations are installed at the correct elevations.

The Figure 8-14 graphics are taken from the Traffic Engineering Manual (TEM) and illustrate the guidelines for the placement of poles at common geometric situations based on luminaire photometrics.

Each plan will show stationing for each pole and offset distances. Pole placement should be uniform. Use the maximum offset distance whenever possible. If the minimum offset cannot be obtained contact the MnDOT district traffic office.

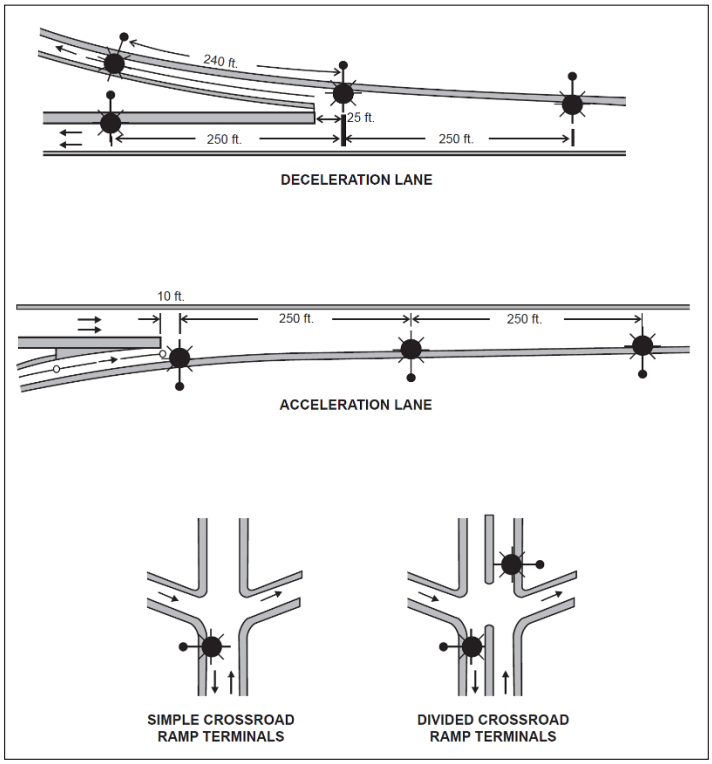

Figure 8-14: Typical Luminaire Locations Partial Interchange Lighting Davit Arm Poles (Assumes Luminaire Mounted at 40-Feet)

Ditches

If the stationing and offset distance calls for a light pole to be placed in the bottom of a ditch do not place the pole at that exact location. Move the pole closer to the driving lane while maintaining the minimum offset distance so the pole foundation is not placed in a ditch bottom (as pictured in Figure 8-15).

Figure 8-15: Light Pole in Ditch Location

Ponding or standing water in ditches can create situations where the lighting cable shorts out. This can force the circuit breaker to trip making all the luminaires on that specific cable run to go dark. It also creates an unsafe working condition.

Poles should be moved to the minimum offset if the maximum offset would put the pole in the bottom of the ditch.

Obstructions

The exact locations of light poles may be adjusted to avoid obstructions encountered in the field. Such items as solid rock, power lines, slopes, guardrail, etc., may make it necessary or desirable to locate the pole differently than is indicated in the plan.

Light pole locations can be moved 10 feet in either direction parallel to the roadway if there is an obstruction. If more than 10 feet is required, the project engineer should consult with the respective district traffic office to determine if such a change requires changing the placement of other light poles in the system. Moving light pole locations should only be done when absolutely necessary as it does affect light pole spacing which in turn impacts the light levels on the roadway.

Guardrail and Noise Wall

The plan contains details showing the placement of light poles from the edge of the traveled roadway. If a guardrail or noise wall exists at the location and is not indicated in the plans, light poles should be placed behind it if possible. Access to the pole base must not be obstructed.

In MnDOT's Road Design Manual 10-7.02.01 deflection for guardrail design B W- Beam Guardrail has a deflection of 3 feet. Clearance between the back of the guardrail and the front of the light poles should be at least 4 feet to allow the guardrail to properly deflect on impact.

Power Lines

Poles should not be closer than 20 feet in any direction from power lines. If 20 feet cannot be maintained, contact the electric utility or the respective MnDOT district traffic office.

8.3 Chapter 8 Resources

- MnDOT Accessibility Policy
  http://www.dot.state.mn.us/ada/index.html
- Traffic Engineering Manual (TEM)
- Signal Design Manual
- Lighting Design Manual

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