1.0 General Policy

All driveways (a/k/a "connections") on the STH system shall adhere to the statutory design requirements listed in Wis. Admin. Code § Trans 231. Under Trans 231.01(5), only the Secretary of Transportation may approve exceptions to these requirements. Also see HMM 09-10-20, 3.0, 7d. In addition to the statutory requirements, this section provides guidance on many design elements not found in Trans 231 and has been developed from the following sources:

- Access *Management Manual*, 2nd Edition, Transportation Research Board
- *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway Transportation Officials ("Green Book")
- *Facilities Development Manual*, WisDOT ("FDM")
- *Construction and Materials Manual*, WisDOT ("CMM")

Document STH connection design information on form DT1247 *STH Connection Site Design Checklist* and/or any additional plans or sketches as needed and include it with the permit.

2.0 Connection Design Elements – Local and Private Roads

Use the intersection design guidance in FDM 11-25-1 on STH connections for local roads, or for private roads and driveways serving multiple properties that act as local roads. Private roads and driveways serving multiple properties shall, as a minimum, conform to Town road standards as listed in Wis. Stat. § 82.50.

3.0 Connection Design Elements – General

In addition to statutory design requirements and those noted in section 2.0, review the design elements listed in this section as appropriate for each STH connection permit application.

3.1 Intersection Sight Distance / Vision Corners

Use FDM 11-10-5.1 when evaluating STH connections for intersection sight distance (ISD) and vision corner requirements (Figure 1). Use Table 5.2 for ISD criteria with various intersection control cases. Refer to HMM 09-10-20, 3.0, (7b-c-d) for help with assessing whether the proposed (measured) ISD is an acceptable safety risk.

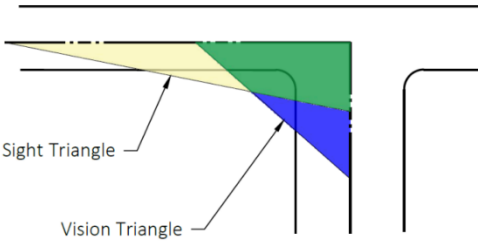


Figure 1: Intersection sight distance

3.2 Spacing

Use FDM 11-5-5.3 when evaluating STH connections for spacing requirements. Additional guidance from TRB's Access Management Manual may also be used if needed. For example, when evaluating spacing and attempting to provide ISD for connections, spacing may be affected by overlapping right-turn maneuvers as shown in Figure 2. Spacing may also be a concern if it could affect ISD as shown in Figure 3.

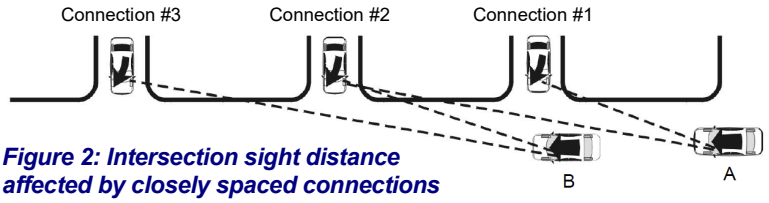


Figure 2: Intersection sight distance affected by closely spaced connections

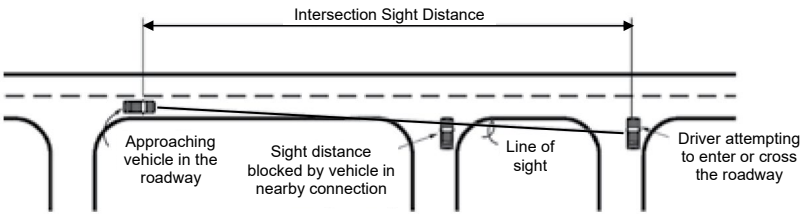


Figure 3: Intersection sight distance affected by line of sight

4.0 Configuration

Some connections may need highway modifications in the form of separate left and/or right turn lanes, a left turn bypass lane, raised medians or median openings, islands, etc., to provide for the safe and efficient movement of traffic on the STH and the connection. These modifications are based on many factors, but primarily connection AADT and its use. If a traffic impact analysis is involved, these modifications are identified in the document. Use Trans 231, FDM 11-25-48, and the table below to aid with determining an appropriate connection configuration:

CONNECTION CONFIGURATION GUIDELINES		
Connection AADT	**Typical Uses**	**Recommendation**
>1000	▪ Large commercial or industrial	**Rural**: Type A intersection*; evaluate for left turn lane or left turn lane bypass **Urban**: Design as intersection
100 - 1000	▪ Medium commercial or industrial ▪ Multiple residential (>10 dwelling units)	**Rural**: Type B intersection*; evaluate for left turn lane or left turn lane bypass **Urban**: Design as intersection
26 - 99	▪ Small commercial or industrial ▪ Multiple residential (5-10 dwelling units)	**Rural**: Type C or D intersection*, or 35' wide max with 40' max radius **Urban:** Use Trans 231.06
1 - 25	▪ Residential units ▪ Shared residential (1-4 dwelling units)	**Rural:** Use Trans 231.05 **Urban:** Use Trans 231.07
<10 trips (Intermittent)	▪ Agricultural ▪ Hunting land ▪ Field entrance ▪ Recreational use	Use Trans 231.05
Non-automobile	▪ Bicycle trail ▪ ATV trail ▪ Snowmobile trail ▪ Pedestrian trail	Construction varies. May be limited to non-automobile and/or non-motorized traffic

* Exceeds Trans 231 requirements. Intersection design is in FDM 11-25-1. See SDD 9A1-a and b for design details

5.0 Grades and Profiles

The change in grade between a highway cross-slope and a connection apron slope is important for achieving a smooth transition. An abrupt change in grade will likely cause a vehicle bumper to drag on the highway and/or connection surface. Drivers may then make a connection turn at a wide angle instead of a sharp one, which may slow down highway traffic. Vertical curves are also used to provide a smoother transition between changes in grade on the connection profile.

FDM 11-25-48, Attachment 48.1 (cases 1-4) provides guidance on profiles for urban connections including maximum grades and maximum break-over angles. Where a sidewalk crosses a connection, the sidewalk cross-slope shall be 2%. The low point of the profile for many urban residential connections will be at the gutter line of the street. However, the low point for urban connection profiles can vary depending on stormwater management for the property. FDM 11-25-48, Attachment 48.1 (cases 5-7) provides guidance on profiles for rural connections including maximum grades. The low point for rural connection profiles is generally over the roadside ditch.

6.0 Foreslopes

Connection embankment slopes may be impacted at right angles by errant vehicles leaving the highway. Flatter slopes are desirable at these locations because steeper slopes may cause a vehicle's bumper to dig in or cause a vehicle to vault.

In FDM 11-15-1, a foreslope of 6:1 or flatter shall be provided on connections within the clear zone[1] of highways with AADT of 3,500 or more, and is recommended for all connections regardless of AADT. For highways with an AADT less than 3,500, the maximum connection foreslope that may be allowed in the clear zone is 4:1. Outside the clear zone, the steepest foreslope shall be 2½:1. Culvert end treatments, which have similar clear zone requirements, are detailed in 8.5. Foreslopes are also categorized by posted highway speed. See SDD 09A14.

[1] See FDM 11-15-1.10 for a detailed explanation of clear zone.

7.0 Throat Width, Driveway (Connection) Return Radius, and Throat Length

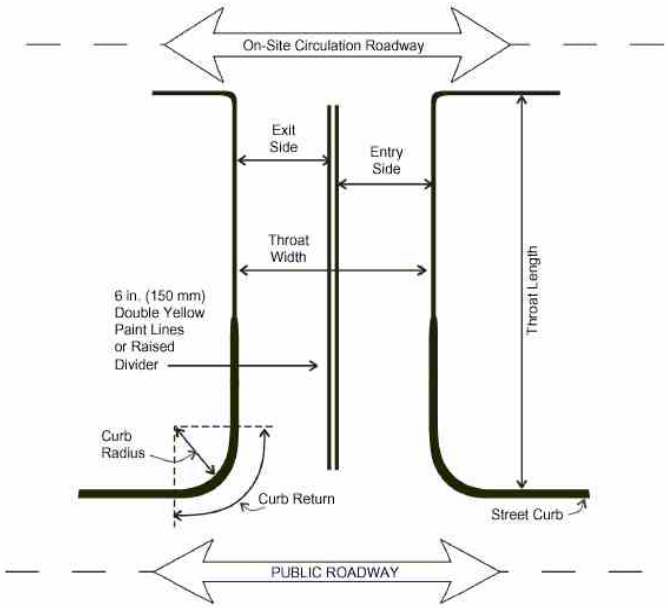
Throat width (Figure 4) is the edge-to-edge distance of a connection measured at the right-of-way line.[2] The maximum width of any commercial connection is limited to 35 feet under Trans 231. The width of residential connections is limited to between 16 and 24 feet. The maximum width requirements may be exceeded in special cases, for example, to accommodate multiple bays for a fire station. But only the Secretary of Transportation may approve these design exceptions.

A connection return radius is a circular pavement transition at the entrance of a connection that facilitates turning movements.[3] All connections shall have sufficient radii to allow vehicles to safely make turns when entering and exiting a STH. The maximum radius allowed for most connections is 40 feet. In Trans 231.06(2), Commercial – Urban, "the return radii shall be determined by [WisDOT] basing its decision on the type of traffic and the restrictions given in subs. (1) and (4). In all cases, the entire flare shall fall within the right-of-way."

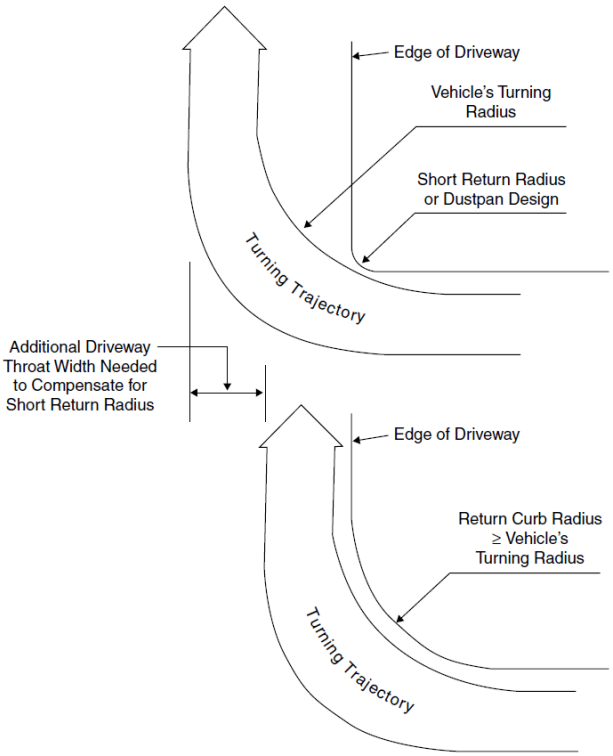
Throat width and connection return radii are interdependent, for example, a longer radius permits the use of a narrower throat.[4] If a radius is less than the minimum inside turning radius of a vehicle, then drivers are displaced to the left in the connection throat when completing the entry maneuver (Figure 5).

Throat length is the distance parallel to the centerline of a connection to the first on-site location at which a driver can make a right or left turn. It is measured on highways with curb and gutter from the face of the curb, and on highways without curb and gutter from the edge of the shoulder.[5] The throat length for any connection must be sufficient to prevent traffic from backing up onto a STH. Guidelines for throat lengths can be found in the *TRB Access Management Manual*, pages 181-186.

[6] ***Figure 4: Driveway elements***



[7] ***Figure 5: Effect of curb return radius on driveway entry maneuver***



[2] TRB Access Management Manual, 2nd Edition, Glossary, page 528
[3] TRB Access Management Manual, 2nd Edition, Glossary, page 524
[4] TRB Access Management Manual, 2nd Edition, pages 310-312
[5] TRB Access Management Manual, 2nd Edition, Glossary, page 528
[6] TRB Access Management Manual, 2nd Edition, Exhibit 13-23, page 308
[7] TRB Access Management Manual, 2nd Edition, Exhibit 13-25, page 310

8.0 Drainage

To maintain highway safety and operability, a STH connection may not block or impair right-of-way (ROW) drainage, which includes the highway ditches and roadside areas. Culvert pipes (culverts), where necessary, shall be adequate for surface water drainage along the ROW. Specific guidelines regarding culverts for STH connections are listed below. Consult the Bureau of Structures if a box culvert is required for a connection.

8.1 Culvert Size

A hydraulic (drainage) study shall be done to properly size the culvert opening for all connections, unless WisDOT determines that the opening can be sized by matching the opening of an upstream culvert. This assumes no additional water is being placed in STH ditches and that upstream and downstream culverts are functioning properly. Hydraulic design of culverts is in FDM 13-15-10. A 25-year storm frequency shall be used as a minimum for a side pipe (connection) culvert design.

The minimum culvert size that should be allowed is 18” in diameter. This is slightly larger than the 15” diameter allowed in Trans 231.03(5) because the smaller pipe size tends to become clogged easier and frequently creates maintenance problems. A culvert is not required when the STH connection is at the high point of a roadside ditch profile. A culvert may not be required in cases where ditch grades are nearly flat, and drainage is allowed to occur naturally through the soil.

8.2 Culvert Material

Culvert types that may be used under a connection include reinforced concrete (recommended for heavy truck traffic), corrugated steel, and corrugated aluminum. Plastic pipes, polyethylene (AASHTO M294-black) and polypropylene (AASHTO M330 – grey) are also allowed with polypropylene being a little stronger. See SS 530. Reinforced concrete box culverts may also be used if necessary. More information on culvert pipe selection is in FDM 13-1-15. All culverts shall be from a WisDOT-approved manufacturer.

8.3 Culvert Length

The length of a culvert will vary depending on the connection width, side slopes and ditch depth. WisDOT staff shall either check the applicant’s calculation or perform one for the applicant to ensure that a proper length will be installed. Use the minimum length of pipe necessary to span a connection plus allow for appropriate endwalls since a longer pipe may get clogged easier and frequently creates maintenance problems. In addition, the flattened area adjacent to the connection invites the possibility for illegal use.

8.4 Culvert Placement

Culvert pipes shall be placed as far from the main roadway as possible while still following the flow line of the roadside ditch. Significant earthwork for the placement of connection culvert pipes should be avoided. However, if earthwork is needed that modifies the cross section of the main roadway, then that earthwork shall conform to applicable WisDOT design and construction standards.

8.5 Culvert End Treatments

Culvert end treatments include apron endwalls and safety crossbars. All culverts shall have apron endwalls. Vertical endwalls are not allowed for safety reasons. Safety crossbars are required on all apron endwalls larger than 24” in diameter within the clear zone. Use the table to determine apron endwall slope.

Annual Average Daily Traffic	**Steepest Apron Endwall Slope**	
	Within Clear Zone	Outside Clear Zone
0 - 3500	6:1 *recommended* 4:1 acceptable	2½:1
3500 or more	6:1	2½:1

Endwalls shall conform to the applicable WisDOT Standard Detail Drawing from FDM Chapter 16:

- 8F1: Apron Endwalls for Culvert Pipe
- 8F2: Apron Endwalls for Pipe Arch and Elliptical Pipe

- 8F7: Steel Apron Endwalls for Culvert Pipe and Pipe Arch Sloped Side Drains

8.6 Handling Drainage Problems

Property owners, municipalities, etc. [(collectively: responsible parties (RPs)] are required to maintain their STH connections, which includes preventing the blockage or impairment of ROW drainage. It also includes periodic inspections. A connection's culvert and end section must be clear and undamaged to optimize its capacity. Connections without culverts must not cause ponding in ROW ditches. If drainage issues occur, direct an RP to fix the culvert, line the culvert, or install a new (or gently used) culvert, and/or repair or replace culvert end sections. If the connection:

1. Has an existing valid permit, amend it, or reissue it and void and supersede the old one.
2. Is unpermitted and cannot be legally permitted, issue a DT1504 work permit and document on a ROUNC.
3. Is illegal, first determine if the connection can remain. If no, remove the connection if the property has alternative access. If yes, then issue a permit or ROUNC along with addressing the drainage issue.

WisDOT may require the connection RP to correct drainage problems at their own expense. WisDOT should also do periodic inspections for connection drainage issues during normal surveillance activities.

8.7 Minimum Distance Between Connection Culverts and Cross-Highway Culverts

No minimum distance is required between a connection culvert and a cross-highway culvert, but ensure that:

- Proper culvert end sections/grates are installed so errant vehicles will traverse over them.
- Proper grading is done around both end sections. FDM 11-45 Attachment 30.10 shows the connection culvert in relation to the fill slope and traveled way. Guardrail may be needed to protect both culvert ends if fill slopes are too steep.
- Drainage is not impeded or misdirected. Water should not run past the cross-culvert or form a pool.

9.0 Surface Material

Most connections are constructed with a surface material of asphalt, concrete, gravel, or earth. If paved, the connection surface within the STH shoulder boundaries should be the same surface as the STH's paved shoulder (if present) or the pavement (if there are no paved shoulders). A property owner may use any surface material up to the gravel shoulder edge (figure 30-3).

WisDOT is obligated to replace the materials in kind when reconstructing a connection within the ROW during an improvement project under FDM 11-15-1.15. When a property owner requests to construct a specialized or ornate connection surface such as brick paving – one that typically costs more than what WisDOT would spend to restore a typical asphalt or concrete surface – include a special provision in a permit that requires the owner to pay the cost differential between the typical and specialized surfaces each time WisDOT must reconstruct the connection or a portion thereof for an improvement project.

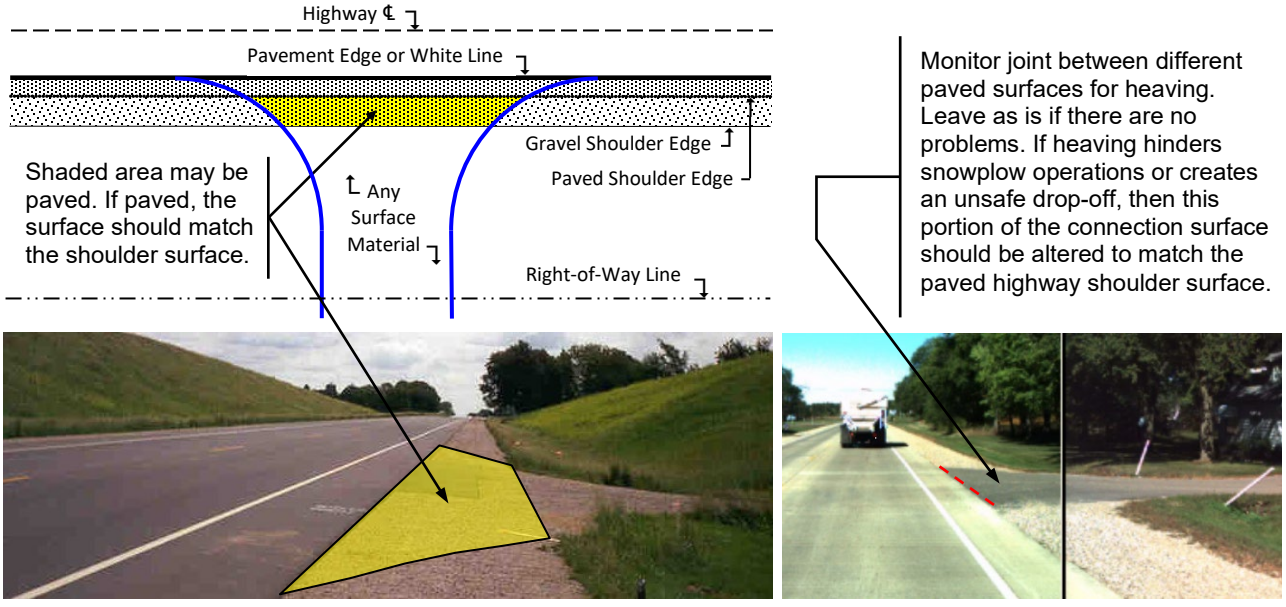


Figure 4: Rural connection surface pavement detail

10.0 Traffic Signals

In most cases, connections will not be signalized. Those connection applications requesting traffic signals must meet required traffic warrants. The regional traffic engineer determines if the applicant's request for signals is merited. If signals are warranted, the regional traffic engineer also determines the necessary design, timing, and configuration of the signals. TEOpS Manual 4-2-1

11.0 Traffic Control Devices

Traffic control devices such as STOP and YIELD signs are not WisDOT's responsibility. Property owners who desire to install such signs may do so on their own property and at their own expense. Under § 346.18(4), drivers must yield before entering a highway when coming from an alley, driveway, or private road.

12.0 Design Restrictions

Restrict the design of a connection as needed to protect and preserve STH safety and operability. Include the restrictions with a STH connection permit in the form of conditions, supplemental provisions, etc. A list of these conditions is in 09-10-25, 2.0. In addition to these restrictions, WisDOT does not allow the following:

- Unique, non-standard, or homemade signs (photos below). While sometimes used on local roads at a maintaining authority's discretion, they are not appropriate for STHs. In section 2C.16 of the Wisconsin Manual of Uniform Traffic Control Devices, a "Hill Blocks View" sign may be used when there is limited stopping sight distance. TEOpS 2-3-14 provides additional guidance on when the sign may be used.

- Speed zone reductions, which are based solely on a particular STH connection or spot location. Speed limits are typically established with an engineering speed study. Speed advisory plaques, however, may be appropriate in certain situations.
- Any special device (e.g., mirrors, television cameras, pavement sensors, etc.) that is intended to assist or substitute for normal viewing of oncoming vehicles while entering or exiting from a STH connection.