Nebraska Department of Transportation (NDOT)

Roadway Design Division – Policy Letter

Policy Number: **DES 23–01**

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This policy affects the **NDOT** Roadway Design Manual; Chapter Four: Intersections, Driveways and Channelization, Section 1

Reduced Conflict Intersections

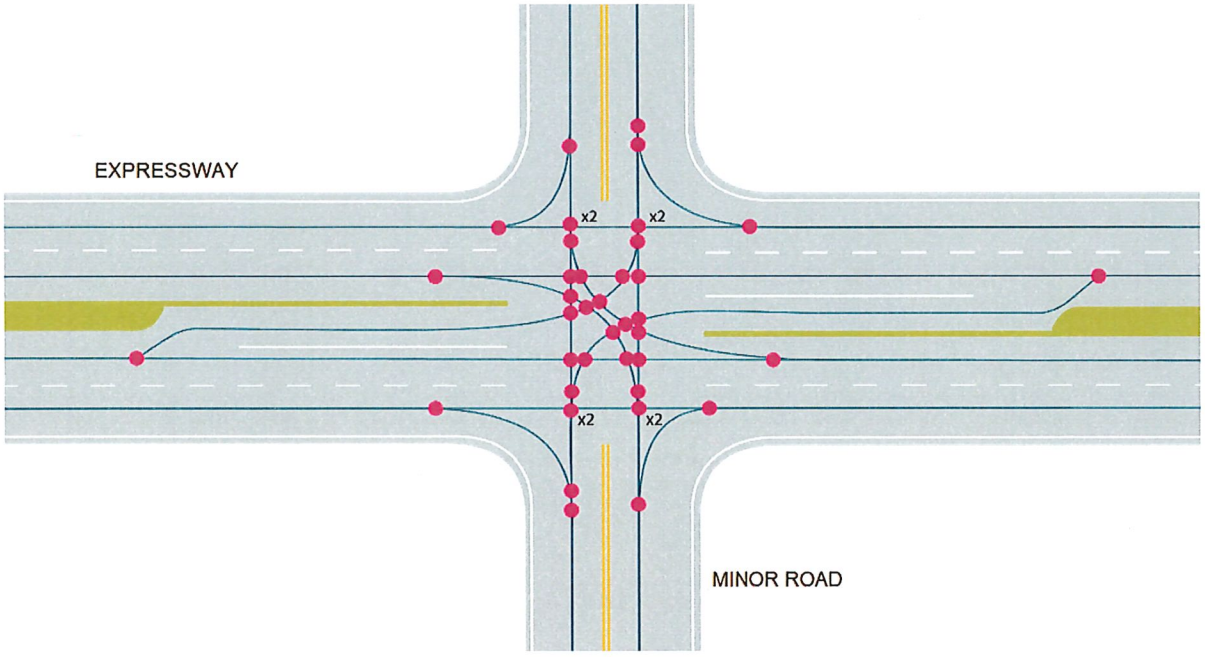
Purpose

Reduced Conflict Intersections (RCIs) reduce the frequency of higher severity crash types at the intersection of a divided highway and a lower volume roadway. This purpose of this policy is to provide guidance in the design of RCIs.

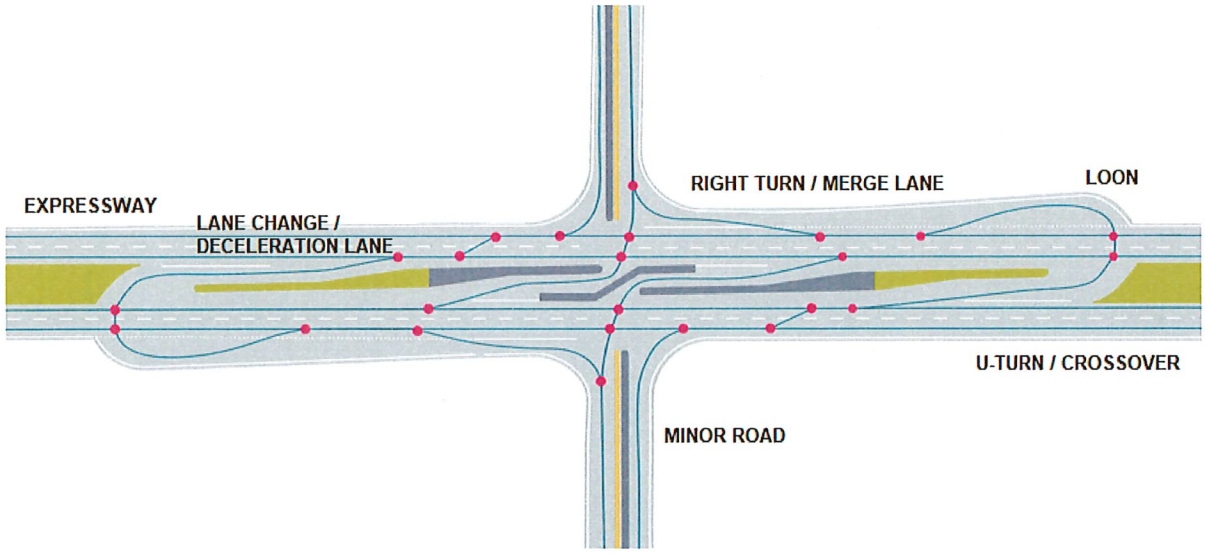
Sent to: NDOT Roadway Design, NDOT "Distribution B", and selected consultants.

Policy:

Reduced Conflict Intersections (RCIs) (also known as Restricted Crossing U-Turns (RCUT) or J-Turns) are typically used by **NDOT** at the intersection of a rural four-lane divided expressway or State Highway (major road) and a lower volume minor road as a means to reduce the frequency of higher severity crashes compared to a conventional intersection (See **EXHIBIT 1**).



Traditional Intersection = 42 Points of Conflict



RCI = 24 Points of Conflict

Exhibit 1 Typical Reduced Conflict Intersection

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RCIs eliminate left-turns and through movements from the minor road. Drivers intending to perform these maneuvers are first required to make a right turn onto the expressway and then make a U-turn maneuver at a median opening downstream of the intersection. All movements (left-turns, right-turns, and through) remain available to traffic on the expressway at the intersection (See **EXHIBITS 1 & 2**).

For additional information see Section 9.9.4, "Wide Medians with U-Turn Crossover Roadways" and Section 9.9.5, "Location and Design of U-Turn Median Openings", in Chapter 9 of A Policy on Geometric Design of Highways and Streets (*Green Book*). Additional guidance available to the designer includes:

- **FHWA** publication Alternative Intersections/Interchanges: Informational Report (AIIR) (https://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf)
- **FHWA** publication Restricted Crossing U-Turn Intersection (https://safety.fhwa.dot.gov/intersection/rltci/fhwasa14070.pdf),
- Chapter Nine of the North Carolina Roadway Design Manual (https://connect.ncdot.gov/projects/Roadway/Pages/Roadway-Design-Manual.aspx),
- Minnesota DOT publication Best Practices for the Design and Operation of Reduced Conflict Intersections (https://www.dot.state.mn.us/roadwork/rci/docs/bestpracticesfordesignandoperations.pdf).

The design of a retrofit RCI is dependent on the geometrics of the existing roadways and on the site conditions; there is no one size fits all solution. The designer will coordinate the design with **Traffic Engineering**. General **NDOT** design guidance for a RCI installation includes:

Expressway or Four-Lane State Highway

- **Design Vehicle:** The WB-67 is the design vehicle for the intersection of all expressways & major arterials.
- **Design Speed:** 70 mph
- **Shoulder Improvements:** The existing outside shoulder may be removed from the end of the Loon (the bulb opposite the median U-Turn provided for the design vehicle turn movement, see **EXHIBIT 1**) to the intersection with the minor road. The shoulder will be replaced from the end of the Loon to the intersection with a right-turn / merging lane, 12 feet wide with a two-foot right surfaced shoulder with full depth surfacing.
- **Right Turns from Expressway to Minor Road:** (See **EXHIBIT 1** and Chapter Four: Intersections, Driveways and Channelization, Section 1.D.3 of the Roadway Design Manual *RDM*)
  - Existing parallel turn lanes may be retained, if approved by **Traffic Engineering** and/or there are right-of-way constrictions or environmental concerns. New right turn lanes should be designed as tapered offset (See **EXHIBIT 4.14** of the *RDM*).
- **Left Turn Lanes from Expressway to Minor Road:** (See **EXHIBIT 2** and Chapter Four: Intersections, Driveways and Channelization, Section 1.D of the *RDM*)
  - Design Speed: 15-20 mph
  - Cross-Section: 12 feet wide with a four-foot integral left shoulder until the raised median, see below (dependent on median width and type)
  - The median should be raised at the intersection with a minimum width of four-foot
  - Intersection Sight Distance: (See Case F, **EXHIBIT 2c**)
  - Lane Change & Deceleration Lane Length: (See **EXHIBIT 4.26** of the *RDM*)
  - Taper Rate from Expressway: 15:1 (See Chapter Four: Intersections, Driveways and Channelization, Section 1.D.2 of the *RDM*)
  - Storage Lane Length: Coordinate with **Traffic Engineering** (100 foot minimum, see Chapter Four: Intersections, Driveways and Channelization, Section 1.D.1 of the *RDM*)

Right Turns from the Minor Road

- See **EXHIBIT 2** and Chapter Four: Intersections, Driveways and Channelization, Section 1.D of the *RDM*
  - Number of Turn Lanes: One (based on low traffic volumes).
  - Angle of Approach: 90 degrees to the expressway (possibly a slight right-hand skew of the turn lane, coordinate with **Traffic Engineering**)
  - Intersection Sight Distance: (See Case B-2, **EXHIBIT 2b**)

Median U-Turns/ Crossover

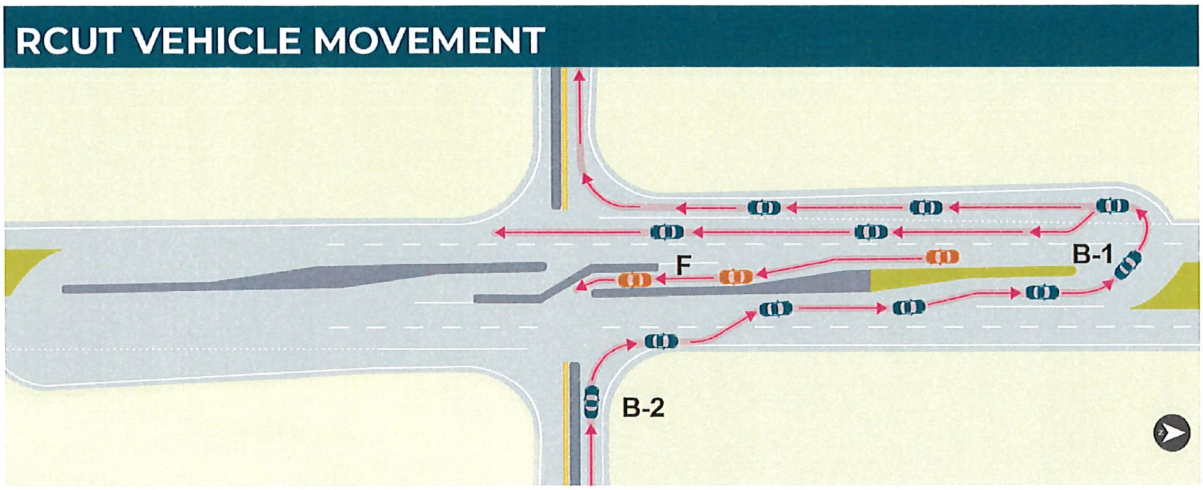
- **Design Speed:**
  - Approach to U-Turn: 9 to 14 mph
  - U-Turn: 10 mph
- **Crossover Spacing:** 600 to 1,000 feet from intersection to the U-turn, see **EXHIBIT 1** (design of the turn lanes may dictate the overall spacing)
- **Total Length:** Depends on the crossover spacing (from crossover to crossover)
- **Median Width:**
  - Desirable: 54 feet
  - Minimum: Existing (a narrow median impacts the turn speed, U-turn opening, and Loon dimensions)
- **Lane Change & Deceleration Lane** (See **EXHIBIT 1**):
  - Beginning Location: Coordinate with **Traffic Engineering** (tied to weaving analysis)
  - Taper Rate from Expressway: 15:1 (See Chapter Four: Intersections, Driveways and Channelization, Section 1.D.2 of the *RDM*)
  - Length: See **EXHIBIT 4.26** of the *RDM*
  - Cross-Section: 12 feet wide with a four-foot integral left shoulder past the raised median, if present, see Channelization below (dependent on median width and type)
- **Storage Lane:**
  - Length: Coordinate with **Traffic Engineering** (100 foot minimum, see Chapter Four: Intersections, Driveways and Channelization, Section 1.D.1 of the *RDM*)
  - Cross-Section: 12 feet wide with a four-foot integral left shoulder (dependent on median width and type)
- **Median U-Turn, Left-Turn to State Highway:**
  - Intersection Sight Distance: See Case B-1, **EXHIBIT 2a**
  - Geometrics (width and radius): Based on turn radius of a WB-67 (angle of U-Turn at 90 degrees to expressway)
- **Width:** Based on turn radius of a WB-67
- **Loon** (See **EXHIBIT 1**):
  - Geometrics (width and radius): Based on turn radius of a WB-67, construction of the Loon may require additional right-of-way.
  - The Loon includes a two-foot outside shoulder.

Channelization

- **Left Turns from Expressway at Minor Road Intersection:**
  - Raised islands a minimum four-foot wide
- **Right Turns from Minor Road:**
  - Need: based on volumes, crash history (Coordinate with **Traffic Engineering**)
  - If needed: Raised median and/ or islands, a minimum four-foot wide
- **Curbs:** Appropriate to the design speed (see Chapter Six: The Typical Roadway Cross-Section, Section 3.B, of the *RDM*)
- **Curb Clearance:** A three-foot minimum clear distance will be maintained between the outside tire edge of the design vehicle wheel path and the back of the outer curb

Additional Design Considerations

- **Grades:** Grading impacts sight distance; if grading is impractical, signage may be required (Coordinate with **Traffic Engineering**)
- **Environmental Impacts**
- **Right-of-Way**
- **Access Control:** Expressways should have existing Access Control within the project limits
- **Utilities**
- **Drainage:** Maintain existing patterns and ditch width(s), may need to include inlets where they currently don't exist
- **Lighting:** Typically, from Loon to Loon; coordinate with the **Lighting Unit** in **Roadway Design**
- **Signing / Pavement Markings / Candlestick Delineators:** Coordinate with **Traffic Engineering**
- **ADA/ Pedestrian Crossings:** Not likely but possible at Suburban/ Rural Town (see Chapter Sixteen: Pedestrian and Bicycle Facilities, Section 6, of the *RDM*)
- **Bicycles:** Not likely but possible if on bike route and/ or at Suburban/ Rural Town (see Chapter Sixteen: Pedestrian and Bicycle Facilities, Section 3, of the *RDM*)
- **Design Vehicles:** Farm equipment can navigate the intersection via the Loon, emergency vehicles typically experience no additional time in traversing the intersection



Intersection Sight Distance Left Turn from Stop on the Minor Road Case B-1, *Green Book*, page 9-43			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck** ②	**Passenger Car** ③
55 mph	990 feet	825 feet	650 feet
60 mph	1075 feet	900 feet	705 feet
65 mph	1165 feet	975 feet	765 feet
70 mph	1255 feet	1050 feet	825 feet
75 mph	1345 feet	1125 feet	880 feet

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

$ISD = 1.47\ V_{MAJOR}\ t_g$

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

Assumption: Turning vehicle is crossing two lanes of traffic to enter Loon

① t_g = 12.2 sec (11.5 sec + 0.7 sec for additional lane, *Green Book* **Table 9-6**, page 9-44)

② t_g = 10.2 sec (9.5 sec + 0.7 sec for additional lane, *Green Book* **Table 9-6**, page 9-44)

③ t_g = 8.0 sec (7.5 sec + 0.5 sec for additional lane, *Green Book* **Table 9-6**, page 9-44)

Note: "Furthermore, a departure sight triangle for left turns from the median roadway should be provided for the largest design vehicle that can be stored on the median roadway with adequate clearance to the through lanes." *Green Book*, page 9-47

Exhibit 2a Intersection Sight Distances for a RCI
Case B-1, Left Turn from Stop on the Median to the Loon

Sent to: NDOT Roadway Design, NDOT "Distribution B", and selected consultants.

Intersection Sight Distance Right Turn from Stop on the Minor Roadway Case B-2, *Green Book*, page 9-47			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck** ②	**Passenger Car** ③
55 mph	850 feet	690 feet	525 feet
60 mph	925 feet	750 feet	575 feet
65 mph	1005 feet	815 feet	645 feet (SSD)
70 mph	1080 feet	875 feet	730 feet (SSD)
75 mph	1160 feet	940 feet	820 feet (SSD)

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

ISD = 1.47 V_{MAJOR} t_g

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

SSD = Stopping Sight Distance (*Green Book* **Table 9-9**, page 9-48). SSD will be used as the minimum condition when it exceeds the computed ISD.

① t_g = 10.5 sec (*Green Book* **Table 9-8**, page 9-47)
② t_g = 8.5 sec (*Green Book* **Table 9-8**, page 9-47)
③ t_g = 6.5 sec (*Green Book* **Table 9-8**, page 9-47)

Exhibit 2b Intersection Sight Distances for a RCI
Case B-2, Right Turn from Stop on Minor Road

Intersection Sight Distance Left Turn from the Major Road Case F, *Green Book*, page 9-56			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck** ②	**Passenger Car** ③
55 mph	625 feet	540 feet	495 feet (SSD)
60 mph	680 feet	590 feet	570 feet (SSD)
65 mph	735 feet	645 feet (SSD for car)	645 feet (SSD)
70 mph	790 feet	730 feet (SSD for car)	730 feet (SSD)
75 mph	850 feet	820 feet (SSD for car)	820 feet (SSD)

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

ISD = 1.47 V_{MAJOR} t_g

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

SSD = Stopping Sight Distance (*Green Book* **Table 9-17**, page 9-57). SSD will be used as the minimum condition when it exceeds the computed ISD.

Assumption: Turning vehicle is crossing an additional four-foot median (.3333 equivalent lane)

① t_g = 7.7 sec (7.5 sec + 0.2 sec for equivalent lane, *Green Book* **Table 9-16**, page 9-57)
② t_g = 6.7 sec (6.5 sec + 0.2 sec for equivalent lane, *Green Book* **Table 9-16**, page 9-57)
③ t_g = 5.7 sec (5.5 sec + 0.2 sec for equivalent lane, *Green Book* **Table 9-16**, page 9-57)

Note: "Sight distance design should be based on a left turn by a stopped vehicle, since a vehicle that turns left without stopping would need less sight distance." *Green Book*, page 9-56

Exhibit 2c Intersection Sight Distances for a RCI
Case F, Left Turn from Expressway

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