

City of West Lafayette

River Road

Traffic Reports

River Road Speed Report

Purpose of Study

The sight distances of N River Road from both Catherwood Drive and Happy Hollow Road have been brought up as a concern. The purpose of this study is to evaluate whether the speed limit on N River Road in this area should be lowered.

Speed Study

The Indiana Department of Transportation, INDOT, has performed two speed studies on River Road in 2015. One was near the south entrance to Mascouten Park while the other was on the highway signs south of Happy Hollow Road.

Table 1: Speed Study Findings

N River Road	85th Percentile Speed (MPH)
Point A Park Entrance	44
Point B Signs	44

The 85th percentile speed and below covers 85% of drivers on the road. This is common metric used by all levels of government in order to determine speed limits. This is also used in road design.

Accident Reports

The West Lafayette Police Department compiled all of the crash reports from the past 5 years at the two intersections in question.

Observations

Due to the curvature of the road and the obstructions along the roadside, the sight distances are restricted. Either the speed limit needs to be reduced, the obstructions need to be removed, or some combination of the two.

Table 2: Speed Limits

N River Road	Existing Speed Limit (MPH)		Proposed Speed Limit (MPH)	
	Northbound	Southbound	Northbound	Southbound
Point A Park Entrance	40	40	30	30
Point B Signs	40	40	30	30



Figure 1: Location of Speed Studies Conducted by INDOT.

N River Road (Intersections with Happy Hollow Road and Catherwood Drive) Crashes

January 2012 – June 2016

This report contains information that is protected from disclosure by Federal Law, 23 USC Section 409:

Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-Aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data

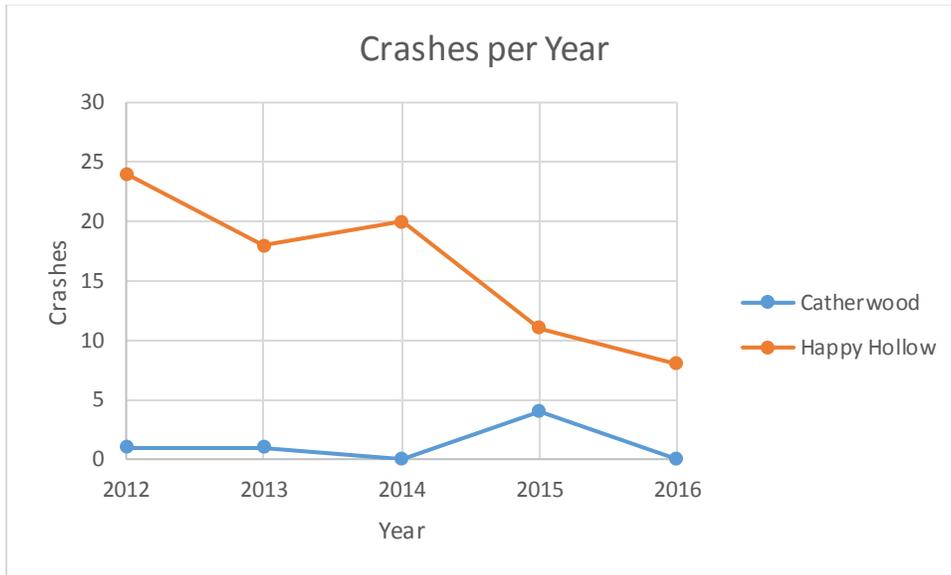


Figure 2: N River Rd Crashes by Year

Table 3: N River Rd Yearly Crashes

Catherwood		Happy Hollow	
Year	Crashes	Year	Crashes
2012	1	2012	24
2013	1	2013	18
2014	0	2014	20
2015	4	2015	11
2016	0	2016	8

Table 4: N River Road Crash Primary Factors

Primary Factors	Happy Hollow	Catherwood
Following too Closely	60	4
Other	11	1
Distracted Driver	4	0
Failure to yield	3	1
Roadway Surface	3	1
Speed/Weather Conditions	2	0
Improper Passing	1	0
Unsafe Speed	1	0
Brake Failure	1	0

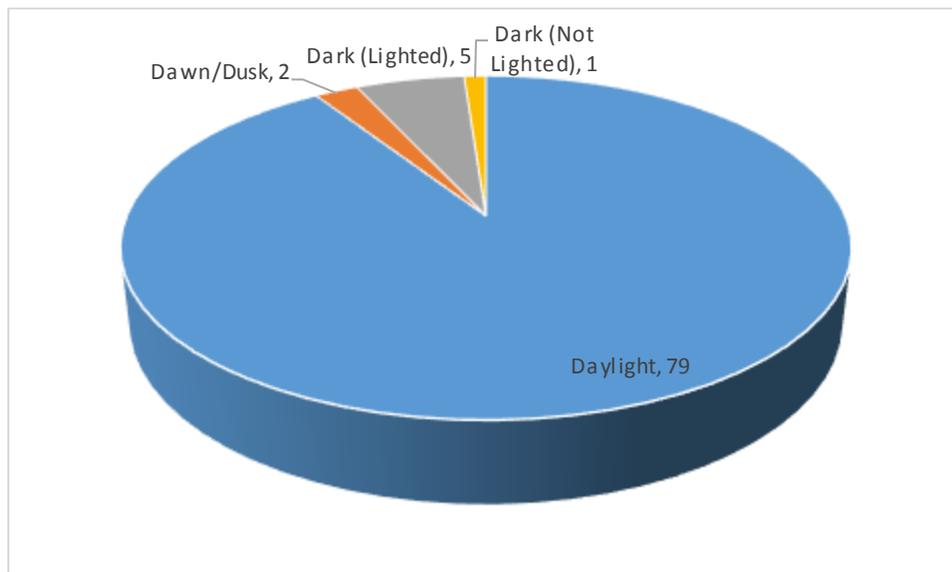


Figure 3: N River Road Light Conditions in Crashes

Table 5: N River Road Crashes by Weather Conditions

Weather Conditions	Catherwood	Happy Hollow	Total
Clear	4	50	54
Cloudy	1	25	26
Rain	1	5	6
Snow	0	1	1

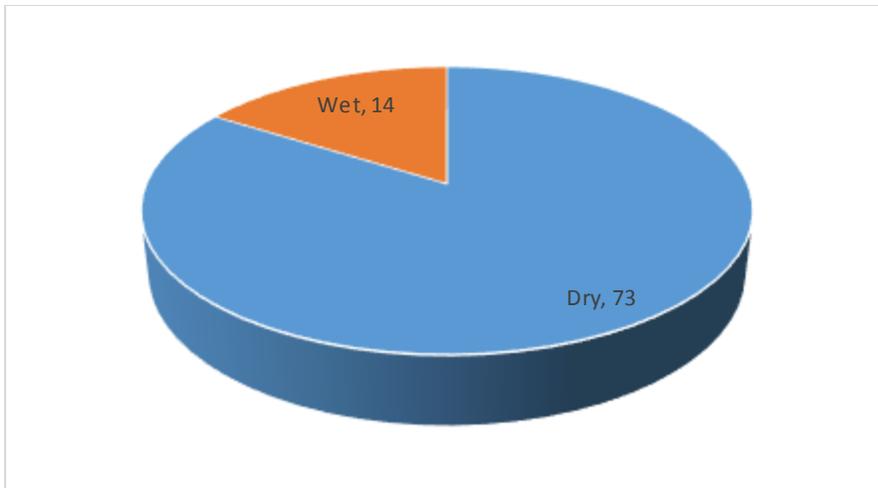


Figure 4: N River Road Crashes by Pavement Condition

Notes:

- There was a total of 20 injuries from the crashes reported from January 2012 to June 2016; three occurred at the Catherwood Drive and N River Road intersection and the remaining 17 happened at the intersection of Happy Hollow Road and N River Road.

River Road Sight Distance Analysis

Catherwood/N River & Happy Hollow/N River Intersection Sight Distance Analysis

Summary

- Vehicles traveling Southeast on Happy Hollow Road that are looking Southwest are not able to see the required distance for oncoming cars from 10 feet behind the stop sign due to a wall obstructing the view.
- Vehicles traveling Southeast on Happy Hollow Road that are looking to the Northeast are not able to see the required distance for oncoming cars from 10 feet behind the stop sign due to the curve in N River Road and trees.
- Vehicles traveling East on Catherwood Drive that are looking South are not able to see the required distance for oncoming cars from 10 feet behind the stop sign due to trees and the curve in N River Road.
- Vehicles traveling East on Catherwood Drive that are looking North are not able to see the required distance for oncoming cars from 10 feet behind the stop sign due to bushes on ground that is already at a higher elevation than Catherwood Drive.

A sight distance analysis was completed at N River Road's intersections with Happy Hollow Road and Catherwood Drive. Traffic from both Happy Hollow and Catherwood have to stop at River Road. The curve in River Road and several obstructions has resulted in numerous crashes at these intersections; the sight distance analysis was completed in order to illustrate this problem. It was assumed that vehicles were traveling at a speed of 45 mph on River Road based on the 85th percentile and that decreasing the speed limit to 30 mph in the area is a viable solution. Chapter 42 of the *INDOT 2013 Design Manual* and the *Indiana MUTCD* were referenced when completing the analysis.

Table 6: Happy Hollow Road – Left Turn. See Figure 5.

Happy Hollow Road Width	40 ft
Happy Hollow Road Lanes at Intersection	3
Car Location (Relative to Stop Sign)	10 ft behind
River Road Street Width	24 ft
River Road Lanes	2
Traffic Controls	Stop
Measured Sight Distance	180 ft
Recommended Sight Distance @ 45 MPH	500 ft
Is Sight Distance Met?	No
Recommended Sight Distance @ 30 MPH	335 ft
Is Sight Distance Met?	No



Table 7: Happy Hollow Road – Right Turn. See Figure 6.

Happy Hollow Road Width	40 ft
Happy Hollow Road Lanes at Intersection	3
Car Location (Relative to Stop Sign)	10 ft behind
River Road Street Width	24 ft
River Road Lanes	2
Traffic Controls	Stop
Measured Sight Distance	290 ft
Recommended Sight Distance @ 45 MPH	430 ft
Is Sight Distance Met?	No
Recommended Sight Distance @ 30 MPH	290 ft
Is Sight Distance Met?	Yes



Table 8: Catherwood Drive – Left Turn. See Figure 7.

Catherwood Drive Width	40 ft
Catherwood Drive Lanes at Intersection	3
Car Location (Relative to Stop Sign)	10 ft behind
River Road Street Width	24 ft
River Road Lanes	2
Traffic Controls	Stop
Measured Sight Distance	422 ft
Recommended Sight Distance @ 45 MPH	500 ft
Is Sight Distance Met?	No
Recommended Sight Distance @ 30 MPH	335 ft
Is Sight Distance Met?	Yes



Table 9: Catherwood Drive – Right Turn. See Figure 8.

Catherwood Drive Width	40 ft
Catherwood Drive Lanes at Intersection	3
Car Location (Relative to Stop Sign)	10 ft behind
River Road Street Width	24 ft
River Road Lanes	2
Traffic Controls	Stop
Measured Sight Distance	120 ft
Recommended Sight Distance @ 45 MPH	430 ft
Is Sight Distance Met?	No
Recommended Sight Distance @ 30 MPH	290 ft
Is Sight Distance Met?	No



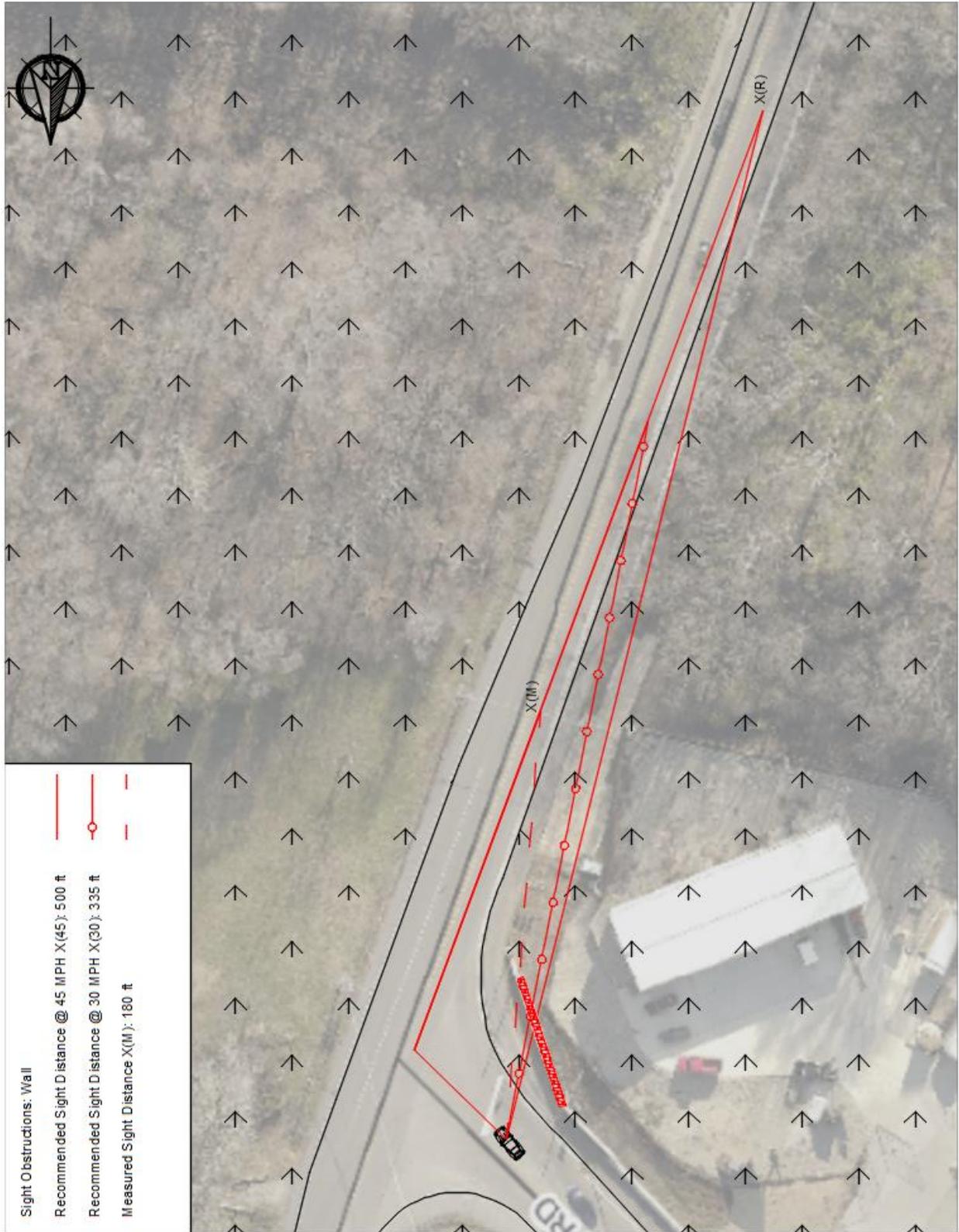


Figure 5: Turn Left Onto N River Road from Happy Hollow Road (Stop 10' Behind Stop Sign). N River Road Speed Limit = 40 mph, assumed vehicle speed = 45 mph.

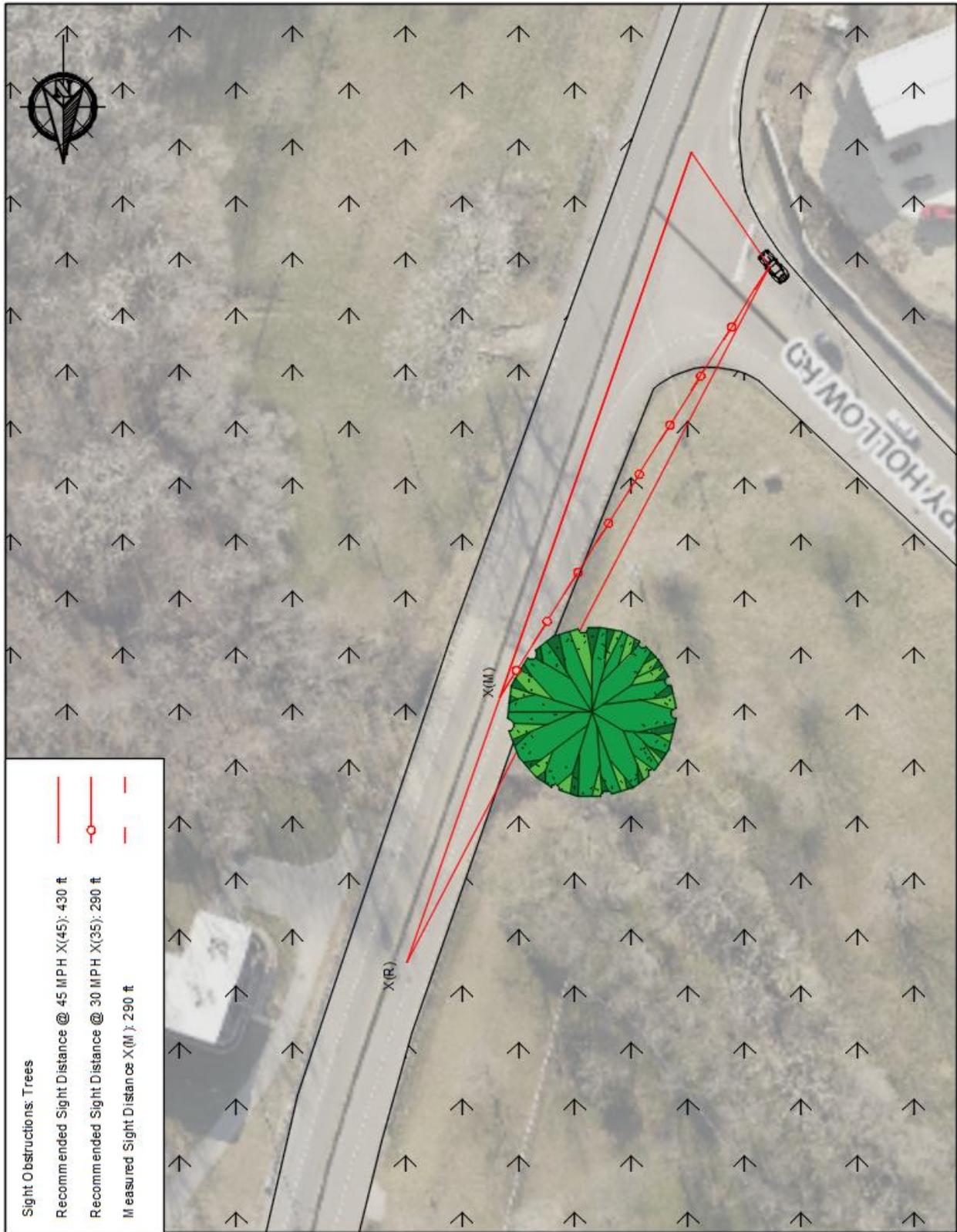


Figure 6: Turn Right Onto N River Road from Happy Hollow Road (Stop 10' Behind Stop Sign). N River Road Speed Limit = 40 mph, assumed vehicle speed = 45 mph.

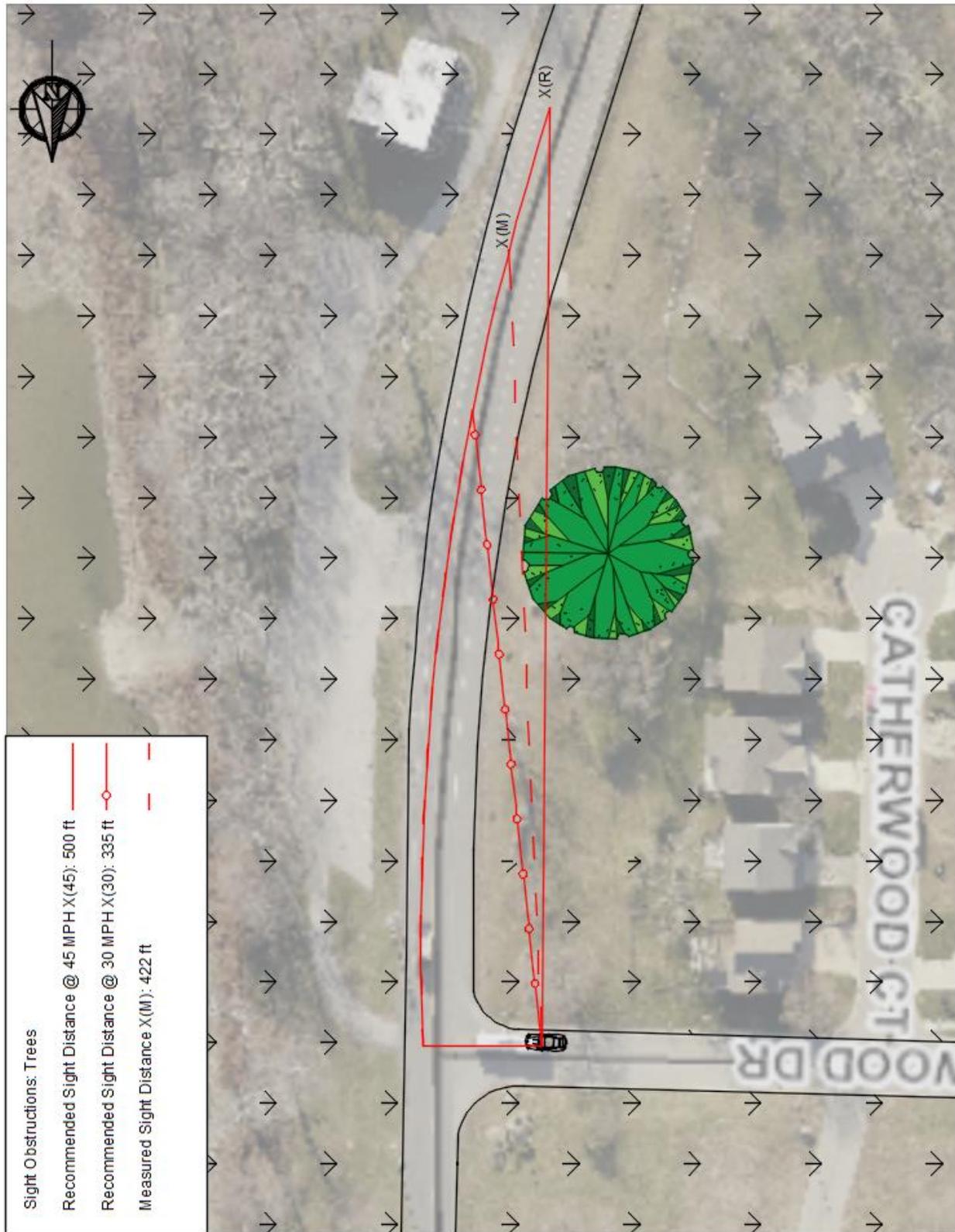


Figure 7: Turn Left Onto N River Road from Catherwood Drive (Stop 10' Behind Stop Sign). N River Road Speed Limit = 40 mph, assumed vehicle speed = 45 mph.

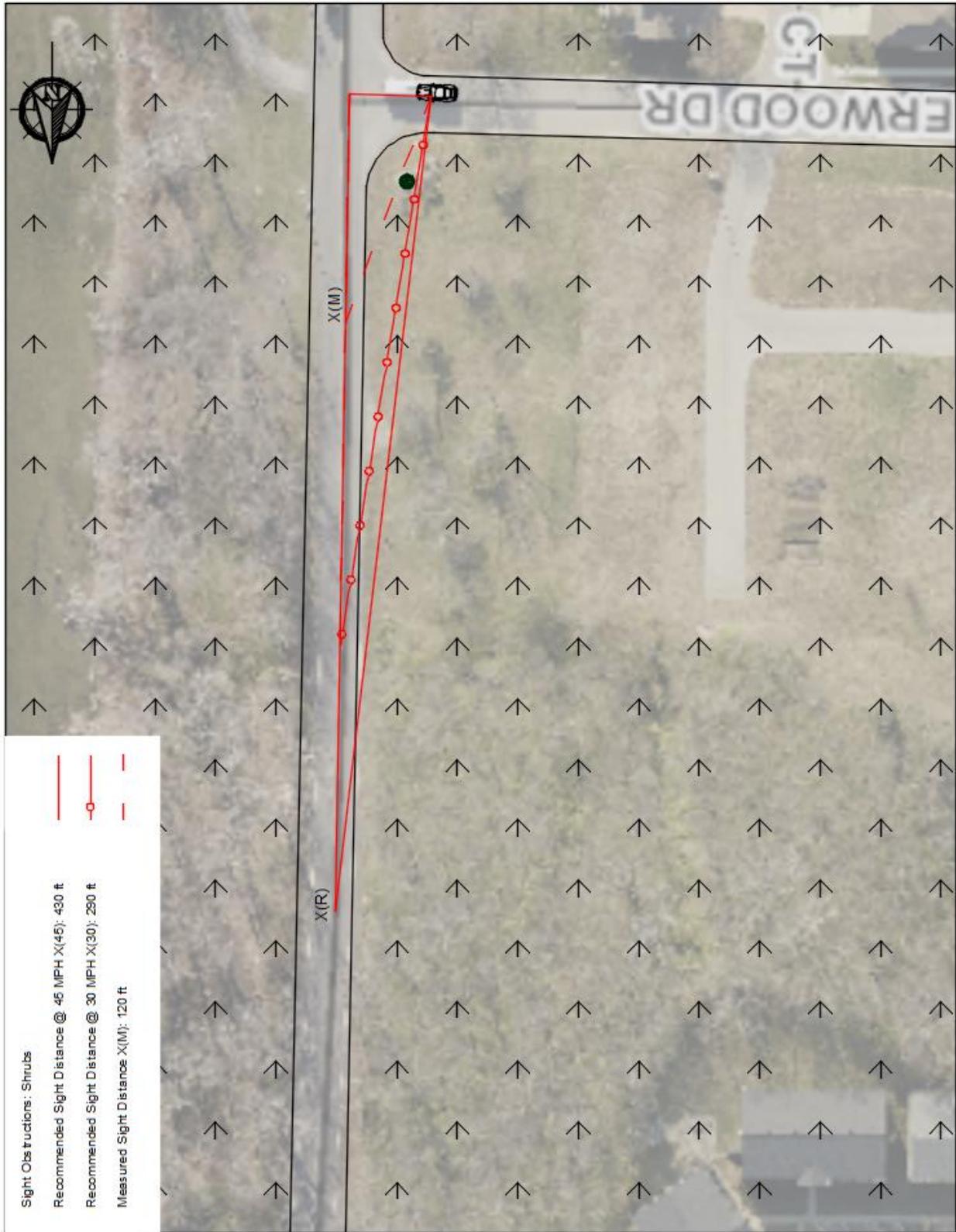


Figure 8: Turn Right Onto N River Road from Catherwood Drive (Stop 10' Behind Stop Sign). N River Road Speed Limit = 50 mph, assumed vehicle speed = 45 mph.

Recommendation

The data from the sight analysis and the number of crashes occurring at the Happy Hollow and Catherwood intersections require N River Road's reduction in speed to be relocated further north, before the Catherwood Intersection. A layout of the current system and the proposed system can be viewed in Figures 9 and 10 below. Additionally, trees can be trimmed back to further alleviate sight distance issues.



Figure 9: Existing layout.



Figure 10: Proposed layout

Appendix

CHAPTER 42

Sight Distance

NOTE: This chapter is currently being re-written and its content will be included in Chapter 302 in the future.

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42-4.0 INTERSECTION SIGHT DISTANCE

Section 46-10.0 discusses the design requirements for intersection sight distance.

Raised pavement markings, raised reflectors, roughened pavement, or paint striping is used in advance of and around the island to warn the driver. These traffic control devices are important at the approach to a divisional curbed island for the direction of approaching traffic. Figures 46-9A and 46-9B illustrate the pavement markings used with a channelizing island. Section 76-2.03 provides additional information for pavement markings around an island.

46-9.05 Island Offset to Through Lanes

In an urban area on an approach roadway without shoulders, the raised corrugated island should be offset 2 ft from the travel lane. Where shoulders are present, the raised corrugated island should be offset a distance equal to the shoulder width. In a rural area or where a separate turning lane is used, the island should be offset from the turning lane by 2 ft (see Figure 46-9A). If there is no turning lane, the island should be offset a distance equal to the shoulder width. If a corner island is preceded by a right-turn deceleration lane, the shoulder offset should be at least 8 ft.

The designer should also ensure that the island will not interfere with the turning movement of a truck turning from the opposite side on a 4-legged intersection. If there is a conflict, the island should be set back farther or made flush.

46-9.06 Typical Channelizing Intersection

Figure 46-9C illustrates an example of an island treatment at an intersection. Each channelizing intersection must be studied individually considering turning volumes, traffic lane configurations, potential conflicts, and practical signing arrangements.

46-10.0 INTERSECTION SIGHT DISTANCE (ISD)

For an at-grade intersection to operate properly, adequate sight distance should be available. The designer should provide sufficient sight distance for a driver to perceive potential conflicts and to perform the actions needed to negotiate the intersection safely.

The additional costs and impacts of removing sight obstructions are often justified. If it is impractical to remove an obstruction blocking the sight distance, the designer should consider providing traffic-control devices or applications (e.g., warning signs, traffic signals, or turn lanes) which may not otherwise be warranted.

The height of eye for a passenger car driver should be taken as 3.5 ft. The height of eye for a single-unit or combination-truck driver should be taken as 7.6 ft. Its height of object should be taken as 3.5 ft.

The sight line is shown on the plans in the plan and profile views. The proposed profile grade line along the centerline is also shown, however, this is meaningless for intersection sight distance analysis. The proposed ground line under the sight line is the relevant line.

**** PRACTICE POINTER ****

Intersection sight distance should be analyzed for each local service road or frontage road in the same manner as a public road.

46-10.01 No Traffic Control

An intersection between a low-volume and a low-speed road or street should be either yield-controlled or stop-controlled. However, for a local-road or -street intersection with no traffic control, sufficient corner sight distance should be available to allow an approaching vehicle to see a potentially conflicting vehicle in sufficient time to stop before reaching the intersection. Figure 46-10A provides the ISD criteria for an intersection with no traffic control and approach grades between -3% and $+3\%$. For approach grades greater than 3% , multiply the sight distance value in Figure 46-10A by the appropriate adjustment factor from Figure 46-10B. These Figures are not applicable to State highways.

If the appropriate sight distance cannot be provided, consideration should be given to installing a “Stop” sign on one or more approaches.

46-10.02 Yield Control

46-10.02(01) Intersection With Yield Control on the Minor Road

A driver approaching a Yield sign is permitted to enter or cross the major road without stopping, if there is no potentially conflicting vehicle on the major road. The sight distance needed by a driver on a yield-controlled approach exceeds that for a stop-controlled approach.

A yield-controlled approach needs greater sight distance than a stop-controlled approach, especially at a four-leg yield-controlled intersection where the sight distance needs of the crossing maneuver should be considered. If sight distance sufficient for yield control is not available, use of a “Stop” sign instead of a “Yield” sign should be considered. At a location where the recommended sight distance cannot be provided, consideration should be given to installing other traffic control devices at the intersection on the major road to reduce the speeds of approaching vehicles.

46-10.02(02) Left- or Right-Turn Maneuver

The length of the leg of the approach sight triangle along the minor road to accommodate a left or right turn without stopping should be 80 ft. This distance is based on the assumption that a driver making a left or right turn without stopping will slow to a turning speed of 10 mph.

The leg of the approach sight triangle along the major road is similar to the major-road leg of the departure sight triangle for a stop-controlled intersection. However, the time gap for a left turn, as shown in Section 46-10.03 should be increased by 0.5 s to the value shown in Figure 46-10C. The appropriate length of the sight triangle leg is shown in Figure 46-10D for a passenger car. The minor-road vehicle needs 3.5 s to travel from the decision point to the intersection. This represents additional travel time that is needed at a yield-controlled intersection, but is not needed at a stop-controlled intersection. However, the acceleration time after entering the major road is 3.0 s less for a yield condition than for a stop condition because the turning vehicle accelerates from 10 mph rather than from a stop condition. The net 0.5-s increase in travel time for a vehicle turning from a yield-controlled approach is the difference between the 3.5-s increase in travel time and the 3.0-s reduction in travel time.

A departure sight triangle like that provided for a stop-controlled approach should also be provided for a yield-controlled approach to accommodate a minor-road vehicle that stops at the “Yield” sign to avoid a conflict with a major-road vehicle. However, because the approach sight triangle for a turning maneuver at a yield-controlled approach is larger than the departure sight triangle used at a stop-controlled intersection, no specific check of departure sight triangle at a yield-controlled intersection should be needed.

A yield-controlled approach needs greater sight distance than a stop-controlled approach, especially at a four-leg yield-controlled intersection where the sight distance needs of the crossing maneuver should be considered. If sight distance sufficient for yield control is not available, use of a “Stop” sign instead of a “Yield” sign should be considered. At a location where the recommended sight distance cannot be provided, consideration should be given to installing other traffic control devices at the intersection on the major road to reduce the speeds of approaching vehicles.

46-10.02(03) Turning Roadway

Yield control may also exist, for example, at a freeway ramp terminal where the ramp traffic is provided a free-flowing right turn onto the minor road. The assumptions as discussed in Section 46-

10.02(01) are also applicable to turning-roadway yield conditions, except the eye location of the entering vehicle is on the turning roadway itself (see Figure 46-10E).

If insufficient intersection sight distance is available for the operational characteristics of yield control, it may be appropriate to convert the intersection to stop control.

46-10.03 Stop Control

Where traffic on the minor road of an intersection is controlled by a “Stop” sign, the driver of the vehicle on the minor road must have sufficient sight distance for a safe departure from the stopped position assuming that the approaching vehicle comes into view as the stopped vehicle begins its departure. The location of the eye should be as described in Section 46-10.03(01).

46-10.03(01) Departure Sight Triangle and Time Gap

The departure sight triangle for an intersection with stop control on the minor road must consider the situations as follows:

1. left turn from the minor road;
2. right turn from the minor road; and
3. crossing the major road from minor-road approach.

A departure sight triangle for traffic approaching from either the right or left, like that shown in Figure 46-10F, Departure Sight Triangles, should be provided for a left turn from the minor road onto the major road for each stop-controlled approach.

Field observations of the gaps in major-road traffic actually accepted by drivers turning onto the major road have shown that the values shown in Figure 46-10G, Intersection Sight Distance for Stop-Controlled Intersection, provide sufficient time for the minor-road vehicle to accelerate from a stop and complete a left turn without unduly interfering with major-road traffic operations.

The intersection sight distance in both directions should be equal to the distance traveled at the design speed of the major road during a period of time equal to the time gap. At a minimum, ISD should be checked for both a passenger car and a single unit truck turning from the minor-road approach. Where a substantial volume of heavy vehicles enter the major road, the use of combination trucks should be considered.

No adjustment is needed for the major-road grade. However, if the minor-road design vehicle is a truck and the intersection is located near a sag vertical curve with a grade over 3%, an adjustment of the intersection sight distance should be considered.

Figure 46-10G provides the criteria for intersection sight distance in both directions for a vehicle turning left.

Intersection sight distance for a left turn at a divided-highway intersection should consider multiple design vehicles and median width. If the design vehicle used to determine sight distance for a divided-highway intersection is larger than a passenger car, sight distance for a left turn will need to be checked for that selected design vehicle and for smaller design vehicles as well. If the divided-highway median is wide enough to store the design vehicle with a clearance to the through lanes of 3 ft at both ends of the vehicle, no separate analysis for the departure sight triangle for a left turn is needed on the minor-road approach for the near roadway to the left.

If the design vehicle can be stored in the median with adequate clearance to the through lanes, a departure sight triangle to the right for a left turn should be provided for that design vehicle turning left from the median roadway. Where the median is not wide enough to store the design vehicle, a departure sight triangle should be provided for that design vehicle to turn left from the minor-road approach. The median width should be considered in determining the number of lanes to be crossed. The median width should be converted to an equivalent number of lanes.

The sight triangle for a left or right turn onto the major road will also provide more than adequate sight distance for a minor-road vehicle to cross the major road. However, the intersection sight distance for a crossing maneuver must be checked for the situations as follows:

1. where left or right turns are not permitted from a particular approach and the crossing maneuver is the only legal maneuver;
2. where the crossing vehicle would cross the equivalent width of more than 6 lanes; or
3. where a substantial volume of heavy vehicles cross the highway, and steep grades that might slow such vehicles while their back portions are still in the intersection are present on the departure roadway on the far side of the intersection.

The time gap shown in Figure 46-10H(1), Time Gap for Crossing Maneuver, may be used for the crossing-maneuver check.

Figure 46-10H, Intersection Sight Distance for Passenger Car to Turn Right provides the intersection sight distance for a passenger car making a right turn from a stop or a crossing maneuver.

At a divided-highway intersection, depending on the median width and the length of the design vehicle, intersection sight distance may need to be considered for crossing both roadways of a divided highway or for crossing the near lanes only and stopping in the median before proceeding.

The ISD value will establish one leg of the sight triangle which needs to be visible to the entering vehicle. The leg on the stop-controlled road or street will be determined by the assumed location of the eye. This is established as 18 ft behind the edge of the travel lane for a new or reconstruction project, or 14.5 ft for a 3R project (see Figure 46-10F, Departure Sight Triangle).

46-10.03(02) Measures to Improve Intersection Sight Distance

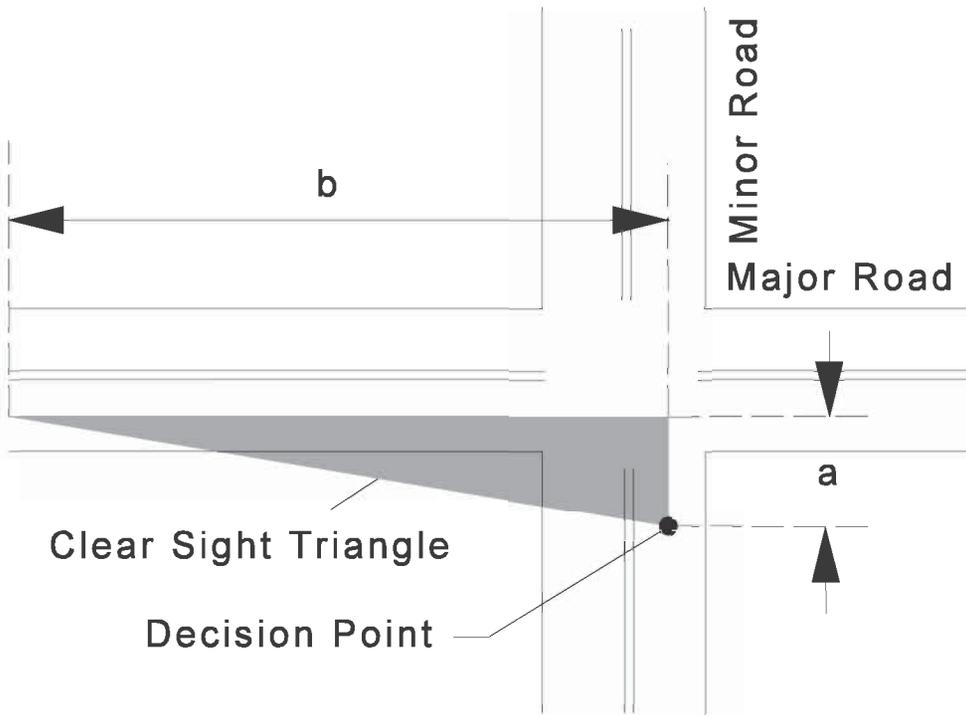
The available ISD should be checked using the parameters described above. If the line of sight falls above a bridge railing and guardrail and the ISD value from Figure 46-10G is provided, no further investigation is needed. If the line of sight is restricted by the bridge railing, guardrail, or other obstruction, or the horizontal and vertical alignment of the major road and the ISD value is not available, one or more of the modifications, or a combination of them, should be evaluated to achieve the intersection sight distance as follows:

1. relocate the minor road or drive farther from the end of the bridge;
2. widen the structure on the side where the railing is restricting the line of sight;
3. flare the approach guardrail;
4. revise the grades on the major road or the minor road or drive;
5. remove the obstruction that is restricting sight distance;
6. close the minor road or drive;
7. make the minor road or drive one-way away from the major road; or
8. review other measures that may be practical at a particular location.

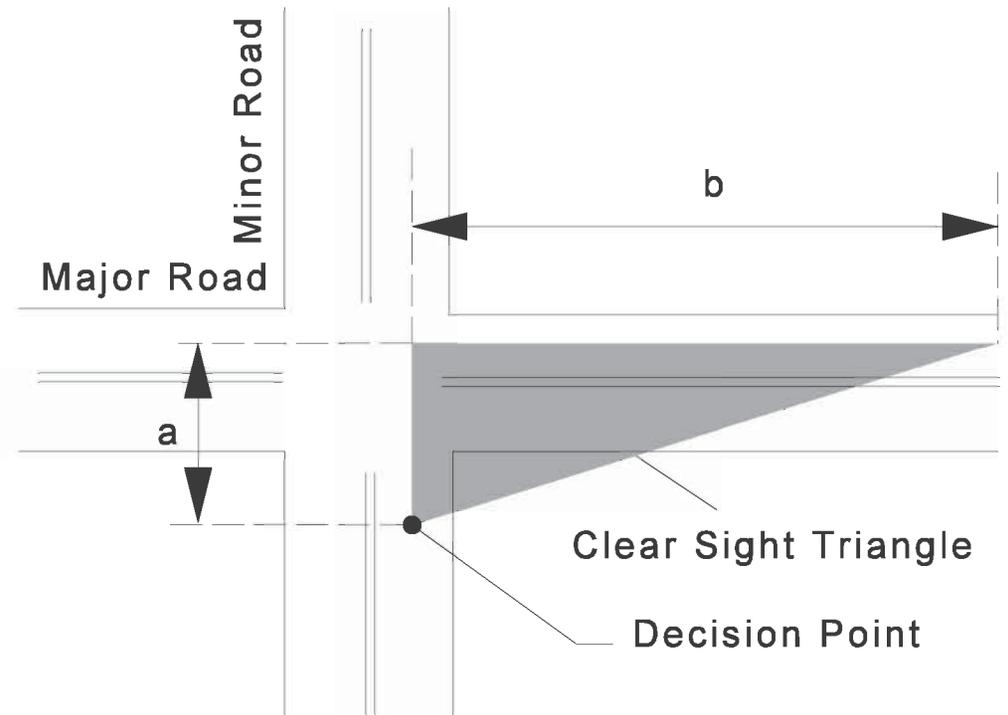
If intersection sight distance along the major road cannot be achieved, consideration should be given to installing advance intersection signing with advisory speed plates.

46-10.04 Left Turn From the Major Road

Each location along the major road from which a vehicle is permitted to turn left across opposing traffic, including an intersection or drive, should have sufficient sight distance to accommodate the



Clear Sight Triangle for Viewing Traffic Approaching from the Left.



Clear Sight Triangle for Viewing Traffic Approaching from the Right.

DEPARTURE SIGHT TRIANGLES

Figure 46-10F

V_{major} (mph)	Passenger Car				Single-Unit Truck		Combination Truck	
	Local Road		Collector or Arterial		t_g (s)	ISD (ft)	t_g (s)	ISD (ft)
	t_g (s)	ISD (ft)	t_g (s)	ISD (ft)				
15	7.5	170	7.5	170	9.5	210	11.5	260
20	7.5	220	7.5	220	9.5	280	11.5	340
25	7.5	280	7.5	280	9.5	350	11.5	430
30	7.5	330	7.5	330	9.5	420	11.5	510
35	7.5	390	7.5	390	9.5	490	11.5	600
40	7.5	440	7.5	440	9.5	560	11.5	680
45	7.5	500	7.5	500	9.5	630	11.5	760
50	7.5	550	8.5	630	10.5	780	12.5	920
55	7.5	610	9.0	730	11.0	890	13.0	1060
60	7.5	670	9.5	840	11.5	1020	13.5	1190
65	7.5	720	10.0	960	12.0	1150	14.0	1340
70	7.5	780	10.0	1030	12.0	1240	14.0	1440

V_{major} = Design speed of major road

t_g = Time gap for minor road vehicle to enter major road

ISD = Intersection sight distance (length of leg of sight triangle along major road)

ISD is shown for a stopped vehicle to turn left onto a two-lane highway with approach grades of 3% or flatter. For other conditions, the time gap should be adjusted and the required ISD recalculated using the formula $ISD = 1.47 V_{major} t_g$.

For a left turn onto a two-way highway with more than two lanes, add 0.5 s for a passenger car, or 0.7 s for a truck for each additional lane from the left in excess of one, to be crossed by a turning vehicle.

For the minor-road approach, if its grade is an upgrade that is steeper than 3%, add 0.2 s for each percent grade for a left turn. The adjustment for the minor-road approach grade is required only if the rear wheels of the design vehicle would be on an upgrade steeper than 3%.

INTERSECTION SIGHT DISTANCE FOR STOP-CONTROLLED INTERSECTION

Figure 46-10G

Design Speed (mph)	Intersection Sight Distance For Passenger Car	
	Calculated (ft)	Design (ft)
15	143.3	145
20	191.1	195
25	238.9	240
30	286.7	290
35	334.4	335
40	382.2	385
45	430.0	430
50	477.8	480
55	525.5	530
60	573.3	575
65	621.1	625
70	668.9	670

Note: Intersection sight distance shown is for a stopped passenger car to turn right onto or cross a two-lane highway with no median and grades of 3% or flatter. For other conditions, the time gap should be adjusted and the required sight distance recalculated.

**INTERSECTION SIGHT DISTANCE FOR PASSENGER CAR
TO TURN RIGHT FROM A STOP OR TO MAKE A CROSSING MANEUVER**

Figure 46-10H