APPENDIX OO

SR 45 OPERATIONAL AND SAFETY ANALYSIS

The Indiana Department of Transportation has prepared a traffic operations analysis and safety assessment of 4 intersections to determine if safety at these intersections will be adversely impacted by diverted traffic during the I-69 Section 4 construction period. These intersections included SR 37 with Victor Pike, SR 45 with Breeden Road, SR 45 with Burch/Stanford Road, and SR 45 with Harmony Road. Figure 1 shows these study locations. This analysis was prompted by concerns raised by Monroe County officials regarding the construction of Section 4 of I-69 and the possible diversion of traffic to SR 45 during the I-69 Section 4 construction years.

Bernardin, Lochmueller & Associates reviewed INDOT's Crash and Operations Analysis of these intersections along SR 45 and SR 37. The review sought to qualify the merits of the improvements recommended by INDOT. More specifically, the review assessed whether the improvements would be warranted and whether their implementation could be justified by long-term benefits (that would extend beyond the construction period).

Background

Monroe County officials raised concerns about the safety and operational performance of the three intersections of county roads with SR 45 and one with SR 37 during these I-69 Section 4 construction years.[1] Grade separation structures at I-69 are proposed to be constructed on Breeden Road, Burch Road, and Harmony Road. Traffic on the local county road system is expected to continue at the current traffic volumes or increase slightly, according to Monroe County officials. The SR 37 and Victor Pike intersection was requested to be evaluated since it is close to the projected I-69/SR 37 interchange.

Traffic volume, speed, and the character of the highway contribute to the operations and crash risk of any highway segment. After evaluation of the maps and the location of the proposed grade separations at I-69, it was estimated that minimal local traffic would divert to I-69 since there are no local interchanges with the local road system planned for central Monroe County. The interchange at I-69/SR 37 is the only Monroe County interchange planned for Section 4.

However, the scenario where I-69 is constructed and open to traffic from Evansville to Crane Naval Warfare Center was considered. Commercial and vehicular traffic would be diverted from I-69 at the US 231 interchange to SR 45, then use SR 45 to travel to Bloomington, where it would connection with SR 37 to Indianapolis. Traffic on SR 45 is expected to increase; there will be a large increase in commercial vehicles. Year 2015 traffic information for SR 45 was provided by Bernardin - Lochmueller & Associates.

The projected increase in traffic along SR 45 after the completion of Sections 1 through 3 of I-69, and while Section 4 is under construction, is significant (a 40% increase is projected).

---

[1] These concerns were documented in a comment letter on the Section 4 Draft EIS dated October 27, 2010, sent by the Monroe County Board of Commissioners and the Monroe County Department of Highways. This letter is comment letter LG022, and is included in Volume III of the Section 4 Final EIS.

Average daily traffic would increase by 40% with the resulting volumes ranging from 16,500 to nearly 20,000 vehicles per day on the two-lane rural highway.

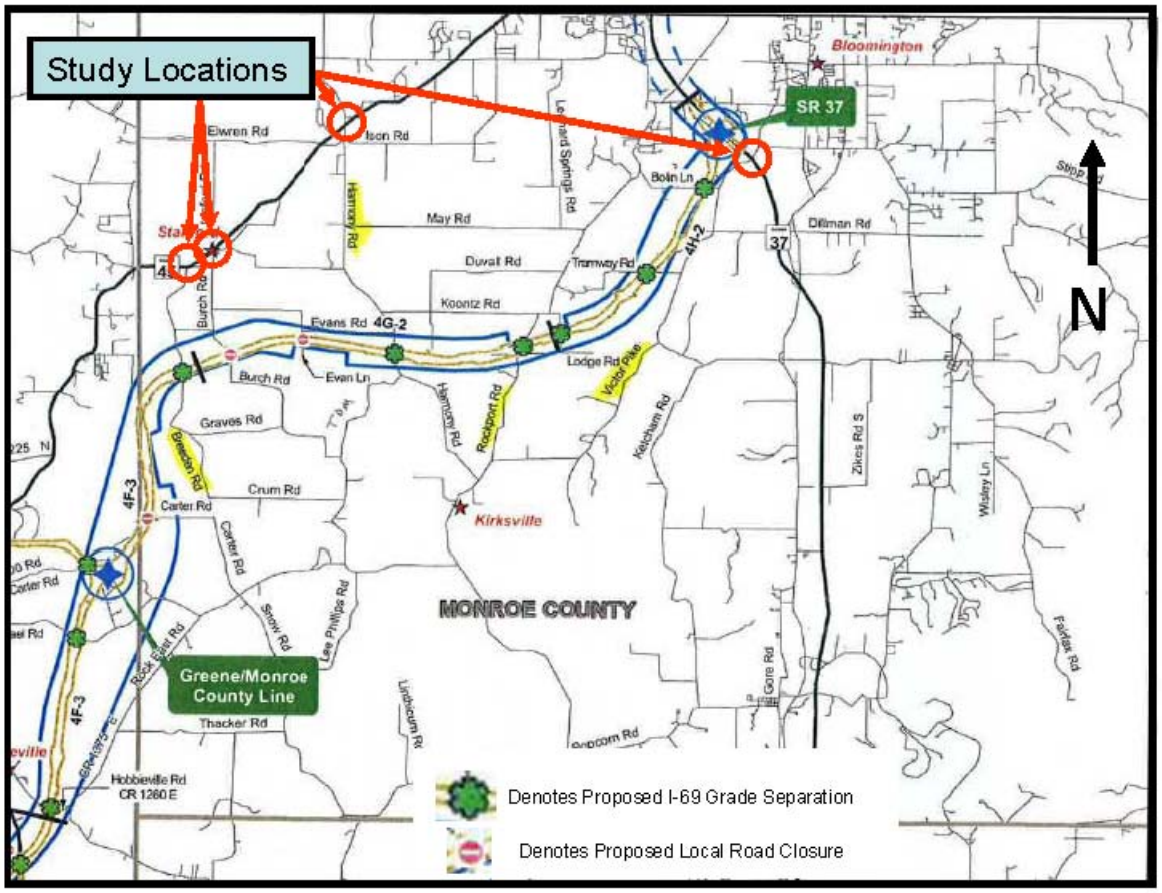

Figure 1 – Safety/Operational Study Locations

SR 45 is a rural principal arterial with two 12 ft travel lanes. Routine field observations characterize the condition of its asphalt pavement as excellent. SR 45 is on the National Truck Network[2], not on the National Highway System, and is a regional corridor on the statewide planning system[3]. Posted speed on most of SR 45 is 50 mph. A projected increase in traffic, coupled with the fact that SR 45 is a major commuter route, may warrant improvements at the SR 45 intersections. Improvements at SR 45 and Harmony/Garrison Chapel Road are currently

[2] The Surface Transportation Assistance Act of 1982 authorized the establishment of a national network of highways designated for use by large trucks. On these highways, Federal width and length limits apply. The National Network (NN) includes almost all of the Interstate Highway System and other, specified non-Interstate highways. The network comprises more than 200,000 miles of highways. See http://www.fhwa.dot.gov/policyinformation/pubs/pl08021/fig1_4.cfm.

[3] For planning purposes in its Long-Range Transportation Plan (LRTP), INDOT has developed a 3-level corridor classification scheme. "Regional corridors" are the second level in this scheme. Regional corridors provide mobility with regions of the state. See INDOT's LRTP (approved June, 2007), pp. 140f for more information.

programmed in the State Project Management Systems (SPMS)[4] in a future year (2017). However the project has not been formally adopted/funded into the traffic safety program at this point, and so is not at this point a committed project.

SR 45 traffic volume is expected to increase by about 40% on average when I-69 Sections 1-3 are complete and Section 4 is under construction. SR 45 cross sectional geometry and shoulder width are not ideal for such an increase in traffic.[5] Intersection and other spot type improvements will assist in improving traffic flow and reducing crash risk.

Analysis

The analysis consisted of a simplified Engineering Review process, which is appropriate for minor projects of low complexity. The analysis included development of the essential project intent (outline of course of action) and process documentation. Engineering review is a requisite process for a (candidate) project which addresses safety or minor congestion issues. INDOT staff from the Office of Traffic Safety as well as Seymour District Traffic Operations participated in the analysis. Each identified location was evaluated. The entire process for implementing improvements has seven steps; the first five steps comprise the evaluation process, which is the focus of this analysis. A capacity analysis using procedures in the Highway Capacity Manual (HCM) was considered. However, the effect of heavy commercial traffic does not affect the Level of Service (LOS) for minor approaches on stop-controlled intersections. Therefore, capacity analyses are not included in this report. Additional traffic does affect the approach road LOS, but a signal warrant analysis is beyond the scope of the project.[6] The first five steps in the process include:

1. Identify potential safety issues
2. Characterize the crash experience
3. Identify field conditions
4. Identify contributing factors and appropriate countermeasures
5. Assess the countermeasures and select the most appropriate countermeasure

Steps 6 and 7 include implementing the recommendations and determining the funding mechanisms.

<u>SR 45 and Breeden Road Intersection</u>

<u>Figure 2 shows the existing intersection of SR 45 and Breeden Road.</u>

---

[4] SPMS is a database containing every project under development (past the planning level analysis) by INDOT. It includes a schedule for development activities from preliminary engineering through construction.

[5] Factors which lead to this assessment include the forecasted 40% increase in traffic levels, narrow shoulders and large number of driveways. There will be increased conflicts between turning and through vehicles.

[6] A traffic signal warrant analysis is a more detailed assessment which is performed by the District Traffic Engineer. The need/justification for a warrant analysis would be made at a later date.

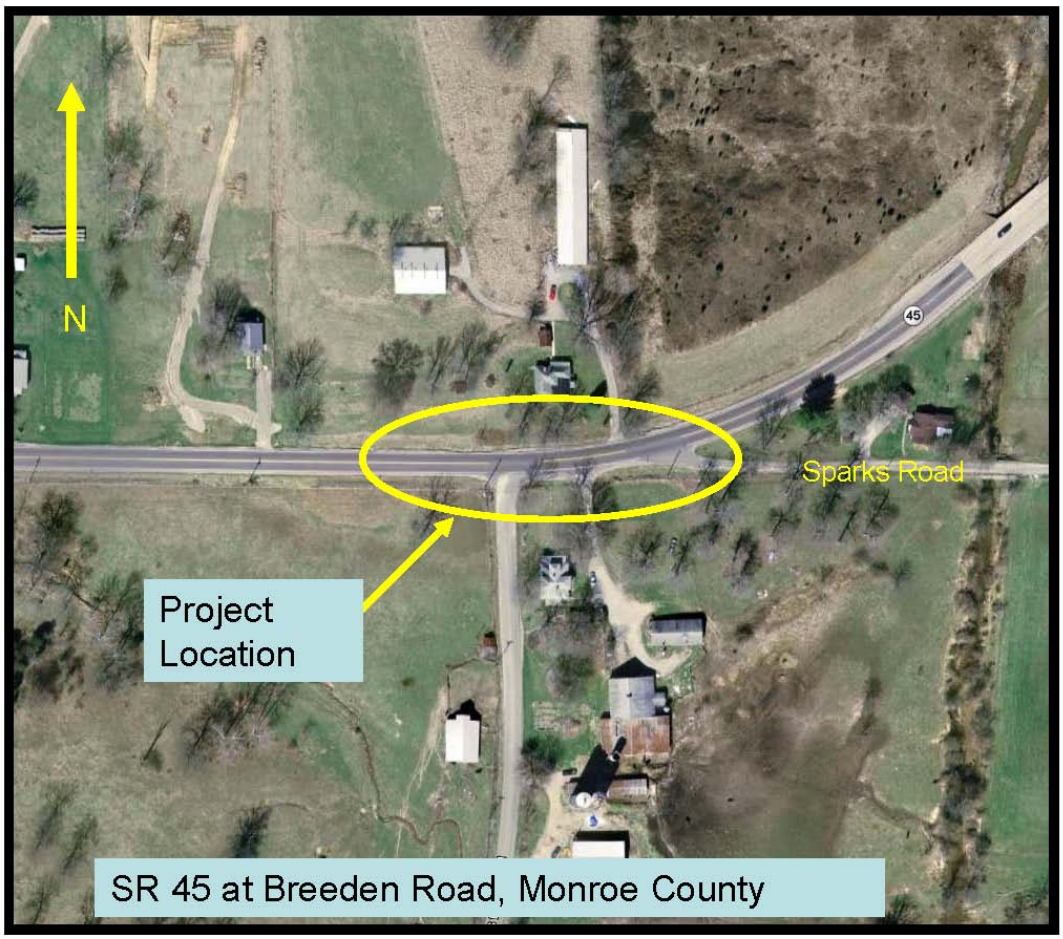

Figure 2 - Intersection of SR 45 and Breeden Road

This location has higher than expected crash rates, including rear end and head-on crashes. The intersection geometry (sharp horizontal curve approaching the intersection and the proximity of the Sparks Rd. and Breeden Rd. intersections) is a factor in these higher crash rates. Existing crash rate is 3.67 crashes per year (11 crashes during the three-year period). The expected crash rate per the formulas provided in the Highway Safety Manual (HSM)[7] is 0.92 crashes per year. Breeden Road will have a grade separation at I-69 and will remain open after I-69 Section 4 is completed. SR 45 has a 45 degree horizontal curve approaching the Breeden Road intersection from the east. Breeden intersects SR 45 at 90 degrees. Sparks Road has a nearby intersection that intersects SR 45 at approximately 20 degrees. There were no sidewalks or generators of pedestrian traffic at this intersection. Many minor roads in Monroe County have *Share the Road* signage indicating bicyclists are likely to enter the intersection using the minor approaches. Any improvement would be beneficial to non-motorized vehicles. Increased vehicular and commercial traffic increases the crash risk for nonmotorized intersection users.

Construction of a passing blister on SR 45 would greatly improve mobility, operations, as well as reduce crashes. Operations would be greatly enhanced because vehicles would not be delayed

[7] The *Highway Safety Manual, First Edition* (2010), published by the American Association of State Highway and Transportation Officials.

by left turning drivers waiting to turn onto Breeden Road. The risk of rear end collisions would be reduced since eastbound vehicles could safely pass stopped vehicles at the intersection. Intersection sight distance is restricted for eastbound approaching traffic due to SR 45's horizontal alignment.

By enabling through traffic to pass left-turning vehicles, this improvement would lessen delays during construction. Although post-construction volumes do not satisfy guidelines for a dedicated left-turn treatment (as specified in the Green Book), long-term safety benefits – reduced risk of rear-end crashes – would be realized. Left-turning traffic onto Breeden Road may increase (albeit marginally) once I-69 is complete since Breeden Road would have an overpass at I-69. Breeden Road may be used by travelers now using other roads which will be closed at I-69. A passing lane is an appropriate means of enhancing conditions for westbound vehicles. As a supplemental improvement, consideration should be given to eliminating the Sparks Road approach. The three residences served by Sparks Road can use Burch Road to access SR 45.

SR 45 and Harmony/Garrison Chapel Road Intersection

Figure 3 shows the existing intersection of SR 45 and Harmon/Garrison Chapel Road.

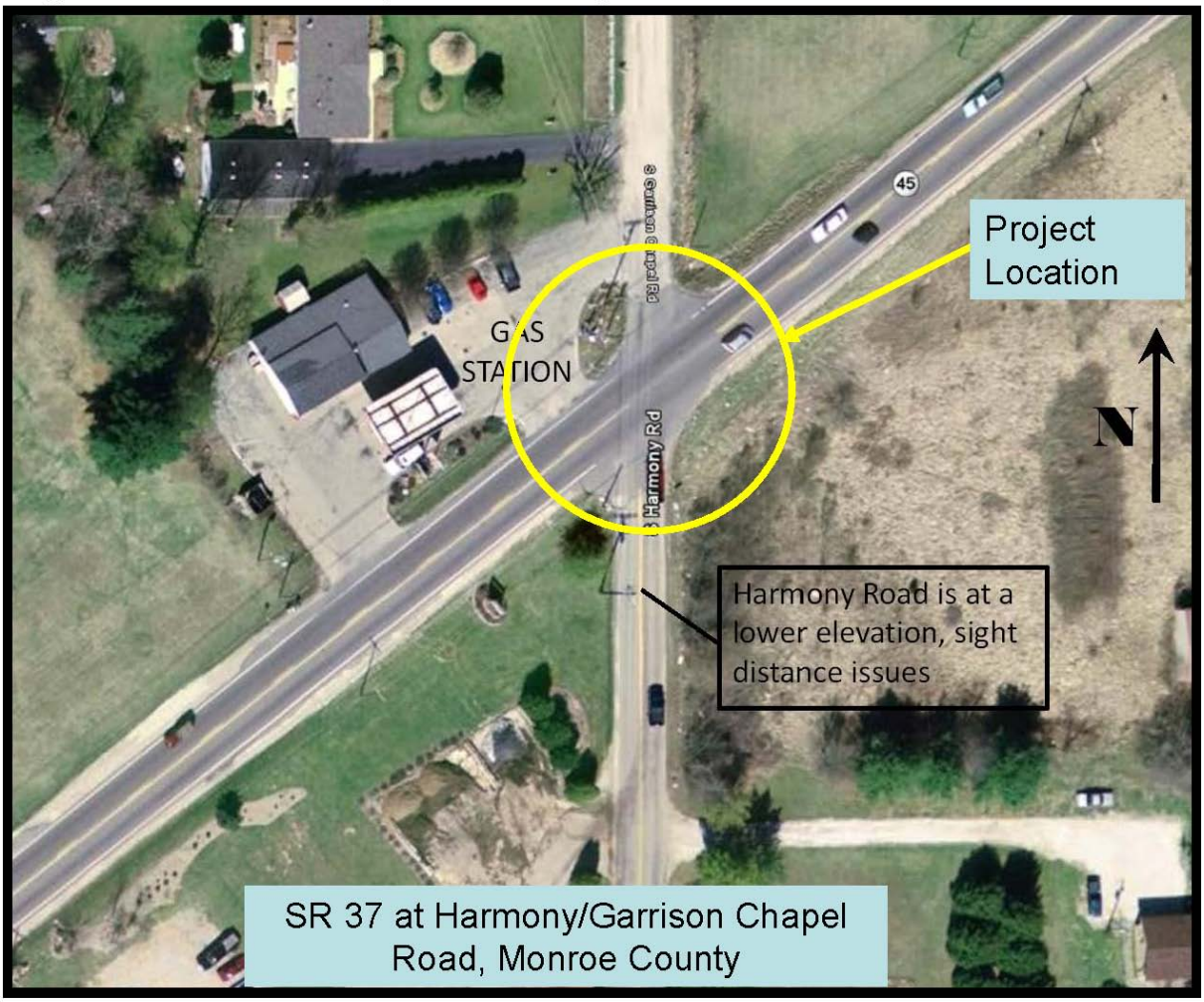

Figure 3 - Intersection of SR 45 with Harmony/Garrison Chapel Road

The evaluation of the intersection is described in an engineer's report prepared by the Seymour District. The report concluded that an effective countermeasure would be the construction of opposing left turn lanes on SR 45. Additional commercial vehicles or additional traffic on SR 45 because of I-69 phased construction would not alter the conclusions of that report. Many minor roads in Monroe County have *Share the Road* signage indicating bicyclists are likely to traverse the intersection using the minor approaches. Any improvements would be beneficial to non-motorized vehicles and increased vehicular and commercial traffic increases crash risk with non-motorized intersection users. The expected crash rate per HSM is 2.3 crashes per year. The existing crash rate is 9.67 crashes/ year.

In accordance with the American Association of State Highway Transportation Officials' publication, *A Policy on Geometric Design of Highways and Streets* (known as the "Green Book"), a westbound left-turn lane is warranted by construction and post-construction (2020) traffic projections. Being near to Bloomington, traffic is likely to continue to grow as development pushes west. In addition, annual crashes at this intersection are more than 4 times the expected amount. By enabling the intersection to more safely and efficiently

accommodate ultimate traffic loads, the recommended improvement would provide long-term benefits.

SR 37 and Victor Pike Intersection

Figure 4 shows the existing intersection of SR 37 and Victor Pike. It should be noted that the discussion below describe conditions at this intersection after the completion of Sections 1 through 3 of the I-6 project. A separate appendix (Appendix QQ) to this FEIS provides an analysis of conditions along SR 37 after the completion of Sections 1 through 4. Appendix QQ analyzes this intersection under those conditions as well.

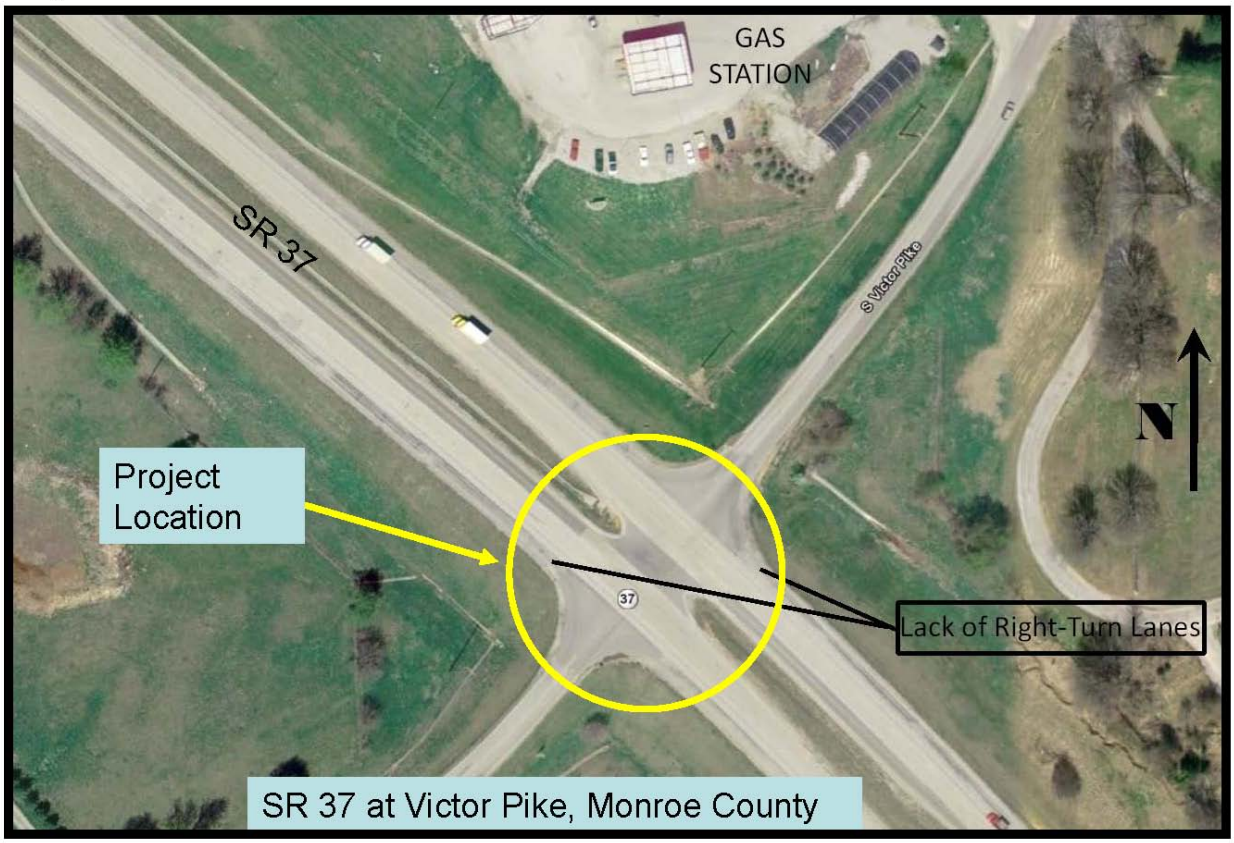

Figure 4 - Intersection of SR 37 and Victor Pike

The safety issues here are high numbers of rear end collisions during peak periods on southbound SR 37. The posted speed is 60 mph on SR 37. Rear end collisions occur in the mainline southbound lanes when there is a queue of cars waiting to turn right onto westbound Victor Pike. The intersection crash rate of 11 crashes per year is over twice the expected, so mitigation may be necessary from a safety standpoint. The expected crash rate using HSM is 4.5 crashes per year.

The intersection is signalized and has left turn lanes but there is no left turn phase in the signal light to protect left turns. Victor Pike crosses SR 37 at a 90 degree angle. Northbound vehicles have been observed using the northbound shoulder as a right turn lane to proceed east on

Victor Pike. The existing traffic signals do not have back plates. These crashes relate to existing traffic levels, which are not anticipated to change significantly after Sections 1 through 3 of I-69 are completed. The Seymour District is planning to study the intersection for the installation of protected left turn signals. Signal back plates have been shown to increase signal visibility and reduce crashes. Addition of yellow flashing lights to the advance warning signs on SR 37 north and south of the intersection would be desirable.

Implementation of improvements such as adding the signal back plates and advance warning signs are greatly encouraged, and district funds could be used if desired. In order to improve operations, the addition of a right turn lane on SR 37 on both the northbound and southbound approaches should be considered. Many minor roads in Monroe County have *Share the Road* signage indicating bicyclists are likely to traverse the intersection using the minor approaches. Any improvement would be beneficial to non-motorized vehicles and increased vehicular and commercial traffic increases crash risk with non-motorized intersection users.

SR 45 and Stanford/Burch Road Intersection

Figure 5 shows the existing intersection of SR 45 and Stanford/Burch Road.

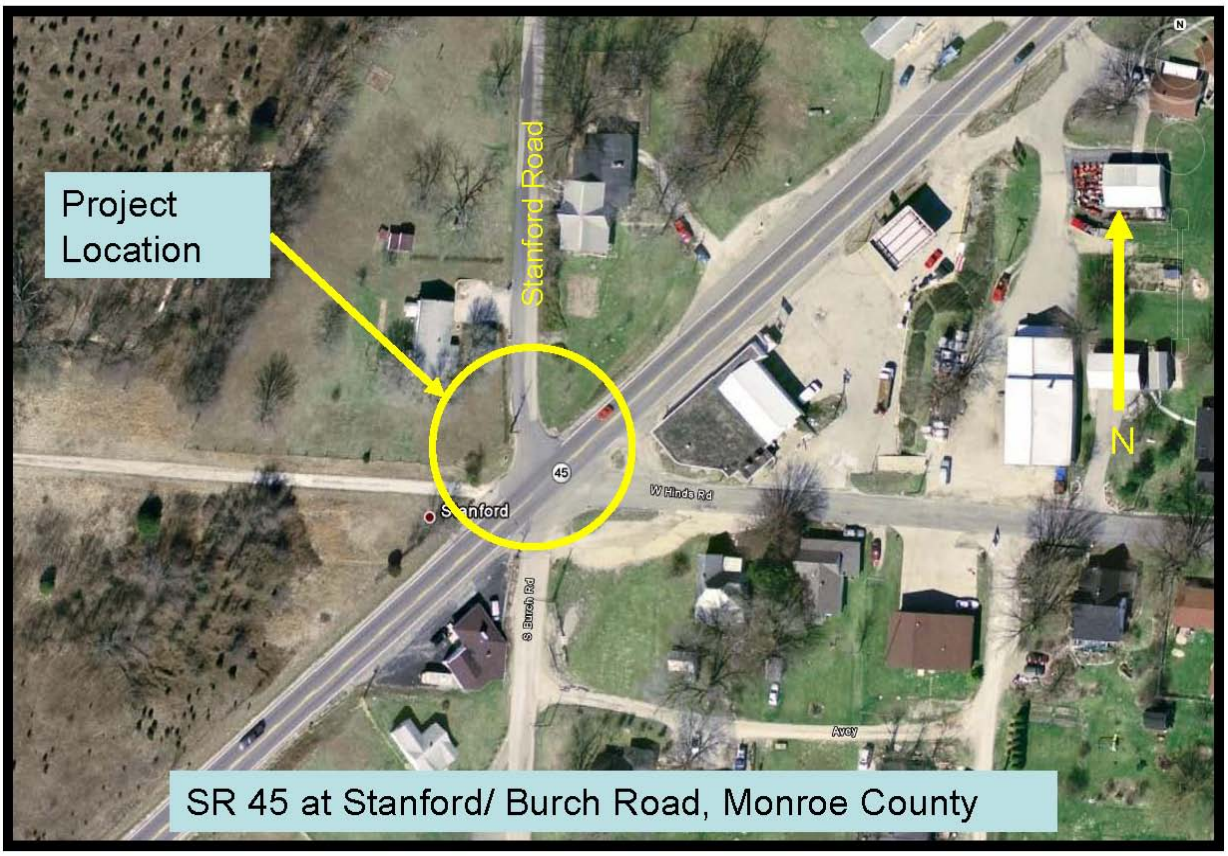

Figure 5 - SR 45 and Stanford/Burch Road

This intersection has problematic geometry, particularly with the side road approaches. With increased auto and commercial vehicle traffic, crashes could increase due to the limited sight distance and geometrics. Currently the intersection has a lower crash rate than most intersections in the Seymour District.

The intersection at Stanford/Burch Road is a five leg intersection with a sixth leg being a private driveway. From a geometry standpoint the intersection has the following deficiencies:

(1) Approach grades on the minor approaches are greater than the desirable grade
(2) It is a five legged intersection; four legs is the desirable maximum
(3) Driveway forms 6th leg
(4) Site distance issue from commercial building on SE quadrant
(5) Vertical alignment of SR 45
(6) Horizontal alignment of SR 45
(7) SR 45 cross sectional elements (including shoulder width and fore slopes) are deficient
(8) Guardrail placement is desirable due to steep side slopes
(9) Intersection skew angle, minor roads to not intersect SR 45 at 90 deg
(10) Pavement width of minor approach roads deficient (travel lanes too narrow, no shoulder)

Many minor roads in Monroe County have *Share the Road* signage indicating bicyclists are likely to traverse the intersection using the minor approaches. Any improvement would be beneficial to non-motorized vehicles and increased vehicular and commercial traffic increases crash risk with non-motorized intersection users.

From a crash analysis standpoint the intersection had seven crashes in a three year period, or 2.3 crashes per year. The expected crash rate is 0.92 crashes/year per FHWA equations. The most effective countermeasure to improve operations and reduce future crash risk would be total reconstruction and relocation of Hinds Road. This would consist either of closing Hinds Rd. to through traffic or realigning it to connect with another approach to SR 45. In order to remove all of the deficiencies approximately $4.0 million would need to be expended for construction and R/W acquisition. There would be at least four (or more) relocations of residences and businesses. A possible relocation of SR 45 to bypass Stanford and the intersection area may be appropriate to minimize R/W and relocation issues.

Recommendations

Our recommendations are summarized below:

- Improvements are warranted along SR 45 to lessen the impact of the traffic diversions. Improvements at the SR 45 and Breeden Road intersection and the SR 45 and Harmony Road intersection address the most pronounced safety concerns and offer long-term benefits. The SR 37 and Victor Pike intersection is not projected to be significantly affected by the traffic diversions during the time prior to the construction of Section 4 of

I-69; however, existing safety-related issues are identified and improvement are recommended. The SR 45 and Stanford/Burch Road intersection has a relatively low crash rate and a high cost of improvement. It is not recommended at the current time for an improvement.

- Once construction is complete, traffic volumes along SR 45 will fall below current levels. Projected traffic in 2020 will be 40-45 percent lower than current volumes, although those levels will still be significant for a two-lane highway – particularly for the section near Harmony/Garrison Chapel Road where average daily traffic will exceed 9,000 vehicles per day. Improvements along SR 45 was considered in the context of these ultimate, long-term traffic volumes.

- Delays are likely to be worse for motorists turning onto SR 45 from the minor street approaches (and particularly for those turning left). Volumes would be heaviest at the Harmony/Garrison Chapel Road intersection, where the northbound and southbound approaches would operate at a high LOS F. At times, delays could exceed several minutes for those motorists, since there would be very few gaps in passing traffic for vehicles turning left from side roads.

- Opportunities to alleviate side street delays are very limited. Since approaching volumes are light, it would not be appropriate to signalize these intersections and MUTCD warrants would not be satisfied.