Heartland Highway Road Safety Audit

A report detailing a road safety audit of State Road 25 from Lafayette to Logansport, Indiana

August 2000

Delphi Systems Inc.

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Disclaimer

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1.0 Introduction

State Road 25 (SR25) is part of the Hoosier Heartland Industrial Corridor, which extends from Lafayette, Indiana to Toledo, Ohio. Improvements to the highway to provide a four-lane divided limited access facility have been underway for the past 25 years, with the most recent section, Peru to Logansport, opened several months ago. Later this year, two other segments of the highway will be dedicated. These include a section from Huntington, Indiana to Wabash, Indiana, and a new interchange at US31. The process to select an alignment and complete the Environmental Impact Statement (EIS) on the last remaining section, Logansport to Lafayette, is presently underway.

SR25**,** as it presently exists, was designed in the 1940's and some segments were constructed in the 1950's. Other than regular maintenance activities and a number of localized improvements with respect to structures and their approach elements, little has been done to enact comprehensive improvements over the years. Over time, the use of the highway has changed significantly. In addition to accommodating traffic from the communities along the highway for which it was originally designed, the highway now accommodates through traffic, commuter traffic destined to Lafayette, and an increasing volume of heavy truck traffic. In essence, the highway has outgrown its originally intended use. Traffic volumes, truck volumes, the size of trucks, development along the highway, and vehicle operating speeds have all increased. Improvements are needed.

In conjunction with the preparation of the Environmental Impact Statement (EIS) and in recognition of the increasing safety issues on this section of SR25 resulting from the changing character of the traffic and the highway, the Hoosier Heartland Industrial Corridor Inc. has identified the need to document the current level of safety of this section of SR25 through a road safety audit and to submit the results with the EIS.

A road safety audit is an independent and formal process, conducted by a team of road safety specialists who, based on their experience and expertise, identify issues related to the geometry or operating features of the highway that have the potential to contribute to the occurrence of collisions.

Road safety audits address only safety issues and do so in an explicit manner. They do NOT directly address issues of conformity to standards, but provide opinions on the safety issues by the auditors from the perspective of the road users. This perspective is important, since it is necessarily different from that of the designer and often focuses on elements of human factors science, on combinations of design features that may create potential problems, on unusual design situations that may not be adequately addressed in the context of conventional design approaches, or on changed circumstances in the role and usage of a road which may contribute to inadequacies in what was at one time an acceptable design.

The audit also does not present solutions to any identified safety issue, but merely points out the relevant issues of concern. The identification of potential solutions and the decision about whether any practical solutions can

be identified are left to the responsible road agency and design team, who must necessarily consider a broader range of issues than just safety in evaluating alternative approaches to mitigating such problems. This approach frees the audit team from having to consider constraints or a restriction on what is possible, concentrating instead on where problems appear to exist. It is this ability to focus exclusively on road safety issues that is the underlying strength of the road safety audit process.

Road safety audits may be carried out at the planning stage of a road, at its conceptual or detailed design stage, as part of the commissioning process, or on existing facilities. They are also being increasingly applied to temporary roadwork situations. When applied to existing situations – as in the case of SR25 – they can be of substantive assistance in helping to identify the underlying causes of existing safety-related problems and the priority areas where scarce rehabilitation funds can be best invested. They may also indirectly help to rule out the practicality of some solution paths.

This report documents the results of an existing facility audit on the section of SR25 from Lafayette to Logansport, comprising part of the Heartland Highway Project in the State of Indiana. Mr. Garry Petersen of William-Lynn-James Inc. on behalf of the Hoosier Heartland Industrial Corridor Inc. commissioned the report.

2.0 Background

The section of SR25 involved in the audit extends from County Road 300N outside of Lafayette to the interchange with US 35 at Logansport, a distance of 31 miles. Within that section, SR25 is primarily an unimproved two-lane undivided highway. At County Road 300N the facility has a four-lane cross-section, with a common center left turn lane, reducing to a two-lane section with a common center left turn lane, and then to the typical two-lane section over the first 0.6 miles. Within the city of Delphi, the cross-section expands to accommodate turning lanes at some intersections and parking lanes on each side of the highway.

With the exception of the areas noted above, the cross-section of the highway is rural in nature, with lane widths estimated to be in the order of 11 to 12 feet (typical for such a facility), but with virtually non-existent shoulders throughout its length. Drainage is provided by means of open ditches which, in several instances, incorporate concrete linings. Although property or geometric plans of the highway were not reviewed, judging by the nature of developments in close proximity to the edge of the highway, the right-of-way appears to be severely constrained for most of its length. If this is the case, the ability for this facility to be upgraded in place may be substantively compromised.

SR25, within the limits of the audit, carries significant volumes of both automobile and commercial vehicle traffic. Average Annual Daily Traffic (AADT) volumes in 1994 were between 7,500 and 12,000 between Lafayette and the Carroll County line.[1] In 1997, records show volumes in excess of 16,000 per day on SR25 within the city of Delphi. The 1997 records also show volumes dropping in the vicinity of SR 218, with an AADT immediately south of SR 218 of 6,500 and approximately 4,300 north of SR 218.[2] Anecdotal information provided by local road authorities and law enforcement officers suggests that traffic volumes have generally undergone a substantial increase in the last 12 to 15 months, particularly commercial vehicles [3]. These increases have been attributed, at least in part, to traffic pattern shifts resulting from the opening of sections of the Heartland Highway north of Logansport.

The posted speed limit on SR25 is 55 mph, except near the existing communities where it is reduced to between 25 and 45 mph. School bus stops occur at frequent intervals along the highway.

A total of 1,094 collisions were reported along the section of SR25 between Lafayette and Logansport during the period 1995 to 1998. This translates into a collision rate of just over 3 collisions per million vehicle miles of travel on the facility. Of the 1,094 collisions, 15 were fatalities, 282 were personal injury and 797 were property damage. Of the 15 fatalities, 10 occurred in the section of SR25 between Lafayette and the city of Delphi.[4] Using American Association of State Highway and Transportation Officials (AASHTO) ranges of estimates of societal costs associated with these differing accident types,

these collisions represent a societal cost over the period of between $37,000,000 and $74,000,000. [5]

3.0 The road safety audit

3.1 The audit team

This road safety audit was carried out by:

- John B. L. Robinson, Ph.D., P. Eng.
  Delphi Systems Inc.
- Gerry Smith, M.Sc., P. Eng.
  GCS Technology
- **Observer**: Mr. Garry Petersen
  William-Lynn-James Inc.

The audit was carried out on site and in the offices of the respective firms, and comprised the following:

- A review of a previous technical report looking at corridor alternatives provided by William-Lynn-James Inc. in preparation for the audit. [6]

- A site visit and field audit, conducted by the full audit team during the nighttime hours of August 24th, 2000.

- A site visit and field audit, conducted by the full audit team during the daytime hours of August 25th, 2000.

- Preparation of an on-highway field video of the roadway during daytime hours, in both directions on the facility on August 25th, 2000.

- Meetings with various officials and law enforcement personnel held on August 25th, 2000 during the course of the audit.

The audit was carried out in accordance with general procedures set out in guidelines prepared for such work by Delphi Systems Inc.[7] These guidelines are based on generally accepted industry practices with respect to such surveys and follow well established models originally developed by Australian and British road authorities. The Federal Highway Administration (FHWA) has recognized and advocates road safety audit procedures as useful and cost-effective tools for the explicit evaluation of road safety issues related to both existing and planned roadway facilities.

3.2 The audit process

The field survey began immediately north of Lafayette, at the intersection of SR25, and County Road 300N. It then proceeded in a northerly direction along SR25 to the city of Delphi. Continuing north on SR25 through the city, the audit terminated at the southerly boundary of Logansport at the interchange with US35.

The field survey was then extended over the same portion of SR25 in a southerly direction to the original starting point at County Road 300N. Six passes were completed of the study area and, in the course of one of these a video survey of the road environment was captured as a permanent record of conditions as of the survey date (August 25th, 2000). A number of still pictures of specific sites of concern were also gathered at this time.

In the course of the field survey, we also took time to observe traffic operations at a number of specific locations in order to better appreciate how drivers are using the facility. The results of one traffic collision were noted during the course of the survey day – a sideswipe between vehicles traveling in opposite directions on the study route just at the southerly edge of the city of Delphi. Vehicle damages were extensive, but no fatalities or personal injuries were incurred.

Police enforcement operations were also observed on at least two occasions on portions of the highway north of Delphi. A number of substantive traffic violations were also observed, including one vehicle reversing (backward) on SR25 in traffic in the vicinity of its intersection with County Road 300N.

3.3 Format for the observations

As noted previously, this audit is not a geometric or signing standards conformity check. It focuses on the identification of safety-related concerns of the road and its related signing, appurtenances, roadside etc. The commentary is based primarily on field observations. No detailed review of plans, collision statistics or other supporting material was carried out other than as noted in Chapter 1 of this report.

The observations are summarized in two parts:

1. ***Predominant concerns***: This section constitutes the majority of the audit report. It provides a series of observations describing operational features, design elements and other aspects of the road environment which constitute road safety-related concerns common to all or a great majority of the road length. The commentary cites typical examples of such hazards, but does not catalogue each and every occurrence.

2. ***Specific comments***: This portion of the report cites particular features and characteristics of concern on individual parts of the road at defined locations. This commentary should not be interpreted as being comprehensive. It is selective in nature, and identifies only certain elements judged to be of particular significance. These are documented in point form, proceeding in a northerly direction beginning at County Road 300N. In this case, the part of SR25 under review is divided into three distinct road sections:

    - Section 1: County Road 300N to County Road 900N
    - Section 2: County Road 900N to State Road 218
    - Section 3: State Road 218 to US 35 at Logansport

In both sets of observations, the commentaries may cover any or all of the following technical areas:

- Alignment and cross-section
- Auxiliary lanes
- Intersections and accesses
- Traffic control devices and illumination
- The roadside
- Pavements
- Provision for non-motorized modes of transportation
- Other considerations

4.0 Predominant concerns

The comments in this section bear on features that:

- Give cause for concern from a road safety standpoint; and
- Are ubiquitous throughout all – or a substantive part – of the facility.

While some examples and photographs are provided as illustrations, these are not necessarily the only instances of such features within the study area.

4.1 Alignment and cross-section

Three (3) road safety issues were identified bearing on alignment and cross-sectional features of the roadway. These included:

1. The presence of several long tangent sections of road followed by short sections of fairly tight curvilinear alignment which serve to link continuing offset sections of the tangents. These sections are located in the portion of the study area to the north of the city of Delphi in the general areas of Rockfield, Burrows, and Clymers.

   Research in the area of design consistency has shown that long tangent sections followed by the abrupt introduction of single or back-to-back curves are generally associated with higher collision rates than those which might occur with more consistent, regular, curvilinear alignment design. Human factors research suggests that this may be the case because drivers become accustomed to the longer tangent sections and have some difficulties adapting to the sudden isolated presence of one or more curves.

2. Shoulder widths throughout the study area are virtually zero, leaving no room for maneuvering in the event of emergencies, recovery from an excursion from the traveled way, stopping because of breakdown, or even police enforcement activities.

   Shoulders play an important part in providing the user with such opportunities, and also influence driver behavior on the road itself. The absence of shoulders may tend to encourage drivers to place their vehicles closer to the centerline than might otherwise be the case – thus increasing the possibilities of sideswipes and/or head-on collisions between opposing vehicular traffic. During the course of the audit, the aftermath of at least one collision of this type was observed.

   The absence of appropriate shoulder widths can also substantially compromise safe and efficient maintenance activities.

   Figure 1, is illustrative of the typical shoulder availability on SR25.

Figure 1: Lack of shoulder in the cross-section

3. With the exception of the portion of SR25 that falls within the city of Delphi municipal boundaries, the cross-section does not make any provision for either bicycle or pedestrian activity within the right of way. In spite of this fact, signing indicating the possible presence of bicycles can be found in at least one location in the northern part of the study area for traffic moving in a southbound direction. Provisions for even a limited pedestrian roadside presence would normally be expected – particularly in light of the fact that SR25 is a school bus route. The lack of such provision – particularly in the face of the lack of shoulders on the road - increases the potential for child or other pedestrian involvement in a serious collision.

4. The general horizontal and vertical alignment of SR25 between Lafayette and Delphi often appears to compromise minimum stopping sight distance requirements, and seriously constrain passing opportunities.

4.2 Auxiliary lanes

Auxiliary lanes play an important part in providing drivers with protected areas which can serve differing purposes: storage for right or left turning vehicles; channelizations at intersections; acceleration and deceleration lanes; passing and climbing lanes; bypass lanes for through traffic at rural intersections with left turns; and others. When properly designed, such lanes have been shown to reduce vehicle conflicts – particularly in the area of intersections – and to reduce the potential for rear-end, sideswipe and right-angled accidents in such locations.

Our field observations identified four problematic areas with auxiliary lanes within the study area:

1. The widths of the auxiliary lanes, where present. In traditional geometric design practice, auxiliary lanes may have a narrower width than the traveled lanes of a highway. Typical values for the width of auxiliary lanes in regular service will lie between 10 and 12 feet.

Throughout the study area we observed the presence of an unusual type of right turn auxiliary lane, and a through traffic bypass lane (to allow through traffic to pass around left turning traffic in the normal through lane).

Field measurements of the width of these lanes were not made because of the danger to audit personnel, however the width of these lanes was estimated to be in the order of 8 feet. Such widths provide neither the protection nor the maneuvering room required for effective use, and may mislead drivers into a false sense of security of being out of the rapidly moving through traffic stream. This in turn, increases the potential for high-speed rear-end and sideswipe collisions which – because of the speeds involved – have a higher probability of fatal or personal injury involvement.

2. The means of developing right turn and "bypass" lanes. All of the lanes discussed above are developed (and tapered out) using a very short taper distance and abrupt transition from the normal cross-section. This further reduces the effectiveness of these lanes for drivers – generally forcing more abrupt steering and deceleration maneuvers which in turn increase the potential for loss of vehicular control.

3. Pavement markings play an important role in communicating lane use information to drivers. None of the auxiliary turning or bypass lanes noted above possesses any pavement marking or signing information to help communicate to drivers how they are to be used. Lack of such information can lead to confusion – particularly for drivers unfamiliar with this road. Such ambiguities in signing and marking can have particularly negative consequences when associated with high inter-vehicle speed differentials (stopped and turning vehicles vs. normal through-lane traffic speeds). The potential for collisions will generally increase under such circumstances.

4. The section of road between Delphi and Lafayette offers few locations where passing sight distance is available. This fact, combined with the high volumes occurring on this stretch, means that few if any passing opportunities are available, particularly during higher volume periods. Such restrictions may, because of driver frustration, induce drivers to make rash and incorrect decisions that can compromise both their own safety and that of other drivers. Desirably, the provision of adequate passing opportunities in such circumstances is assured through the use of auxiliary passing lanes. None are provided on the section of SR25 reviewed in this project.

The case of auxiliary lanes, their design, and use as discussed above presents a particularly significant dilemma, since each of the factors noted above compounds the effects of the others. Research suggests that the negative influence on safety performance in such circumstances is certainly compounded to some degree – thus substantively increasing collision potential.

4.3 Intersections and access

Intersections and driveway accesses to any highway are critical focal points for vehicle conflicts. Geometric designers are particularly attentive to design details in such situations, recognizing the need to minimize conflicts, provide positive guidance to drivers, and ensure effective use of the common intersection areas by vehicles and pedestrians alike. In our review of SR25, we encountered two broadly based concerns regarding both signalized and unsignalized intersections.

1. The lack of effective auxiliary lanes. As noted in the earlier parts of our report, traffic volumes on SR25 are particularly heavy between Delphi and Lafayette. Previous discussions highlighted the problems associated with the designs currently used on the facility, which effectively leave most of the unsignalized intersections with no protection or guidance for turning vehicles. The need for such provisions is well established in both practice and in the research literature, as is the potential for increasing collision occurrence when they are not provided.

2. Severely oblique intersections and driveways. North American design codes generally recommend that intersection angles not be less than 70 degrees. Severe intersection angles may create visibility and maneuverability problems, slowing traffic operations and (in the case of unsignalized intersections) exposing vehicles to potential conflicts for a greater period of time than would otherwise be the case. In addition, under nighttime conditions, severe intersection angles (of which several were observed) may result in headlight glare and/or orientation problems for drivers on the main road – particularly when rural intersections are not illuminated (as is the case on SR25). Additional comments on this problem are provided in Chapter 5.0.

4.4 Traffic control devices and illumination

Traffic control devices include signs, pavement markings, traffic signals and related technologies. These serve a vital complementary role to design – helping to eliminate or control conflicts, provide positive guidance to motorists, and present regulatory, warning, directional and service information to drivers. Such devices are carefully designed and standardized through organizations such as the Institute of Transportation Engineers (ITE) and the federal government, who publish a national guideline under the rubric of the Manual of Uniform Traffic Control Devices which forms the basis of state and municipal practices.

Illumination – when appropriately applied – has been shown to be a very effective road safety countermeasure, achieving collision reductions of up to 70% of nighttime accidents. It is particularly effective at high conflict points such as unsignalized intersections and major commercial driveways – increasing the conspicuity of the intersection, and rendering the pavement area readily visible to approaching traffic. It is through these mechanisms of increased conspicuity and visibility that this technology achieves its impressive results.

In reviewing the study area of the project, we noted three ubiquitous problems associated with illumination and specific traffic control devices.

1. The lack of illumination at intersections. With the exception of the portion of the road within the Delphi city limits, there is no illumination at any of the intersections within the study area. As can be expected, this renders night visibility in critical intersection areas difficult at best. In the course of the night audit, a lack of intersection and driveway conspicuity was observed throughout the project. At least one case of misleading approach headlights at a severely oblique intersection was also noted.

2. The quality (reflectivity/visibility) of existing pavement markings. Drivers depend on pavement markings to provide clear and unequivocal guidance for lane placement, vehicle control, and effective continuous navigation. This is particularly the case at night, when road features, intersection configurations and directional changes are not as clearly visible as during the day. While no reflectance measurements were taken, and notwithstanding the excellent application of centerline in-pavement reflective devices (cat's eyes), both the yellow painted centerline and white edgelines appeared to lack adequate reflectivity. Related pavement markings (i.e. stop bars at minor road intersections, etc.) were similar. The lack of clear positive guidance through the medium of pavement markings can have a serious and deleterious effect on the safety performance of the road.

3. The lack of any warning/information signing or pavement markings at intersection left turn bypasses and right turn lanes. Signing and supplementary directional pavement markings play an important role for drivers – especially those who are not necessarily familiar with the route and/or any unusual design features. We found no evidence of measures taken to provide such positive guidance to road users. The lack of good positive guidance leaves motorists in an ambiguous position, and increases the likelihood of collisions in situations where driver workload is already high, such as that which occurs on intersection approaches.

Figure 2: Lack of pavement markings or signing with auxiliary lanes

4.5 The roadside

The roadside plays a determining role in the overall safety performance of a road. Errant vehicles (those which depart the traveled way) must be provided a suitable recovery area and, since the 1950's, AASHTO has adopted and espoused the concept of a "forgiving roadside" – one which allows for recovery without collision, or one which minimizes the impact of such collisions in the event they occur. A fundamental principle of the forgiving roadside is that of the clear zone: the provision of a minimum distance from the outside lane edge that is free of obstacles and encumbrances that might mitigate against recovery, or increase the severity of a collision. The clear zone concept is complemented by well-established principles for the use of traffic barriers in instances where such requirements cannot be met.

Our field audit revealed substantive and ubiquitous shortcomings with respect to both appropriate clear zone provisions and the application of guide rail technologies on SR25 in the study area.

1. It is clear from our review that the kind of clear zone we would normally expect to see on a facility of this type, carrying these volumes of traffic, is not provided anywhere along its length.

   Numerous instances of utility pole lines, trees, retaining walls, culvert headwalls, and other roadside "furniture" were noted throughout the study area. These have very serious negative implications for both the frequency and severity of collisions occurring in the study area and merit early attention. Two examples of such problems are provided in Figure 3 on the page following.

Figure 3: Typical roadside obstacle: Utility Poles and Trees

2. Multiple instances of inappropriate traffic barrier installations were noted throughout the project. Among the problems found were: incorrect mounting height and lateral placement; obsolete barrier technology; and the use of outdated barrier terminations. Once again, these problems can reduce the effectiveness of the barrier installations and increase collision frequencies and severities. One example of such barrier related problems is shown in the photograph in Figure 4.

Figure 4: Example of one roadside barrier installation problem: Outdated terminal

4.6 Pavements

Pavements were subject to only a visual inspection in the course of the audit. This visual inspection did not reveal any readily apparent pavement-related safety concerns. However, no physical testing or measurements of skid resistance, rut depths, aggregate polishing etc. were carried out. No observations were carried out during heavy rain conditions.

One instance of a substantive pavement drop off in an area which had been recently repaired without adequate shoulder re-grading was noted.

4.7 Non-motorized modes of transportation

In the course of our field audit, little use of the road by either pedestrians or cyclists was noted. Nonetheless, a bicycle sign at the northern end of the audit area was observed, apparently warning of the presence of bicycles. In addition, anecdotal information provided in the course of our meeting held on site, suggests that horse and carriages of the Amish community in the region use the road on occasion. The constrained cross-section of the facility provides no accommodation for non-motorized traffic.

The presence of a school bus route and stops throughout the study area, with its implied use of the SR25 roadside - even if only briefly - by school-age children underlines the importance of this major concern.

4.8 Other considerations

Six additional considerations were noted in the course of our work.

1. Headlight presence at some oblique intersections. At some intersection locations with particularly acute angles of intersection, the presence of headlights on the side road combined with the directional changes of SR25 in its immediate vicinity, could present drivers with confusing signals about the directional change of the main road.

2. Glare from parallel railway tracks at night. Although we were not able to confirm the phenomenon visually at night, there appears to be some potential for glare from railway locomotive headlights to interfere with the night vision of oncoming vehicles on the lanes immediately parallel to the track. This question should be reexamined at a later date.

3. The lack of any shoulders on the road means that there are no breakdown areas where a vehicle might be able to pull off in the event of a tire puncture, engine stoppage, or other vehicle failure. This can result in a very dangerous situation for both the driver of the broken down vehicle, and others on the road attempting to get by.

4. The lack of any shoulders on the road makes law enforcement virtually impossible because of the relatively few areas where vehicles can be pulled over safely. In the event that such enforcement is undertaken, officers are exposed to excessively dangerous conditions while stopped and outside of their vehicles.

5. The presence of an active and intense agricultural industry in the region suggests that the road will be used and crossed by slow-moving agricultural traffic regularly during the harvest season. Discussions with stakeholders confirmed this fact. The lack of signing and/or passing opportunities for traffic when the road is being used in this manner - particularly in the section of the road between Delphi and Lafayette - is a source of concern.

6. There is a tendency for vegetation along the highway to restrict sight distance availability at both intersections/driveways and horizontal curves.

5.0 Detailed comments

Our comments in this section are arranged on a section-by-section breakdown. As noted in Chapter 3, we have broken the study area down into three major parts:

- Section 1: County Road 300N to County Road 900N
- Section 2: County Road 900N to State Road 218
- Section 3: State Road 218 to US 35 at Logansport

References to mileage points are measured from the intersection of County Road 300N going north.

5.1 Section 1: County Road 300N to County Road 900N

5.1.1 Context

This section begins with a four-lane cross-section that includes a common left turn lane in the center of the undivided two through lanes per direction facility. The cross-section is initially urban. Within 0.3 miles of its beginning, the section begins to transition to a rural, two-lane, two-way undivided facility as described in the opening sections of this report

5.1.2 Observations

- The signalized intersection with County Road 300N is not illuminated. Given the volumes it handles, its relative complexity, and its proximity to the urban area, illumination would probably provide a cost effective safety improvement.

- The transition from four lanes to two begins at about mile 0.3. At one point the transition is marked by a series of oddly arranged and sharply tapered pavement marking edge lines on the right side. This arrangement does not appear to provide smooth, continuous guidance to motorists at what is a critical point in the road.

Figure 5: Transition from four lanes to two leaving Lafayette

- The first portion of the section (up to 0.3 miles.) contains multiple driveway accesses to both residential and commercial properties. Given the relatively high volumes present in this part of the section (in excess of 12,000 vpd) the lack of effective access control is problematic.

- After the transition from four lanes to two lanes, (accomplished between mile 0.3 and mile 0.6 in the northbound direction), there are few if any shoulders throughout the section. See Chapter 4 for a discussion of the implications of this fact.

- Multiple obstacles exist in the clear zone of this section, including: utility pole lines; vee-ditches; trees; culvert headwalls; and retaining walls on private property. These constitute serious safety hazards. Additional discussion on this issue is contained in Chapter 4.

- The use of poorly transitioned left-turn by-pass lanes and right-turn auxiliary lanes is common in this section at many unsignalized intersections. As noted in Chapter 4, such treatments provide the motorist neither adequate time to take advantage of them, nor sufficient width to make their use practical. In addition, there are no pavement markings or signs to indicate to unfamiliar users how these facilities are to be used. These unconventional treatments are misleading, poorly implemented, and constitute a substantive safety hazard to motorists.

- Law enforcement officers identified the junction of SR25 and State Road 225 (SR225) as an area of particular concern. Our review showed that this intersection is located in the sag of a vertical curve, with substantive grades on the approaches, apparent sight distance restrictions at the approach crests, and horizontal curves on both approaches. No right turn auxiliary lane is provided on SR25. Turning radii do not permit southbound heavy articulated vehicles to maneuver from SR25 to SR225 without intruding into the opposite direction approach lanes on SR225. The approach grades on SR225 are substantial. This combination of critical factors creates a uniquely hazardous location on SR25 at this intersection.

Figure 6: Intersection of SR25 and SR225: Southbound approach

- The entrance to Ruby Hill Farm (at approximately mile 4.5) is at an acute angle to SR25 and is located at the start of a downgrade with a sharp horizontal curve to the left for northbound traffic, with the driveway approaching from the right. At night, vehicles approaching SR25 on the driveway create a disturbing illusion and tend to disorient drivers such that they may mistake the path that SR25 actually takes.

- The lack of passing opportunities in this section – due to both topography and volume – creates driver frustration and inappropriate passing attempts. Law enforcement personnel have also identified this situation as a critical hazard on this portion of SR25.

- The area in and around Americus (approximately miles 6.5 to 7.0) has a number of residential and business driveways, as well as at least two intersections. There are few auxiliary lane or signing provisions to provide guidance or warnings to motorists using the road in this area - a surprising fact given the apparent node of development that occurs here.

- The intersection of SR25 and County Road 900N marks the end of this section. This intersection is severely oblique, with steep approach grades on County Road 900N. Although it is a major turning point – providing access to the Delphi Municipal Airport and the community of Flora - no provision has been made for appropriate auxiliary turning lanes. Vegetation in the immediate area of the intersection appears to create some sight distance issues.

Figure 7: Intersection of SR25 and County Road 900N

5.2 Section 2: County Road 990N to State Road 218

5.2.1 Context

This section begins south of Delphi and ends at State Road 218, north of the city along SR25. Our audit in this section was interrupted just north of the intersection of SR25 with US421 (west), and began again at the transition

from the urban cross-section to the two-lane rural cross-section on the exit from the city of Delphi.

5.2.2 Observations

- The intersection of SR25 with US421 is located on a horizontal curve. Although channelizations and turning lanes are present, they are poorly marked from both a pavement marking and signing standpoint. Superelevation transitions in the intersection area are poorly executed and lead to vehicle disturbances that may be disruptive to some drivers. Trucks attempting to turn from SR25 (northbound) to US421 encounter difficulties because of insufficient room to allow for vehicle off-tracking. The intersection approach from the north carries the following message: "Wait: Delayed Signal". The meaning of this message is unclear and confusing to motorists unfamiliar with the route. This combination of design and operational factors creates a hazardous location for its users. The collision noted earlier in this report occurred on the south leg of this intersection.

- The part of this section within municipal boundaries was not reviewed for audit purposes.

- The barrier treatment through the underpass at mile 13.9 should be reviewed for adequacy.

- The bridge rail used on the overpass at mile 14.2 should be examined with respect to its adequacy.

5.3 Section 3: State Road 218 to US 35 at Logansport

5.3.1 Context

The last section audited was almost completely rural in nature, with the exception of the presence of three, small, rural communities along its path. Unlike Section 1, the alignment in this section was primarily straight and flat. The primary concerns noted below related to the changes in alignment in the environs of the three rural communities.

5.3.2 Observations

- The observations relative to general issues continue to apply to this section, although they are not specifically cited.

- Changes in vertical and horizontal alignment in the areas of the rural settlements, coupled with the multiple driveways within their boundaries, and their locations at the end of long tangents create an unusual and unexpected situation for the driver. The phenomenon of driver expectations contributes to the particularly hazardous nature of these areas: sudden curves after extended periods of driving in a straight line are known to be areas of higher collision occurrence.

- At mile 20.8 there is a structure with bridge rail that lacks any barrier on the approach. This should be reviewed and corrected as necessary.

- At mile 27.7, there is a rail crossing with crossing signal standards that lie within the clear zone.

- The intersection with Anderson's major grain facility (at Clymers, approximately 28 miles from the beginning point of the audit) represents a major turning point for heavy commercial vehicles, and possesses the same problematic design features (lack of adequate turning, bypass and acceleration lanes) as virtually all of the major unsignalized intersections throughout the study area.

- At about mile 28.2, there is another rail crossing with crossing signal standards within the clear zone.

- At mile 31.2, there is a bridge rail immediately adjacent to the traveled lanes of the highway, with no approach barrier.

6.0 Concluding statement

A field audit of SR25 from Lafayette to Logansport was carried out, operational and related information provided by various parties was reviewed, and discussions were held with stakeholders identified by the client. The audit has been carried out for the sole purpose of identifying any features of the facility that could be altered or removed to improve its level of safety. The identified problems have been noted in this report for review and consideration of the client.

7.0 Summary of areas of concern

The following point form list provides a summary of the key areas of concern identified in the course of the safety audit. It should be read in conjunction with the main text of the report.

- The presence of road sections with long tangents (straight sections of road) followed by isolated short portions of tight curvilinear alignment.
- The lack of adequate shoulders on the road.
- The lack of provision for bicycle or pedestrian use of the highway.
- The lack of adequate passing opportunities on the highway between Lafayette and Delphi.
- The inadequacy of the general design of auxiliary lanes, where present.
- The lack of adequate pavement striping or signing in conjunction with auxiliary lanes, where such are present.
- The general lack of auxiliary lanes at major intersections.
- The ubiquitous presence of severely oblique intersections and major driveways.
- The lack of illumination at intersections.
- The apparent lack of reflectance of existing pavement markings at night.
- The presence of numerous roadside obstacles within the clear zone of the roadside.
- Multiple instances of inappropriate and/or outdated roadside barrier installations.
- The lack of provision in the cross-section to accommodate horse and carriage traffic that is known to exist.
- The presence of school bus routes and stops without any apparent adequate roadside features to accommodate school-age children as pedestrians.
- The potential for headlights at oblique intersections to confuse and/or disorient drivers on SR25 at nighttime.

- The potential for headlight glare from locomotives to create visibility problems for drivers on SR25 at nighttime where sections of track are parallel and close to the highway.
- The lack of adequate storage or refuge areas for vehicles that break down.
- The lack of adequate storage or refuge areas to allow for law enforcement activities without unnecessarily endangering law enforcement personnel.
- Various observations regarding specific features as noted in the report.

8.0 For further information

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9.0 References

[1] Indiana Department of Transportation. 1994 Average Annual Daily Traffic Summary.
[2] Indiana Department of Transportation. 1997 Average Annual Daily Traffic Summary
[3] Meeting with various municipal and law enforcement officials held in Delphi on Aug. 25th, 2000.
[4] Collision summaries provided by William-Lynn-James, Inc. Franklin, Indiana. August 2000.
[5] American Association of State Highway and Transportation Officials. "Roadside Design Guide". AASHTO. Washington, DC. 1996. P. A-17.
[6] The Corradino Group. "State Road 25, Hoosier Heartland Corridor Evaluation of Alternatives". Technical Report. Indiana. March, 1995.
[7] Delphi Systems Inc. "Road Safety Audit Guide: Existing Roads". Internal Procedures Manual. Scotsburn, NS. 1997.