FDOT Research Project

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Manual

Local Agency Guide for Developing Highway Safety Projects

Safety Project Development Capacity for Small Communities in Coordination with Local Technical Assistance Program (LTAP) Center

October 2013

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FDOT Contract BDK77 977-21

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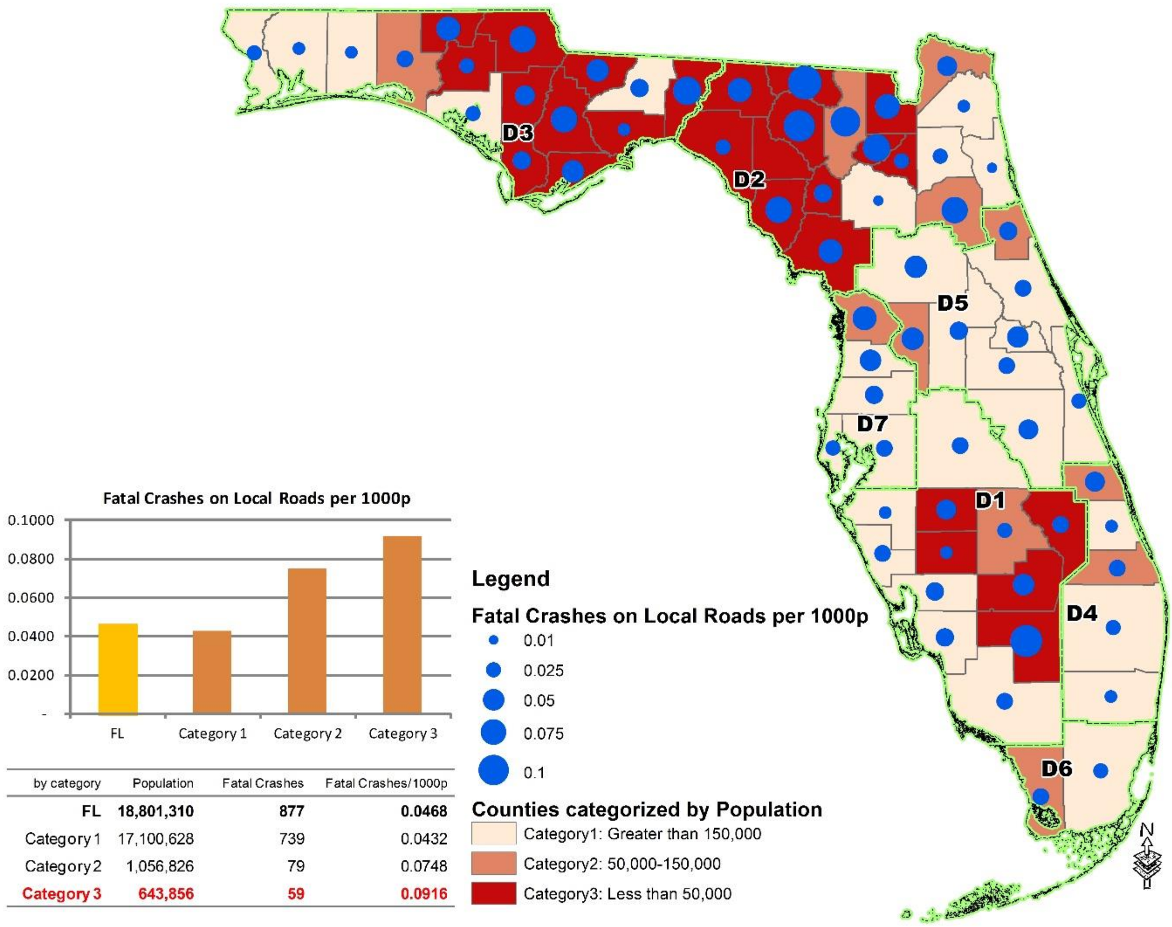
1. INTRODUCTION

This document is developed in response to the need to address safety issues on local roads in Florida with the assistance of the Local Transportation Assistance Program (LTAP) Center and the Florida Department of Transportation (FDOT). This concern is supported by the crash statistics on local roads, the goals of Florida's Strategic Highway Safety Plan (SHSP) and the local agency's lack of traffic safety improvement expertise in small counties. The intent of this guide is to assist local agencies in identifying safety projects that can reduce crashes and strongly compete for funding. A rigorous data-driven procedure is outlined to identify projects that will significantly reduce crashes and will yield a high level of benefit for each dollar spent. A process for developing appropriate justification material and applying for funding is described.

1.1 BACKGROUND

From 2007 to 2011, an average of 13,961 fatalities and serious injuries per year occurred on locally owned roads in Florida, accounting for 42 percent of all fatalities and serious injuries statewide. In small counties - with population less than 50,000 - the disproportionate number of fatal crashes and fatalities on locally owned roads is especially evident.

During a three year period from 2009 to 2011, local roads in small counties experienced annually 0.0916 fatal crashes per 1,000 people which it twice the rate of 0.0468 fatal crashes per 1,000 people for statewide local roads. The chart and map in Figure 1 illustrates these statistics. In addition to small counties, the mid-size counties – with population 50,000 to 150,000 – experienced fatal crashes at 1.8 times the statewide rate of fatal crashes on local roads.



by category	Population	Fatal Crashes	Fatal Crashes/1000p
FL	**18,801,310**	**877**	**0.0468**
Category 1	17,100,628	739	0.0432
Category 2	1,056,826	79	0.0748
Category 3	**643,856**	**59**	**0.0916**

Figure 1 Fatal Crashes on Local Roads per 1,000 people (one year average from 2009 to 2011)

The Florida SHSP states that more than 4,000 people died in Florida and over 50,000 were seriously injured in intersection-related crashes between 2006 and 2010. Additionally, nearly 39 percent of the statewide traffic fatalities can be attributed to lane-departure crashes. According to the National Highway Traffic Safety Administration (NHTSA) Traffic Safety Facts 2010, 24.3 percent of Florida's fatal crashes occurred with a fixed object as the first harmful event. Although Florida is experiencing a decline in lane-departure crashes due to significant steps taken to implement strategies on the State Highway System identified in the 2006 SHSP such as audible pavement markers and barrier programs, these strategies have not been implemented as widely on Florida's local roads, which, with 110,000 centerline miles, make up 90 percent of all Florida roads.

Safety improvements to reduce crashes on local roads for small counties are challenging, often due to the limited resources in staff and funding of local agencies responsible for maintenance. Also lacking is access to crash data and the knowledge to relate the statistical data with challenges and formulate acceptable solutions to mitigate the identified challenges. Based on a survey conducted by University of Florida in June of 2013, most small counties have neither sufficient staff nor the data inventories and analytical tools to conduct safety studies.

1.2 DOCUMENT OBJECTIVES, ORGANIZATION, AND AUDIENCE

In light of the discussions above, FDOT funded a study to develop a mechanism to assist local agencies conduct and implement safety improvements with the assistance of the LTAP Center. Broadly, it is envisioned that the LTAP Center will work with local agencies (especially counties with a population under 150,000 which typically have the most limited staff and data resources) to determine crash issues, conduct safety studies, coordinate with FDOT on the funding application process and oversee the execution of the design and construction of improvements.

This document serves as a guide to help local agencies define safety projects, develop safety studies on their local roads, and get these projects programmed. Specifically, this document first identifies the key stakeholders (LTAP staff, local agency staff and FDOT managers, and technical personnel) and their roles in this process. The major sources of funds available are discussed (Chapter 2) along with details on application criteria. This would be of particular interest to local agency managers / decision makers. The overall process of developing an application for these funds is presented (Chapter 3). It is envisioned that LTAP staff will generally apply this procedure for any local agency to develop funding applications for specific safety projects. The document also has several appendices that present the technical details of the individual steps in the overall procedure. While these appendices are primarily for the LTAP staff who will be leading the data collection and analysis efforts, staff in the local agency may also be interested.

Once funding is approved for a project, there is an established procedure for FDOT to pass federal dollars to local agencies using, in most cases, the Local Agency Program (LAP; see Chapter 2 for more details). In cases where the local agency does not have the capability to do LAP projects, FDOT may design, contract, and inspect projects implemented on their behalf. FDOT may also involve LTAP expertise as appropriate.

FDOT District 7 has developed a robust and effective outreach program to help the local agencies within the district apply for federal safety funds for their projects. The program includes: detailed guidance in the form of a manual and other documents, consultants who serve as “safety ambassadors” to work with agencies in each county of the district, and a web site with guidance about the program, schedules, and other useful resources. The program includes a well-developed application process and a series of meetings with local agencies scheduled to help keep submittal deadlines corresponding to the timetable for adding projects to FDOT’s Work Program during the annual update cycle.

While most local roads in District 7 are within agencies that have staff with expertise to analyze their safety challenges and prepare applications, many of the smaller agencies in other districts lack this expertise and must rely completely on outside assistance for this help. As stated previously, the focus of this guide is on assisting counties which do not have this in-house expertise and how the agency can work with LTAP analysts to identify and develop justifications for safety projects. It is envisioned that LTAP will play a role in helping agencies understand their challenge and develop some long term strategies that will address them through not only projects, but also operational practices.

2. FUNDING GUIDE

This chapter begins by identifying funds available for safety improvement projects on local roads (Section 2.1). The federal Highway Safety Improvement Program (HSIP) and Florida's Small County Programs are first discussed followed by other federal-aid programs including those that focus specifically on bicycle and pedestrian facilities. The implementation protocols for these funds are discussed next (Section 2.2). Although the Local Agency Program (LAP) is the primary mechanism for administering safety project funds, other models are also being explored in the state to expedite the process of implementing the identified safety treatments.

2.1 SOURCES

2.1.1 Local Funds

A portion of Florida's motor fuel tax is reserved for cities and counties to be used for construction, maintenance, and operation of local transportation systems. Some local agencies have augmented these funds with other revenue sources such as impact fees, optional sales tax, or appropriations from the agency's general revenues. Economic conditions in recent years have led to the decline in all of these revenues, and significant cutbacks in transportation budgets have been required. Most local agencies are now faced with serious issues in simply providing basic maintenance services, and have very limited resources for enhancements of their system.

While state transportation revenues are indexed so that revenues increase as the Consumer Price Index changes, the local share of the motor fuel tax is still based on a fixed number of pennies per gallon. As the cost of construction and maintenance of the highway system increases, the capacity of local gas taxes to support this need continues to decline. The downturn in building activity in recent months has drastically reduced the impact fees that are collected, but these fees are reserved for new capacity projects and generally not a viable source to support most safety projects. The overall decline in property values throughout the state has drastically affected the ad valorem revenues in most cities and counties.

While minor safety improvements can and should be made by agencies through their routine maintenance operations, local governments are faced with increasing difficulty in finding the resources necessary to develop or enhance road safety programs. Additional revenues from sources such as the federal aid program will be required in order for the State of Florida to make significant reductions in serious crashes on local roads.

2.1.2 Federal Safety Funds (HSIP)

The Federal Highway Administration's (FHWA) Highway Safety Improvement Program (HSIP) is the primary source of funds FDOT uses to assist local governments with their highway safety programs. Although other funds may be available from time to time, this guide describes the processes for selecting safety projects and developing the documentation needed to support the use of federal safety funds on local roads.

The following excerpt from FHWA[1] describes the Highway Safety Improvement Program:

> *The Moving Ahead for Progress in the 21st Century Act (MAP-21) went into effect on October 1, 2012. It continued the Highway Safety Improvement Program (HSIP) as a core Federal-aid program. The goal of the program is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on tribal lands. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance.*

Florida's share of HSIP funds as appropriated by MAP 21 is more than $100 Million per year. These funds are available for use on both state and local roads, and can be used for design and construction of qualifying safety projects. Unlike most other federal funds, HSIP funding is not limited to roads on the federal highway system.

All federal highway funds flow from FHWA through the state highway agencies. In Florida, these funds must be budgeted in FDOT's Five-Year Work Program. FDOT is responsible for selecting projects and ensuring that all federal and state requirements are satisfied. FDOT adds new projects to the Work Program during the annual program update. For HSIP funded projects, Safety Offices develop lists of candidate safety projects, but final project selection is made by FDOT's State Safety Office. Local agencies should work with their District Safety Engineer to develop requests to fund highway safety improvements.

The general time line for the annual update of FDOT's Work Program and for obtaining approval for funding a project with HSIP funds is:

- Summer – District Safety Offices compile lists of candidate safety improvements along with cost estimates and supporting documentation.
- Fall – State Safety Office finalizes selection of projects and prepares a proposed update to Five Year Work Program.
- Winter / Spring – Legislature reviews/approves state budget, including FDOT's Five Year Work Program
- July 1 – Funds are available for expenditure on projects approved for the next 12 months.

The key criteria for selecting a project for HSIP funding are:

- Project must be consistent with Florida's SHSP[2].

    Two of the SHSP emphasis areas that are common challenges on rural local roads are Intersection Crashes and Lane Departure Crashes

[1] http://safety.fhwa.dot.gov/hsip/
[2] http://www.dot.state.fl.us/safety/SHSP2012/StrategicHwySafetyPlan.pdf

- Project must be supported by data.

  Data should demonstrate that the proposed improvements can be expected to significantly reduce serious injury and fatal crashes. As a general guide, projects should have a benefit/cost (B/C) ratio of at least 2.0 to be considered, but projects with higher B/C can be expected to receive higher priority for funding.

2.1.3 State Funds for Small Counties (SCOP and SCRAP)

Florida Statute (FS 339.08) spells out the authorized uses of the State Transportation Trust Fund. While the primary use of state transportation revenues is for the state transportation system, the statute authorizes state funds to match all federal transportation funds, including funds used for roads under the jurisdiction of cities and counties. This statute also authorizes state funds for certain other programs like the Small Counties Outreach Program (SCOP) and Small Counties Road Assistance Program (SCRAP). These programs are intended to assist small counties in addressing their challenges in preserving their roads.

Small County Outreach Program (SCOP) for counties with population of 150,000 or less

From Work Program Instructions, Part III – Chapter 32: The purpose of this program is to assist small county governments in repairing or rehabilitating county bridges, paving unpaved roads, addressing road-related drainage improvements, resurfacing or reconstructing county roads, or constructing capacity or safety improvements to county roads. Small counties shall be eligible to compete for funds that have been designated for the small county outreach program (SCOP) for projects on county roads.

Small County Road Assistance Program (SCRAP) for counties with population of 75,000 or less

From Work Program Instructions, Part III – Chapter 33: The purpose of this program is to assist small county governments in resurfacing and reconstructing county roads.

These programs are administered by the FDOT district offices. The districts, working with their counties, select projects to be funded through these programs. Further details of these programs (including detailed eligibility criteria) are described in Chapters 32 and 33 of FDOT's Work Program Instructions[3].

Note that these funds are not designated specifically for safety but may be used for certain safety improvements or combined with Federal Aid safety funds. This may be especially useful when it is desirable to perform certain road restoration work in conjunction with a safety project. For example, if a safety project to add paved shoulders is needed, but the cost of resurfacing the existing roadway is beyond the scope of an HSIP project, the two improvements could be combined into a single project funded with a combination of the two fund sources.

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[3] http://www.dot.state.fl.us/programdevelopmentoffice/Development/WP_instructions.shtm.

2.1.4 Other Federal Aid Highway Funds

The federal highway system includes most highways under the jurisdiction of FDOT as well as some of the major roads on city and county road systems. Roads that are on the federal highway system are eligible for funding with "regular" federal aid highway funds, although most of these federal funds are used for state highway improvements. For counties in Metropolitan Planning Organization (MPO) areas, the decisions to program these funds are generally made through the MPO. In smaller counties, the decisions about programming federal funds on eligible local roads are made by the FDOT district. Projects funded by "regular" federal aid funds are not subject to the same safety data requirement as HSIP funds; however, all federal processes must be followed in consultant selection, right of way acquisition, design, and construction.

The Safe Routes to School Program is included in the Transportation Alternatives program and is managed separately. Guidance for this program is included in FDOT's Work Program Instructions[4] (See Part III, Chapter 31, and F.) Other bicycle and pedestrian facilities may be eligible for various categories of Federal funds. (See Part III, Chapter 31, G.)

2.2 IMPLEMENTATION

In Florida, FDOT is responsible for ensuring that all federal requirements are satisfied whether the project is on the state highway system or local highway system. The *Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways*[5] *(Florida Greenbook)* and *Manual on Uniform Traffic Control Devices*[6] *(MUTCD)* govern the design and construction of road projects on local roads in Florida. Other federal requirements also control the contracting process.

Table 1 summarizes options that are available for implementing safety improvement projects. The typical method FDOT uses in implementing projects using federal funds on local roads is the Local Agency Program[7] (LAP, see first row in Table 1). Following this process, the local agency performs design, and administers the construction contract with oversight by FDOT. FHWA reimburses the local agency (through FDOT) upon certification that the work has been performed and complies with the appropriate standards.

To use the LAP process a local agency must meet certain minimum capability requirements and be certified by FDOT to have this capability. Not all local agencies have this capability. In some instances, consultants may be certified to perform this work on behalf of a local agency that does not have the available staff or expertise. (If a consultant is paid with project funds, this

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4 http://www.dot.state.fl.us/programdevelopmentoffice/Development/WP_instructions.shtm.
5 http://www.dot.state.fl.us/rddesign/FloridaGreenbook/FGB.shtm
6 http://mutcd.fhwa.dot.gov/
7 http://www.dot.state.fl.us/projectmanagementoffice/lap/

consultant must have been selected in accordance with the federal criteria.) In other cases, FDOT may handle projects on local roads for agencies that do not have this capability.

Table 1 Options for implementing highway safety improvements with HSIP funds

Implementation Method	***Description***	***Typical Example***	***Issues***
Conventional construction contract for specified project (managed by local agency as a LAP project or by FDOT)	Major work that may require significant survey, design, environmental impacts, or other issues unique to the site	Realignment of road to eliminate sharp curve; major road widening	• Traditionally implemented through LAP. • Small local agencies may not be LAP certified, and must rely on FDOT.
Design-build; push button contract	Work that is repetitive in nature, easy to scope and for which quantities can be reasonably bid on unit price basis before projects are defined.	Guardrail, signals, shoulder paving (if project does not involve extensive earthwork, environmental permitting, or similar complexities)	• Improvements can be implemented quickly. • Contractor may prepare some of the plans if work is simple – reducing both time and resource requirement for agency and FDOT. • Contract administered by FDOT; local agencies have little direct control. • Process is still in trial basis and not fully adopted by all districts.

Force Account	Work is performed by agency personnel and reimbursed by FHWA	Work the agency is capable to perform	• May speed up work if agency resources are available and FHWA criteria can be satisfied.
			  ◦ FHWA criteria may be difficult to satisfy. See: FHWA 23 CFR 635 Subpart (B)
			  ◦ Requires justification confirming lower cost or emergency.
			  ◦ Requires agency to have a system for tracking costs that can be audited by federal agencies.
			• State statute limits size of project that can be performed by in-house personnel (see FS 336.41).

Implementation Method	***Description***	***Typical Example***	***Issues***
Furnish equipment / materials to local agency; installation at agency cost	Local agency installs equipment using in-house personnel or contractors	Install signs; flashing beacons; signal upgrades, etc.	• Can be implemented quickly. • Local agency pays cost of labor. • May require plans or sketches developed by engineer. • May require follow up review by FDOT. • Agency personnel may require additional training.
FDOT forces	Work is performed by FDOT forces or contractor	Pavement marking, other emergency work	• Local projects would compete with state projects for FDOT resources.

3. PROCESS FOR DEVELOPING SAFETY PROJECTS

This section describes the procedure involved in securing assistance for requesting funding for local agency safety projects. The overall steps are first outlined and the individual steps are discussed in detail subsequently (Section 3.1 – 3.5). It is envisioned that an analyst from the LTAP center will lead the overall effort and be primarily responsible for all technical aspects of the work. However, an agency may choose to apply the procedure with in-house expertise if deemed appropriate.

It is also useful to emphasize that certain steps in this procedure are iterative. Specifically, information about both an agency's maintenance practices and policies (provided by the local agency) and the results from the technical analysis (done by the LTAP analyst) should be considered in the process. This may require revisions to the analysis based on local policies and practices. Overall, it is critical that agency management participate in decisions about sites to be studied and options to be recommended for implementation.

The major steps in the process for developing safety projects are:

1. Local Agency (say a county) requests help from LTAP. LTAP analyst (LTAP staff member) undertakes initial discussions with agency management to resolve scope of study, resource needs, initial plan, and identify any additional concerns.
2. Analyst assembles a team of local stakeholders. This team should include people with familiarity of agency practices and policies regarding road maintenance, ability to help obtain information from agency records, ability/authority to help with field issues like maintenance of traffic or data collection (if required), familiarity with the local road system and any history of crashes or other safety challenges. These persons may be from local administration, law enforcement/emergency management, or road maintenance unit. The team leader should also have obtained a commitment for the support and team participation required from the local agency.
3. Analyst performs preliminary/aggregate review of crashes on the county's local roads using tools such as Signal Four Analytics and FDOT's Safety Portal and identifies preliminary sites (Section 3.1)
4. Analyst convenes initial team meeting to present data about preliminary sites (Section 3.2) and to finalize the sites for field-review and further analysis.
5. Analyst conducts field review of potential sites with members of the team (see Section 3.3). Site-specific data and potential countermeasures are identified.
6. Analyst performs B/C analysis on packages of countermeasures for each of the study sites (Section 3.4)
7. Analyst presents analysis results to the management of the local agency. Feasibility of measures and reasonableness of the cost estimates and the analysis are discussed (may require inputs from the district safety office in addition to the local expertise). Additional field visits may be required and the analyses are updated as appropriate. Finally, the analyst prepares justification reports to request funding for the chosen projects (Section 3.5)

8. Once the funds are approved, the local agencies will use the established procedures for implementation in coordination with FDOT (see section 2.2) and potentially LTAP.

3.1 PRELIMINARY SITE SELECTION

Once a request for assistance has been received from a county, the analyst undertakes aggregate analyses of data to identify a preliminary set of sites. To the extent possible, the study will be conducted using data that are available from public records. This includes crash records, aerial photography, highway network maps, and available records from the local agency. It will also rely extensively on the use of Google's Street View photographs. There are several sources of information (tools) available to help the analyst select a set of preliminary sites for investigation. These include:

FDOT's Safety Portal[8] identifies road segments in each county that have crash rates calculated to be higher than the statewide averages. This is an important starting point to identify candidate sites for further investigation.

Signal Four Analytics[9] provides a robust tool for identifying locations with high crash experience (See Appendix A for an overview of this system). The graphics provide by this tool permit quick visualization of areas of concern. While further development of analytic tools to facilitate network screening can improve this process, a visual review of a map showing locations and basic attributes of crashes is an effective way to identify challenges. At a minimum, crashes should be examined for the three most recent years. For low volume roads, data for a longer period will usually provide a more complete picture of the factors contributing to crashes.

While the analyst is examining overall crash rates on local roads, it is important to pay particular attention to the following issues:

- Fatal crashes (or crash severity)
- Crash types that are considered to be emphasis areas (such as lane-departure and intersection crashes)
- Clusters of crashes – especially in rural areas
- Road segments with a high percentage of wet weather crashes
- Road segments with a high percentage of night time crashes
- Locations of motorcycles, bicycles, and pedestrian crashes

[8] http://www2.dot.state.fl.us/trafficsafetywebportal/index.aspx

[9] Available at http://s4.geoplan.ufl.edu/. Other similar tools are available and may be used. Signal Four Analytics has been developed with public funding and is available to public agencies for this purpose.

If it appears that major construction beyond the scope of the HSIP program may be needed on a site, the concern should be called to the attention of the agency management to consider alternatives.

3.2 INITIAL TEAM MEETING AND REVIEW OF PRELIMINARY SITES

The analyst convenes a meeting of the team of local stakeholders to present the findings from the initial aggregate analysis and to review the preliminary set of sites. In this meeting, input from local people who are familiar with the road network and crash history may be obtained. Emergency responders who work the crashes (both EMTs and law enforcement officers) can provide valuable insight about both areas of concerns as well as causes and potential mitigation measures. This is especially valuable in some rural areas where crashes are often not reported and not a part of the database. News reports of serious crashes and feedback from various citizens groups may also be valuable sources of information. Further, knowledgeable local agency personnel should also be consulted to determine whether there are any planned road improvements or land developments in the area that would affect the need for or usefulness of improvements at each site under consideration.

At the end of this process, certain sites may be eliminated from further consideration and/or other sites may be included for further analysis. Visits will be subsequently undertaken to the set of sites identified in this process.

3.3 FIELD REVIEW

The LTAP analyst will lead the efforts to conduct field reviews of the sites identified. Members of the local stakeholder team will participate. Separate day- and night-time reviews may be warranted for certain sites depending on the type of crashes.

The field visits generally follow the FHWA Road Safety Audit (RSA)[10] procedure. A detailed template for conducting these site reviews is presented in Appendix B. Broadly there are four main steps in this Field Review process.

First, the LTAP analyst undertakes further data analysis and prepares material for use in the field review. In addition to crash data, the analyst also obtains information from public resources such as Property Appraisers GIS files (rights of way), FDOT GIS files (Navtec Map), Google Earth or other GIS software, and information from the agency’s records (road inventory and maintenance records, traffic counts, speed limits, parking regulations, and other traffic related ordinances, etc.) . Maps are prepared and printed to assist with site review (further details are presented in Appendix B).

[10] http://safety.fhwa.dot.gov/rsa/

Second, the team members undergo training/orientation on the field review process. Ideally, all team members should have participated in a formal RSA training course. FHWA offers a two-day training course[11] in Road Safety Audits. LTAP also provides a one-day course in Road Safety Assessments covering the key elements of the Road Safety Audit. However, in smaller agencies, most of the local representatives will not likely have had such training and time and resources may not permit them to participate in a full RSA session. For this purpose, a short training/orientation presentation has been prepared for use by the analyst to train the field review team[12]. Appendix B also describes other items to be discussed at the orientation meeting before the site visits occur.

The third step is the actual field review. This step involves examination of crash data and field conditions to (1) understand factors contributing to the crashes, (2) identify potential counter measures and (3) collect enough data about the road and surrounding environment to assess the feasibility and approximate costs of various countermeasures.

While reviewing sites to identify safety challenges and potential counter measures, the team should first ascertain whether the traffic control devices and messages are consistent with current Manual on Uniform Traffic Control Devices (MUTCD) standards. Generally, upgrades of traffic control devices to meet current MUTCD standards should take place whenever improvements are made to a road. For rural roads, upgrades to comply with MUTCD most often deal with signs and pavement markings, and may represent relatively low cost improvements. Often, these upgrades can be installed by agency personnel.

The team should make a general assessment of whether the road conforms to Florida Greenbook standards. While it may be unrealistic to upgrade a road to full compliance, the team should have a good understanding of which elements may not comply. In some cases it may be cost effective to incorporate such upgrades into a safety project. In other cases, it may be appropriate to address the non-conforming features with a design exception.

Given the volume and nature of the crashes at the site, the roadway geometry and other features, the review team may determine several possible countermeasures. Typical countermeasures to address a wide variety of issues are addressed in various publications. FHWA has published Local Rural Road Owners Manuals[13] that include countermeasure applicable to rural roads. The Transportation Research Board has published a series of reports discussing countermeasures for a variety of issues. The complete listing of these reports is available at: NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan Transportation Research[14]. While suggestions and examples from these documents are helpful, these should be used as a starting point for the countermeasure selection, not as a "cookbook". Site specific conditions will often govern and may indicate other options that are more appropriate.

[11] http://safety.fhwa.dot.gov/rsa/training/
[12] Power point slides available along with this guide
[13] http://safety.fhwa.dot.gov/local_rural/training/#lrrom
[14] http://www.trb.org/Main/Blurbs/152868.aspx

Field reviews also involve site-specific data collection to support further analysis. In smaller communities, detailed information about road features (signs, culverts, road widths, etc.) may not be available and will need to be collected during the field investigation. Much of this can be obtained quickly and easily using a hand held GPS device. For the purpose of preparing an estimate and an analysis of the B/C, quantities estimated on the basis of a sample may be sufficient. The extent of the detailed data required will vary from site to site.

It is useful to note that the current state-of-practice B/C analysis procedure does not make use of traffic volumes. However, these are an important input to analytical methods described in the Highway Safety Manual[15] (HSM). Given that traffic volumes are not readily available for most roads in rural communities, it may be necessary to either use FDOT's estimated traffic volumes or conduct traffic counts if the HSM equations are to be used instead of the simplified state-of-practice methods (See further discussion in Section 3.5).

The final step is a debriefing meeting to review the data collected on site. It is very important that the field review leads to a preliminary assessment that cost effective countermeasures can be implemented (and the identification of some potential countermeasures). After preliminary reviews have been completed and tentative sites have been identified, the analyst should obtain concurrence from agency management that the sites are appropriate.

3.4 BENEFIT COST ANALYSIS

Florida DOT emphasizes a data-driven approach for identifying and prioritizing safety projects. The state of the practice approach is the B/C analysis that uses site specific crash history and crash modification factors (CMFs) associated with potential countermeasures in order to evaluate safety treatment alternatives.

The benefits of a treatment are determined based on the monetary worth of the estimated reduction in the number of crashes due to the application of the chosen countermeasure(s). The reduction in crashes due to application of a countermeasure is determined using the crash history at the site and CMFs. If multiple countermeasures are applied as a package, the net benefit is obtained by multiplying the CMFs associated with each of the treatments. FDOT has determined[16] standard resources[17] [18]from which values of CMFs may be obtained. The reduction in the crashes (per year) can be monetized using estimates of crash costs available from FDOT.

The next step of the analysis is to determine the total annual project cost for the identified countermeasures. The costs are estimated using the FDOT Item Average Unit Cost

[15] http://safety.fhwa.dot.gov/hsm/
[16] FDOT State Safety Office Bulletin 10-01 http://www.dot.state.fl.us/rddesign/Bulletin/RDB10-09.pdf
[17] http://cosharepoint.dot.state.fl.us/sites/safety/Safety%20Engineering/references/default.aspx
[18] http://www.cmfclearinghouse.org/

Spreadsheet[19]. The annuity factor is calculated using the interest rate (4%) and the lifespan of the specified countermeasure.

The B/C ratio is simply the ratio of the annual benefits to the annualized costs. The overall procedure has been implemented in a simple spreadsheet program for use by the LTAP analyst. Appendix C presents the B/C analysis spreadsheets as used in an example project (Level 1 countermeasure implementation for the S-curve on CR 229, south of SR 121). The direct project site includes 0.9 miles of CR 229 and is expanded to 2.2 miles for signs and markings.

It is appropriate to note two items about this approach. First, the B/C analysis based on crash history is a simple data-driven approach relying generally on data items that are readily available. This is currently used in practice. However, it is very likely that there are sites (especially in rural areas) that have a strong potential for crashes that “just haven’t happened yet”. When applied to such sites, (i.e., no historical crashes), the B/C approach would simply indicate that improvements are not needed. Therefore, it may be preferable to perform the analysis based on the number of potential crashes (crash “risk”) rather than the actual historical crash estimates. The Highway Safety Manual provides Safety Performance Functions (SPFs) that provide estimates of potential crashes. If reliable estimates of traffic volumes are available, the analyst may consider using a combination of SPFs and local data (the “empirical bayes method” described in the HSM) to estimate crash reduction benefits rather than relying on purely historical data.

Second, this procedure generally concentrates on the use of a “spot” approach to selecting projects and analyzing potential benefits of improvements at such locations. An alternative, the “systemic” approach recognizes that crashes are more likely to occur on roads with certain characteristics, but these crashes may occur at random locations throughout the road or road network. This approach involves examination of roads on a system wide basis, and generally requires collection of significant amounts of data about road characteristics. Documentation of additional risk factors observed during the analysis is helpful in assessing the priority of a potential improvement.

3.5 PRODUCTION OF A JUSTIFICATION REPORT

At the completion of all analysis, a justification report is prepared for the identified safety project at each site. This report should include a qualitative assessment based on field reviews and local knowledge as well as emphasis on data-driven analysis and satisfying all federal requirements. The justification report should include a site description (scope of the project), an analysis of potential safety challenges based on crash history and field observations, emphasis areas for corrections, countermeasure scenarios, countermeasure B/C analysis, and consideration of countermeasure implementation issues. The selected countermeasure(s) should have a B/C ratio of greater than or equal to 2.0 and should support the emphasis areas identified in Florida’s SHSP. An example of a justification report is provided in Appendix D.

[19] http://www.dot.state.fl.us/specificationsoffice/Estimates/HistoricalCostInformation/HistoricalCost.shtm

Before finalizing recommendations, draft versions of the report should be reviewed with senior managers and/or elected officials of the local agency. This review should highlight issues that may require decisions or commitments by the agency (e.g. traffic signal maintenance, financial participation, etc.) It should also address consistency with agency policy and potential community impacts such as noise from rumble strips or objections to removal of trees. This discussion also provides an opportunity for the review team to discuss recommendations for actions by the local agency. These discussions may lead to revisions in the analysis and even additional site visits. The set of assessments included in the final report should have the “buy-in” from all stakeholders.

APPENDIX A: SIGNAL FOUR ANALYTICS

Introduction

Ability to access and analyze crash data is a necessary step in the process of developing safety projects because determination of needs and prioritization of interventions is expected to be data driven. Collection and maintenance of a crash data inventory requires significant resources which typically are out of reach for small to medium county agencies due to limited resources.

To address this concern and to make the crash data available and easily accessible in a timely fashion, Florida Traffic Records Coordinating Committee (TRCC) has funded the development of a statewide crash data analytical system to support the needs of local agencies in the state. This system is called Signal FourSignal Four Analytics and it is developed and hosted at University of Florida Geoplan Center. Access is free of charge and available through the internet using an internet browser such as Internet Explorer or Firefox or Chrome.

This appendix provides a brief summary of the essential information and the capabilities of Signal Four Analytics. The Quick Reference Guide with more details on how to use Signal Four Analytics is included in the software and is available in Signal Four Analytics website. Additionally, the website contains recorded webinar sessions that show how to use the system.

Access: Signal Four Analytics main web site is at http://s4.geoplan.ufl.edu/. This site contains general information about the system, the database and the updates. An account is required to access the interactive system from this website. Please contact your agency Signal Four Analytics user administrator to obtain one, or, if your agency doesn't have one, please follow the link on the website to request an account. Once you have an account, click on the *Login* link located in the home page to get in.

Database: Signal Four Analytics contains long form crash data for all the counties from January 1st 2006 till present. It also contains short form data for all the counties from July 1st 2012 till present. The new crash data are loaded in the system daily. It's expected the database will be updated with both long and short form crash records in the future without interruptions. For the crash reports completed by law enforcement agencies that use electronic crash collection systems, the crash data is either current or one or two days late. For agencies that still use crash paper forms, the information could be 2-6 weeks late due to delays during mail and data entry from paper to digital by Highway Safety Motor Vehicle (HSMV) contractors. As soon as the digital data become available to HSMV, it is loaded in Signal Four Analytics within the same day.

Analytical Features: Signal Four Analytics has many functions designed to explore and analyze the crash data. Main features include:

- *Visualization:* Users can see where crashes are located on the map. The maps can be navigated easily by zooming in and out or panning. An aerial photography or a cartographic map can be used as basemap. Crashes are shown in clusters when zoomed out to a large area. The clusters turn into individual crash points shown by crash type symbology.

- *Selection:* The system allows the user to selected crashes of interest on the map.
- *Crash Attributes*: The main crash attributes are shown in a table at the bottom of the map. Attributes include date, time and place of crash, injuries involved, environment, human behavior variables.
- *Summary Statistics:* Summary statistics by attributes are shown in chart and graph form. Summaries include time of day, day of the week, month of the year, crash type, injury severity, lighting conditions etc.
- *Queries:* Crashes of interest can be searched based on numerous attributes of interest. Main query options include, date range, geographic area, network feature (i.e. an intersection or a street), mode of travel, distracted driving factors, main violation, weather, road system, pavement conditions, lighting conditions, etc.
- *Access to individual crash reports:* The full police crash report is available for each crash in the database. This is useful information to read the crash narrative and/or review the crash diagram in order to understand how and possibly why the crash occurred.
- *Automated Intersection diagram:* Signal Four Analytics generates automatic diagrams that summarize the intersection crash data by crash type and direction of travel or injury severity. The crash type for each crash is shown on the map.
- *Data Export:* Crashes of interest can be exported in csv format. The csv data can be loaded in excel for further analysis. The exported crash data can also be loaded in GIS. Instructions for converted the exported data to GIS are provided during the export process.
- *Network Ranking:* Most problematic locations – intersection or roadway segments can be determined using crash frequency, crash rate or crash severity. When local crash volume is not available the system uses estimated traffic volume for local roads determined by FDOT. If local traffic volumes are available please contact the Signal Four Analytics team to inquire about loading them into the database.

APPENDIX B: TEMPLATE FOR CONDUCTING FIELD STUDIES

Purpose

This document provides a basic template for conducting investigations required to develop highway safety improvement projects and to produce the documentation required for federal HSIP funding. It is intended as a guide for the LTAP analyst to use in preparing for and leading the study.

Assumptions

- This effort is designed to collect the data and develop the documentation and justification required for HSIP funds as these funds are the primary source of funding for these types of projects. Other sources of federal, state, or local funds may be used to supplement the program.
- The sites to be studied are on the local road system. (This guide refers to the study process after the site has been selected.)
- The site studies and analyses will generally follow the FHWA process for Road Safety Audits. This process is described in detail at: http://safety.fhwa.dot.gov/rsa/.
- The study will be conducted by a team that includes technical personnel from LTAP and one or more representatives of the local agency.
- Crash data will be analyzed using Signal Four Analytics or another database capable of displaying complete crash reports and map showing crash locations.

Composition of the Review Team

The review team for this effort should consist of approximately 3 to 5 people and will be led by an LTAP representative with experience in conducting road safety audits. The team should include at least one other person with expertise in highway design or road safety audits. The team should also include a local representative with knowledge of the agency's road construction and maintenance programs. It is desirable to include a law enforcement officer or emergency medical responder with experience in working crashes in the area.

Local representatives on the team should be able to provide background information and data from the agency's records. Local representatives should also provide insight into the agencies policies and practices as well as anecdotal information about the safety concerns.

Field Review Process

Broadly there are four main steps in this Field Review process.

- The LTAP analyst analyzes crash data and prepares material for use in the field review including base maps of locations and associated crash data / crash reports.
- The team members receive training/orientation on the field review process.
- The actual field review is performed.

- A debriefing meeting is conducted to review the data collected on site.

Preparation of Field Review Materials

Prior to the initial team meeting, the LTAP staff will conduct an analysis of the crashes and prepare materials to be used by the team. This package should include Base Maps of the locations and associated crash data / crash reports.

Base Maps

The map should be prepared on an aerial photograph in formats suitable for projecting to a screen and for printing. If practical, paper copies should be provided to each team member. Maps scaled to 11x17 inch paper are convenient for use in a vehicle. The maps should show:

- Road alignment (centerline from FDOT map should be sufficient)
- Road name
- Right of way limits
- Locations of intersecting or crossing features such as railroads, state highways, rivers, major power lines, etc.
- Traffic volumes (if available)

Information about the following features is important, but it may be necessary to collect this data during the field review:

- Traffic regulations affecting the study area. (i.e. speed limits, no parking, traffic controls at intersections such as signals, stop signs, etc.)
- Signage – location, type, and condition signs
- Culverts (across the road and at driveways)
- Guardrail
- Pavement width
- Pavement marking configuration
- Sidewalks, bicycle paths, etc.
- Marshes, wetlands, or other environmentally sensitive areas adjacent to right of way

This typical base map shows road alignment, right of way, and water crossings.

Crashes are plotted using symbols to designate severity and color to represent lighting conditions.

Figure 2 Typical base map for a study site

<u>Crash data:</u>

Crash data should be displayed on the map. It should include: crash number, date, severity, type of crash, and lighting condition. This data may be displayed using a combination of symbols and text. Electronic copies of the full report for each crash should also be available for use by the study team during the field investigation. The team will be interested primarily in the narrative and diagram sections of the report, but may occasionally need other details.

Crash summaries are critical for identifying trends and potential contributing factors. (If a study site covers a long road section with different characteristics or crash types, it may be useful to divide the site into segments.) Typical summaries may address conditions like severity, lighting, road surface, crash type, or harmful event; however, the nature of the site or crashes should be considered in deciding how to organize the summary data. The team leader should use these summaries to prepare prompts to be used by the team during the field investigations. Figure 3 Sample crash summary shows a typical crash summary with prompts prepared by the team leader to help guide the site review.

CR 229 - South of SR 121

	HSMV_Report_Number	Crash_Date	Crash_Time	Crash_Severity	Crash_Type	First_Harmful_Event	Light_Cond	Weather_Cond	Alcohol_Related	Drug_Related	Vehicles	Potential to correct	Dir of travel	Inj Severity	Curve	Intersection	Overturn?	Comments
1	77258926	1/24/2010	1:00 AM	Injury	Off Road	Ditch	Dark - Not Light	Clear	Y	N	1	Y	NB	2			Y	exit left
2	82024158	12/23/2010	4:26 PM	Fatality	Rollover	Overturn/Rollov	Daylight	Clear	N	N	1	Y	NB	5			Y	exit right; speeding
3	76998500	2/14/2009	11:15 PM	Injury	Off Road	Ditch	Dark - Not Light	Cloudy	N	N	1	Y	SB	2	Y	Y		failed to negotiate curve
4	76995572	1/27/2008	10:35 PM	Property Damage Onl	Off Road	Guardrail Face	Dark - Not Light	Clear	Y	N	1	Y	SB	1	Y	Y		failed to negotiate curve; did not see curve in time
5	77253555	10/29/2009	6:50 AM	Property Damage Onl	Parked Vehicl	Parked Motor V	Dawn	Fog, Smog, Smo	N	N	2	Y	SB	1	Y	Y		failed to negotiate curve
6	76982388	6/5/2006	1:40 AM	Injury	Rollover	Overturn/Rollov	Dark - Not Light	Clear	N	N	1	Y	SB	4			Y	exit right; speeding

	Number	*Percent*
Total Crashes	**6**	
Fatal	1	17%
Injury	3	50%
PDO	2	33%
Daylight	1	17%
Dark/other	5	83%
Curve?	3	50%
Intersection?	3	50%
Overturn?	3	50%

Site issues:

- Visibility of curve (pavement) in southbound direction
  - *Look at: advanced warnings; pavement markings; chevrons or other curve markers; intersection signage*
- Shoulder condition and recovery area - especially east shoulder before curve; recovery area
  - *Look at: pavement width; shoulder condition; shoulder width and slope*
- Night time visibility of curves and edges throughout
  - *Look at: pavement markings*
- Posted speed /vs conditions (curve and CR 793 intersection)
  - *Look at: superelevation (Ball Bank); cross slope consistency*
- Markings, signing for CR 793 at interesection

Possible countermeasures:

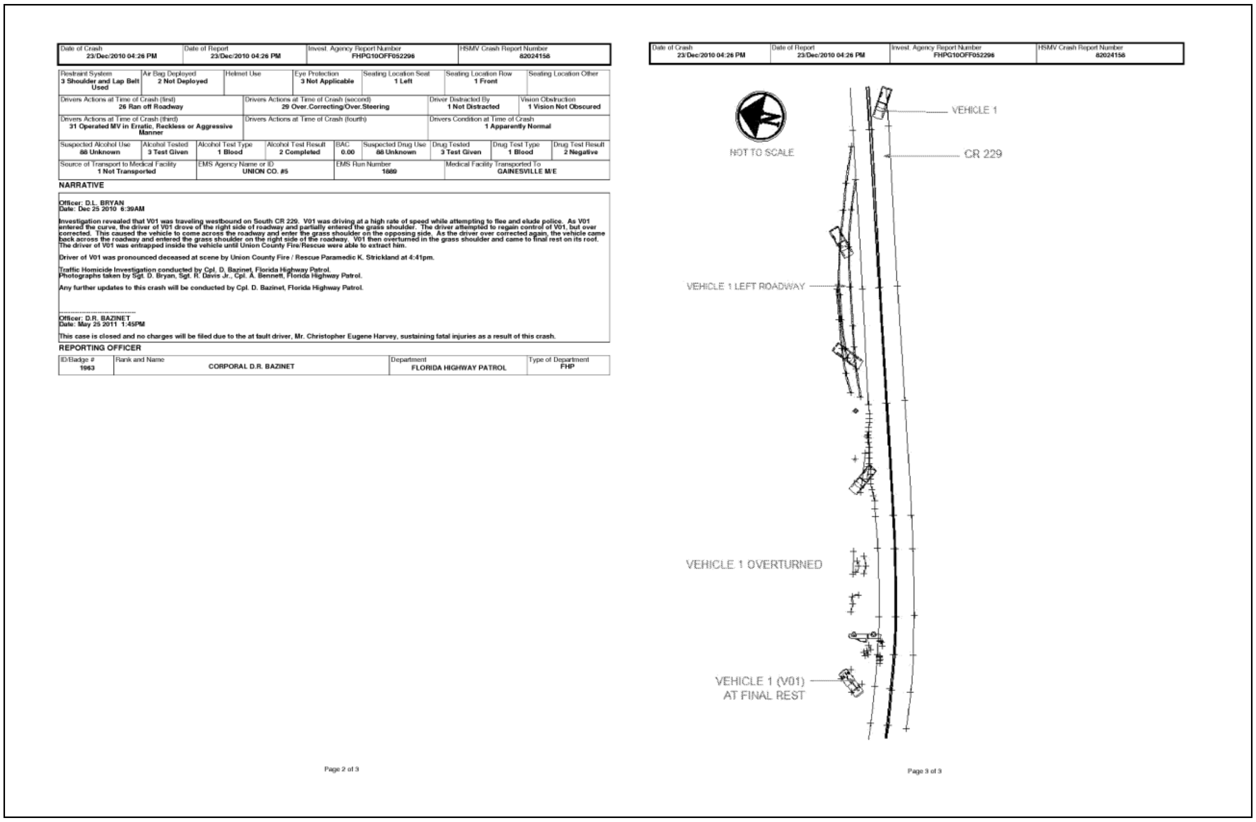
- Paved shoulders - especially on outside of curves
- Chevrons on outside of curve
- Advanced warnings for curves and intersections
- Upgrade pavement markings - edge and centerline to include audible markings or rumble stripes
- RPMs or other high visibility devices for nightime delineation of curve

Other factors

- Check bicycle usage regarding feasibility of audible warning devices.

Figure 3 Sample crash summary with prompts

The narrative and sketches in the detailed crash reports often provide important information that cannot be obtained from tabular data. Where practical, copies of these pages for the relevant crash should be included in the package prepared for each reviewer. If the number of crash reports is large and the review package is unwieldy, then a copy should be available to the review team during both the initial meeting and the field review.



Date of Crash	Date of Report	Invest. Agency Report Number	HSMV Crash Report Number
23/Dec/2010 04:26 PM	23/Dec/2010 04:26 PM	FHPG10OFF052296	82024158

Restraint System	Air Bag Deployed	Helmet Use	Eye Protection	Seating Location Seat	Seating Location Row	Seating Location Other
3 Shoulder and Lap Belt Used	2 Not Deployed		3 Not Applicable	1 Left	1 Front	

Drivers Actions at Time of Crash (first)	Drivers Actions at Time of Crash (second)	Driver Distracted By	Vision Obstruction
26 Ran off Roadway	29 Over.Correcting/Over.Steering	1 Not Distracted	1 Vision Not Obscured

Drivers Actions at Time of Crash (third)	Drivers Actions at Time of Crash (fourth)	Drivers Condition at Time of Crash
31 Operated MV in Erratic, Reckless or Aggressive Manner		1 Apparently Normal

Suspected Alcohol Use	Alcohol Tested	Alcohol Test Type	Alcohol Test Result	BAC	Suspected Drug Use	Drug Tested	Drug Test Type	Drug Test Result
88 Unknown	3 Test Given	1 Blood	2 Completed	0.00	88 Unknown	3 Test Given	1 Blood	2 Negative

Source of Transport to Medical Facility	EMS Agency Name or ID	EMS Run Number	Medical Facility Transported To
1 Not Transported	UNION CO. #5	1889	GAINESVILLE M/E

NARRATIVE

Officer: D.L. BRYAN
Date: Dec 25 2010 6:39AM

Investigation revealed that V01 was traveling westbound on South CR 229. V01 was driving at a high rate of speed while attempting to flee and elude police. As V01 entered the curve, the driver of V01 drove of the right side of roadway and partially entered the grass shoulder. The driver attempted to regain control of V01, but over corrected. This caused the vehicle to come across the roadway and enter the grass shoulder on the opposing side. As the driver over corrected again, the vehicle came back across the roadway and entered the grass shoulder on the right side of the roadway. V01 then overturned in the grass shoulder and came to final rest on its roof. The driver of V01 was entrapped inside the vehicle until Union County Fire/Rescue were able to extract him.

Driver of V01 was pronounced deceased at scene by Union County Fire / Rescue Paramedic K. Strickland at 4:41pm.

Traffic Homicide Investigation conducted by Cpl. D. Bazinet, Florida Highway Patrol.
Photographs taken by Sgt. D. Bryan, Sgt. R. Davis Jr., Cpl. A. Bennett, Florida Highway Patrol.

Any further updates to this crash will be conducted by Cpl. D. Bazinet, Florida Highway Patrol.

Officer: D.R. BAZINET
Date: May 25 2011 1:45PM

This case is closed and no charges will be filed due to the at fault driver, Mr. Christopher Eugene Harvey, sustaining fatal injuries as a result of this crash.

REPORTING OFFICER

ID/Badge #	Rank and Name	Department	Type of Department
1963	CORPORAL D.R. BAZINET	FLORIDA HIGHWAY PATROL	FHP

Page 2 of 3

Date of Crash	Date of Report	Invest. Agency Report Number	HSMV Crash Report Number
23/Dec/2010 04:26 PM	23/Dec/2010 04:26 PM	FHPG10OFF052296	82024158

Page 3 of 3

Figure 4 Excerpt from typical crash report showing narrative and diagram

Initial Team Meeting

The study process should begin with an initial team meeting, typically no more than half a day. This meeting has several purposes:

1. Provide orientation and training for the team for conducting the field review
2. Gather information about agency's polices, practices, plans, and data systems related to road management
3. Familiarize the team with the specific crash sites and crashes
4. Plan the itinerary and strategy for the field review.

Agenda for Initial Team Meeting

Introductions

1. **Orientation/Training**
   - *Review study process*
   - *PowerPoint presentation is available.*
2. **Site review – (office review)**
   - *Discuss site characteristics and related data*
   - *Review crash records*
   - *Local team member insights about sites and crash experience*
   - *Other data and information from the local agency*
3. **Develop Strategy / Plan for field review**
   - *Safety Reminder!*
   - *What to look for at each study site?*
   - *What data to collect?*

Orientation/Training

Ideally, the team members will have had previous training in road safety audits or at least be familiar with highway design standards; however, for many small agencies, participants are not likely to have had such training. The focus of this meeting is to provide the basic understanding that the team will need to conduct the specific study. Road Safety Audit training is available, and team members should be encouraged to takes such courses. Available for use is a sample PowerPoint presentation which includes a brief discussion of highway design standards, examples of safety challenges found on rural Florida roads, resources available to assist local staff, and additional references for issues like countermeasure selection. The team leader should consider adjusting this presentation to include examples of challenges likely to be encountered at the specific study site.

Review specific sites for the field study

Before beginning the field work, the team should review the study site and crash records to help the team focus on the issues they will be looking at in the field. For this review, the leader should provide a map showing the crash locations, copies of the detailed crash reports (at least the narrative and diagram), and a summary of the crashes (See Figures 2-4). This information may be presented using a projector, but copies of the map and relevant documents should also be provided to each team member for reference and note taking.

The initial team meeting should also be used to gather other background information that could affect the study site such as:

- Planned road improvements
- Recent or pending land developments
- Agency ordinances, policies, and practices regarding traffic regulation, right of way use, and road maintenance
- Asset management data systems or other agency records

Develop plan for field study

Field reviews must be conducted with a high level of attention to safety and minimum disruption to the travelling public. A careful plan should be developed for conducting the study at each site, and each team member should have a clear understanding of that plan before leaving the meeting. This portion of the meeting should address:

- Safety – including personal protective equipment, arrangements for parking, walking, etc.
- Itinerary – if possible, all team members should ride through the study area in the same vehicle to facilitate sharing observations among team members during the study.
- Schedule for follow-up reviews – at a minimum, review in both daylight and non-daylight hours will be needed for most sites. Additional reviews may also be needed or some sites.
- Data to be collected – identify specific data elements to be collected and method of measurement. Data requirements will likely vary from site to site. The team leader should have prepared an appropriate check list for each site before the meeting. Figure 5 is an example.

Field Safety Review - Site Characteristics Check list

Site: ____ Date: __________

Pavement		
	Lane width	*measure representative sites*
	Condition	*subjective assessemtn - time to overaly*
	Cross slope (if applicable)	*comment if this is likely to*
	Consider variations in superelevated curves	*contribute to crash probems*
	Other	
Shoulders		
	Width and type	*at typical locations*
	Cross slope	*show multiple sketches at problems*
	General Conditions	______________________________
	Drop offs	*use gps to mark if significant*
	Other	
Signage		
	Location/type/conditon of all critical signs	*mark with GPS and/or photos*
	may use gps and photos for documentation	______________________________
	condition	*subjective desc ription of overal conditions*
	Speed limits and advisory speeds	*show changes*
	locations of changes	______________________________
	Visibility issues affecting signs	*Identify specific problem locations*
	obstructions/ vegetation/ light condition	______________________________
	Other	
Markings		
	type and condition	*general assessent of markings*
	RPMs?	*are rpms present*
	Rumble strip: (show locations)	*locaion and conditions*
	Other	
Features in clear zone		
	guardrail	*show location and design features*
	location/ condition/ charactristics?	*is installation obsolete or incorrect? Condition?*
	utilities/ trees/other fixed objects	*do objects pose hazard?*
	Culverts/endwalls/etc	*show locations of each culvert/structure*
	ditches /steep slopes/etc	*id locations using gps*
	Other	
Intersections		
	signage/ markings/advanced warnings?	*are advanced warnings present/adequate*
	stop bars	*functional*
	visibility of oncoming traffic?	*are there sight restrictions to/from oncoming veh*
	Other?	______________________________
Other		
	______________________________	______________________________
	______________________________	______________________________
	______________________________	______________________________

Figure 5 Typical check list for field site review

Field review

Safety – **Throughout the process the team leader should continue to reinforce the need to be alert to safety issues for both the team and the motoring public.** This is especially critical if the team includes personnel who do not routinely work on road rights of way. (See the PowerPoint presentation for safety tips.)

What to look for –The field review should be focused on discovering how crashes occurred and what factors or road features may have contributed to them. In preparing the crash summary, the team leader should note issues or questions the study team should look at during the field review. Figure 3 provides an example of such an analysis and the associated prompts.

Data collection - Some field data collection will probably be required, and may be used to determine the extent to which the site conforms to MUTCD or other standards and to assess the feasibility of certain countermeasures. The exact data requirements will depend largely on the characteristics of the site being reviewed.

Some of this information may be collected during the initial field review. Often, much of this information can be obtained from aerial photographs or Google Street View. Follow up visits may be necessary.

For the purposes of these studies, survey accuracy is not usually needed. Devices such as a hand held GPS unit, measuring wheel, and smart level will usually yield adequate precision and can speed up data collection. Geocoded photographs can also be useful in documenting conditions– especially if the study site involves a long corridor. A ball bank indicator and smart level are also useful tools.

Follow-up team meeting

The team should meet for a debriefing immediately following the completion of each field review. The purpose of this debriefing is to compare observations and conclusions about the concerns and potential contributing factors associated with the crashes. The team should also brainstorm potential mitigations and, where possible, suggest countermeasure options to be analyzed. This information should be documented in the form that can ultimately be incorporated in the final report.

Analysis and Review

Following the initial site review and recommendations by the team, the LTAP team members will estimate costs and perform an initial analysis of the benefits. During this process, additional or alternative countermeasures may also be identified. After an initial analysis has been prepared, a follow up review of the site should be conducted to verify that the countermeasures considered are appropriate and feasible. The preliminary analysis may also identify additional data that must be collected or verified during such a field review. Individuals planning for the study should anticipate at least one or more return visits to the site for such verification.

After the analysis has been complete, a report will be prepared describing the potential countermeasures for the site. This will include estimated cost and an analysis of benefits. The report will also document the findings from the field review.

APPENDIX C: TEMPLATE FOR BENEFIT/COST ANALYSIS

This appendix explains the benefit/cost analysis spreadsheets as used in an example project (Level 1 countermeasure implementation for the S-curve on CR 229, south of SR 121). The direct project site includes 0.9 miles of CR 229 and is expanded to 2.2 miles for signs and markings.

The first step of the analysis is to determine the total annual project cost for the identified countermeasures. For this example, the costs are estimated using the FDOT Item Average Unit Cost Spreadsheet, which can be found at the following location: http://www.dot.state.fl.us/specificationsoffice/Estimates/HistoricalCostInformation/HistoricalCost.shtm. Cost assumptions were made for general calculations across all sites in Union County. Item and project specific costs should be used when detailed project plans are available. The annuity factor is calculated using the interest rate and the lifespan of the specified countermeasure. Each cost for the example site is provided in Table 2, which results in a total annualized project cost of $11,570.

Table 2 CR 229 S-Curve: Level 1 Project Costs.

Countermeasure		Level 1					
		unit	cost/unit	number	cost	annuity factor	annual cost
Upgrade signs to MUTCD standards		mile	$ 3,909.50	2.2	$ 8,601	5.24	$ 1,641
Pavement Markings							
	Centerline	lf	$ 0.67	23,232	$ 15,456	5.24	$ 2,948
	Edge line	lf	$ 0.66	23,232	$ 15,368	5.24	$ 2,932
	RPMs	ea	$ 3.34	581	$ 1,940	5.24	$ 370
Curve Treatments (MUTCD 2C-2)							
	Advanced warning signs	ea	$ 250.87	2	$ 502	5.24	$ 96
	Curve warnings signs with adviso	ea	$ 376.31	2	$ 753	5.24	$ 144
	Chevons	ea	$ 250.87	20	$ 5,017	5.24	$ 957
	Turn arrow	ea	$ 250.87	1	$ 251	5.24	$ 48
	Sign removal	ea	$ 14.85	3	$ 45	5.24	$ 8
Other							
	Stop sign	ea	$ 250.87	2	$ 502	5.24	$ 96
	Stop sign removal	ea	$ 14.85	1	$ 15	5.24	$ 3
	Stop bar	lf	$ 7.35	10	$ 74	5.24	$ 14
Subtotal					$ 48,522		$ 9,256
Engineering and contingencies			25%		$ 12,131		$ 2,314
Total Cost					$ 60,653		$ 11,570

The estimated number of crashes reduced due to countermeasure implementation is based on the crash history at the project site and the CMFs associated with the selected countermeasures. This site experienced a total of 6 crashes (1 fatal crash, 1 incapacitating injury crash, 2 possible injury crashes, and 2 PDO crashes) over a study period of 6 years. As specified by FDOT State Safety Office Bulletin 10-01 (http://www.dot.state.fl.us/rddesign/Bulletin/RDB10-09.pdf), CMFs should be obtained from either the FDOT State Safety Office (http://cosharepoint.dot.state.fl.us/sites/safety/Safety%20Engineering/references/default.aspx) or from the FHWA CMF Clearinghouse (http://www.cmfclearinghouse.org/). CMFs for the selected countermeasures for the example site are given in Table 3. The combined CMF for each severity level is determined by multiplying each of the individual CMFs together.

Table 3 CR 229 S-Curve: Level 1 CMFs.

CMF by Crash Severity				
Crash Severity	Edgelines	Curve Warning Signs	Chevrons	Level 1 Combined CMF
Fatal	0.741	0.70	0.78	0.405
Injury	0.741	0.70	0.78	0.405
PDO	0.741	0.92	0.78	0.532

The estimated number of crashes following the implementation of the selected countermeasures is then calculated by multiplying the observed crashes by the respective CMF based on crash severity and crash type (for this site, all crashes were run-off-the-road). The total number of crashes reduced is then found by subtracting the estimated crashes after countermeasure implementation from the previously observed crashes. For this location, there is an estimated total of 2.68 crashes for the period following countermeasure implementation (0.45 crashes/year), resulting in a reduction of 3.32 total crashes (0.55 crashes/year). To determine the benefit per year, the crashes reduced per year is multiplied by the crash cost, which is shown in Table 4. For this location, the annual benefit is $222,319.

Table 4 Crash Cost by Facility Type.

HSIPG COST/CRASH BY FACILITY TYPE						
FACILITY TYPE	DIVIDED			UNDIVIDED		
	URBAN	SUBURBAN	RURAL	URBAN	SUBURBAN	RURAL
2-3 Lanes	$85,851	$151,015	$260,531	$92,847	$228,613	$402,003
4-5 Lanes	$83,359	$181,265	$366,422	$83,359	$193,774	$94,171
6+ Lanes	$107,658	$130,385	$478,263	n/a	n/a	n/a
Interstate	$141,197	n/a	$295,810	n/a	n/a	n/a
Turnpike	$124,459	n/a	$215,507	n/a	n/a	n/a

Finally the benefit cost ratio is computed as a ratio of the annual benefit divided by the annualized project cost. This step is shown in Table 5 and results in a B/C ratio of 19.21 for the selected countermeasure implementations on this site. Table 5 also shows the net present value for the project, which is calculated as the difference between the annual benefit and the annualized cost. A positive value of the net present value shows that the project is economically justified. Further details on calculating a benefit cost ratio and net present value can be found in chapter 4 of the FHWA Highway Safety Improvement Program Manual http://safety.fhwa.dot.gov/hsip/resources/fhwasa09029/sec4.cfm.

Table 5 CR 229 S-Curve: Level 1 Benefit/Cost Ratio.

Benefit/Cost Ratio Calculation	
Annual Benefit	$ 222,319
Annualized Cost	$ 11,570
B/C Ratio	19.21
Net Present Value	$ 210,749