Roadway Data Representation and Application Development:
Developing a New Straight Line Diagram Application for the Florida Department of Transportation

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16. Abstract

The Straight Line Diagram (SLD) is a roadway mapping and data presentation methodology that has been used by the Florida Department of Transportation (DOT) for more than 25 years. It is utilized by technicians and engineers to verify field Roadway Characteristics Inventory (RCI) data, for field survey preparation, and for other related applications. The basic structure of the current programs and methodologies used to produce SLDs has become somewhat dated, considering recent developments in Geographic Information System (GIS) technology, which provides flexibility and efficiency in presenting/mapping data, and the proliferation of various new alternatives, based on aerial photography or roadway Videolog applications, that are capable of producing customized products through optional parameters.

This research project focuses on the development of a more contemporary, versatile, and user-friendly SLD application for the Florida DOT, based on output products that incorporate technological advances in GIS, automated mapping, data processing, and reporting.

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Disclaimer

"The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation."

TABLE OF CONTENTS

Executive Summary

The Straight Line Diagram (SLD) is a roadway mapping and data presentation methodology that has been used by the Florida Department of Transportation (DOT) for more than 25 years. It is utilized by engineers, planners, and technicians to verify field Roadway Characteristics Inventory (RCI) data, for field survey preparation, planning purposes, and for other related applications or needs. The primary methodology and technology used to produce SLDs in an automated fashion was developed for Florida DOT in the late 80's. The perception for some is that this approach is somewhat dated (it's almost 20 years old). Recent developments in Geographic Information System (GIS) technology, advances in the ability to use aerial photography, digital roadway Videolog applications, and other production techniques will most likely provide improvements in flexibility and efficiencies in presenting and mapping data.

This research project focuses on the review of existing SLD applications abroad and development of a modified prototype SLD application for the Florida DOT, based on output products that incorporate technological advances in GIS, automated mapping, data processing, and reporting. The specific phases and corresponding objectives of this project are summarized as follows:

Phase One: Research to give direction to the new application:

1. Assess and evaluate SLD methodologies, procedures, and products currently used in other states in order to guide enhancements to the Florida SLD application;

2. Develop specific recommendations for a versatile and user-friendly SLD application by conducting detailed surveys of: (a) individuals involved with the SLD creation and generation process (SLD producers), and (b) end-users of the product (SLD users), in Florida, in order to determine such matters as the use of the current software application,

preferred output format, difficulties faced in creating SLDs, common applications of SLDs, expectations, unmet needs, and other suggestions for improvement.

Phase Two: Development of prototype SLD application:

3. Develop and describe a prototype for a redesigned and contemporary SLD system that addresses user concerns and recent technological advances in automated cartography, GIS, data processing and reporting.

4. Describe proposed applications in sufficient detail to allow replication of the processes described and full implementation by the Florida DOT.

The results from the first phase of the project can be summarized as follows:

- Only six State DOTs (Colorado, Iowa, Ohio, New Hampshire, Vermont. and New Jersey) are currently relying on commercially available SLD products or GIS processes to generate SLDs. Additionally, several SLD tools and products used in these states (e.g., Colorado, Vermont, New Jersey) contain functionalities and features desirable in a contemporary and versatile SLD, such as dynamic web-enabled data access, visually appealing SLDs, and standardized symbology.

- The results from our surveys suggest that although a majority of respondents are satisfied with several aspects of the current SLD methodology, SLD producers are least satisfied with the mapping capabilities and SLD end-users are least satisfied with their ability to read/understand the SLD. Specific enhancements that were ranked to be of the highest priority included the software program and updating procedure for SLD producers, and the increased use of aerial photography and traffic data for SLD end-users.

- The survey results led to the recommendation that two separate SLD applications be developed for meeting the needs of SLD producers and end-users and addressing their

key concerns. The first of these two applications (Application 1) would focus specifically on the enhancements that were ranked to be of the highest priority and address only those characteristics that SLD users are least satisfied with, and incorporate other related suggestions (e.g., automatic link to RCI data). The second application (Application 2) would emphasize modifications and improvements that are of medium or lower importance and address aspects that SLD, such as the automated development of enhanced graphics, developed on-top of Application 1.

The findings and recommendations from the first phase of the project were used to inform and guide the second phase, which focused on developing two prototypes for a re-designed and contemporary SLD application for the Florida DOT.   Both prototypes incorporate a dynamic web-based visualization tool that "assembles" and represents the user selected data in a graphical and text environment. In response to expressed end-user preferences, the first prototype presents the majority of the data as text in a comparatively easy to read document. The user can select various attributes of interest and generate an SLD type of document very easily.

The second prototype extends the graphics component of the first prototype by adding enhanced roadway characteristic inventory graphics of up to 20 variables. This prototype requires further refinement in order to be a potential replacement of current SLD production procedures.

The new and dynamic web-based roadway data visualization tool (RCI Data Graphing) prototypes developed through this project are expected to provide a number of important benefits, such as:

- increased utilization and exchange of roadway data for all users (the web-based and dynamic data access components of the prototypes open up the SLDs to a whole new group of end users and make them more accessible throughout the Department);

- better integration and exploitation of RCI data through increased usage of GIS technology;

- improved usefulness of the SLD as a tool for reviewing inventory information on all roadways through a more intuitive and user-friendly format;

- an alternative and potential future replacement of the current semi-automated SLD application with a more contemporary and user-friendly application; and

- greater flexibility and reduction of time burden associated with roadway and mapping exhibits by integrating the use of GIS-based mapping systems.

Future recommendations for the next steps to be taken by the Florida DOT regarding SLD application and implementation include the following:

- further review of SLD methodologies in other states by coordinating WebEx demonstrations or site visits to become familiar with the technology options, especially in Vermont, New Hampshire, Colorado, and New Jersey;

- deploying Prototype 1 to potential end-users for testing the RCI Data Graphing functionality and validating its usefulness;

- deploying Prototype 2 to SLD producers for reviewing the enhanced graphics components of the prototype and validating its usefulness; and

- further development of the current prototypes and/or research additional software options that are capable of utilizing aerial photography and linkages to the existing FDOT Videolog system.

1. Introduction

The Straight Line Diagram (SLD) is a major roadway mapping and data presentation methodology that has been used by State Departments of Transportation (DOTs) for more than 25 years. It is utilized by transportation planners, technicians, and engineers to verify field Roadway Characteristics Inventory (RCI) data, for field survey preparation, and for many other related applications. The basic structure of the current programs and methodologies used by the Florida DOT to generate SLDs, manipulate data contents, and display information has become somewhat out-of-date, considering recent developments in spatial information technologies and related software applications. The availability of Geographic Information System (GIS) technology, which adds flexibility and efficiency in presenting/mapping data, and the proliferation of various new options, based on aerial photography or roadway Videolog applications, provide opportunities for improving the current layout and organization of the SLD, the RCI data contents, and the ways in which information is currently displayed (text or graphics). Considerable research is necessary, therefore, to: (a) fully examine the current generation of SLDs and related modifications, (b) explore new methods for generating SLDs, (c) examine options for their integration into the Florida DOT's SLD procedures, (d) recommend specific changes or technological enhancements, and (e) present a specific upgrade process to modernize the SLD methodology.

This research project focuses on the development of a more contemporary, versatile, and user-friendly SLD application for the Florida DOT and other general users based on output products that incorporate recent technological advances in GIS/mapping, data processing, and reporting. In order to give direction to the new application, the first phase of the project examines SLD methodologies used in other states and summarizes current needs and concerns, based on

feedback from individuals involved in producing and using SLDs in Florida. The second phase of the project provides specific recommendations to develop a set of prototypes for a redesigned SLD system that utilizes and integrates new tools and technologies that are missing from the current methodology. The specific goals and tasks associated with this research project are described in the following section.

1.1 Project Objectives

The specific objectives of this project are to:

1. Assess and evaluate SLD methodologies, procedures, and products currently used in other states in order to guide enhancements to the Florida SLD application;

2. Develop specific recommendations for a versatile and user-friendly SLD application by conducting detailed surveys of: (a) individuals involved with the SLD creation and generation process (SLD producers), and (b) end-users of the product (SLD users), in Florida, in order to determine such matters as the use of the current software application, preferred output format, difficulties faced in creating SLDs, common applications of SLDs, expectations, unmet needs, and other suggestions for improvement.

3. Develop and describe a prototype for a redesigned and contemporary SLD system that addresses user concerns and recent technological advances in automated cartography, GIS, data processing and reporting.

4. Describe proposed applications in sufficient detail to allow replication of the processes described and full implementation by the Florida DOT.
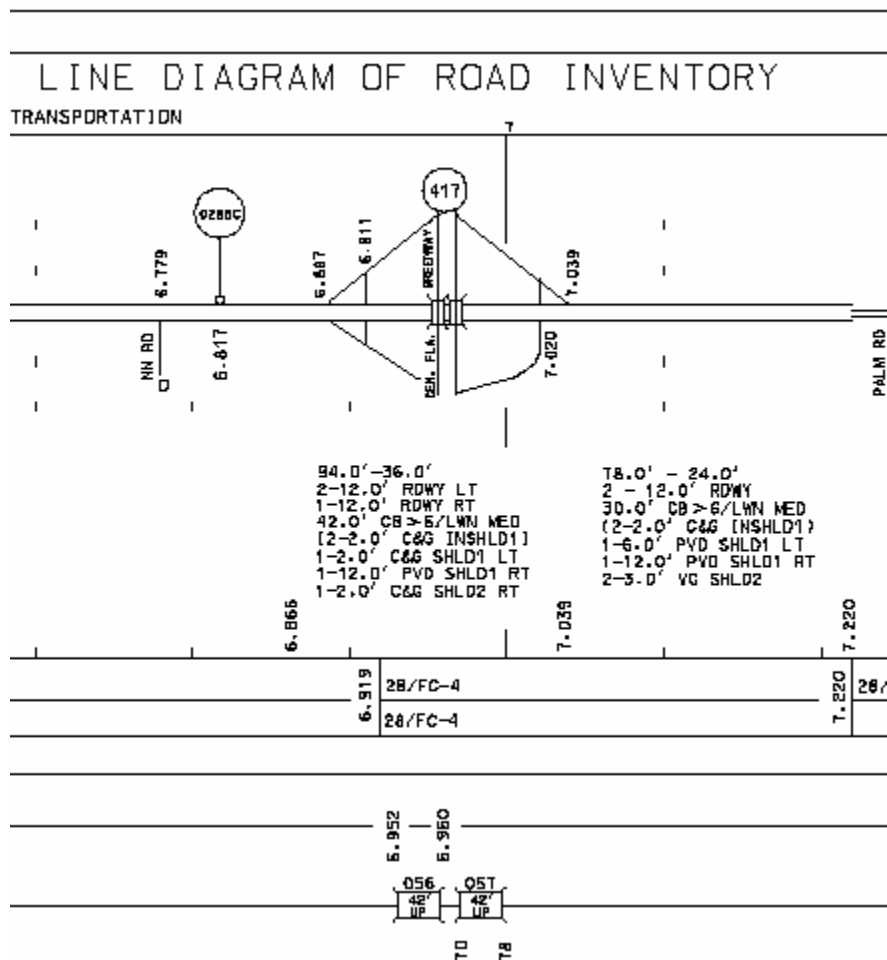
1.2 Document Organization

This document is a technical report of the conduct of the project, which describes the different project goals, phases, results, recommendations, and conclusions. The report is

organized into several sections. Section 2 provides a comparative assessment and evaluation of SLD products used in other states, followed by a summary of results from the surveys of SLD producers and users in Florida. Section 3 introduces and describes the two prototypes for a re-designed SLD application developed on the basis of recommendations outlined in the previous section. Section 4 summarizes the project findings, conclusions, benefits, and recommendations for future research.

2. Evaluation of Current SLD Applications: Review and Recommendations

The SLD application currently used by the Florida DOT provides primarily a graphical linear representation of select RCI data reported for individual roadways on the State Highway System. The SLD diagram is annotated with text information and graphics that describe or illustrate information considered to be general interest roadway data (e.g. intersecting roads, roadway descriptions, bridges and other structures, functional classification, and curve data). A sample SLD is depicted in Figure 1 below.

Figure 1. Straight Line Diagram Representation of RCI Data (Legend on following page)

STRAIGHT-LINE DIAGRAM ROADWAY INVENTORY LEGEND SHEET

CROSSDRAINS & STRUCTURES

TYPE OF STRUCTURE
CBC - Concrete Box Culvert
CC - Concrete Pipe
CIP - Cast Iron Pipe
CMP - Corrugated Metal Pipe
UNM - Unlisted Clearance
BR - Bridge (travels over facility)
UP - UP (travels under facility)

STRUCTURE ATTRIBUTES
MP - Milepost
HC - Horizontal Clearance*
VC - Vertical Clearance*
UNM - Unlisted Clearance*
TS - Type Structure
SN - Structure Number
TSW - Travel Surface Width
NC - Number of Pipes/Culverts
DIA - Diameter
L - Length
W - Width

*Optional Data

CROSSDRAINS & STRUCTURES (FEATURES 241 & 250)

Examples: Feature 241 Crossdrains
Crossdrains (20)   Culverts (20'/30)

Example: Feature 258 Structures
Bridges, Culverts (> 20')

HORIZONTAL ALIGNMENT

HORIZONTAL CURVE (221) & NON-CURVE INTERSECTION (220)
△ - Horizontal Curve Central Angle (degrees)
D - Degree of Curvature (degrees or radians (meters))
PC - Point of Curvature (MP)
PI - Point of Intersection (MP)
PT - Point of Tangency (MP)
B - Bearing (Compass Bearing on Tangent, i.e. compass direction
N or S in degrees, & curve)
NC - Non-Curve Point of Intersection (MP)
- Non-Curve change in bearing only, major turns shown using bearings)

Example: Horizontal Curves Formal

CURVE TO RIGHT   CURVE TO LEFT

PLANNING TRANSPORTATION STATISTICS

TRAFFIC MONITORING SITES (FEATURE 230)

SITE TYPE
TTMS - Telemetered Traffic Monitoring Site
(Central Office Statistics)
PTMS - Portable Traffic Monitoring Site
(District Planning Sites)

FUNCTION CODE
W - WIM - Weight, class, speed
T - Class - Class or speed
S - Speed - Speed
C - Count - Count
- All Sites collect counts

TRAFFIC COUNT SITES

ROADWAY FEATURE SECTION MAINLINE SYMBOLOGY

STANDARD LANE WIDTHS

Current	Softrounded	Hard	Current	Softrounded	Hard
8'	2.44m	2.4m	7	0.6m	0.6m
9'	2.74m	2.7m	4'	1.22m	1.2m
10'	3.05m	3.0m	6'	1.83m	1.8m
11'	3.35m	3.4m	8'	2.44m	2.4m
12'	3.66m	3.6m	10'	3.05m	3.0m
14'	4.27m	4.3m	12'	3.66m	3.6m
15'	4.57m	4.5m			

STANDARD SHOULDER WIDTHS

S.L.D. ENGLISH & METRIC EQUIVALENCE TABLE

DRAINAGE STRUCTURES
Curb & Gutter (C&G)
1.50 - 458mm
2.00 - 610mm
2.25 - 688mm

Pipe Diameters
8" - 458mm
24" - 610mm
30" - 762mm
36" - 914mm
48" - 1219mm

MISCELLANEOUS
Horizontal Alignment
Bearings & Delta △Angles
(Deg Min Sec)
Degree of Curve in Radians
on Metric SLDs

Feet (>) Meters
feet', meters·m, millimeters·mm
feet (') - .3048 · meters (m)
meters (m) · 3.280 · feet (')

URBAN AND MUNICIPAL BOUNDARIES (FEATURE 130)

BOUNDARY STATUS COMBINATIONS
URBAN & MUNICIPAL STATUS
X Inside City & Urban
X Winter Garden, Orlando
REPORT FORMATS

ROADWAY COMPOSITION (FEATURES 230 & 232)

SURFACE DESCRIPTION (230)
Pavement Surface Type
08 - Portland Cement Concrete
25 - Brick
28 - Asphaltic Concrete
99 - Other

SURFACE LAYERS (232)
Friction Course
FC - Friction Course Type
Type 0, 1, 2, 3, 4

FEDERAL FUNCTIONAL CLASSIFICATION (FEATURE 121)

URBAN DESIGNATIONS
Urban Principal Arterial/Interstate
Urban Principal Arterial/Other
Urban Other Principal Arterial
Urban Minor Arterial
Urban Collector
Urban Local

RURAL DESIGNATIONS
Rural Principal Arterial/Interstate
Rural Principal Arterial/Other
Rural Minor Arterial
Rural Major Collector
Rural Minor Collector
Rural Local

NOTE: Consult the 1998 Roadway Characteristics Inventory and Straight-Line Diagram Handbooks for more details

Rev. 4-1-98 RMF, 1-26-93 NB/RMF

Currently, combinations of semi-automated and manual processes are utilized to generate SLDs. In addition, the software product used to semi-automate the process, the Auto SLD Diagrammer, has nearly reached the limits of the ability to be significantly improved or to add more sophisticated functionality to it. This might be somewhat acceptable if user expectations remained constant. These factors, combined with the advancement of GIS and web-based technologies, have contributed to the initiation of this research project that focuses on developing a contemporary and versatile SLD product. Today's users are more familiar with the flexibility and efficiency in presentation and mapping data using GIS technology and different ways of producing customized products through various optional parameters. While current manual generation and visualization techniques are adequate in creating SLDs, the Department understands the importance of researching new technology, tools, and approaches that could potentially improve automation and efficiency.

In order to identify the enhancements and modifications necessary to make Florida DOT's more contemporary, versatile, and user-friendly, the first phase of this project focused on: (a) evaluating SLD methodologies and procedures used in other states; and (b) summarizing current concerns, unmet needs, and expectations of individuals involved in creating and using SLDs in Florida. The activities and results associated with these two research components are described in detail, in this section of the report.

2.1 SLD Products Used in Other States

Our research revealed that there are only six states (Colorado, Iowa, Ohio, New Hampshire, Vermont, and New Jersey) utilizing commercially available SLD products or GIS-based SLD generation processes. Two other states provide on-line access to previously completed SLDs in PDF format through FTP – North Carolina and Oregon. A brief outline of

the key functionality, including the pros and cons associated with the six state SLD applications

is provided in Table 1.

Table 1. Assessment of SLD Products used by State Departments of Transportation.

State DOT	Functionality	Pros	Cons
Colorado	• Pull down forms to checkbox RCI data • Resulting GIS map and RCI data tables	• Quick, easy to use • Extensible • Scalability • Web-based, dynamic in nature	• Inability to select roadway projects from map interface • Not engineering level drawing
Iowa	• GeoData Library (GDL) - houses the Iowa DOT enterprise transportation data • CTAMS allows users to access the data in the GDL for viewing, reporting, decision-making support, and in-depth analysis.	• Unknown as site is Internal to DOT	• A potential con only because the application is developed on-top of GeoMedia by Intergraph which is non-standard GIS software for Florida DOT Central Office - who is standardized on the ArcGIS ESRI platform
Ohio	• Archive of SLDs accessible via the web	• Quick, easy to locate and use • Adequate for its purpose	• Essentially a file system available on the web – no "dynamic" functionality
Vermont	• Pull down forms to checkbox roadway characteristics type data • Maps their route log system	• Developed on ESRI technology • Report output is visually appealing • scaleable	• Difficult to determine how much of functionality is available on web application vs. desktop application (which is doing the heavy lifting)
New Hampshire	• Pick list, Map, and Template driven access to SLDs through web interface	• Web-based access to tools • Unable to fully evaluate due to access issues	• Unable to fully evaluate due to access issues
New Jersey	• Access to PDF based SLDs – in a "book" format	• Visually appealing SLDs • Available Statewide in one PDF (with links)	• Not automated SLD generation • Not web-based • SLD generation requirements unknown beyond that it is client-server based

What Table 1 reveals is that these states are trying to offer access to SLD information via the web in a variety of ways, including:

- Providing archived, non-editable files for download, or

- Allowing some level of on-screen viewing, or

- Providing tools to allow interactive building and downloading of SLD information

Ohio DOT's SLD products are similar to what the Florida DOT currently provides on Infonet. It is a file access system of completed SLDs that are developed manually and placed in file folders organized by County. It provides easy access to the SLDs, but does not allow editing by the end-user. The Colorado SLD application is useful because it provides web-based access to roadway characteristics and associated information and dynamically produces a GIS location map and associated data graphing. However, the application does not include engineering level SLD design and is most useful to SLD end-users, rather than producers. The Vermont and New Jersey SLD applications provide probably the most visually appealing output products including strip maps, standardized symbology, and easy to read graphic displays (see example below). However, these applications do not currently offer web-based generation.

Figure 2. SLD Output Example from New Jersey DOT
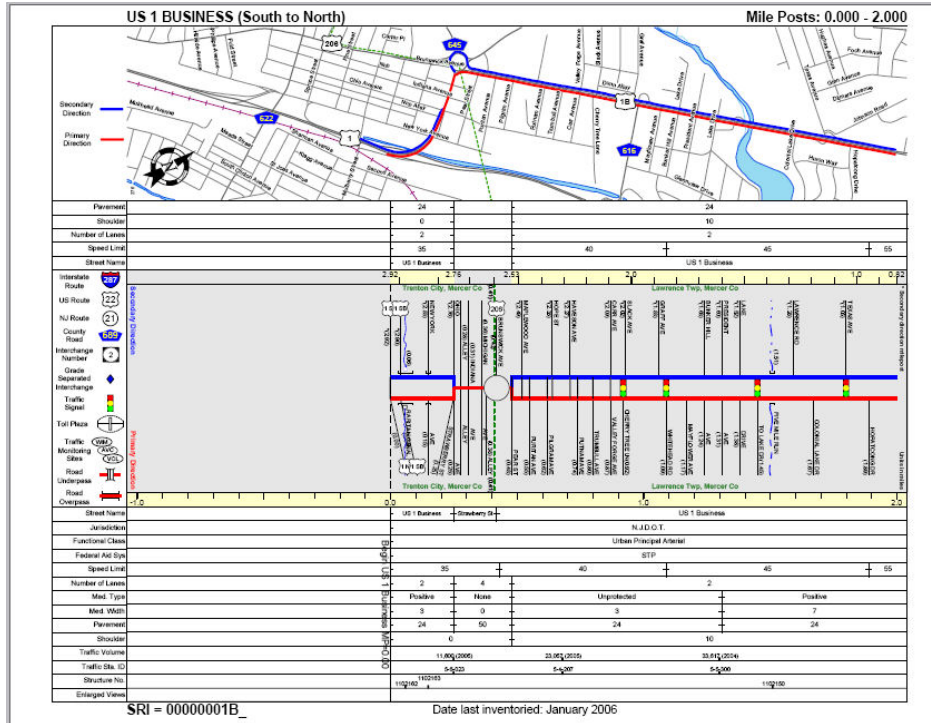
Our evaluation of SLD methodologies and products in other states led to the
identification of four specific characteristics that contribute to making an SLD application more
contemporary, informative, and useful:

- dynamic roadway characteristic information generation through web-enabled access;

- visually appealing SLD output products that include standard symbology, headings, and
  layouts;

- ability to utilize GIS to generate SLDs; and

- multiple selection methods including checkbox and GIS map options.

We recommend that these features be incorporated in the prototype SLD application for the
Florida DOT, to the fullest extent possible.

The next step in the SLD review process consisted of surveying individuals currently involved with producing and using SLDs in the Florida DOT, in order to solicit their feedback and recommendations for future SLD applications.

2.2 SLD Survey Results

This sub-section summarizes the results of the two surveys that were conducted to guide the modification and enhancement of the Florida DOT's SLD product and application. The first survey focused on those who are involved with the SLD creation and generation process (SLD producers), while the second survey was administered to the end-users of the product (SLD users). Following the project objectives described in Section One of this report, these surveys examined the following issues and questions:

- whether the current SLD program meets the needs and expectations of producers and users;

- extent of usage difficulties;

- extent of available products contrasted to current user needs;

- difficulties with editing or using current formatting;

- extent of unmet needs;

- need for better presentation procedures such as mapping, text, graphics, and tabular presentations that are unavailable through current processes;

- enhancements to output format that are relevant to user's mission;

- need and type of training desired; and

- other suggested needs or modifications;

2.2.1. Producer Survey

The first survey was administered to planners, technicians, and analysts in different Florida departments who are involved with the creation and generation of SLDs. The goal of this

SLD producer survey was to identify: (a) problems and difficulties associated with the current programs/methods for generating SLDs; and (b) modifications and enhancements necessary to make the SLD production methodology more efficient and useful. A 12-item survey questionnaire was administered to a representative sample of 12 SLD producers from different Florida DOT departments attending the DSA meeting in Tallahassee, Florida (February 22, 2006). A copy of this survey instrument can be found in Appendix A1.1 (page 36). Statistical summaries of responses to all survey questions are provided in Appendix A 2.1 (page 42). The key findings can be summarized as follows:

- All respondents currently use SLDs for *Roadway Characteristics Inventory (RCI) review*, and most of them use SLDs for *Functional Class review*, *traffic operations*, *design*, and *public transportation*. The least utilized SLD application is *Level of Service breaks*.

- Two-thirds of SLD producers are satisfied or very satisfied with their general experience with FDOT's SLD. The level of satisfaction for these respondents is highest for *overall user-friendliness* and lowest for *ease of SLD creation/generation*.

- In terms of specific aspects, SLD producers are more satisfied with the *output format*, *software program*, *updating procedure* and *mix of rendered data*, but less satisfied with the *mapping capabilities* and *integration with other software/programs*.

- Improvements to the SLD, based on the respondents' current needs, were ranked as follows:
  - highest priority: *software program*, *updating procedure* and the *output format*;
  - medium priority: *editing capabilities* and *integration with other software/programs*;
  - lowest priority: *mapping capabilities* and *mix of rendered data*.

- Other specific enhancements were ranked by SLD producers as follows:

— highest priority: *increased use of GIS technology*, *increased use of the FDOT's GIS Basemap*; and *increased utilization of FDOT's aerial image catalog*;

— medium priority: *increased use of the FDOT's Videolog* and *more use of automated graphics (CADD) applications*;

— lowest priority: *use of additional RCI data not currently in the SLD* and the *use of non-RCI information*.

- All respondents indicated the need for training, with reference documents being the most preferred type of training desired.

- Other specific suggestions for improvement focused on:

— Fix Diagrammer issue with bridge numbers.

— Fix text/annotation.

— Automatically link to RCI.

— Add traffic data and access management.

— Link to Basemap.

— Less time on editing.

— Interested in implementing in a GIS environment.

2.2.2 User Survey

The second survey was administered to Florida DOT staff that uses SLDs in their office or department, but is not directly involved with the SLD creation or generation process. The objectives of this SLD user survey were to identify: (a) problems with the current layout or organization of the SLD and related needs; and (b) modifications and enhancements necessary to make the SLD presentation methodology more effective and useful for their department. A pilot test of this survey was conducted at the DSA Meeting in Tallahassee, Florida (February 22,

2006) using a representative sample of 12 SLD users from different FDOT departments. The

responses from the pilot survey were used to revise and improve the survey instrument. The

finalized 12-item survey questionnaire was administered electronically to a representative group

of 38 SLD users in different FDOT departments across the state (April 2006). A copy of the

survey instrument can be found in Appendix A1.2. A total of 25 respondents filled out the

survey—a very high response rate of approximately 66 percent. Statistical summaries of

responses to survey questions are provided in Appendix A2.2 (page xx). The results can be

summarized as follows:

- SLDs are utilized by end-users primarily for *Roadway Characteristics Inventory (RCI)*

  review and *maintenance*. Few respondents use SLDs for *outdoor advertising*, *public*

  transportation, or *National Highway System designations.*

- Nearly 88 percent of SLD end-users are satisfied or very satisfied with their overall

  experience with FDOT's SLD. While a large majority of these respondents are satisfied with

  these specific aspects: *overall user-friendliness*, *meeting current needs*, *SLD layout*, and

  ability to read/understand the SLD, a few of them are dissatisfied with the *SLD layout* and

  the *ability to read/understand the SLD*.

- Specific improvements and upgrades to the SLD, based on the respondents' current needs,

  were ranked as follows:

  — highest priority: *use of aerial photography in the SLD* and *linking of Videolog to SLD*;

  — medium priority: *increased use of GIS* and the *use of additional RCI data not*

    currently in the SLD;

  — lowest priority: the *use of non-RCI information*.

- About two-thirds of SLD users indicated the need for training, with *reference documents* being the most preferred type of training desired.

- Other limitations identified by the SLD users include:

  — Text data difficult to read

  — Traffic data needed on SLDs.

  — The accuracy of information on SLDs.

  — ROW data is not specific to any given location.

  — Need to know the right-of-way limits.

  — Would like to see ramp lengths on the SLD's.

  — Losing new construction overlay information, needed for pavement evaluation needs for the SMO Pavement Evaluation Program.

2.3 Recommendations for Prototype SLD Application

The two surveys provide several important insights on the current difficulties and needs of both SLD producers and end-users, as well as the modifications necessary to improve and update the SLD. The results suggest that it could be beneficial to develop two separate, but related, SLD applications to meet the needs of the producers and end-users. Given that most respondents are satisfied with several aspects of the current SLD, the first of these two applications could focus specifically on the enhancements that were ranked to be of the highest priority (e.g., increased use of aerial photography, traffic data) and address only those characteristics that SLD users are least satisfied with (e.g., ability to read/understand the SLD). The second application would emphasize modifications and improvements that are of medium or lower importance (e.g., use of additional RCI data, linking of Videolog), address aspects that SLD users are moderately satisfied with (e.g., integration with other software/programs), and

incorporate other related suggestions (e.g., automatic link to RCI data). These prototype

applications developed on the basis of these recommendations are described in the following

section.

3. Development of Prototype Application and Related Tools

Following our assessment of SLD methodologies used in six other states and the results from our survey of SLD producers and users in Florida, we proposed two prototypes for a redesigned and contemporary SLD system that addresses current needs and utilizes new technologies. The first of these proposed prototypes is based on a new dynamic web-based visualization tool for roadway data with limited graphics, while the second application contained extended graphic representations of roadway characteristic variables. The key features of each prototype are summarized below:

1. **Application 1 (dynamic web-based roadway data visualization tool with limited graphics):** This application allows an SLD user to select various attributes of interest and develop a "dynamic web-based visualization tool" on the fly using RCI and additional variables to be selected. The application could also include checkboxes to select aerial photography and Videolog links in the future.

2. **Application 2 (dynamic web-based roadway data visualization tool with enhanced graphics):** This application builds on the first one but adds enhanced graphics for additional RCI variables. Up to twenty RCI variables can be created dynamically based on characteristics stored in the Oracle database using this version. Additionally, this prototype could be extended to include buffering, aerial photography, and videolog connections.

The rest of this section details the application specifications of the prototypes. A detailed user's manual is provided in Appendix B (page 68).

3.1 Prototype Application Specification for a RCI Data Graphing Tool

3.1.1 Conceptual High Level Architecture

The RCI Data Graphing application is a Web-based GIS application implemented on

ArcIMS and Oracle relational database technology. The following diagram details the

application program flow for implementation.

Figure 3. Implementation of Proposed RCI Data Graphing Application
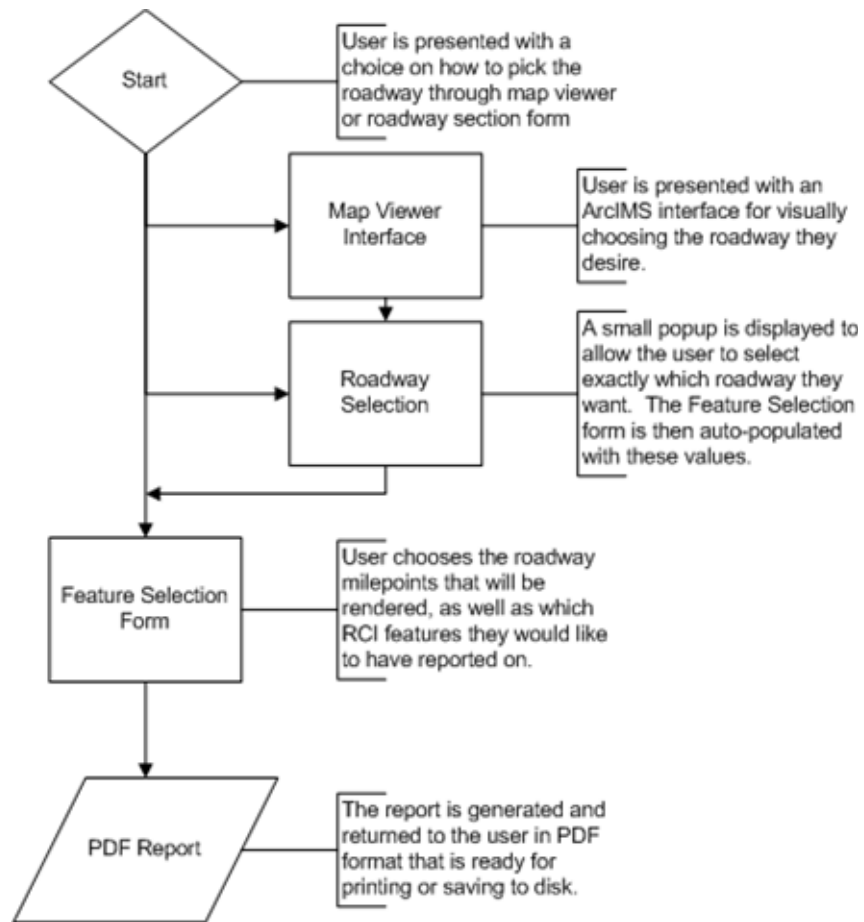
3.1.2 Graphical User Interface Design

1) The user is offered 2 options of choosing a section of roadway of interest.

- via the Map viewer

- via the roadway Selection page

The user can select the entire roadway section or between specific from and to mileposts along

a roadway.

Figure 4. RCI Data Graphing Tool Main Screen
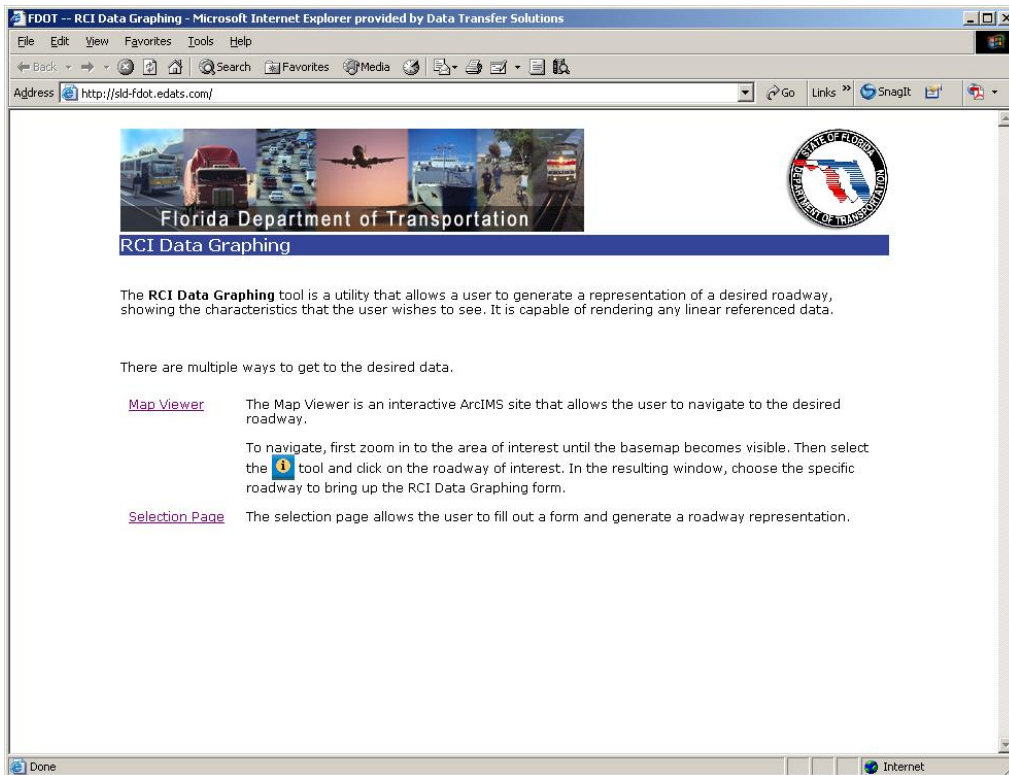
Figure 5. RCI Data Graphing Map Viewer Zoom-in
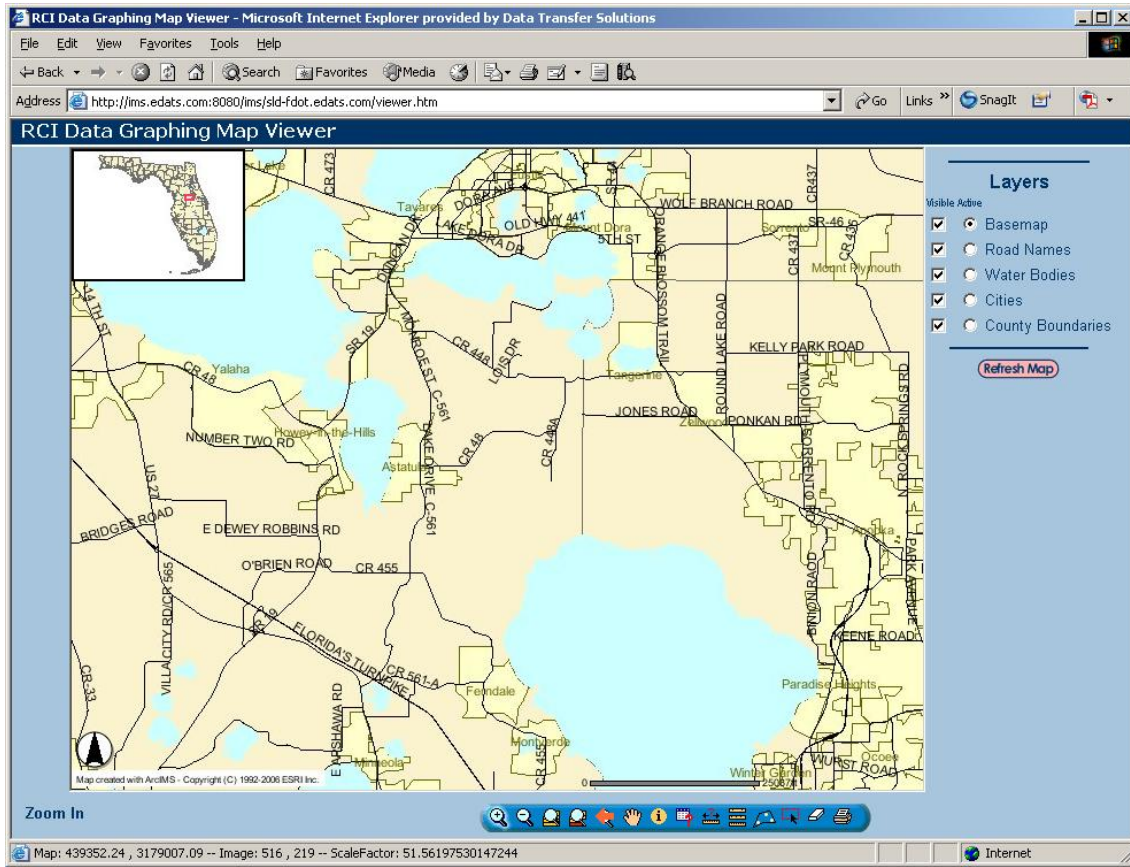
2) The mapping interface allows the user to zoom into an area of interest and, using the identify

   tool [i], they can click on a road on the map.

Figure 6. Selecting a Roadway
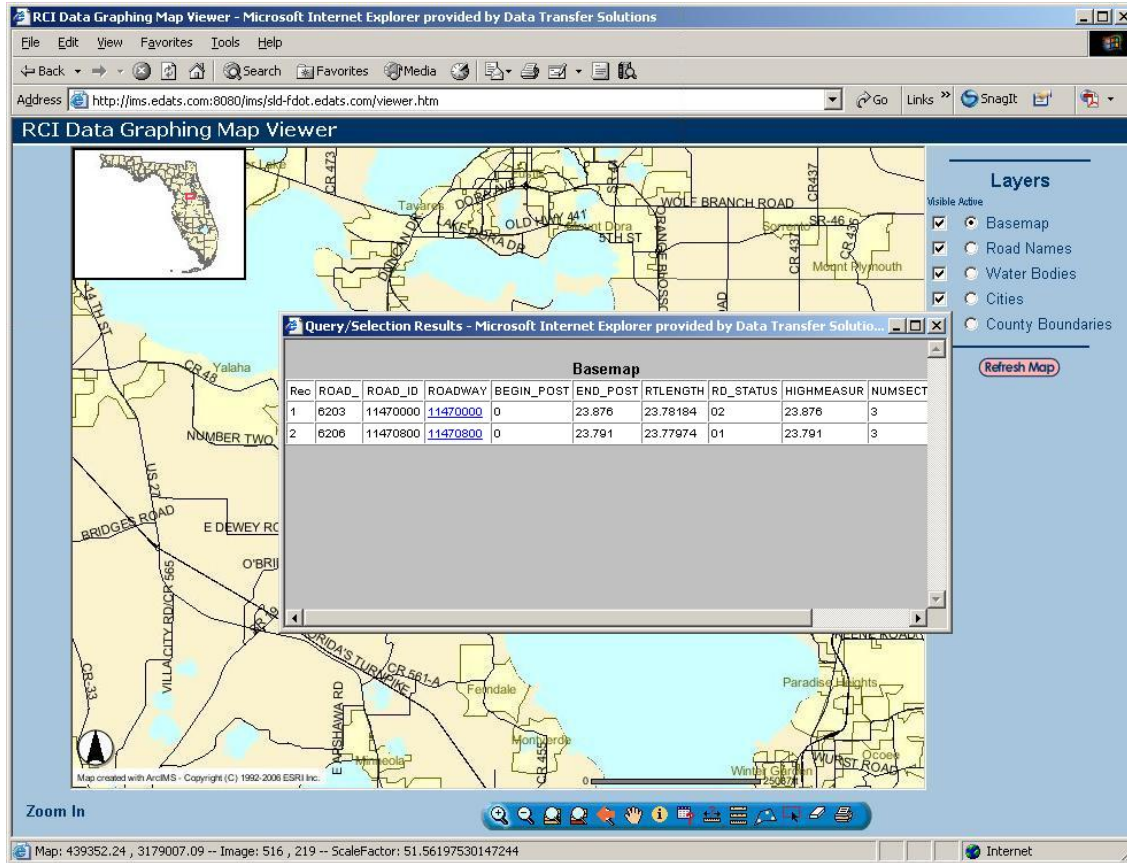
3) A list of roadways along with attributes is presented to allow the user to choose exactly which roadway they would like to produce the SLD. This is necessary when there may be overlapping roadways.

Figure 7: Selection Page from Map Viewer

4) The following options are presented to the user by the Form portion of the application

- Step 1 – Used to filter the roadways displayed to the user by county

- Step 2 – Choose a specific roadway

- Step 3 – Choose specific milepoints of that roadway

- Step 4 – Allow the user to configure the number of miles per page that are rendered to allow for easier readability during printing.

- Step 5 – Features on the roadway that will be reported on

- Load and Save defaults allow the user to save or load the current options

- Show RCI coded values which forces the PDF to render only the RCI codes, not their corresponding lookup values

- Then the user hits submit and receives the resulting PDF.

3.2 Prototype Architecture

The following sub-sections describe the prototype application architecture and functionality.

3.2.1 Conceptual Low Level Architecture

Form page

The Form is designed to present all records for the user to choose from. If the user took the path of utilizing the Map Viewer, this subprocess is initialized with the roadway choice the user originally made.

1) Fetch Variables from user:

    a. Action

    b. County Name

    c. Roadway ID

    d. Events

    e. Miles

    f. Feature Codes

2) If Action is "Save", then store current options to cookie.

3) If Action is "Load", then initialize values from cookie.

4) Establish connection to 'route', 'event' data sources.

5) Query the 'route' data source for a list of districts and counties used for filtering

6) Query the 'route' data source for a list of roadways in the selected county

7) Query the 'event' data source for the list of features a user is allowed to select from

8) Return generated form to user

This part of the program generates a PDF.

1) Connect to the 'route', 'event', 'map', 'source'

2) Get 6 variables from the user:

      a. Roadway ID

      b. Begin Milepost

      c. End Milepost

      d. Event list

      e. Miles Per Page

      f. Feature Codes

3) Query RCI database for all of the features used for drawing the graphical representation of the roadway.

4) Connect to all of the data sources listed in the data sources table.

5) Query events from those data sources based on the event list from the user and their corresponding definitions in the events table

6) Query ArcIMS for map

7) Pass the data from steps 3-6 to the PDF Rendering engine.

8) Return Generated PDF to User

3.2.2 Conceptual Data Model

Entity Relationships

The SLD application currently has one database connection to the Oracle database. To define additional database connections, open the datasources table in the SLD Development.mdb file locates in the cgi-bin directory. The fields are as follows:

- ID – a unique number

- Name – the unique name used internally by the application in the events table

- DSN – a full dsn connection string, specifying what driver to use and what server to connect to. Can be a system predefined ODBC connection

- Username – Username used to connect to the database

- Password – Password used to connect to the database

The events table contains the various field mappings, categories, and other information needed to list and query various features for the RCI Data Grapher.

- ID – Unique ID, Autonumber

- Category – The grouping the event belongs to

- Datasource – This is the datasource name the feature is found in.

- Sourcetable – Table name to query in the data source

- Route – Field containing the roadway ID

- Frommp – Field containing the begin mile point

- Tomp – Field containing the end mile point

- Datafield – Field containing the raw data for the event

- Displayfield – Field containing the formatted or lookup data for the event

---

- Title – The short description displayed in the Form Page feature list

- Wherestr – parameters to pass to the SQL WHERE clause when querying

- Description – The value to show during mouseover on the Form Page.

  The other data sources used by the RCI Data Grapher are stored in the Central Office Oracle database. These include a list of roadway ID's and their corresponding local names, counties and their corresponding districts, and work program information. The diagram below depicts the entities and relationships.

Figure 8. Entity-Relationship Diagram

datasources	
PK	ID - Unique ID, Autonumber
FK1	Name - the name used to reference this datasource by the events table DSN - Connection string containing the driver and database name and other necessary values Username - Username used to connect to the datasource as Password - Password used to connect to the datasource

events	
PK	ID - Unique ID, Autonumber
	Category - The grouping the event belongs to Datasource - This is the datasource name the feature is found in. Sourcetable - Table name to query in the data source Route - Field containing the roadway id Frommp - Field containing the begin mile point Tomp - Field containing the end mile point Datafield - Field containing the raw data for the event Displayfield - Field containing the formatted or lookup data for the event Title - The short description displayed in the Form Page feature list Wherestr - parameters to pass to the SQL WHERE clause when querying Description - The value to show during mouseover on the Form Page.

The events in the E-R diagram can be applied to any linear referenced FDOT data set include RCI feature classes, the Work Program, Level-of Service, etc.

3.2.3 Adding RCI Variables to the Application

To add extra features to the application, open the events table and add records.

The fields are as follows:

- ID - a unique number

- Category - the category that the characteristics belongs to. This may only use alphanumeric characters, and no spaces.

- Datasource - the datasource name as defined in the datasources table

- Sourcetable - the table or view name to query

- Route - the field or SQL expression containing the roadway id

- Frommp - the field or SQL expression containing the beginning milepoint

- Tomp - the field or SQL expression containing the ending milepoint

- Datafield - the field or SQL expression containing the coded value

- Displayfield - the field or SQL expression containing the decoded/lookup value (may be the same as datafield)

- Title - the name of the field as it will show up in the report, and in the characteristic selection list

- Wherestr - optionally, the SQL expression containing a WHERE and/or GROUP BY clause

- Description - the text to display when the user hovers their mouse over a characteristic

4. Conclusions and Recommendations

This research project encompasses a variety of objectives associated with the development of a more contemporary, versatile, and user-friendly SLD application for the Florida DOT and additional general users, based on output products that incorporate recent technological advances in automated cartography, GIS, data processing, and reporting. In order to give direction to this new application, the first phase of the project examined SLD applications used in other states and summarized current concerns, expectations, and unmet needs based on feedback from individuals involved in producing and using SLDs in the Florida DOT. The findings from this phase of the project can be summarized as follows:

- With regards to SLD usage in other states, our research indicates that Colorado, Iowa, Ohio, New Hampshire, Vermont, and New Jersey are the only states currently relying on commercially available SLD products or GIS processes to generate SLDs. In addition, several SLD tools and products used in these states (e.g., Colorado, Vermont, New Jersey) contain functionalities and features that are desirable in a contemporary and versatile SLD product, such as dynamic web-enabled data access, visually appealing SLDs, and standardized symbology.

- The results from our surveys suggest that although a majority of respondents are satisfied with several aspects of the current SLD methodology, SLD producers are least satisfied with the mapping capabilities and SLD end-users are least satisfied with their ability to read/understand the SLD. Specific enhancements that were ranked to be of the highest priority included the software program and updating procedure for SLD producers, and the increased use of aerial photography and traffic data for SLD end-users.

- The survey results led to the conclusion that it would be more useful and advantageous to develop two separate, but related, SLD applications for meeting the needs of SLD producers and end-users in Florida DOT and addressing their key concerns. The first of these two applications (**Application 1**) would focus specifically on the enhancements that were ranked to be of the highest priority and address only those characteristics that SLD users are least satisfied with, and incorporate other related suggestions (e.g., automatic link to RCI data). The second application (**Application 2**) would emphasize modifications and improvements that are of medium or lower importance and address aspects that SLD, such as the automated development of enhanced graphics, developed on-top of Application 1.

The findings, results, and recommendations from the first phase of the project were used to inform and guide the second phase, which focused on developing two prototypes for a re-designed and contemporary SLD application for the Florida DOT. The first of these proposed prototypes allow an SLD user to select various attributes of interest and develop a "dynamic web-based visualization tool" on the fly using RCI and additional variables to be selected. The second of the prototypes extends the graphics component of the first prototype by adding enhanced roadway characteristic inventory graphics of up to 20 variables.

The following matrix highlights some of the advantages and disadvantages of the two prototypes that were developed. The first prototype is targeted for end-users of SLD applications and shows promise for dynamic and web-enabled access to RCI data for visualization, maintenance, and quality control purposes. The second prototype focuses more on enhanced graphics automatically generated based on RCI variables. This prototype would require further refinement in order to be a potential replacement of current SLD production procedures.

Table 2. Assessment of Two Proposed Prototype Applications

App. #	Development Time/Complexity	Potential Number of Users	Propriety Software Required
1	Real-time RCI integration and access through web-based GIS map or checkbox selection menu. Took **2-3 months** to complete prototype.	Large – targeted at all users needing RCI and associated data. Estimated in the **hundreds to thousands**.	Requires one copy of ArcIMS stored on Central Office server to service all District needs at a license cost of $7,500.
2	Complex application required re-engineering of existing software code and algorithms to develop enhanced graphics. Took **4-5 months** to complete prototype.	Small – targeted mostly at SLD producers' requirements. **Estimated 15-30**.	Requires one copy of ArcIMS stored on Central Office server to service all District needs at a license cost of $7,500.

In conclusion, the new and dynamic web-based roadway data visualization tool (RCI Data Graphing) prototypes developed through this research project are expected to provide a number of important benefits. These can be summarized as follows:

- increased utilization and exchange of roadway data for all users (the web-based and dynamic data access components of the prototypes open up the SLDs to a whole new group of end users and make them more accessible throughout the Department);

- better integration and exploitation of RCI data through increased usage of GIS technology;

- improved usefulness of the SLD as a tool for reviewing inventory information on all roadways through a more intuitive and user-friendly format;

- an alternative and potential future replacement of an aging and awkward to use, manually-oriented SLD application with a more contemporary and user-friendly application;

- greater flexibility and reduction of time burden associated with roadway and mapping exhibits by integrating the use of GIS-based mapping systems.

Future recommendations for the next steps to be taken by the Florida DOT regarding SLD application and implementation include the following:

- further review of SLD methodologies in other states by coordinating WebEx demonstrations or site visits to become familiar with the technology options, especially in Vermont, New Hampshire, Colorado, and New Jersey;

- deploying Prototype 1 to potential end-users for testing the RCI Data Graphing functionality and validating its usefulness;

- deploying Prototype 2 to SLD producers for reviewing the enhanced graphics components of the prototype and validating its usefulness; and

- further development of the current prototypes and/or research additional software options that are capable of utilizing aerial photography and linkages to the existing FDOT videolog system.

APPENDICES

1. Survey Questionnaire for SLD Producers

Straight Line Diagram (SLD) Producer Survey

Hello! We are conducting a survey of planners, technicians, and engineers who create or produce Straight Line Diagrams (SLDs) for roadway mapping, data presentation, field data verification, and other applications associated with Roadway Characteristics Inventory (RCI) data. The goal of this survey is to identify: (a) problems and difficulties associated with the current programs/methods for generating SLDs; and (b) modifications and enhancements necessary to make the SLD production methodology more effective, efficient, and user-friendly.

We are interested in your opinions, ideas, and experiences. The results of the survey will guide the Florida Department of Transportation (FDOT) to develop a more contemporary and useful SLD application and include output products that incorporate recent technological advances in geographic information systems (GIS), aerial photography, data processing, and reporting.

The survey should take no more than 10 minutes to complete. Please fill out the entire questionnaire. All your answers will remain completely confidential and will be published only in summary statistical form. You will not be identified in any way.

Please mail your survey to:

Allen Ibaugh, AICP
Chief Executive Officer
Data Transfer Solutions, LLC
13013 Founders Square
Orlando, FL 32828
(407)-382-5222 phone
(407)-382-5420 fax
(407)-383-6055 cell
aibaugh@edats.com

If you have any questions or would like more information, please contact Mr. Allen Ibaugh, AICP, Data Transfer Solutions, aibaugh@edats.com, 407-382-5222.

FIRST, WE WOULD LIKE TO ASK YOU SOME GENERAL QUESTIONS ABOUT YOUR PERSONAL EXPERIENCE WITH FDOT'S STRAIGHT LINE DIAGRAM (SLD) METHODOLOGY

1. How long have you been involved with the production of SLDs in your organization, office, or department?

CIRCLE ONE

5 or more years	1
2 to 5 years	2
1 to 2 years	3
6 months to 1 year	4
Less than 6 months	5

2. How would you rate your level of *direct* experience with the production of SLDs ?

CIRCLE ONE

Very High	1
High	2
Medium	3
Low	4
Very low	5

3. What are SLDs primarily used for, in your organization, office, or department?

CIRCLE ALL THAT APPLY

Functional Class Review	1
Roadway Characteristics Inventory (RCI) Review	2
Level of Service Breaks	3
Maintenance	4
Traffic Operations	5
Planning & Environmental Management	6
Design	7
Outdoor Advertising	8
Public Transportation	9
Other:	10

Please describe_____

4. In terms of meeting your needs and expectations, how would you classify your overall experience with the generation and production of SLDs ?

CIRCLE ONE

Very Satisfied	1
Satisfied	2
Neither Satisfied nor Dissatisfied	3
Dissatisfied	4
Very Dissatisfied	5

5. What is your present level of satisfaction with the SLD production methodology, with regards to these *general* aspects:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
Overall user friendliness	1	2	3	4	5
Presentation procedure	1	2	3	4	5
Ease of creation/generation	1	2	3	4	5

6. Please give us your opinion on the following *specific* characteristics of the current SLD production methodology:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
Software program	1	2	3	4	5
Mix of rendered data	1	2	3	4	5
Updating procedure	1	2	3	4	5
Mapping capabilities	1	2	3	4	5
Editing capabilities	1	2	3	4	5
Output format	1	2	3	4	5
Integration with other software/programs	1	2	3	4	5

7. Please list other problems or unmet needs with SLD production in the space below.

_____

_____

_____

_____

THE SECOND SET OF QUESTIONS FOCUS ON THE MODIFICATIONS AND ENHANCEMENTS NECESSARY TO MAKE THE SLD GENERATION PROCESS MORE EFFICIENT, EFFECTIVE, AND USER-FRIENDLY.

8. In order to facilitate your work and meet your current needs, which of the following aspects needs to be improved or upgraded?

Rank on a scale of 1 to 5, from 'highest priority' to 'lowest priority'.

	HIGHEST PRIORITY				LOWEST PRIORITY
Software program	1	2	3	4	5
Mix of rendered data	1	2	3	4	5
Updating procedure	1	2	3	4	5
Mapping capabilities	1	2	3	4	5
Editing capabilities	1	2	3	4	5
Output format	1	2	3	4	5
Integration with other software/programs	1	2	3	4	5

9. Please select a rank to indicate the need or importance of each of the following enhancements, in terms of meeting your current needs.

Rank on a scale of 1 to 5, from 'highest priority' to 'lowest priority'.

	HIGHEST PRIORITY				LOWEST PRIORITY
More use of automated graphics (CADD) applications	1	2	3	4	5
Increased use of GIS technology	1	2	3	4	5
Increased use of the FDOT's Videlog	1	2	3	4	5
Increased use of FDOT's GIS Basemap	1	2	3	4	5
Increased utilization of FDOT's aerial image catalog.	1	2	3	4	5
Use of additional RCI data not currently in the SLD	1	2	3	4	5
Use of non-RCI information	1	2	3	4	5

10. Select one or more of the following options associated with the need and/or type of training desired for the SLD application in your office, department, or organization.

CIRCLE ALL THAT APPLY

No training necessary	1
Reference documents	2
One-on-one training	3
Classroom sessions	4
Other	5

Please describe:_____

11. For each of the following characteristics of the SLD program, please list specific suggestions for improvement in the spaces below:

Software program (RCI file transfer options, SLD Diagrammer, etc.):

_____

_____

_____

Additional RCI or non-RCI data that could be included:

_____

_____

_____

Mapping capabilities (RCI basemap, etc.):

_____

_____

_____

Editing capabilities:

_____

_____

_____

Output format (.dgn/.pdf/.tif):

_____

_____

_____

Integration with other programs/software (GIS/database/IT)

_____

_____

_____

12. Please provide any other suggestions for modifications or improvements for SLD production in the space below.

_____

_____

_____

_____

_____

THAT COMPLETES THE SURVEY. THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

Straight Line Diagram (SLD) User Survey

Hello! The Central Transportation Statistics Office (TranStat) is conducting a study to enhance its Straight-line Diagram (SLD) product and application in order to make the SLDs more informative and useful for Florida Department of Transportation (FDOT) departments. We are in the process of examining the current layout and organization of the SLD, the Roadway Characteristics Inventory (RCI) data contents, and the ways in which information is currently displayed (mainly using text or graphics). We are also trying to explore other ways in which some SLD users may require this data to be represented, and the potential need for a more versatile tool to be considered in the future.

You have been selected as a representative of a group of potential SLD users and we need your help in identifying enhancements and modifications that could benefit your Department. We want to know how the current layout, data format, and other related characteristics of the SLD can be improved.

Please take a few minutes to fill out the attached survey questionnaire and return to:

Allen Ibaugh, AICP
Chief Executive Officer
Data Transfer Solutions, LLC
aibaugh@edats.com

by April 17, 2006

If you have any questions regarding the survey, please contact Mr. Allen Ibaugh.

Thank you for filling out the survey. Please remember that your responses will help us enhance and retool the SLD program in the near future.

Rodney M Floyd, SLD Project Manager
Highway Data Collection/QC
Transportation Statistics Office
605 Suwannee St. MS 27
Tallahassee, FL 32399-0450
Ph: 850.414.4702 SC: 994.4702 FAX: 850.414.4878

FIRST, WE WOULD LIKE TO ASK YOU SOME GENERAL QUESTIONS ABOUT YOUR OWN EXPERIENCE WITH USING FDOT'S STRAIGHT LINE DIAGRAMS (SLD)

1. How long have you been involved with the use of SLDs in your organization, office, or department?

CIRCLE ONE

5 or more years	1
2 to 5 years	2
1 to 2 years	3
6 months to 1 year	4
Less than 6 months	5

2. How would you rate your level of *direct* experience with SLD usage?

CIRCLE ONE

Very Frequent	1
Frequently	2
Infrequent	3
Seldom	4
Never	5

3. What are SLDs primarily used for in your organization, office, or department?

CIRCLE ALL THAT APPLY

Strategic Intermodal System (SIS)	1
Functional Class Review	2
Roadway Characteristics Inventory (RCI) Review	3
Level of Service Breaks	4
Maintenance	5
Traffic Operations	6
Planning & Environmental Management	7
Design	8
Outdoor Advertising	9
Public Transportation	10
Right-of-Way Data	11
Determining On/Off System Mileage	12
National Highway System (NHS) Designations	13
Other:	14

Please describe_____

4. For each application(s) selected in the previous question, how would you classify your extent of SLD usage, in terms of *frequency* of use?

	VERY HIGH	HIGH	MODERATE	LOW	VERY LOW
Strategic Intermodal System (SIS)	1	2	3	4	5
Functional Class Review	1	2	3	4	5
RCI Review	1	2	3	4	5
Level of Service Breaks	1	2	3	4	5
Maintenance	1	2	3	4	5
Traffic Operations	1	2	3	4	5
Planning & Env. Management	1	2	3	4	5
Design	1	2	3	4	5
Outdoor Advertising	1	2	3	4	5
Public Transportation	1	2	3	4	5
Right-of-Way Data	1	2	3	4	5
Determine On/Off System Mileage	1	2	3	4	5
NHS Designations	1	2	3	4	5

5. In terms of meeting your needs and expectations, how would you classify your overall experience with the use of SLDs ?

	CIRCLE ONE
Very Satisfied	1
Satisfied	2
Neither Satisfied nor Dissatisfied	3
Dissatisfied	4
Very Dissatisfied	5

6. What is your present level of satisfaction with the current SLD, with regards to these aspects:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
Overall user friendliness	1	2	3	4	5
Meeting current needs	1	2	3	4	5
Layout of SLD	1	2	3	4	5
Ability to read & understand the SLD	1	2	3	4	5

7. Please list other problems or unmet needs, if any, with the current SLD in the space below.

_____

_____

_____

_____

_____

_____

8. Please list what specific kind of information/data you glean/obtain from the SLD in the space below.

_____

_____

_____

_____

_____

_____

THE SECOND SET OF QUESTIONS FOCUS ON THE MODIFICATIONS AND ENHANCEMENTS NECESSARY TO MAKE SLD PRESENTATION MORE EFFICIENT, EFFECTIVE, AND USER-FRIENDLY.

9. Please select a rank to indicate the need or importance of each of the following enhancements, in terms of meeting your current needs.

Rank on a scale of 1 to 5, from 'highest priority' to 'lowest priority'.

	HIGHEST PRIORITY				LOWEST PRIORITY
Increased use of GIS (i.e. other data sets: land use, demographics)	1	2	3	4	5
Linking of Videolog to SLD	1	2	3	4	5
Use of aerial photography in SLD	1	2	3	4	5
Use of additional RCI data not currently in the SLD	1	2	3	4	5
Use of non-RCI information	1	2	3	4	5

10. Select one or more of the following options associated with the need and/or type of training desired for the SLD application in your office, department, or organization.

CIRCLE ALL THAT APPLY

No training necessary	1
Reference documents	2
One-on-one training	3
Classroom sessions	4
Other	5

   Please describe:_____

11. For each of the following characteristics of the SLD, please list specific suggestions for improvement in the spaces below:

a. Additional RCI or non-RCI data that could be included:

_____

_____

_____

_____

b. Additional Mapping Components (Aerials, Videolog, GIS Basemap overlays):

_____

_____

_____

_____

c. Output format (pdf, jpeg, dgn, etc.)

_____

_____

_____

_____

12. Please provide other suggestions for modifications or improvements, based on your usage needs, in the space below.

_____

_____

_____

_____

_____

THAT COMPLETES THE SURVEY. THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

APPENDIX A2

1. SLD Producer Survey: Statistical Summaries of Responses

This survey was administered to planners, technicians, and analysts in different FDOT departments who are involved with the creation and generation of SLDs. The goal of this SLD producer survey was to identify: (a) problems and difficulties associated with the current programs/methods for generating SLDs; and (b) modifications and enhancements necessary to make the SLD production methodology more efficient and useful. A 12-item survey questionnaire was administered to a representative sample of 12 SLD producers from different FDOT departments attending the DSA meeting in Tallahassee, Florida (February 22, 2006). The results of this phase survey are summarized and described in this section.

1.1 Personal Experience with FDOT's SLD

The first set of questions focused on the respondents' own experience with SLD production or creation. Exactly half of them have been producing SLDs for five or more years and all 12 respondents in the sample have been involved with the SLD production or generation for at least one year (Figure 1.1).

Figure 1.1 How long have you been involved with the production of SLDs in your office or department?
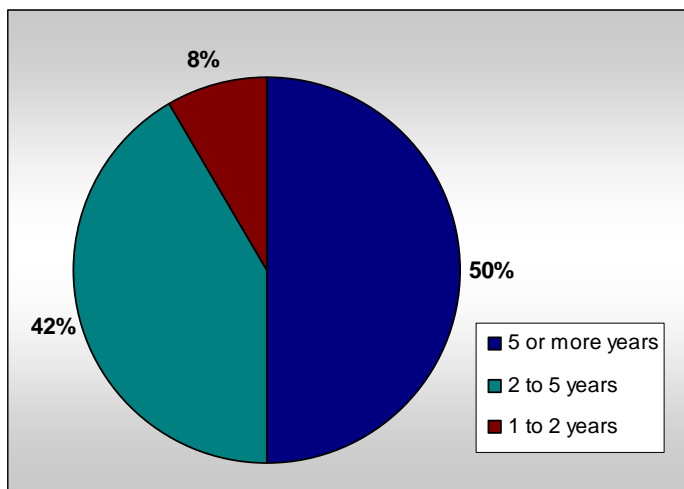
In terms of their level of direct experience with SLD production (Figure 1.2), two-thirds of respondents rated their experience as either 'very high' or 'high' and none of the respondents selected the 'low' or 'very low' rating.

Figure 1.2. How would you rate your level of direct experience with the production of SLDs?
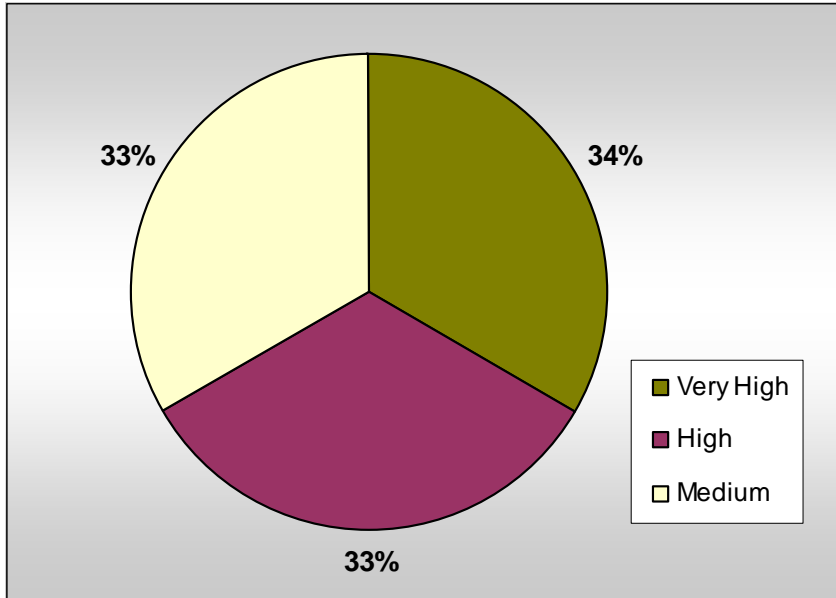
Those responding to the survey were also asked to identify what SLDs are primarily used for in their office or department (Figure 1.3). The most common application for SLD producers is *Roadway Characteristics Inventory (RCI) review*, which was selected by all respondents (100 percent). Other commonly used applications include *Functional Class review*, *traffic operations*, *design*, and *public transportation*. Almost 67 percent of producers in our sample use SLDs for *Functional Class review*, 58 percent for *traffic operations*, and 58 percent for *design*. The least utilized SLD application is *Level of Service breaks*.

Figure 1.3. What are SLDs primarily used for in your organization, office, or department?
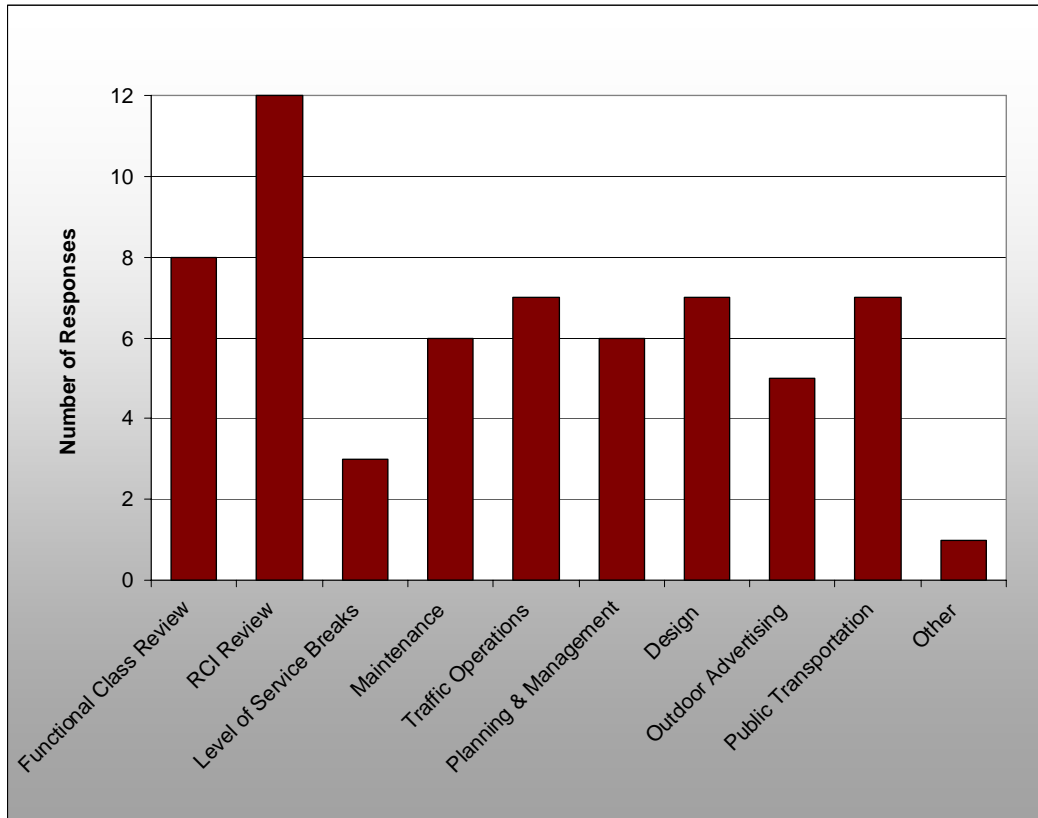
In terms of meeting the SLD producers' needs and expectations, 67 percent said that they are either 'satisfied' or 'very satisfied' with their overall experience, and only one respondent is 'dissatisfied' (Figure 1.4). SLD producers were subsequently asked to evaluate their level of satisfaction with three aspects of the current SLD (Figure 1.5). The proportion of respondents who are either 'satisfied' or 'very satisfied' comprised 67 percent for *overall user-friendliness*, 75 percent for the *presentation procedure*, and only 50 percent for *ease of creation/generation*. The highest level of dissatisfaction was also observed for *ease of SLD creation/generation*; 25 percent of SLD producers are 'dissatisfied' with this particular aspect of the current SLD.

Figure 1.4. In terms of meeting your needs and expectations, how would you classify your overall experience with the generation and production of SLDs ?
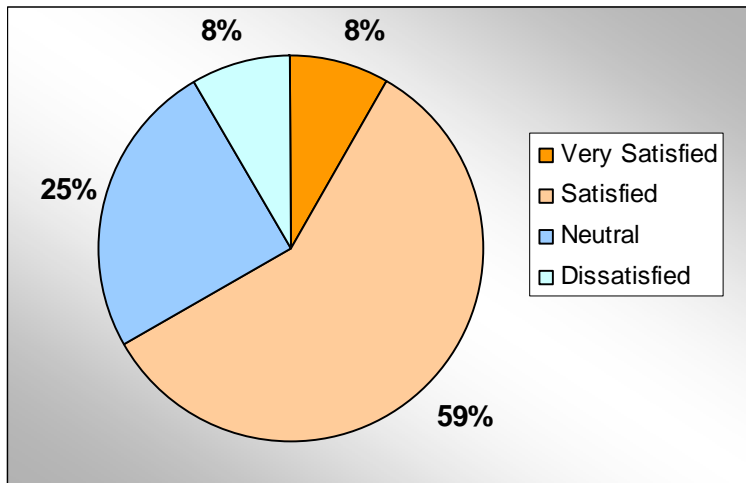
Figure 1.5. What is your present level of satisfaction with these general aspects of the SLD production methodology?
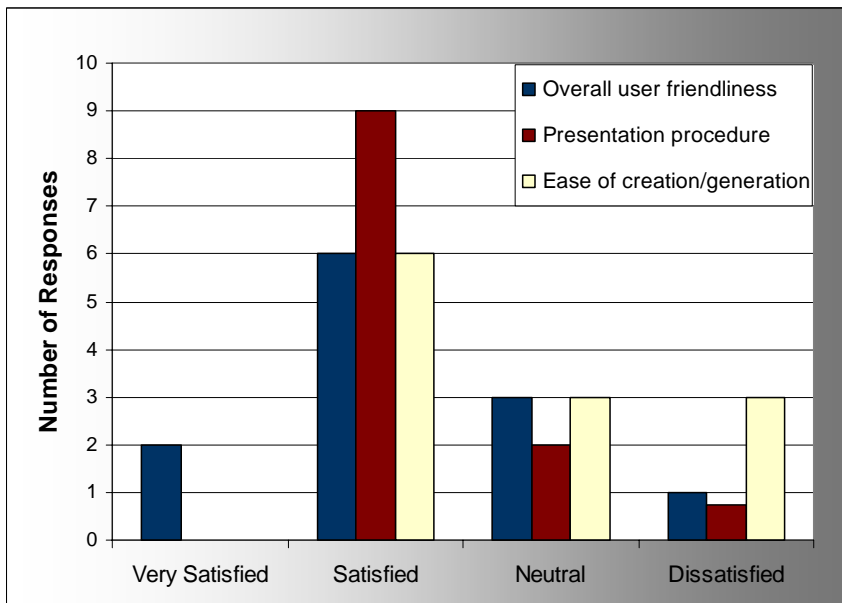
Respondents were also asked to provide their opinion on several specific characteristics of the current SLD (Table 1.1). Although few SLD producers are 'very satisfied' with any of these characteristics, the highest levels of satisfaction were observed for the *output format*. Half of the respondents are satisfied with the *software program*, *updating procedure*, and the *mix of*

rendered data. However, *mapping capabilities* and *integration with other software/programs* are two characteristics of the SLD that indicated the lowest levels of satisfaction. Only one of the 12 respondents is satisfied, and 25 percent of them are either 'dissatisfied' or 'very dissatisfied' with the *mapping capabilities*. At the same time, none of the SLD producers surveyed are satisfied or very satisfied with how the SLD integrates with other software or programs.

Table 1.1. Ratings for specific characteristics of the current SLD methodology: Number of responses for each rank (n=12)

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
Software program	1	5	3	2	0
Mix of rendered data	0	6	3	2	0
Updating procedure	1	5	3	1	1
Mapping capabilities	0	1	6	1	3
Editing capabilities	0	4	4	3	0
Output format	0	10	1	1	0
Integration with other software/programs	0	0	8	1	2

1.2 Changes and Enhancements Necessary to Improve the Current SLD

The second set of questions focused on the modifications required to make SLD creation and generation more efficient, effective, and user-friendly. The respondents were first asked to rank the need or importance of several technical improvements in terms of meeting their current needs and facilitating their work (Figure 1.6). The improvement indicated by the largest number of respondents to be the highest priority was the *software program*, followed by the *updating procedure* and the *output format* of the SLD. *Editing capabilities* were ranked by most SLD producers to be of medium-high or medium priority, while *integration with other software/programs* fell mainly in the medium priority category. Enhancements rated to be of

medium-low or lowest priority by a majority of respondents was the *mapping capabilities* and *mix of rendered data*.

Figure 1.6. In order to facilitate your work and meet your current needs, which of the following aspects needs to be improved or upgraded?
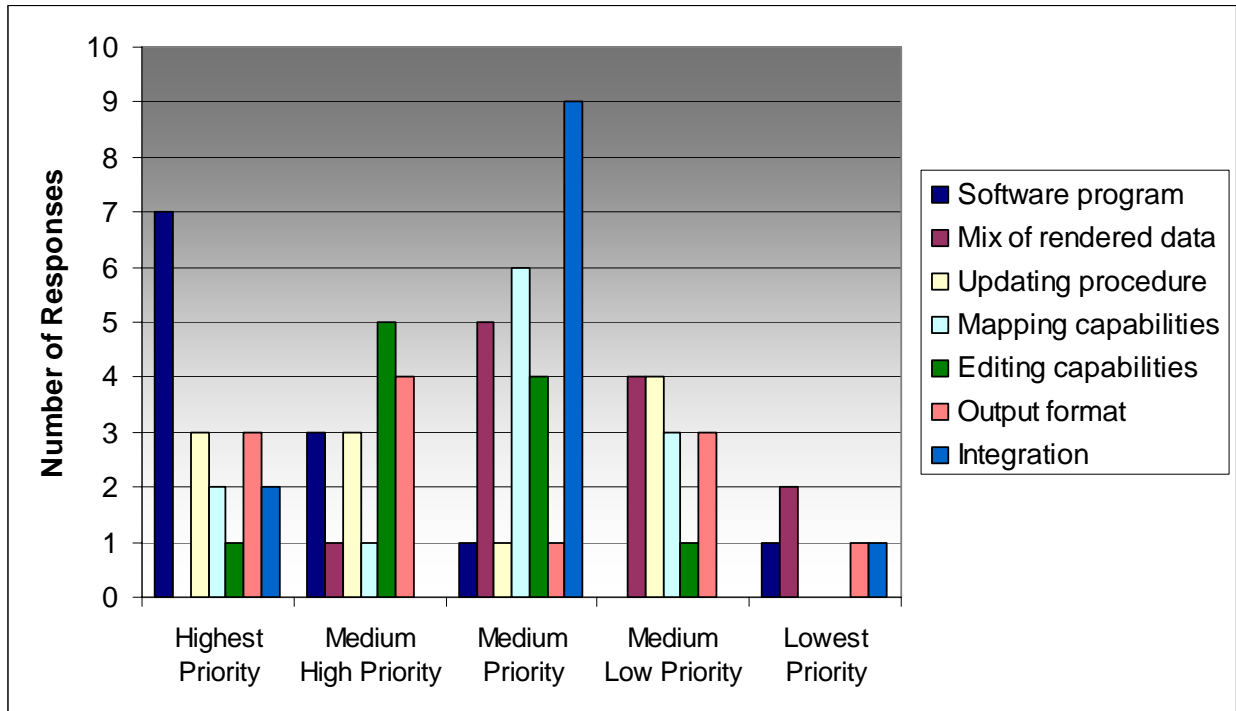
Respondents were then asked to rank specific enhancements to the current SLD program, based on the need and importance of each enhancement (Table 1.2). *Increased use of GIS technology* and the *increased use of the FDOT's GIS Basemap* are the two improvements selected by 75 percent of SLD producers in the sample as a high (highest or medium-high) priority. At least half of the respondents indicated that *increased use of the FDOT's Videolog*, *more use of automated graphics (CADD) applications*, and *increased utilization of FDOT's aerial image catalog* were all high priorities. The enhancements chosen by most respondents to be of medium-low or low priority are the *use of additional RCI data not currently in the SLD* and the *use of non-RCI information*.

Table 1.2. Ratings for specific enhancements to current SLD: Number of responses (n=12)

	HIGHEST PRIORITY	MEDIUM HIGH	MEDIUM	MEDIUM LOW	LOWEST PRIORITY
More use of automated graphics (CADD) applications	3	4	2	2	1
Increased use of GIS technology	5	4	3	0	0
Increased use of the FDOT's Videolog	1	6	4	0	1
Increased use of FDOT's GIS Basemap	4	5	2	1	0
Increased utilization of FDOT's aerial image catalog.	4	2	5	1	0
Use of additional RCI data not currently in the SLD	1	0	6	5	0
Use of non-RCI information	0	1	2	3	6

When asked about the type of training desired for SLD application (Figure 1.7), none of the respondents felt that no training was necessary. As many as 75 percent of SLD producers indicated that *reference documents* are the most desired type of training, while 67 percent selected *classroom sessions* or *one-on-one training*.

Figure 1.7. Type of training desired for the SLD application
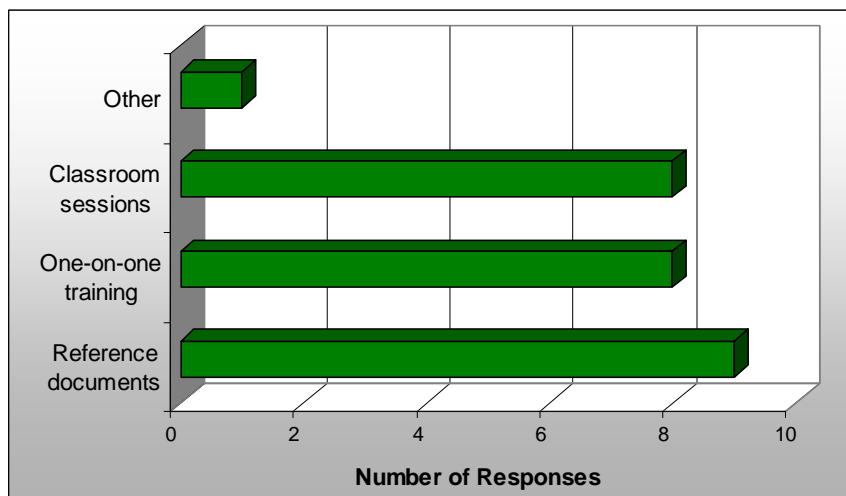
The survey also included a set of open-ended questions for SLD producers regarding specific suggestions for improvement. These responses are listed, as direct quotes, in Table 1.3.

Table 1.3. Specific suggestions for improvement on different aspects of the SLD

Characteristics	Comments and Suggestions
Software program (RCI file transfer options, SLD Diagrammer, etc.):	- Fix small problems with Diagrammer, ex bridge number leaving out exceptions. - Would like to see Diagrammer include 4 digit bridge numbers instead of 3. Diagrammer at this point has been leaving out exceptions - Include 4 digits on bridge info. Exceptions. - Needs to be more user-friendly from mainframe. - Would like to access RCI data from Oracle, eliminating a need to log onto mainframe; more flexibility from RCI data mix; option to include Basemap strips. - Import it into Microstation is cumbersome, time spent fixing the data overlaps. - Update so text is in a more orderly matter. - The SLD Diagrammer should be replaced with a one-touch application that would auto generate SLDs in a non-CADD format from RCI with the minimum FDOT standards met from there, the SLD should be easy to enhance and link out to RCI reports, Videologs, etc. - Automatically linked to RCI
Additional RCI or non-RCI data the could be included:	- Traffic data, signalized intersections, identify points. - Include HPMS samples for state roads to be plotted on SLDs for district use. - QC the data. - Speed limits, access management, traffic signals.
Mapping capabilities (RCI basemap, etc.):	- Actual picture, Basemap - Like to be able to download the Basemap routes for active-exclusive to draw the ramps as they exist (like district) - Show location/direction of route, show the limits of entire route/segment.
Editing capabilities	- Less time having to edit the data - Prefer a GIS editing environment with tools. - Less time should be spent on editing. (MP, RD Names, FC, etc.) - Should definitely be incorporated - Keep previous enhancements editable but allow certain elements to be protected to safeguard data integrity.

Characteristics	Comments and Suggestions
Output format (.dgn/.pdf/.tif)	• DGN • DGN/PDF • Optional DGN, PDF, or TIFF selected by user. • Easier process to DGN • Could these be in ArcView format. I know we can take a DGN and transfer to ArcView. Can a downloaded DGN be automatically transferred to ArcView? • Another proprietary format? • PDF with color to distinguish certain items, highlight capabilities, be able to turn sometimes on or off, be able to easily search/locate items
Integration with other software/programs (GIS/database/IT)	• It would be nice to tie-in with some RCI reporting capabilities. • GIS and other database, outside data not in RCI.

Other suggestions provided by the SLD producers regarding modifications and improvements, based on their current needs, are listed below (as direct quotes):

• Training from start to finish would be nice.

• Ability to produce a final document without having to edit much; association with aerials on GIS Basemap strip.

• The interface between DOT mainframe to DGN needs to be more user friendly; pull in construction notices.

• The drop down box so users could select from a menu different items to produce SLDs they want.

• Batch production of SLDs, the ability to QC changes between versions/updates of SLDs.

Allow each office to produce their own SLD with their own enhancements. Increase navigation, go to bottom like third street "A" and automatically zoom in like other map products like Mapquest.

APPENDIX A2:

2. SLD User Survey: Statistical Summaries of Responses

The second survey was administered to FDOT staff that use SLDs in their office or department, but are not directly involved with the SLD creation or generation process. The objectives of this SLD user survey were to identify: (a) problems with the current layout or organization of the SLD and related needs; and (b) modifications and enhancements necessary to make the SLD presentation methodology more effective and useful for their department. A pilot test of this survey was conducted at the DSA Meeting in Tallahassee, Florida (February 22, 2006) using a representative sample of 12 SLD users from different FDOT departments. The responses from the pilot survey were used to revise and improve the survey instrument. The finalized 12-item survey questionnaire was administered electronically to a representative group of 38 SLD users in different FDOT departments across the state (April 2006). A total of 25 respondents filled out the survey—a very high response rate of approximately 66 percent. The results of this survey are summarized and described in this section.

2.1 Personal Experience with the FDOT's SLD

The first set of questions focused on the respondents' own experience with the SLD. As many as 20 (80 percent) of them have been involved with the use of SLD for at least five years and 23 (92 percent) of respondents have been using SLDs for two or more years (Figure 2.1). In terms of their level of direct experience, 56 percent of respondents rated themselves as 'very frequent' SLD users and 88 percent as either 'very frequent' or 'frequent' users (Figure 2.2).

Figure 1. How long have you been involved with the use of SLDs in your organization, office, or department?
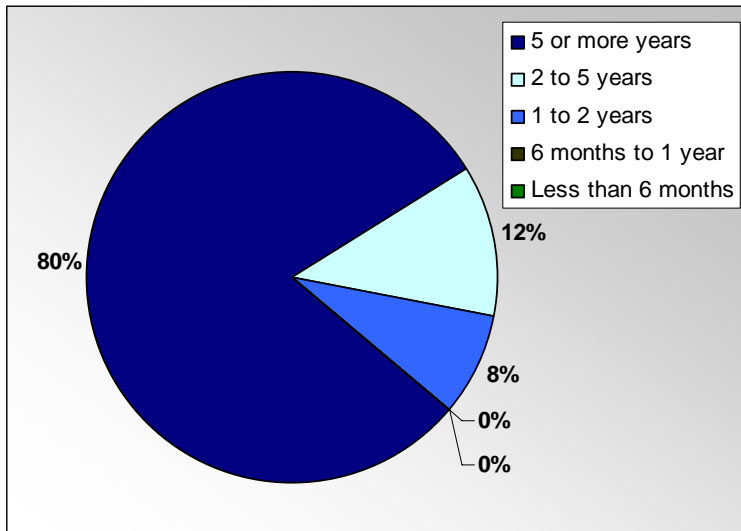
Figure 2. How would you rate your level of direct experience with SLD usage?
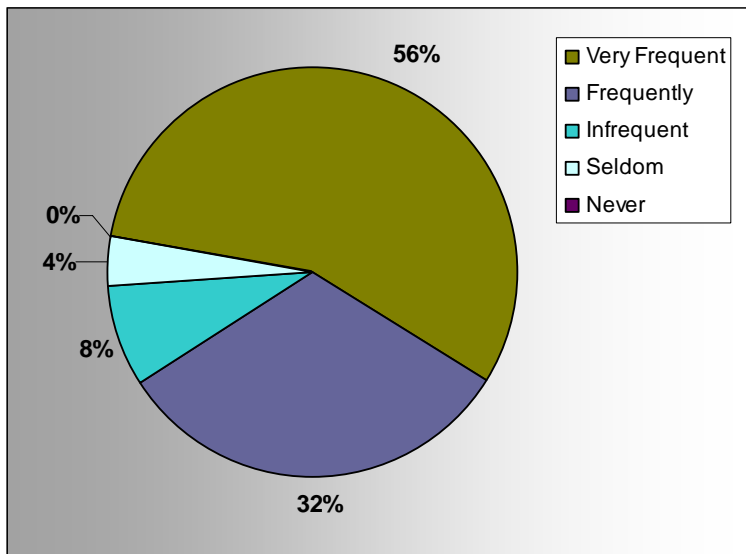
Those responding to the survey were also asked to identify what SLDs are primarily used for in their office or department (Figure 2.3). The two most common applications included *Roadway Characteristics Inventory (RCI) review* and *maintenance*. More than 56 percent of respondents use SLDs for RCI review, 52 percent for *maintenance*, and 36 percent for *traffic*

operations. The least utilized SLD applications are *outdoor advertising*, *public transportation*, and *National Highway System designations*.

Figure 2.3. What are SLDs primarily used for in your organization, office, or department?
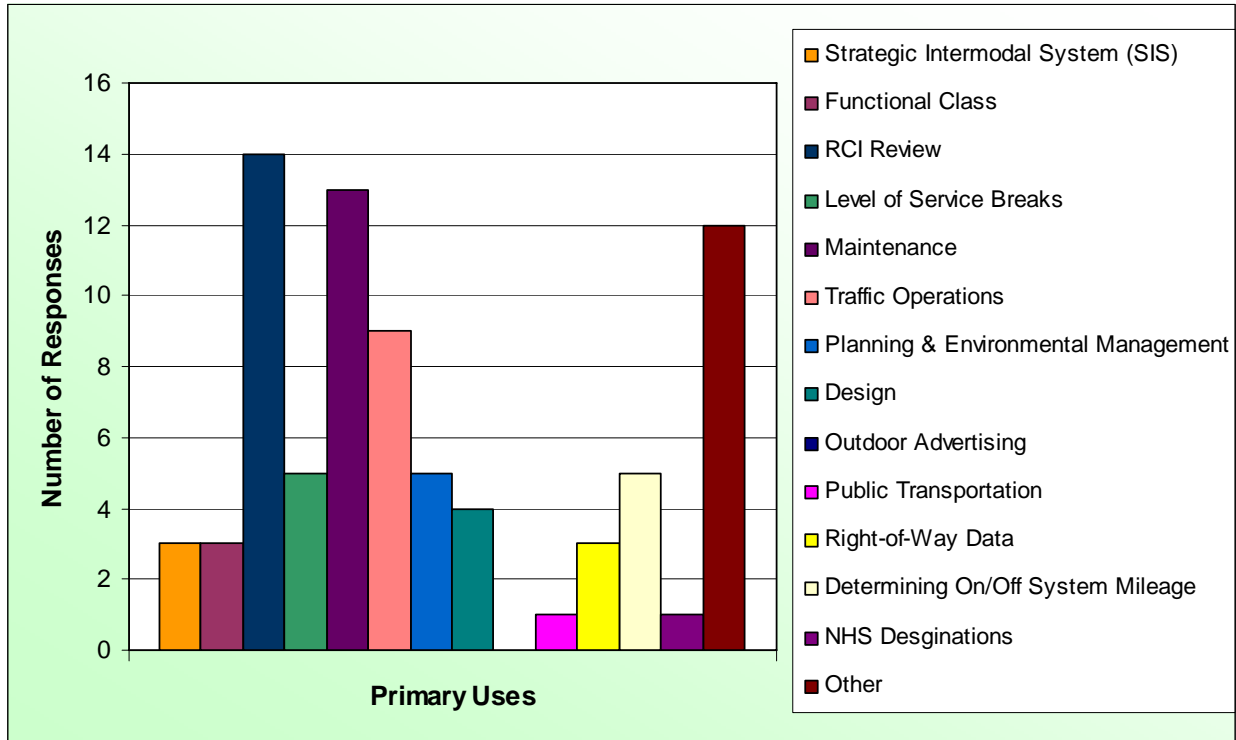
SLD users were also asked to rate the extent of use for each application, based on their frequency of usage. Applications rated with a 'very high' or 'high' frequency of usage also included *RCI review*, *maintenance*, and *traffic operations*, while those with 'very low' or 'low' frequency included *planning and environmental management*, *design*, *public transportation*, and *outdoor advertising*.

In terms of meeting the SLD users' needs and expectations, 12 percent of respondents are 'very satisfied' and 88 percent are either 'satisfied' or 'very satisfied' with their overall experience; only 4 percent indicated that they are 'dissatisfied' (Figure 2.4).

Figure 2.4. In terms of meeting your needs and expectations, how would you classify your overall experience with the use of SLDs?
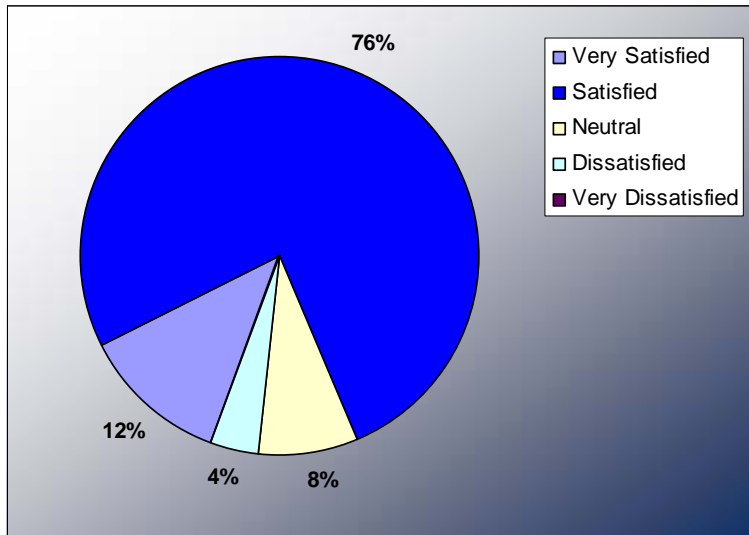
When asked to evaluate their level of satisfaction with specific aspects of the current

SLD, at least 87 percent of respondents indicated that they are either 'satisfied' or 'very satisfied'

with all four aspects: *overall user-friendliness*, *meeting current needs*, *SLD layout*, and their

ability to read/understand the SLD (Figure 2.5). The only aspect with one 'very dissatisfied'

respondent was the *ability to read/understand the SLD*.

Figure 2.5. What is your present level of satisfaction with the current SLD methodology, with regards to these general aspects?
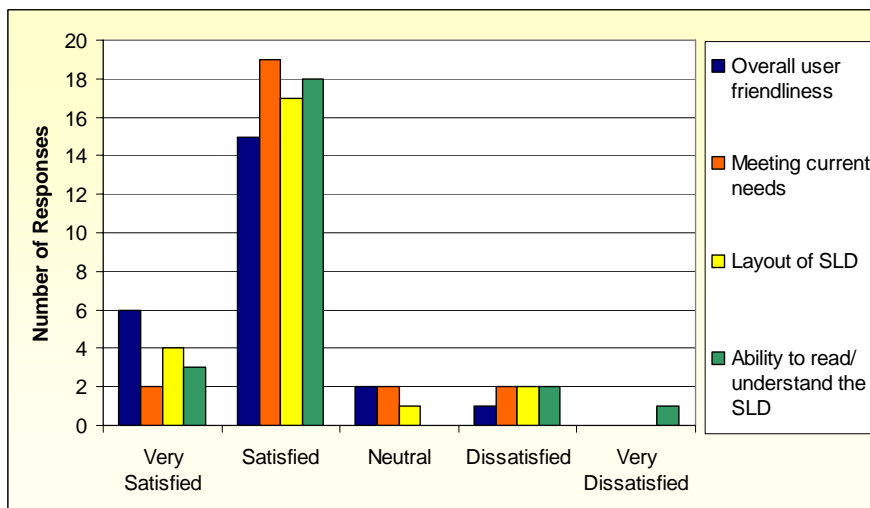
Respondents were also asked to list other difficulties or unmet needs associated with the current SLD, in the form of an open-ended question. The following issues were identified by the SLD users who responded to this question, listed here as direct quotes:

- Text

- Some of our cross drain locations were removed from SLDs without field verifying the location, these locations are key to several of our reviews. Our SLD key sheet for Pinellas County was recently changed and it was not created for a user to use. I understand that it is a quicker method of creating a key sheet however if it is quicker but doesn't have the function of the previous map then it is almost pointless. I would rather have an out of date key sheet than the one that is being proposed. It has absolutely no benefit to the user what so ever.

- Speed limits aren't always incorporated and that is quite useful

- Some of the SLDs need to be verified as to the street names, street is on the right side of roadway and the names are correct. New streets have been constructed and have not been placed on the revised SLDs.

- The accuracy of information on SLDs

- Side streets updates

- ROW data is not specific to any given location.

- Seems that some of the pavement materials info may not always be up to date.

- Need to know the right-of-way limits.

- Reduced size of newer SLDs very hard to read. Older larger SLDs were much easier to read. Index mapping (diagrams) often unclear. Often hard to find right SLD section. Can't identify unusual intersections such as modern roundabouts.

- District 5 uses a viewer that limits users ability to utilize full extent of screen. Viewing in pure PDF viewer is the preferred method. Also many districts only provide one SLD sheet in each PDF file. This is cumbersome because we are usually interested in viewing entire project, not only one sheet.

- Would like to see speed breaks and signals identified on SLDs.

- I would like to see ramp lengths on the SLDs.

- Sometimes difficult to relate asc/desc direction between SLD and roadmap. Must use in conjunction with Road map to meet my needs.

- Losing new construction overlay information needed for pavement evaluation needs for the SMO Pavement Evaluation Program.

2.2 Changes and Enhancements Necessary to Improve the Current SLD

The second set of questions focused on the modifications necessary to make SLD presentation more effective, and user-friendly. The respondents were first asked to rank the need for, or importance of, several enhancements in terms of meeting their current needs (Table 2.1). The improvement indicated by the largest number of respondents to be the highest priority was the *use of aerial photography in the SLD*, followed by the *linking of Videolog to SLD*. *Increased use of GIS* was ranked by most respondents to be of medium-high or medium priority, while the use of *additional RCI data not currently in the SLD* fell mainly in the medium priority category. The enhancement rated to be of the lowest priority by a majority of respondents was the *use of non-RCI information*.

Table 2.1. Ratings for specific enhancements to current SLD, based on current needs of SLD users (n=25)

	HIGHEST PRIORITY	MEDIUM HIGH	MEDIUM	MEDIUM LOW	LOWEST PRIORITY
Increased use of GIS (i.e. other data sets: land use, demographics)	4	10	6	4	0
Linking of Videolog to SLD	9	9	4	0	2
Use of aerial photography in SLD	12	6	5	0	2
Use of additional RCI data not currently in the SLD	5	6	8	5	1
Use of non-RCI information	3	1	11	5	4

When asked about the type of training desired for SLD application (Figure 2.6), nearly a third of the respondents felt that no training was necessary. Most of the other SLD users, however, indicated *reference documents* are the most desired type of training.

Figure 2.6. Type training desired for the SLD application
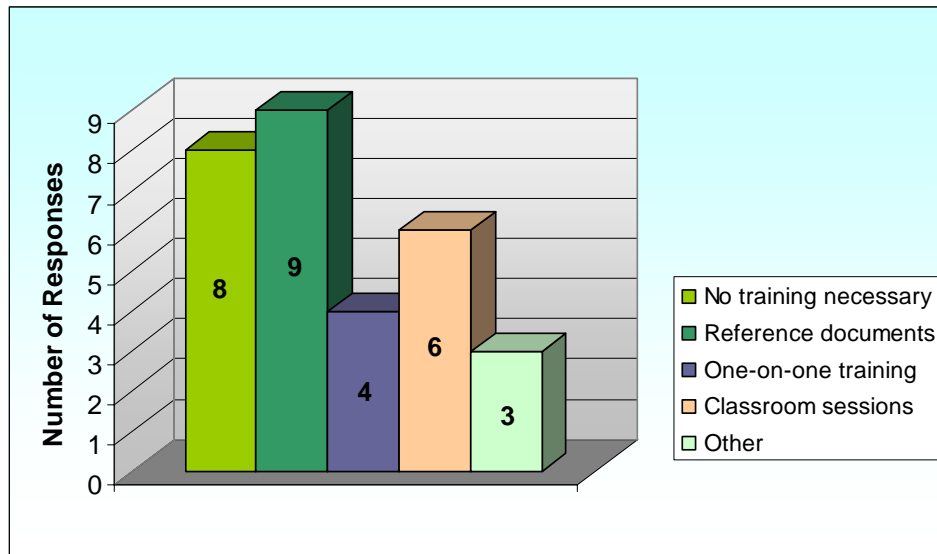
The survey also included a set of open-ended questions regarding specific suggestions for improvement. In terms of additional RCI or non-RCI data that could be included, respondents mentioned the need for local street names for street roads, land use classification information, safety data, traffic data, and information on off roadway areas (e.g., retention areas and crosswalks). Additional mapping components suggested by SLD users included the ability to download SLDs and insert locally generated overlays, links to a road map showing all intersecting roadways, and the need to tie land use to the FDOT system for better integration of growth management and transportation. Most respondents also indicated that the most preferred output format was PDF. Finally, it terms of other suggestions for improving the FDOT'S SLD application, respondents provided several useful suggestions. One respondent requested that the FDOT look at SLDs used in other states in order to select the best fit for FDOT. Another respondent had three specific suggestions:

3. Consider a key sheet similar to the one being used by D7 for Hillsborough County. It is nice having a summary of the roads in the county color coded and with local names, it is often a one stop shop for quick info when trying to locate a flooding complaint.

4. Previously when segments were transferred or deleted the street was grayed out in that location. This was a good feature because you could quickly tell if a complaint was in or out of the departments' maintenance area. Now if you can't find the street you have to go to another map and verify where the street falls on the SLD to refer the caller to the correct agency. It is a waste to throw data away.

5. A search for mile post by local road name. I often have to scroll through every SLD because the find button in adobe acrobat does not recognize the text used on the SLD. This would save a lot of time when locating a mile post number to find a project.

Appendix B.
User's Manual for the Roadway Characteristics Inventory (RCI) Data Graphing Tool

Florida Department of Transportation

RCI Data Graphing Tool

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November 30, 2006

Table of Contents

Table of Figures

Florida Department of Transportation
Interactive RCI Data Graphing Tool
November 2006

Introduction

Using the FDOT RCI Graphing Tool

The **RCI Data Graphing** tool is a utility that allows a user to generate a representation of a desired roadway, showing the characteristics that the user wishes to see. It is capable of rendering any linear referenced data.

> To start the application, navigate to the RCI Graphing Tool website:
> http://cotranstat.dot.state.fl.us/sld
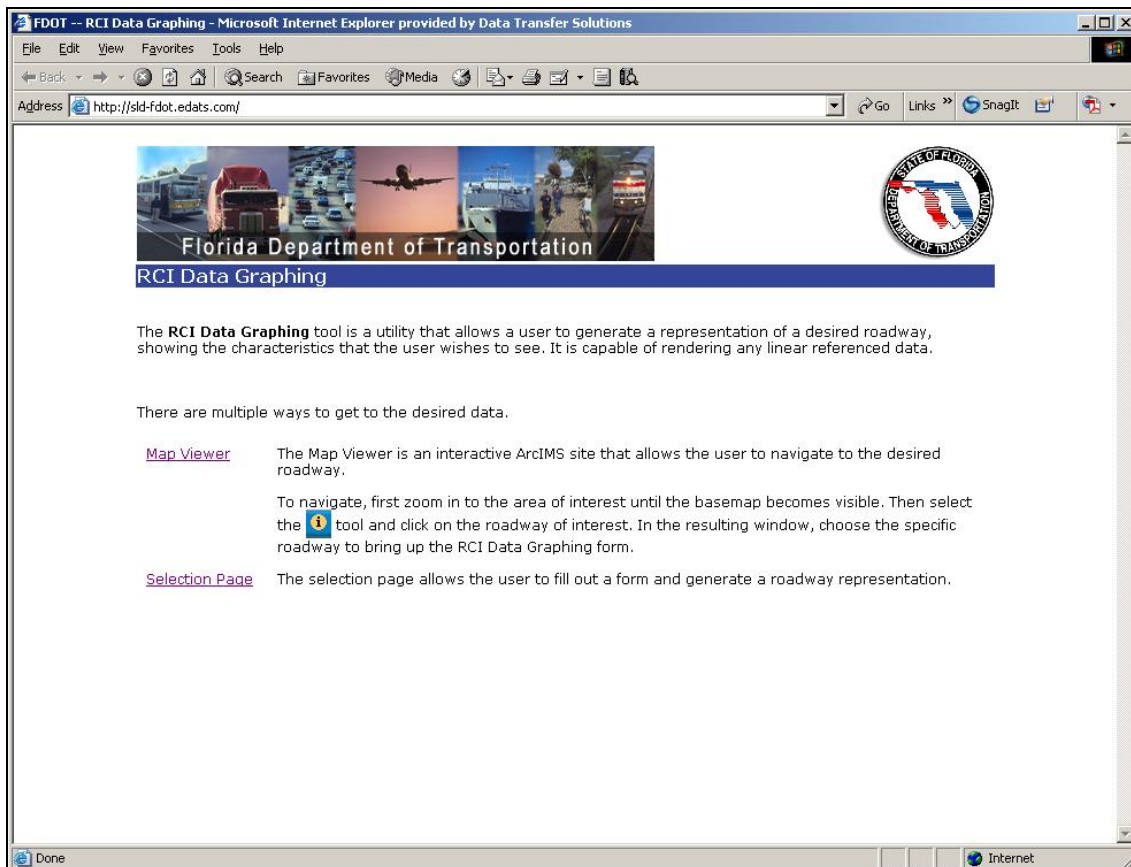
Figure 1: RCI Data Graphing Tool Main Screen

The user is offered two options for choosing their roadway;

- Via the **Map Viewer**
- Via the roadway **Selection Page**

Using the Map Viewer

The Map Viewer is an interactive mapping tool that allows users to navigate to a desired roadway. Clicking on the **Map Viewer** link will open the RCI Data Graphing Map Viewer shown in Figure 2.
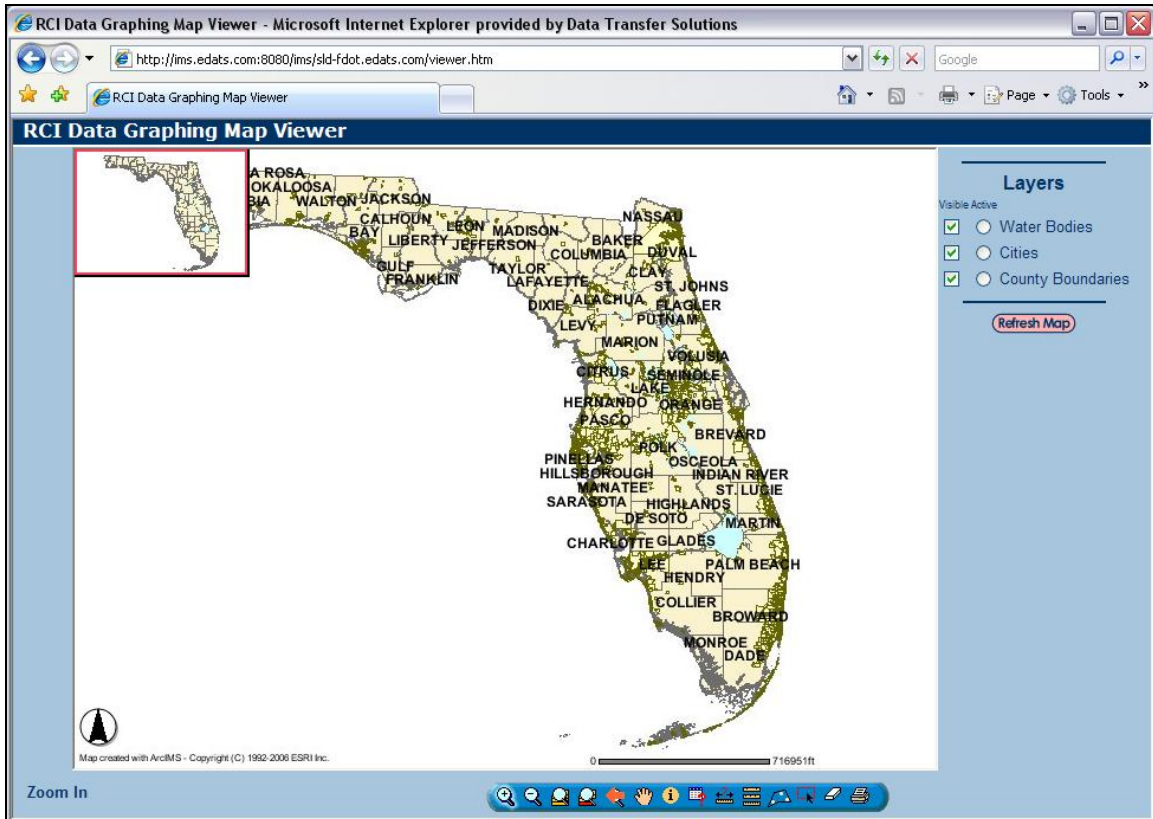
Figure 2: RCI Data Graphing Map Viewer

Layers shown on the right side of the screen can be made visible or turned off. Many layers are scale dependent (as you zoom in, more layers will be made available). You can make a layer active by selecting the radial button in the active list. When turning layers on and off, use the Refresh Map button to re-display the map. The various buttons from the mapping toolbar are described in the table below:

Icon Table

 Zoom In

Zoom Out

Zoom to Full Extent

Zoom to Active Layer

Back to Last Extent

Pan

Identify
Use this button to display information for features in the active layer

Query
Use this button to initiate interactive query tool to select features in the active layer

Measure
Initiates Interactive Measuring Tool

Set Units
Sets units for scale display and measurement

Select by Rectangle
Interactively select features in the active layer by drawing a rectangle

Clear Selection

Print

The mapping interface allows the user to zoom into an area of interest. As you zoom in the Basemap layer will become available for display and query. Now using the **Identify** tool the user can select a roadway on the map. Using the **Select by Rectangle** tool will allow the user to select multiple roadways. A list of roadways along with properties associated with them is then presented to allow the user to choose the desired roadway. This is necessary when there are overlapping roadways.
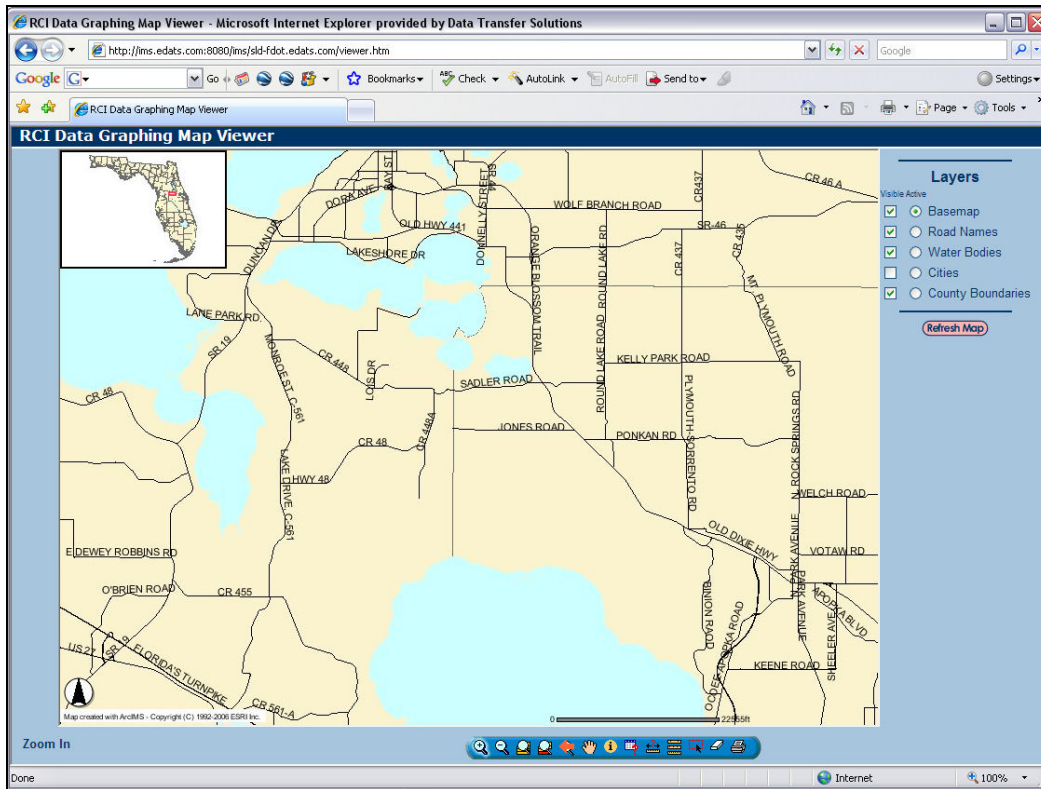
Figure 3: RCI Data Graphing Map Viewer Zoom-in
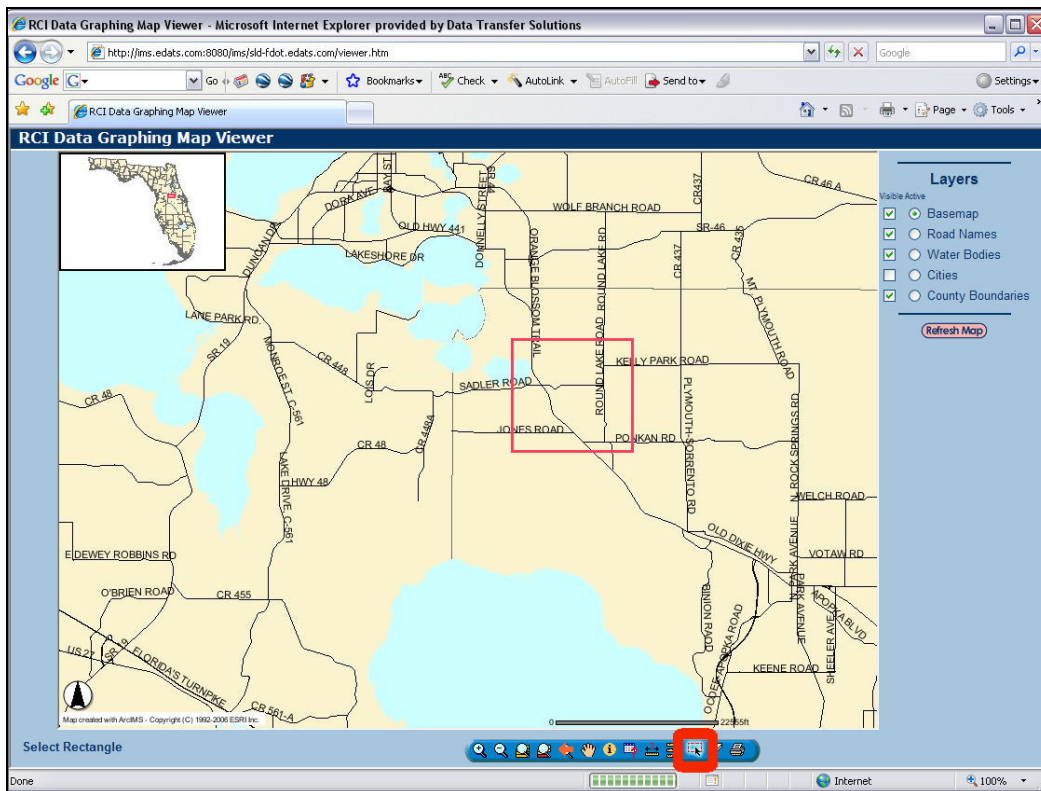
Figure 4: Selection Using Rectangle Tool
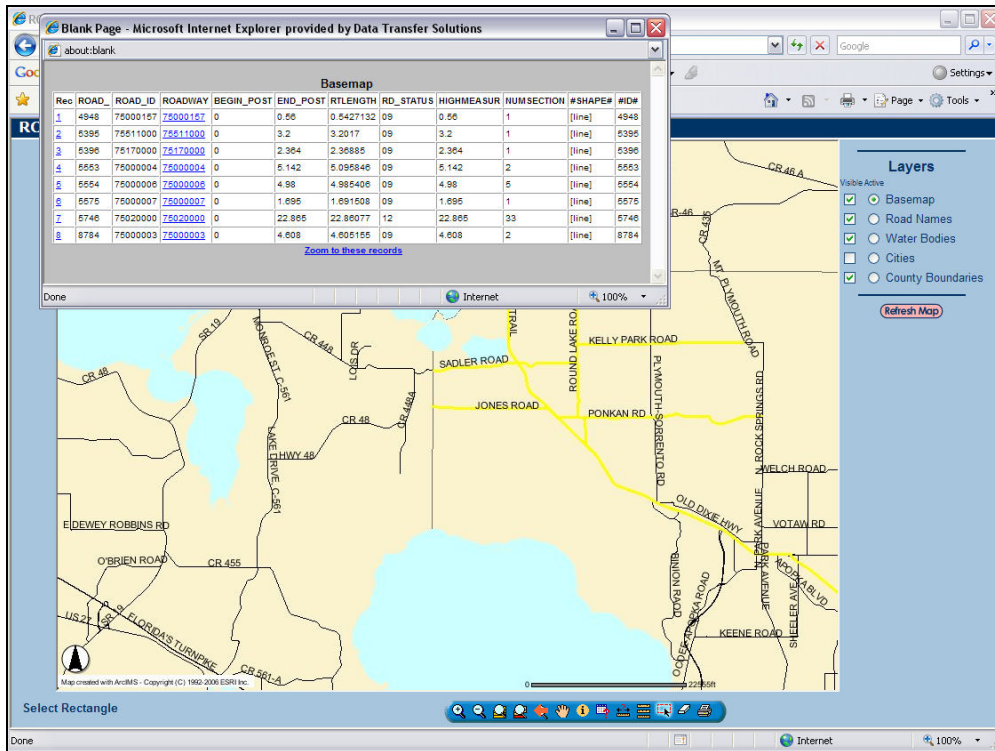
Figure 5: Basemap Selection Table

From the Basemap selection table, the user can select any roadway listed by simply clicking on the roadway hyperlink as shown below.
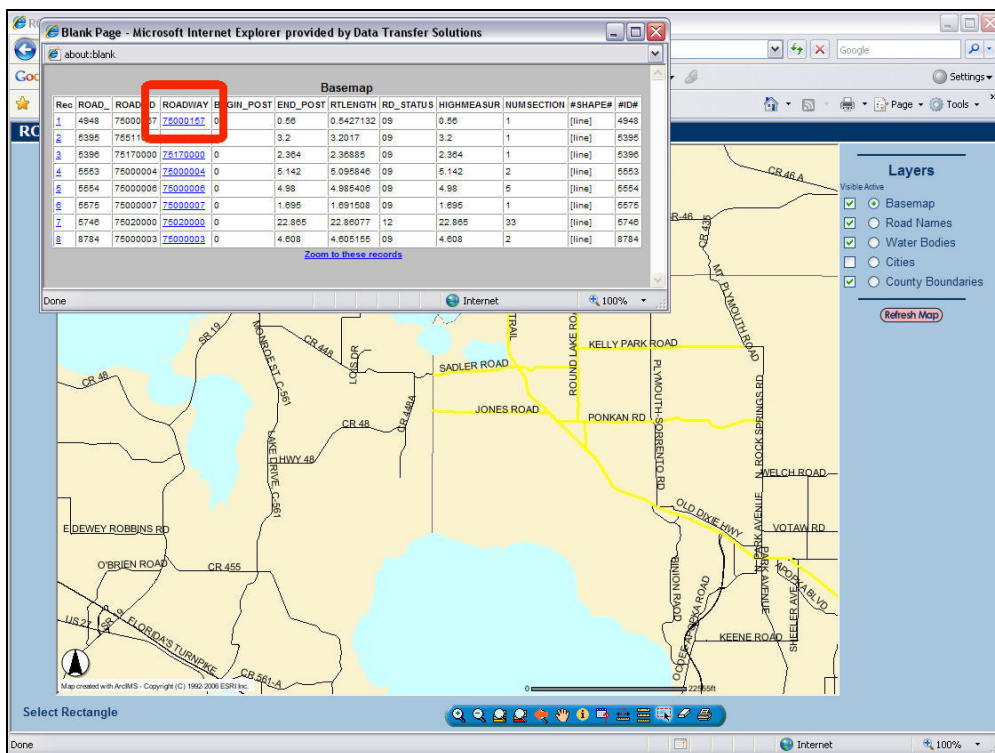

Figure 6: Selecting a Roadway

Selecting a roadway will then take you to the **Selection Page** where all attributes for the roadway you have selected will be populated from the map (County, Roadway ID, Road Name, and Milepoints).
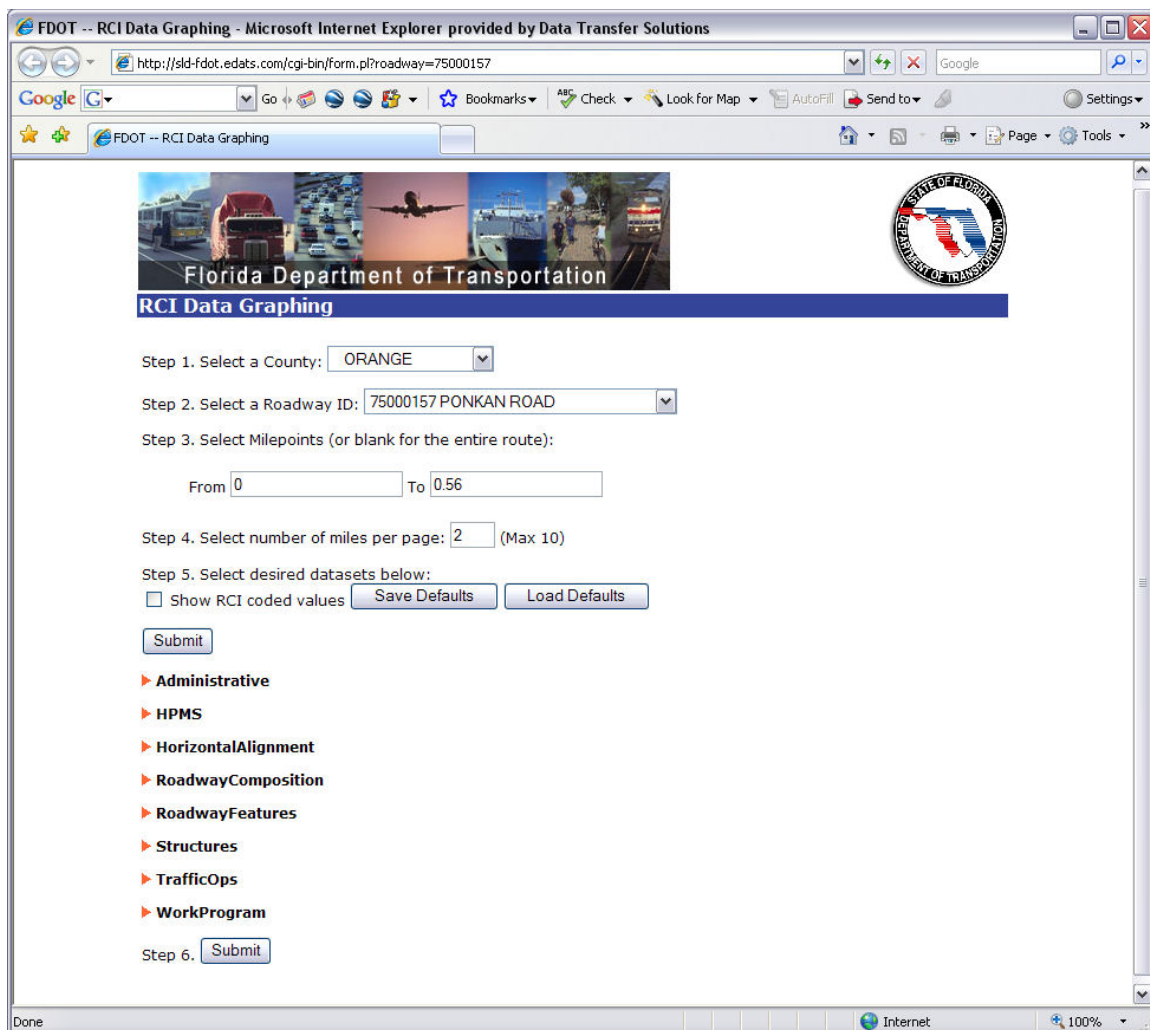

Figure 7: Selection Page from Map Viewer

The user can further modify **Step 3** to select portions of the selected route and **Step 4** to modify the number of miles displayed per page in the final data graphing product.

Step 5 involves selecting all the desired datasets for inclusion in the final product. All datasets have been grouped into one of 8 categories. By clicking on the orange arrow, the individual layers for each major category are revealed. Clicking on the desired datasets in each category will add the datasets to the final data graphing product.

Another available feature is the ability to save the selected datasets as defaults. Selecting the ⬚Save Defaults button will allow you to save all your selected datasets as the default. When starting another roadway, simply select the ⬚Load Defaults button to restore your saved settings.

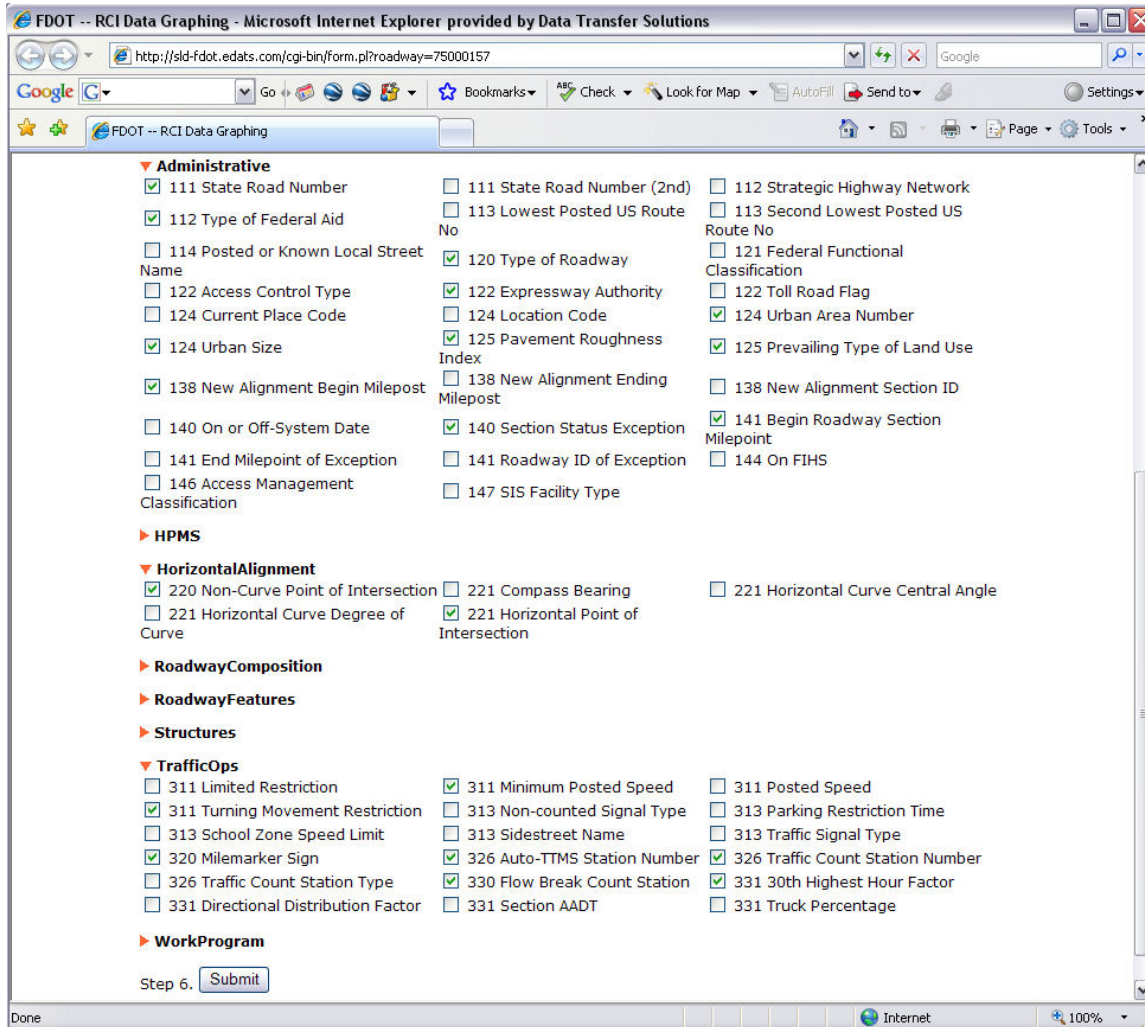Once your selections are complete simply select the submit button at **Step 6** to generate the product.

Figure 8: Selection Page details

Once the submit button is selected, the database will be queried and the product created for downloading.

When complete, simply click on the **Download** hyperlink to view the PDF document.

The PDF document is made up of a map showing the location of the selected roadway and several pages (number depends on number of layers selected) showing the graphing of the selected features along the roadway.
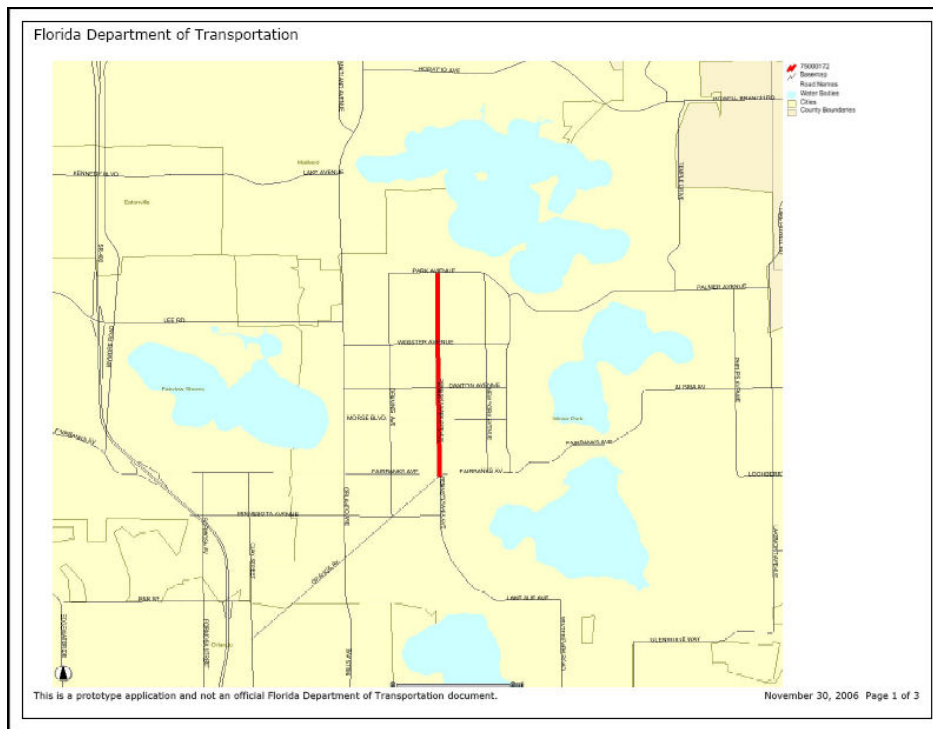
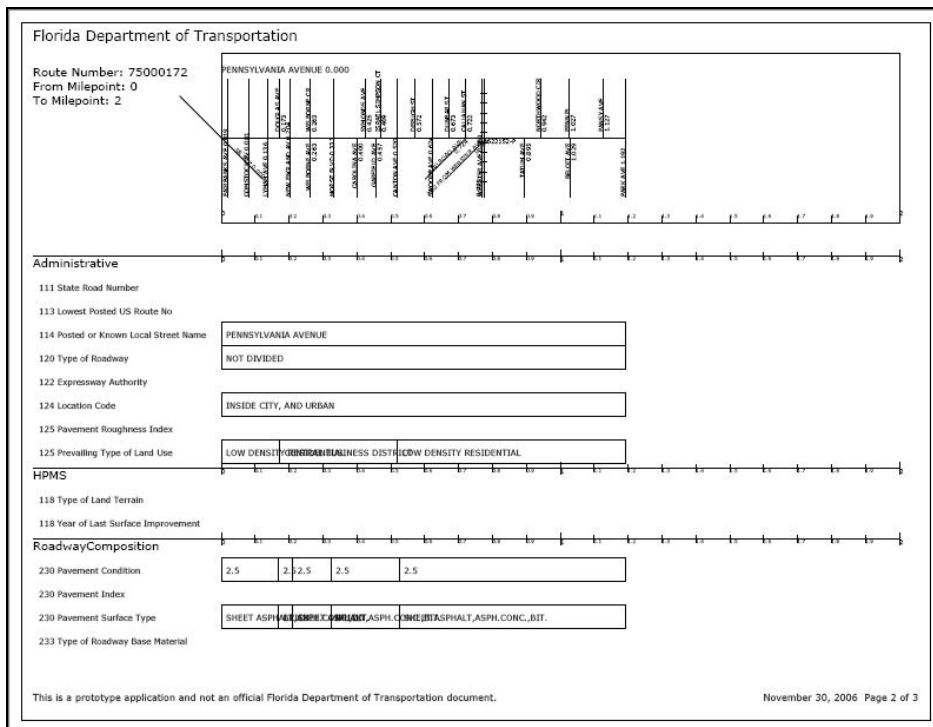*Figure 9: PDF Map showing selected roadway*
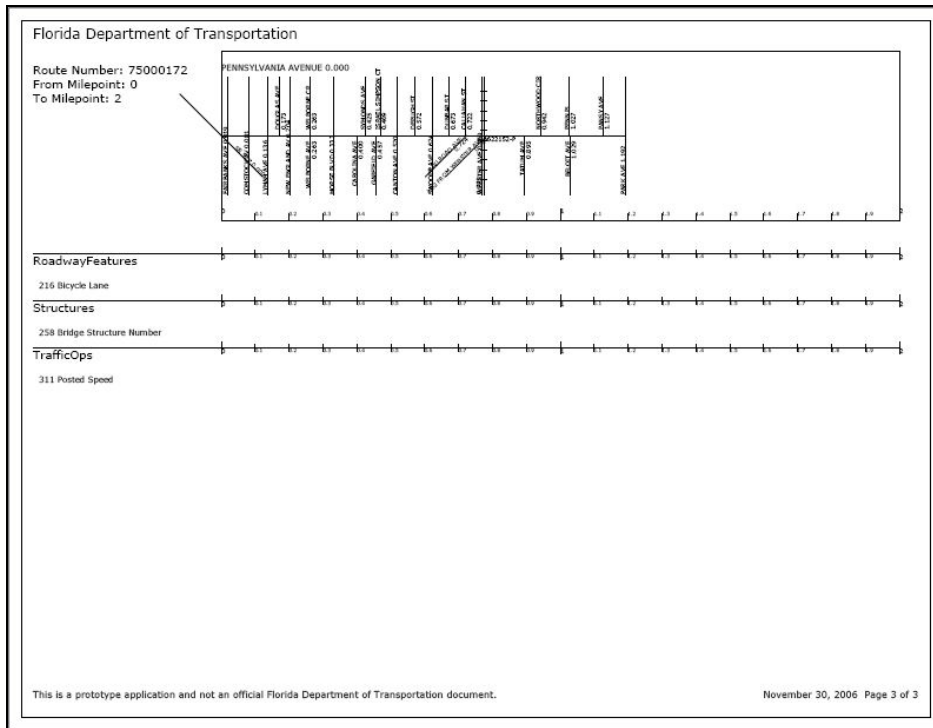

Figure 10: PDF Roadway Graphing – Page 1

Figure 11: PDF Roadway Graphing – Page 2

Using the Selection Page

In addition to using the map interface for selecting roadways, the user has the option of going straight to the **Selection Page** to select the roadway of interest. The user will interactively select the desired District, County, and Roadway ID from a pull-down list.
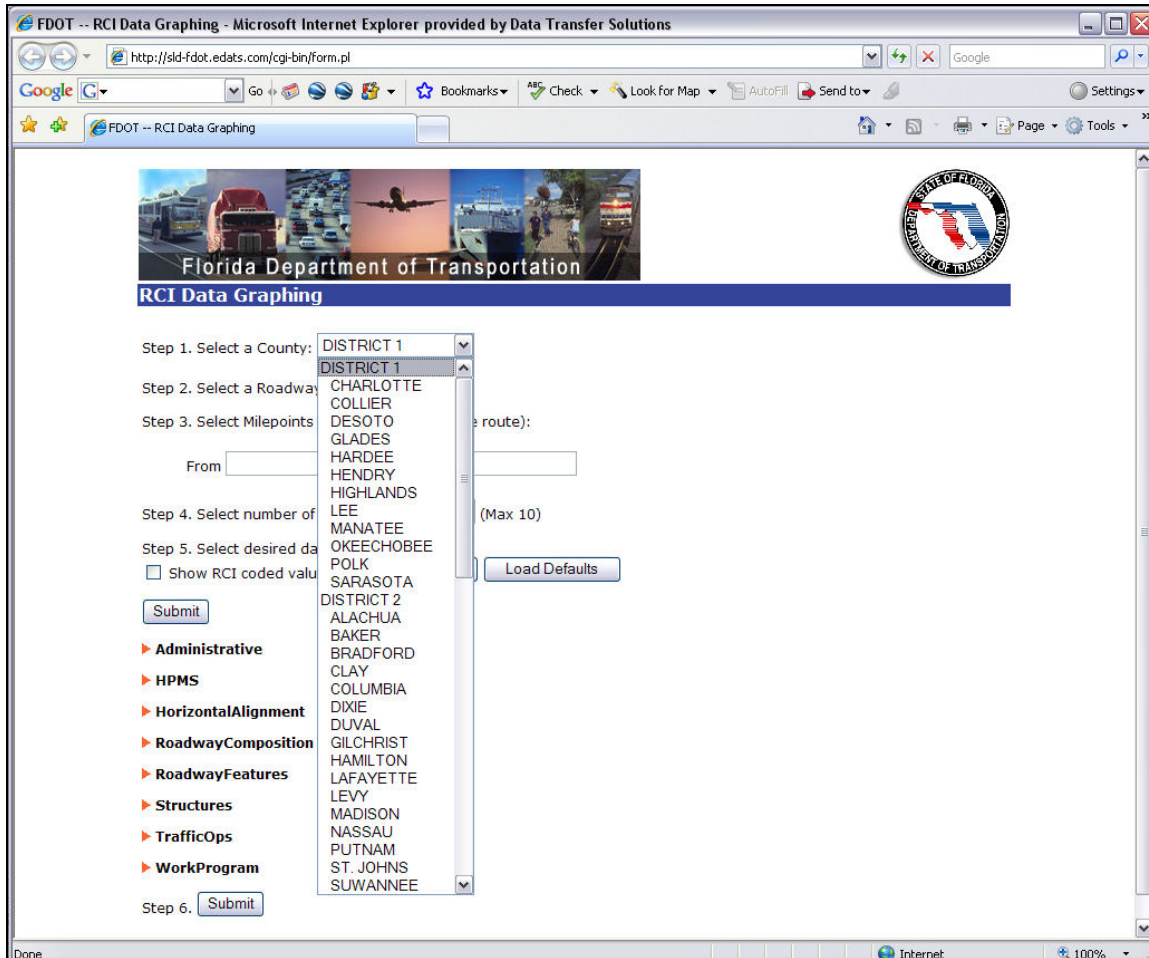

Figure 12: Selection Page Step 1

In the pull-down list for **Step 1**, Counties are listed by FDOT District. After completing **Step 1** selecting the drop-down menu for **Step 2** will load Roadways for the selected County only.
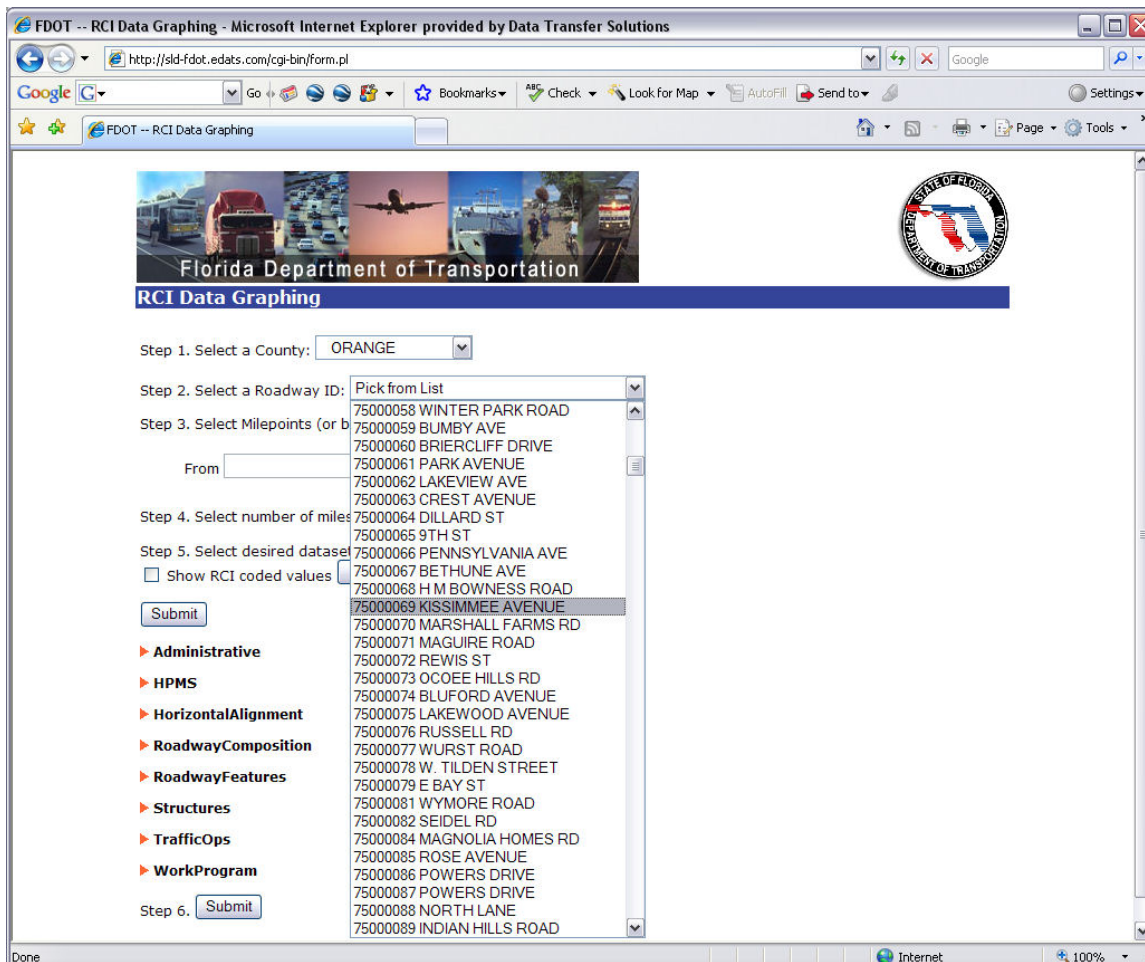
Figure 13: Selection Page Step 2

Once **Step 1** and **Step 2** are completed, the user will finish steps 3 through 6 as described in the **Using the Map Viewer** section. These steps will allow the user to select milepoints along the roadway (**Step 3**), select number of miles per page (**Step 4**) and select desired datasets (**Step 5**). Once complete, **Step 6** will generate the PDF document.