CRASH DATA ANALYSIS TOOL 2.0

Research Report + User Guide

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WHAT CAN CDAT 2.0 DO FOR ME?

THE VALUE OF CDAT

- Provides better access to crash data to improve safety performance across Kentucky
- Offers easy and consistent access to methodologies
- Helps users, including divisions of the Kentucky Transportation Cabinet, understand where safety improvement opportunities exist
- Integrates crash and roadway data
- Ability to query a segment or intersection to obtain a safety score and compare it with other segments
- Features a mapping interface which can be used to query and display crashes as well as roadway data.
- Generates charts and graphs to provide a better understanding of crash types and develop comparisons with similar roads
- Pre-loaded with current state-based safety performance functions (SPFs) for a variety of crash types and severities
- Can be used to prioritize projects or evaluate highway improvements
- Promotes the importance of roadway segment homogeneity in safety analysis

1. CDAT 2.0 BACKGROUND

The Kentucky State Police (KSP) provides a feature-rich crash data tool with public- and private-facing (secure) access options called the Kentucky Open Portal Solution (KyOPS). The secure portal is sufficient for tabulation and rudimentary analysis of crash data. Currently, KyOPS is undergoing a major upgrade to enhance public and private access to crash data.

Despite the major upgrade, advanced crash data analysis can require significant post-processing. For instance, the Kentucky Transportation Cabinet (KYTC) routinely monitors several crash types, including lane departures, cable crossovers. These crash types are defined based on complex queries of crash and roadway data; they are stored as crash flags that are easy to query against. Many of these flags have been developed based on research. Furthermore, crash analysis relies heavily on advanced statistical calculations to account for issues (e.g., regression to the mean) consistent with methodologies in the *Highway Safety Manual* (HSM), which are beyond the scope of the KyOPS system.

This user's guide describes the updated Crash Data Analysis Tool (CDAT) — CDAT 2.0. KYTC staff and the agency's work partners can use CDAT to securely analyze crash datasets. Users can query and download data using flags stored during post-processing. Unlike KyOPS, CDAT's location data are validated using geographic coordinates and several county, route, and milepoint fields to ensure crashes are properly geocoded.

CDAT grants access to data and information that can be used in conjunction with KYTC's *Data Driven Safety Analysis (DDSA) Implementation Guide*[1] to conduct highway safety analysis for many KYTC processes. Historically, the Cabinet's Division of Traffic Operations has occasionally requested this type of safety analysis.

Now that CDAT is available, other business areas can realize benefits from advanced safety analysis. Recently, the Divisions of Planning and Design collaborated with Traffic Operations to better understand how the HSM can be incorporated into their routine functions.

Moving forward, the *DDSA Implementation Guide* and CDAT will play a critical role in the Cabinet's efforts to integrate HSM methodology into agency decision making. CDAT can also help maintain consistency across safety analyses. Often, KYTC staff and Kentucky Transportation Center (KTC) researchers perform analyses that produce dissimilar crash counts. Inconsistent results are common when queries are complex or rely on specific crash location information, when different tools or different data sets are used, or if staff have incomplete knowledge of crash coding.

[1] https://business.kytc.ky.gov/work/DDSA/Pages/default.aspx

1.1 CDAT 2.0 UPDATES

KTC researchers developed CDAT 2.0 based on user feedback. Comments submitted by users made it clear that a major version update would greatly enhance the tool. Many users requested features not available in the first phase of development as they were outside the scope of the original project. With this second phase of development, CDAT has been updated to include new functionality. Key CDAT 2.0 updates include:

- A new mapping interface that makes it easier to select and analyze results
- Ability to separate intersection analysis from segment analysis
- Bug fixes and additions made at the instruction of the Study Advisory Committee (SAC)
- Integration of the Continuous Highways Analysis Framework (CHAF)

2. HOW TO USE CDAT

2.1 ACCESS & REGISTRATION

Users must register before they can access CDAT. Multiple levels of access are available.

Visit http://CrashTool.uky.edu and click *Register* at the top right of the page to get started (Figure 1; yellow arrow).

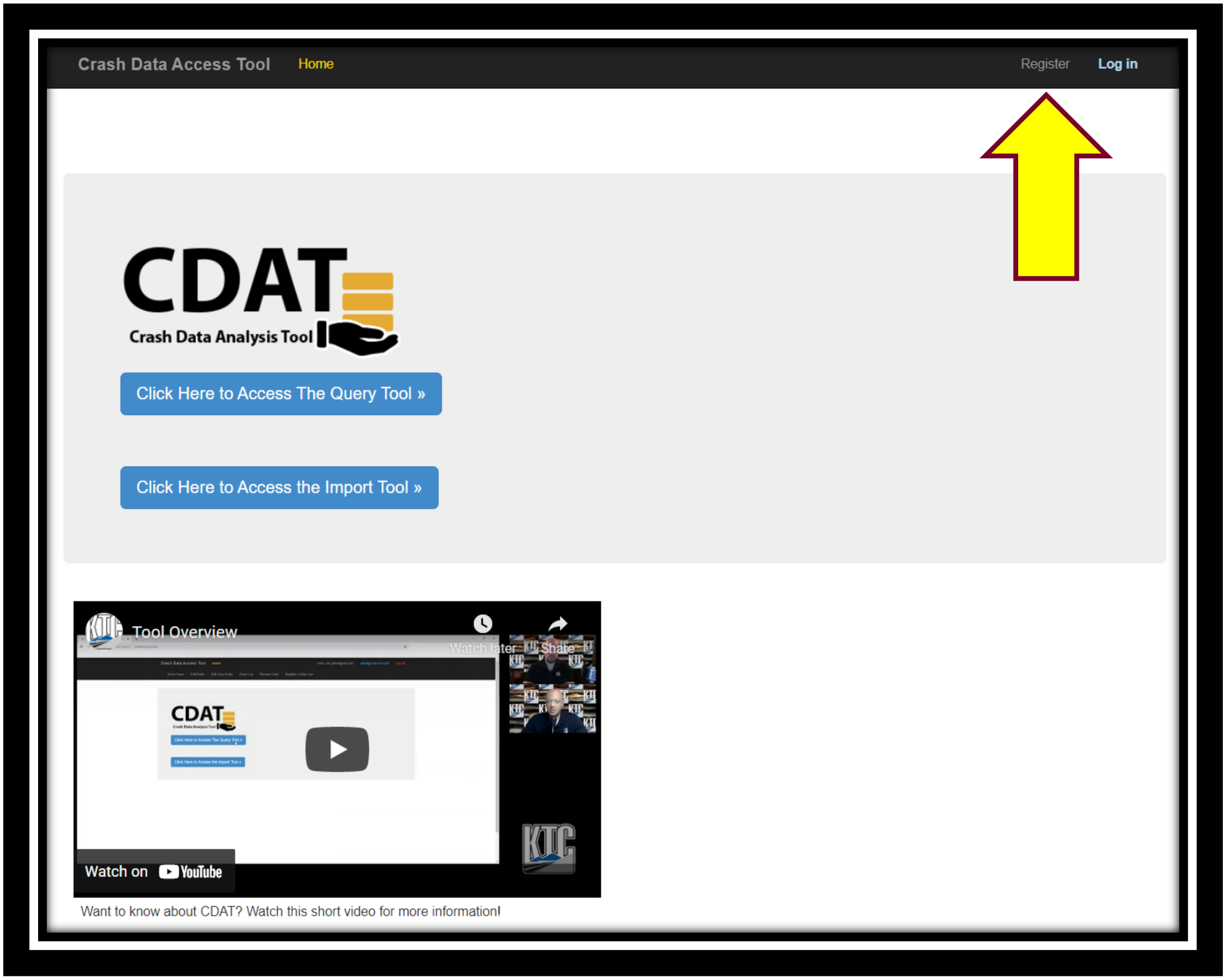

Figure 1 CDAT Home Screen

When users register, they are not automatically granted access to CDAT. CDAT's administrators decide whether to grant new users **Basic, Test, Advanced,** or **Admin** privileges.

Privileges granted to each type of user are summarized below:

Basic

A **Basic** user has a current and signed Memorandum of Understanding (MOU) on file with KYTC and has access to information as outlined in that agreement (Level 1). **Basic** users have access to information currently available to the public, but it is generated from CDAT's database.

Test

A **Test** user can access the same features as a **Basic** user; however, they cannot access crash location data. For **Test** users, all counties and routes are anonymized with random numbers. While an MOU is not required to view crash locations, this protection was built in out of an abundance of caution. KSP provides public access to these data at: http://crashinformationky.org/. Data in CDAT were sourced from KSP under the MOU. While **Test** users can access and test the system, they cannot use data for analysis.

Advanced

An **Advanced** user has a current and signed MOU on file with KYTC and can access data in accordance with that agreement (Level 2 or higher). They can view crash images, narratives, and personally identifiable data.

Admin

An **Admin** user has all advanced rights; they can also delete users and change user permissions.

2.2 QUERY TOOL & DATA IMPORT

To view information, users can select from two options on the CDAT Tool Sector page (see the yellow arrow in Figure 2):

- Query Tool
    - A web-based interface that lets users query CDAT using a given set of parameters
- Import Tool
    - Users upload a CSV with their own data

Users should choose the option that best matches their preferred workflow.

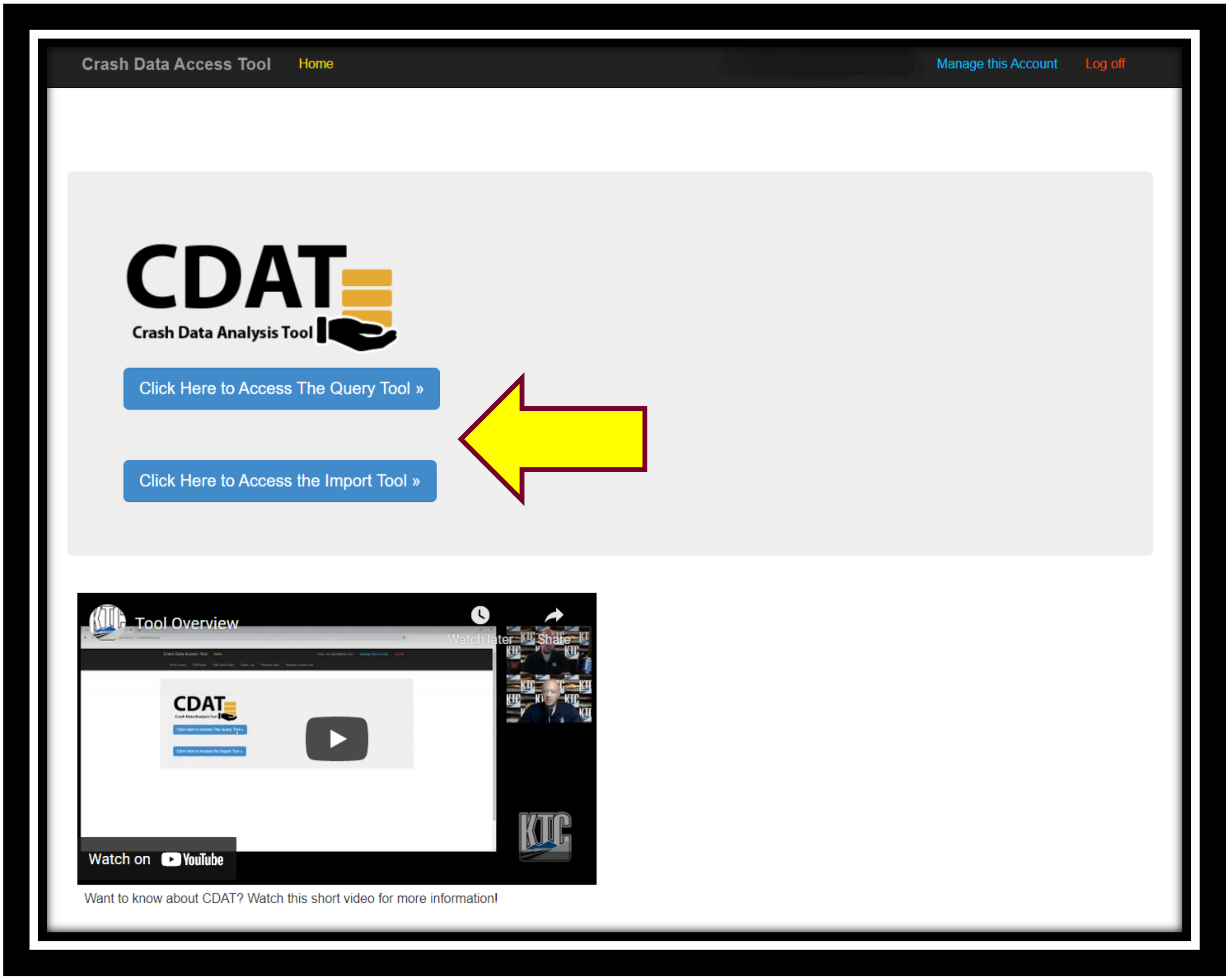

Figure 2 CDAT Tool Selector

2.3 QUERY TOOL – STEP 1

If users choose the Query Tool (Figure 3), they must first select the county, route, and milepoint range. Any roadway segment from KYTC's statewide roadway network can be selected (state and local roads).

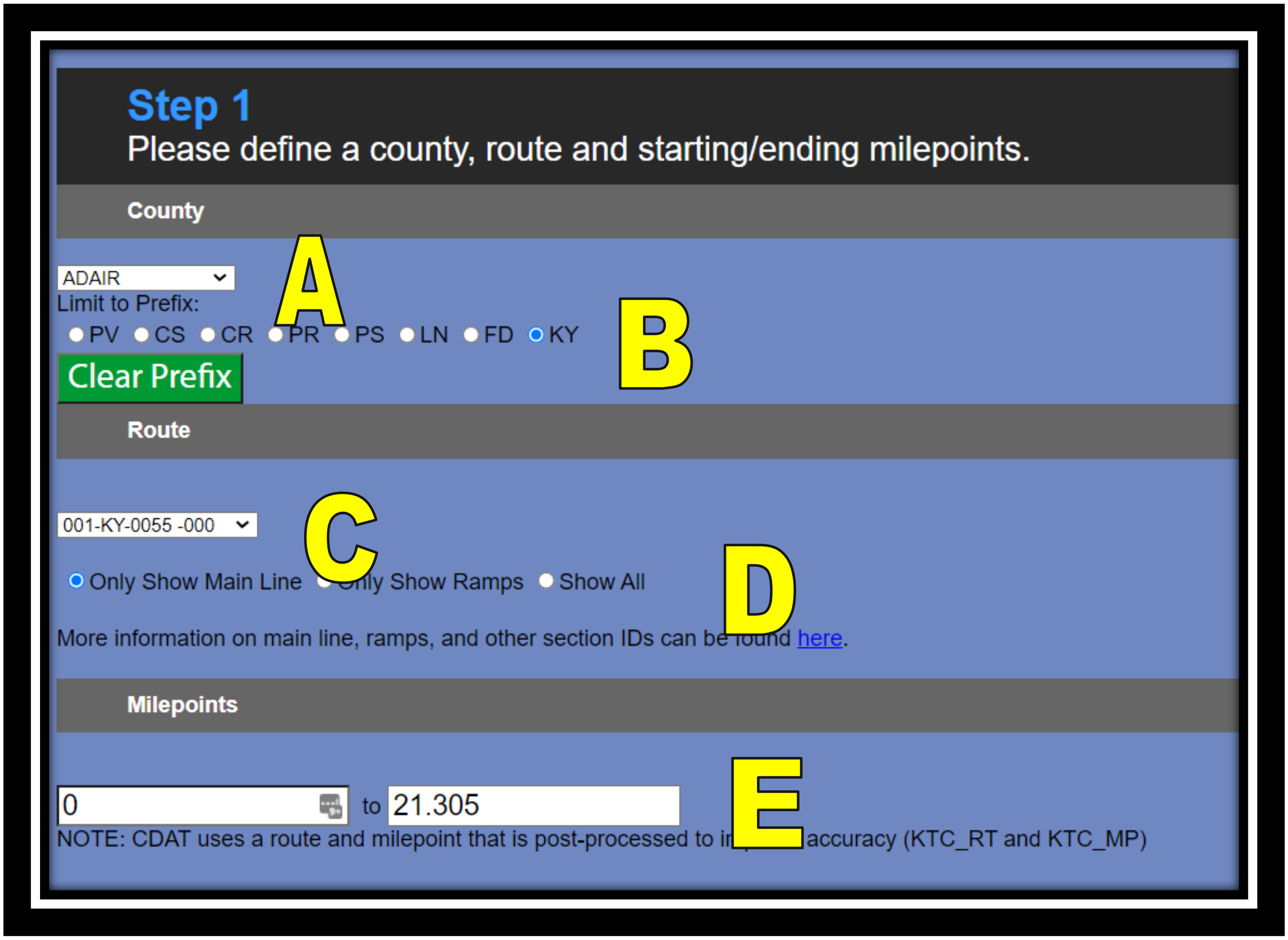

Figure 3 Query Tool — Step 1

Figure 3 is a capture of the screen on which users input data. First, the user selects a county (**Figure 3** Query Tool — Step 1Figure 3**A**). Once they select a county the form reloads. On the reloaded form, users select a route prefix by clicking on a radio button (Figure 3**B**) and then choose a route from the Route dropdown menu (Figure 3**C**). When the user selects a route prefix, routes displayed on the Route dropdown menu are filtered, leaving only routes with the specified prefix. By default, only mainline routes are shown in the dropdown menu, however, users can also include ramps by using the section ID radio buttons (Figure 3**D**). Last, users define a milepoint range (Figure 3**E**). By default, the lowest and highest milepoints for the route are displayed for the specified county.

More information on section IDs can be found at the following website: https://transportation.ky.gov/Planning/Pages/Road-Centerline-Attributes-and-Codes-Metadata.aspx.

2.4 MAPPING

CDAT 2.0 includes a mapping platform (Figure 4). Once a user selects a county, route, and milepoint range, CDAT displays (1) a table that lists segments with major geometric changes (Figure 4**A**) and (2) a route map (Figure 4**B**). When users click on a segment in the table, the query is changed to that milepoint range including a map of the route. Changing the county, route, or milepoint ranges automatically updates the map.

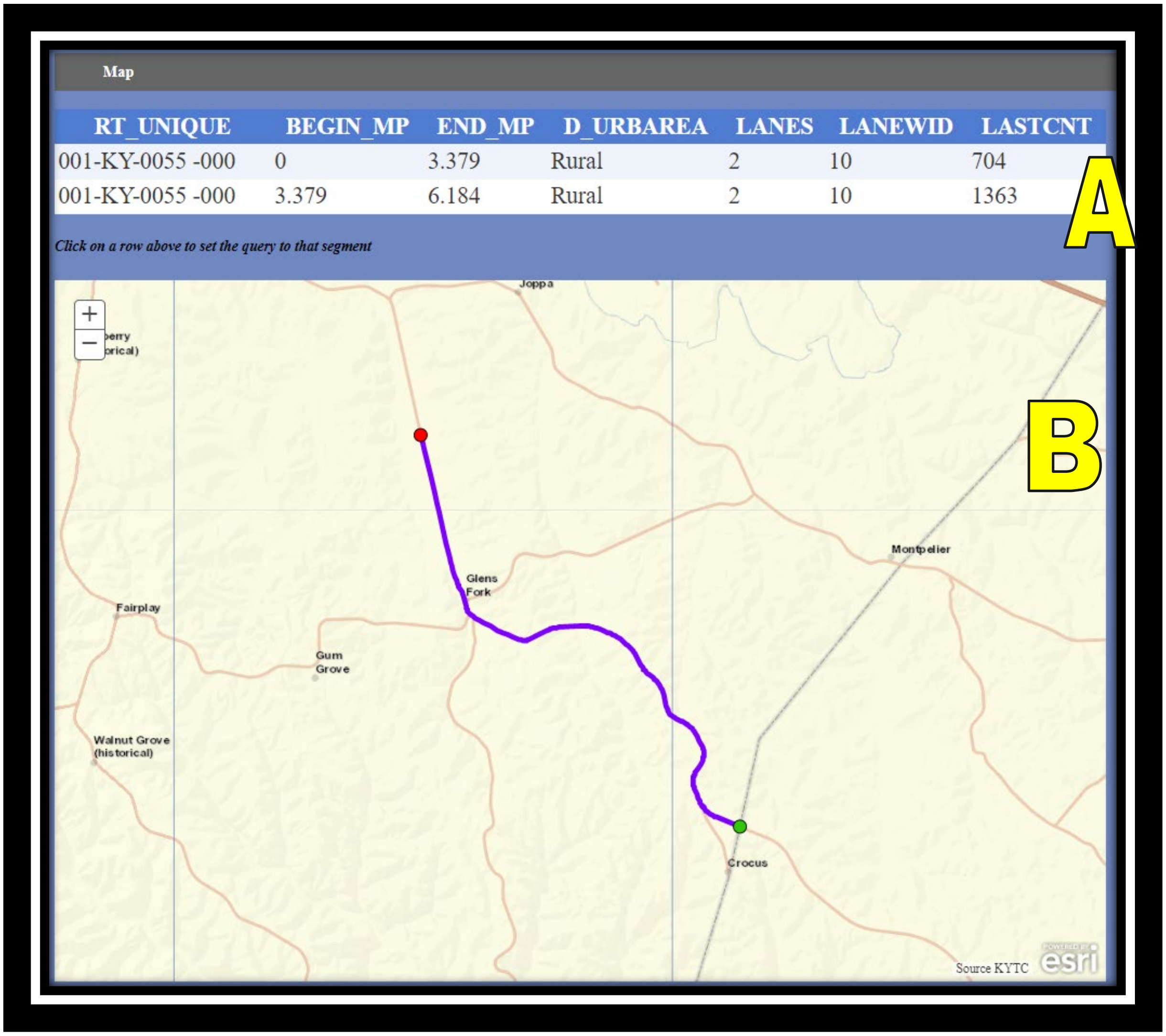

Figure 4 Mapping

Users can also highlight a route by clicking it on the map. If a new route is highlighted, the query can be changed to the entire identified route (Figure 5**A**) or to near the route identified (Figure 5**B**).

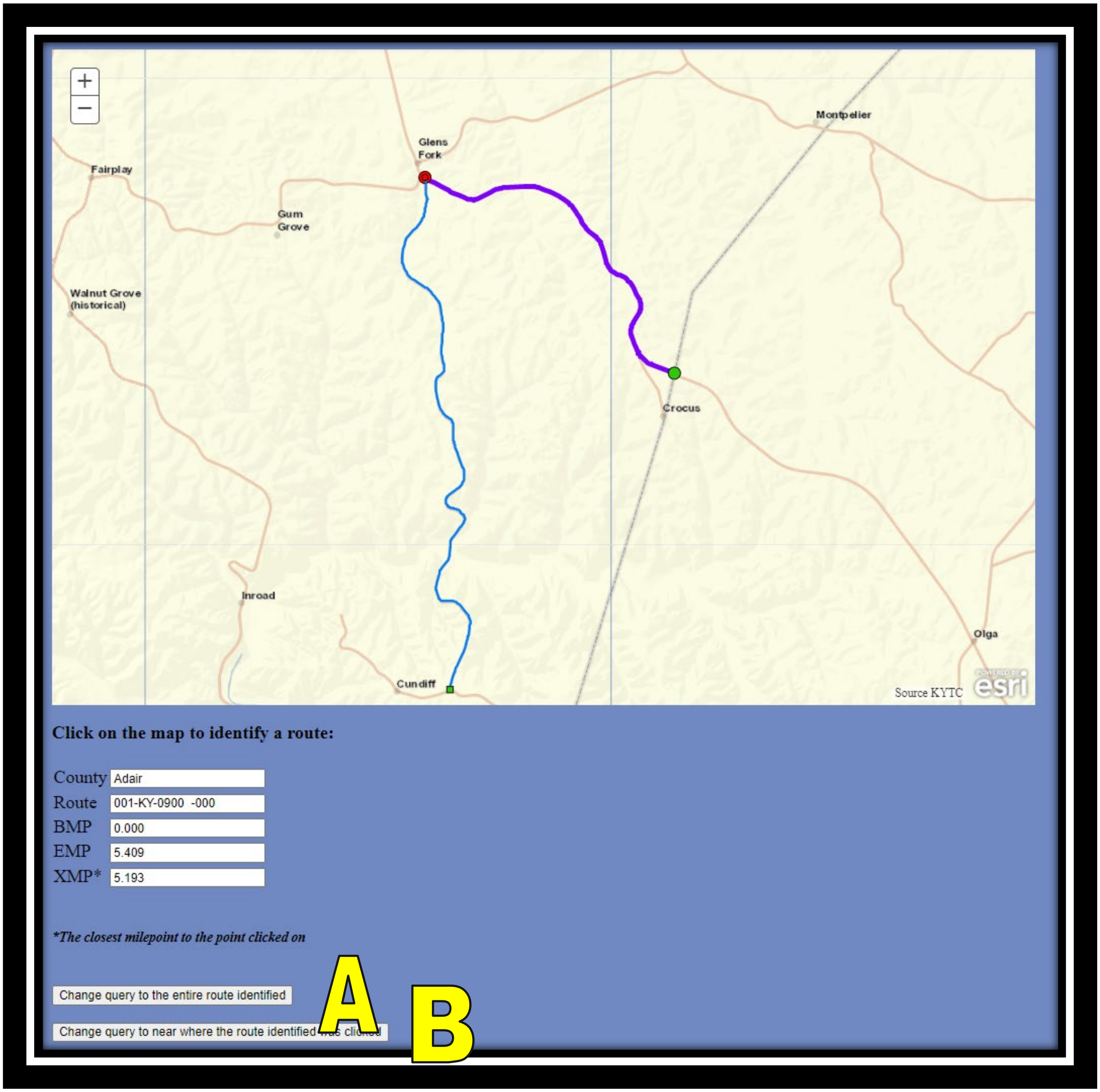

Figure 5 CDAT Map Click

2.5 QUERY TOOL – STEP 2 ADDITIONAL PARAMETERS

In Step 2, users define which crash severities to include. Crash severity is classified using the KABCO scale. Severity is rated based on the most seriously injured person (Figure 6A).

Along with KABCO classifications, two additional categories are included — U (Unknown) and H (Hit and Run with Unknown Injury). U denotes crashes that lack injury severity data for all people who were involved. An H crash is a hit-and-run incident involving a parked car. For H crashes, no people were at the scene of the crash, and therefore could not be evaluated. It is unlikely for occupants of a fleeing vehicle to have fatal injuries, but it is possible they sustained injuries. The user can select as many crash injury categories as they want. Limiting analyses to K crashes (fatal) typically returns very small samples. To increase sample size, analysts typically combine K and A crashes into one dataset.

Users filter by crash type(s) in the Filters section (Figure 6B). Most crash types are derived based on several crash attributes. Appendix A defines crash types and the query logic used to generate them. Most of the options are crash types described in Kentucky's Strategic Highway Safety Plan. If a user checks more than one filter, CDAT returns crashes that have both properties. For example, checking *Motorcycle* and *Commercial Vehicle* only returns crashes that involved a motorcycle ***and*** a commercial vehicle.

In the Road Type section (Figure 6C), users select one option in each row. The first row relates to property. Users can select (1) private property and public road crashes, (2) private property crashes, or (3) public road crashes. Crashes on private property are generally excluded from analysis. Options in the second row relate to parking lots crashes. Users can select (1) parking lot and non-parking lot crashes, (2) parking lot only crashes, and (3) non-parking lot only crashes. Parking lot crashes are also generally excluded from crash analysis. Intersection filters have been removed from CDAT 2.0 as it includes a new panel that displays intersection data (discussed in detail below).

In the Timeframe section (Figure 6D), users select years for which data should be retrieved. CDAT does not support partial-year queries because crash data are added to the tool once a year. KYTC's highway Information view and Extract interface (HIVEi) can be used for partial-year queries. Although CDAT may eventually include more than five years of data, for now this limitation is necessary for using the safety performance function (SPF) analysis.

Once users finish selecting options on the Step 2 page, they click *View Data* to begin analysis.

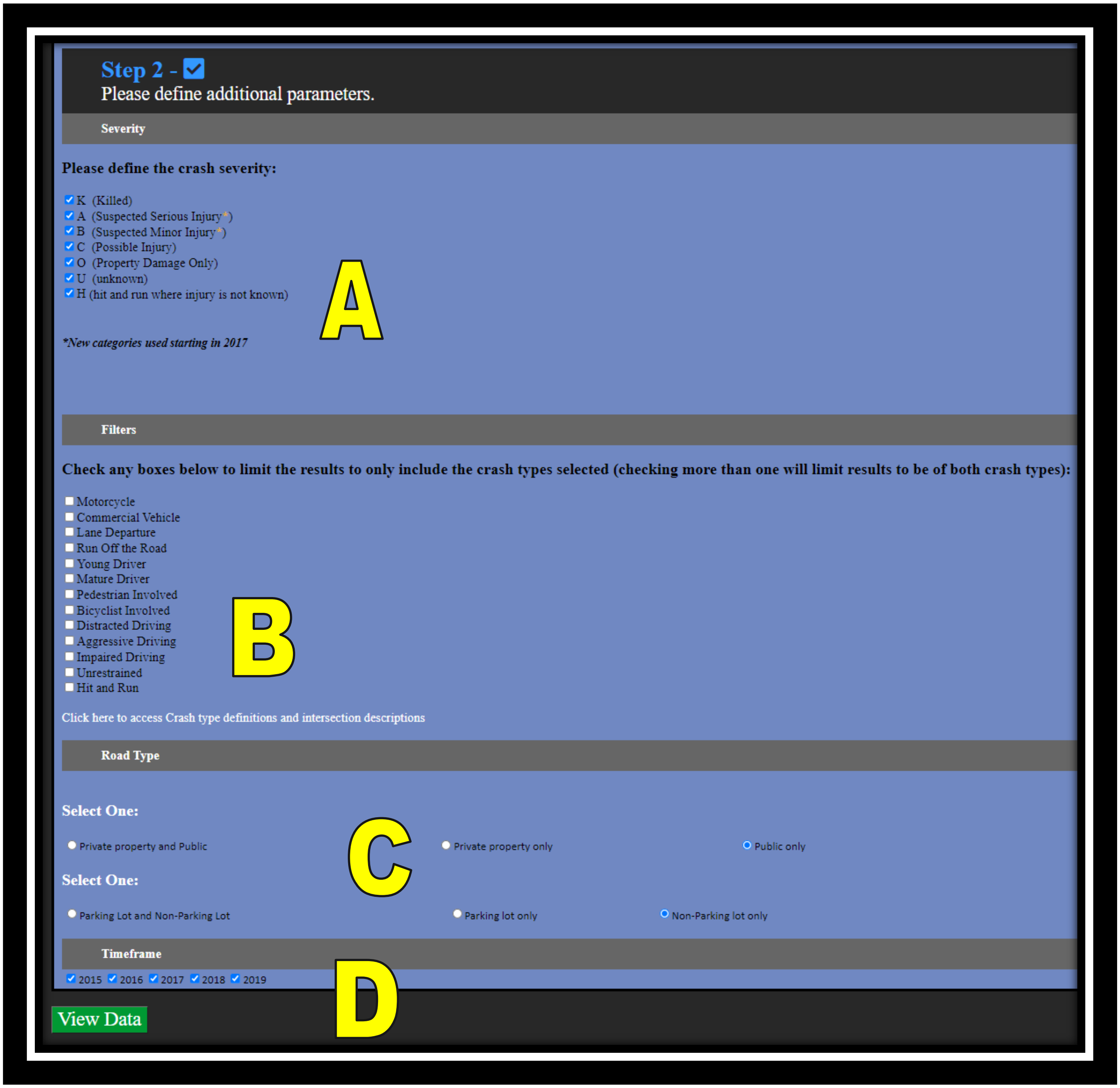

Figure 6 Query Tool — Step 2

2.6 ROADWAY DATA

Figure 7 illustrates roadway data results for the roadway segment selected in Step 1. Roadway geometrics are displayed, with the length represented by each category shown. Note that some roadway segments may exceed the start and end segments provided in Step 1. In this case, the total mileage is slightly longer than the segment length.

Figure 7 View Data Roadway Results

Users can change the behavior of graphics by clicking on a chart title. In the lower-left portion of the screen, users have three options for adjusting chart appearance. Users should select the radio button which corresponds to their choice. The default option is *Display table version of the chart*. If this option is selected, when users click on the chart title graphed data are presented in tabular format. If *Toggle between pie and bar chart* is chosen, clicking the title converts a bar graph to a pie chart. Clicking again on the title reverts it to a bar graph. If the *Both* is selected, clicking on the title lets the user cycle through all display options (tabular data, bar graph, pie chart).

Clicking *Show Table* button at the top of the page displays all roadway data in a single table that is separated into multiple pages. Users can sort data in the table by clicking on the column header. Clicking on the header the second time reverses the order in which data are sorted. By clicking the *Download* button, users can export the table as a CSV file.

2.7 INTERSECTION CRASH DATA

CDAT 2.0 adds a new intersection section. KTC created and maintains an intersection database (Green et al. 2015).

Crashes that occur within the boundaries of defined intersections are coded as intersection crashes. However, the intersection flag coded by law enforcement does not align with how highway safety professionals define an intersection. Any crash within the queried milepoint range associated with a defined intersection is flagged as an intersection and not included in the segment analysis (see below).

Figure 8 illustrates how intersection crash data are presented for the chosen segment. This section displays multiple groups of charts. Each group can be accessed via one of the seven gray tabs at the top of the teal-colored box. Users can toggle between different sets of graphs by clicking on the tabs. Clicking the *Show Table* displays crash data. Users can also sort and download data. Any request to download crash data is logged. Download logs are audited regularly. If contacted, users will need to justify their downloaded data and confirm they have not shared said data. Clicking on graph titles lets users view data in tabular form or switch between bar and pie charts.

Along with crashes on the queried route, users often need to analyze crashes on side roads. These crashes are not included in the analysis described above.

Intersection crashes identified in a query are each tied to a unique intersection ID. A table of these intersections is provided, including the total intersection average annual daily traffic (AADT), crash counts by KABCO rating, and excess expected crashes (EEC). In this table crash counts by KABCO rating include all crashes, even those that occurred on a side route.

This list includes any intersection whether the queried route is the main approach or a side route. However, if no crash along the queried segment occurred at a given intersection ID, it is not included. This is a limitation of the query tool as it is a tabular query (i.e., based on intersection ID) and not a spatial query. To overcome this limitation, users can still analyze missing intersection(s) in the advanced map.

Figure 8 Intersection Crash Data

2.8 ADVANCED MAP

Another addition to CDAT 2.0 is the inclusion of an advanced map. This map displays crashes, roadway, and other relevant safety data. By default, the map denotes crashes using color-coded triangles. As indicated in the legend, the color coding aligns with the KABCO scale (Figure 9**A**). Users chose which layers to display by selecting from the nine options in the Layer panel (Figure 9**B**). By default, the EEC layer is turned on. This layer displays current statewide EEC data using a color coding system that has been approved by KYTC. One option lets users display intersection EEC. This visualizes intersection data omitted from the previous section.

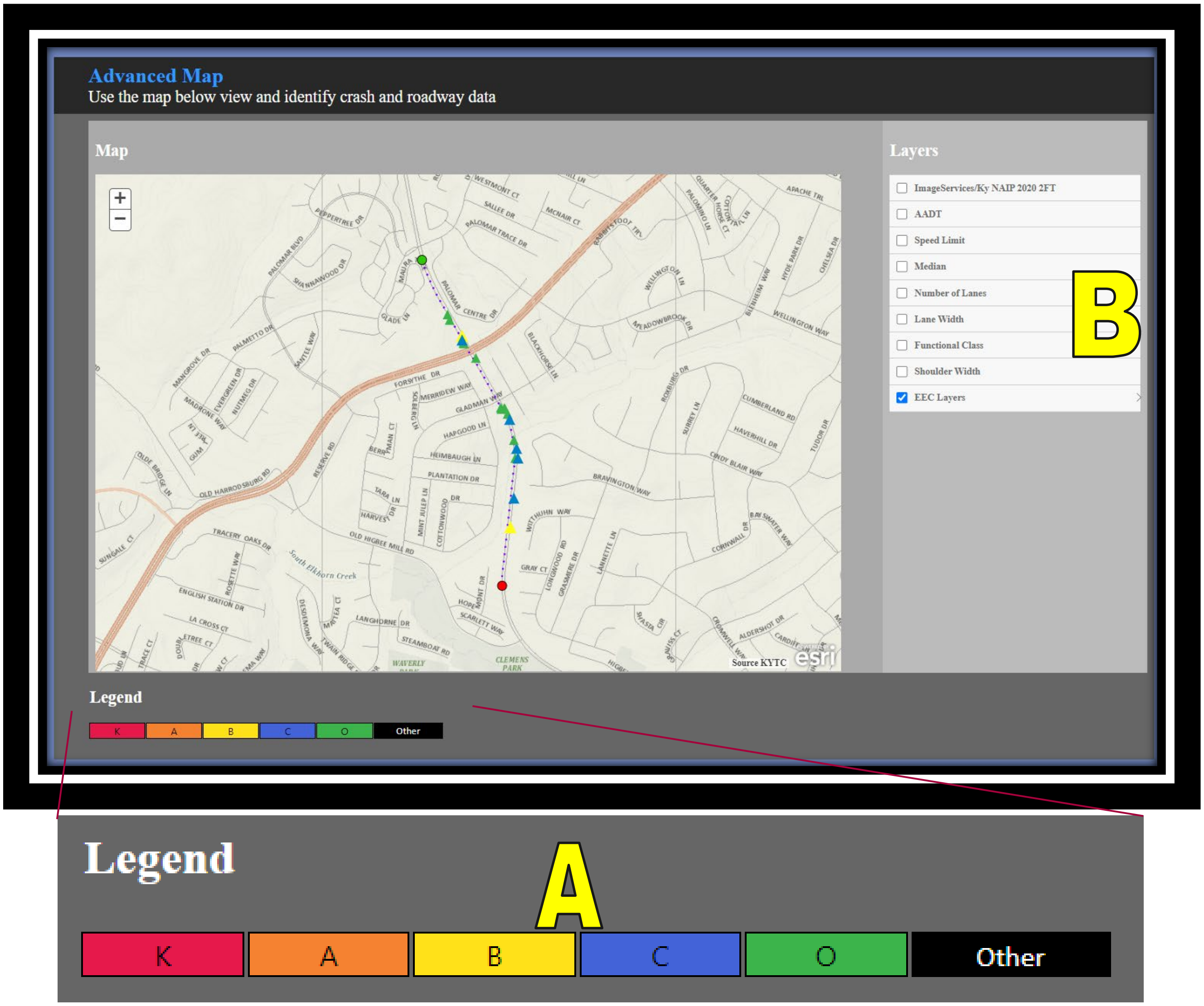

Figure 9 CDAT Advanced Map - Crashes

In addition to the EEC layer, users can view HIS layers, such as speed limits (Figure 10), and satellite imagery (Figure 11). The dropdown arrow to the right of the layer name can be used to view the legend for that layer.

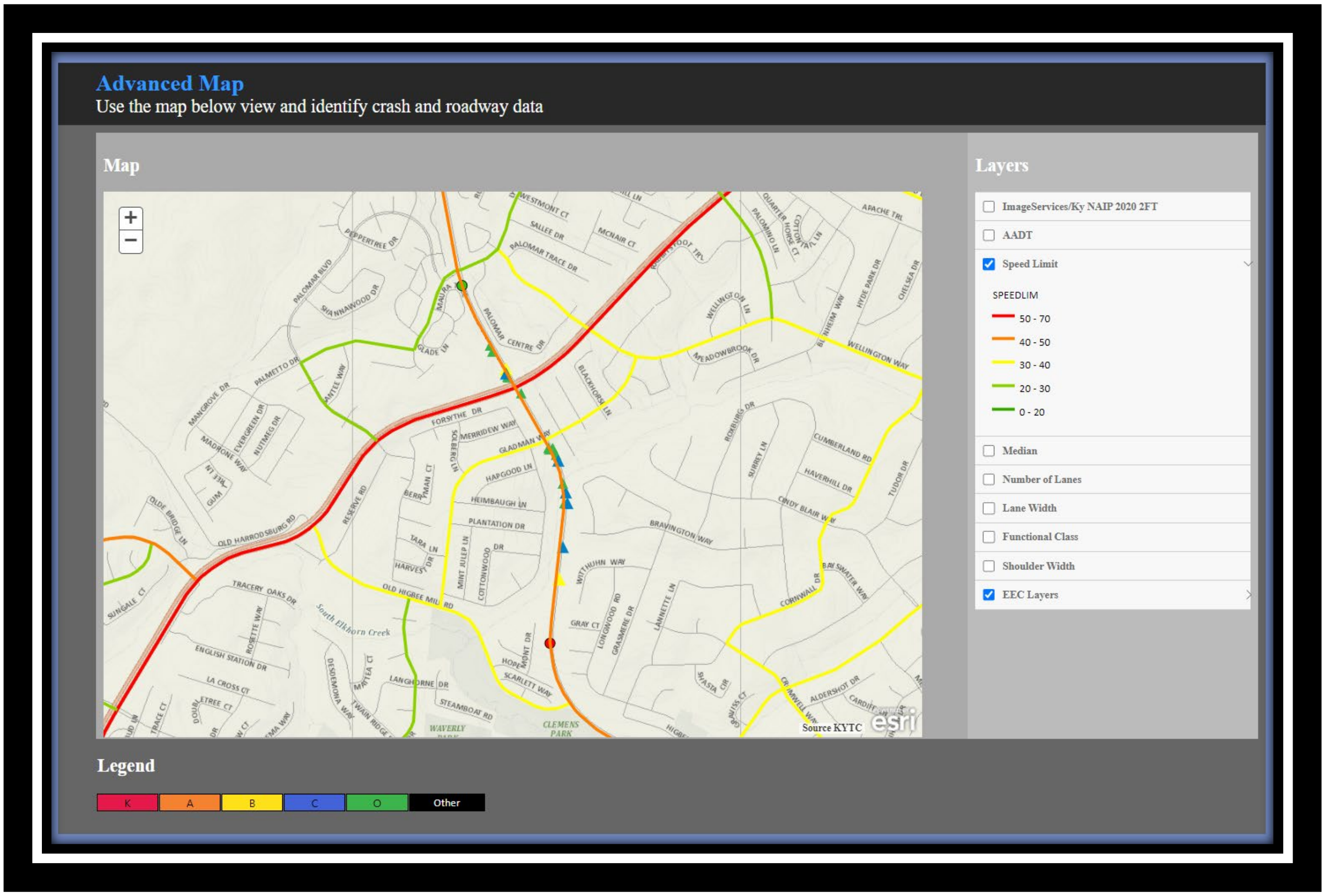

Figure 10 Advanced Map – HIS Layers

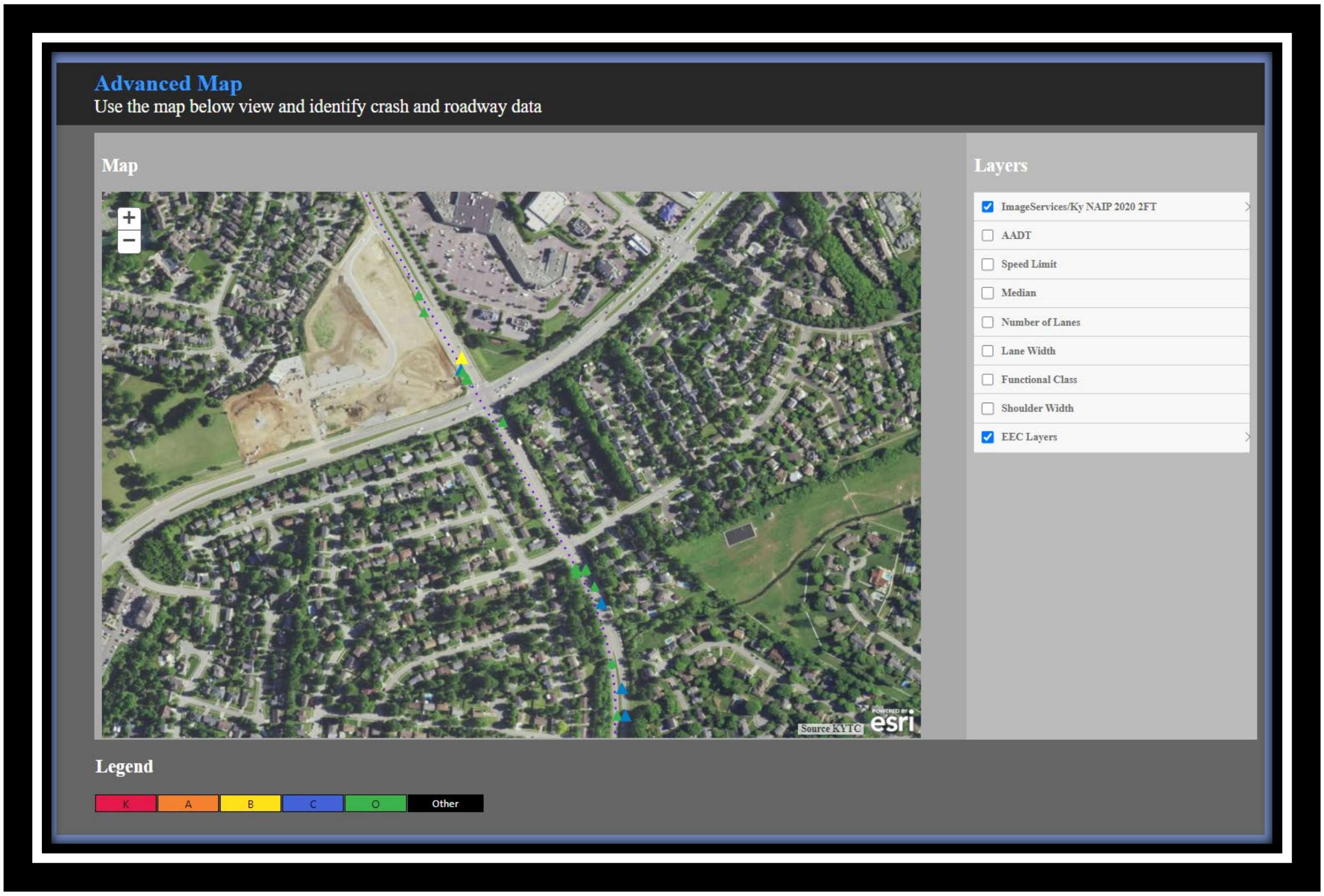

Figure 11 Advanced Map with Aerial Imagery

2.9 SEGMENT CRASH DATA

Figure 12 illustrates the presentation of segment-level crash data. Users can choose from seven groups of charts. Groups are accessed by clicking on the gray tabs located at the top of the teal-colored box. Clicking the *Show Table* button displays crash data. Users can also sort and download data. All requests to download crash data are logged. Download logs are audited regularly. If contacted, users will need to justify their downloads by confirming they have not shared data. Clicking on graph titles lets users view data in tabular form or toggle between bar and pie charts.

Figure 12 View Data Crash Results

If problems arise with the query, users can display the query code. The query code can be accessed by checking the box next to the text which reads: *Show query code (advanced)*. This code can be shared with CDAT developers, who can help debug problems.

2.10 SIMILAR ROADS

Figure 13 illustrates the Similar Roads section (the final section of the View Results group). This section presents crash graphs for roads whose predominant geometrics are similar to those of the queried segment. *Predominant* refers to the most frequently occurring roadway geometrics on the queried segment.

Users should note that the most predominant geometrics may not be represented in the same milepoint range. For example, the beginning of the segment may have 10-foot lanes, while the end of the segment is divided — here, both features may be identified as predominant. Graphs sync with crash results, allowing side-by-side comparisons. Users can then identify crash types that are over- or underrepresented on the queried segment relative to similar roads.

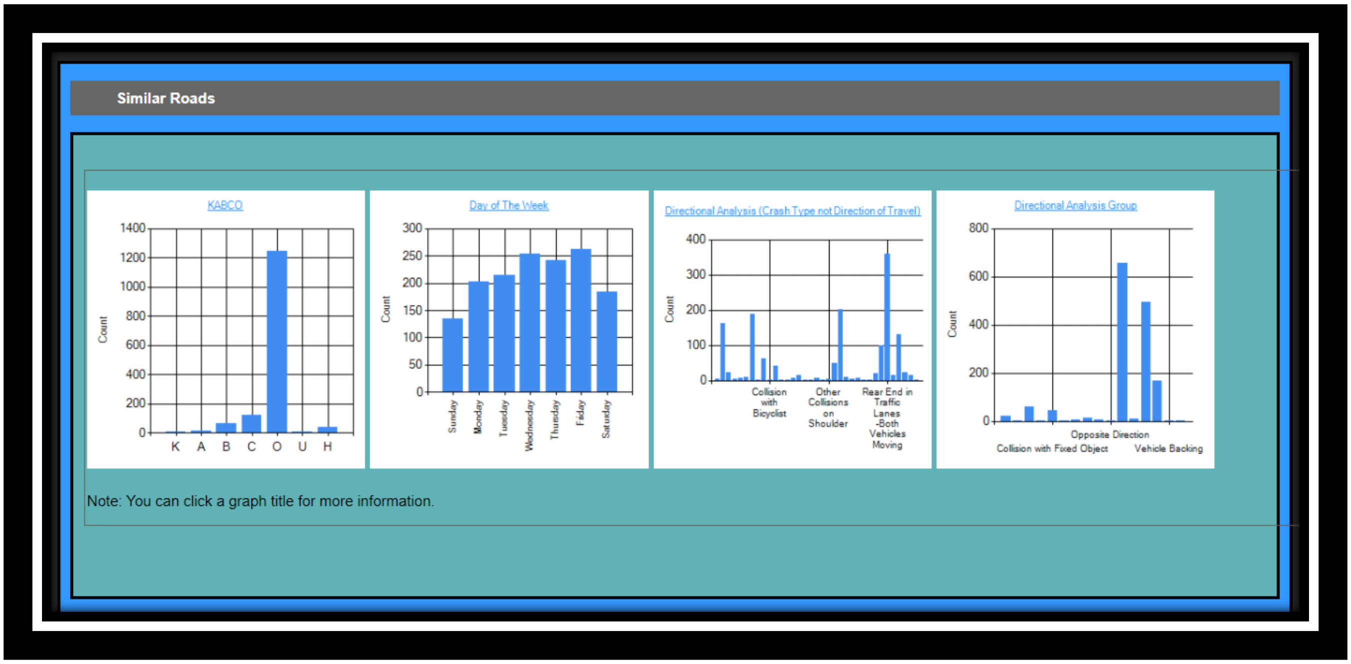

Figure 13 Similar Roads

Beneath the charts depicted in Figure 13, users see the information captured in Figure 14. CDAT automatically fills in information on relevant geometric roadway features (e.g., number of lanes, lane width, shoulder width, roadway type). But users can manually adjust these details by clicking on the radio buttons. Changing the selected features updates routes listed in the Similar Roads section. However, changing default selections is not recommended when performing Advanced Analysis (see below).

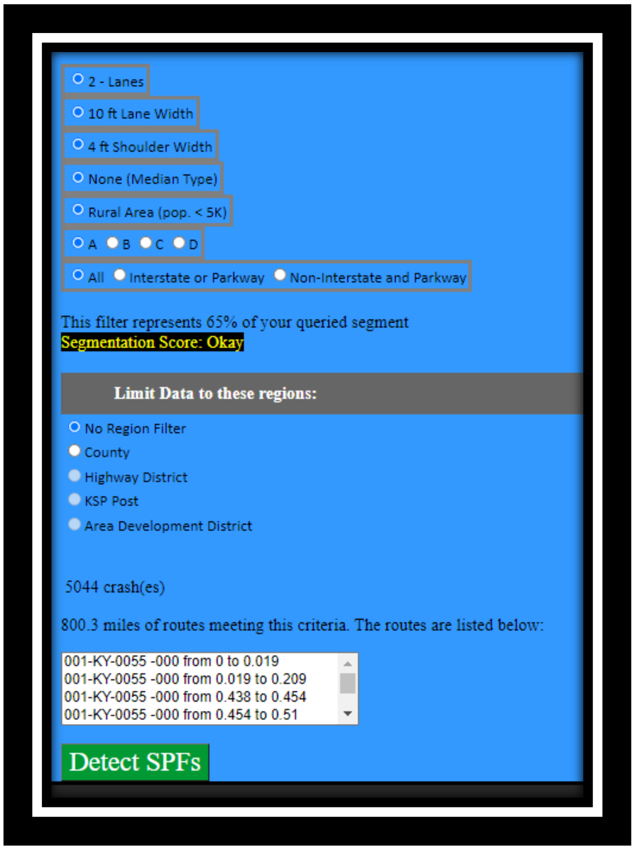

Figure 14 Similar Roads (Details)

CDAT grades the route segmentation. If the queried segment returns routes whose features vary significantly, users should split the segment into more homogeneous segments. That is, segments with similar roadway characteristics and geometrics from beginning to end. Changes in geometry and land use contribute to roadway heterogeneity, which should be avoided when performing safety analysis. The segmentation score is in the middle of Figure 14. The segmentation score is the percentage of the segment that matches the predominant geometry. The predominate geometry is made up of the most frequently occurring geometry. The segmentation score is grouped into four categories as defined by the percentages shown below:

- Perfect – 100%
- Great – 75% to 99%
- Okay – 50% to 74%
- Poor – Below 50%

The higher the segmentation score, the more reliable the safety analysis will be. Engineering judgement should be used when considering this score. A lower segmentation score may be acceptable if the changes in geometry are found to have little effect on the crash experience.

For local comparisons, graphs in the Similar Roads section can be restricted to a county or highway district. Crash numbers and the mileage of segments matching the predominant geometry are displayed along with a list of the routes.

2.11 QUERY TOOL – STEP 3
SAFETY PERFORMANCE FUNCTIONS

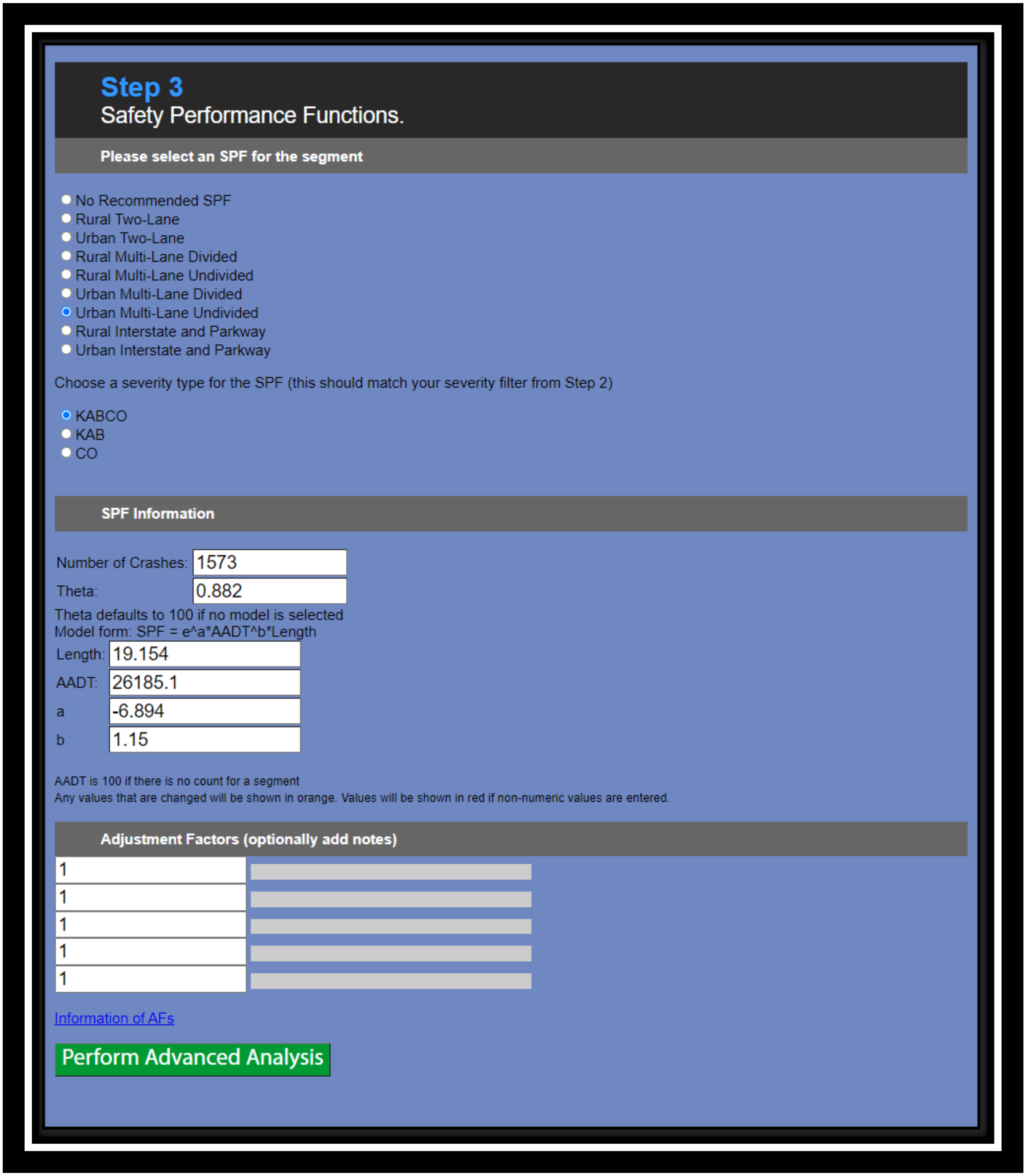

Figure 15 Safety Performance Function Section

In the Safety Performance Functions section, CDAT gives users the option to select a SPF for the segment that best matches the predominant geometry as well as a severity type for the SPF (Figure 15). The tool populates the SPF Information subsection with SPF parameters based on predominant roadway geometrics. The most appropriate SPF is chosen and listed by roadway type. Not all segments have a suitable SPF. In some cases, there will be no recommended SPF.

If no SPF is recommended, the most conservative parameters are used for calculations. Once a segment has been selected, the number of crashes is populated in an editable text box at the top of the SPF Information subsection. Also shown are the over-dispersion parameter (theta, 1/k), model parameters, and segment length. The segment's length-weighted AADT is calculated and displayed. This is calculated by weighting each segment's AADT by its length and dividing by the total segment length:

$$AADT_{LW} = \frac{\sum_1^i (L_1 * AADT_1 + \cdots + L_i * AADT_i)}{L_{tot}}$$

Adjustment factors can be applied when the selected SPF's base condition geometry differs from the segment's geometry. More information about adjustment factors can be found in Souleyrette et al. (2019). Users can edit any value in the SPF Information subsection to correct for known data errors or to undertake exploratory analysis.

The last section of this step is computed by performing Advanced Analysis.

2.12 SAFETY SCORE

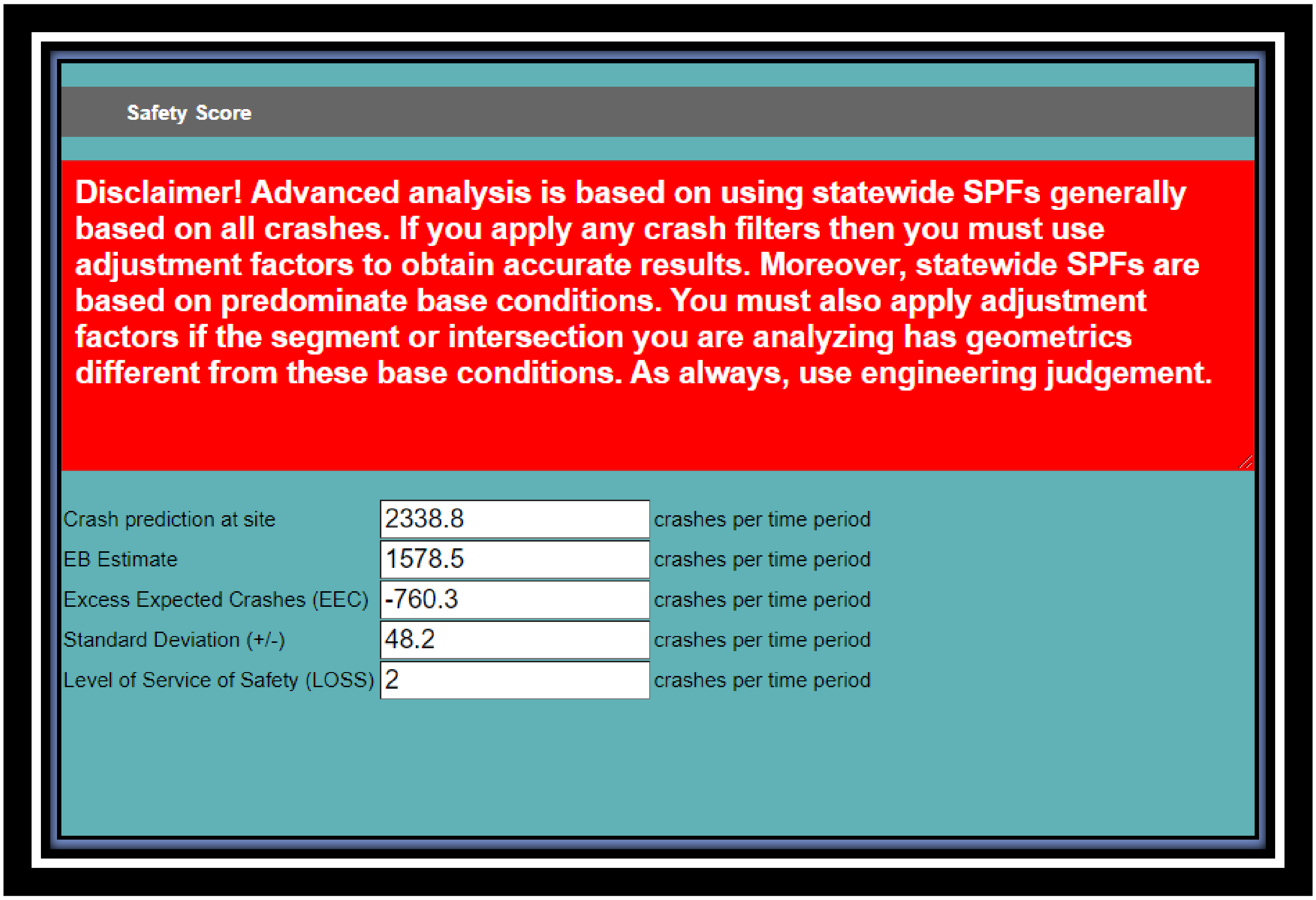

Figure 16 Advanced Analysis Results

Figure 16 displays the results of Advanced Analysis. Table 1 describes each calculation generated by Advanced Analysis.

Table 1 CDAT Safety Calculations

Calculation	Comments
Crash Prediction at Site	• Calculated using the SPF, segment length, and weighted AADT
Empirical Bayes (EB) Estimate	• The preferred option as it accounts for regression to the mean • Used to calculate EEC
Excess Expected Crashes (EEC)	• The difference between the observed number of crashes on a segment and the EB Estimate • KYTC's preferred measure to evaluate the safety performance of a segment or intersection • EECs for different roadway segments and intersections can be compared to prioritize safety performance • Higher EECs indicate more crashes occur than predicted by the EB estimate and suggest the need for installing countermeasures
Standard Deviation (+/-)	• A measure of data spread
Level of Service of Safety (LOSS)	• A semi-quantitative measure used to identify potential safety issues by comparing the number of crashes that occur on a roadway segment or at an intersection to the number of crashes predicted by that feature's SPF at a particular AADT • LOSS is derived from the SPF's standard deviation and represents the magnitude of potential error in the estimate • Alternatively, it is the upper and lower ranges of possible error in the EEC.

Table 2 lists the four LOSS levels and their associated crash reduction potentials. A LOSS of 1 encompasses points more than two standard deviations from the mean in the negative direction. On segments with a LOSS of 1, because the number of observed crashes is much lower than predicted by the SPF, the potential for crash reductions is low.

Table 2 Definitions of LOSS Levels

LOSS	EEC Sign	Number of SDs Away from Mean	Crash Reduction Potential
1	-	> 2	Low
2	-	0 – 2	Low to Moderate
3	+	0 – 2	Moderate to High
4	+	> 2	High

LOSS is useful because it can be used to compare segment or intersection priority for different roadway/intersection types.

Comparing EECs potentially favors segments and intersections with higher AADTs as EECs, for them, are typically larger in magnitude. Sites with LOSS scores of 4 are in the greatest need of safety improvements. Figure 17 depicts LOSS bands atop a SPF (Kononov and Allery 2003).

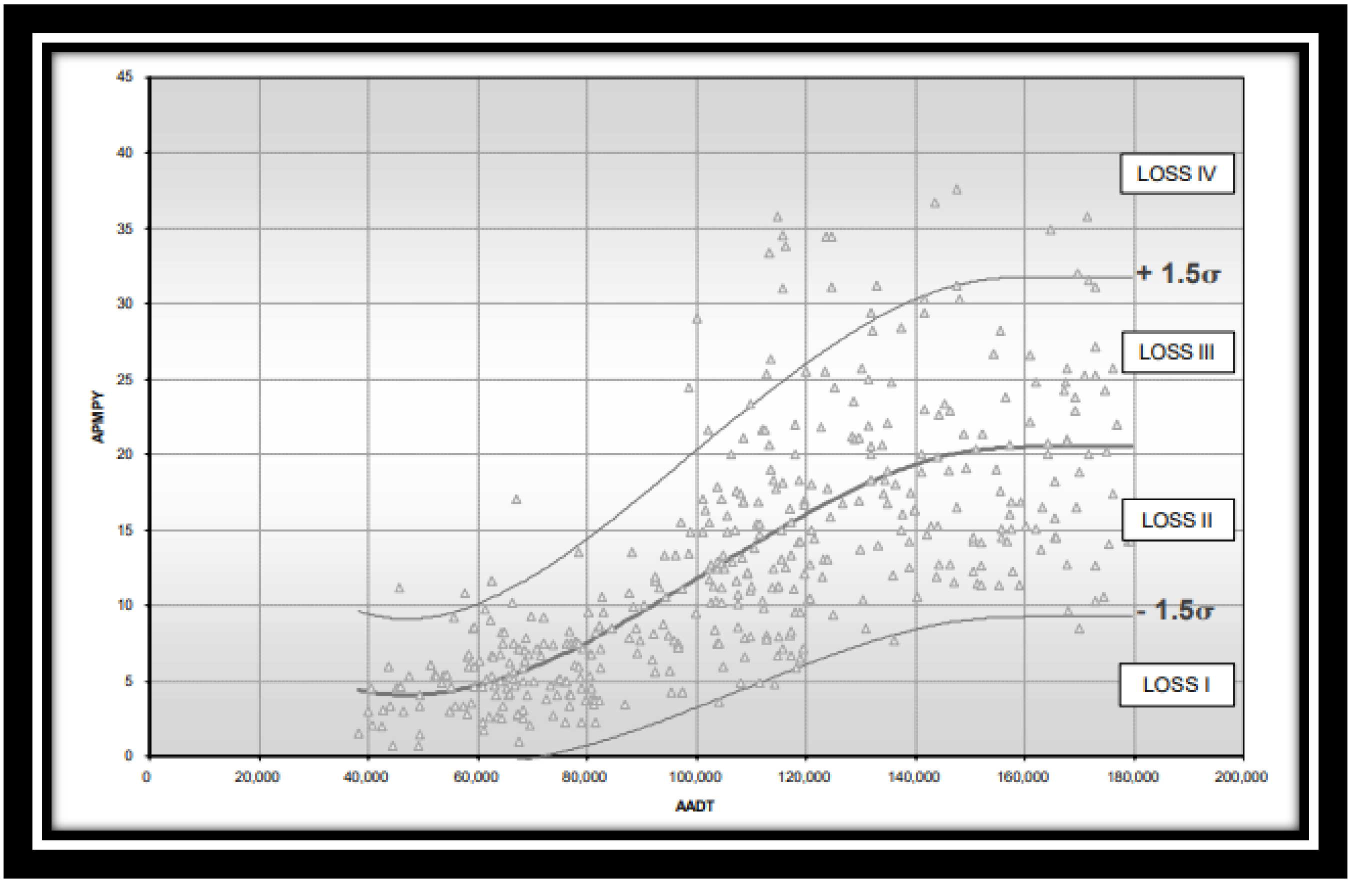

Figure 17 Depiction of Level of Service of Safety (LOSS)

2.13 IMPORT TOOL

The Import Tool behaves like the Query Tool. Rather than identifying a location, users import a list of locations in CSV format. The imported CSV file must denote in some form the route as well as the beginning and ending milepoints. The file must include a header row. Required field names include:

- RT_Unique
- BMP
- EMP

The following fields can also be used as column names:

- FROM
- BEGIN_MP
- START
- BEGIN
- TO
- END_MP
- END
- WORKINGID
- RT
- RID
- KTC_RT

Segment length is not required — it is calculated using the provided starting and ending. milepoints. Starting points and endpoints may not accurately reflect segment length when a route runs concurrent with a higher priority route (i.e., lower priority routes do not increase in milepoints when running concurrently).

Several filters can be applied. Unlike the Query Tool, graphs are not displayed. Instead, Advanced Analysis is performed for each row of the imported file. EECs are generated for each row along with the other parameters. As this is a batch tool, it is very important to import very homogeneous segments. For each row, an SPF is selected automatically based on the predominant roadway geometry. No user guidance is involved.

2.14 EFFECT OF SEGMENTATION

Users should always consider segment homogeneity when determining a segment's starting points and endpoints. Whether using the Query Tool or Import Tool, roadway segmentation strongly impacts safety analysis. CDAT generates a segmentation score that indicates the degree of geometric similarity between the segment being analyzed and the base conditions represented in the selected SPF. This score is provided as a percentage.

Consider a segment that is one mile long with the following characteristics:

- The first portion of the segment is a rural, two-lane roadway that is 0.75 miles long and has 11-foot lanes, 1-foot shoulders, and no curvature.
- The final 0.25 miles enters an urban area and has wider shoulders and lanes.

CDAT will quantify safety based on the 0.75-mile segment, assigning it a segmentation score of 75% and measuring safety using a rural, two-lane SPF. Thus, 25% of the segment is incorrectly treated as a rural, two-lane segment. Traffic volume is likely misrepresented because CDAT uses length-weighted averages. The effects of low segmentation can be demonstrated using the query tool on a Kentucky state route (denoted Route X). A one-mile section, when queried, returns the geometry shown in Figure 18.

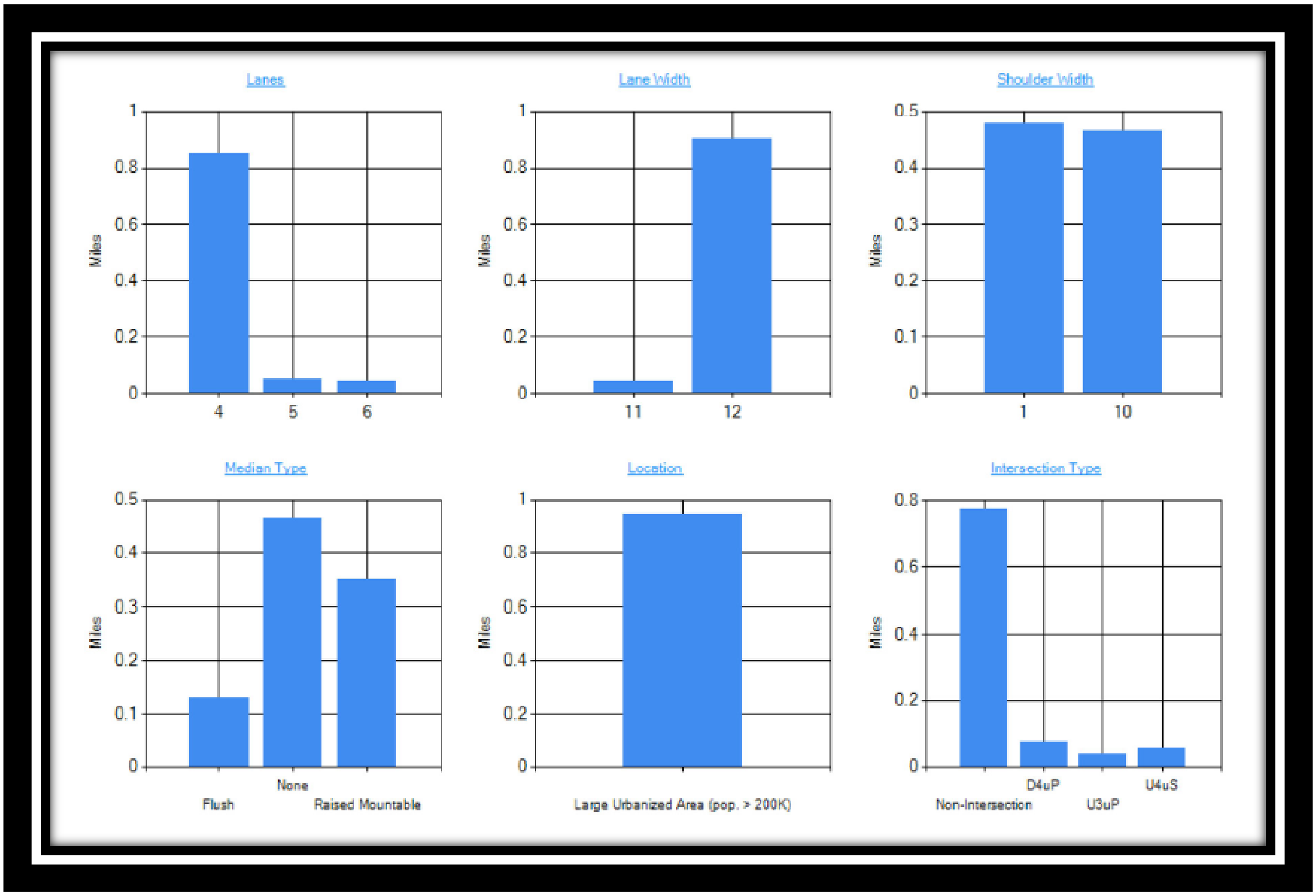

Figure 18 Geometric Results on Route X from milepoints 0 to 0.94.

Notice the variation in shoulder widths and median types. Typically, they strongly influence SPF model parameters. Figure 19 shows the results of Advanced Analysis.

Crash prediction at site	213.7	crashes per time period
EB Estimate	120.4	crashes per time period
Excess Expected Crashes (EEC)	-93.3	crashes per time period
Standard Deviation (+/-)	14.6	crashes per time period
Level of Service of Safety (LOSS)	2	crashes per time period

Figure 19 Advanced Results on Route X from Milepoints 0 to 0.94

The results show the segment has much safer performance than similar segments, with the EEC indicating 93 fewer crashes occurring than expected. Based on this information, the segment would generally not rate high in a network screening process. But this conclusion runs counter to the observed performance of Route X. The first 0.46 miles of the segment is undivided and has no median (Figure 20).

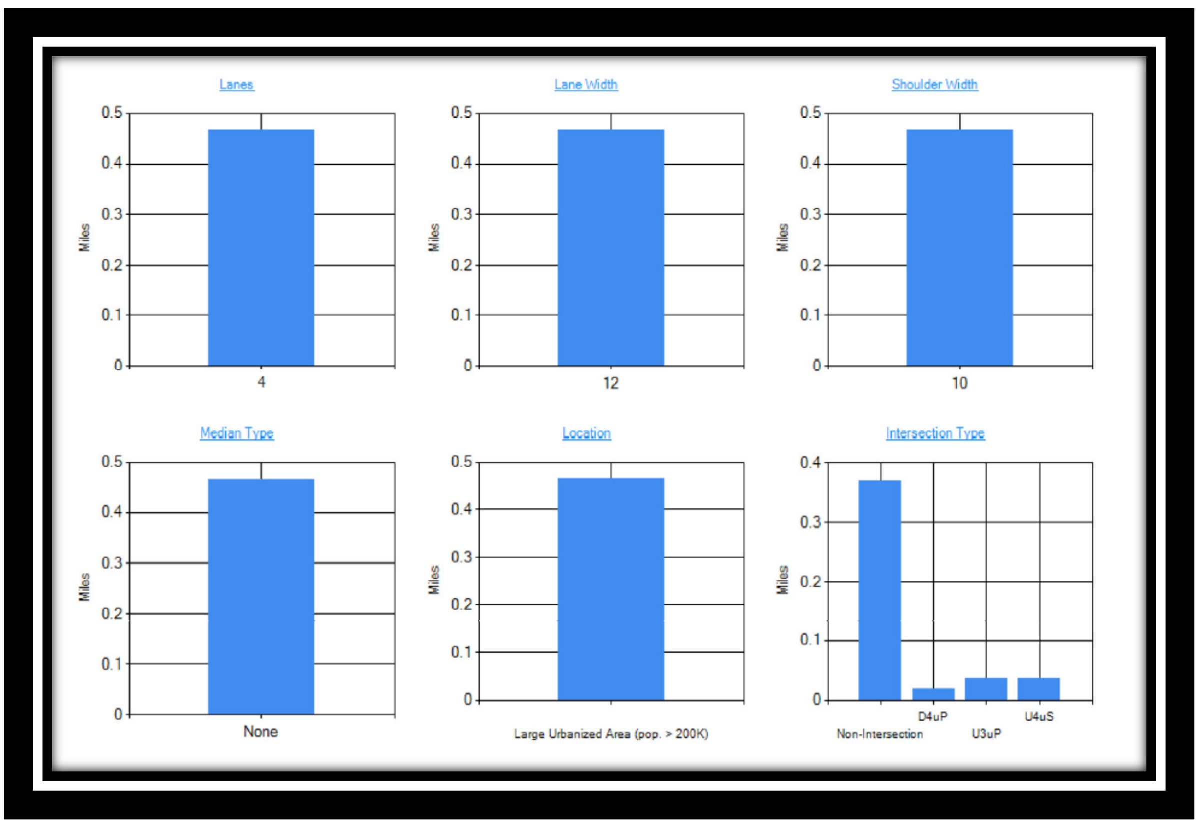

Figure 20 Geometric Results on Route X from Milepoints 0 to 0.465

Figure 21 show the results of Advanced Analysis.

Crash prediction at site	105.2	crashes per time period
EB Estimate	63.2	crashes per time period
Excess Expected Crashes (EEC)	-42	crashes per time period
Standard Deviation (+/-)	10.2	crashes per time period
Level of Service of Safety (LOSS)	2	crashes per time period

Figure 21 Advanced Results on Route X from Milepoints 0 to 0.465

The segment's EEC remains low but is less impressive than before (42 fewer crashes than expected). Figure 22 shows geometry for the remainder of the segment.

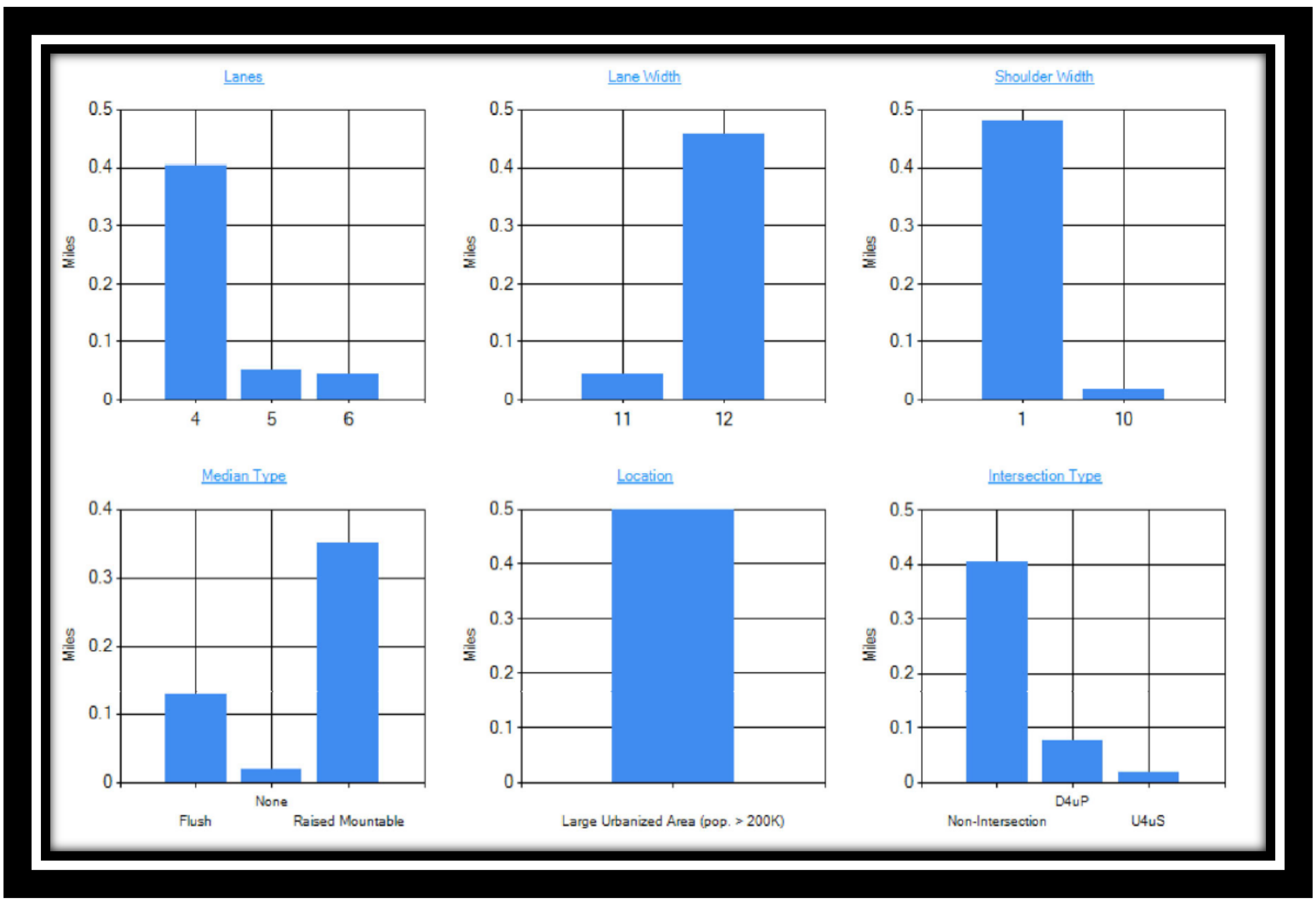

Figure 22 Geometric Results on Route X from Milepoints 0.456 to 0.94

Corresponding safety results are shown in Figure 23.

Crash prediction at site	26.1	crashes per time period
EB Estimate	56.5	crashes per time period
Excess Expected Crashes (EEC)	30.4	crashes per time period
Standard Deviation (+/-)	5.1	crashes per time period
Level of Service of Safety (LOSS)	3	crashes per time period

Figure 23 Advanced Results on Route X from Milepoints 0.456 to 0.94

At this point, CDAT returns a more intuitive EEC of 30.4, indicating that about 30 more crashes are occurring on this segment than expected. The urban, divided, multi-lane SPF is not a good model to apply to the entire segment because nearly half of the segment is undivided. Consider the differences in the model parameters (Table 3).

Table 3 Comparison of Urban SPFs

Segment Type	Theta	Intercept	Beta
Urban Multi-Lane Divided	0.814	-4.171	0.761
Urban Multi-Lane Undivided	0.882	-6.894	1.15

The segment closely matches the selected SPF. The segmentation score is a good way to quantify the quality of a match and avoid erroneous results as shown on Route X.

2.15 CONCLUSIONS

CDAT supports more advanced safety analysis than older methods (e.g., critical rate analysis). To obtain accurate results, users must pay close attention to the effects segmentation, the accuracy of crash data, and the statistical robustness of the results (e.g., confidence intervals/standard deviation). Local knowledge of queried segments can help minimize errors and improve the quality of results.

Online training courses for CDAT are available at the link below:
https://www.youtube.com/playlist?list=PLkLOmq3_0b_sX02kCr0yjuj-4U65okvUz

3. REFERENCES

Green, E.R., Blackden, C.L., Fields, M.A. 2015. *Spatial Database for Intersections*. Report No. KTC-15-11/SPR14-480-1F. Kentucky Transportation Center.

Kononov, Jake, and Bryan Allery. 2003. Level of Service of Safety: Conceptual Blueprint and Analytical Framework. *Transportation Research Record: Journal of the Transportation Research Board*, 1840(1), 57–66., doi:10.3141/1840-07.

Souleyrette, R.R., Tanzen, R., Staats, W.N., Green, E.R., Chen, M. 2019. *Safety Analysis for SHIFT Implementation*. Report No. KTC-19-23/PL31-1F. Kentucky Transportation Center.

APPENDIX A. QUERY LOGIC

OCCUPANT PROTECTION
For Fatalities: Injury Severity = 01 - fatal
For Serious Injuries: Injury Severity = 02 - A injury

Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

For 'Restraint Used': Restraint Use Code is one of
01 - Shoulder/Lap Belt
03 - Lap Belt Only
04 - Shoulder Belt Only

For 'Restraint Not Used': Restraint Use Code is one of
02 - Installed/Not in Use
09 - Not Installed

For 'Restraint Not Applicable': Restraint Use Code is one of
NULL
05 - Child Safety Seat
06 - Helmet
07 - Helmet Not Used
08 - Other Passive Restraint
80 - Air Bag – KARS

YOUNG AND OLD DRIVERS
For Fatalities: Injury Severity = 01 - fatal
For Serious Injuries: Injury Severity = 02 - A injury

Person Type Code = 01 (driver)
Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

For Older Drivers: Age at Collision Time > 64
For Younger Drivers: Age at Collision Time < 21

PEDESTRIANS AND BICYCLISTS
For Fatalities: Injury Severity = 01 - fatal
For Serious Injuries: Injury Severity = 02 - A injury

For Pedestrians: Person Type Code = 02 (pedestrian)
For Bicyclists: Person Type Code = 05 (bicyclist)

AGGRESSIVE DRIVING
Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

Human Factor Code is one of:
03 – Disregard Traffic Control
07 – Exceeded Stated Speed Limit
08 – Failed to Yield Right of Way
11 – Following Too Close
13 – Improper Passing
22 – Too Fast for Conditions
24 – Weaving in Traffic

DISTRACTED DRIVING
Human Factor Code is one of:
02 – Cell Phone
04 – Distraction
06 – Emotional
09 – Fatigue
10 – Fell Asleep
14 – Inattention
15 – Lost Consciousness/Fainted
16 – Medication
21 – Sick

Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

IMPAIRED DRIVING
Human Factor Code is one of:
01 – Alcohol Involvement
05 – Drug Involvement

Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

MOTORCYCLES
Unit Type Code = 10 - Motorcycle

Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

COMMERCIAL VEHICLES
For any vehicle involved in the crash,
Commercial Vehicle Indicator = YES

Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

INTERSECTIONS
Intersection Indicator = YES
Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

ROADWAY DEPARTURE
Directional Analysis is one of:
04 – Collision with Fixed Object
05 – Non-Collision Object Collision
06 – Collision with Parked Vehicle
17 – Opposite Direction - Both Vehicles Going Straight Ahead
19 – Sideswipe, Same Direction
40 – Collision with Fixed Object
41 – Collision with Non-Fixed Object
44 – Ran off Roadway (1 vehicle with/earth embankment, ditch)
50 – Rear End on Shoulder
51 – Other Collisions on Shoulder
52 – Head-on Collision
53 – Sideswipe Collision - Same Direction
54 – Sideswipe Collision - Opposite Direction
71 – Collision with Fixed Object in Gore
72 – Collision with Fixed Object not in Gore
73 – Ramp - Vehicle Ran off Roadway

OR

Any Event Collision with Code (First Event Collision With / Second Event Collision With / Most Harmful Event) is one of:

9 - Bridge Parapet End
10 - Bridge Pier Abutment
11 - Bridge Rail
12 - Building Wall
13 - Crash Cushion/Impact Attenuator
14 - Culvert/Head Wall
15 – Curbing
16 - Earth Embankment/Rockcut/Ditch
17 – Fence
18 - Fire Hydrant
19 - Guardrail End
20 - Guardrail Face
21 - Light/Luminaire Support
22 – Mailbox
23 - Median Support
24 - Other Post/Pole/Support
25 - Overhead Sign Post
26 - Sign Post
27 - Snow Embankment
28 - Toll Booth
29 - Traffic Signal Support
30 – Tree
31 - Utility Pole
32 - Other Fixed Object
36 – Overturned
37 - Ran Off Roadway (Only) Obsolete In KYOPS 2016
40 - Cable Barrier
41 - Concrete Barrier

Intersection Indicator = NO
Land Use Code is not 05 (private property)
Parking Lot Indicator is NO

APPENDIX B. KTC CRASH DATA USE

Crash Data Access Policies

Pursuant to KRS 189.635, the Kentucky State Police (KSP) has identified several fields in the crash database that contain confidential information. These fields require authorization to access. Non-confidential crash data can be accessed through KSP's Open Portal: (http://crashinformationky.org/).

Individuals who are not authorized to access confidential data may request data from KTC provided they do not include any confidential or linkable data. Each year KTC will review data available on the Open Portal and adjust the list of non-confidential data fields accordingly.

Effective immediately, all KTC staff needing to access crash data must submit a request via this form. Requestors must provide the following information in the request: 1) name, 2) title, 3) email address, 4) a justification for the request, and 5) a specific indication of what data are needed. If raw data are requested for research (as opposed to summary data), the requestor must specify the timeframe for the research and the project sponsor.

The Kentucky Traffic Safety Data Service (KTSDS) team reviews all requests. When evaluating a request, team members apply their knowledge of acceptable data use to judge its merits. Qualifying requests are forwarded to KYTC's Memorandum of Understanding (MOU) point of contact. Once a request is approved, the requestor must review the Cabinet's MOU and sign an acknowledgement form. They must also sign a document that outlines KTC-specific access restrictions.

Users receive access to data on an as-needed basis. Thus, if a KTC employee with an MOU on file 1) leaves the Center, or 2) is no longer working on a project that requires access to data granted by the MOU, KTC will notify KYTC and have their access revoked.

Appendix C lists available data fields and characterizes each as either confidential or linkable.

Data/access available with confidential access:

- Crash report narratives
- PDF/Image of the police report
- All crash fields in Appendix A
- KYOPS credentials
- KYTC HIVEe and VPN credentials
- Advanced CDAT credentials
- KTC SQL server access
- Other Excel, Access, and raw crash data

Data available to non-confidential access:

- All crash fields* in Appendix A flagged as public (non-confidential and non-linkable)
- Public CDAT credentials

*Note: Some of these data may not qualify as confidential but could potentially be used to link to other data sources which do contain confidential data.

The following bullet points further clarify KTC's crash data access policies.

- Data requests must be limited and focused on a specific research project. Once granted access, users may not leverage data for other research. If a user would like to conduct additional research they must submit a separate request. Note that while crash data can be archived, they cannot be shared or reused on other projects.

- Store confidential and highly sensitive data in secure locations. The following table describes what data management practices should be used as well as those which must be avoided.

Sound Data Management Practices	Data Management Practices to Avoid
Only store sensitive data on secure, password-protected machines.	**Do Not** store files on an unlocked machine accessible by others.
Never share login credentials for any reason.	**Do Not** store files on computers with shared logins.
Only use locked and secured local storage or encrypted and password-protected network storage.	**Do Not** store files on unsecure network storage.
Be conscientious about who has access to files and folders shared in the cloud. Create new shared volumes only with users who have a signed MOU on file.	**Do Not** store files in cloud locations shared by users without an MOU on file.
Only use KTC-managed services with security measures such as file encryption and HIPPA- and FERPA-compliant technology.	**Do Not** use cloud locations that are not centrally managed by KTC
Keep printed copies of data and reports in locked drawers and offices when not physically in contact with them.	**Do Not** leave printed copies of data or reports in unsecure areas
Use a secure shredding service to dispose of printed copies.	**Do Not** Improperly dispose of printed copies

- KTC ensures the secure transfer of all confidential information by limiting transfer to methods approved by KTC that are encrypted and reasonably secure.

- Information may only be stored on KTC-owned hardware, and not synced with personal equipment.

- Information must be stored in a secure location. It must not be stored in a shared volume accessible by anyone without a signed MOU.

- Summary crash data may be published with the sponsor’s consent. Unless specifically requested, published tables and maps should not include information that indicates the safety priority of specific roadway segments or intersections.

- Under no circumstances may users share data they have received with others. This includes publicly available data. If another researcher needs access to data, instruct them to submit their own request. This lets us track user activity and develop a clearer understanding of data needs. If an audit is conducted, adhering to this practice also generates an accurate representation of data usage.

- In some cases, we may need to refuse crash data access requests even for publicly available data. This may include instances where a company is attempting to profit off of the value-added data we can provide.

- When a KTC employee leaves the Center, they must go through a formal crash data access protocol. During this process, the employee is required to disable access accounts and delete or shred all crash data.

- Each authorized user must complete training by KSP, which instructs participants on how to use the new KYOPS portal.

- KTC/KYTC will keep copy of signed MOU on file.

- If an authorized user observes the misuse of crash data, they should report this activity to Eric Green at eric.green@uky.edu.

APPENDIX C. – DATA FIELDS AND THEIR CONFIDENTIALITY STATUS

Field Name	SQL Table	In Public Extract	Field in Public Extract
# Occupants	Record 2	NO	
Age at Collision Time	Record 3	YES	AgeAtIncident
AgencyORINumber	Record 1	YES	AgencyORI
Air Bag Switch	Record 2	YES	AirbagSwitchCde
BeatPostNumber	Record 1	NO	
BetweenStreet1_Direction_	Record 1	NO	
BetweenStreets_Indicator_	Record 1	NO	
BetweenStreets1_NameRoadway_	Record 1	YES	BetweenStRdwyName1
BetweenStreets1_RoadwaySuffix_	Record 1	NO	
BetweenStreets2_Direction_	Record 1	NO	
BetweenStreets2_NameRoadway_	Record 1	YES	BetweenStRdwyName2
BetweenStreets2_RoadwaySuffix_	Record 1	NO	
Birth Date	Record 3	NO	
Bus Use Code	Record 2	NO	
Cargo Body Type Code	Record 2	NO	
Carrier Name Source Code	Record 2	NO	
Carrier Type Code	Record 2	NO	
Chemical Test Results	Record 3	YES	TestResults
City	Record 3	NO	
CityCountyCode	Record 1	NO	
CollDescPresentInd	Record 1	NO	
CollisionDate	Record 1	YES	CollisionDate
CollisionDayWeekCode	Record 1	NO	
CollisionTime	Record 1	YES	CollisionTime
Commercial Vehicle Indicator	Record 2	YES	IsCommercialVeh
Commercial Vehicle Type Code	Record 2	NO	
CountyCode	Record 1	YES	County
Crash Avoidance Code	Record 2	YES	CrashAvoidCde
Current US DOT Number	Record 2	NO	
CurrentDerivedMiepointNumber	Record 1	NO	
CurrentRoadwayNumber	Record 1	NO	
Damage Other Property Indicator	Record 2	YES	DamageDescription
DeathDate	Record 3	YES	DeathDte
DiagramPresentIndicator	Record 1	NO	
DirectionalAnalysis	Record 1	YES	DirAnalysisCode
DirectionFromCity_NSEW_	Record 1	NO	
DirectionfromMilepoint_NSEW_	Record 1	NO	
Driver Identified Code	Record 2	YES	DriverIdentifiedCde
Ejection From Vehicle Code	Record 3	YES	EjectionCde
Ejection Path Code	Record 3	YES	EjectionPathCde
EnforcementsIndicator	Record 1	NO	
Environmental Factor	Record 13	YES	Factor Type/Factor

Extent of Damage Code	Record 2	YES	PropDamageType
FeettoMilepoint	Record 1	NO	
Filial	Record 3	NO	
Fire Indicator	Record 2	YES	HasFire
First Area of Contact Combo Vehicle Ind	Record 2	NO	
First Area of Contact Vehicle Code	Record 2	NO	
First Event Collision With Code	Record 2	YES	EventCollWithFirstCde
First Name	Record 3	NO	
FirstAidSceneIndicator	Record 1	NO	
FunctionClassCode	Record 1	NO	
Gender Code	Record 3	YES	Gender
GVWR Total	Record 2	NO	
GVWR Total Code	Record 2	NO	
Haz Cargo Code	Record 2	NO	
Haz Cargo Ind	Record 2	NO	
Haz Spill Ind	Record 2	NO	
Hit and Run Vehicle Ind	Record 2	NO	
Hit&RunIndicator	Record 1	YES	HitandRun
HM Class Code	Record 2	NO	
HumanFactorCode	Record 11	YES	Factor Type/Factor
ICC/MC Number	Record 2	NO	
InCityLimitsIndicator	Record 1	NO	
Injury Location Code	Record 3	YES	InjuryLocationCde
Injury Severity	Record 3	YES	InjurySeverityCde
Insurance Carrier	Record 2	NO	
IntersectionWith_Direction_	Record 1	NO	
IntersectionWith_Indicator_	Record 1	NO	
IntersectionWith_NameRoadway_	Record 1	YES	IntersectionRdwyName
IntersectionWith_RoadwaySuffix_	Record 1	NO	
InvestigatingFirstInitial	Record 1	NO	
InvestigatingLastName	Record 1	NO	
InvestigatingNameFilial	Record 1	NO	
InvestigationCompleteIndicator	Record 1	NO	
InvestigationID	Record 1	NO	
KARSCityCode	Record 1	NO	
KilometersIndicator	Record 1	NO	
LandUseCode	Record 1	NO	
Large Truck or Bus	Record 2	NO	
Last Name	Record 3	NO	
LatitudeDecimalNumber	Record 1	YES	Latitude
LatitudeDegrees	Record 1	NO	
LatitudeMinutes	Record 1	NO	
LatitudeSeconds	Record 1	NO	
LightConditionCode	Record 1	YES	LightCondition

LocalCode	Record 1	NO	
LocationFirstEventCode	Record 1	NO	
LongitudeDecimalNumber	Record 1	YES	Longitude
LongitudeDegrees	Record 1	NO	
LongitudeMinutes	Record 1	NO	
LongitudeSeconds	Record 1	NO	
MannerofCollisionCode	Record 1	YES	MannerofCollision
MapIt	Record 1	NO	
Master File	Record 3	NO	
Master File #	Record 2	NO	
MasterFile	Record 1	NO	
MedianCrossoverIndicator	Record 1	NO	
Middle Initial	Record 3	NO	
Milepoint	Record 1	YES	Milepoint
MilesFromCity	Record 1	NO	
MilestoMilepoint	Record 1	NO	
Most Harmful Event	Record 2	NO	
Motor Carrier City	Record 2	NO	
Motor Carrier Name	Record 2	NO	
Motor Carrier State	Record 2	NO	
Motor Carrier Street	Record 2	NO	
Motor Carrier Zip	Record 2	NO	
NAS Safety Report Number	Record 2	NO	
NationalHwySysCode	Record 1	NO	
No Axles	Record 2	NO	
No Trailers	Record 2	NO	
NumberInjured	Record 1	YES	NumberInjured
NumberKilled	Record 1	YES	NumberKilled
ofMotorVehicleUnits	Record 1	YES	MotorVehiclesInvolved
ofUnits	Record 1	YES	UnitsInvolved
OneWayIndicator	Record 1	NO	
Operator CDL Indicator	Record 3	YES	HasCDLicense
Operator Comp Indicator	Record 3	NO	
Operator County Resident Indicator	Record 3	NO	
Operator License Endorsment Indicator	Record 3	YES	HasOpEndorsements
Operator License Indicator	Record 3	YES	HasOpLicense
Operator License Number	Record 3	NO	
Operator License Restrictions Indicator	Record 3	YES	HasLicenseRestrictions
Operator License State	Record 3	NO	
Overturned Indicator	Record 2	NO	
Owner Indicator	Record 3	YES	IsOwner
ParkingLotIndicator	Record 1	NO	
Person Number	Record 3	YES	PersonNo
Person Type Code	Record 3	YES	PersonTypeCde

PhotosTakenIndicator	Record 1	NO	
Placard Present	Record 2	NO	
Position In/On Vehicle Code	Record 3	YES	PosInVehicleCde
Pre-Collision Vehicle Action	Record 2	YES	PreCollActionCde
ProcessedBy	Record 1	NO	
ProcessedCode	Record 1	NO	
ProcessedDate	Record 1	NO	
ProcessedTime	Record 1	NO	
PropertyDamageIndicator	Record 1	YES	PropertyDamageNo
RampFromCoupletID	Record 1	NO	
RampFromDirCode	Record 1	NO	
RampFromIdentifier	Record 1	YES	RampFromRdwyId
RampIndicator	Record 1	NO	
RampToCoupletID	Record 1	NO	
RampToDirCode	Record 1	NO	
RampToidentifier	Record 1	YES	RampToRdwyId
Registration Number	Record 2	NO	
Registration Year	Record 2	NO	
ReportMilepointDeriveNumber	Record 1	NO	
Restraint Use Code	Record 3	YES	RestraintUseCde
RoadwayCharacterCode	Record 1	YES	RdwyCharacter
RoadwayConditionCode	Record 1	YES	RdwyConditionCode
RoadwayfromReport	Record 1	NO	
RoadwayIdentifier	Record 1	YES	RdwyNumber
RoadwayName_Direction_	Record 1	YES	StreetDir
RoadwayName_HouseBusinessNumber_	Record 1	NO	
RoadwayName_RoadwayName_	Record 1	YES	RoadwayName
RoadwayName_RoadwaySuffix_	Record 1	YES	StreetSfx
RoadwayNumberCoupletID	Record 1	NO	
RoadwaySurfaceCode	Record 1	NO	
RSEUniqueGIS	Record 1	NO	
RSEUniqueGISRampFrom	Record 1	NO	
RSEUniqueGisRampTo	Record 1	NO	
RT_UNIQUE	Record 1	NO	
SchoolBusRelatedCode	Record 1	NO	
Second Event Collision With Code	Record 2	YES	EventCollWithSecondCde
SecondaryCollisionIndicator	Record 1	YES	IsSecondaryCollision
SpeedLimitNumber	Record 1	NO	
State	Record 3	NO	
Street	Record 3	NO	
SubmissionTypeCode	Record 1	NO	
Suspected Drinking Indicator	Record 3	YES	SuspectedOfDrinking

Test Offered Indicator	Record 3	YES	TestOffered
Test Refused Indicator	Record 3	YES	TestRefused
Test Sent To	Record 3	YES	TestSentTo
Tested For	Record 3	YES	TestedForCde
TimeArrived	Record 1	NO	
TimeNotified	Record 1	NO	
TimeRoadwayOpened	Record 1	NO	
TotalLanes	Record 1	NO	
Towed Indicator	Record 2	NO	
Traffic Control	Record 8	YES	TrafficControl
Transported Indicator	Record 3	YES	WasTransported
Trapped Code	Record 3	YES	TrappedCde
Travel Direction Code	Record 2	NO	
Travel Speed From	Record 2	NO	
Travel Speed To	Record 2	NO	
Type Cargo/Commodity	Record 2	NO	
Underride/Override Code	Record 2	YES	UnderOverrideCde
Unit Number	Record 2	YES	UnitNumber
Unit Number	Record 3	YES	UnitNumber
Unit Type Code	Record 2	YES	UnitType
US DOT Number - Report	Record 2	NO	
ValidMilepointIndicator	Record 1	NO	
Vehicle Color	Record 2	NO	
Vehicle Configuration	Record 2	NO	
Vehicle Insured Indicator	Record 2	YES	VehicleIsInsured
Vehicle Make Code	Record 2	YES	MakeCde
Vehicle Make Description	Record 2	YES	MakeDescription
Vehicle Model Code	Record 2	YES	ModelCde
Vehicle Model Description	Record 2	YES	ModelDescription
Vehicle NCIC Type Code	Record 2	YES	VehicleType
Vehicle Registration Ind	Record 2	NO	
Vehicle State Code	Record 2	NO	
Vehicle Year	Record 2	NO	
Vehicular Factor	Record 12	YES	Factor Type/Factor
VIN	Record 2	NO	
WeatherCode	Record 1	YES	Weather
Zip	Record 3	NO	

APPENDIX D. – DIRECTIONAL ANALYSIS CODES

Code	DESCRIPTION	LOGIC	DA_Group
1	Collision with Pedestrian	For the first motor vehicle unit, 1st Event Collision With = Pedestrian	Collision with Pedestrian
2	Collision with Bicycle	For the first motor vehicle unit, 1st Event Collision With = Bicyclist	Collision with Bicycle
3	Collision with Animal	For the first motor vehicle unit, 1st Event Collision With = Animal or Deer	Collision with Animal
4	Collision with Fixed Object	For the first motor vehicle unit, 1st Event Collision With = Fixed Object values (G)	Collision with Fixed Object
5	Non-Collision Object Collision	For the first motor vehicle unit, 1st Event Collision With = Non-Collision values (H)	Other
6	Collision With Parked Vehicle	For second motor vehicle, Pre-Collision Vehicle Action must = Parked	Collision With Parked Vehicle
7	Angle Collision - Both Vehicles Going Straight	Manner of Collision = Angle and	Angle
8	Angle Collision - One Vehicle Turning Left	Manner of Collision = Angle and	Angle
9	Angle Collision - One Vehicle Turning Right	Manner of Collision = Angle and	Angle
10	Angle Collision - Other	Manner of Collision = Angle and	Angle
11	Rear End - One Vehicle Stopped	Manner of Collision = Rear End and	Rear End
12	Rear End - Both Vehicles Going Straight	Manner of Collision = Rear End and	Rear End
13	Rear End - One Vehicle Turning Left	Manner of Collision = Rear End and	Rear End
14	Rear End - One Vehicle Turning Right	Manner of Collision = Rear End and	Rear End
15	Rear End - Other	Manner of Collision = Rear End and	Rear End
16	Opposing Left Turn	Manner of Collision = Opposing Left Turn	Opposing Left Turn
17	Opposite Direction - Both Vehicles Going Straight Ahead	Manner of Collision = Head On or Sideswipe, Opposite Direction	Opposite Direction
18	Vehicle Backing	Manner of Collision = Backing	Vehicle Backing
19	Sideswipe, Same Direction	Manner of Collision = Sideswipe, Same Direction	Sideswipe
35	Other Intersection Collisions	Does not meet any of the above conditions for intersection directional analysis codes	Other
36	Collision with Pedestrian	For the first motor vehicle unit, 1st Event Collision With = Pedestrian	Collision with Pedestrian

37	Collision with Bicyclist	For the first motor vehicle unit, 1st Event Collision With = Bicyclist	Collision with Bicyclist
38	Collision with Animal	For the first motor vehicle unit, 1st Event Collision With = Animal or Deer	Collision with Animal
39	Occupant Fell from Moving Vehicle	For the first motor vehicle unit, 1st Event Collision With = Fell From Vehicle	Other
40	Collision with Fixed Object	For the first motor vehicle unit, 1st Event Collision With = Fixed Object values (excluding earth embankment/rock cut/ditch)	Collision with Fixed Object
41	Collision with Non-Fixed Object	For the first motor vehicle unit, 1st Event Collision With = Other Object/Not Fixed Object (8)	Other
42	Median Cross-Over Collision	Traffic Control = Median, and	Median Cross-Over Collision
43	Vehicle Going in Wrong Direction	For the first motor vehicle unit, Pre-Collision Vehicle Action = Wrong Way	Vehicle Going in Wrong Direction
44	Ran off Roadway (1 vehicle with/earth embankment, ditch)	For the first motor vehicle unit, 1st Event Collision With = Earth Embankment/Rock Cut Ditch or Ran Off Roadway or Submersion	Ran Off Roadway
45	Overturned in Roadway	Location 1st Event = On Roadway and	Overturned in Roadway
46	1 Vehicle Entering or Leaving Parked Position (not Parking Lot)	For the first or second motor vehicle, Pre-Collision Vehicle Action = Entering Parked Position or Starting from Parking	Other
47	1 Vehicle Parked Position (not Parking Lot, driveway)	For the second motor vehicle, Pre-Collision Vehicle Action = Parked	Other
48	Rear End in Traffic – One Vehicle Stopped	Manner of Collision = Rear End and	Rear End
49	Rear End in Traffic Lanes –Both Vehicles Moving	Manner of Collision = Rear End and	Rear End
50	Rear End on Shoulder	Manner of Collision = Rear End and	Rear End
51	Other Collisions on Shoulder	Manner of Collision NOT= Rear End and	Other
52	Head-on Collision	Manner of Collision = Head On	Head-on Collision
53	Sideswipe Collision - Same Direction	Manner of Collision = Sideswipe, Same Direction	Sideswipe
54	Sideswipe Collision - Opposite Direction	Manner of Collision = Sideswipe, Opposite Direction	Sideswipe
55	1 Vehicle Entering/Leaving Entrance	Manner of Collision = Angle and	Other

56	Vehicle Backing	Manner of Collision = Backing	Other
70	Other Roadway or Mid-Block Collision	Catchall for anything that does fall into the above	Other
71	Collision with Fixed Object in Gore	Location of 1st Event = Gore and	Collision with Fixed Object
72	Collision with Fixed Object not in Gore	Location of 1st Event NOT = Gore and	Collision with Fixed Object
73	Ramp - Vehicle Ran off Roadway	For the first motor vehicle unit, 1st Event Collision With = Ran Off Roadway (only)	Ran Off Roadway
74	Overturned on Ramp	Location of 1st Event = Roadway and	Overturned in Roadway
75	Rear End - on Ramp	Manner of Collision = Rear End and	Rear End
76	Multiple Vehicle Collision on Ramp	Manner of Collision NOT = Rear End and	Other
85	Other Ramp Related Collisions not Listed Above	Catchall for ramp collisions that don't fall into categories 65, 66, 67, 68, 70, 73	Other
90	Collision in Parking Lot	Parking Lot = Y	Other
91	Collision with Train	For the first motor vehicle unit, 1st Event Collision With = Train	Collision with Train
99	All Other Collisions	Anything that does not fall into any of the above categories	Other