Final Deliverable

Contract BDV24-977-06

Enhancing and Generalizing the Two-Level Screening Approach Incorporating the Highway Safety Manual (HSM) Methods, Phase 2

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May 2016

DISCLAIMER

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UNITS CONVERSION

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3

NOTE: volumes greater than 1000 L shall be shown in m^3				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	^oC
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft

m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**

TEMPERATURE (exact degrees)				
^{o}C	Celsius	1.8C+32	Fahrenheit	^{o}F
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **Enhancing and Generalizing the Two-Level Screening Approach Incorporating the Highway Safety Manual (HSM) Methods, Phase 2**		5. Report Date **April, 2016** 6. Performing Organization Code
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9. Performing Organization Name and Address **Department of Civil, Environmental & Construction Engineering University of Central Florida 12800 Pegasus Drive, Suite 211 Orlando, FL 32816-2450**		10. Work Unit No. (TRAIS) 11. Contract or Grant No. **BDV-24-977-06**
12. Sponsoring Agency Name and Address **Florida Department of Transportation**		13. Type of Report and Period Covered **Final Deliverable (Draft) April, 2014 – May, 2016** 14. Sponsoring Agency Code
15. Supplementary Note		

16. Abstract

This project aims at developing a novel methodology to identify traffic safety hotspots and hot zones for at the macroscopic and microscopic levels. In order to achieve these objectives, the following tasks were performed. The research team followed the HSM screening procedure and extended it to the macroscopic level. TAZs (Traffic analysis zones) have been most widely used as a spatial unit for macroscopic analysis; however, TAZs have two disadvantages: small size in urban areas and high percentage of zonal boundary crashes. Thus, we have suggested two ways to overcome this issue. The first way is to develop a new study unit – Traffic safety analysis zones (TSAZs), created by aggregating existing TAZs with similar crash rates. The second way is to apply a larger geographic unit such as TADs (Traffic analysis districts) or counties. We explored traffic safety not for TAZs only but also for TSAZs, TADs, and counties. The research team developed a series of SPFs (Safety performance functions) both at the macro-level and micro-level for 17 crash types. At the macro-level, overall, 204 SPFs were developed based on SWTAZs (Statewide TAZs), TSAZs, TADs, and counties. The research team has found various contributing factors for each traffic crash type at the macro-level. At the micro-level, overall, 404 Florida-specific SPFs were estimated for 13 segments and 16 intersection facility types. Before the research team proceeded to the screening analysis, we performed a grid structure analysis to identify the best geographic units. The results showed that SWTAZs are the optimal zone system for analyzing non-motorized crashes such as pedestrian and bicycle crashes. On the other hand, TADs are found to be the best geographic unit for all other crash types. Subsequently, screening analysis was conducted at the two-levels using PSI (Potential for Safety Improvement) and ranked. Two stage screening could be suggested as a simple way to identify high risk locations. The screening results from the two-levels were integrated, and all the results were provided in Excel spreadsheets for the convenient application of practitioners. It is intended that the results of the project would provide a comprehensive perspective on appropriate traffic safety plans and help practitioners screen and rank any area, segment, or intersection in the state.

17. Key Word	18. Distribution Statement
safety performance functions; SPFs; Florida-specific SPFs; network screening, hotspot identification; macroscopic analysis; microscopic analysis; integrated screening	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
	Unclassified	428	

EXECUTIVE SUMMARY

The Highway Safety Manual (HSM) provides comprehensive screening methodologies for microscopic entities such as segments, intersections, or corridors (AASHTO, 2010). While microscopic screening analysis can identify specific locations with high traffic crash risk, macroscopic screening investigation can consider an overall zonal level risk. In Phase I of the project, we followed the HSM screening procedure and extended it to the macroscopic level. Thus, our vision is to provide more practical and useful safety screening methodologies with comprehensive and balanced perspectives, macro- and micro-levels.

TAZs (Traffic analysis zones) have been most widely used as a spatial unit for macroscopic analysis; however, TAZs have two disadvantages: small size in urban areas and high percentage of zonal boundary crashes. Thus, in this study we have suggested two ways to overcome this issue. The first way is to develop a new study unit – Traffic safety analysis zones (TSAZs) by aggregating existing TAZs with similar crash rates. The second way is to apply a larger geographic unit such as TADs (Traffic analysis districts) or counties. We explored traffic safety not only at TAZs but also at TSAZs, TADs, and counties.

The research team developed Florida-specific SPFs (Safety performance functions) both at the macro-level and micro-level for 17 crash types. At the macro-level, overall, 204 SPFs were developed based on SWTAZs (Statewide TAZs), TSAZs, TADs, and counties. The research team has found various contributing factors for each traffic crash type at the macro-level. At the micro-level, overall, 404 SPFs were estimated for 13 segments and 16 intersection facility types.

Before the research team proceeded to the screening analysis, we performed a grid structure analysis to identify the best geographic units. The results showed that SWTAZs are the optimal zone system for screening non-motorized crashes such as pedestrian and bicycle crashes. On the other hand, TADs are found to be the best geographic unit for all other crash types.

Subsequently, screening analysis was conducted at the two-levels using PSI (Potential for Safety Improvement) and ranked. The screening results from the two levels were integrated, and all the results were provided in Excel spreadsheets for the convenient application for practitioners.

In summary, this project developed numerous Florida-specific SPFs both at macro-level and micro-level using statewide data. The research team explored 17 major crash types. The research team suggests using TADs as a geographic unit along with SWTAZs, TSAZs, and counties. Moreover, this project presents a separate and an integrated screening method that can be used to overcome the shortcomings of macro- and micro-level approaches by integrating the two levels. A reasonable approach is two steps: first identify the problematic areas; second zoom in with micro-screening to identify the specific problems and locations. It is intended that the results of the project would provide a comprehensive perspective on appropriate traffic safety plans and help practitioners screen and rank any area, segment, or intersection in the state.

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LIST OF ACRONYMS AND ABBREVIATIONS

3TL	3-lane two-way left-turn lane
4FR	4-lane full access control
5TL	5-lane two-way left-turn lane
6FR	6-lane full access control
8FR	8-lane full access control
A	Incapacitating injury crash
AADT	Annual Average Daily Traffic
Adj_R2	Adjusted R-squared
AIC	Akaike Information Criterion
B	Non-incapacitating injury crash
BIC	Bayesian Information Criterion
BIKE	Bicycle-involved collision
C	Possible injury crash
CARS	Crash Analysis Reporting System
DIST_TO_URBAN	Distance to the nearest urban area
DUI	Crash due to driving under the influence of alcohol or drugs
FDOT	Florida Department of Transportation
FGDL	Florida Geography Data Library
FOG	Crash under foggy condition
HMT	Hotel, Motel, and Timeshare
HSM	Highway Safety Manual

K	Fatal crash
k	Dispersion parameter
KDE	Kernel density estimation
LL	Log-likelihood
ln(AADT)	Natural log of AADT of segments
ln(MJ_AADT)	Natural log of AADT of major road of intersections
ln(MN_AADT)	Natural log of AADT of minor road of intersections
ln(TEV)	Natural log of total entering vehicles of intersections
LN_BIKELANE	Natural log of bike lane length
LN_HMTS_DENS	Natural log of hotel, motel, timeshare room density
LN_INTER_MI	Natural log of intersections per mile
LN_LAKE_AREA	Natural log of lake or pond area in square mile
LN_ROAD_DEN	Natural log of roadway density
LN_SCH_DENS	Natural Log of school enrollment density
LN_SIDEWALK	Natural log of sidewalk length
LN_SIGNAL_MI	Natural log of signals per mile
LN_TOT_COM	Natural log of number of total commuters
LN_TOT_EMP	Natural log of total employment
LN_VMT	Natural Log of VMT
MAD	Mean absolute deviation
MFU	Multi family units
MPO	Metropolitan planning organization

MV	Multiple-vehicle collision
O	Property damage only crash
P_0AUTO	Proportion of families with 0 vehicle
P_2AUTO	Proportion of families with 2 vehicles
P_AGE1524	Proportion of residents between 15 and 24 years old
P_ARTERIAL	Proportion of arterial roads
P_COLLECTOR	Proportion of collectors
P_COM_BIKE	Proportion of commuters using bicycle
P_COM_PUB	Proportion of commuters using public transportation
P_COM_WALK	Proportion of commuters by walking
P_FREEWAY	Proportion of freeway/expressway
P_HBOA	Proportion of home-based other trip attraction
P_HBSHP	Proportion of home-based shopping trip production
P_HBSRA	Proportion of home-based social and recreational trip attraction
P_HBSRP	Proportion of home-based social and recreational trip production
P_HBWA	Proportion of home-based working trip attraction
P_HBWP	Proportion of home-based working trip production
P_HEAVY_VMT	Proportion of heavy vehicle in VMT
P_HIGHPSL	Proportion of roadway length with posted speed limit higher than 55 mph
P_LOCALROAD	Proportion of local roads
P_URBAN	Proportion of urban area

PED	Pedestrian-involved collision
PSI	Potential for safety improvement
R_3ST_1S	Rural 3-leg stop-controlled: 1-way stop
R_4SG	Rural 4-leg signalized
R_4ST_2S	Rural 4-leg stop-controlled: 2-way stop
R_4ST_4S	Rural 4-leg stop-controlled: 4-way stop
R2D	Rural 2-lane divided
R2U	Rural 2-lane undivided
RAIN	Crash under rainy condition
RMD	Rural multi-lane divided
RMU	Rural multi-lane undivided
ROUNDABOUT	Roundabouts
RTAZs	Regional TAZs
S4A	Signal Four Analytics
SFU	Single family units
SPFs	Safety performance functions
SV	Single-vehicle collision
SWTAZs	Statewide TAZs
TADs	Traffic analysis districts
TAZs	Traffic analysis zones
TRANSTAT	Transportation Statistics Office
TSAZs	Traffic safety analysis zones

U_3SG	Urban 3-leg signalized
U_3ST_1S	Urban 3-leg stop-controlled: 1-way stop
U_3ST_1SD	Urban 3-leg stop-controlled: 1-way stop- divided
U_3ST_3S	Urban 3-leg stop-controlled: 3-way stop

1 INTRODUCTION

In Phase I of the project, we extended the screening procedure in Part B of the Highway Safety Manual from microscopic to macroscopic safety analysis. A regionalization method was used to develop a new study unit - Traffic safety analysis zones (TSAZs) - in order to overcome the limitations of the current Traffic analysis zones (TAZs) such as small unit sizes in the urban areas and a high percentage of zonal boundary crashes. The newly developed TSAZs were used as a basic geographic unit for the analysis. We selected three counties of Central Florida to apply the new screening process, and we have for the first time integrated both micro-level screening (i.e., identifying high risk locations such as intersections and roadway segments) with the newly developed macro-level screening based on the zonal level. The procedure would help safety professionals and engineers to identify the locations and zones simultaneously that are in urgent need of safety treatments. The innovation is the combined screening and prioritization approach, which extends the current HSM approach to incorporate micro and macro levels. It is expected that this integrated screening approach can provide a comprehensive perspective by balancing two aspects: macroscopic and microscopic approaches.

Our novel integrated screening method overcame the shortcomings of the current macro- and micro-level approaches and provided a comprehensive perspective on appropriate safety treatments by balancing the accuracy and efficiency of screening in Phase I. However, Phase I research illustrated that there are five main issues that need to be addressed before finalizing this work.

First, from a developmental point of view, the results must be inclusive and useful to the whole state. Currently we have used Orange, Seminole, and Osceola Counties as the study area. This area is part of FDOT District 5 and MetroPlan Orlando. Our current results are area specific at this stage, particularly because the research team has integrated TAZs to develop new zonal system: TSAZs. Thus, there is a need to make this system more general to the whole state so any district or MPO can effectively use the method. This project can be considered part of the "Big data" initiatives, as the data requirements are extensive and include complete planning, census, roadway, crash and other data to be integrated. There is a need to collect data from at least one or more districts (e.g., Tampa) and validate and refine our results to reach a common methodology for the 2-level screening across the state. By doing so, we can also examine the transferability of the SPFs to other regions.

Second, practitioners and policy makers may want to define zones with high crash risks at different macroscopic levels in Florida. Although TSAZs were developed and suggested for the macro-level screening in Phase I, larger geographic units such as statewide traffic analysis zones (SWTAZ), traffic analysis districts (TADs) and counties may be also useful from a practical perspective.

Third, from an applications point of view, we have already developed simple spreadsheets to implement the results that were delivered with the final report of Phase I. However, these spreadsheets can be enhanced to be more user-friendly and applicable to all regions in Florida. Also, the ideal spreadsheet should have the ability not only to implement the results of phase I, but also to use the TSAZs, which are key to this work. Since the development of TSAZs is very complex and would not be easy for practitioners, the research team will either develop the TSAZ map for the whole state to facilitate the integration with the new spreadsheets or develop a mapping procedure to convert the TAZs into TSAZs. Another alternative approach would be to explore the applicability of existing geographical units for safety analysis such as SWTAZ, TAD and County.

Fourth, while this work is very useful from a safety perspective, accommodating the relationship with transportation demand will allow us to integrate safety and transportation planning process for better planning and safety prediction. We expect that there will be an opportunity for proactive safety management application in both long and short-range transportation plans.

Fifth, it would be desirable to extend the methodology to different injury levels, collision types (such as Pedestrians), times, and other conditions. For example implementation of screening by peak/off-peak or night/day, etc. The analysis would help produce well defined safety treatments for target crashes. Also, the latest 3-years of crash data (from 2010 to 2012) will be included, and the new analysis results will be compared to our current crash patterns in Phase I.

In summary, our vision is to provide more practical and useful safety screening methodologies and results for various crash types to FDOT and its districts. Based on the above discussion, the main objectives of this second phase of the project are summarized as follows:

1. Develop TSAZs for other areas in Florida
2. Develop SPFs for 17 crash types based on micro-level (i.e., intersection and segment) and macro-level (i.e., SWTAZs, TSAZs, TADs, counties),
3. Identify hot zones at different spatial scales, such as SWTAZ, TAD and county,
4. Identify hot intersections and sections,
5. Use and adapt the HSM screening procedures,
6. Develop practical and user-friendly spreadsheets for the integrated screening,
7. Provide a stepwise procedure for integrating micro and macro screening results with transportation planning, and
8. Analyze hot sites/zones by various crash types, times, and conditions.

Chapters by each task in this research project are as follows:

- Chapter 1: Introduction
- Chapter 2: Data Collection (Task 1)
- Chapter 3: Data Preparation and Explanatory Analysis (Task 2)
- Chapter 4: Development of TSAZs (Task 3)
- Chapter 5: Development of Various SPFs at Macro-level (Tasks 4-6)
- Chapter 6: Macro-level Screening (Task 7)
- Chapter 7: Development of Various SPFs at Micro-level (Task 8)
- Chapter 8: Micro-level Screening (Task 8)
- Chapter 9: Integration of Macro-Level and Micro-level Screening Results (Task 9)

- Chapter 10: Integration Results (Task 9)
- Chapter 11: Development of Spreadsheets (Task 10)
- Chapter 12: Summary and Conclusion

2 DATA COLLECTION

In order to achieve the objectives as described in the previous chapter, the research team has collected crash, geographic boundary maps, demographic, socio-economic, facility, roadway, and traffic data from multiple sources. The crash data were obtained from FDOT (Florida Department of Transportation) CARS (Crash Analysis Reporting System) database and Signal Four Analytics (S4A). The geographic units such as TAZ, TAD, and county boundary maps were collected from FDOT District Offices/MPOs (or FDOT Central Office), U.S. Census Bureau, and Florida Geographic Data Library (FGDL), respectively. The demographic data and socioeconomic data were obtained from the U.S. Census Bureau and FDOT District Offices/MPOs (or FDOT Central Office). Lastly, the roadway and traffic data were collected from FDOT Transportation Statistics Office (TRANSTAT).

2.1 Crash Data

Figure 2-1 presents the overall process of the crash data collection from the two sources: FDOT CARS and S4A.Two forms of crash report are used in Florida. They are short form and long form crash reports. Crashes reported on the long forms involve either higher injury severity level or criminal activities such as hit-and-run or DUI. Since only long form crashes have been coded and archived in FDOT's CARS database. The research team has collected short form crashes from S4A. Therefore, the research team is able to use more complete crash data in this research project.

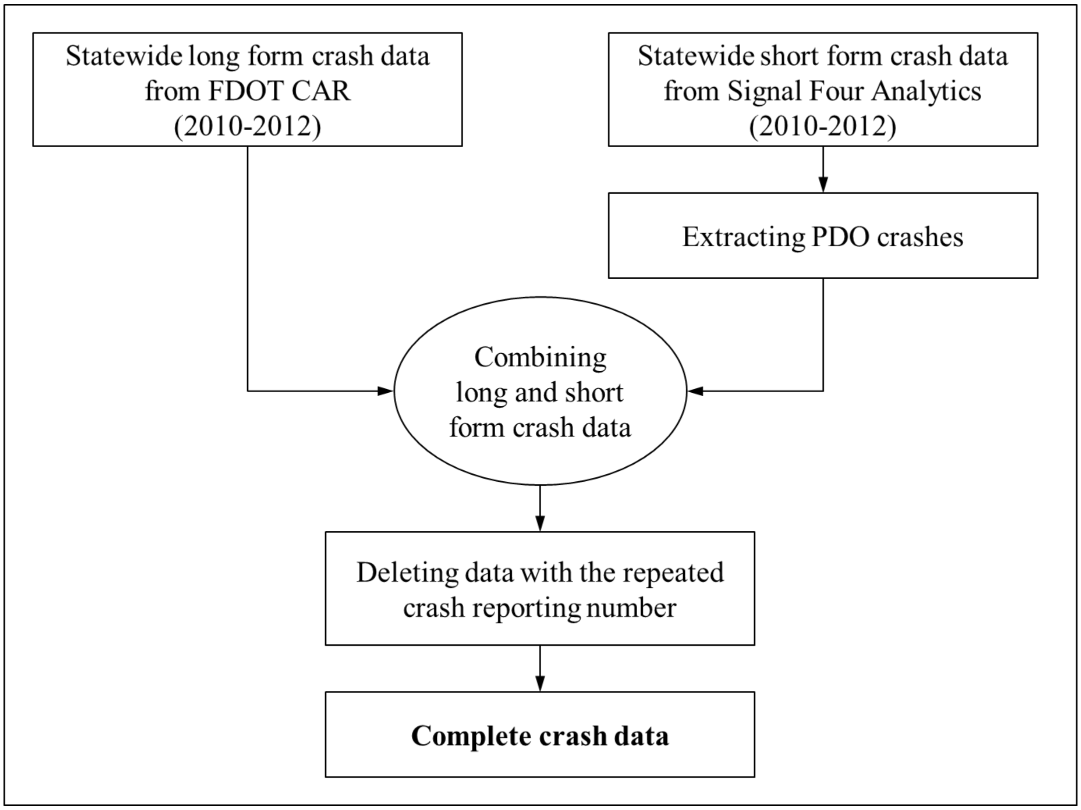


Figure 2-1 Crash data collection process

The number of crashes by severity levels, form types, and years is shown in Table 2-1. The number of injury and fatal crashes are stable across 3 years. However, it is evident that many PDO (Property Damage Only) crashes in 2010-2011 are under-reported compared to the number of PDO crashes in 2012. The possible reasons for the underreporting of PDO crashes are as follows: First, S4A started to collected short form crash data from all counties in Florida from 2010 onward. However, very few short form crash data were collected in 2010 except for select counties. The number of reported short form crashes has significantly increased since 2011. Second, the crash report form has been changed in 2011, and thus it is thought that there was confusion in submitting crash reports. Third, The Florida Statutes regarding the crash reporting rules (F.S. 316.066) have been amended, and the number of reportable long form crashes has increased since 2012. The amended Florida Statutes regulate that traffic crashes should be reported by long form if a crash: 1) resulted in death of, personal injury to, or any indication of complaints of pain or discomfort by any of the parties or passenger involved in the crash; 2) involves DUI (Driving Under the Influence of alcohol or drugs) or hit-and-run (F.S. 316.061(1) and 316.193); 3) rendered a vehicle inoperable to a degree that required a wrecker to remove it from the scene of the crash; or 4) involved a commercial motor vehicle. These possible reasons may increase the number of PDO reported long crashes in 2012. The State is moving in the right direction and the data appear to be more complete. More PDO crashes are captured by both long and short forms. There is an indication that the percent of PDO crashes reported on Long forms is increasing. In July 2010 agencies were no longer required to submit short forms; this led to some agencies to change to all long forms. We are trying to use as much complete crash database as possible, while maintaining consistency. This is difficult as it is apparent that the changes in 2010 and 2011 are impacting the number of reported crashes. Up to the time of writing this report, the 2013 geocoded crash data were not available from FDOT.

Table 2-1 The number of crashes by severity levels, form types, and years

Year	Severity levels			Source		Sum
	PDO	Injury	Fatal	S4A	CARS	
2010	147,872	122,288	2,183	15,370	256,973	272,343
2011	169,484	102,398	2,103	53,343	220,642	273,985
2012	241,321	111,450	2,136	99,885	255,022	354,907
Sum	558,677	336,136	6,422	168,598	732,637	901,235

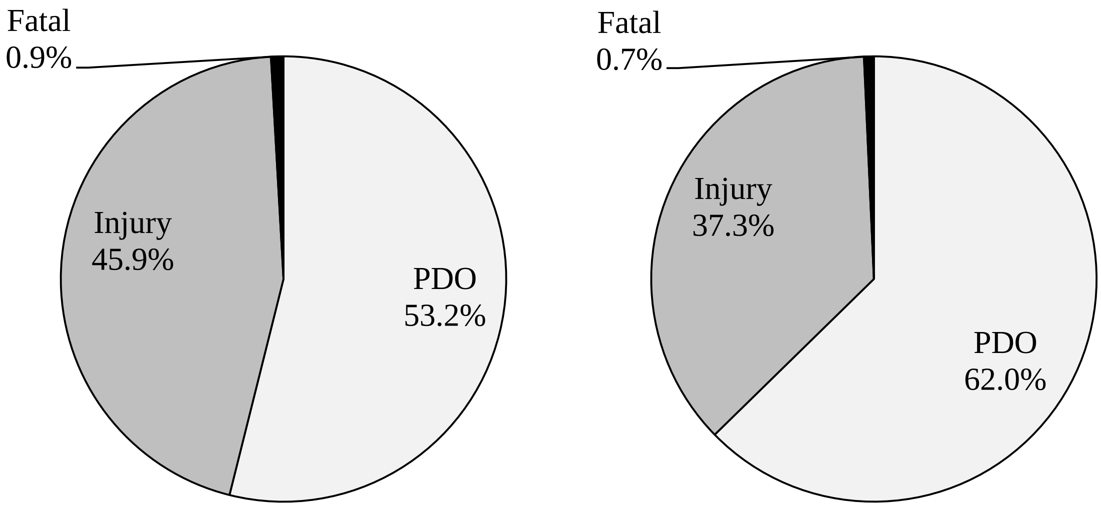


Figure 2-2 Comparison of the proportion of crashes by severity levels between long form only (left) and complete data (right)

As shown in Figure 2-2, crash data without short form reports (long form only data) have 45.9% of injury crashes and 53.2% PDO crashes. On the other hand, the percentage of injury crashes was dropped to 37.3% whereas PDO crashes were 62.0%, which is obviously more reasonable. Using data with many missing PDO crashes may result in biased model estimation, particularly for total and PDO SPFs (no effect for injury and fatal SPFs). Therefore, the complete data including both short and long form data were used in this research project.

Each yellow point in Figure 2-3 represents the location of a traffic crash. Figure 2-4 shows the result of Kernel Density Estimation (KDE) of crashes, which defines the spread of risk as an area around a defined cluster in which there is an increased likelihood of a traffic crash to occur based on spatial dependency. As seen in Figure 2-4, the largest cluster is located in Miami-Dade County, and Hillsborough and Pinellas Counties and Orange County have the second and third largest clusters, respectively. Also, Duval and Escambia Counties show the relatively high concentration of traffic crashes.

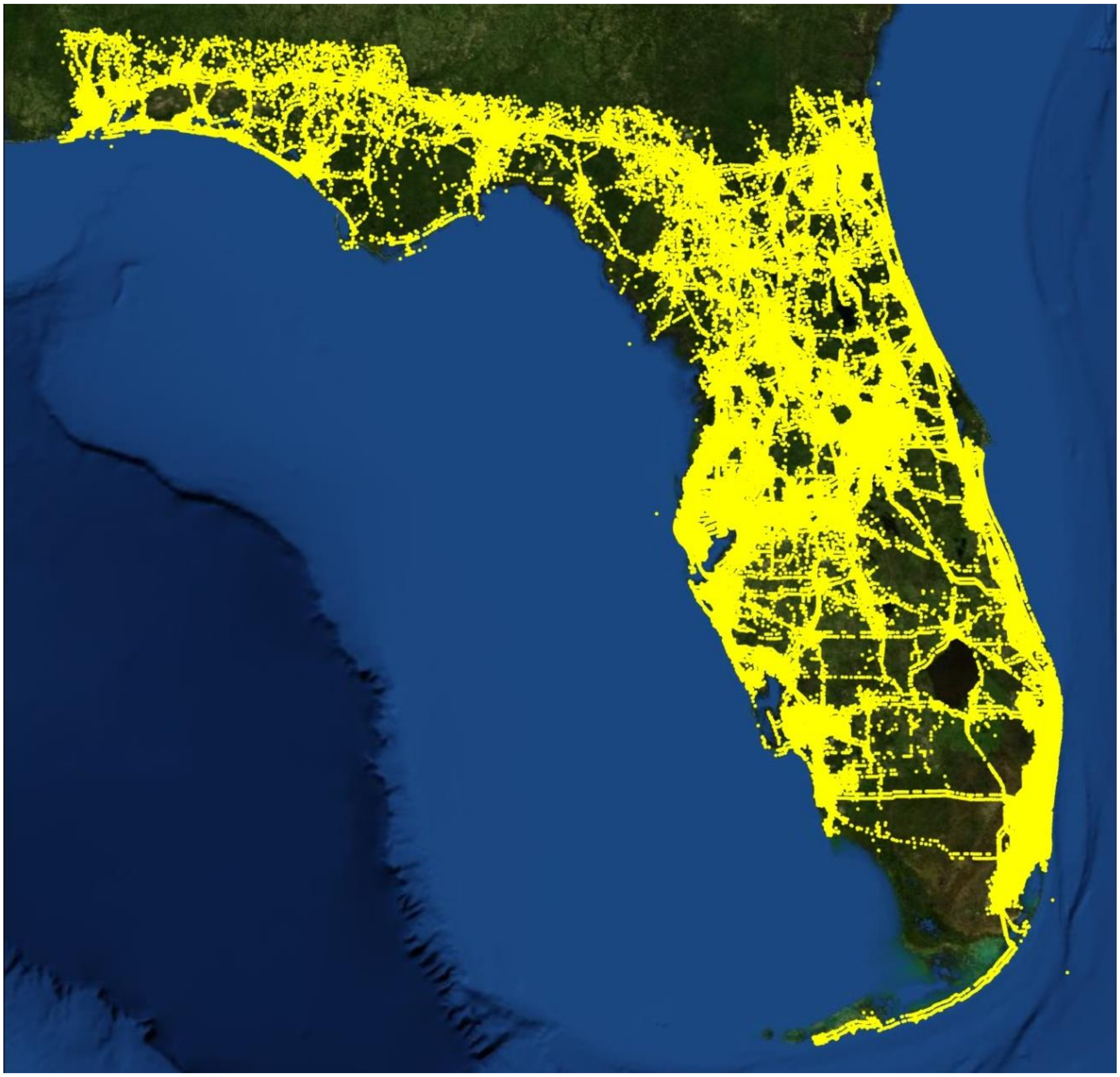


Figure 2-3 Crash locations (2010-2012)

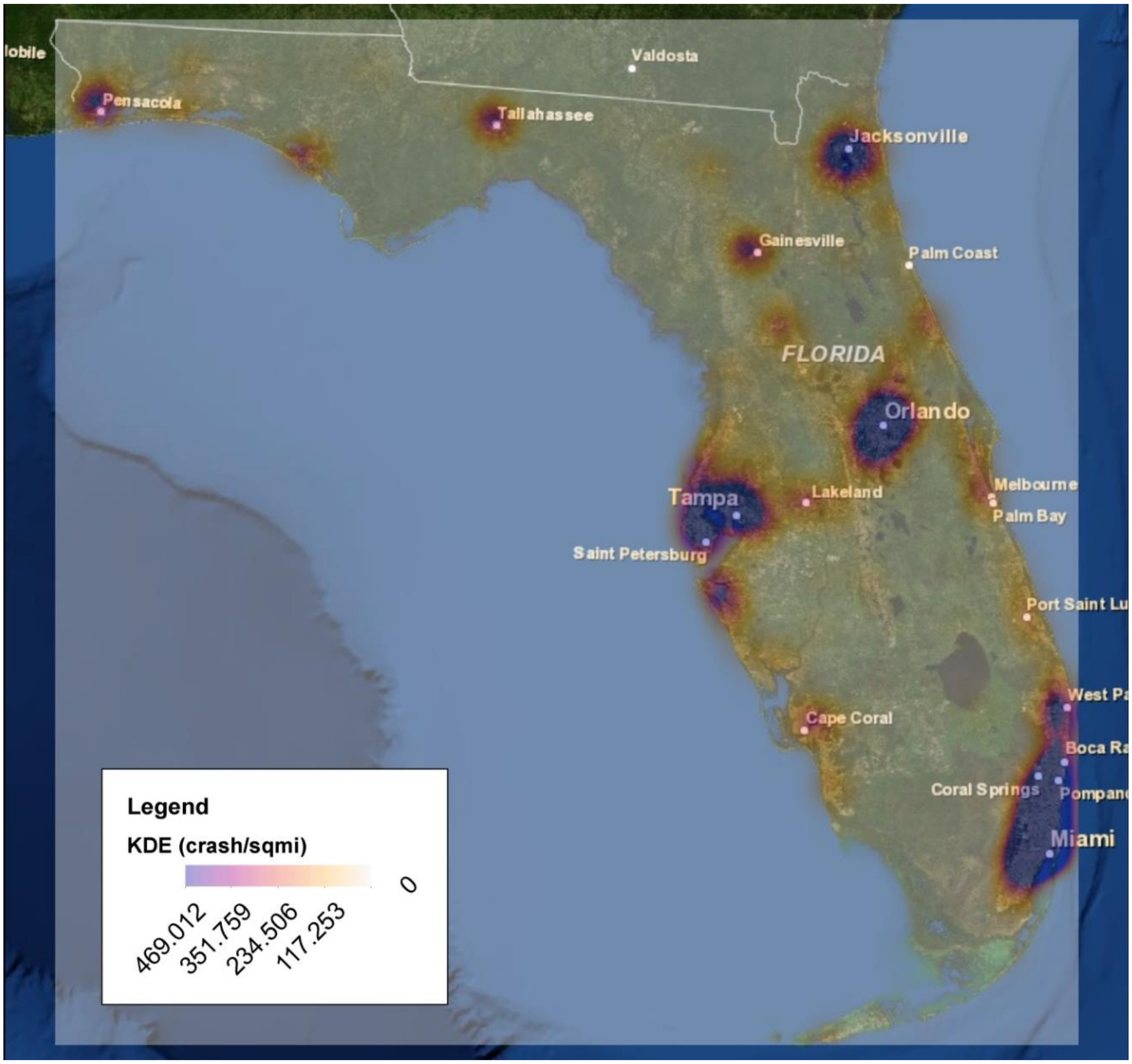


Figure 2-4 Kernel density estimation of traffic crashes

2.2 Geographic Boundary Maps

Four types of geographic boundary maps were collected: regional TAZ (RTAZ), statewide TAZ (SWTAZ), TAD, and county maps. RTAZs are used by FDOT district offices and MPOs for regional transportation plans whereas the SWTAZ is used by FDOT Central Office for statewide transportation plans.

Moreover, SWTAZ needs to be explored to be determined if it is suitable for the traffic crash analysis. TAD is a new and highly aggregated geographic unit for traffic analysis. TAD may be useful if practitioners want to define crash patterns at a higher aggregate level. Lastly, Florida county maps will be used for the highest aggregation level screening analysis in this study.

Table 2-2 summarizes the collected RTAZ systems by districts. Overall, nine RTAZ systems were collected from seven FDOT districts/MPOs. Some areas located in the rural area have very large average TAZ areas, such as District 1 (2.447 mi^2). In contrast, some TAZs in the urban area have relatively small average TAZ areas, for example, the average area in District 6 is 0.431 mi^2. Figure 2-5 exhibits the collected TAZ maps.

Table 2-2 Summary of RTAZ systems by districts

District		Covered counties (No of counties)	Area (mi^2)	No of TAZs	Avg. area per TAZ
1		Collier, Charlotte, DeSoto, Glades, Hardee, Hendry, Highlands, Lee, Manatee, Okeechobee Polk, and Sarasota (12)	11,977	4894	2.447
2	2-1	Duval, Baker, Clay, Putnam, Nassau, and St. Johns (6)	4,117	1862	2.213
	2-2	Alachua (1)	969	560	1.730
3	3-1	Leon, Gadsden, Wakulla, and Jefferson (4)	2,456	1309	1.877
	3-2	Bay, Calhoun, Escambia, Franklin, Gulf, Holmes, Jackson, Okaloosa, Santa Rosa, Walton, and Washington (11)	8,214	1359	6.044
4		Brevard, Indian River, St. Lucie, Martin, and Palm Beach (5)	4,377	2454	1.784
5		Orange, Seminole, Osceola, Lake, and Volusia (5)	4,667	2028	2.301
6		Broward and Miami-Dade (2)	1,061	2459	0.431
7		Pinellas, Hillsborough, Pasco, Hernando, and Citrus (5)	3,275	2370	1.382
Total		51 Counties	41,113	19,295	2.131

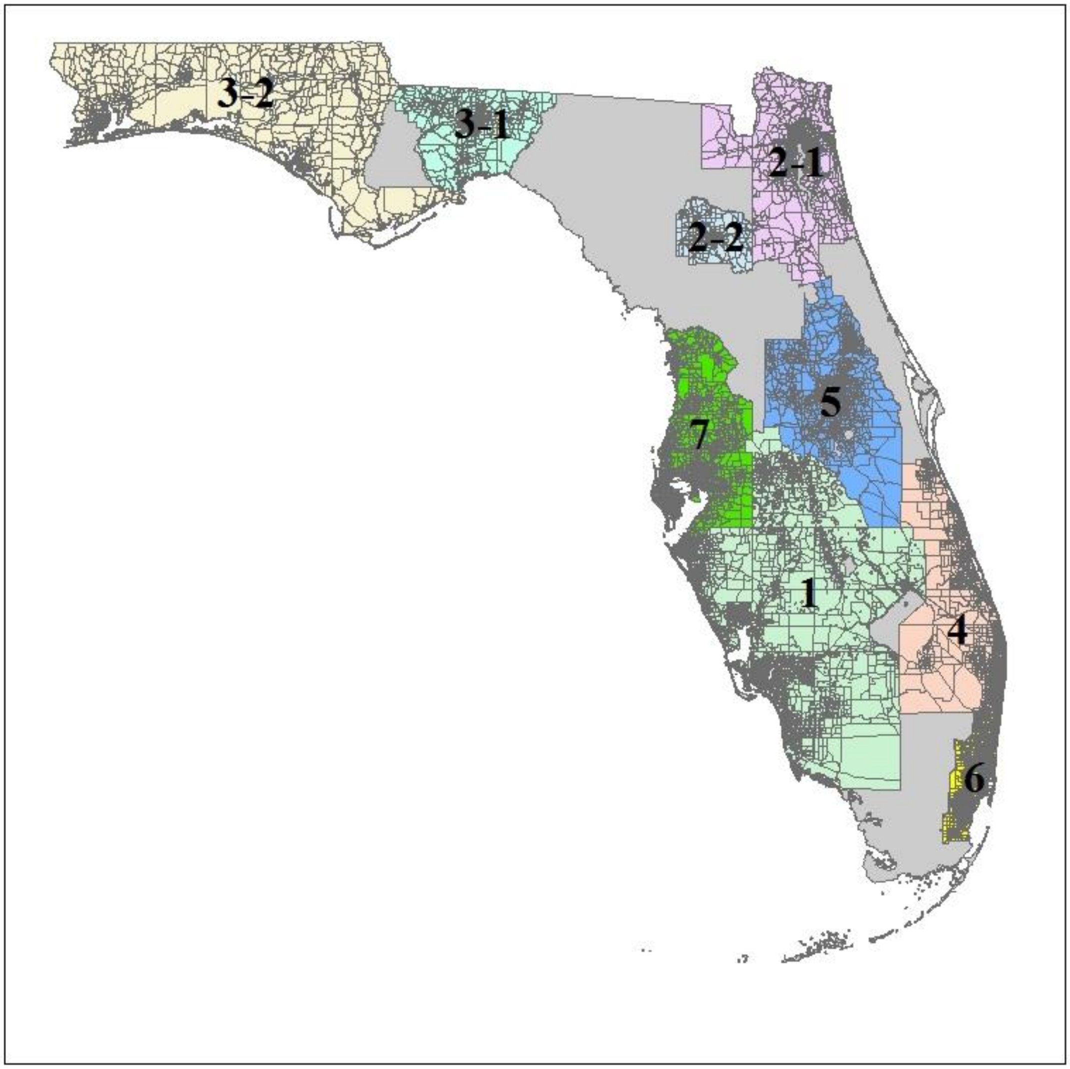


Figure 2-5 Collected RTAZ maps by district

SWTAZ, TAD, and county maps are summarized in Table 2-3. Considering the overall average regional TAZ area is 1.9 mi^2, SWTAZs are approximately 3.5 times larger (6.472 mi^2) compared to regional TAZs. In case of TADs and counties, their areas are 50 and 450 times greater than those of the regional TAZs, respectively. Figures 2-6 to 2-8 depict the SWTAZ, TAD, and county map in Florida, respectively.

Figure 2-9 compares the regional TAZ, SWTAZ, and TAD in Leon County. RTAZ, SWTAZ and TAD have 1,309, 353, and 22 zones in the area, respectively. All these three zonal systems have tendency that their zones are smaller in the urban area whereas they are relatively bigger in the rural area. It is observed that zones are extremely small in case of the regional TAZ, especially in the urban area.

Table 2-3 Summary of SWTAZ, TAD and county maps

Geographic Units	County (No of counties)	Area (mi^2)	No of SWTAZs	Avg. area/SWTAZ
SWTAZ	All counties (67)	55,127	8,518	6.472
TAD		61,368	594	103.314
County		56,695	67	846.194

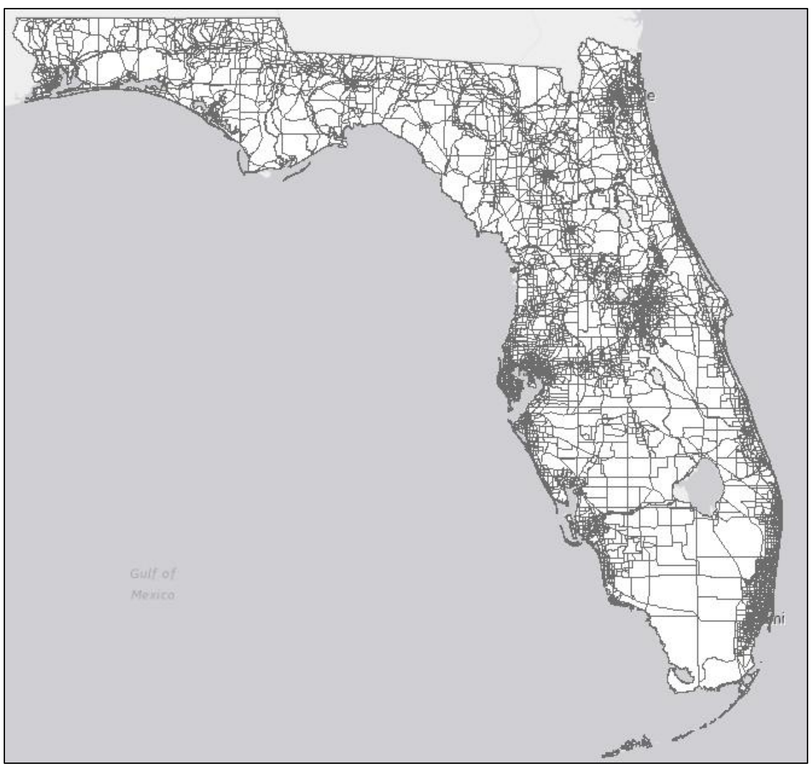


Figure 2-6 SWTAZ map (N=8,518)

Figure 2-7 TAD map (N=594)

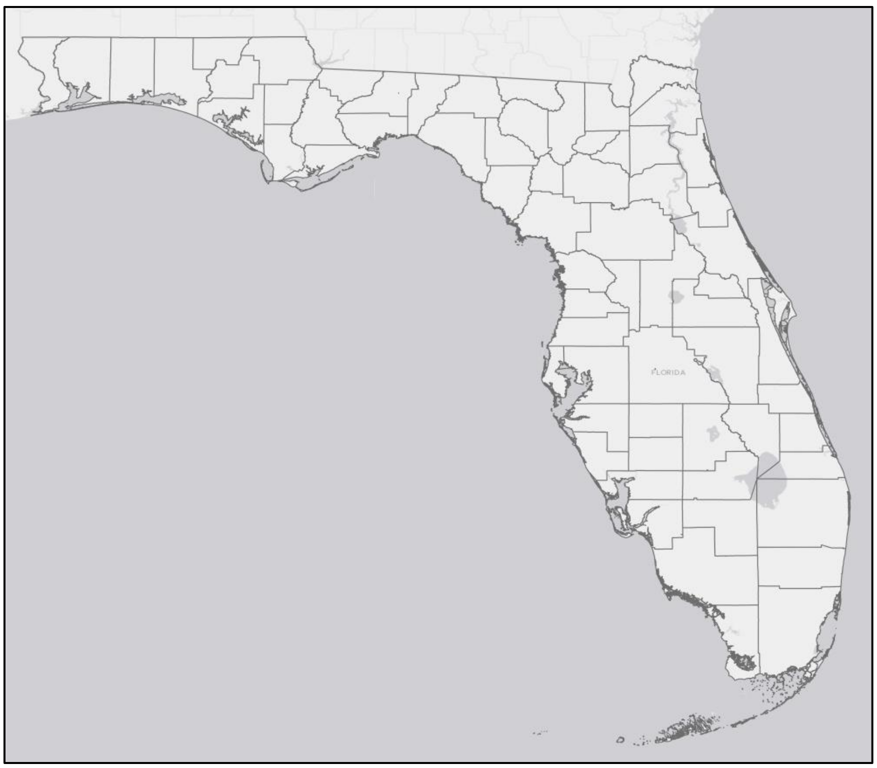


Figure 2-8 County map (N=67)

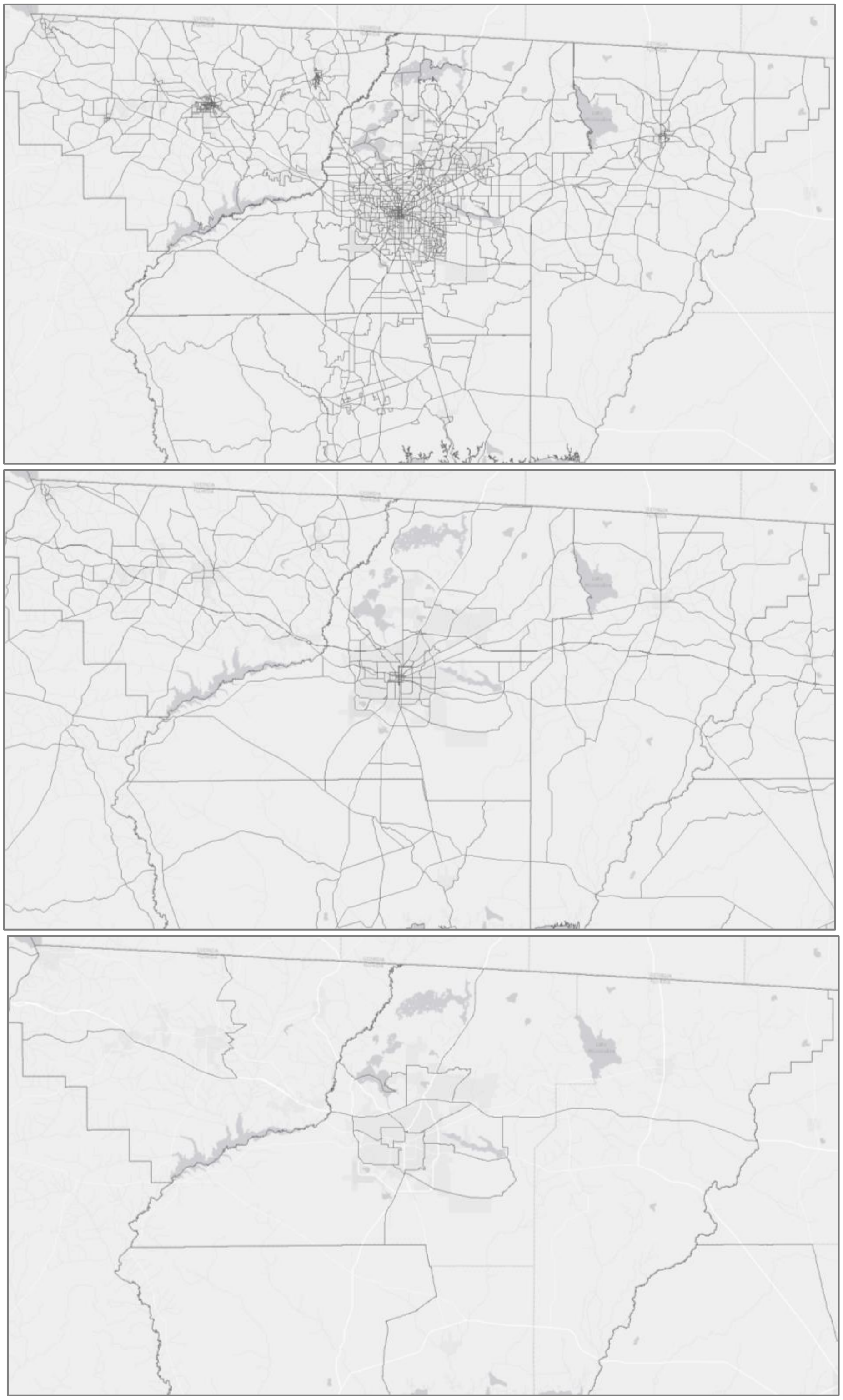


Figure 2-9 Comparison of RTAZ (upper), SWTAZ (middle), and TAD (lower)

2.3 Demographic and Socioeconomic Data

Demographic and socioeconomic data, which can serve as surrogate for traffic volumes that affect crash occurrence, are collected (Table 2-4). The demographic data such as population, population by race/ethnicity, and population by age group based on the census block were acquired from the U.S. Census Bureau. TAZ-based data were provided by FDOT District Offices/MPOs, which are called Zone Data (ZDATA). Single Family Units (SFU), MFU (Multi Family Units), and HMT (Hotel, Motel, and Timeshare) data were acquired, which are very closely related to trip generation. Furthermore, trip attraction factors such as employments and school enrollments are obtained based on TAZ maps.

Table 2-4 Summary of demographic and socioeconomic data

Category	**Variables**	**Base units**	**Sources**
Demographic	Population Population by race/ethnicity Population by age group	Census block	U.S. Census Bureau
	Number of SFU Percentage of the nonpermanent vacant in SFU Percentage of the single family vacant Population of SFU in residential area Number of MFU Percentage of the nonpermanent vacant in MFU Percentage of the multiple family vacant Population of MFU in residential area	TAZ	FDOT District Offices/MPOs or FDOT Central Office
Socioeconomic	Percentage of SFU owns no vehicle Percentage of SFU owns one vehicle Percentage of SFU owns two or more vehicles Percentage of MFU owns no vehicle Percentage of MFU owns one vehicle Percentage of MFU owns two or more vehicles		
	Number of HMT rooms Percentage of HMT occupancy Number of HMT occupants		
	Industrial Employment Commercial Employment Service Employment Total Employment School Enrollment		
	Urban boundaries	Polygon	FGDL
	Median household income	Block Group	U.S. Census Bureau

2.4 Roadway and Traffic Data

Roadway/traffic data were collected from FDOT TRANSTAT and FDOT UBR (Unified Basemap Repository) (Table 2-5). The roadway data includes the location of intersections and traffic signals, total roadway length, and roadways by speed limits. Traffic data contain AADT (Annual Average Daily Traffic) and truck traffic volume. Roadway and traffic data are expected to be important contributing factors for the crash occurrence.

Table 2-5 Summary of roadway and traffic data

Category	**Variables**	**Base units**	**Sources**
Roadway	Intersection Traffic signal locations	Point	FDOT TRANSTAT
	Total roadway length Roadway by speed limits	Polyline	FDOT UBR
Traffic	AADT Truck traffic volume	Polyline	FDOT TRANSTAT

3 DATA PREPARATION AND EXPLORATORY ANALYSIS

The newly collected data has been processed for developing various SPFs (Safety performance functions) in this chapter. This chapter summarizes descriptive statistics and several spatial distributions of the collected data by different geographic units. The geographic units include nine RTAZs, SWTAZs, TADs, and counties.

3.1 Regional Traffic Analysis Zone (RTAZ)

There are nine RTAZ systems in Florida. In general, each district has one RTAZ system. However, In the case of Districts 2 and 3, they have two RTAZ systems each. RTAZs do not cover all areas in Florida. For instance, some rural areas in Districts 2 and 3 are not covered by RTAZs.

3.1.1 Regional traffic analysis zone 1

RTAZ 1 is located in Southwestern Florida. RTAZ 1 includes 12 counties in District 1: Collier, Charlotte, DeSoto, Glades, Hardee, Hendry, Highlands, Lee, Manatee, Okeechobee Polk, and Sarasota counties as shown in Figure 3-1. Descriptive statistics for roadway and crash variables are summarized in Tables 3-1 and 3-2, respectively. Moreover, Figures 3-2 and 2-3 display roadways by functional classifications and spatial distribution of total crashes in RTAZ 1.

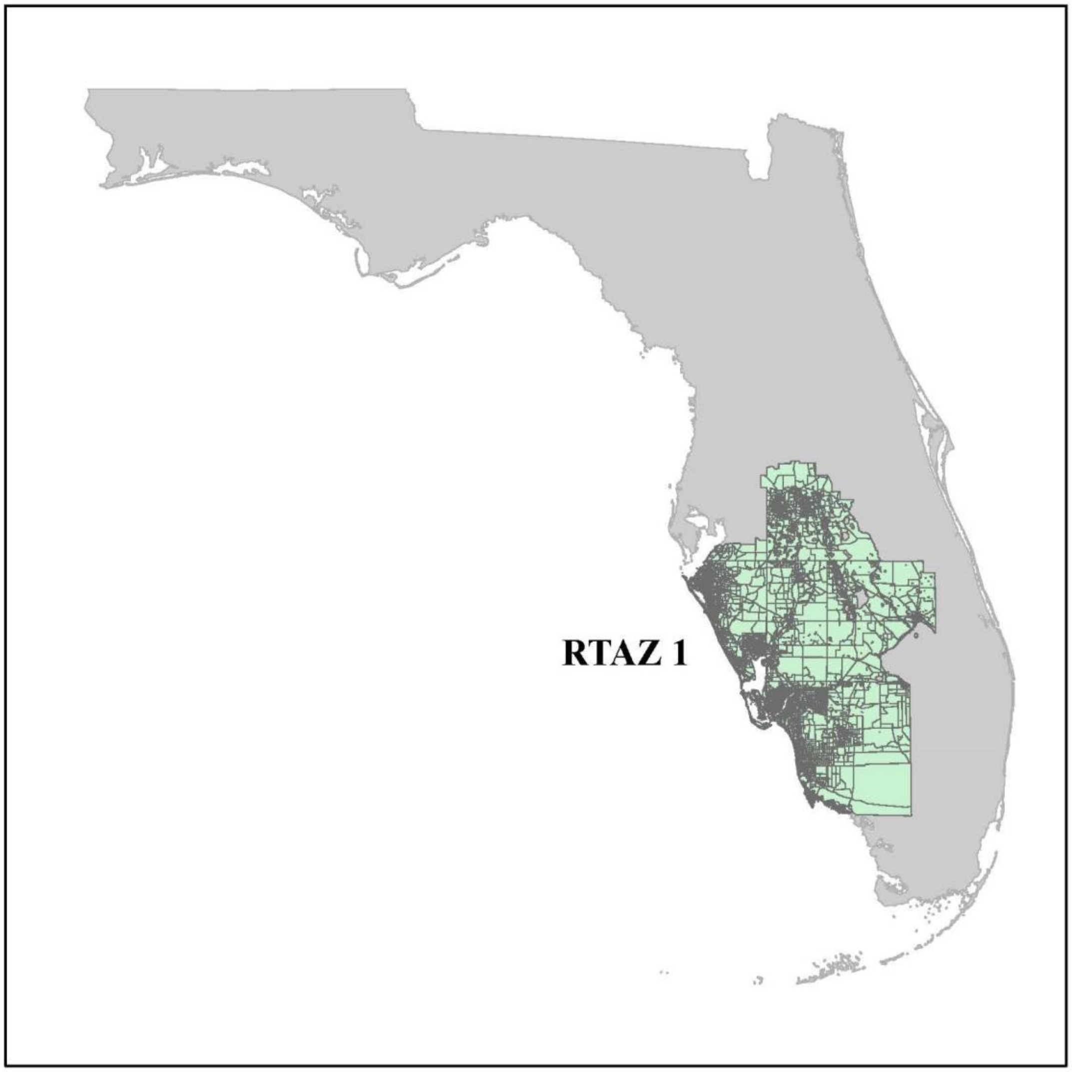


Figure 3-1 Location of RTAZ 1

Table 3-1 Descriptive statistics for roadway variables in RTAZ 1

Variables	Mean	Stdev	Min	Max
Area (mi^2)	2.447	13.020	0	602.794
Total road length (mi)	6.469	20.183	0	1233.702
Road density (mi/mi^2)	12.936	11.795	0	424.666
Proportion of freeway/expressway	0.008	0.050	0	1.000
Proportion of principle arterial road	0.056	0.139	0	1.000
Proportion of minor arterial road	0.043	0.125	0	1.000
Proportion of collector road	0.111	0.175	0	1.000
Proportion of local road	0.763	0.254	0	1.000
Proportion of roadway length with low speed limit $\leq$ 30 mph	0.728	0.282	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.177	0.216	0	1.000
Proportion of roadway length with high speed limit $\geq$ 55 mph	0.076	0.184	0	1.000
Number of intersection per mile	1.735	3.068	0	93.394
Number of signal per mile	0.134	0.680	0	18.085
Number of intersection per square mile	27.981	69.464	0	1739.852
Number of signal per square mile	2.465	15.662	0	337.061
Daily vehicle miles traveled	11155	30863	0	1340586
Proportion of daily heavy vehicle miles travel	0.060	0.062	0	0.423
Urban dummy (1=urban, 0=rural)	0.822	0.383	0	1.000

Table 3-2 Descriptive statistics for crashes in RTAZ 1

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	9.59	16.89	0	318	46948	55.7
Possible injury	3.28	5.76	0	108	16052	19.1
Non-incapacitating injury	2.89	4.86	0	105	14153	16.8
Incapacitating injury	1.09	2.00	0	32	5315	6.3
Fatal	0.19	0.56	0	8	949	1.1
Total	17.21	28.20	0	568	84217	100.0
Weekday morning peak (7-9am)	1.28	2.45	0	41	6286	7.5
Weekday off peak (9am-4pm)	5.27	9.53	0	177	25790	30.6
Weekday evening peak (4-6pm)	2.06	3.89	0	71	10073	12.0
Weekday nighttime (6pm-7am)	4.55	8.05	0	203	22270	26.4
Weekend daytime (7am-6pm)	2.15	4.03	0	63	10537	12.5
Weekend nighttime (6pm-7am)	1.89	3.30	0	78	9230	11.0
DUI	0.93	1.55	0	19	4542	5.4
Fog	0.10	0.40	0	10	486	0.6
Cloud	2.50	5.05	0	130	12259	14.6
Rain	1.47	3.63	0	89	7202	8.6
Clear	12.62	20.38	0	389	61757	73.3
Single vehicle	3.20	6.26	0	142	15655	18.6
Multiple vehicle	13.26	23.48	0	445	64872	77.0
Pedestrian	0.36	0.86	0	16	1749	2.1
Bicycle	0.40	0.99	0	20	1940	2.3

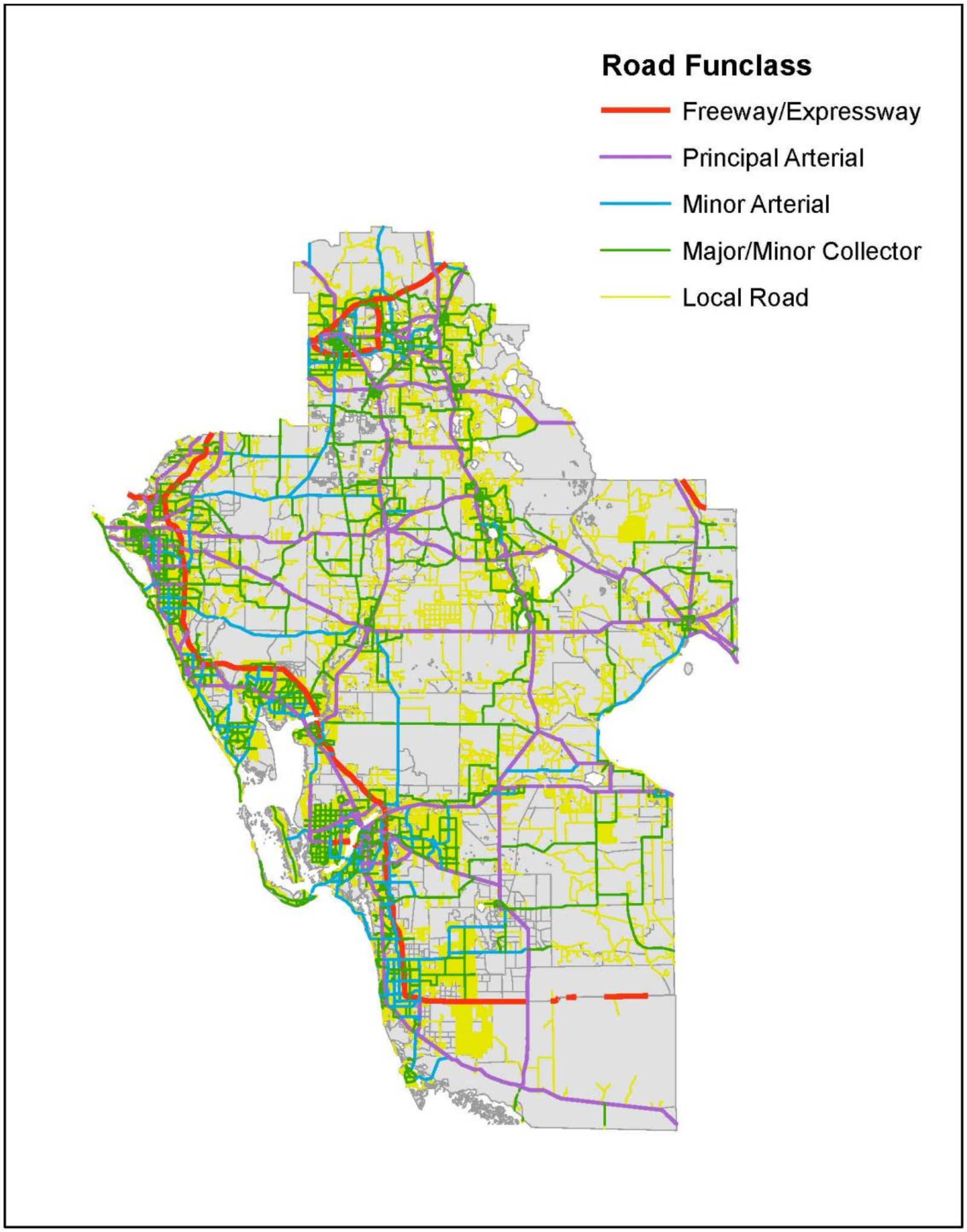


Figure 3-2 Roadways by functional classifications in RTAZ 1

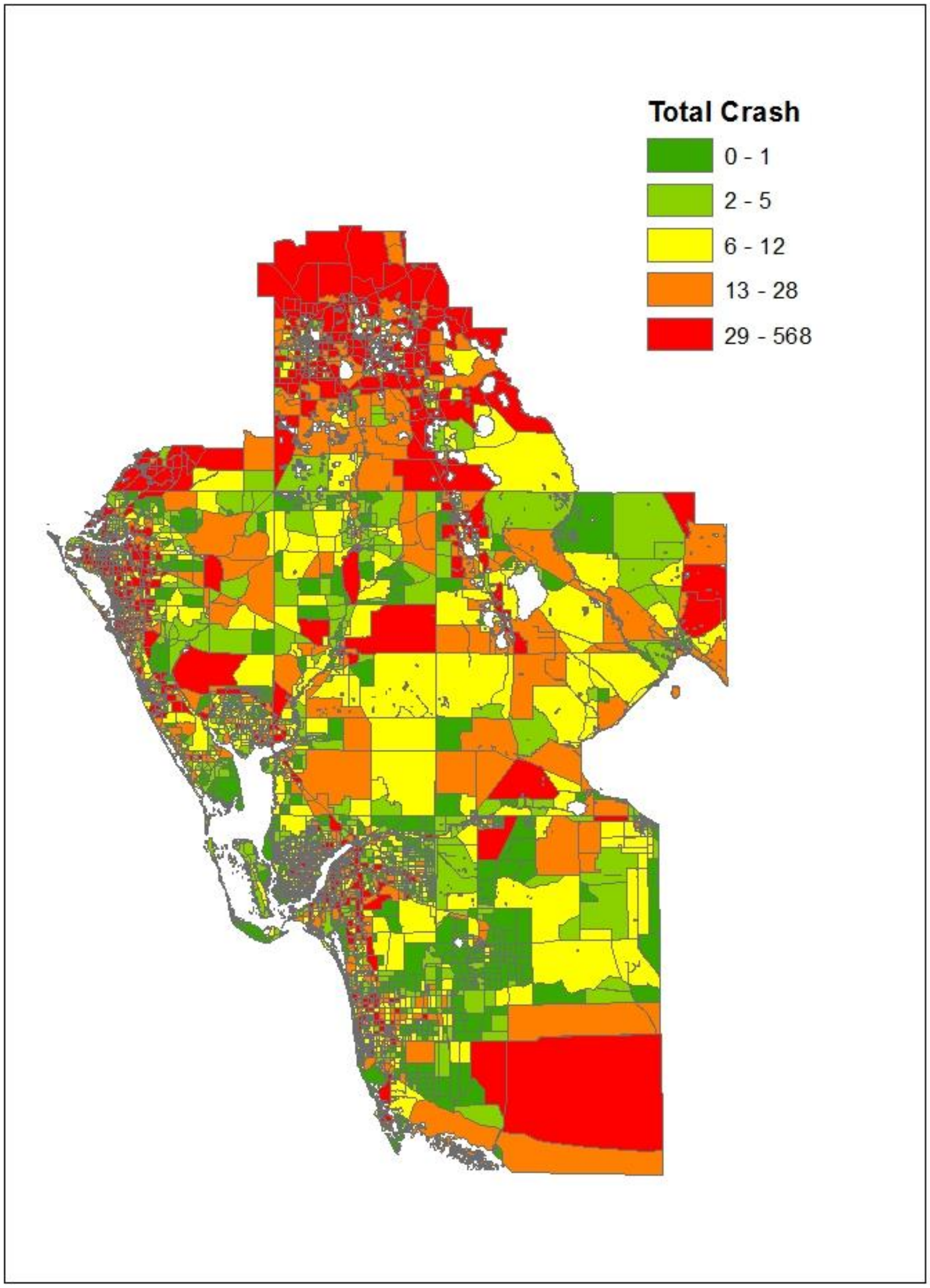


Figure 3-3 Spatial distributions of total crashes in RTAZ 1

3.1.2 Regional traffic analysis zone 2-1

District 2 has two RTAZ systems: RTAZ 2-1 (Jacksonville metropolitan area) and RTAZ 2-2 (Alachua County). RTAZ 2-1 covers 6 counties including Duval, Baker, Clay, Putnam, Nassau, and St. Johns. RTAZ 2-1 is located in the northeastern Florida as shown in Figure 3-4. Descriptive statistics for roadway and crash variables are presented in Tables 3-3 and 3-4, respectively. Furthermore, Figures 3-5 and 3-6 exhibit roadways by functional classifications and spatial distribution of total crashes in RTAZ 2-1.

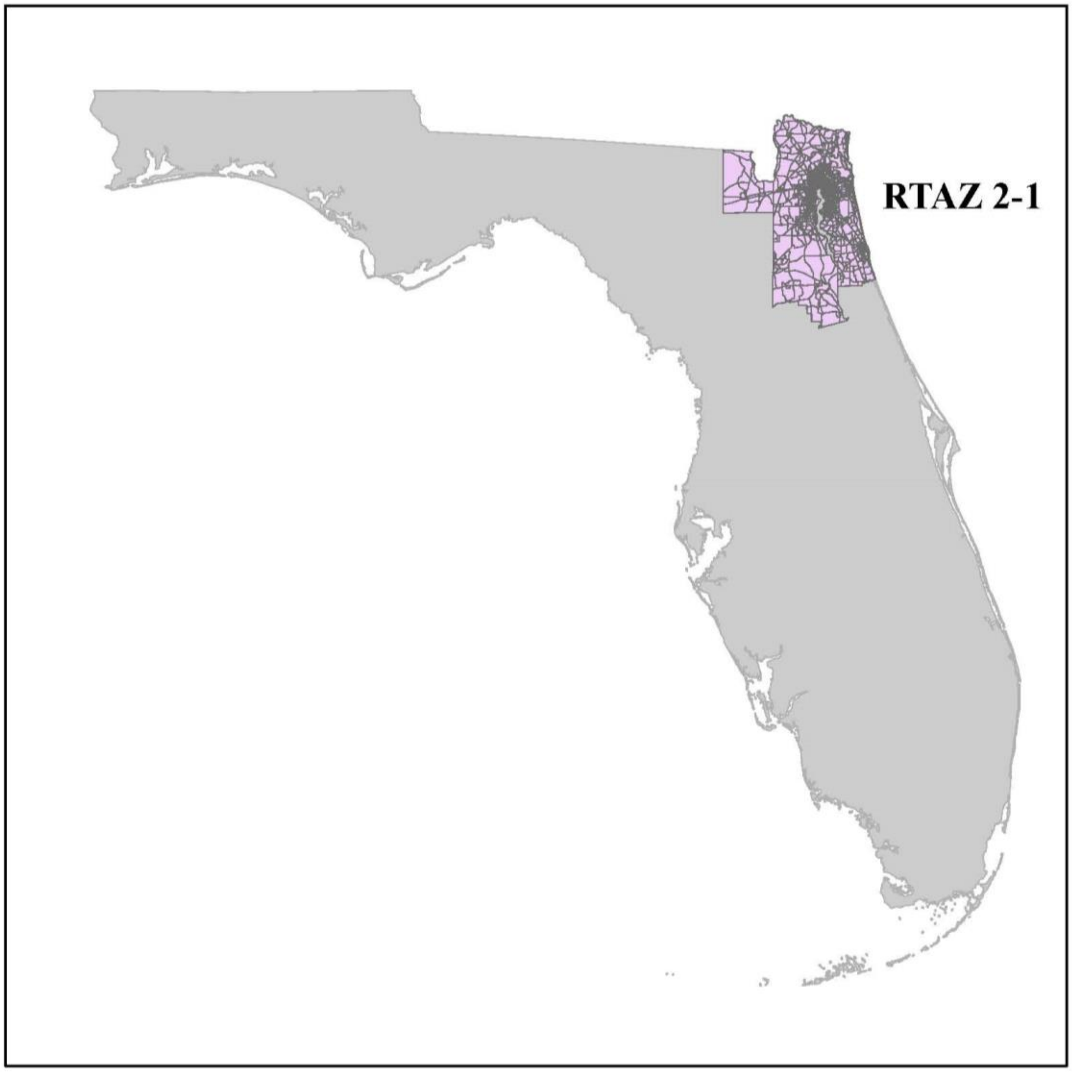


Figure 3-4 Location of RTAZ 2-1

Table 3-3 Descriptive statistics for roadway variables in RTAZ 2-1

Variables	Mean	Stdev	Min	Max
Area (mi^2)	1.671	4.712	0.003	72.860
Total road length (mi)	6.097	8.592	0	150.140
Road density (mi/mi^2)	14.899	10.955	0	65.831
Proportion of freeway/expressway	0.024	0.066	0	0.497
Proportion of principle arterial	0.043	0.108	0	1.000
Proportion of minor arterial	0.066	0.141	0	1.000
Proportion of collector road	0.107	0.162	0	1.000
Proportion of local road	0.758	0.216	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.710	0.268	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.214	0.216	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.074	0.165	0	1.000
Number of intersection per mile	2.611	6.651	0	169.563
Number of signal per mile	0.308	1.300	0	22.769
Number of intersection per square mile	49.794	108.386	0	1134.003
Number of signal per square mile	7.498	39.469	0	524.344
Daily vehicle miles traveled	18524	33544	0	355506
Proportion of daily heavy vehicle miles travel	0.039	0.047	0	0.386
Urban dummy (1=urban, 0=rural)	0.926	0.261	0	1.000

Table 3-4 Descriptive statistics for crashes in RTAZ 2-1

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	22.91	31.12	0	264	37084	59.6
Possible injury	7.52	10.38	0	81	12174	19.6
Non-incapacitating injury	5.67	7.57	0	66	9187	14.8
Incapacitating injury	1.58	2.37	0	17	2560	4.1
Fatal	0.27	0.62	0	5	431	0.7
Total	38.40	49.81	0	391	62172	100.0
Weekday morning peak (7-9am)	3.89	6.18	0	56	6292	10.1
Weekday off peak (9am-4pm)	11.57	15.52	0	140	18731	30.1
Weekday evening peak (4-6pm)	5.29	7.99	0	71	8560	13.8
Weekday nighttime (6pm-7am)	8.91	11.89	0	89	14423	23.2
Weekend daytime (7am-6pm)	4.75	6.89	0	74	7685	12.4
Weekend nighttime (6pm-7am)	3.98	5.24	0	47	6440	10.4
DUI	1.63	2.28	0	16	2644	4.3
Fog	0.24	0.58	0	6	384	0.6
Cloud	7.41	10.66	0	85	11997	19.3
Rain	4.11	7.38	0	94	6646	10.7
Clear	25.60	31.91	0	248	41451	66.7
Single vehicle	7.07	10.50	0	95	11439	18.4
Multiple vehicle	30.09	41.60	0	357	48710	78.3
Pedestrian	0.65	1.17	0	10	1047	1.7
Bicycle	0.61	1.35	0	15	981	1.6

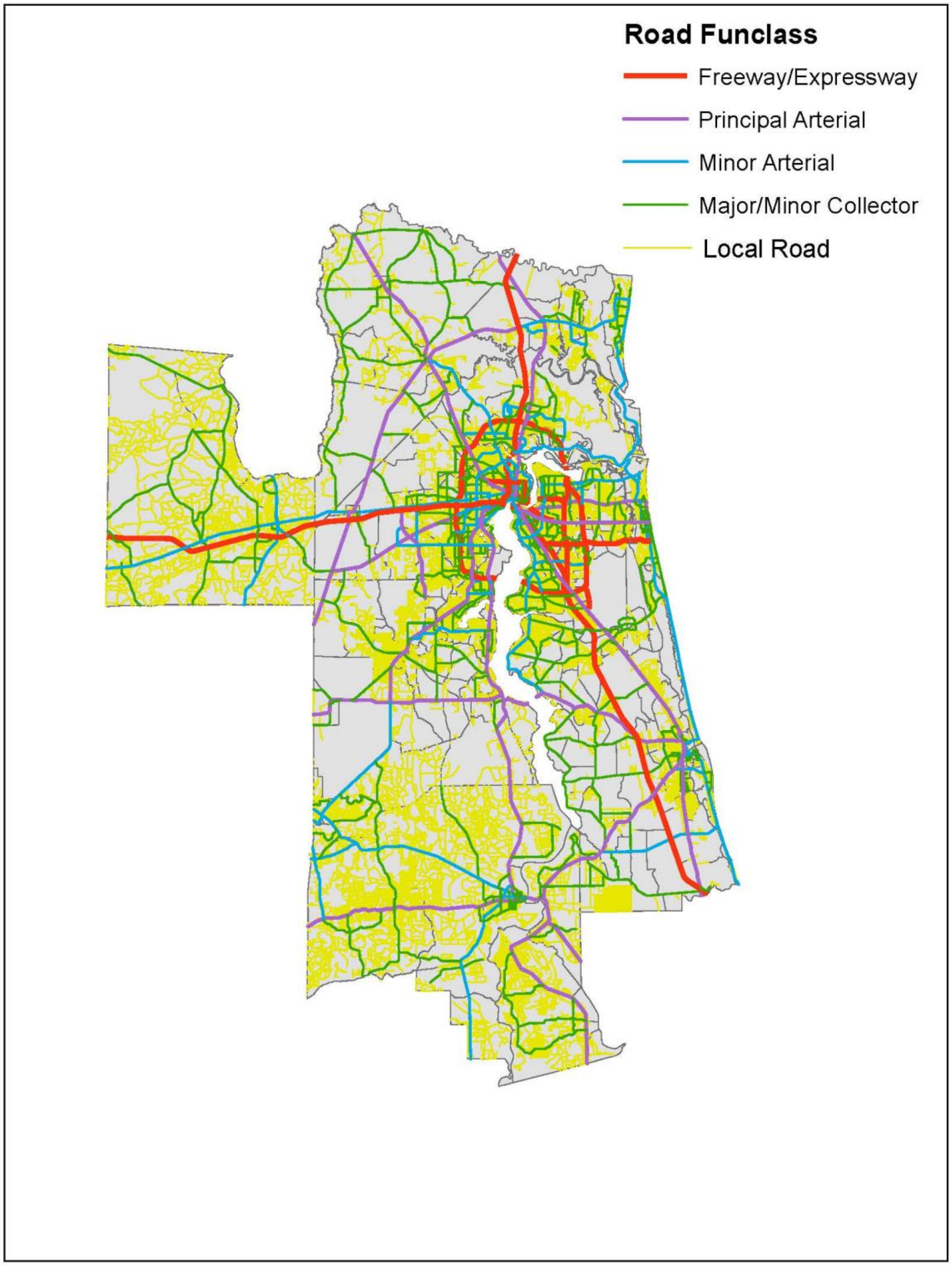


Figure 3-5 Roadways by functional classifications in RTAZ 2-1

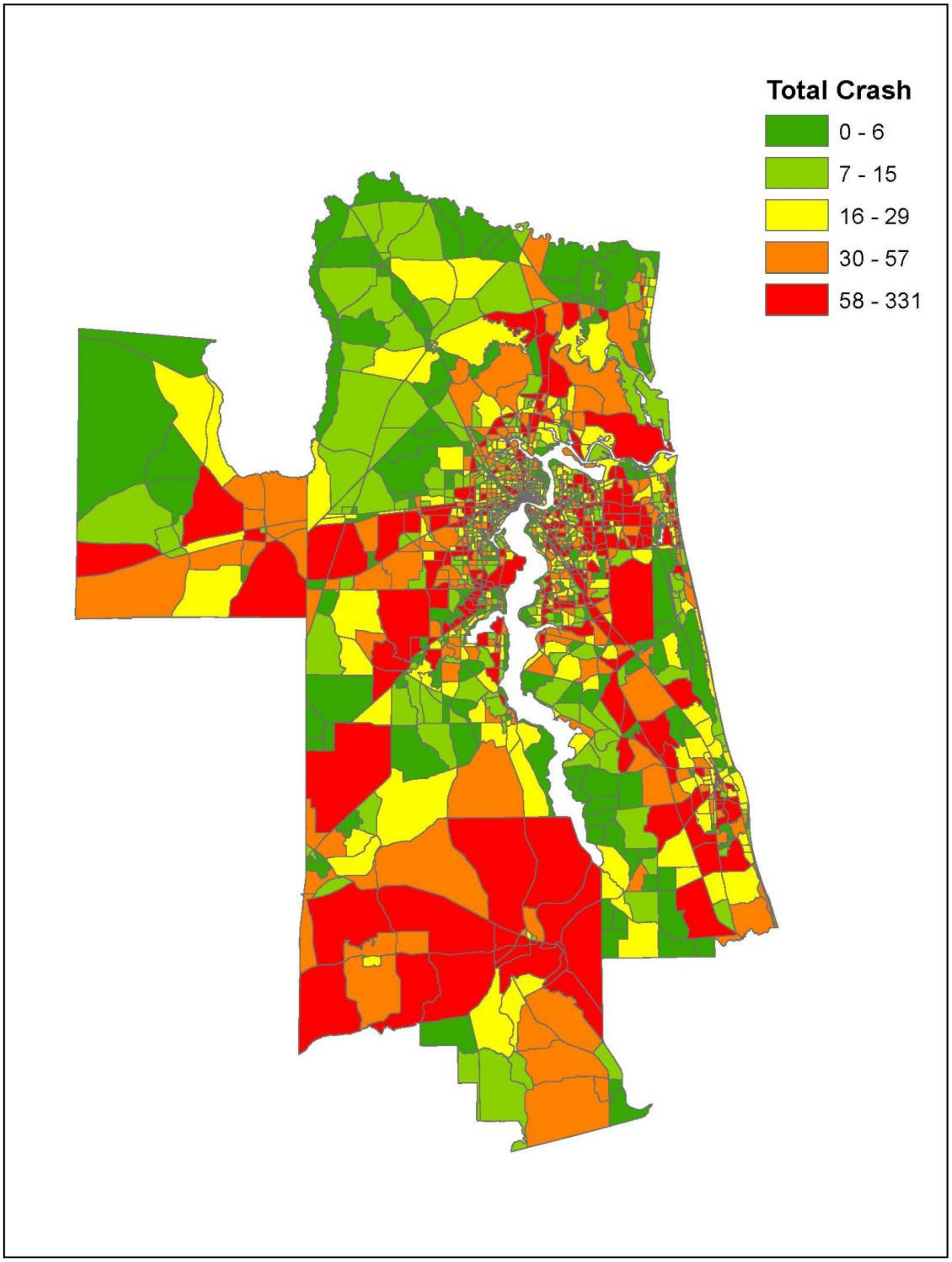


Figure 3-6 Spatial distributions of total crashes in RTAZ 2-1

3.1.3 Regional traffic analysis zone 2-2

RTAZ 2-2 only contains Alachua County. The location of RTAZ 2-2 is shown in Figure 3-7. Descriptive statistics for roadway and crash variables are presented in Tables 3-5 and 3-6, respectively. Furthermore, Figures 3-8 and 3-9 exhibit roadways by functional classifications and spatial distribution of total crashes in RTAZ 2-2.

Figure 3-7 Location of RTAZ 2-2

Table 3-5 Descriptive statistics for roadway variables in RTAZ 2-2

Variables	Mean	Stdev	Min	Max
Area (mi^2)	1.730	3.519	0.008	28.229
Total road length (mi)	4.107	4.117	0	27.495
Road density (mi/mi^2)	10.887	10.918	0	54.594
Proportion of freeway/expressway	0.013	0.064	0	0.494
Proportion of principle arterial	0.080	0.152	0	0.982
Proportion of minor arterial	0.051	0.125	0	0.945
Proportion of collector road	0.196	0.250	0	1.000
Proportion of local road	0.639	0.284	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.605	0.316	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.211	0.234	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.160	0.250	0	1.000
Number of intersection per mile	12.855	254.777	0	6030.718
Number of signal per mile	2.166	42.482	0	1005.120
Number of intersection per square mile	35.282	81.446	0	723.880
Number of signal per square mile	8.356	40.199	0	481.459
Daily vehicle miles traveled	11220.045	20215.923	0	245968.300
Proportion of daily heavy vehicle miles travel	0.049	0.056	0	0.312
Urban dummy (1=urban, 0=rural)	0.616	0.487	0	1.000

Table 3-6 Descriptive statistics for crashes in RTAZ 2-2

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	19.67	33.23	0	296	11017	65.5
Possible injury	5.23	9.23	0	96	2928	17.4
Non-incapacitating injury	3.61	5.67	0	45	2023	12.0
Incapacitating injury	1.23	1.90	0	14	688	4.1
Fatal	0.13	0.41	0	4	71	0.4
Total	30.02	48.73	0	453	16809	100.0
Weekday morning peak (7-9am)	2.69	4.78	0	42	1504	8.9
Weekday off peak (9am-4pm)	10.20	17.72	0	155	5712	34.0
Weekday evening peak (4-6pm)	4.62	8.34	0	66	2585	15.4
Weekday nighttime (6pm-7am)	6.19	10.26	0	101	3468	20.6
Weekend daytime (7am-6pm)	3.70	6.74	0	78	2074	12.3
Weekend nighttime (6pm-7am)	2.62	4.46	0	48	1466	8.7
DUI	0.79	1.26	0	8	443	2.6
Fog	0.15	0.47	0	6	86	0.5
Cloud	4.88	9.05	0	86	2734	16.3
Rain	3.15	6.48	0	60	1763	10.5
Clear	21.42	34.54	0	311	11996	71.4
Single vehicle	3.94	7.23	0	73	2206	13.1
Multiple vehicle	25.06	44.59	0	394	14031	83.5
Pedestrian	0.42	1.00	0	10	235	1.4
Bicycle	0.60	1.33	0	10	338	2.0

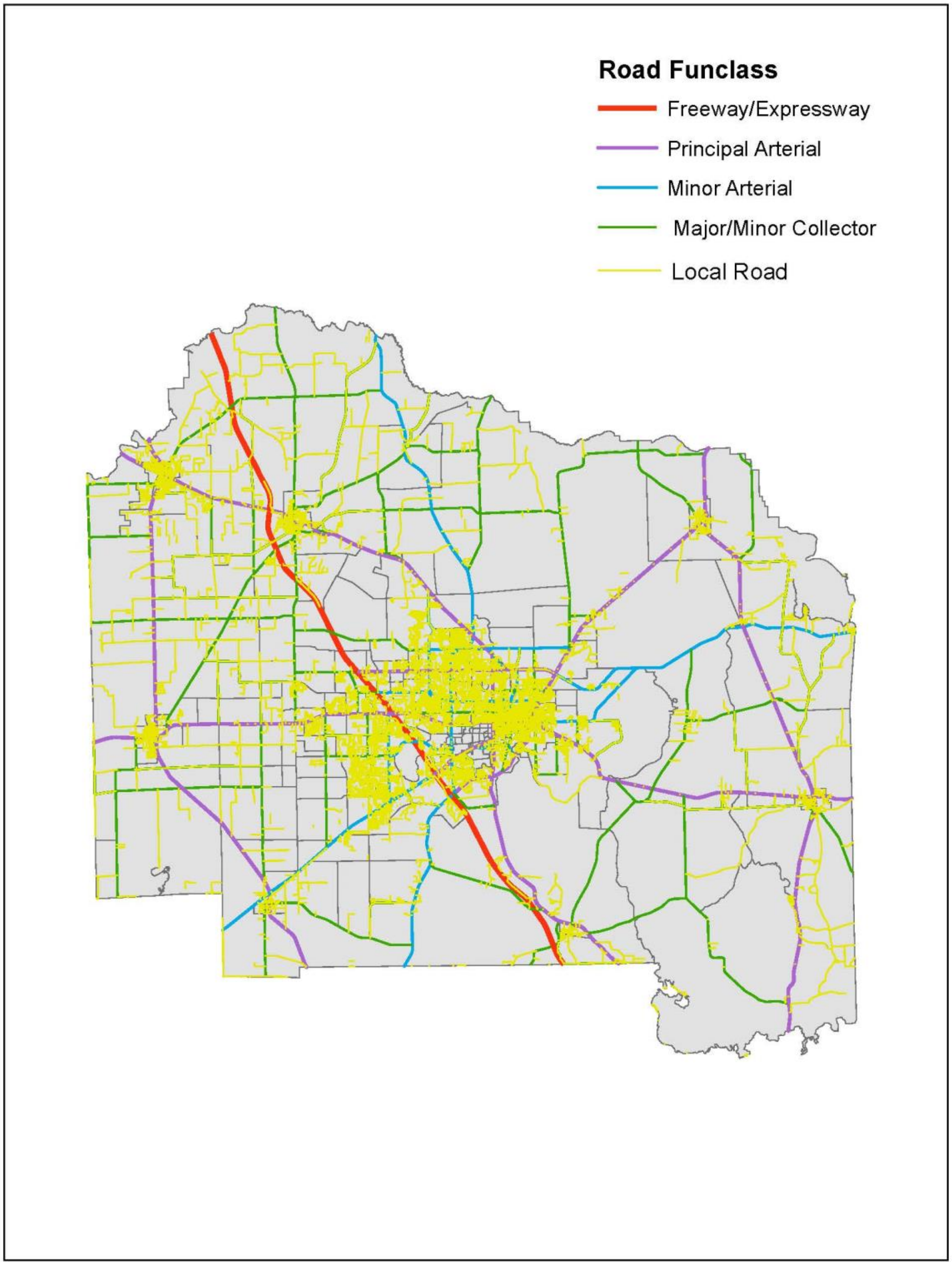


Figure 3-8 Roadways by functional classifications in RTAZ 2-2

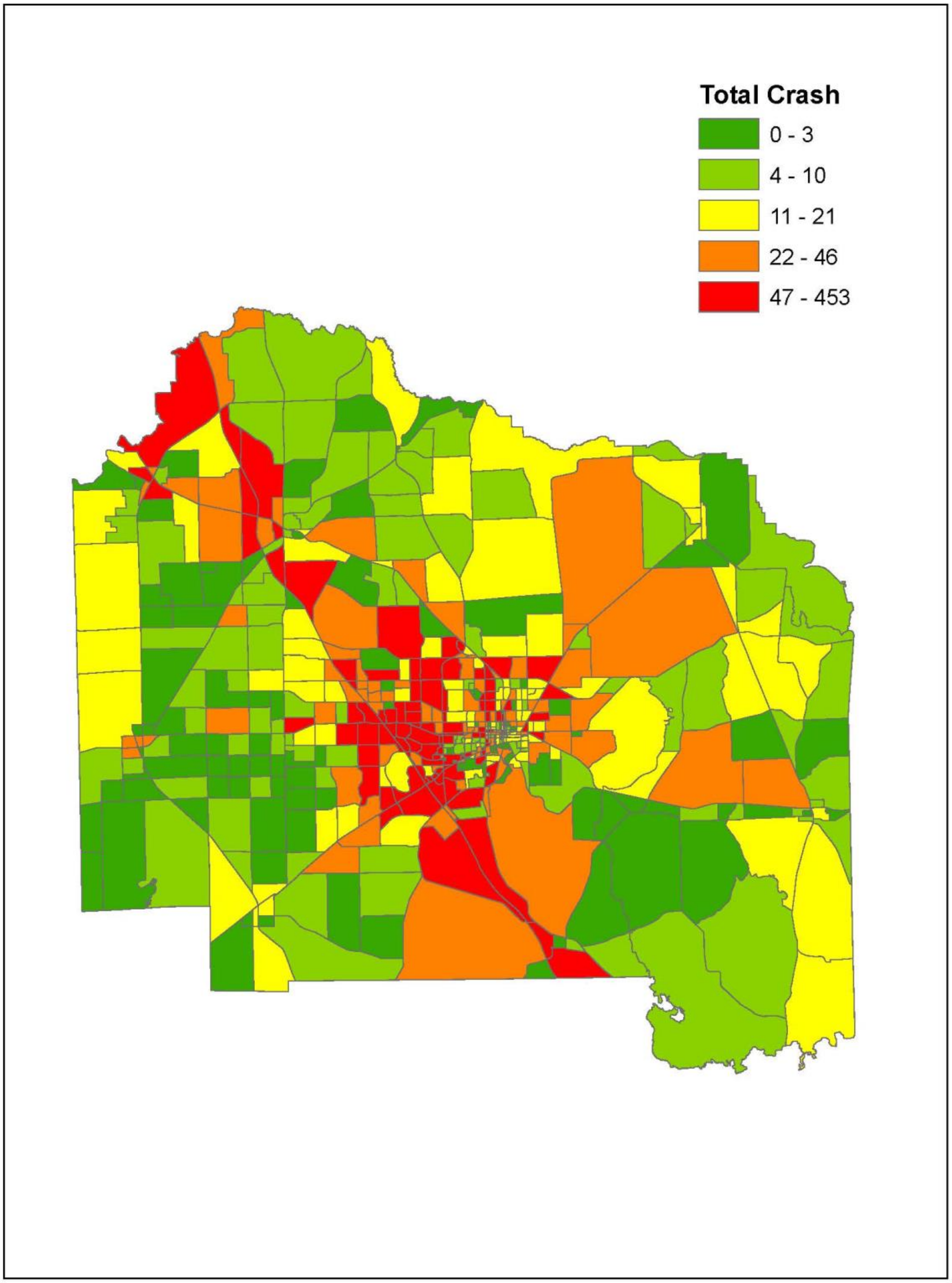


Figure 3-9 Spatial distributions of total crashes in RTAZ 2-2

3.1.4 Regional traffic analysis zone 3-1

RTAZ 3-1 covers 4 counties in the Capital region in District 3: Leon, Gadsden, Wakulla, and Jefferson counties. The location of RTAZ 3-1 is presented in Figure 3-10. Descriptive statistics for roadway and crash variables are presented in Tables 3-7 and 3-8, respectively. In addition, Figures 3-11 and 3-12 display roadways by functional classifications and spatial distribution of total crashes in RTAZ 3-1.

Figure 3-10 Location of RTAZ 3-1

Table 3-7 Descriptive statistics for roadway variables in RTAZ 3-1

Variables	Mean	Stdev	Min	Max
Area (mi^2)	1.877	5.883	0.002	109.116
Total road length (mi)	4.323	8.356	0	130.105
Road density (mi/mi^2)	12.582	11.706	0	83.246
Proportion of freeway/expressway	0.011	0.061	0	0.823
Proportion of principle arterial	0.050	0.125	0	1.000
Proportion of minor arterial	0.092	0.191	0	1.000
Proportion of collector road	0.132	0.212	0	1.000
Proportion of local road	0.691	0.293	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.698	0.318	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.200	0.264	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.077	0.179	0	1.000
Number of intersection per mile	3.314	6.326	0	102.470
Number of signal per mile	0.319	1.567	0	25.690
Number of intersection per square mile	60.940	143.167	0	1577.309
Number of signal per square mile	7.381	39.860	0	701.026
Daily vehicle miles traveled	6233	10653	0	130329
Proportion of daily heavy vehicle miles travel	0.055	0.055	0	0.344
Urban dummy (1=urban, 0=rural)	0.686	0.464	0	1.000

Table 3-8 Descriptive statistics for crashes in RTAZ 3-1

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	7.71	12.08	0	126	10088	56.3
Possible injury	2.88	5.09	0	54	3776	21.1
Non-incapacitating injury	2.15	3.48	0	35	2810	15.7
Incapacitating injury	0.56	1.05	0	12	728	4.1
Fatal	0.12	0.37	0	4	154	0.9
Total	13.68	20.63	0	187	17903	100.0
Weekday morning peak (7-9am)	1.05	1.91	0	18	1371	7.7
Weekday off peak (9am-4pm)	3.82	6.68	0	60	4999	27.9
Weekday evening peak (4-6pm)	1.84	3.45	0	37	2409	13.5
Weekday nighttime (6pm-7am)	3.69	5.73	0	57	4825	27.0
Weekend daytime (7am-6pm)	1.54	2.48	0	19	2015	11.3
Weekend nighttime (6pm-7am)	1.74	2.85	0	27	2273	12.7
DUI	0.62	1.12	0	10	814	4.5
Fog	0.11	0.37	0	3	147	0.8
Cloud	2.21	3.76	0	40	2893	16.2
Rain	1.60	3.20	0	51	2095	11.7
Clear	9.59	14.61	0	142	12549	70.1
Single vehicle	3.11	4.69	0	46	4066	22.7
Multiple vehicle	10.18	17.99	0	165	13328	74.4
Pedestrian	0.25	0.70	0	7	325	1.8
Bicycle	0.14	0.51	0	9	185	1.0

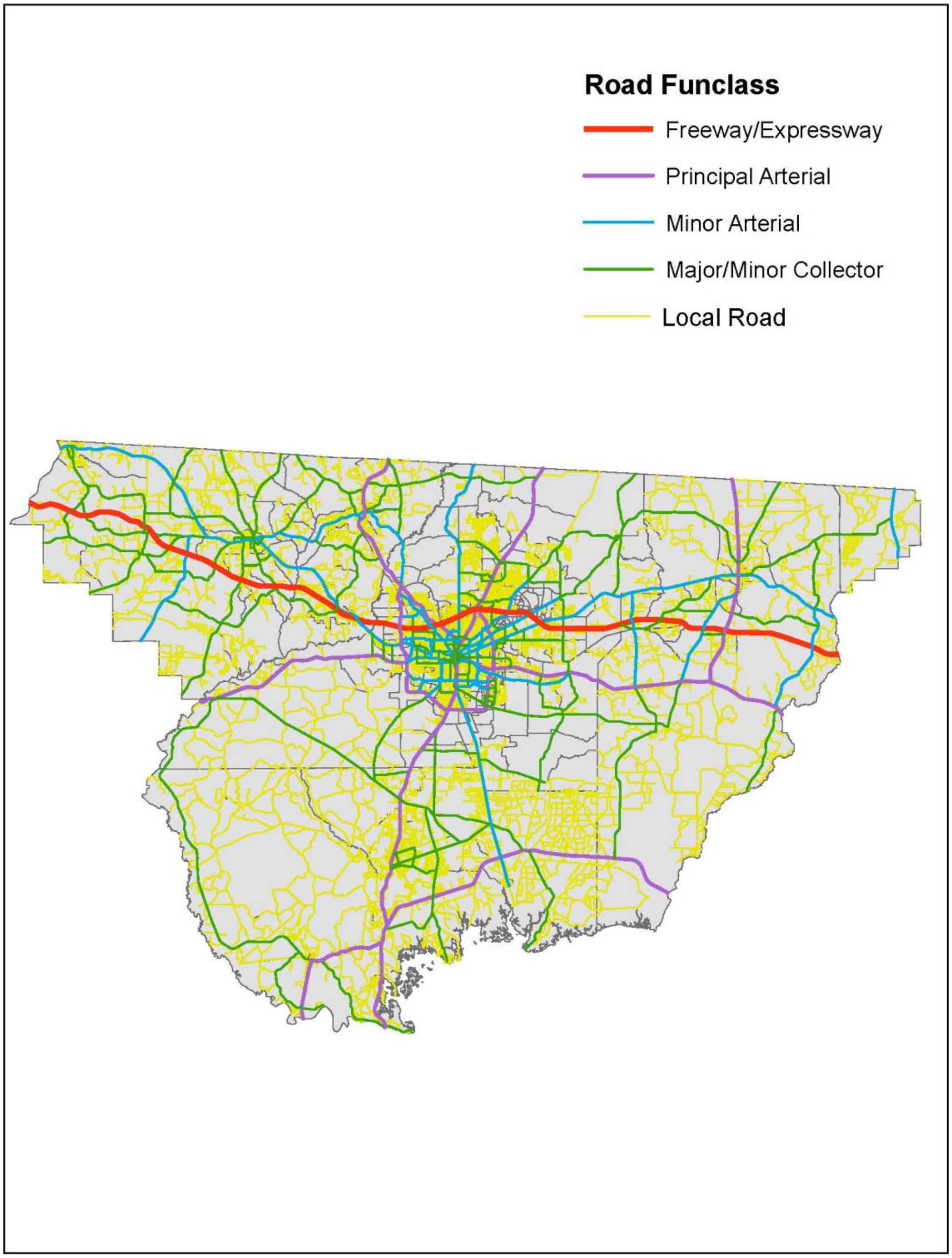


Figure 3-11 Roadways by functional classifications in RTAZ 3-1

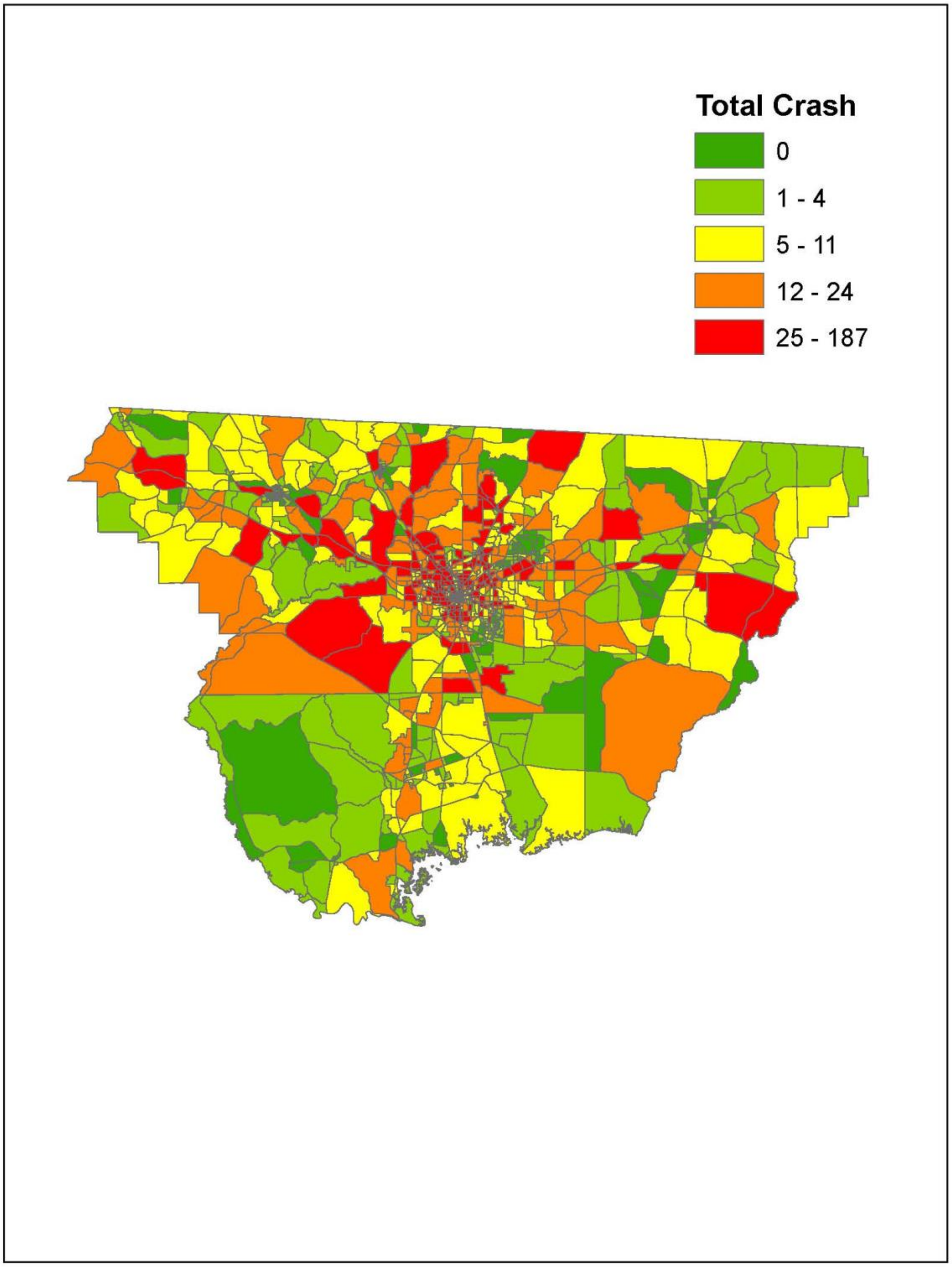


Figure 3-12 Spatial distributions of total crashes in RTAZ 3-1

3.1.5 Regional traffic analysis zone 3-2

RTAZ 3-2 contains 11 counties in the northwestern area in District 3: Bay, Calhoun, Escambia, Franklin, Gulf, Holmes, Jackson, Okaloosa, Santa Rosa, Walton, and Washington counties. The location of RTAZ 3-2 is presented in Figure 3-13. Descriptive statistics for roadway and crash variables are presented in Tables 3-9 and 3-10, respectively. In addition, Figures 3-14 and 3-15 demonstrate roadways by functional classifications and spatial distribution of total crashes in RTAZ 3-2.

Figure 3-13 Location of RTAZ 3-2

Table 3-9 Descriptive statistics for roadway variables in RTAZ 3-2

Variables	Mean	Stdev	Min	Max
Area (mi^2)	6.044	16.882	0.007	349.303
Total road length (mi)	15.988	28.492	0	485.286
Road density (mi/mi^2)	10.925	8.628	0	50.648
Proportion of freeway/expressway	0.007	0.029	0	0.277
Proportion of principle arterial	0.056	0.126	0	0.976
Proportion of minor arterial	0.059	0.116	0	1.000
Proportion of collector road	0.090	0.137	0	1.000
Proportion of local road	0.786	0.192	0	1.000
Proportion of roadway length with low speed limit $\leq$ 30 mph	0.763	0.217	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.164	0.190	0	1.000
Proportion of roadway length with high speed limit $\geq$ 55 mph	0.070	0.133	0	0.998
Number of intersection per mile	2.498	2.852	0	32.961
Number of signal per mile	0.156	0.464	0	6.834
Number of intersection per square mile	38.490	62.637	0	541.126
Number of signal per square mile	2.744	9.845	0	122.492
Daily vehicle miles traveled	17629	29319	0	588715
Proportion of daily heavy vehicle miles travel	0.072	0.053	0	0.356
Urban dummy (1=urban, 0=rural)	0.681	0.466	0	1.000

Table 3-10 Descriptive statistics for crashes in RTAZ 3-2

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	23.19	37.20	0	458	31520	62.2
Possible injury	5.89	9.53	0	107	7998	15.8
Non-incapacitating injury	5.31	7.34	0	68	7212	14.2
Incapacitating injury	2.35	3.45	0	40	3189	6.3
Fatal	0.32	0.77	0	10	438	0.9
Total	37.30	54.56	0	560	50695	100.0
Weekday morning peak (7-9am)	2.87	4.74	0	44	3901	7.7
Weekday off peak (9am-4pm)	12.55	20.77	0	264	17052	33.6
Weekday evening peak (4-6pm)	5.16	9.12	0	86	7019	13.8
Weekday nighttime (6pm-7am)	7.78	10.75	0	99	10577	20.9
Weekend daytime (7am-6pm)	5.04	7.72	0	73	6848	13.5
Weekend nighttime (6pm-7am)	3.90	5.29	0	50	5294	10.4
DUI	2.18	3.05	0	22	2967	5.9
Fog	0.37	0.78	0	7	500	1.0
Cloud	7.28	12.07	0	110	9896	19.5
Rain	3.74	6.58	0	75	5081	10.0
Clear	25.33	36.89	0	382	34420	67.9
Single vehicle	7.12	9.21	0	117	9675	19.1
Multiple vehicle	29.24	48.70	0	523	39742	78.4
Pedestrian	0.51	1.07	0	10	692	1.4
Bicycle	0.43	0.96	0	9	588	1.2

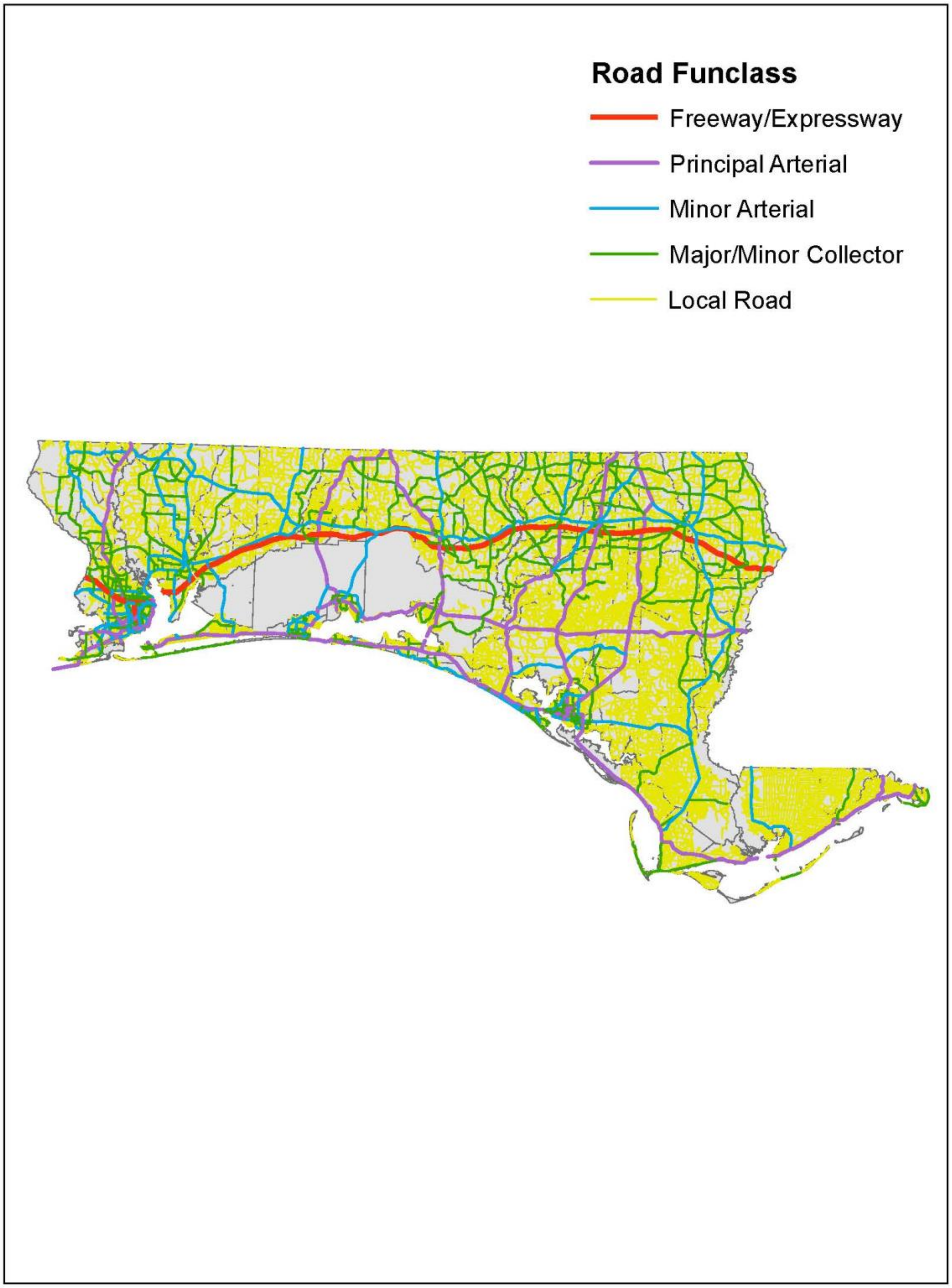


Figure 3-14 Roadways by functional classifications in RTAZ 3-2

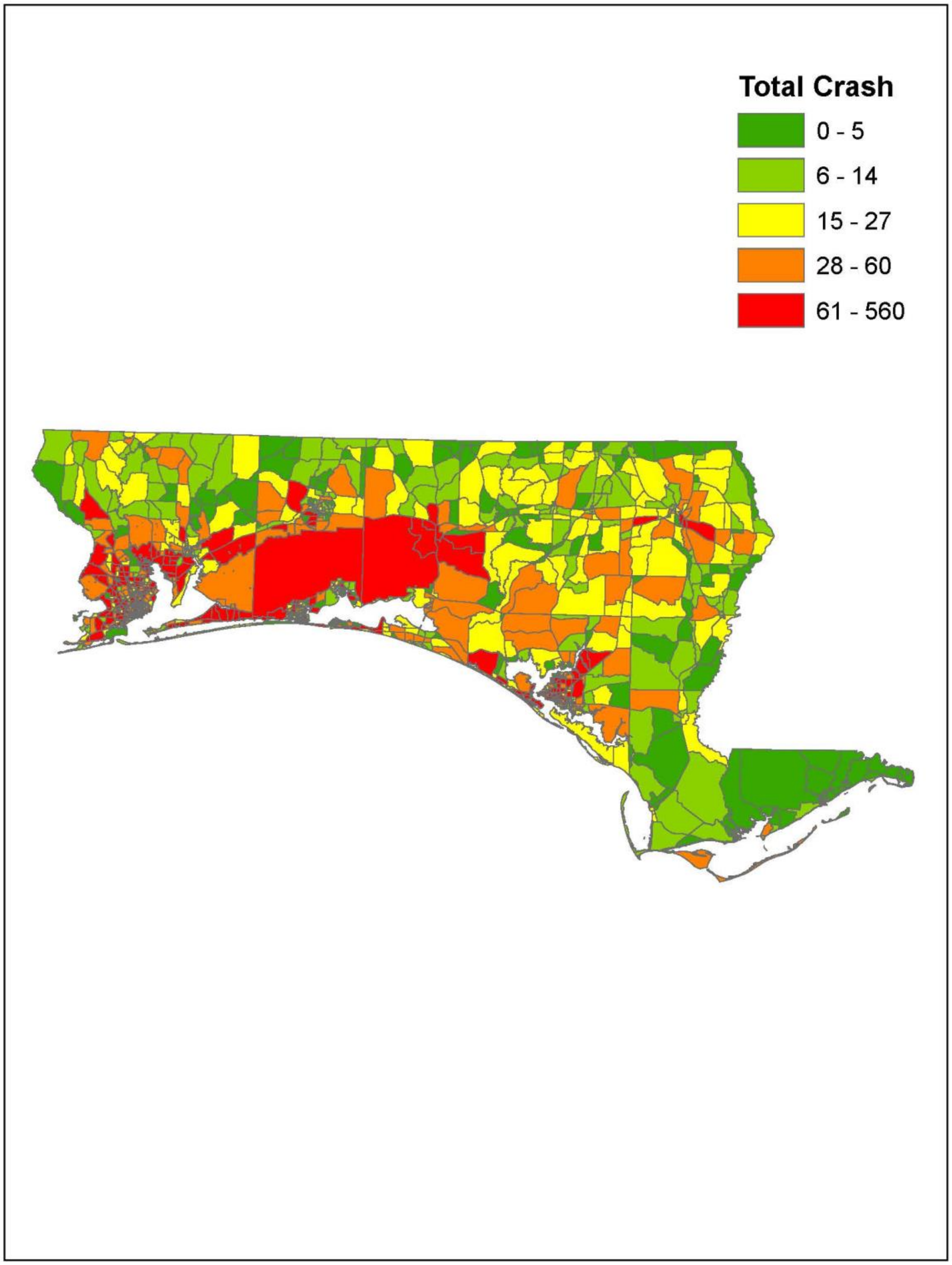


Figure 3-15 Spatial distributions of total crashes in RTAZ 3-2

3.1.6 Regional traffic analysis zone 4

RTAZ 4 is located in the Southeastern Florida in District 4. RTAZ 4 includes 5 counties in District 4: Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties as shown in Figure 3-16. Descriptive statistics for roadway and crash variables are summarized in Tables 3-11 and 3-12, respectively. Besides, Figures 3-17 and 3-18 present roadways by functional classifications and spatial distribution of total crashes in RTAZ 4.

Figure 3-16 Location of RTAZ 4

Table 3-11 Descriptive statistics for roadway variables in RTAZ 4

Variables	Mean	Stdev	Min	Max
Area (mi^2)	1.784	10.683	0.003	235.684
Total road length (mi)	5.472	7.281	0	103.969
Road density (mi/mi^2)	13.495	8.724	0	52.354
Proportion of freeway/expressway	0.013	0.055	0	0.626
Proportion of principle arterial	0.070	0.150	0	1.000
Proportion of minor arterial	0.076	0.164	0	1.000
Proportion of collector road	0.114	0.178	0	1.000
Proportion of local road	0.709	0.263	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.653	0.309	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.269	0.271	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.061	0.176	0	1.000
Number of intersection per mile	2.547	3.267	0	40.264
Number of signal per mile	0.202	0.731	0	13.421
Number of intersection per square mile	36.714	57.091	0	700.000
Number of signal per square mile	3.123	15.257	0	400.000
Daily vehicle miles traveled	17633	32210	0	529577
Proportion of daily heavy vehicle miles travel	0.053	0.045	0	0.412
Urban dummy (1=urban, 0=rural)	0.969	0.172	0	1.000

Table 3-12 Descriptive statistics for crashes in RTAZ 4

Crash variables	**Mean**	**Stdev**	**Min**	**Max**	**Sum**	**%**
Property damage only	15.37	25.77	0	309	37715	55.9
Possible injury	5.83	8.41	0	111	14304	21.2
Non-incapacitating injury	4.47	6.24	0	88	10958	16.2
Incapacitating injury	1.45	2.21	0	20	3570	5.3
Fatal	0.23	0.57	0	6	566	0.8
Total	27.52	40.14	0	529	67524	100.0
Weekday morning peak (7-9am)	2.48	5.00	0	73	6076	9.0
Weekday off peak (9am-4pm)	8.49	12.41	0	134	20836	30.9
Weekday evening peak (4-6pm)	3.51	6.45	0	111	8623	12.8
Weekday nighttime (6pm-7am)	6.52	9.64	0	139	16012	23.7
Weekend daytime (7am-6pm)	3.46	5.44	0	54	8501	12.6
Weekend nighttime (6pm-7am)	3.05	4.63	0	45	7474	11.1
DUI	1.31	2.08	0	22	3206	4.7
Fog	0.05	0.27	0	4	125	0.2
Cloud	5.22	11.52	0	190	12804	19.0
Rain	2.95	7.07	0	146	7231	10.7
Clear	17.67	23.57	0	260	43352	64.2
Single vehicle	5.20	10.40	0	124	12763	18.9
Multiple vehicle	21.04	31.48	0	427	51632	76.5
Pedestrian	0.60	1.13	0	14	1463	2.2
Bicycle	0.68	1.32	0	15	1673	2.5

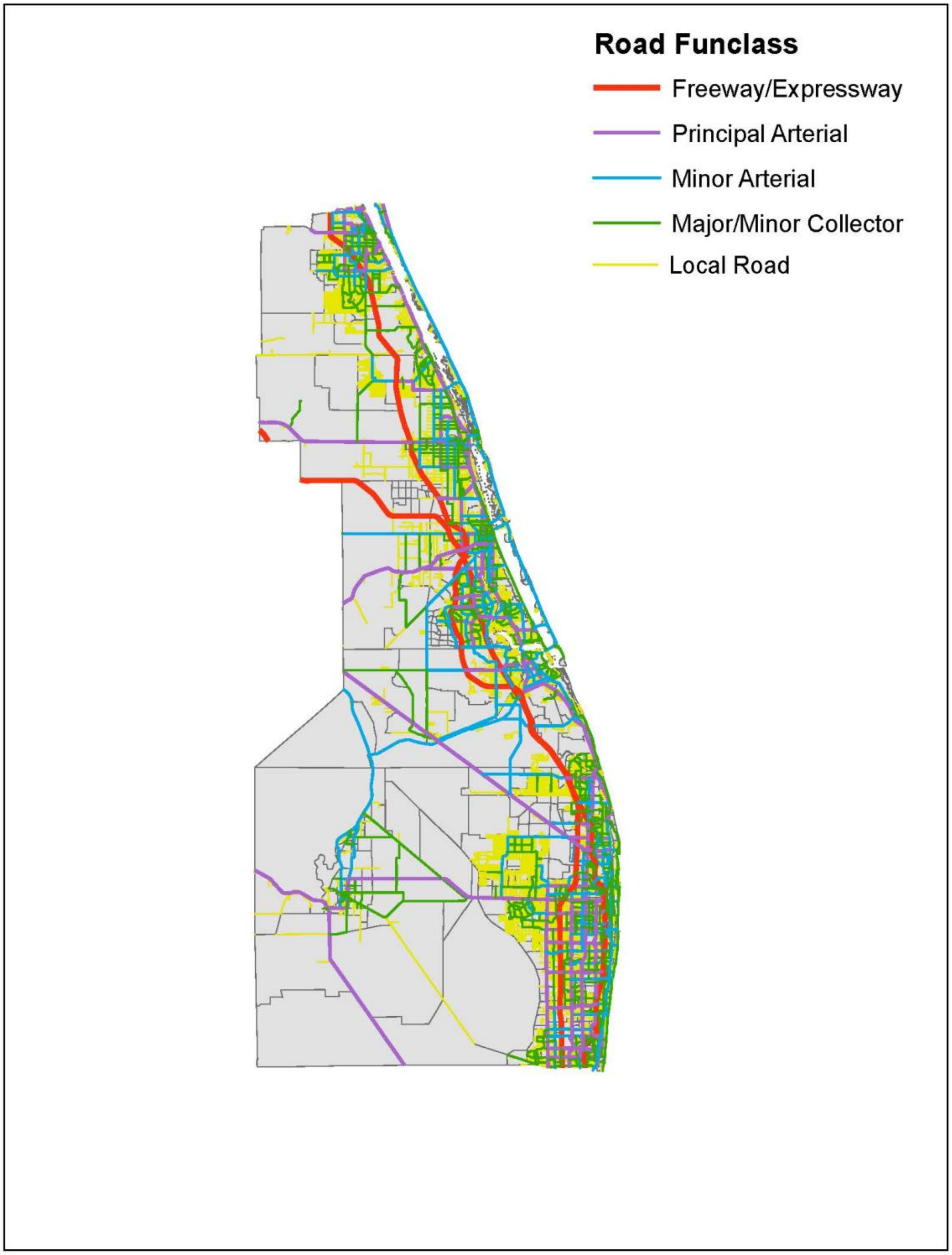


Figure 3-17 Roadways by functional classifications in RTAZ 4

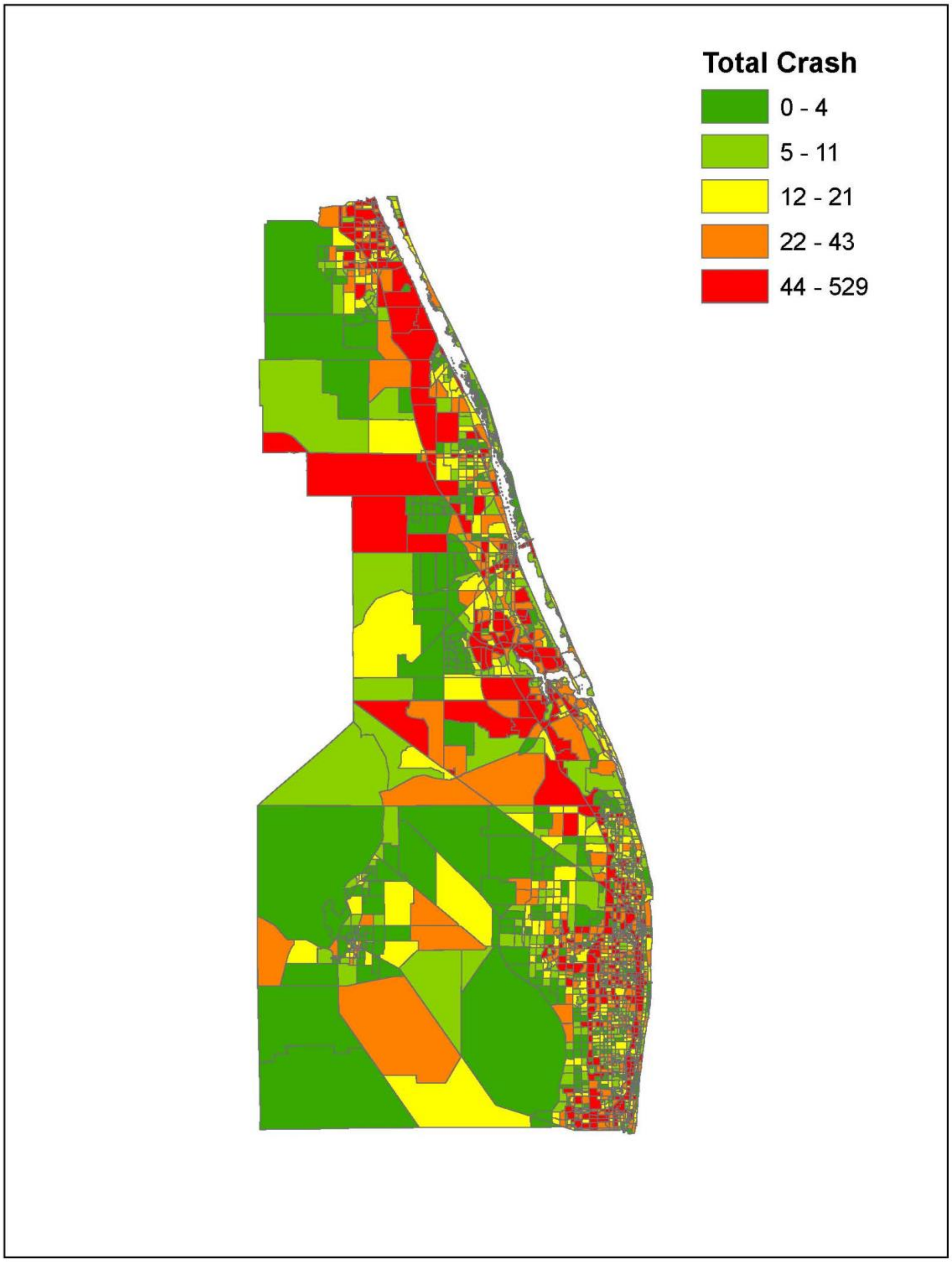


Figure 3-18 Spatial distributions of total crashes in RTAZ 4

3.1.7 Regional traffic analysis zone 5

RTAZ 5 covers 4 counties in the Central Florida region, including Orange, Seminole, Osceola, Lake, and Volusia counties in District 5. The location of RTAZ 5 is presented in Figure 3-19. Descriptive statistics for roadway and crash variables are presented in Tables 3-13 and 3-14, respectively. In addition, Figures 3-20 and 3-21 display roadways by functional classifications and spatial distribution of total crashes in RTAZ 5.

Figure 3-19 Location of RTAZ 5

Table 3-13 Descriptive statistics for roadway variables in RTAZ 5

Variables	Mean	Stdev	Min	Max
Area (mi^2)	2.301	8.641	0.008	170.302
Total road length (mi)	8.192	9.430	0	148.314
Road density (mi/mi^2)	11.684	7.833	0	50.335
Proportion of freeway/expressway	0.022	0.070	0	0.813
Proportion of principle arterial	0.054	0.109	0	1.000
Proportion of minor arterial	0.052	0.111	0	1.000
Proportion of collector road	0.121	0.152	0	1.000
Proportion of local road	0.746	0.202	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.700	0.264	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.205	0.206	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.090	0.175	0	1.000
Number of intersection per mile	1.913	2.034	0	17.535
Number of signal per mile	0.123	0.316	0	2.918
Number of intersection per square mile	28.163	45.750	0	510.204
Number of signal per square mile	2.025	6.787	0	118.180
Daily vehicle miles traveled	24182	39918	0	651571
Proportion of daily heavy vehicle miles travel	0.071	0.050	0	0.294
Urban dummy (1=urban, 0=rural)	0.925	0.264	0	1.000

Table 3-14 Descriptive statistics for crashes in RTAZ 5

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	38.31	57.73	0	566	77696	64.6
Possible injury	10.09	14.69	0	139	20455	17.0
Non-incapacitating injury	8.07	10.98	0	108	16357	13.6
Incapacitating injury	1.95	2.73	0	23	3955	3.3
Fatal	0.38	0.79	0	8	769	0.6
Total	59.33	83.99	0	761	120329	100.0
Weekday morning peak (7-9am)	4.48	6.91	0	87	9080	7.5
Weekday off peak (9am-4pm)	15.88	23.91	0	281	32206	26.8
Weekday evening peak (4-6pm)	7.10	11.15	0	113	14408	12.0
Weekday nighttime (6pm-7am)	18.22	27.29	0	204	36951	30.7
Weekend daytime (7am-6pm)	6.76	10.66	0	118	13710	11.4
Weekend nighttime (6pm-7am)	6.89	10.09	0	80	13964	11.6
DUI	1.80	2.53	0	23	3658	3.0
Fog	0.21	0.57	0	10	429	0.4
Cloud	9.71	16.18	0	205	19697	16.4
Rain	5.64	9.57	0	121	11437	9.5
Clear	41.98	58.73	0	517	85139	70.8
Single vehicle	7.64	11.27	0	143	15497	12.9
Multiple vehicle	45.65	70.27	0	676	92581	76.9
Pedestrian	0.93	1.62	0	17	1887	1.6
Bicycle	0.80	1.57	0	18	1622	1.3

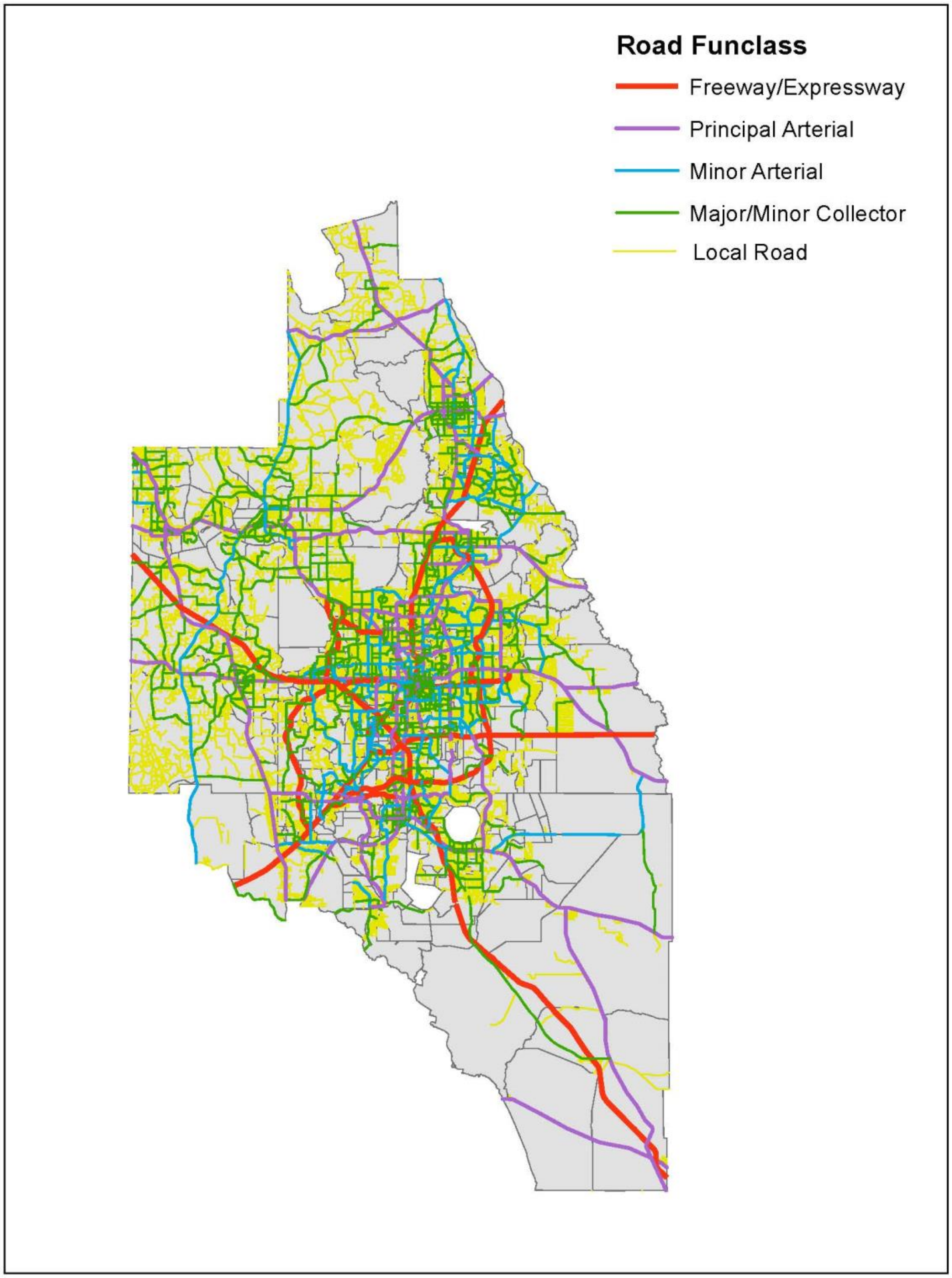


Figure 3-20 Roadways by functional classifications in RTAZ 5

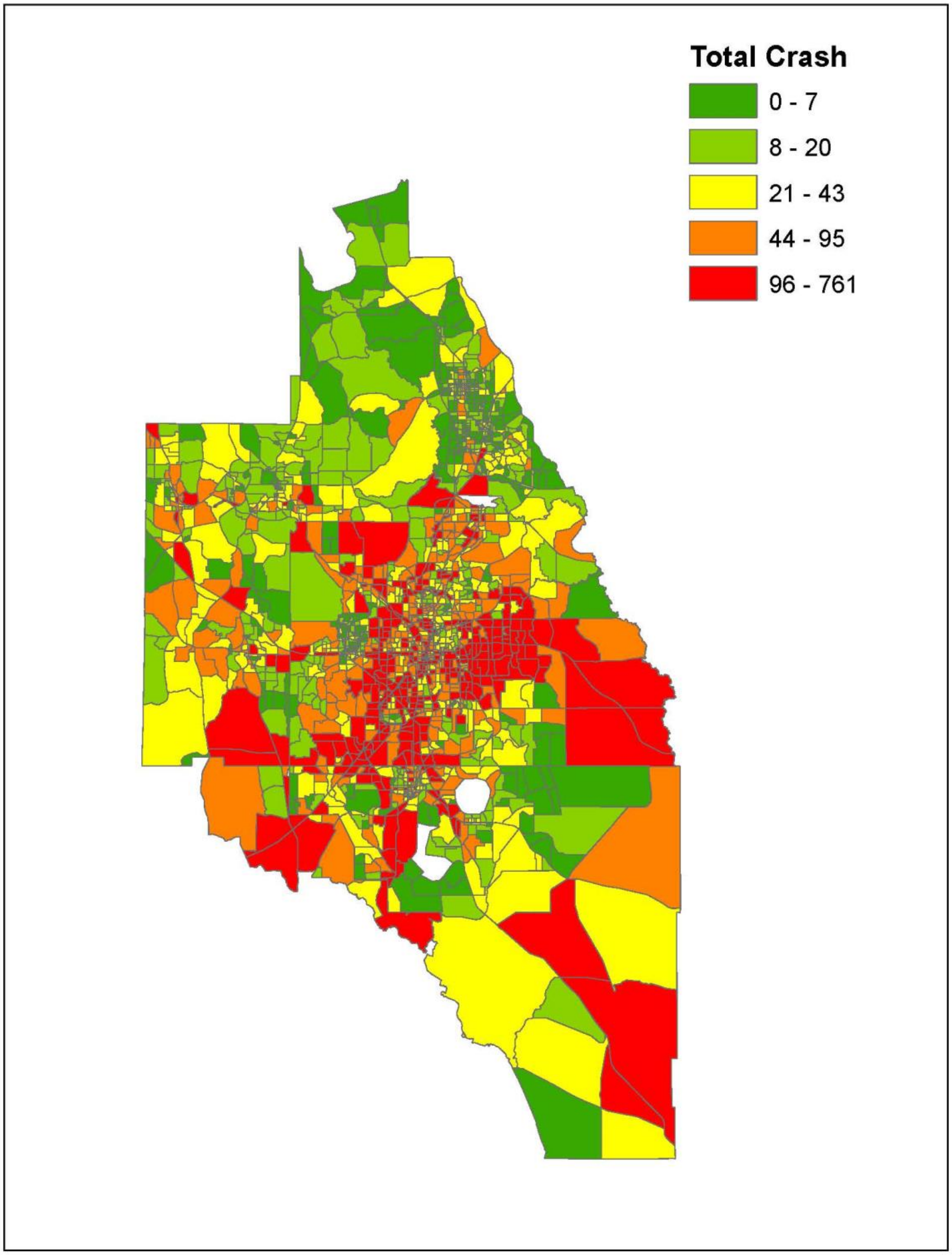


Figure 3-21 Spatial distributions of total crashes in RTAZ 5

3.1.8 Regional traffic analysis zone 6

RTAZ 6 contains Broward and Miami-Dade counties. RTAZ 6 is located in the most Southeastern area in District 6 as shown in Figure 3-22. Descriptive statistics for roadway and crash variables are presented in Tables 3-15 and 3-16, respectively. Furthermore, Figures 3-23 and 3-24 exhibit roadways by functional classifications and spatial distribution of total crashes in RTAZ 6.

Figure 3-22 Location of RTAZ 6

Table 3-15 Descriptive statistics for roadway variables in RTAZ 6

Variables	Mean	Stdev	Min	Max
Area (mi^2)	0.431	0.819	0.003	26.248
Total road length (mi)	6.148	4.733	0.000	41.710
Road density (mi/mi^2)	20.233	9.447	0	74.447
Proportion of freeway/expressway	0.017	0.051	0	0.811
Proportion of principle arterial	0.050	0.101	0	0.995
Proportion of minor arterial	0.057	0.090	0	0.831
Proportion of collector road	0.084	0.117	0	1.000
Proportion of local road	0.762	0.207	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.748	0.223	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.210	0.190	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.039	0.102	0	0.988
Number of intersection per mile	2.710	3.781	0	141.980
Number of signal per mile	0.268	0.636	0	7.298
Number of intersection per square mile	57.844	70.663	0	873.003
Number of signal per square mile	6.338	18.603	0	352.456
Daily vehicle miles traveled	27030	41754	0	512287
Proportion of daily heavy vehicle miles travel	0.052	0.043	0	0.779
Urban dummy (1=urban, 0=rural)	0.989	0.102	0	1.000

Table 3-16 Descriptive statistics for crashes in RTAZ 6

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	81.54	92.08	0	643	200516	69.8
Possible injury	19.89	23.27	0	178	48911	17.0
Non-incapacitating injury	10.49	11.41	0	107	25785	9.0
Incapacitating injury	3.54	5.54	0	96	8697	3.0
Fatal	0.44	0.81	0	9	1094	0.4
Total	116.81	125.38	0	847	287236	100.0
Weekday morning peak (7-9am)	10.46	13.06	0	131	25727	9.0
Weekday off peak (9am-4pm)	35.28	40.14	0	318	86752	30.2
Weekday evening peak (4-6pm)	14.00	16.27	0	151	34435	12.0
Weekday nighttime (6pm-7am)	29.91	32.91	0	277	73554	25.6
Weekend daytime (7am-6pm)	14.34	16.44	0	163	35262	12.3
Weekend nighttime (6pm-7am)	12.77	14.77	0	127	31403	10.9
DUI	1.88	2.54	0	22	4615	1.6
Fog	0.07	0.29	0	4	180	0.1
Cloud	17.28	24.28	0	267	42495	14.8
Rain	11.23	15.27	0	242	27624	9.6
Clear	84.34	90.18	0	544	207401	72.2
Single vehicle	10.98	17.01	0	444	26995	9.4
Multiple vehicle	102.19	112.79	0	752	251276	87.5
Pedestrian	2.09	2.97	0	28	5143	1.8
Bicycle	1.56	2.22	0	23	3830	1.3

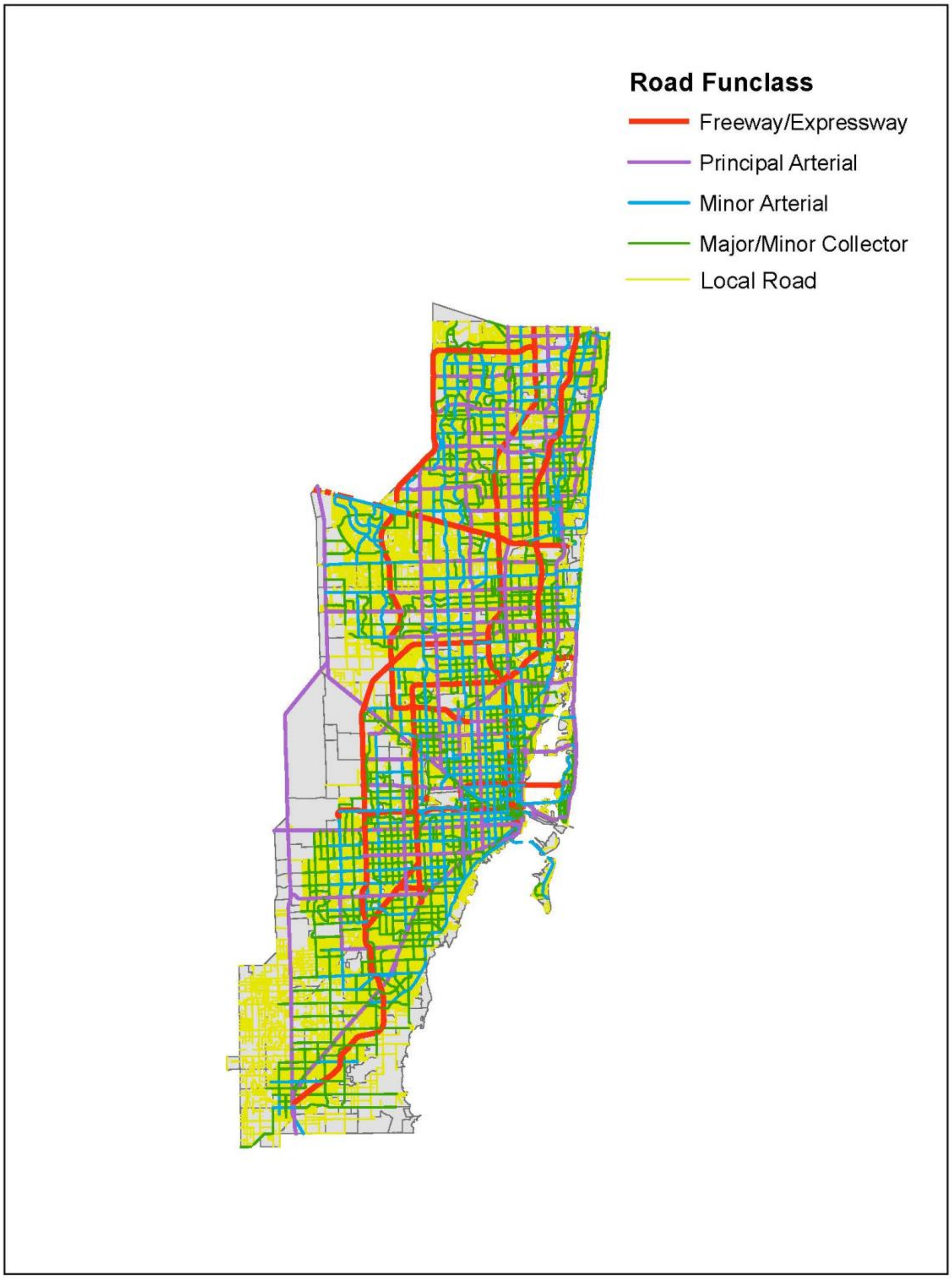


Figure 3-23 Roadways by functional classifications in RTAZ 6

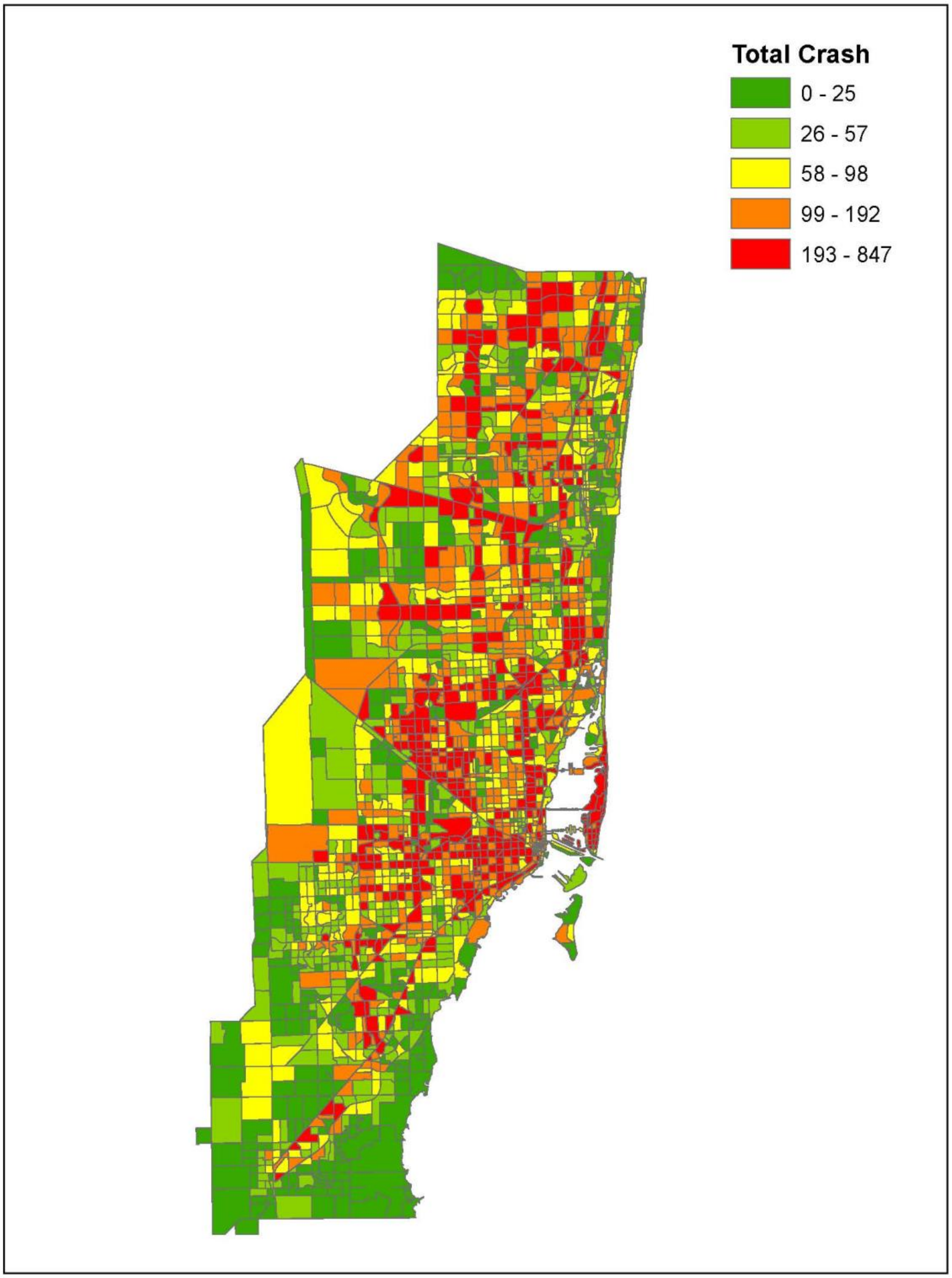


Figure 3-24 Spatial distributions of total crashes in RTAZ 6

3.1.9 Regional traffic analysis zone 7

RTAZ 7 includes 5 counties in District 7: Pinellas, Hillsborough, Pasco, Hernando, and Citrus counties as shown in Figure 3-25. Descriptive statistics for roadway and crash variables are summarized in Tables 3-17 and 3-18, respectively. Moreover, Figures 3-26 and 3-27 display roadways by functional classifications and spatial distribution of total crashes in RTAZ 7.

Figure 3-25 Location of RTAZ 7

Table 3-17 Descriptive statistics for roadway variables in RTAZ 7

Variables	Mean	Stdev	Min	Max
Area (mi^2)	1.382	3.648	0.006	75.707
Total road length (mi)	8.370	9.744	0	228.526
Road density (mi/mi^2)	14.530	9.818	0	99.552
Proportion of freeway/expressway	0.016	0.066	0	1.000
Proportion of principle arterial	0.055	0.118	0	0.998
Proportion of minor arterial	0.059	0.117	0	1.000
Proportion of collector road	0.084	0.120	0	1.000
Proportion of local road	0.781	0.193	0	1.000
Proportion of roadway length with low speed limit ≤ 30 mph	0.729	0.237	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.182	0.175	0	1.000
Proportion of roadway length with high speed limit ≥ 55 mph	0.086	0.175	0	1.000
Number of intersection per mile	2.184	2.473	0	30.210
Number of signal per mile	0.178	0.538	0	9.177
Number of intersection per square mile	41.274	77.652	0	1462.718
Number of signal per square mile	4.056	19.754	0	392.085
Daily vehicle miles traveled	23077	33952	0	403518
Proportion of daily heavy vehicle miles travel	0.049	0.034	0	0.272
Urban dummy (1=urban, 0=rural)	0.922	0.269	0	1.000

Table 3-18 Descriptive statistics for crashes in RTAZ 7

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	31.18	36.02	0	305	73900	54.4
Possible injury	12.21	14.52	0	117	28930	21.3
Non-incapacitating injury	8.77	9.29	0	81	20790	15.3
Incapacitating injury	4.19	5.10	0	40	9940	7.3
Fatal	0.44	0.82	0	8	1049	0.8
Total	57.28	62.20	0	533	135760	100.0
Weekday morning peak (7-9am)	5.25	7.26	0	69	12433	9.2
Weekday off peak (9am-4pm)	17.85	20.05	0	147	42302	31.2
Weekday evening peak (4-6pm)	7.79	10.26	0	110	18458	13.6
Weekday nighttime (6pm-7am)	13.56	15.22	0	132	32129	23.7
Weekend daytime (7am-6pm)	7.14	8.19	0	71	16918	12.5
Weekend nighttime (6pm-7am)	5.69	6.41	0	63	13483	9.9
DUI	2.69	3.13	0	31	6369	4.7
Fog	0.22	0.55	0	5	524	0.4
Cloud	9.47	12.47	0	118	22442	16.5
Rain	5.02	7.35	0	89	11899	8.8
Clear	41.89	44.75	0	417	99289	73.1
Single vehicle	8.18	10.46	0	129	19375	14.3
Multiple vehicle	46.77	54.28	0	442	110842	81.6
Pedestrian	1.10	1.79	0	20	2598	1.9
Bicycle	1.25	1.91	0	16	2954	2.2

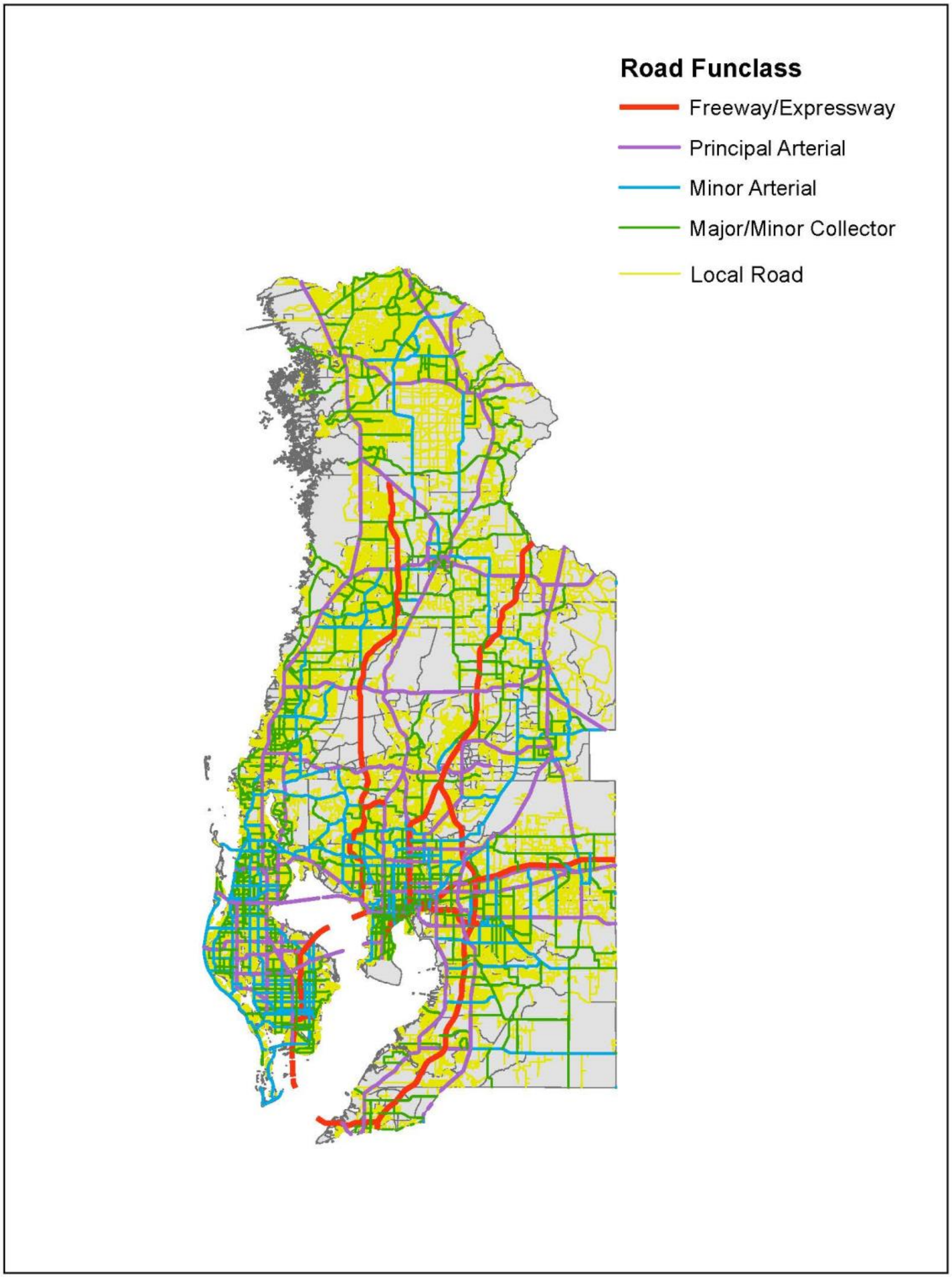


Figure 3-26 Roadways by functional classifications in RTAZ 7

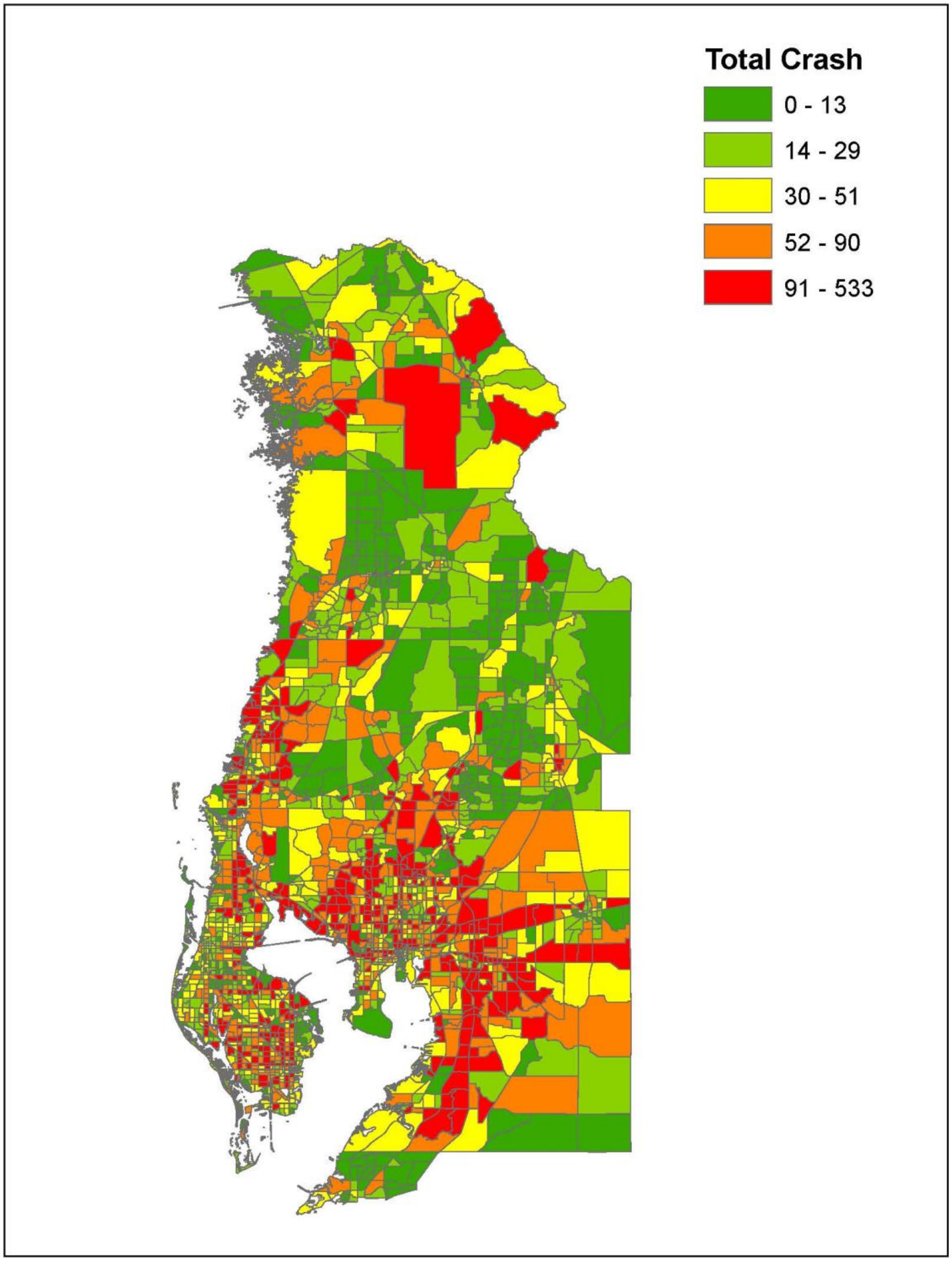


Figure 3-27 Spatial distributions of total crashes in RTAZ 7

3.2 Statewide TAZ (SWTAZ)

There are 8,518 SWTAZs in the Florida (Figure 3-28). SWTAZs cover the whole state and are used by FDOT Central Office for statewide long-term transportation plans. The collected data were processed based on SWTAZs and socio-demographic, roadway, and crash variables are summarized in Tables 3-19 to 3-21, respectively. Also, roadways by functional classifications and spatial distribution of total crashes are shown in Figures 3-29 and 3-30, correspondingly. SWTAZs will be used for developing Traffic safety analysis zones (TSAZs) in the following chapter.

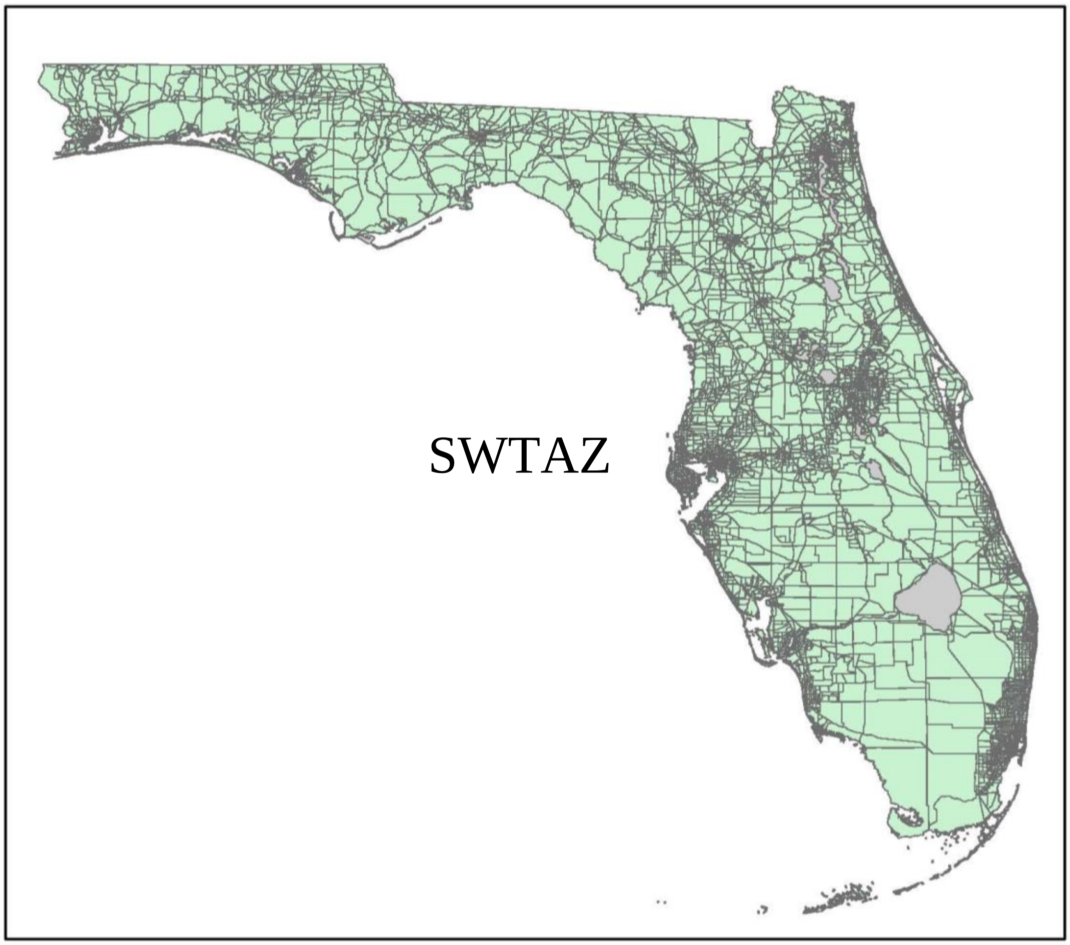


Figure 3-28 Statewide traffic analysis zone (SWTAZ)

Table 3-19 Descriptive statistics for socio-demographic variables in SWTAZ

Variables	Mean	Stdev	Min	Max
Total population	2172	3007	0	38980
Number of family unit	817	1147	0	18200
Proportion of the nonpermanent vacant	0.107	0.091	0	0.500
Proportion of the families vacant	0.071	0.068	0	0.500
Proportion of families have no vehicle	0.095	0.123	0	1.000
Proportion of families have 1 vehicle	0.372	0.146	0	1.000
Proportion of families have 2 or more vehicles	0.490	0.205	0	1.000
Number of HMT rooms per square mile	172.486	941.718	0	32610.839
Total employment	1140	1722	0	31931
Proportion of industry employment	0.176	0.232	0	1.000
Proportion of commercial employment	0.299	0.235	0	1.000
Proportion of service employment	0.492	0.259	0	1.000
School enrollments per square mile	775.020	5983.006	0	255140.358

Table 3-20 Descriptive statistics for roadway variables in SWTAZ

Variables	Mean	Stdev	Min	Max
Area (mi^2)	6.47	24.80	0	885.32
Road density	9.396	28.397	0	2496.049
Proportion of freeway/expressway	0.016	0.084	0	1.000
Proportion of principle arterial	0.104	0.202	0	1.000
Proportion of minor arterial	0.117	0.211	0	1.000
Proportion of collector road	0.191	0.246	0	1.000
Proportion of local road	0.572	0.329	0	1.000
Proportion of roadway length with low speed limit 5-30 mph	0.747	0.277	0	1.000
Proportion of roadway length with medium speed limit 35-50 mph	0.170	0.218	0	1.000
Proportion of roadway length with high speed limit 55-70 mph	0.059	0.150	0	1.000
Number of intersection per mile	16.699	230.370	0	8614.967
Number of signal per mile	2.904	86.103	0	6347.763
Number of intersection per square mile	57.081	149.704	0	4857.521
Number of signal per square mile	8.257	47.040	0	1619.174
Daily vehicle miles travel	31381.035	41852.293	0	684758.350
Proportion of daily heavy vehicle miles travel	0.067	0.052	0	0.519
Proportion of urban area	0.722	0.430	0	1.000

Table 3-21 Descriptive statistics for crashes in SWTAZ

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	65.59	96.32	0	1119	558677	62.0
Possible injury	19.45	27.43	0	280	165695	18.4
Non-incapacitating injury	13.99	17.79	0	219	119132	13.2
Incapacitating injury	5.12	7.21	0	110	43631	4.8
Fatal	0.75	1.24	0	14	6408	0.7
Total	105.80	142.25	0	1507	901235	100.0
Weekday morning peak (7-9am)	9.00	13.85	0	151	76650	8.5
Weekday off peak (9am-4pm)	31.92	44.99	0	524	271918	30.2
Weekday evening peak (4-6pm)	13.30	19.34	0	218	113313	12.6
Weekday nighttime (6pm-7am)	26.93	37.74	0	426	229365	25.5
Weekend daytime (7am-6pm)	13.13	18.36	0	214	111801	12.4
Weekend nighttime (6pm-7am)	11.50	15.68	0	164	97940	10.9
DUI	3.82	5.06	0	86	32545	3.6
Fog	0.39	0.83	0	9	3348	0.4
Cloud	17.21	26.27	0	360	146569	16.3
Rain	10.10	15.28	0	233	86004	9.5
Clear	74.96	101.84	0	1052	638475	70.8
Single vehicle	15.60	19.54	0	322	132841	14.7
Multiple vehicle	85.48	124.86	0	1376	728149	80.8
Pedestrian	1.91	3.31	0	39	16240	1.8
Bicycle	1.80	3.31	0	88	15307	1.7

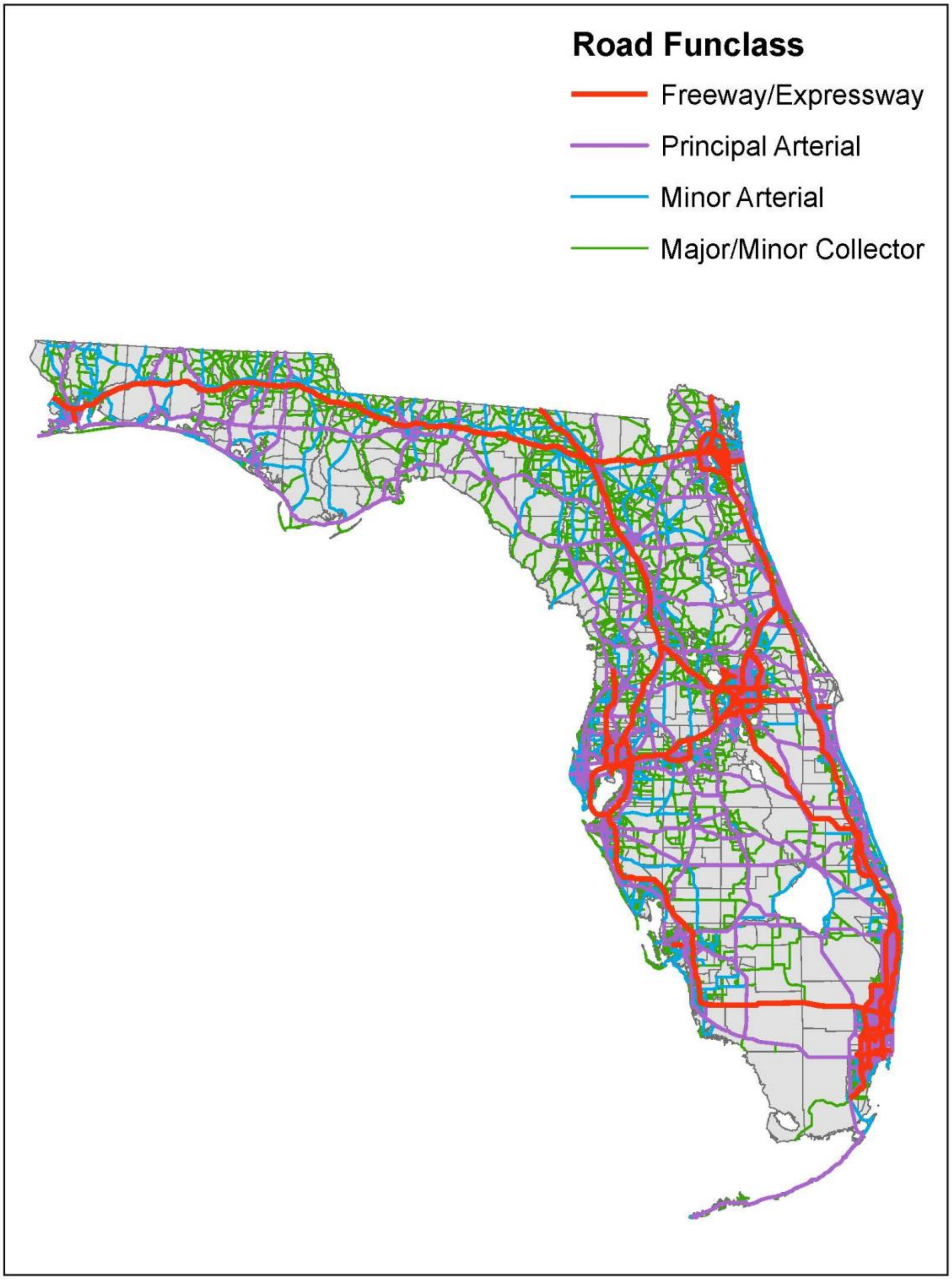


Figure 3-29 Roadways by functional classifications in SWTAZ

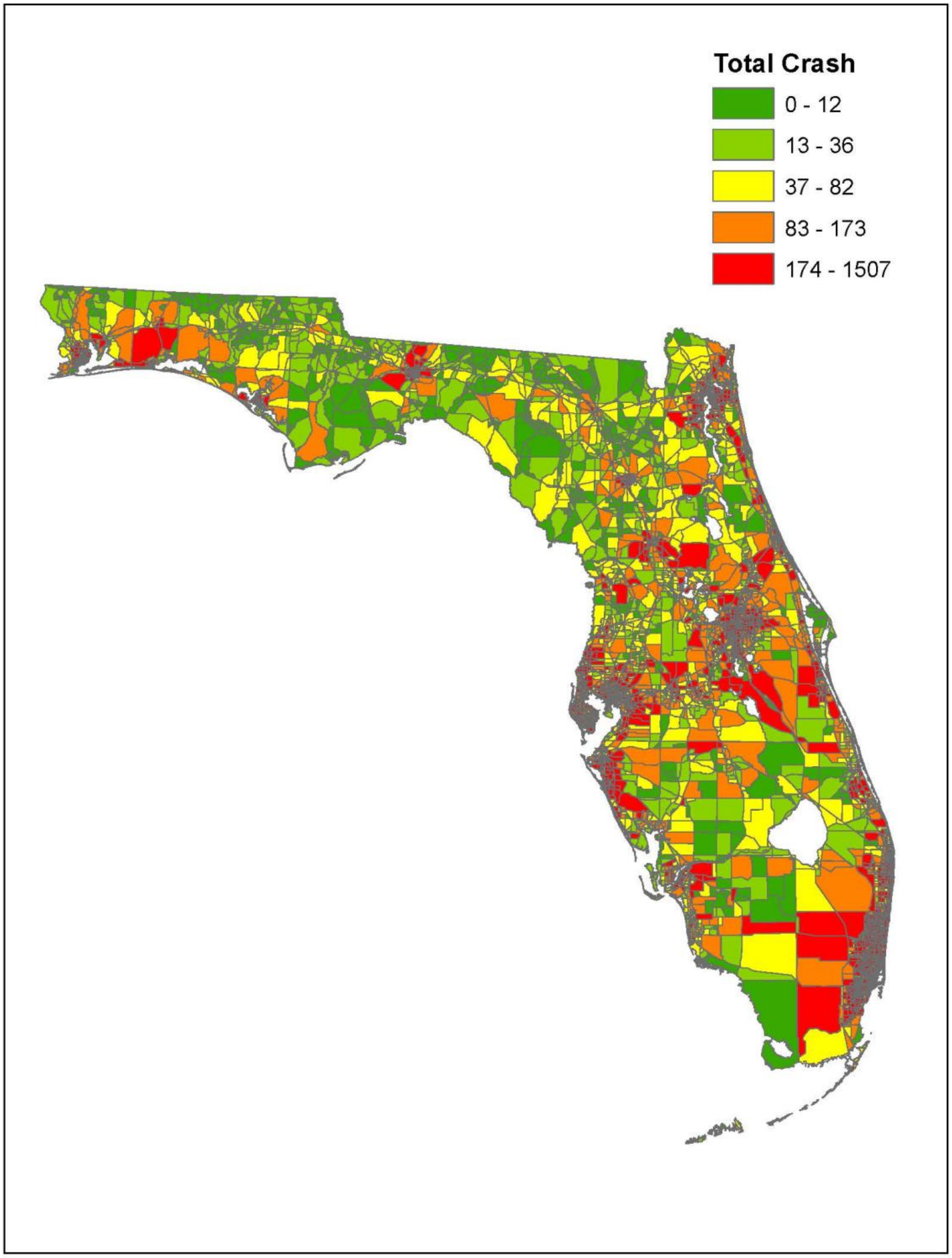


Figure 3-30 Spatial distributions of total crashes in SWTAZ

3.3 TAD

Similar to TSAZ, TADs (Traffic analysis districts) cover the whole state (Figure 3-31). However, TAD is a much more highly aggregated geographic unit compared to TSAZ. TADs may be useful if practitioners want to define crash patterns at a higher aggregate level. The collected data were prepared based on TAD, and processed socio-demographic, roadway, and crash variables are summarized in Tables 3-22 to 3-24, correspondingly. Moreover, population density, roadways by functional classifications, and total crash maps are displayed in Figures 3-32 to 3-34, respectively.

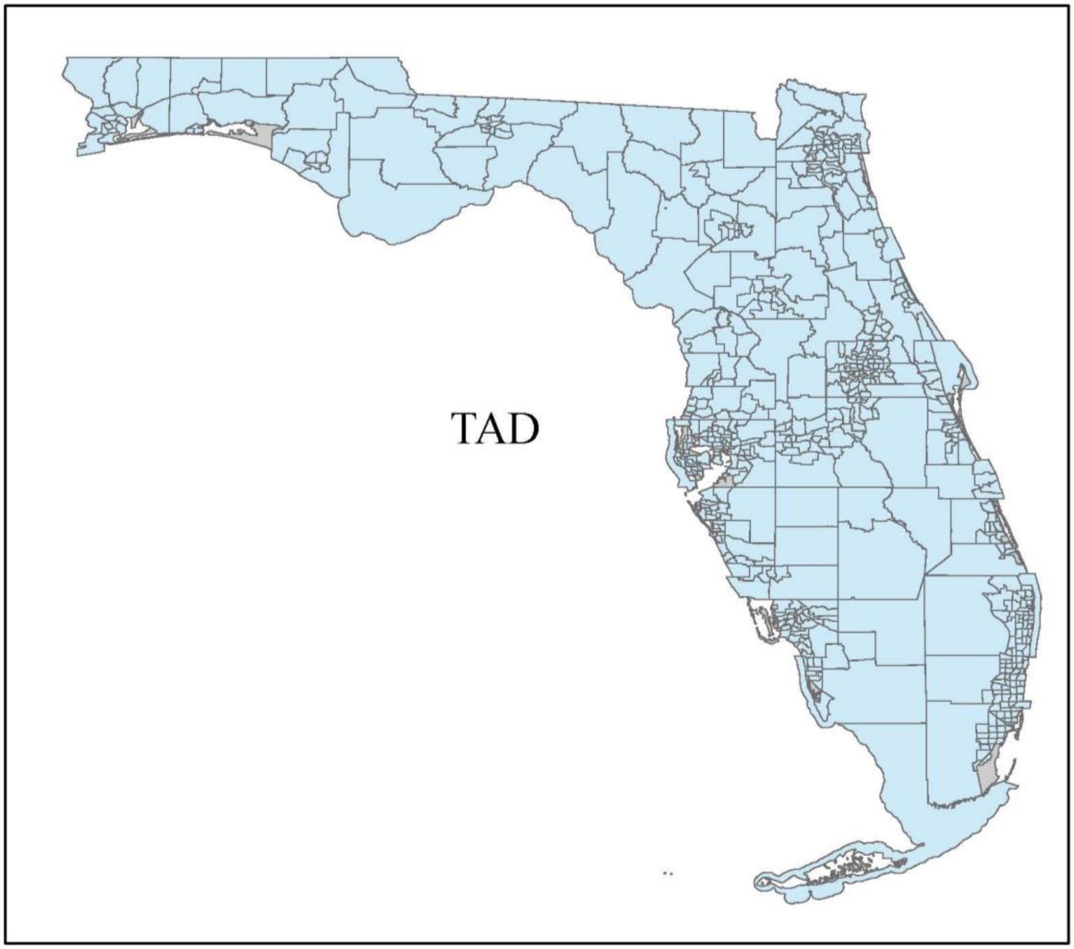


Figure 3-31 Traffic analysis district (TAD)

Table 3-22 Descriptive statistics for socio-demographic variables in TAD

Variables	Mean	Stdev	Min	Max
Total population	103.314	260.083	2.617	3095.520
Number of family unit	30718	35919	8	358901
Proportion of the nonpermanent vacant	11557	12454	2	108195
Proportion of the families vacant	0.102	0.045	0.000	0.310
Proportion of families have no vehicle	0.065	0.034	0.000	0.286
Proportion of families have 1 vehicle	0.077	0.065	0.004	0.544
Proportion of families have 2 or more vehicles	0.386	0.068	0.170	0.675
Number of hotel, motel, timeshare rooms per square mile	0.536	0.105	0.078	0.825
Total employment	38.145	96.745	0.000	766.641
Proportion of industry employment	16150	18159	7	157003
Proportion of commercial employment	0.177	0.136	0.000	0.819
Proportion of service employment	0.338	0.139	0.012	0.854
School enrollments per square mile	0.485	0.134	0.045	0.977

Table 3-23 Descriptive statistics for roadway variables in TAD

Variables	Mean	Stdev	Min	Max
Area (mi^2)	212.454	283.916	25.774	2685.062
Road density	7.613	5.311	0.074	24.561
Proportion of freeway/expressway	0.022	0.032	0.000	0.316
Proportion of principle arterial	0.053	0.045	0.000	0.314
Proportion of minor arterial	0.058	0.041	0.000	0.280
Proportion of collector road	0.112	0.066	0.000	0.603
Proportion of local road	0.755	0.108	0.077	0.935
Proportion of roadway length with low speed limit 5-30 mph	0.831	0.085	0.432	0.987
Proportion of roadway length with medium speed limit 35-50 mph	0.121	0.058	0.005	0.445
Proportion of roadway length with high speed limit 55-70 mph	0.048	0.057	0.000	0.425
Number of intersection per mile	1.995	1.115	0.217	7.881
Number of signal per mile	0.121	0.126	0.000	1.363
Number of intersection per square mile	17.895	19.765	0.130	126.392
Number of signal per square mile	1.171	1.728	0.000	13.376
Daily vehicle miles travel	599647	428747	38547	4632469
Proportion of heavy vehicle	0.071	0.038	0.015	0.290
Proportion of urban area	0.720	0.376	0.000	1.000

Table 3-24 Descriptive statistics for crashes in TAD

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	940.53	1192.29	79	12081	558677	62.0
Possible injury	278.95	263.35	27	2160	165695	18.4
Non-incapacitating injury	200.56	140.96	21	959	119132	13.2
Incapacitating injury	73.45	54.57	4	457	43631	4.8
Fatal	10.79	8.13	0	77	6408	0.7
Total	1517.23	1603.29	188	15094	901235	100.0
Weekday morning peak (7-9am)	129.04	140.47	10	1287	76650	8.5
Weekday off peak (9am-4pm)	457.77	515.47	40	5022	271918	30.2
Weekday evening peak (4-6pm)	190.76	198.75	15	1738	113313	12.6
Weekday nighttime (6pm-7am)	386.14	417.32	53	3895	229365	25.5
Weekend daytime (7am-6pm)	188.22	196.74	20	1770	111801	12.4
Weekend nighttime (6pm-7am)	164.88	178.96	17	1830	97940	10.9
DUI	54.79	36.31	6	345	32545	3.6
Fog	5.64	5.58	0	46	3348	0.4
Cloud	246.75	249.21	14	2658	146569	16.3
Rain	144.79	153.44	9	1297	86004	9.5
Clear	1074.87	1193.98	155	12268	638475	70.8
Single vehicle	223.64	156.51	27	1263	132841	14.7
Multiple vehicle	1225.84	1452.91	107	13723	728149	80.8
Pedestrian	27.34	33.39	1	344	16240	1.8
Bicycle	25.77	29.59	0	312	15307	1.7

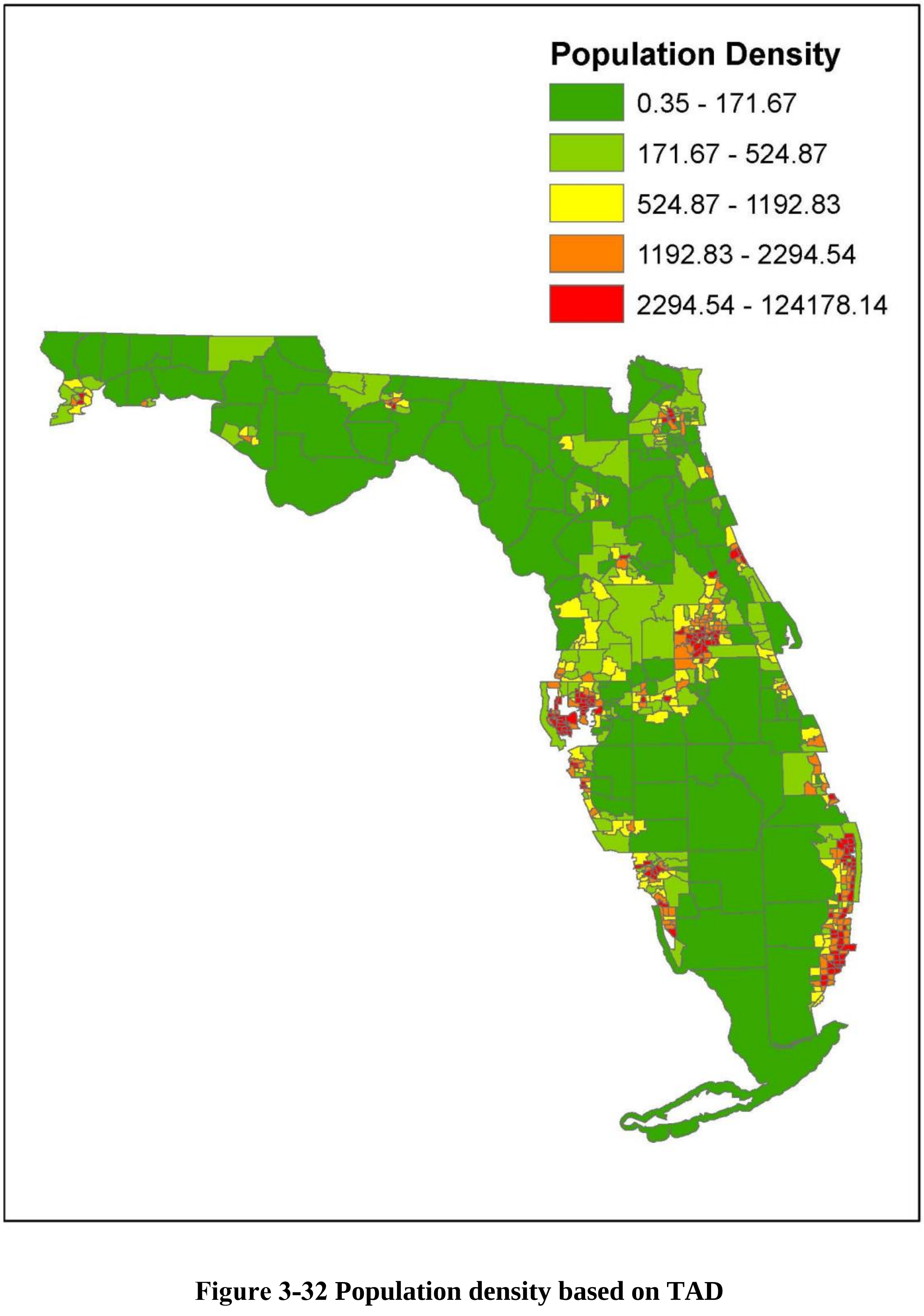


Figure 3-32 Population density based on TAD

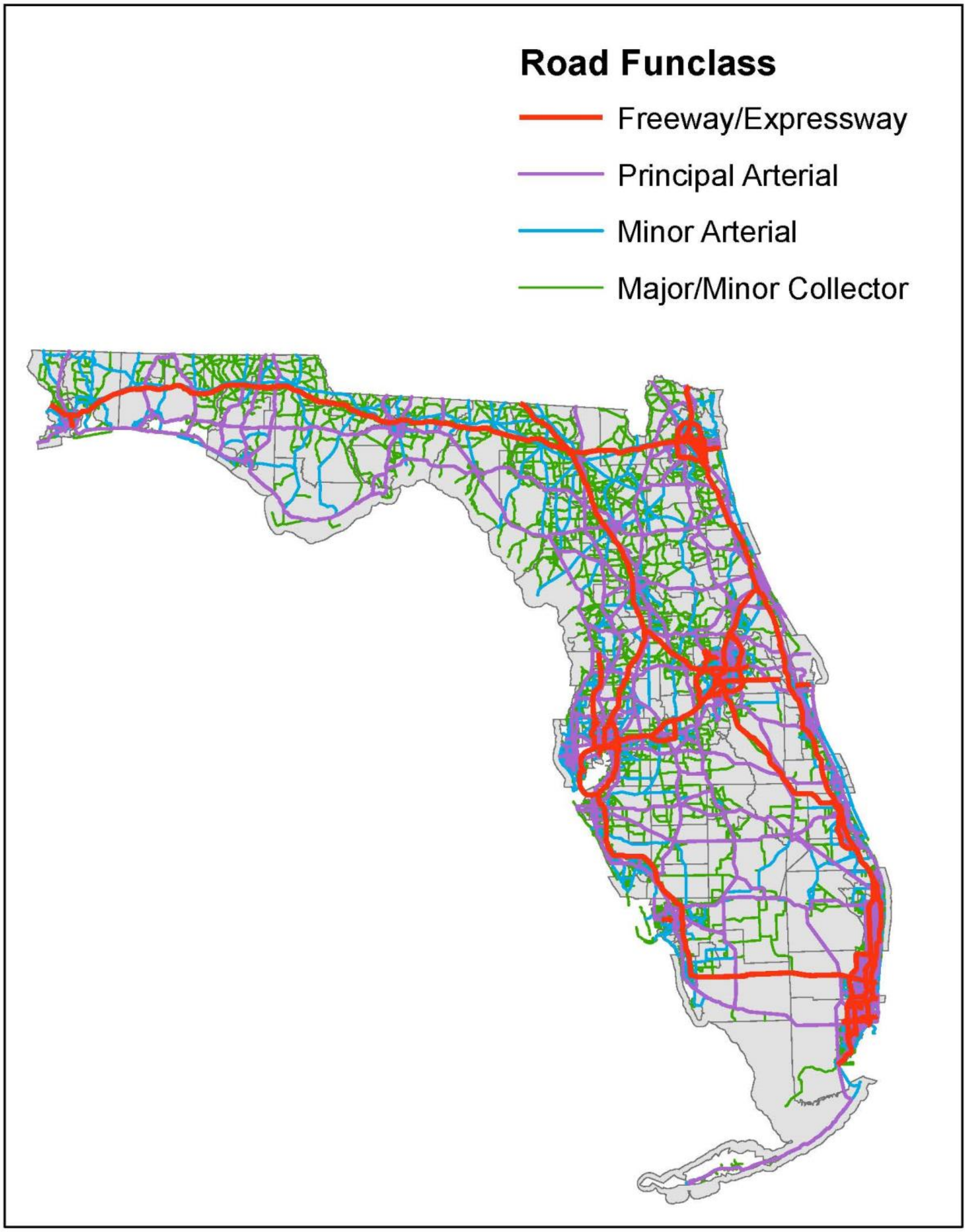


Figure 3-33 Roadways by functional classification in TAD

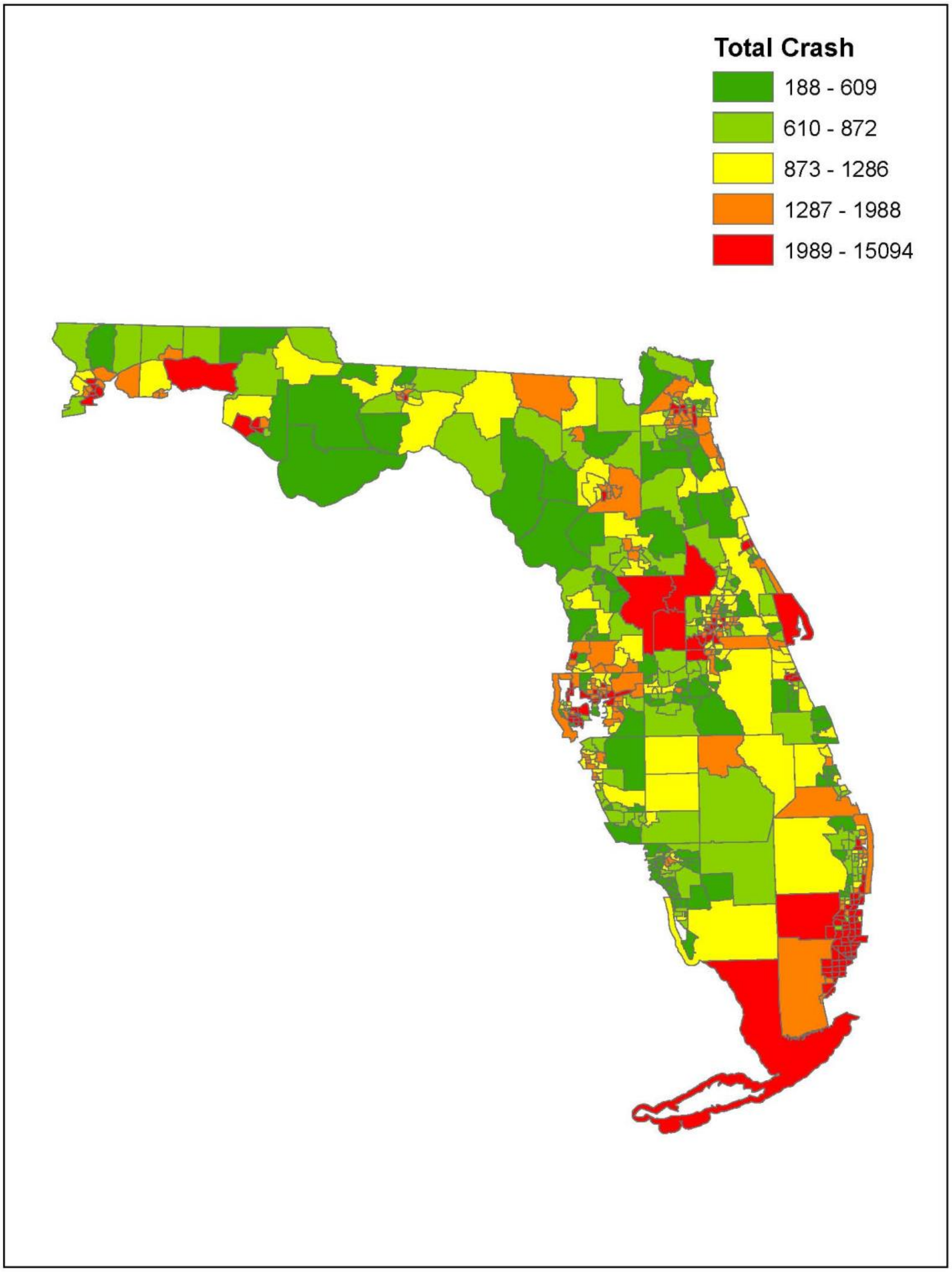


Figure 3-34 Spatial distributions of total crashes in TAD

3.4 County

Florida has 67 counties as presented in Figure 3-35. The counties will be used for the highest aggregation level traffic safety analysis. The collected data were also processed based on counties. Tables 3-25 to 3-27 show the summary of socio-demographic, roadway, and crash variables, correspondingly. Furthermore, population density, roadways by functional classifications, and total crash maps are exhibited in Figures 3-36 to 3-38, respectively.

Figure 3-35 Counties in Florida

Table 3-25 Descriptive statistics for socio-demographic variables in counties

Variables	Mean	Stdev	Min	Max
Total population	280617	445756	8365	2496435
Proportion of population age 0-5	0.056	0.009	0.024	0.080
Proportion of population age 6-14	0.115	0.018	0.050	0.152
Proportion of population age 15-24	0.126	0.032	0.053	0.263
Proportion of population age ≥65	0.181	0.067	0.094	0.434
Proportion of female	0.486	0.039	0.353	0.524
Proportion of African American	0.145	0.095	0.028	0.560
Proportion of Hispanics or Latino	0.125	0.121	0.019	0.650
Number of family unit	119161	158919	7046	727157
Proportion of the nonpermanent vacant	0.135	0.057	0.049	0.300
Proportion of the families vacant	0.083	0.038	0.039	0.251
Proportion of families have no vehicle	0.062	0.022	0.026	0.131
Proportion of families have 1 vehicle	0.367	0.047	0.260	0.491
Proportion of families have 2 or more vehicles	0.569	0.052	0.453	0.709
Number of hotel, motel, timeshare rooms per square mile	6.242	14.110	0	105.825
Total employment	159332	265008	6273	1395502
Proportion of industry employment	0.228	0.075	0.087	0.406
Proportion of commercial employment	0.290	0.082	0.123	0.443
Proportion of service employment	0.482	0.050	0.384	0.625
School enrollments per square mile	58.078	88.325	0	350.109
Proportion of unemployment	0.112	0.021	0.071	0.184
Median household income	43876	7428	32480	64346
Proportion of population below poverty line	0.177	0.051	0.098	0.297

Table 3-26 Descriptive statistics for roadway variables in counties

Variables	Mean	Stdev	Min	Max
Area (mi^2)	981.863	571.689	249.661	3734.530
Road density	2.022	1.053	0.155	5.499
Proportion of freeway/expressway	0.016	0.016	0.000	0.062
Proportion of principle arterial	0.056	0.038	0.000	0.203
Proportion of minor arterial	0.052	0.027	0.003	0.165
Proportion of collector road	0.137	0.061	0.028	0.359
Proportion of local road	0.739	0.096	0.439	0.914
Proportion of roadway length with low speed limit 5-30 mph	0.819	0.070	0.547	0.926
Proportion of roadway length with medium speed limit 35-50 mph	0.096	0.042	0.028	0.210
Proportion of roadway length with high speed limit 55-70 mph	0.085	0.051	0.011	0.265
Number of intersection per mile	1.099	2.432	0.120	20.166
Number of signal per mile	0.040	0.072	0.001	0.578
Number of intersection per square mile	1.397	0.740	0.284	3.131
Number of signal per square mile	0.061	0.053	0.001	0.215
Daily vehicle miles travel	5825979	8166366	212076	36775223
Proportion of heavy vehicle	0.112	0.052	0.034	0.307
Proportion of urban area	0.147	0.166	0.000	0.673

Table 3-27 Descriptive statistics for crashes in counties

Crash variables	Mean	Stdev	Min	Max	Sum	%
Property damage only	8338.21	19729.32	39	137643	558660	62.0
Possible injury	2473.06	4978.58	14	30264	165695	18.4
Non-incapacitating injury	1778.08	2937.24	16	14727	119131	13.2
Incapacitating injury	651.21	1005.74	21	4509	43631	4.8
Fatal	95.64	123.74	3	633	6408	0.7
Total	13451.00	28588.37	94	189214	901217	100.0
Weekday morning peak (7-9am)	1144.00	2567.62	8	16576	76648	8.5
Weekday off peak (9am-4pm)	4058.34	8587.81	22	58112	271909	30.2
Weekday evening peak (4-6pm)	1691.22	3489.31	8	22176	113312	12.6
Weekday nighttime (6pm-7am)	3423.31	7460.69	25	48645	229362	25.5
Weekend daytime (7am-6pm)	1668.61	3449.50	14	22955	111797	12.4
Weekend nighttime (6pm-7am)	1461.81	3118.35	17	20676	97941	10.9
DUI	485.75	661.21	13	2788	32545	3.6
Fog	49.97	55.46	3	274	3348	0.4
Cloud	2187.55	4383.21	16	26736	146566	16.3
Rain	1283.58	2755.81	9	17791	86000	9.5
Clear	9529.31	20552.28	65	137627	638464	70.8
Single vehicle	1982.61	2920.91	52	15705	132835	14.7
Multiple vehicle	10867.72	24765.03	40	168284	728137	80.8
Pedestrian	242.39	507.50	1	3251	16240	1.8
Bicycle	228.46	419.52	0	1980	15307	1.7

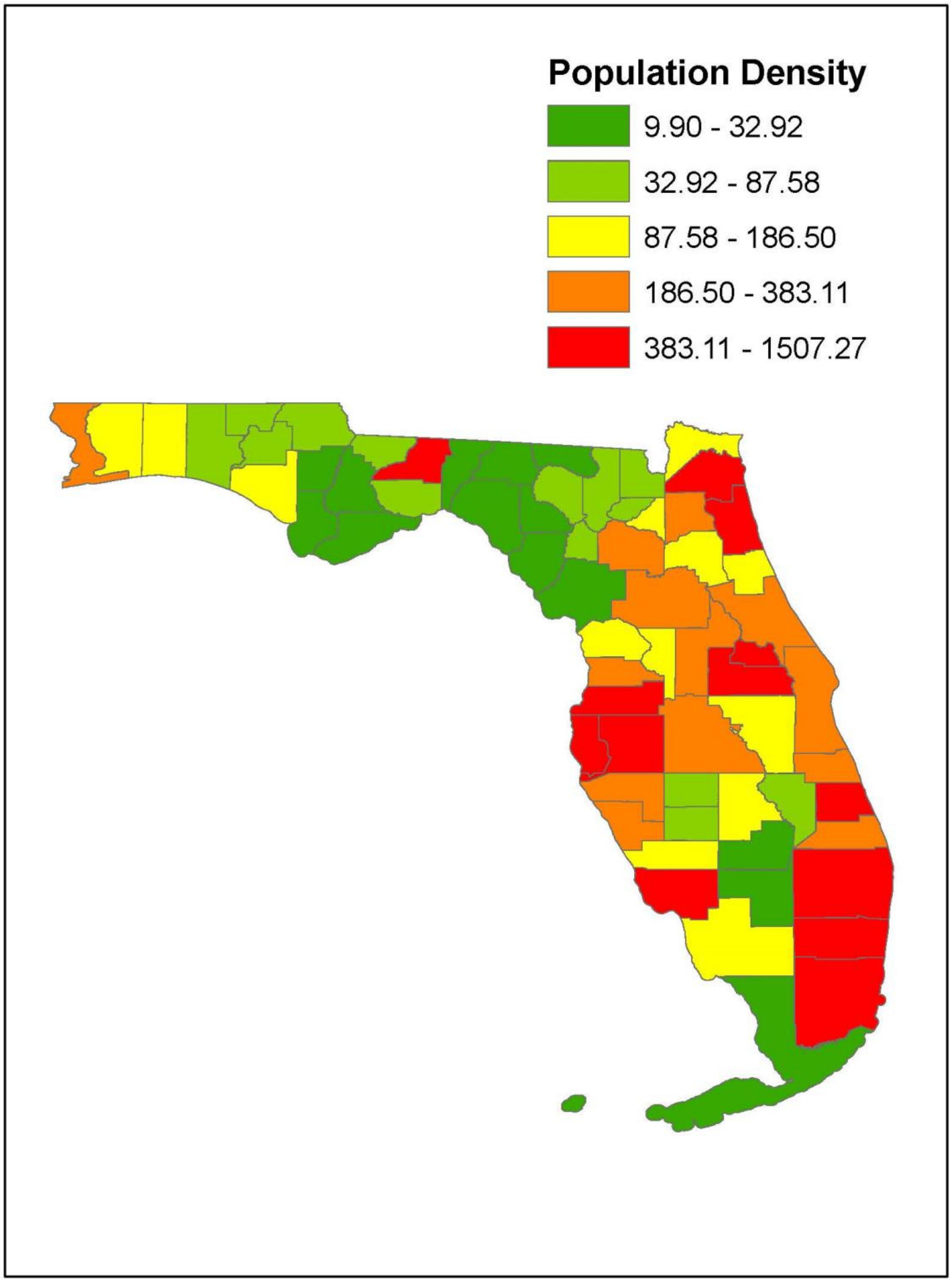


Figure 3-36 Population density based on counties

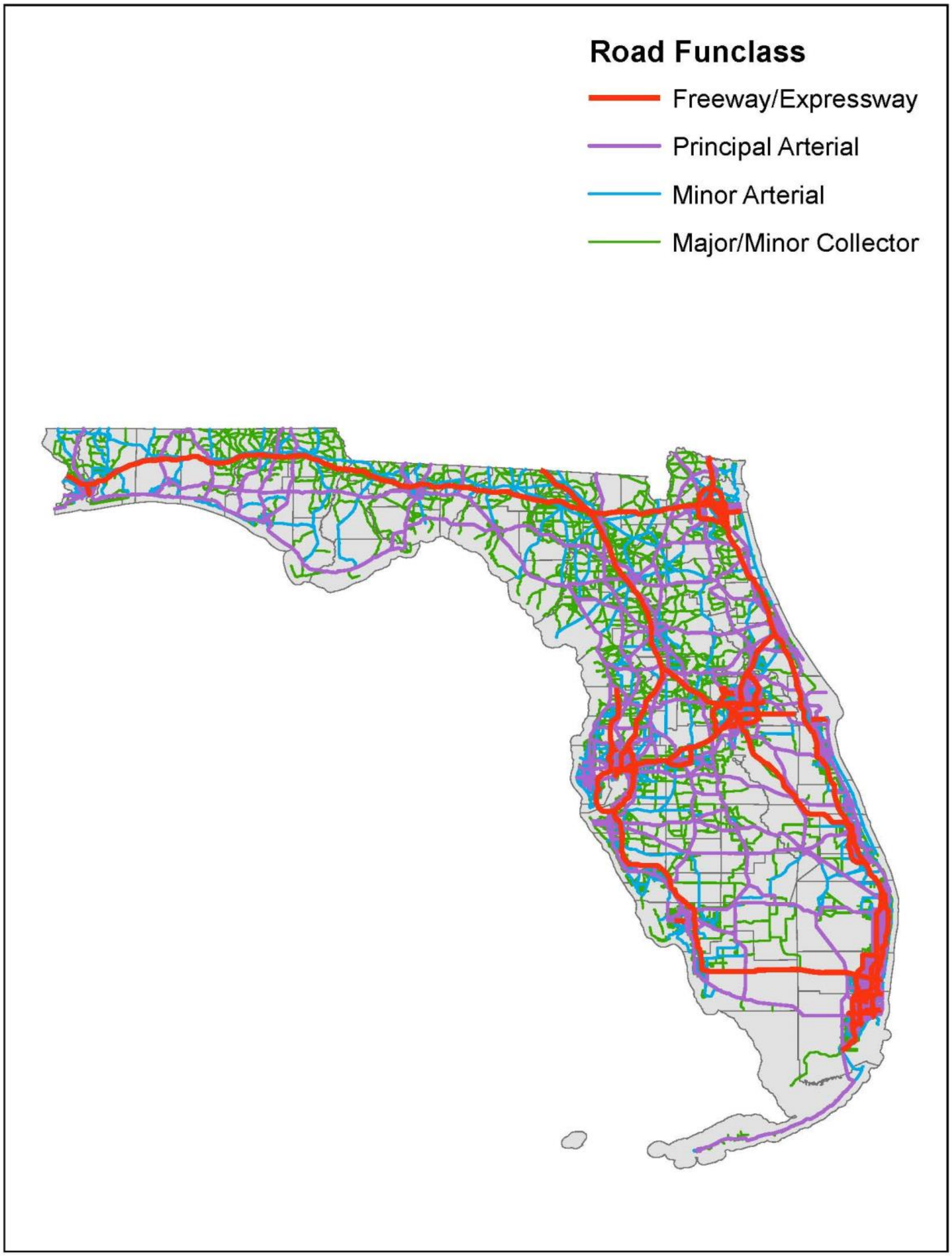


Figure 3-37 Roadways by functional classifications in counties

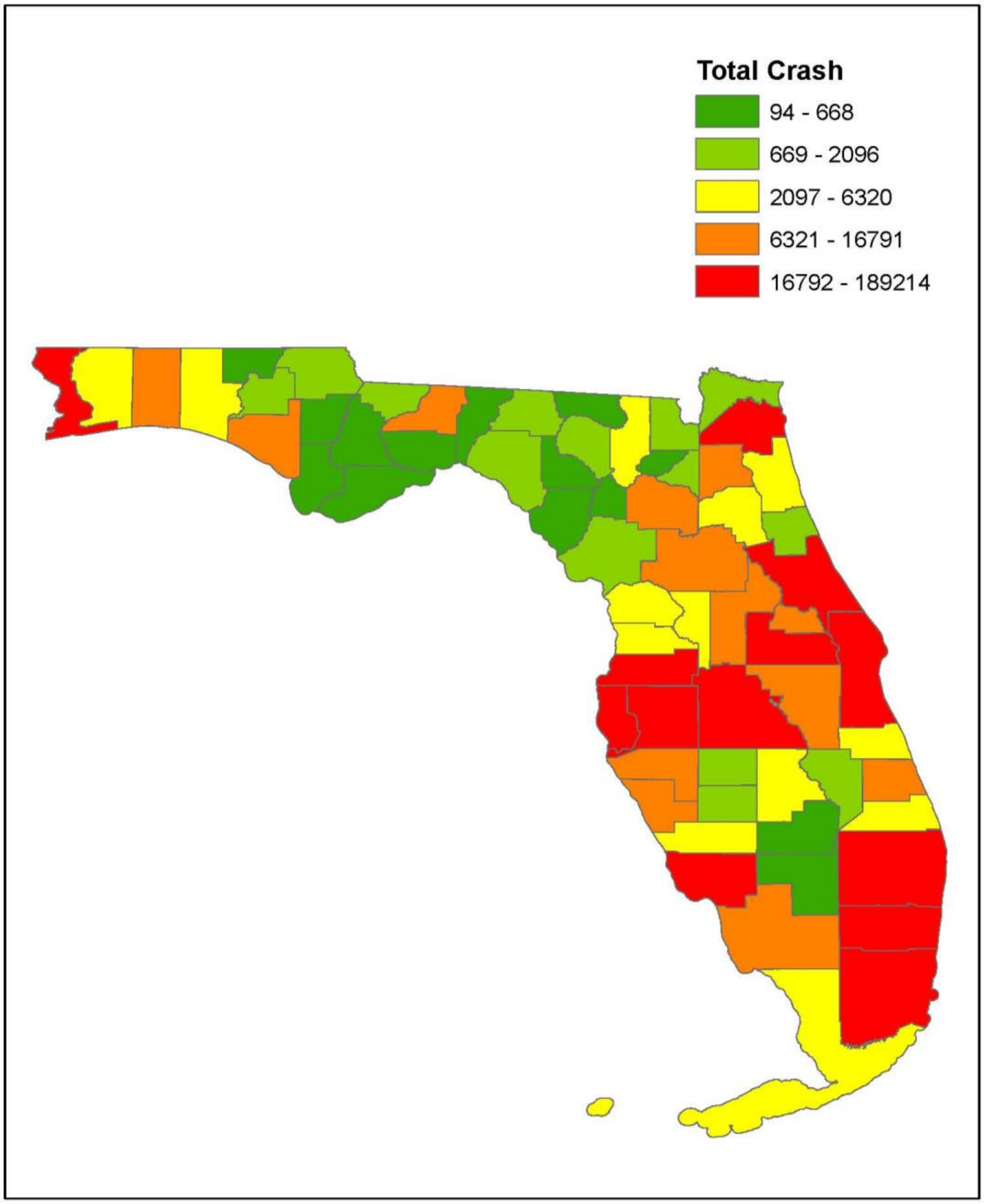


Figure 3-38 Spatial distributions of total crashes in counties

4 DEVELOPMENT OF TRAFFIC SAFETY ANALYSIS ZONES

4.1 Overview

Many researchers have used TAZs as a spatial unit for their macroscopic traffic safety analysis (Ng et al., 2002; Hadayeghi et al., 2003, 2006, 2010a, 2010b; De Guevara et al., 2004; Naderan and Shahi, 2010; Abdel-Aty et al., 2011; Siddiqui et al., 2012; Siddiqui and Abdel-Aty; Abdel-Aty et al., 2013). Using TAZs in the macroscopic safety analysis is reasonable because they are transportation/traffic related zone system. However, Lee et al. (2014) pointed out that TAZs may have several limitations due to the following general zoning criteria for TAZs (Baass, 1980; Meyer and Miller, 2001):

- Minimizing the number of intra-zonal trips
- Recognizing physical, political, and historical boundaries

Basically TAZs are designed to analyze origin-destination pairs of trips generated from each zone. Thus, transportation planners need to minimize trips which start and end in the same zone. It is inferred that minimizing intra-zonal trips end up with the small size of TAZs. On the other hand, traffic safety analysts need to consider traffic crashes that occur inside zones. So they can be related to zonal characteristics with traffic safety of the zones. Therefore, it is possible that TAZs are too small to analyze traffic safety at the macroscopic level. Moreover, the small size of zones makes many zones with zero crash counts, especially for rarely occurring crashes such as fatal crashes. The second criterion abovementioned indicates that TAZs are usually divided by physical boundaries, mostly arterial roadways. Considering that many crashes occur on arterial roads, between zones, inaccurate results will be made from relating traffic crashes on the boundary of the zone to only the characteristics of that zone (Siddiqui and Abdel-Aty, 2012). A simple way to overcome these two issues while using TAZs for safety analysis is to aggregate TAZs into sufficiently large and homogenous traffic crash patterns.

4.2 Regionalization

The research team decided to use SWTAZs (Statewide traffic analysis zones), instead of RTAZs (Regional traffic analysis zones). Although RTAZs are smaller and they have more detailed information, some regions especially in the rural area are not covered by RTAZs. Therefore the research chose SWTAZs as a base geographic unit for the regionalization. The existing SWTAZs were aggregated if they meet the following conditions:

- Zones are spatially contiguous; and
- Zones have same crash rate levels.

All SWTAZs were classified into several categories based on their crash rates (crashes per mi^2) as shown in Table 4-1.

Subsequently, the neighboring zones with same categories are combined and new five zone systems were created (TSAZ1-5). The optimal zone scale for TSAZs was determined using Brown-Forsythe (F_{BF}) test. F_{BF} test evaluates whether the variance of variables of interests (i.e. crash rates) is equal when the scales of zone systems change. The underlying assumption of F_{BF} is that there is greater variance in crash rates among smaller zones and a lower variance among larger zones. A high variance value means that the crash risks are local, whereas a low variance means that more global crash patterns can be captured. The optimal zone scale ensures that the variance of crash rates is somewhere in between. Root et al. (2011), Root (2012) applied F_{BF} tests to determine the optimal scale for their medical studies. Lee et al. (2014) used F_{BF} test in determine the optimal scale for the new zone system for the traffic safety analysis.

Table 4-1 Classification of SWTAZs by crash rates

No	Number of classifications	Classifications (based on percentile crash rate)	Range (crash per mile)
1	2	Class 1: 50-100%	20000-8.122
		Class 2: 0-50%	8.120-0.000
2	3	Class 1: 66-100%	20000-15.614
		Class 2: 33-66%	15.609-3.751
		Class 3: 0-33%	3.744-0.000
3	5	Class 1: 80-100%	20000-30.249
		Class 2: 60-80%	30.229-11.978
		Class 3: 40-60%	11.975-5.260
		Class 4: 20-40%	5.258-1.616
		Class 5: 0-20%	1.615-0.000
4	7	Class 1: 86-100%	20000-44.702
		Class 2: 71-86%	44.690-19.305
		Class 3: 57-71%	19.296-10.660
		Class 4: 43-57%	10.658-6.058
		Class 5: 29-43%	6.056-2.879
		Class 6: 14-29%	2.878-0.952
		Class 7: 0-14%	0.951-0.000
5	10	Class 1: 90-100%	20000-66.773
		Class 2: 80-90%	66.681-30.249
		Class 3: 70-80%	30.229-18.126
		Class 4: 60-70%	18.102-11.978
		Class 5: 50-60%	11.975-8.122
		Class 6: 40-50%	8.120-5.260
		Class 7: 30-40%	5.258-3.118
		Class 8: 20-30%	3.116-1.616
		Class 9: 10-20%	1.615-0.548
		Class 10: 0-10%	0.546-0.000

F_{BF} statistics are calculated using the following formula:

$$F_{BF} = {[\sum_{i=1}^{t}(\overline{D}_i - \overline{D})^2/(t-1)]}\Big/{\left[\sum_{i=1}^{t}\sum_{j=1}^{n_1}\left(\overline{D}_{ij} - \overline{D}_1\right)^2/(N-t)\right]} \tag{1}$$

where, n_i is the number of samples in the ith zone system, N is the total number of samples for all zone systems, t is the number of neighborhood groups y_{ij} is the crash rates of the jth sample from the ith zone system, $\bar{y}_i$ is the median of crash rate from the ith zone system, and $D_{ij}=\left|y_{ij} - \bar{y}_i\right|$ is the absolute deviation of the jth observation from the ith zone system median, $\overline{D}_i$ is the mean of D_{ij} for zone system i, and $\overline{D}$ is the mean of all D_{ij}. The test assumes that the variances of different zones are equal under the null hypothesis. The calculated value was obtained using an F distribution and α=0.1 was used to test for statistical significance.

There are two steps involved in the F_{BF} test. First, the variance between each zone system from TSAZ5 (N=4,907) to TSAZ1 (N=1,064) (Table 4-2). The largest zone system (TSAZ1) is compared for a total of four separate calculations of F_{BF}, as shown in the F_{BF1} column of Table 4-2. Second, the variance between each neighborhood group from TSAZ1 to TSAZ4 and the smallest zone system (TSAZ5) is compared (F_{BF2}). TSAZ5 was used as the smallest zone system instead of SWTAZ (N=8,518) since the variance of crash rates based on SWTAZs is very large (standard deviation=3,035.39), which shows the crash rates are not relevant to SWTAZs. A significant value of F_{BF1} implies that the zone system does not reflect the global pattern of crash data; in essence, each zone is so small that it only captures local crash patterns. On the contrary, the significant value of F_{BF2} indicates that the zone data are not local; they are so large that local level crash patterns are undetectable. The zone systems between lower and upper limits identify a spatial scale at which local level variation is still detectable but also captures larger zonal level crash characteristics.

Table 4-2 Brown-Forsythe test for determining optimal zone scale

Zone system	No of zones	Crashes per miles		Brown-Forsythe test			
		Mean	Stdev	F_{BF1}	p-value	F_{BF2}	p-value
SWTAZ	8,518	144.5877	3035.39	-	-	-	-
TSAZ5	4,907	14.614	53.510	3.630	0.0567	-	-
TSAZ4	3,920	14.678	59.152	2.810	0.0936	**0.010**	**0.9436**
TSAZ3	**3,041**	**14.947**	**66.557**	**1.960**	**0.1617**	**0.060**	**0.8134**
TSAZ2	**1,754**	**15.634**	**86.843**	**0.440**	**0.5081**	**1.070**	**0.3002**
TSAZ1	1,064	18.036	110.703	-	-	3.630	0.0567

4.3 Traffic Safety Analysis Zones

The F_{BF} test results for homogeneity of variance for crash rates under various zone scales are presented in Table 4-2. The F_{BF1} test statistics shows that zone systems smaller than TSAZ3 (i.e., TSAZ4 and TSAZ5) have significantly different variance from that of TSAZ1. Thus, zone systems smaller than TSAZ3 are too small to capture global crash patterns. On the other hand, F_{BF2} test statistics indicates that the zone system larger than TSAZ2 (i.e., TSAZ1) is so large that it cannot capture local crash characteristics. Given the result, systems with TSAZ2 and TSAZ3 are considered optimal for macro-level crash analysis. In conclusion, TSAZ2 was chosen as the final TSAZ since it can minimize boundary crashes and zones without certain types of crashes.

Table 4-3 contrasts the areas in SWTAZ and TAZ. As shown in the table, the number of zones in TSAZ (N=1,754) is one-fifth of SWTAZ (N=8,518), and the average area in SWTAZ is 18.061 mi^2 whereas that in SWTAZ is 6.472 mi^2.

Table 4-3 Area in SWTAZ and TSAZ

Zone system	No of zones	Average (mi^2)	Stdev	Min	Max
SWTAZ	8,518	6.472	24.803	0.000	885.322
TSAZ	1,754	18.061	226.645	0.000001	9395.0400

Table 4-4 compares the crash rates in SWTAZ and TSAZ. The mean crash rate in SWTAZ is 144.588 crashes per mile while that in TSAZ is almost one-tenth, 15.634 crashes per mile. Moreover, the standard deviation of crash rate in SWTAZ is very large, it is 3035.390. After the regionalization, the standard deviation of crash rate in TSAZ became 86.843. It may imply that the new zone system, TSAZ have more homogenous crash rates compare to SWTAZ.

Table 4-4 Crash rates in SWTAZ and TSAZ

Zone system	Average (crash per mi)	Stdev	Min	Max
SWTAZ	144.588	3035.390	0.000	2517.986
TSAZ	15.634	86.843	0.000	20000

Table 4-5 contrasts the numbers and percentages of zones without crashes in SWTAZ and TSAZ. There is no big difference in the percentage of zones without total crashes before and after the regionalization. However, when it comes to fatal crashes, the percentage of zones without fatal crashes in SWTAZ is 63.0% while it is smaller in TSAZ (54.1%).

Table 4-5 Zones without crashes in SWTAZ and TSAZ

Zone system	Zones without total crashes		Zones without fatal crashes	
	Zones	**Percentage**	**Zones**	**Percentage**
SWTAZ	291	3.4%	5363	63.0%
TSAZ	90	3.0%	1664	54.1%

Table 4-6 compares the numbers and percentages of boundary crashes in SWTAZ and TSAZ. There are 68.2% boundary crashes in SWTAZ whereas there are 47.0% boundary crashes in TSAZ. In other words, more than 20% of boundary crashes has been reduced after the regionalization.

Table 4-6 Boundary crashes in SWTAZ and TSAZ

Zone system	Boundary crashes	Total crashes	Percentage
SWTAZ	614,671	901,235	68.2%
TSAZ	423,275		47.0%

Figures 4-1 to 4-4 compare SWTAZ and TSAZ maps in Districts 7 (Tampa and St. Petersburg area), 6 (Miami-Dade and Broward area), 2 (Jacksonville area), and 5

(Orlando area), respectively. As presented in the Figures, the zones, especially in the urban area, are highly aggregated.

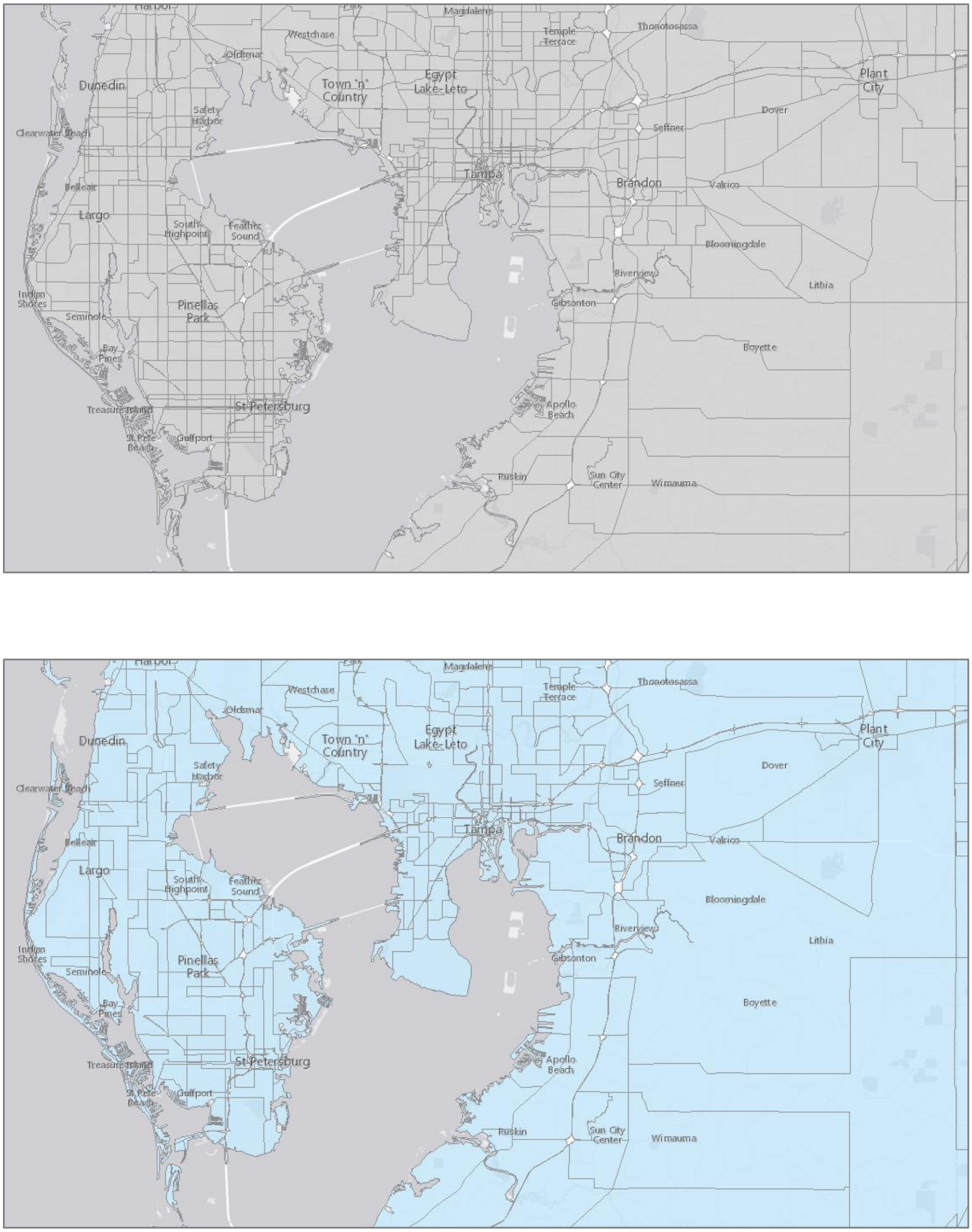


Figure 4-1 SWTAZ (upper) and TSAZ (lower) in District 7 – Tampa and St. Petersburg area

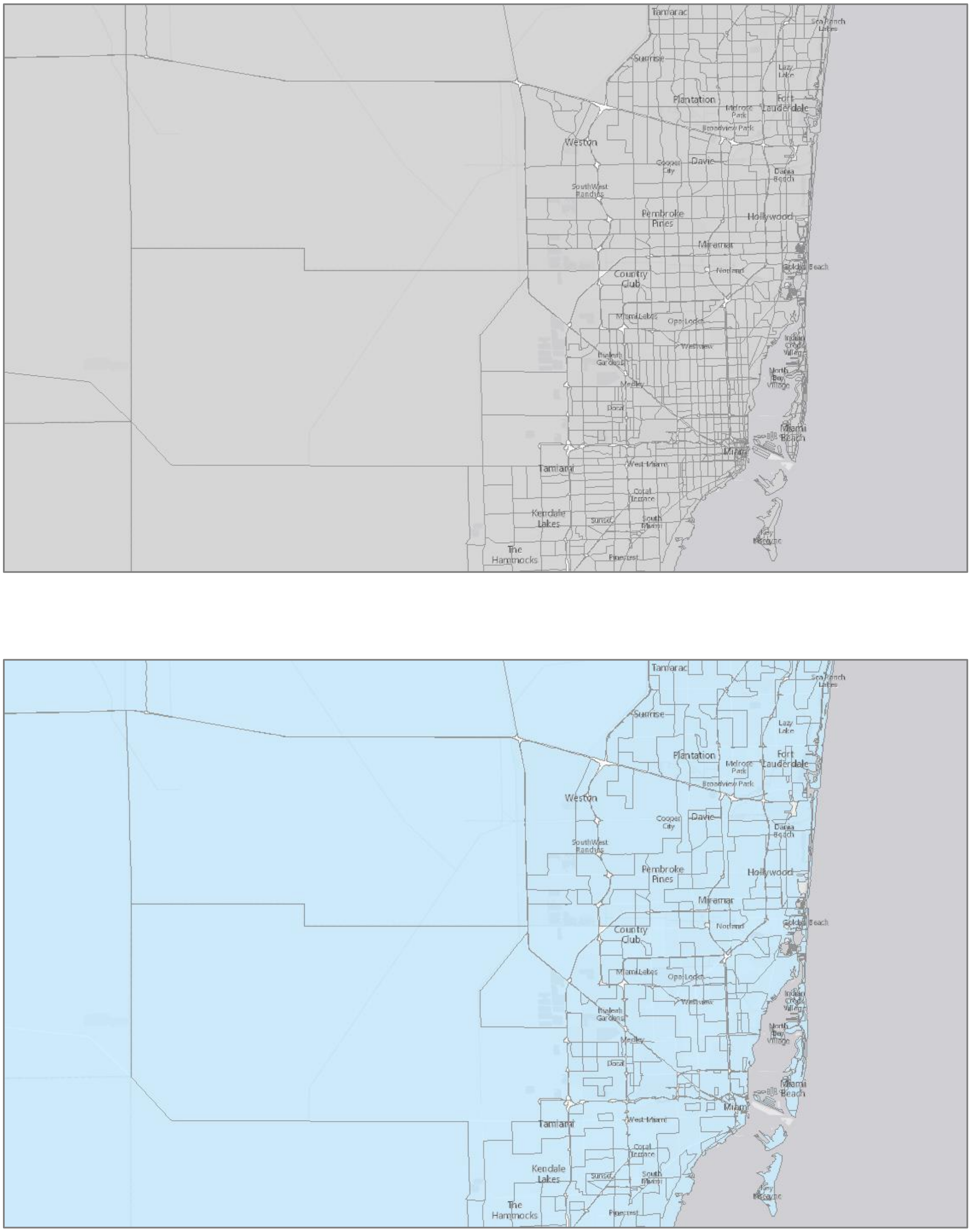
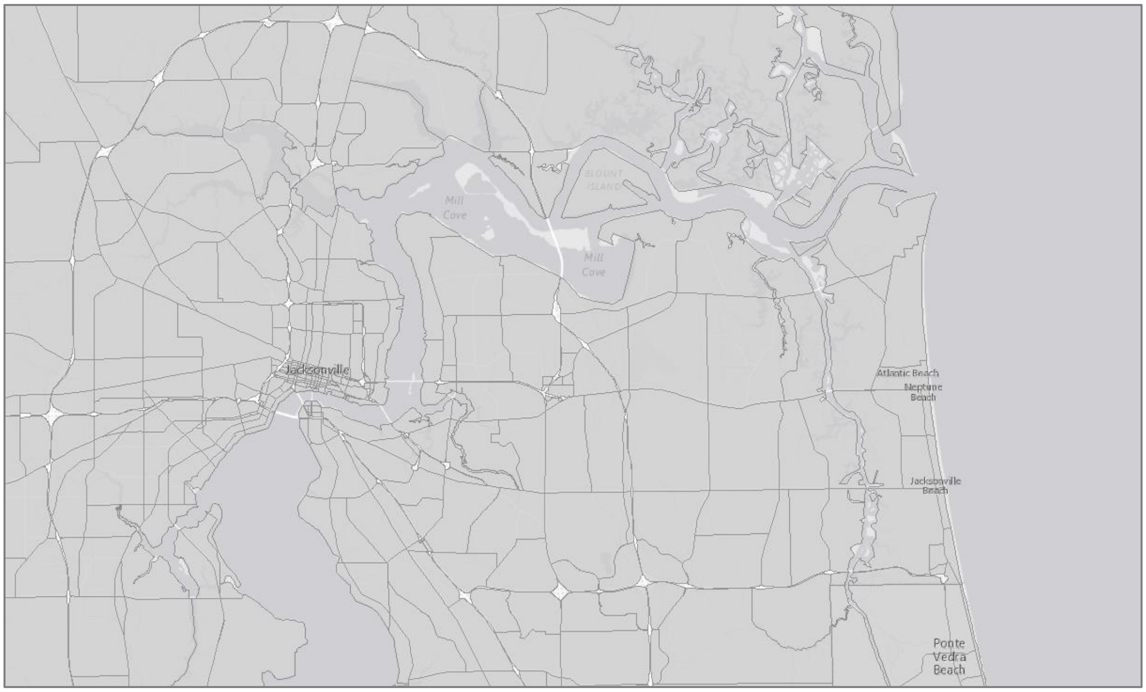


Figure 4-2 SWTAZ (upper) and TSAZ (lower) in District 6 – Miami-Dade and Broward area



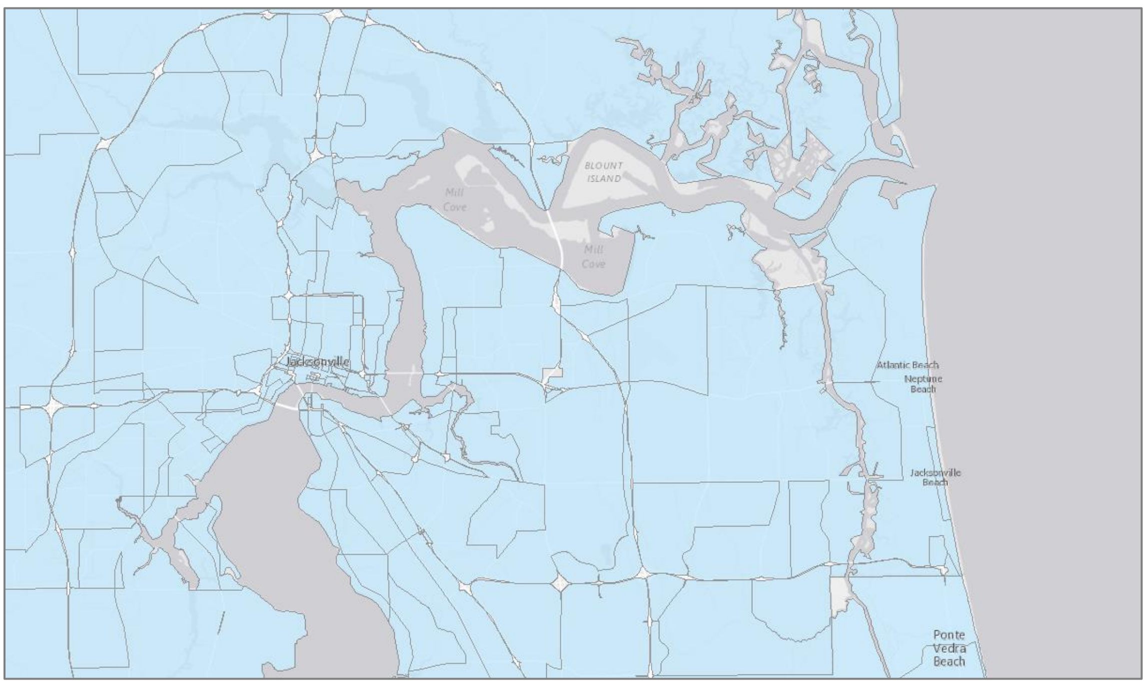
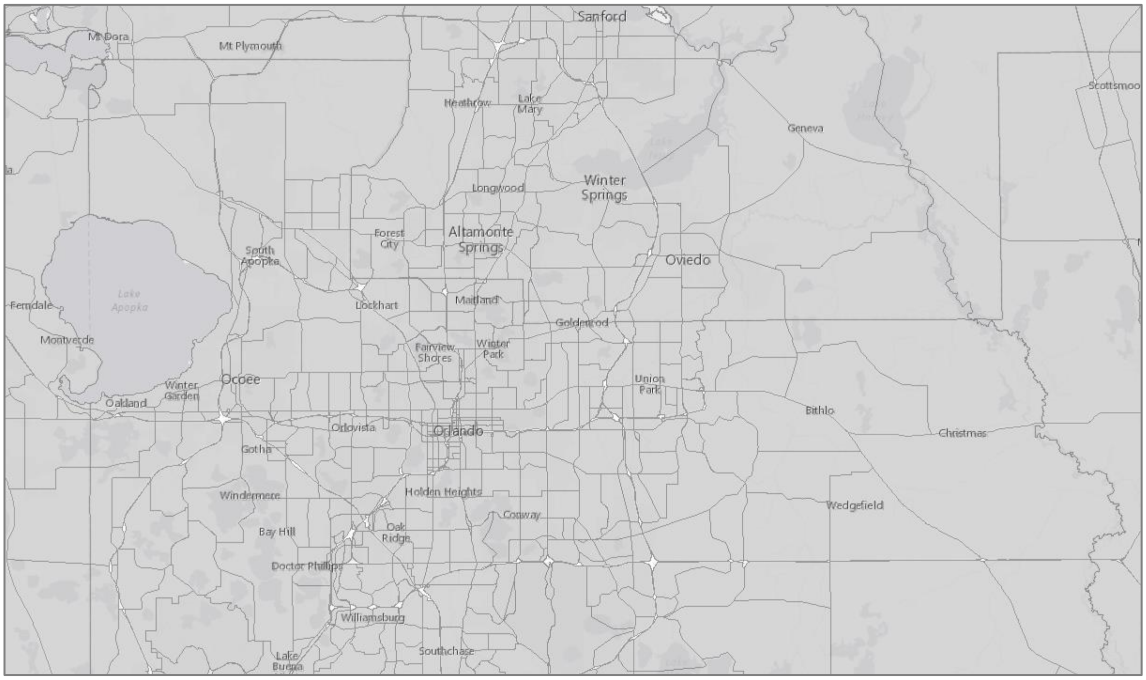


Figure 4-3 SWTAZ (upper) and TSAZ (lower) in District 2 – Jacksonville area



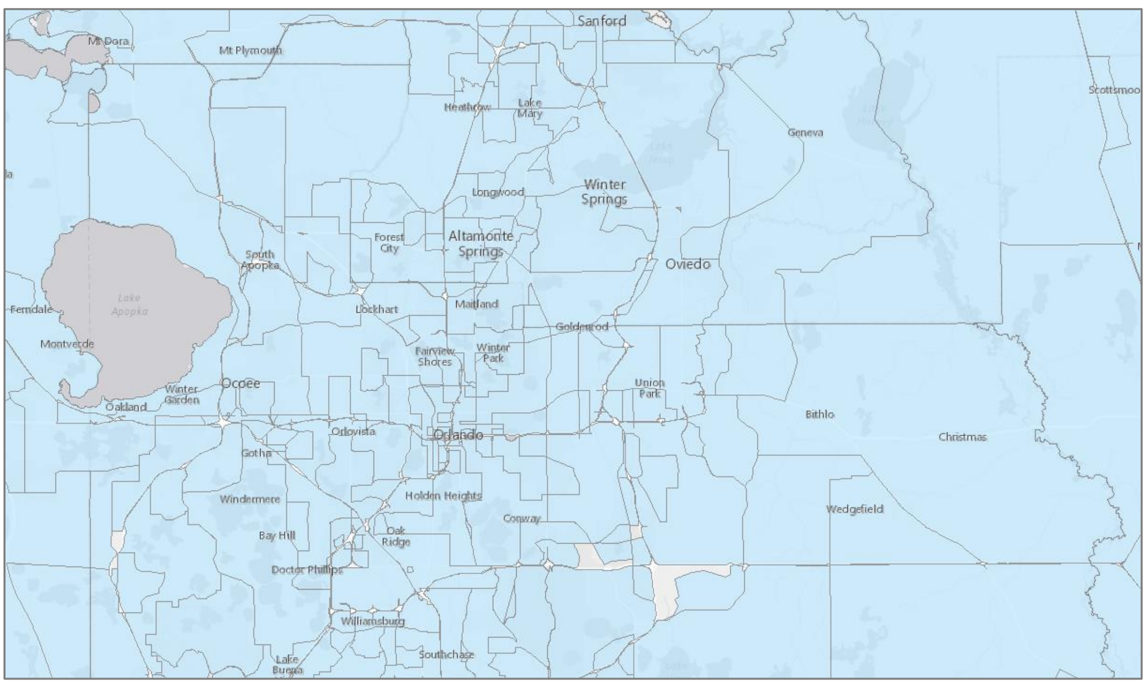


Figure 4-4 SWTAZ (upper) and TSAZ (lower) in District 5 – Orlando metropolitan area

4.4 Suggestions for Using TSAZs

As described in the Phase I report and Lee et al. (2014), TSAZs based SPFs outperform SWTAZ based SPFs. The previous studies pointed out that TAZs have two disadvantages in exploring traffic safety: 1) small size in urban areas and 2) boundary crashes. Regionalization of TAZs by aggregating zones with similar crash rates can alleviate these weaknesses. In rural areas, however, the regionalization may excessively aggregate the existing TAZs because traffic crash rates are generally quite low. Also, the regionalization is not very essential in rural areas as rural TAZs are large in most of cases, different from urban TAZs. Therefore, it is recommended using TSAZs in large metropolitan areas. The research team summarized TSAZ-SWTAZ tables for the following urbanized areas in Appendix A.

- Miami-Dade MPO
- Broward MPO
- Palm Beach MPO
- Hillsborough MPO
- Pinellas MPO
- Pasco MPO
- MetroPlan Orlando (Orange, Seminole, and Osceola Counties)
- North Florida TPOs (Duval, Nassau, Clay, and St. Johns Counties)
- Sarasota-Manatee MPO
- Alachua County
- Leon County

5 DEVELOPMENT OF VARIOUS SPFS AT THE MACRO-LEVEL

In sections 5-1 to 5-4, the research team built various SPFs for four geographic units (i.e., SWTAZs, TSAZs, TADs, and counties). TAZs are the only traffic related zone system which delineated by state and local transportation officials. For this reason, TAZs have been widely adopted for macroscopic traffic safety analysis. However, TAZs have two possible limitations: boundary crash problem and small size. TSAZs were developed by aggregating current SWTAZs to alleviate the possible limitations while keeping advantages of the SWTAZs. TADs are new, higher-level geographic entities for traffic analysis. TADs can be useful if practitioners want to examine traffic crashes at a more aggregate level. Counties are the highest aggregation level of existing geographic units at the state-wide level. County-level analysis will allow practitioners to analyze counties with high traffic crash risks at the highest aggregation level.

The research team has developed many crash types in this research project. First, the research team developed SPFs by severity levels such as KABCO (total), KABC (fatal-and-injury crashes), KAB (fatal-and-injury crashes without possible injury) and KA (fatal-and-severe injury crashes). Second, the research team has built SPFs by time periods. The research team divided crashes into weekday and weekend crashes. The weekday crashes were classified into morning peak (07:00-08:59), off-peak (09:00-15:59), evening peak (16:00-17:59), and nighttime (18:00-06:59). In case of the weekend crashes, since it is known that there is no significant variation in traffic volume during the daytime as during weekdays, only daytime (07:00-17:59) and nighttime (18:00-06:59) were considered. Moreover, SPFs for four major collision types (i.e., single-vehicle, multiple-vehicle, pedestrian-involved, and bicycle-involved collision) were estimated. Lastly, SPFs for special crash types: adverse weather conditions (rain and fog) and DUI (Driving under the influence of alcohol or drugs) were developed.

Three types of SPFs by explanatory variable types were estimated: base, semi-fully specified, and fully specified SPFs. Base SPFs only have the exposure variable, VMT (vehicle miles traveled) in their models. VMT is essential to undertake meaningful and statistically sound traffic safety analyses (AASHTO, 2010) and is easy to collect and process. The semi-fully specified SPFs have both traffic (i.e., VMT, the proportion of heavy vehicles, etc.) and roadway variables (i.e., proportions of arterial/collectors/local roads, signal density, etc.). The variables used in the semi-fully specified SPFs are directly related to traffic or roadway characteristics. It is expected that the semi-fully specified SPFs have better predictability than the base SPFs. The fully specified SPFs have all the variables in their models, including not only traffic- or roadway-related variables but also demographic, socio-economic, and geographic variables. Several demographic, socio-economic, and geographic variables have been found to be key factors for traffic crashes at the macroscopic level (Abdel-Aty et al., 2013; Lee et al., 2014).

A negative binomial (NB) model was used to be consistent with the current Highway Safety Manual (AASHTO, 2010). The number of crashes is a non-negative integer, which is not normally distributed. Poisson or NB models have the ability to develop the crash frequencies with explanatory variables; however, The Poisson model has been criticized because of its implicit assumption that the variance equals the mean. This assumption is often violated in the crash data in particular. Most of crash data have a greater variance than their mean and therefore the data is over-dispersed. NB models can relax the over-dispersion issue. The mean-variance relationship in NB distribution is as follows:

$$Var\ (Y) = \mu + k\mu^2 \tag{1}$$

where, Y is response variable, μ is mean response of the observation, and k is dispersion parameter. Thus, if the dispersion parameter k is close to zero, the variance is also near to the mean, which is the basic assumption of Poisson distribution. The existence of over-dispersion is adjusted by the log-linear relationship between the expected number of crashes and covariates.

$$\log(\mu_i) = \beta_0 + \sum \beta X_i + \varepsilon_i \tag{2}$$

where, i is an observation unit, μ_i is the expected number of crashes per year at i, X_i is covariates, β_0 is the intercept, β is the estimated coefficient vector and ε_i is the random error term. The following function is the probability of mass function of the negative binomial distribution, where $\Gamma\,(x)$ is gamma function and over-dispersion parameter α should be greater than 0.

$$Pr(Y = y_i) = \frac{\Gamma(y_i+\frac{1}{k})}{\Gamma\left(\frac{1}{k}\right)\Gamma(y_i+1)}\left(\frac{k\mu_i}{1+k\mu_i}\right)^{y_i}\left(\frac{1}{1+k\mu_i}\right)^{\frac{1}{k}} \tag{3}$$

The abbreviations used in the modeling results were described in Table 5-1.

Table 5-1 Abbreviations used in the modeling results

Category	Abbreviations	Meaning
Crash types (Target variables)	K	Fatal crash
	A	Incapacitating injury crash
	B	Non-incapacitating injury crash
	C	Possible injury crash
	O	Property damage only crash
	WD_AMPEAK	Crash occurred during weekday AM Peak (07:00-08:59)
	WD_OFFPEAK	Crash occurred during weekday off-peak (09:00-15:59)
	WD_PMPEAK	Crash occurred during weekday PM Peak (16:00-17:59)
	WD_NIGHT	Crash occurred during weekday nighttime (18:00-06:59)
	WE_DAY	Crash occurred during weekend daytime (07:00-17:59)
	WE_NIGHT	Crash occurred during weekend daytime (18:00-06:59)
	SV	Single-vehicle collision
	MV	Multiple-vehicle collision
	PED	Pedestrian-involved collision
	BIKE	Bicycle-involved collision
	RAIN	Crash under rainy condition
	FOG	Crash under foggy condition
	DUI	Crash due to driving under the influence of alcohol or drugs
Explanatory variables	LN_HMTS_DENS	Natural log of hotel, motel, timeshare room density
	LN_TOT_EMP	Natural log of total employment
	LN_SCH_DENS	Natural Log of school enrollment density
	P_FREEWAY	Proportion of freeway/expressway
	P_ARTERIAL	Proportion of arterial roads
	P_COLLECTOR	Proportion of collectors
	P_LOCALROAD	Proportion of local roads
	P_HIGHPSL	Proportion of roadway length with Posted Speed Limit higher than 55 mph

Table 5-1, continued.

Explanatory variables	LN_ROAD_DEN	Natural log of roadway density
	P_AGE1524	Proportion of residents between 15 and 24 years old
	LN_SIGNAL_MI	Natural log of signals per mile
	LN_INTER_MI	Natural log of intersections per mile
	LN_VMT	Natural Log of VMT
	P_HEAVY_VMT	Proportion of heavy vehicle in VMT
	LN_BIKELANE	Natural log of bike lane length
	LN_SIDEWALK	Natural log of sidewalk length
	LN_TOT_COM	Natural log of number of total commuters
	P_COM_PUB	Proportion of commuters using public transportation
	P_COM_BIKE	Proportion of commuters using bicycle
	P_COM_WALK	Proportion of commuters by walking
	P_HBWP	Proportion of Home-Based Working trip Production
	P_HBSHP	Proportion of Home-Based Shopping trip Production
	P_HBSRP	Proportion of Home-Based Social and Recreational trip Production
	P_HBWA	Proportion of Home-Based Working trip Attraction
	P_HBSRA	Proportion of Home-Based Social and Recreational trip Attraction
	P_HBOA	Proportion of Home-Based Other trip Attraction
	P_0AUTO	Proportion of families with 0 vehicle
	P_2AUTO	Proportion of families with 2 vehicles
	P_URBAN	Proportion of urban area
	DIST_TO_URBAN	Distance to the nearest urban area
	LN_LAKE_AREA	Natural log of lake or pond area in square mile
Dispersion, Goodness-of-fit measures, etc.	k	Dispersion parameter
	LL	Log-likelihood
	AIC	Akaike Information Criterion
	BIC	Bayesian Information Criterion
	MAD	Mean Absolute Deviation
	Adj_R2	Adjusted R-squared

5.1 Development of Various SPFs for SWTAZs

There are 8,518 SWTAZs in Florida (Figure 5-1). SWTAZs are used by FDOT Central Office for statewide long-term transportation plans. SWTAZs have been widely adopted for macroscopic traffic safety analysis since they are the only spatial unit related transportation. One of the advantages of using SWTAZs is that we can directly use transportation planning data based on SWTAZs for traffic safety analysis. Moreover, SWTAZ based SPFs enable transportation planners to take traffic safety into consideration in the long-term transportation planning.

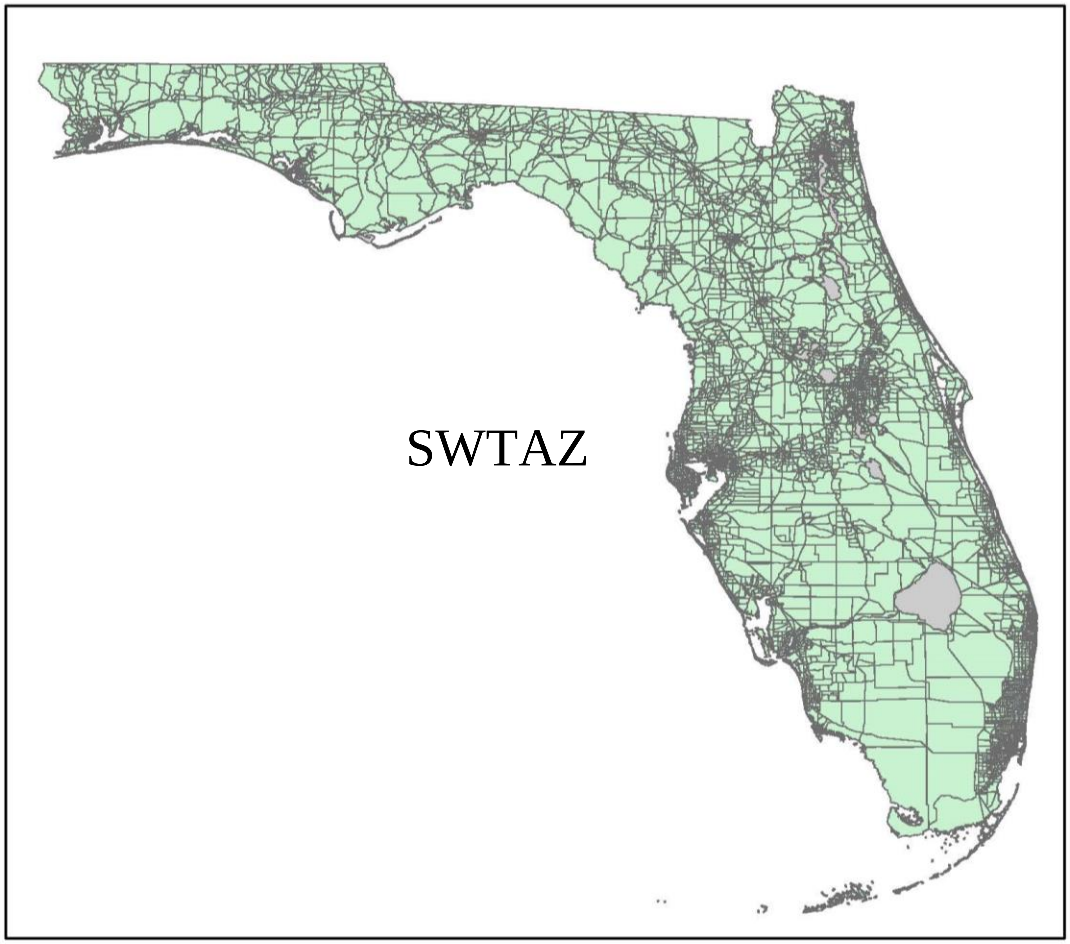


Figure 5-1 Statewide traffic analysis zones (SWTAZs)

Tables 5-2 to 5-4 present the base SPFs by severity levels, time periods, and collision types or special events, respectively. The coefficients of the natural log of VMT (LN_VMT) have a positive sign in all the base SPFs as expected. The values in parentheses indicate p-values for estimated coefficients.

Table 5-2 Base SPFs by severity levels based on SWTAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	1.8099 (<.0001)	0.4312 (<.0001)	-0.4376 (<.0001)	-2.4596 (<.0001)
LN_VMT	0.1787 (<.0001)	0.2158 (<.0001)	0.2339 (<.0001)	0.3132 (<.0001)
k	1.3191	1.1540	0.9807	0.7900
LL	-46895.9	-38308.0	-32568.6	-22567.5
AIC	93797.8	76622.1	65143.3	45141.0
BIC	93819.0	76643.2	65164.4	45162.1
MAD	81.67	27.87	13.16	3.92
Adj_R2	0.162	0.233	0.272	0.284

Table 5-3 Base SPFs by time periods based on SWTAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-0.7621 (<.0001)	0.5148 (<.0001)	-0.3957 (<.0001)	0.4484 (<.0001)	-0.4106 (<.0001)	-0.3926 (<.0001)
LN_VMT	0.1895 (<.0001)	0.1883 (<.0001)	0.1916 (<.0001)	0.1782 (<.0001)	0.1919 (<.0001)	0.1777 (<.0001)
k	1.5740	1.4193	1.4936	1.3639	1.3074	1.2374
LL	-26249.0	-36652.6	-29389.3	-35410.3	-29476.8	-28629.6
AIC	52504.0	73311.1	58784.6	70826.5	58959.5	57265.1
BIC	52525.2	73332.3	58805.7	70847.7	58980.7	57286.3
MAD	7.80	25.60	11.10	21.41	10.36	8.98
Adj_R2	0.130	0.154	0.151	0.146	0.162	0.148

Table 5-4 Base SPFs by collision types or special events based on SWTAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-0.2046 (<.0001)	1.6019 (<.0001)	-3.0681 (<.0001)	-3.6090 (<.0001)	-0.5270 (<.0001)	-7.1409 (<.0001)	-3.2042 (<.0001)
LN_VMT	0.1889 (<.0001)	0.1781 (<.0001)	0.2655 (<.0001)	0.3120 (<.0001)	0.1778 (<.0001)	0.5111 (<.0001)	0.3457 (<.0001)
k	1.0025	1.5987	1.5774	1.6930	1.5917	0.8035	0.7064
LL	-31079.3	-44672.2	-14836.2	-14203.0	-27226.1	-6393.8	-19369.6
AIC	62164.5	89350.4	29678.3	28412.0	54458.1	12793.6	38745.3
BIC	62185.7	89371.5	29699.5	28433.1	54479.3	12814.7	38766.4
MAD	10.85	71.18	1.86	1.79	8.71	0.50	2.65
Adj_R2	0.196	0.137	0.122	0.133	0.126	0.150	0.299

Tables 5-5 to 5-7 present the semi-fully specified SPFs by severity levels, time periods, and collision types or special events, correspondingly. The proportion of arterials (P_ARTERIAL) is not significant in any semi-fully specified SPFs based on SWTAZs whereas the proportion of collectors (P_COLLECTOR) is significant in many semi-fully specified SPFs and it is negatively related to crash counts in most of SPFs except for crash occurred in weekend daytime (WE_NIGHT), pedestrian-involved crash (PED), bicycle-involved crash (BIKE), fog-related crash (FOG) and DUI-related crash (DUI). On the other hand, the proportion of local roads (P_LOCALROAD) is significant in all crash types and it has a positive relationship with the crash counts. It was shown that the natural log of signals per mile (LN_SIGNAL_MI) is significant in SPFs of total crash (KABCO), crash during weekday off-peak (WD_OFFPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), multiple-vehicle-involved crash (MV), pedestrian-involved crash (PED), bicycle-involved crash (BIKE), and fog-related crash (FOG). It is interesting that effect of the signal density is not always consistent. In SPFs of total crash (KABCO), crash during weekday off-peak (WD_OFFPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend nighttime (WE_NIGHT), multiple-vehicle-involved crash (MV), pedestrian-involved crash (PED) and bicycle-involved crash (BIKE), the coefficient of signal density has a positive sign while it has a negative sign in single-vehicle-involved crash (SV) and fog-related crash (FOG) SPFs. It is possible that the natural log of signals per mile (LN_SIGNAL_MI) shows the degree of urbanization. Then it may imply that total crashes, crashes occurring in non-peak hours, multiple-vehicle, pedestrian, and crashes are more likely to occur in the urban area. In contrast, single-vehicle and fog-related crashes are more likely to happen in the rural area. It was revealed that the proportion of heavy vehicle in VMT (P_HEAVY_VMT) is consistently negatively associated to the majority of crash types; except for single-vehicle-involved crash (SV). It was shown that the proportion of heavy vehicle in VMT (P_HEAVY_VMT) is not significant in the SPF of single-vehicle-involved crash (SV).

Table 5-5 Semi-fully specified SPFs by severity levels based on SWTAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	1.5455 (<.0001)	0.1935 (<.0001)	-0.7423 (<.0001)	-2.7474 (<.0001)
P_ARTERIAL				
P_COLLECTOR	-0.3005 (<.0001)	-0.3271 (<.0001)	-0.2300 (<.0001)	-0.2343 (<.0001)
P_LOCALROAD	0.6900 (<.0001)	0.6224 (<.0001)	0.6480 (<.0001)	0.6640 (<.0001)
LN_SIGNAL_MI	0.1473 (<.0001)			
LN_VMT	0.2050 (<.0001)	0.2469 (<.0001)	0.2620 (<.0001)	0.3242 (<.0001)
P_HEAVY_VMT	-6.5691 (<.0001)	-6.3148 (<.0001)	-5.1138 (<.0001)	-2.7226 (<.0001)
k	1.1633	0.9955	0.8450	0.7021
LL	-46249.1	-37650.2	-31996.6	-22210.6
AIC	92512.3	75312.4	64005.3	44433.2
BIC	92561.6	75354.7	64047.6	44475.5
MAD	73.66	25.14	12.08	3.77
Adj_R2	0.267	0.345	0.367	0.332

Table 5-6 Semi-fully specified SPFs by time periods based on SWTAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-0.9321 (<.0001)	0.2369 (<.0001)	-0.5440 (<.0001)	0.1264 (0.0293)	-0.5805 (<.0001)	-0.8256 (<.0001)
P_ARTERIAL						
P_COLLECTOR	-0.5365 (<.0001)	-0.3032 (<.0001)	-0.4422 (<.0001)	-0.2636 (<.0001)	-0.4660 (<.0001)	
P_LOCALROAD	0.6320 (<.0001)	0.7268 (<.0001)	0.5893 (<.0001)	0.7239 (<.0001)	0.5745 (<.0001)	0.7909 (<.0001)
LN_SIGNAL_MI		0.2048 (<.0001)		0.1468 (<.0001)		0.2050 (<.0001)
LN_VMT	0.2236 (<.0001)	0.2139 (<.0001)	0.2283 (<.0001)	0.2064 (<.0001)	0.2181 (<.0001)	0.2030 (<.0001)
P_HEAVY_VMT	-7.6336 (<.0001)	-6.9494 (<.0001)	-8.2576 (<.0001)	-6.2499 (<.0001)	-5.7947 (<.0001)	-5.4976 (<.0001)
k	1.3344	1.2263	1.2599	1.2024	1.1426	1.0863
LL	-25655.6	-35992.6	-28727.2	-34845.5	-28960.2	-28141.9
AIC	51323.3	71999.1	57466.4	69705.0	57932.4	56295.9
BIC	51365.6	72048.5	57508.7	69754.3	57974.7	56338.2
MAD	7.12	22.90	9.97	19.71	9.56	8.35
Adj_R2	0.222	0.263	0.258	0.234	0.247	0.229

Table 5-7 Semi-fully specified SPFs by collision types or special events based on SWTAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-0.5431 (<.0001)	1.3774 (<.0001)	-3.9304 (<.0001)	-4.3025 (<.0001)	-0.6063 (<.0001)	-7.3618 (<.0001)	-3.5359 (<.0001)
P_ARTERIAL							
P_COLLECTOR	-0.1557 (0.0083)	-0.3507 (<.0001)			-0.5403 (<.0001)		
P_LOCALROAD	0.5775 (<.0001)	0.7097 (<.0001)	1.4631 (<.0001)	1.4836 (<.0001)	0.4211 (<.0001)	0.2337 (0.0016)	0.8459 (<.0001)
LN_SIGNAL_MI	-0.2212 (<.0001)	0.2235 (<.0001)	0.5209 (<.0001)	0.3949 (<.0001)		-0.1477 (0.0084)	
LN_VMT	0.1948 (<.0001)	0.2067 (<.0001)	0.2966 (<.0001)	0.3498 (<.0001)	0.2007 (<.0001)	0.5019 (<.0001)	0.3634 (<.0001)
P_HEAVY_VMT		-8.2278 (<.0001)	-8.3203 (<.0001)	-12.3751 (<.0001)	-4.8761 (<.0001)	2.7546 (<.0001)	-5.6357 (<.0001)
k	0.9354	1.3895	1.1168	1.0930	1.4642	0.7499	0.5428
LL	-30807.2	-43956.4	-14134.7	-13341.0	-26914.7	-6356.8	-18732.8
AIC	61626.4	87926.8	28281.5	26693.9	53841.4	12725.5	37475.6
BIC	61668.7	87976.2	28323.8	26736.2	53883.7	12767.8	37510.8
MAD	10.46	63.34	1.69	1.55	8.30	0.49	2.44
Adj_R2	0.231	0.248	0.148	0.257	0.176	0.162	0.393

Tables 5-8 to 5-10 present the fully specified SPFs by severity levels, time periods, and collision types or special events. It was uncovered that the natural log of hotel, motel, timeshare room density (LN_HMTS_DENS) is significant in many SPFs. The coefficient of the natural log of hotel, motel, timeshare room density (LN_HMTS_DENS) has a positive sign in SPFs of total crash (KABCO), crash during weekday off-peak (WD_OFFPEAK), crash during weekday PM peak (WD_PMPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), multiple-vehicle-involved crash (MV), pedestrian-involved crash (PED), bicycle-involved crash (BIKE), and DUI-related crash (DUI) while it has a negative sign in SPFs of fatal and incapacitating injury crash (KA), crash during weekday AM peak (WD_AMPEAK), single vehicle-involved crash (SV), and fog-related crash (FOG). The natural log of total employment (LN_TOT_EMP) is positively related to crash counts in most of SPFs; however, it is not significant in the DUI-related crash (DUI) SPF. It was also shown that the natural log of school enrollment density (LN_SCH_DENS) is significant in all SPFs. In most of cases, its coefficient has a positive sign whereas its coefficient has a negative sign only in the fog-related crash (FOG) SPF.

The natural log of bike lane length (LN_BIKELANE) is found significant in SPFs of fatal and incapacitating injury crash (KA), crash during weekday PM peak (WD_PMPEAK), single-vehicle-involved crash (SV), pedestrian-involved crash (PED), fog-related crash (FOG), and DUI-related crash (DUI). Its effectiveness on crash frequency is positive in fatal and incapacitating injury crash (KA), crash during weekday

PM peak (WD_PMPEAK), single-vehicle-involved crash (SV), fog-related crash (FOG), and DUI-related crash (DUI) whereas it is negative in pedestrian-involved crash (PED). Moreover, the natural log of sidewalk length (LN_SIDEWALK) is significant in many SPFs. It is positively related to crash counts in most of SPFs; however, it was not significant in SPF of crash during weekday PM peak (WD_PMPEAK) and fog-related crash (FOG).

It was found that the proportion of commuters using public transportation (P_COM_PUB) is significant in the most of SPFs except for single-vehicle-involved crash (SV). Its coefficient has a positive sign in most of cases but it has a negative sign in SPF of fog-related crash (FOG) and DUI-related crash (DUI). Positive relationships between the proportion of commuters using bicycle (P_COM_BIKE) and crash frequency were shown in SPFs of pedestrian-involved crash (PED), bicycle-involved crash (BIKE), and DUI-related crash (DUI). On the contrary, negative relationships between the proportion of commuters using bicycle (P_COM_BIKE) and crash counts were found in SPFs of total crash (KABCO), fatal and incapacitating injury crash (KA), crash during weekday AM peak (WD_AMPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekday daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), rain-related crash (RAIN), and fog-related crash (FOG). It was discovered that the proportion of commuters by walking (P_COM_WALK) is positively related to crash counts only in pedestrian-involved crash (PED) and bicycle-involved crash (BIKE) while it is negatively related with crash frequency in total crash

(KABCO), fatal and injury crash (KABC), fatal and severe injury crash (KAB), fatal and incapacitating injury crash (KA), crash during weekday AM peak (WD_AMPEAK), crash during weekday off-peak (WD_OFFPEAK), crash during weekday PM peak (WD_PMPEAK), crash during nighttime (WD_NIGHT), crash during daytime (WE_DAY), single-vehicle-involved crash (SV), multiple-vehicle-involved crash (MV), rain-related crash (RAIN), and fog-related crash (FOG). Distance to the nearest urban area (DIST_TO_URBAN) has a positive sign in the almost all SPFs except for fog-related crash (FOG). In the fog-related crash (FOG) SPF, it has a negative sign, which implies that fog crashes are more frequent in the rural area. Lastly, it is noteworthy to mention that the natural log of lake or pond area in square mile (LN_LAKE_AREA) is only significant in the fog-related crash (FOG) SPF and it was positively related to fog crashes.

Table 5-8 Fully specified SPFs by severity levels based on SWTAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	0.5239 (<.0001)	-0.7559 (<.0001)	-1.5289 (<.0001)	-3.1497 (<.0001)
LN_HMTS_DENS	0.0184 (<.0001)			-0.0281 (<.0001)
LN_TOT_EMP	0.2513 (<.0001)	0.2433 (<.0001)	0.2326 (<.0001)	0.2175 (<.0001)
LN_SCH_DENS	0.0483 (<.0001)	0.0371 (<.0001)	0.0280 (<.0001)	0.0118 (0.0013)
P_ARTERIAL				
P_COLLECTOR	-0.6579 (<.0001)	-0.5103 (<.0001)	-0.3776 (<.0001)	-0.3388 (<.0001)
P_LOCALROAD		0.0793 (0.0354)	0.1622 (<.0001)	0.2688 (<.0001)
LN_SIGNAL_MI				
LN_VMT	0.1228 (<.0001)	0.1621 (<.0001)	0.1762 (<.0001)	0.2294 (<.0001)
P_HEAVY_VMT	-1.5487 (<.0001)	-1.5415 (<.0001)	-0.9513 (<.0001)	
LN_BIKELANE				0.0888 (0.0008)
LN_SIDEWALK	0.2633 (<.0001)	0.2488 (<.0001)	0.2190 (<.0001)	0.1002 (<.0001)
P_COM_PUB	3.6087 (<.0001)	2.3693 (<.0001)	0.9150 (<.0001)	0.5743 (0.0315)
P_COM_BIKE	-1.1734 (0.0050)			-1.0187 (0.0319)
P_COM_WALK	-1.1944 (<.0001)	-1.9465 (<.0001)	-1.8161 (<.0001)	-1.6823 (<.0001)
DIST_TO_URBAN	-0.0462 (<.0001)	-0.0391 (<.0001)	-0.0275 (<.0001)	-0.0124 (<.0001)
k	0.7844	0.6798	0.6073	0.5993
LL	-44338.2	-36023.4	-30716.1	-21595.1
AIC	88702.4	72070.7	61456.2	43218.2
BIC	88794.1	72155.3	61540.8	43316.9
MAD	60.74	21.14	10.68	3.66
Adj_R2	0.435	0.491	0.481	0.368

Table 5-9 Fully specified SPFs by Time Periods based on SWTAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-1.9128 (<.0001)	-0.8630 (<.0001)	-1.7152 (<.0001)	-0.8740 (<.0001)	-1.6751 (<.0001)	-1.8980 (<.0001)
LN_HMTS_DENS	-0.0124 (0.0181)	0.0156 (0.0007)	0.0174 (0.0004)	0.0215 (<.0001)	0.0181 (0.0002)	0.0221 (<.0001)
LN_TOT_EMP	0.2635 (<.0001)	0.2697 (<.0001)	0.2751 (<.0001)	0.2556 (<.0001)	0.2434 (<.0001)	0.2477 (<.0001)
LN_SCH_DENS	0.0554 (<.0001)	0.0502 (<.0001)	0.0494 (<.0001)	0.0488 (<.0001)	0.0367 (<.0001)	0.0403 (<.0001)
P_ARTERIAL						
P_COLLECTOR	-0.7197 (<.0001)	-0.6812 (<.0001)	-0.6883 (<.0001)	-0.6010 (<.0001)	-0.6116 (<.0001)	-0.3982 (<.0001)
P_LOCALROAD					0.0878 (0.0397)	0.1354 (0.0009)
LN_SIGNAL_MI		0.0624 (0.0018)				
LN_VMT	0.1339 (<.0001)	0.1251 (<.0001)	0.1504 (<.0001)	0.1222 (<.0001)	0.1355 (<.0001)	0.1306 (<.0001)
P_HEAVY_VMT	-2.6108 (<.0001)	-1.6860 (<.0001)	-3.1406 (<.0001)	-1.1552 (<.0001)	-0.7070 (0.0046)	-0.8796 (0.0003)
LN_BIKELANE			0.0963 (0.0006)			
LN_SIDEWALK	0.1619 (<.0001)	0.2945 (<.0001)		0.2355 (<.0001)	0.2548 (<.0001)	0.2212 (<.0001)
P_COM_PUB	3.7959 (<.0001)	3.2892 (<.0001)	3.3980 (<.0001)	3.9967 (<.0001)	3.2151 (<.0001)	4.2716 (<.0001)
P_COM_BIKE	-2.4552 (<.0001)			-1.8927 (<.0001)	-1.5749 (0.0009)	-1.1596 (0.0049)
P_COM_WALK	-2.8414 (<.0001)	-1.0907 (<.0001)	-2.2059 (<.0001)	-1.6866 (<.0001)	-1.3088 (<.0001)	
DIST_TO_URBAN	-0.0630 (<.0001)	-0.0498 (<.0001)	-0.0604 (<.0001)	-0.0476 (<.0001)	-0.0407 (<.0001)	-0.0334 (<.0001)
k	0.8970	0.7847	0.8397	0.8023	0.7905	0.7227
LL	-24245.5	-34086.1	-27201.2	-33110.9	-27555.4	-26614.7
AIC	48517.0	68198.1	54426.4	66247.7	55138.7	53255.4
BIC	48608.7	68289.8	54511.0	66339.4	55237.4	53347.1
MAD	6.20	19.00	8.59	16.61	8.35	7.20
Adj_R2	0.351	0.423	0.384	0.391	0.384	0.378

Table 5-10 Fully specified SPFs by Collision Types or Special Events based on SWTAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-1.0043 (<.0001)	0.2090 (<.0001)	-5.3065 (<.0001)	-5.2053 (<.0001)	-1.5839 (<.0001)	-6.9285 (<.0001)	-3.7878 (<.0001)
LN_HMTS_DENS	-0.0182 (0.0002)	0.0257 (<.0001)	0.0250 (<.0001)	0.0184 (0.0022)		-0.0308 (0.0047)	0.1932 (<.0001)
LN_TOT_EMP	0.2048 (<.0001)	0.2601 (<.0001)	0.2888 (<.0001)	0.2508 (<.0001)	0.2285 (<.0001)	0.0914 (<.0001)	
LN_SCH_DENS	0.0153 (<.0001)	0.0568 (<.0001)	0.0434 (<.0001)	0.0439 (<.0001)	0.0400 (<.0001)	-0.0301 (<.0001)	0.0101 (0.0053)
P_ARTERIAL							
P_COLLECTOR	-0.3140 (<.0001)	-0.7453 (<.0001)	0.9312 (<.0001)		-0.6202 (<.0001)		-0.1478 (0.0120)
P_LOCALROAD	0.1367 (0.0019)			0.9430 (<.0001)		0.2216 (0.0027)	0.5341 (<.0001)
LN_SIGNAL_MI	-0.2162 (<.0001)	0.0747 (0.0004)		0.1524 (<.0001)			
LN_VMT	0.1301 (<.0001)	0.1230 (<.0001)	0.1788 (<.0001)	0.2124 (<.0001)	0.1229 (<.0001)	0.4175 (<.0001)	0.2504 (<.0001)
P_HEAVY_VMT	1.6130 (<.0001)	-2.7246 (<.0001)	-2.3843 (<.0001)	-5.5383 (<.0001)		2.0949 (<.0001)	-2.4019 (<.0001)
LN_BIKELANE	0.0854 (0.0026)		-0.1039 (0.0015)			0.1982 (<.0001)	0.1021 (<.0001)
LN_SIDEWALK	0.0674 (0.0010)	0.2995 (<.0001)	0.4166 (<.0001)	0.4169 (<.0001)	0.1622 (<.0001)		0.1772 (<.0001)
P_COM_PUB		4.2328 (<.0001)	5.9113 (<.0001)	3.1999 (<.0001)	3.8661 (<.0001)	-3.0194 (<.0001)	-0.8465 (0.0017)
P_COM_BIKE	-3.5210 (<.0001)		1.3750 (0.0124)	5.7402 (<.0001)	-3.5493 (<.0001)	-3.3763 (0.0152)	1.4123 (0.0008)
P_COM_WALK	-2.5506 (<.0001)	-1.4166 (<.0001)	1.4496 (<.0001)	1.1972 (0.0012)	-2.1932 (<.0001)	-1.7170 (0.0328)	
DIST_TO_URBAN	-0.0134 (<.0001)	-0.0649 (<.0001)	-0.0589 (<.0001)	-0.1409 (<.0001)	-0.0509 (<.0001)	0.0104 (0.0235)	-0.0181 (<.0001)
LN_LAKE_AREA						0.2842 (<.0001)	
k	0.7773	0.9010	0.5762	0.6208	1.0944	0.6682	0.4603
LL	-30064.4	-41893.5	-12783.8	-12145.9	-25845.2	-6277.2	-18145.0
AIC	60158.9	83813.0	25597.5	24319.9	51712.3	12582.4	36315.9
BIC	60264.6	83904.7	25703.3	24418.6	51789.9	12681.1	36407.6
MAD	9.78	52.44	1.42	1.36	7.36	0.48	2.36
Adj_R2	0.296	0.411	0.418	0.398	0.295	0.182	0.432

Table 5-11 compares AIC, BIC, MAD and adjusted R^2 in base, semi-fully specified, and fully specified SPFs. It is evident that the models are significantly improved if more explanatory variables are included. Nevertheless, it needs much time and efforts to collect and process demographic, socio-economic, and other geographic data for estimating fully specified SPFs. Thus, it is a trade-off between model complexity and accuracy. Types of SPFs should be chosen considering data availability and required prediction accuracy. For example, if practitioners want to compute the most accurate and reliable predicted number of crashes, fully specified SPFs are recommended to use. On the other hand, in case practitioners need a simpler model with the limited number of variables despite of lower predictability, base or semi-fully specified SPFs can be considered.

Table 5-11 Comparison of goodness-of-fit measures between SWTAZ SPFs

Crash types	AIC			BIC			MAD			Adj_R2		
	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full
KABCO	93797.8	92512.3	88702.4	93819.0	92561.6	88794.1	81.67	73.66	60.74	0.162	0.267	0.435
KABC	76622.1	75312.4	72070.7	76643.2	75354.7	72155.3	27.87	25.14	21.14	0.233	0.345	0.491
KAB	65143.3	64005.3	61456.2	65164.4	64047.6	61540.8	13.16	12.08	10.68	0.272	0.367	0.481
KA	45141.0	44433.2	43218.2	45162.1	44475.5	43316.9	3.92	3.77	3.66	0.284	0.332	0.368
WD_AMPEAK	52504.0	51323.3	48517.0	52525.2	51365.6	48608.7	7.80	7.12	6.20	0.130	0.222	0.351
WD_OFFPEAK	73311.1	71999.1	68198.1	73332.3	72048.5	68289.8	25.60	22.90	19.00	0.154	0.263	0.423
WD_PMPEAK	58784.6	57466.4	54426.4	58805.7	57508.7	54511.0	11.10	9.97	8.59	0.151	0.258	0.384
WD_NIGHT	70826.5	69705.0	66247.7	70847.7	69754.3	66339.4	21.41	19.71	16.61	0.146	0.234	0.391
WE_DAY	58959.5	57932.4	55138.7	58980.7	57974.7	55237.4	10.36	9.56	8.35	0.162	0.247	0.384
WE_NIGHT	57265.1	56295.9	53255.4	57286.3	56338.2	53347.1	8.98	8.35	7.20	0.148	0.229	0.378
SV	62164.5	61626.4	60158.9	62185.7	61668.7	60264.6	10.85	10.46	9.78	0.196	0.231	0.296
MV	89350.4	87926.8	83813.0	89371.5	87976.2	83904.7	71.18	63.34	52.44	0.137	0.248	0.411
PED	29678.3	28281.5	25597.5	29699.5	28323.8	25703.3	1.86	1.69	1.42	0.122	0.148	0.418
BIKE	28412.0	26693.9	24319.9	28433.1	26736.2	24418.6	1.79	1.55	1.36	0.133	0.257	0.398
RAIN	54458.1	53841.4	51712.3	54479.3	53883.7	51789.9	8.71	8.30	7.36	0.126	0.176	0.295
FOG	12793.6	12725.5	12582.4	12814.7	12767.8	12681.1	0.50	0.49	0.48	0.150	0.162	0.182
DUI	38745.3	37475.6	36315.9	38766.4	37510.8	36407.6	2.65	2.44	2.36	0.299	0.393	0.432

5.2 Development of Various SPFs for TSAZs

Basically TAZs are designed to find out origin-destination pairs of trips generated from each zone. Thus, transportation planners need to minimize trips which start and end in the same zone. It is inferred that minimizing intra-zonal trips ends up with the small size of TAZs. On the other hand, traffic safety analysts need to consider traffic crashes that occur inside zones so they can be related to zonal characteristics with traffic safety of the zones. Therefore, it is possible that TAZs are too small to analyze traffic safety at the macroscopic level. Moreover, TAZs are usually divided by physical boundaries, mostly arterial roadways. Considering that many crashes occur on arterial roads, between zones, inaccurate results will be made from relating traffic crashes on the boundary of the zone to only the characteristics of that zone (Siddiqui and Abdel-Aty, 2012). A simple way to overcome these two issues while using TAZs for safety analysis is to aggregate TAZs into sufficiently large and homogenous traffic crash patterns.

The existing zones were aggregated based on the following conditions (Lee et al. 2014):

- Zones are spatially contiguous; and
- Zones have same crash rate levels.

Table 5-12 contrasts the areas in statewide TAZ (SWTAZ) and TSAZ. As shown in the table, the number of zones in TSAZ (N=1,754) is one-fifth of SWTAZ (N=8,518), and the average area in TSAZ is 18.061 mi^2 whereas that in SWTAZ is 6.472 mi^2.

Table 5-12 Area in SWTAZs and TSAZs

Zone system	No of zones	Average (mi^2)	Stdev
SWTAZs	8,518	6.472	24.803
TSAZs	1,754	18.061	226.645

Table 5-13 compares the numbers and percentages of boundary crashes in SWTAZ and TSAZ. There are 68.2% boundary crashes in SWTAZ whereas there are 47.0% boundary crashes in TSAZ. In other words, more than 20% of boundary crashes has been reduced after the regionalization.

Table 5-13 Boundary crashes in SWTAZs and TSAZs

Zone system	Boundary crashes	Total crashes	Percentage
SWTAZs	614,671	901,235	68.2%
TSAZs	423,275		47.0%

Figure 5-2 compares SWTAZ and TSAZ maps in Districts 6 (Miami-Dade and Broward area). As presented in the figures, the zones are highly aggregated especially in the urban area.

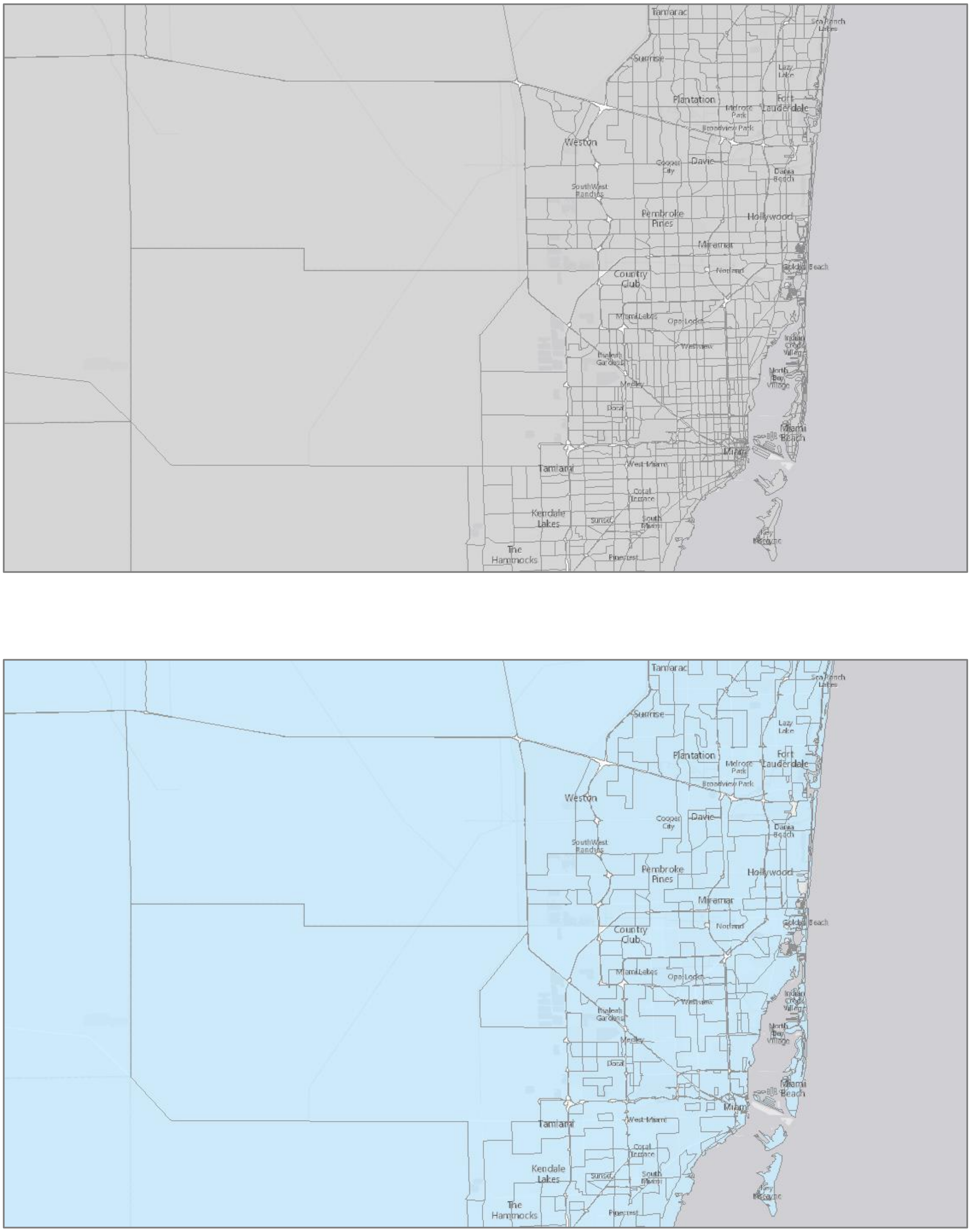


Figure 5-2 TAZs (upper) and TSAZs (lower) in District 6 – Miami-Dade and Broward area

Table 5-14 to 5-16 show the base SPFs based on TSAZs by severity levels, time periods, and collision types or special events, respectively. The natural Log of VMT (LN_VMT) has a positive relationship with crash counts in all SPFs.

Table 5-14 Base SPFs by severity levels based on TSAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	1.3717 (<.0001)	0.1381 (0.0412)	-0.6916 (<.0001)	-3.0809 (<.0001)
LN_VMT	0.3146 (<.0001)	0.3338 (<.0001)	0.3454 (<.0001)	0.4409 (<.0001)
k	1.8420	1.7179	1.5775	1.2299
LL	-11046.3	-9305.6	-8154.3	-6008.9
AIC	22098.5	18617.2	16314.7	12023.8
BIC	22114.9	18633.6	16331.1	12040.2
MAD	448.43	158.96	77.89	21.07
Adj_R2	0.149	0.191	0.199	0.225

Table 5-15 Base SPFs by time periods based on TSAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-1.2664 (<.0001)	-0.0058 (0.9343)	-0.7554 (<.0001)	-0.0162 (0.8226)	-0.9113 (<.0001)	-1.0339 (<.0001)
LN_VMT	0.3299 (<.0001)	0.3290 (<.0001)	0.3193 (<.0001)	0.3161 (<.0001)	0.3311 (<.0001)	0.3300 (<.0001)
k	2.1925	1.8872	2.0895	1.9712	1.8106	1.8671
LL	-6719.6	-8901.7	-7413.0	-8637.8	-7468.5	-7227.0
AIC	13445.2	17809.5	14831.9	17281.6	14943.1	14460.0
BIC	13461.6	17825.9	14848.3	17298.0	14959.5	14476.4
MAD	38.96	134.94	57.44	115.33	53.82	48.13
Adj_R2	0.157	0.145	0.154	0.146	0.163	0.158

Table 5-16 Base SPFs by collision types or special events based on TSAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-0.4766 (<.0001)	1.1190 (<.0001)	-6.4041 (<.0001)	-7.0192 (<.0001)	-0.9441 (<.0001)	-10.3441 (<.0001)	-4.6820 (<.0001)
LN_VMT	0.3099 (<.0001)	0.3177 (<.0001)	0.6277 (<.0001)	0.6772 (<.0001)	0.3135 (<.0001)	0.8316 (<.0001)	0.5435 (<.0001)
k	1.6242	2.0072	1.4923	1.4570	2.1517	0.6201	0.9046
LL	-7917.8	-10572.4	-4008.6	-3871.2	-6994.6	-1989.9	-5301.9
AIC	15841.7	21150.8	8023.2	7748.5	13995.3	3985.8	10609.7
BIC	15858.1	21167.2	8039.6	7764.9	14011.7	4002.2	10626.2
MAD	62.16	370.72	6.92	6.40	43.22	1.43	12.24
Adj_R2	0.140	0.134	0.324	0.400	0.156	0.502	0.378

Table 5-17 to 5-19 display the semi-fully specified SPFs based on TSAZs by severity levels, time periods, and collision or special events, correspondingly. It was discovered that the proportion of arterial roads (P_ARTERIAL) is negatively related to crash frequency when it is significant whereas the proportion of local roads (P_LOCALROAD) is always significant and it is positively associated with crash frequency. Furthermore, the natural log of signals per mile (LN_SIGNAL_MI) is also significant in most SPFs. It has a positive sign in the majority of cases; nevertheless, it has a negative sign only in SPF of single-vehicle-involved crash (SV). It may indicate single-vehicle-involved crash (SV) are more frequent in the areas with less signal density. It was exposed that the proportion of heavy vehicle in VMT (P_HEAVY_VMT) is negatively associated to most of crash types. Nevertheless, it is not significant in SPFs of fatal and incapacitating injury crash (KA) and fog-related crash (FOG).

Table 5-17 Semi-fully specified SPFs by severity levels based on TSAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	0.4692 (<.0001)	-0.7163 (<.0001)	-1.4847 (<.0001)	-4.0956 (<.0001)
P_ARTERIAL	-0.4692 (0.0022)	-0.6991 (<.0001)	-0.5587 (0.0002)	
P_LOCALROAD	1.4266 (<.0001)	1.3038 (<.0001)	1.2246 (<.0001)	1.5726 (<.0001)
LN_SIGNAL_MI	0.1870 (0.0265)	0.1901 (0.0194)		
LN_VMT	0.3615 (<.0001)	0.3843 (<.0001)	0.3923 (<.0001)	0.4461 (<.0001)
P_HEAVY_VMT	-8.1425 (<.0001)	-7.2794 (<.0001)	-6.2801 (<.0001)	
k	1.4905	1.3598	1.2568	1.0445
LL	-10804.2	-9064.5	-7940.5	-5871.5
AIC	21622.4	18143.1	15893.1	11751.1
BIC	21660.7	18181.4	15925.9	11773.0
MAD	399.59	141.15	69.95	19.77
Adj_R2	0.218	0.280	0.283	0.297

Table 5-18 Semi-fully specified SPFs by time periods based on TSAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-2.6233 (<.0001)	-0.9377 (<.0001)	-2.0133 (<.0001)	-0.9803 (<.0001)	-1.8704 (<.0001)	-2.0503 (<.0001)
P_ARTERIAL		-0.5512 (0.0008)		-0.3980 (0.0160)	-0.5001 (0.0021)	-0.7740 (<.0001)
P_LOCALROAD	1.8880 (<.0001)	1.4515 (<.0001)	1.7860 (<.0001)	1.4778 (<.0001)	1.4254 (<.0001)	1.4751 (<.0001)
LN_SIGNAL_MI		0.3000 (0.0008)				0.2933 (0.0004)
LN_VMT	0.3901 (<.0001)	0.3764 (<.0001)	0.3772 (<.0001)	0.3665 (<.0001)	0.3807 (<.0001)	0.3838 (<.0001)
P_HEAVY_VMT	-8.7713 (<.0001)	-8.2838 (<.0001)	-8.9547 (<.0001)	-7.7046 (<.0001)	-6.5473 (<.0001)	-7.1865 (<.0001)
k	1.6892	1.4894	1.6284	1.5948	1.4308	1.4362
LL	-6492.1	-8659.4	-7180.9	-8421.5	-7253.6	-6991.5
AIC	12994.2	17332.9	14371.8	16855.1	14519.3	13997.1
BIC	13021.6	17371.1	14399.1	16887.9	14552.1	14035.4
MAD	34.68	119.86	50.93	104.59	48.12	43.36
Adj_R2	0.251	0.218	0.240	0.216	0.245	0.238

Table 5-19 Semi-fully specified SPFs by collision types or special events based on TSAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-0.9848 (<.0001)	0.0770 (0.5393)	-7.6613 (<.0001)	-7.5909 (<.0001)	-1.7446 (<.0001)	-10.3759 (<.0001)	-5.4778 (<.0001)
P_ARTERIAL	-0.7052 (<.0001)	-0.3761 (0.0199)		-0.8575 (<.0001)	-0.5767 (0.0017)		
P_LOCALROAD	0.9087 (<.0001)	1.5959 (<.0001)	2.1598 (<.0001)	1.7545 (<.0001)	1.2711 (<.0001)	0.3031 (0.0207)	1.4498 (<.0001)
LN_SIGNAL_MI	-0.2999 (<.0001)	0.3213 (0.0004)	0.7287 (<.0001)	0.7946 (<.0001)			0.1476 (0.0196)
LN_VMT	0.3427 (<.0001)	0.3682 (<.0001)	0.6446 (<.0001)	0.6803 (<.0001)	0.3578 (<.0001)	0.8190 (<.0001)	0.5683 (<.0001)
P_HEAVY_VMT	-3.5262 (<.0001)	-9.4289 (<.0001)	-8.1030 (<.0001)	-10.2245 (<.0001)	-6.2066 (<.0001)		-6.4794 (<.0001)
k	1.3836	1.5970	0.9810	0.9222	1.8054	0.6179	0.6288
LL	-7767.3	-10312.9	-3778.4	-3614.7	-6840.2	-1987.2	-5056.7
AIC	15548.5	20639.8	7568.9	7243.3	13692.3	3982.4	10125.5
BIC	15586.8	20678.1	7601.7	7281.6	13725.1	4004.3	10158.3
MAD	58.11	327.61	6.13	5.43	39.93	1.43	10.63
Adj_R2	0.191	0.204	0.420	0.538	0.224	0.502	0.452

Table 5-20 to 5-22 show the fully specified SPFs based on TSAZs by severity levels, time periods, and collision types or special events, respectively. Different from the fully specified SPFs based on TAZs, only a few additional socio-demographic variables were included in the TSAZ-based SPFs because many variables are highly correlated each other in TSAZs.

The natural Log of school enrollment density (LN_SCH_DENS) has a positive coefficient sign in the most of SPFs although it is not significant in fatal and incapacitating injury crash (KA) and fog-related crash (FOG) SPFs. It was shown that the proportion of urban area (P_URBAN) is negatively associated with crash counts in severe injury crash (KAB), fatal and incapacitating injury crash (KA), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), fog-related crash (FOG), and DUI-related crash (DUI). In contrast, it is positively related to crash frequency only in bicycle-involved crash (BIKE). Moreover, the natural log of bike lane length (LN_BIKELANE) is significant in the most SPFs except for fog-related crash (FOG). It has a positive coefficient when it is significant.

It was uncovered that the proportion of commuters using public transportation (P_COM_PUB) has a positive coefficient in the majority of cases. The only exception is the fog-related crash (FOG), in which the proportion of commuters using public transportation (P_COM_PUB) is not significant. Furthermore, the proportion of commuters using bicycle (P_COM_BIKE) has a negative effect on crash counts in general (i.e., total crash (KABCO), fatal and injury crash (KABC), crash during weekday AM peak (WD_AMPEAK), crash during weekday off-peak (WD_OFFPEAK), crash during weekday PM peak (WD_PMPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), multiple-vehicle-involved crash (MV), and rain-related crash (RAIN)); however, it has a positive effect only on bicycle-involved crashes (BIKE). In case of the proportion of commuters by walking (P_COM_WALK), it has a negative sign in the many SPFs; nevertheless, it is not significant in fatal and incapacitating injury crash (KA), pedestrian-involved crash (PED), bicycle-involved crash (BIKE), fog-related crash (FOG), and DUI-related crash (DUI). As in the fog-related crash (FOG) SPF based on TAZs, the natural log of lake or pond area in square mile (LN_LAKE_AREA) has a positive effect on fog crashes based on TSAZs.

Table 5-20 Fully specified SPFs by severity levels based on TSAZs

Parameters	KABCO	KABC	KAB	KA
Intercept	0.4533 (<.0001)	-0.4916 (<.0001)	-0.9971 (<.0001)	-3.3923 (<.0001)
LN_SCH_DENS	0.1197 (<.0001)	0.0930 (<.0001)	0.0916 (<.0001)	
P_ARTERIAL		-0.4929 (0.0005)	-0.3975 (0.0043)	
P_LOCALROAD	1.0929 (<.0001)	0.8721 (<.0001)	0.8753 (<.0001)	1.2773 (<.0001)
LN_SIGNAL_MI		0.1688 (0.0210)	0.1440 (0.0433)	
LN_VMT	0.2676 (<.0001)	0.2937 (<.0001)	0.3009 (<.0001)	0.3709 (<.0001)
P_HEAVY_VMT	-4.2794 (<.0001)	-4.2150 (<.0001)	-4.1243 (<.0001)	
P_URBAN			-0.3274 (<.0001)	-0.1972 (0.0072)
LN_BIKELANE	0.5317 (<.0001)	0.5444 (<.0001)	0.5397 (<.0001)	0.5235 (<.0001)
P_COM_PUB	7.9379 (<.0001)	6.0874 (<.0001)	4.8267 (<.0001)	4.7546 (<.0001)
P_COM_BIKE	-4.2149 (0.0029)	-3.2211 (0.0212)		
P_COM_WALK	-4.0968 (<.0001)	-4.3437 (<.0001)	-4.1332 (<.0001)	
k	1.2057	1.1007	1.0020	0.8927
LL	-10570.0	-8852.7	-7729.0	-5727.2
AIC	21159.9	17729.4	15481.9	11468.4
BIC	21214.6	17795.1	15547.6	11506.7
MAD	326.61	111.55	55.13	16.00
Adj_R2	0.472	0.595	0.631	0.698

Table 5-21 Fully specified SPFs by time periods based on TSAZs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-2.3081 (<.0001)	-0.7773 (<.0001)	-1.6960 (<.0001)	-0.8360 (<.0001)	-1.5133 (<.0001)	-1.6845 (<.0001)
LN_SCH_DENS	0.1188 (<.0001)	0.1248 (<.0001)	0.1154 (<.0001)	0.1253 (<.0001)	0.1031 (<.0001)	0.1104 (<.0001)
P_ARTERIAL		-0.4275 (0.0040)		-0.3372 (0.0218)	-0.3037 (0.0359)	-0.5130 (0.0008)
P_LOCALROAD	1.2508 (<.0001)	0.9645 (<.0001)	1.2026 (<.0001)	0.9102 (<.0001)	0.9594 (<.0001)	0.9727 (<.0001)
LN_SIGNAL_MI		0.2497 (0.0016)				0.2189 (0.0041)
LN_VMT	0.2925 (<.0001)	0.2799 (<.0001)	0.2782 (<.0001)	0.2722 (<.0001)	0.2912 (<.0001)	0.2888 (<.0001)
P_HEAVY_VMT	-5.0740 (<.0001)	-4.5071 (<.0001)	-5.3927 (<.0001)	-3.8559 (<.0001)	-3.7539 (<.0001)	-4.2108 (<.0001)
P_URBAN					-0.2173 (0.0128)	-0.2190 (0.0123)
LN_BIKELANE	0.4764 (<.0001)	0.5193 (<.0001)	0.5184 (<.0001)	0.5155 (<.0001)	0.5036 (<.0001)	0.5042 (<.0001)
P_COM_PUB	8.5650 (<.0001)	7.2477 (<.0001)	7.6069 (<.0001)	8.6992 (<.0001)	8.0792 (<.0001)	9.1282 (<.0001)
P_COM_BIKE	-4.3555 (0.0076)	-3.4928 (0.0121)	-4.2315 (0.0060)	-5.2789 (0.0005)	-4.8082 (0.0017)	-5.2231 (0.0007)
P_COM_WALK	-4.4587 (<.0001)	-4.2475 (<.0001)	-4.6296 (<.0001)	-3.9643 (<.0001)	-3.3224 (<.0001)	-3.0915 (0.0008)
k	1.3599	1.1942	1.3191	1.2605	1.1394	1.1142
LL	-6311.9	-8433.7	-6988.1	-8186.0	-7049.4	-6768.7
AIC	12643.8	16891.3	13996.3	16394.0	14122.7	13563.3
BIC	12698.5	16956.9	14051.0	16454.1	14188.3	13634.4
MAD	29.03	99.00	42.52	85.08	39.57	35.09
Adj_R2	0.481	0.453	0.480	0.465	0.503	0.502

Table 5-22 Fully specified SPFs by collision types or special events based on TSAZs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-0.2099 (0.1286)	0.1943 (0.1003)	-6.8921 (<.0001)	-7.6585 (<.0001)	-1.4917 (<.0001)	-9.3195 (<.0001)	-4.3574 (<.0001)
LN_SCH_DENS	0.0752 (<.0001)	0.1324 (<.0001)	0.1136 (<.0001)	0.0925 (<.0001)	0.1024 (<.0001)		0.0498 (<.0001)
P_ARTERIAL	-0.6202 (<.0001)	-0.3449 (0.0208)		-0.4590 (<.0001)	-0.4805 (0.0035)		
P_LOCALROAD	0.5864 (<.0001)	1.0501 (<.0001)	1.5750 (<.0001)	1.3080 (0.0215)	0.7517 (<.0001)	0.5006 (0.0002)	1.2475 (<.0001)
LN_SIGNAL_MI	-0.1839 (0.0062)	0.2814 (0.0006)	0.4700 (<.0001)	0.4601 (<.0001)			0.1239 (0.0449)
LN_VMT	0.2570 (<.0001)	0.2736 (<.0001)	0.5112 (<.0001)	0.5722 (<.0001)	0.2633 (<.0001)	0.7389 (<.0001)	0.4385 (<.0001)
P_HEAVY_VMT	-2.3106 (0.0006)	-5.3888 (<.0001)	-5.3685 (<.0001)	-6.1078 (<.0001)	-2.4248 (0.0011)		-5.3321 (<.0001)
P_URBAN	-0.5405 (<.0001)			0.5582 (<.0001)		-0.4365 (<.0001)	-0.1766 (0.0194)
LN_BIKELANE	0.5179 (<.0001)	0.5183 (<.0001)	0.3627 (<.0001)	0.3351 (<.0001)	0.5089 (<.0001)		0.4256 (<.0001)
P_COM_PUB	4.1628 (<.0001)	8.6034 (<.0001)	10.3840 (<.0001)	5.8575 (<.0001)	9.0818 (<.0001)		2.1931 (0.0039)
P_COM_BIKE	-5.9053 (0.0002)	-3.7480 (0.0091)		8.6063 (<.0001)	-9.1412 (<.0001)		
P_COM_WALK	-3.3262 (<.0001)	-4.9492 (<.0001)			-4.5053 (<.0001)		
LN_LAKE_AREA						0.1921 (0.0002)	
k	1.1386	1.2766	0.6988	0.6865	1.4828	0.5345	0.5783
LL	-7580.4	-10067.9	-3586.6	-3466.3	-6662.6	-1957.7	-4924.2
AIC	15186.7	20159.8	7191.2	6956.7	13347.3	3927.5	9868.3
BIC	15257.8	20225.4	7240.5	7022.3	13407.5	3960.3	9923.0
MAD	46.80	269.62	5.24	4.59	33.32	1.17	9.21
Adj_R2	0.552	0.441	0.648	0.725	0.477	0.887	0.714

Table 5-23 shows the AIC, BIC, MAD and adjusted R^2 in base, semi-fully specified, and fully specified SPFs. As shown in the table, models perform significantly better if more explanatory variables are contained as in TAZ SPFs.

Table 5-23 Comparison of goodness-of-fit measures between TSAZs SPFs

Crash types	AIC			BIC			MAD			Adj_R2		
	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full
KABCO	22098.5	21622.4	21159.9	22114.9	21660.7	21214.6	448.43	399.59	326.61	0.149	0.218	0.472
KABC	18617.2	18143.1	17729.4	18633.6	18181.4	17795.1	158.96	141.15	111.55	0.191	0.280	0.595
KAB	16314.7	15893.1	15481.9	16331.1	15925.9	15547.6	77.89	69.95	55.13	0.199	0.283	0.631
KA	12023.8	11751.1	11468.4	12040.2	11773	11506.7	21.07	19.77	16.00	0.225	0.297	0.698
WD_AMPEAK	13445.2	12994.2	12643.8	13461.6	13021.6	12698.5	38.96	34.68	29.03	0.157	0.251	0.481
WD_OFFPEAK	17809.5	17332.9	16891.3	17825.9	17371.1	16956.9	134.94	119.86	99.00	0.145	0.218	0.453
WD_PMPEAK	14831.9	14371.8	13996.3	14848.3	14399.1	14051.0	57.44	50.93	42.52	0.154	0.240	0.480
WD_NIGHT	17281.6	16855.1	16394.0	17298.0	16887.9	16454.1	115.33	104.59	85.08	0.146	0.216	0.465
WE_DAY	14943.1	14519.3	14122.7	14959.5	14552.1	14188.3	53.82	48.12	39.57	0.163	0.245	0.503
WE_NIGHT	14460.0	13997.1	13563.3	14476.4	14035.4	13634.4	48.13	43.36	35.09	0.158	0.238	0.502
SV	15841.7	15548.5	15186.7	15858.1	15586.8	15257.8	62.16	58.11	46.80	0.140	0.191	0.552
MV	21150.8	20639.8	20159.8	21167.2	20678.1	20225.4	370.72	327.61	269.62	0.134	0.204	0.441
PED	8023.2	7568.9	7191.2	8039.6	7601.7	7240.5	6.92	6.13	5.24	0.324	0.420	0.648
BIKE	7748.5	7243.3	6956.7	7764.9	7281.6	7022.3	6.40	5.43	4.59	0.400	0.538	0.725
RAIN	13995.3	13692.3	13347.3	14011.7	13725.1	13407.5	43.22	39.93	33.32	0.156	0.224	0.477
FOG	3985.8	3982.4	3927.5	4002.2	4004.3	3960.3	1.43	1.43	1.17	0.502	0.502	0.887
DUI	10609.7	10125.5	9868.3	10626.2	10158.3	9923.0	12.24	10.63	9.21	0.378	0.452	0.714

5.3 Development of Various SPFs for TADs

TADs (Traffic analysis districts) are newly developed geographic units for transportation plans. Compared to SWTAZs and TSAZs, TADs are a much more highly aggregated geographic unit. TADs can be useful if practitioners want to analyze crash patterns at a higher aggregate level than SWTAZs or TSAZs (Figure 5-3).

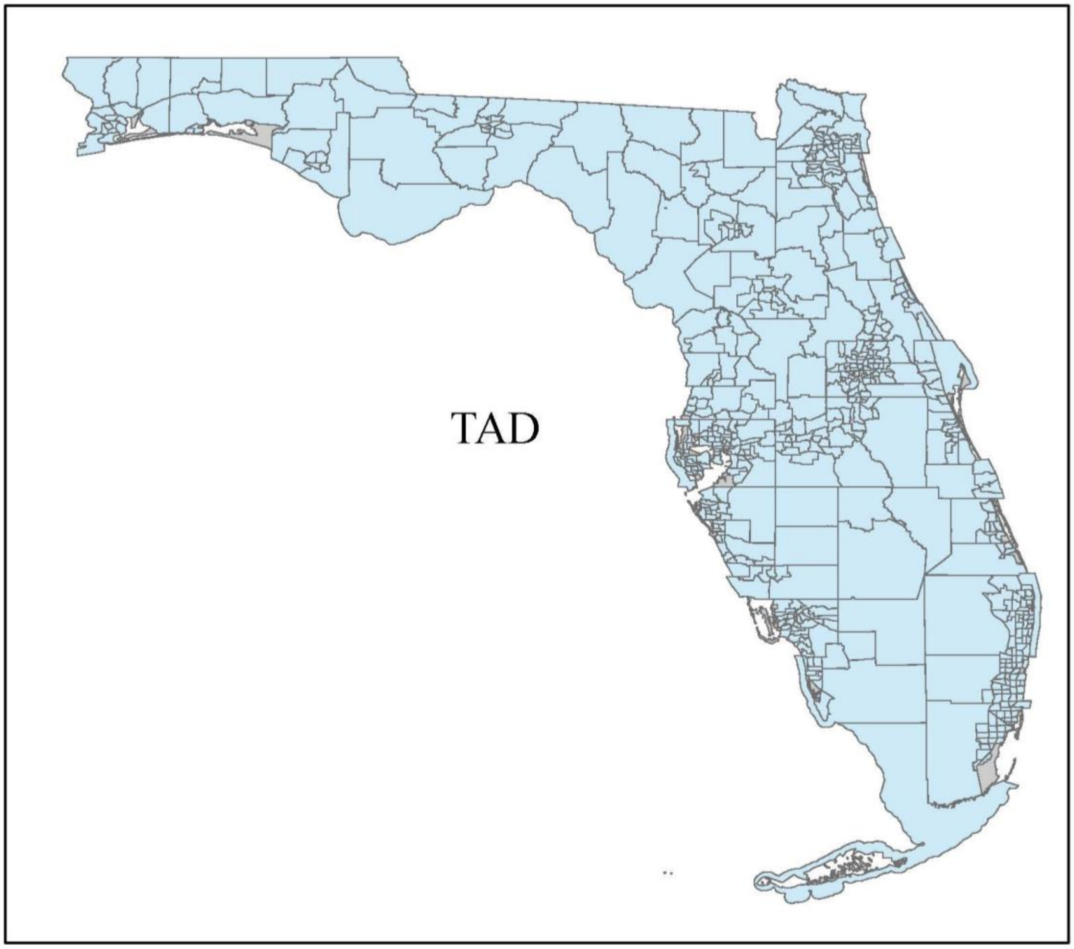


Figure 5-3 Traffic analysis districts (TADs)

Tables 5-24 to 5-26 show the base SPFs based on TADs by severity levels, time periods, and collision types or special events, respectively. The natural log of VMT (LN_VMT) has a positive relationship with crash counts in all SPFs.

Table 5-24 Base SPFs by severity levels based on TADs

Parameters	KABCO	KABC	KAB	KA
Intercept	-3.2844 (<.0001)	-3.2772 (<.0001)	-3.2577 (<.0001)	-4.3314 (<.0001)
LN_VMT	0.7175 (<.0001)	0.6433 (<.0001)	0.5907 (<.0001)	0.5799 (<.0001)
k	0.3591	0.2536	0.2000	0.2662
LL	-4745.4	-4094.6	-3642.0	-2998.8
AIC	9496.9	8195.3	7290.0	6003.7
BIC	9510.1	8208.4	7303.2	6016.8
MAD	794.20	241.32	105.55	105.55
Adj_R2	0.244	0.336	0.382	0.382

Table 5-25 Base SPFs by time periods based on TADs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-6.1974 (<.0001)	-4.6403 (<.0001)	-5.3883 (<.0001)	-4.5171 (<.0001)	-5.1004 (<.0001)	-5.3947 (<.0001)
LN_VMT	0.7505 (<.0001)	0.7295 (<.0001)	0.7199 (<.0001)	0.7073 (<.0001)	0.6971 (<.0001)	0.7094 (<.0001)
k	0.4289	0.4341	0.4258	0.3750	0.3539	0.3631
LL	-3313.4	-4072.3	-3552.1	-3944.7	-3508.8	-3435.7
AIC	6632.8	8150.7	7110.2	7895.4	7023.6	6877.4
BIC	6645.9	8163.8	7123.3	7908.6	7036.7	6890.5
MAD	73.31	263.55	108.04	204.38	96.48	85.11
Adj_R2	0.267	0.216	0.243	0.227	0.250	0.219

Table 5-26 Base SPFs by collision types or special events based on TADs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-5.9460 (<.0001)	-3.6159 (<.0001)	-3.2340 (<.0001)	-2.4796 (<.0001)	-7.7062 (<.0001)	-7.5890 (<.0001)	-3.4171 (<.0001)
LN_VMT	0.7729 (<.0001)	0.7263 (<.0001)	-0.5044 (<.0001)	0.3516 (<.0001)	0.8717 (<.0001)	0.6216 (<.0001)	0.4791 (<.0001)
k	0.1471	0.4761	0.6392	0.7490	0.3641	0.5546	0.2390
LL	-3389.8	-4672.7	-2512.1	-2508.8	-3327.6	-1604.5	-2739.8
AIC	6785.7	9351.3	5030.2	5023.6	6661.3	3215.0	5485.5
BIC	6798.8	9364.5	5043.4	5036.8	6674.4	3228.1	5498.7
MAD	62.57	733.08	18.82	18.25	72.79	3.71	22.00
Adj_R2	0.683	0.198	0.072	0.036	0.345	0.176	0.218

Table 5-27 to 5-29 display the semi-fully specified SPFs based on TADs by severity levels, time periods, and collision or special events, correspondingly. The natural log of intersections per mile (LN_INTER_MI) is significant in many semi-fully specified SPFs while it is positively related with crash counts in most SPFs except for fog-related crash (FOG). The natural log of roadway density (LN_ROAD_DEN) is significant in all crash types and it has a positive relationship with the crash counts other than the single-vehicle-involved crash (SV) and fog-related crash (FOG). It was shown that the natural log of sidewalk length (LN_SIDEWALK) is significant in SPFs of total crash (KABCO), fatal and injury crash (KABC), fatal and severe injury crash (KAB), fatal and incapacitating injury crash (KA), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), multiple-vehicle-involved crash (MV), and pedestrian-involved crash (PED) and all the coefficient of the sidewalk is positive. However, the natural log of bike lane length (LN_BIKELANE) is only significant in bicycle-involved crash (BIKE) and has positive relationship with crash counts. It was revealed that the proportion of freeway/expressway (P_FREEWAY) is only significant in crash during weekday off-peak (WD_OFFPEAK) and bicycle-involved crash (BIKE SPFs) whereas the proportion of local roads (P_LOCALROAD) in only significant in the SPFs of crash during weekday PM peak (WD_PMPEAK) and crash during weekday nighttime (WD_NIGHT). The proportion of roadway length with Posted Speed Limit higher than 55 mph (P_HIGHPSL) is significant in fog-related crash (FOG) and DUI-related crash (DUI) SPFs. It is interesting that the effect of the proportion of roadway length with Posted Speed Limit higher than 55 mph (P_HIGHPSL) for the two crash types is different. In fog-related crash (FOG) SPF, the coefficient of the proportion of roadway length with Posted

Speed Limit higher than 55 mph (P_HIGHPSL) is positive while it has negative sign in DUI-related crash (DUI) SPF. It implies that areas with more high-speed roads are vulnerable to fog crashes whereas those with less high-speed roads are more exposed to DUI-related crashes.

Table 5-27 Semi-fully specified SPFs by severity levels based on TADs

Parameters	KABCO	KABC	KAB	KA
Intercept	-2.7984 (<.0001)	-3.0286 (<.0001)	-2.9694 (<.0001)	-3.9504 (<.0001)
LN_INTER_MI	0.3919 (<.0001)	0.2598 (<.0001)	0.1699 (<.0001)	
LN_ROAD_DEN	0.2389 (<.0001)	0.1997 (<.0001)	0.1365 (<.0001)	0.0812 (<.0001)
LN_SIDEWALK	0.0888 (<.0001)	0.1191 (<.0001)	0.1256 (<.0001)	0.1415 (<.0001)
LN_VMT	0.6113 (<.0001)	0.5627 (<.0001)	0.5198 (<.0001)	0.5149 (<.0001)
k	0.1875	0.1379	0.1334	0.2418
LL	-4536.8	-3905.6	-3519.9	-2970.5
AIC	9085.6	7823.1	7051.7	5951.0
BIC	9112.0	7849.5	7078.1	5973.0
MAD	533.42	161.74	78.23	32.51
Adj_R2	0.550	0.663	0.632	0.400

Table 5-28 Semi-fully specified SPFs by time periods based on TADs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-6.2495 (<.0001)	-5.2634 (<.0001)	-6.7794 (<.0001)	-5.1573 (<.0001)	-4.6696 (<.0001)	-4.6823 (<.0001)
LN_INTER_MI	0.3830 (<.0001)	0.5096 (<.0001)	0.6381 (<.0001)	0.5195 (<.0001)	0.3126 (<.0001)	0.3739 (<.0001)
LN_ROAD_DEN	0.2937 (<.0001)	0.2502 (<.0001)	0.1680 (<.0001)	0.1794 (<.0001)	0.1948 (<.0001)	0.1747 (<.0001)
LN_SIDEWALK					0.1048 (<.0001)	0.1206 (<.0001)
P_FREEWAY		-2.4748 (0.0005)				
P_LOCALROAD			1.2860 (<.0001)	0.7093 (0.0102)		
LN_VMT	0.6940 (<.0001)	0.7198 (<.0001)	0.6961 (<.0001)	0.6644 (<.0001)	0.6032 (<.0001)	0.5903 (<.0001)
k	0.2612	0.2324	0.2252	0.2114	0.2306	0.2138
LL	-3158.7	-3822.1	-3350.5	-3761.7	-3374.0	-3270.1
AIC	6327.4	7660.1	6713.0	7535.5	6760.0	6552.3
BIC	6349.3	7695.2	6739.3	7561.8	6786.4	6578.6
MAD	53.05	181.32	71.21	147.13	74.56	63.07
Adj_R2	0.576	0.540	0.597	0.518	0.480	0.474

Table 5-29 Semi-fully specified SPFs by collision types or special events based on TADs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-5.1493 (<.0001)	-3.0091 (<.0001)	-2.9029 (<.0001)	-1.7053 (0.0042)	-7.5406 (<.0001)	-4.6565 (<.0001)	-2.5381 (<.0001)
LN_INTER_MI		0.4835 (<.0001)	0.5359 (<.0001)	0.8580 (<.0001)	0.3695 (<.0001)	-0.1208 (0.0421)	0.1334 (0.0003)
LN_ROAD_DEN	-0.0352 (0.0313)	0.3010 (<.0001)	0.2744 (<.0001)	0.2290 (<.0001)	0.2445 (<.0001)	-0.1915 (0.0002)	0.2194 (<.0001)
LN_SIDEWALK	0.1127 (<.0001)	0.0802 (0.0015)	0.2668 (<.0001)				
LN_BIKELANE				0.1276 (<.0001)			
P_FREEWAY					1.5234 (0.0412)		
P_HIGHPSL						3.1655 (0.0002)	-1.1073 (0.0028)
P_LOCALROAD							
LN_VMT	0.6968 (<.0001)	0.5977 (<.0001)	0.2679 (<.0001)	0.2018 (<.0001)	0.8042 (<.0001)	0.4110 (<.0001)	0.3699 (<.0001)
k	0.1374	0.2395	0.2821	0.3882	0.2251	0.3987	0.1681
LL	-3369.8	-4447.0	-2275.4	-2312.1	-3180.7	-1545.5	-2641.5
AIC	6749.5	8906.0	4562.7	4636.2	6373.3	3102.9	5295.1
BIC	6771.5	8932.3	4589.1	4662.5	6399.7	3129.2	5321.4
MAD	59.64	487.58	12.70	12.86	52.54	3.33	18.74
Adj_R2	0.703	0.530	0.466	0.372	0.621	0.281	0.438

Table 5-30 to 5-32 present the fully specified SPFs by severity levels, time periods, and collision types or special events. It was disclosed that the natural log of hotel, motel, timeshare room density (LN_HMTS_DENS) is significant in the SPFs of total crash (KABCO), fatal and injury crash (KABC), crash during weekday off-peak (WD_OFFPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), crash for all collision types, rain-related crash (RAIN), and fog-related crash (FOG). The coefficient of the natural log of hotel, motel, timeshare room density (LN_HMTS_DENS) has a positive sign in most crash types except for fog-related crash (FOG). The proportion of families with 2 vehicles (P_2AUTO) is significant and has a positive relationship to crash during weekday nighttime (WD_NIGHT) and multiple-vehicle-involved crash (MV) SPFs while the proportion of families with 0 vehicle (P_0AUTO) is only significant in DUI-related crash (DUI) SPFs and positively related to the crash counts. The proportion of urban area (P_URBAN) is found significant in many SPFs. The coefficient of the proportion of urban area (P_URBAN) is positive in total crash (KABCO), fatal and injury crash (KABC), fatal and severe injury crash (KAB), crash during weekday AM peak (WD_AMPEAK), crash during weekday off-peak (WD_OFFPEAK), crash during weekday PM peak (WD_PMPEAK), crash during weekday nighttime (WD_NIGHT), multiple-vehicle-involved crash (MV), bicycle-involved crash (BIKE), and rain-related crash (RAIN) while it is negative in fatal and incapacitating injury crash (KA), crash during weekend nighttime (WE_NIGHT), single-vehicle-involved crash (SV), and DUI-related crash (DUI).

It was found that the natural log of number of total commuters (LN_TOT_COM) is significant in most crash types except for crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), pedestrian-involved crash (PED), bicycle-involved crash (BIKE) and fog-related crash (FOG) and the coefficient of the natural log of number of total commuters (LN_TOT_COM) has a positive sign in all SPFs. It was uncovered that the proportion of commuters using public transportation (P_COM_PUB) has positive relationship with pedestrian-involved crash (PED) and bicycle-involved crash (BIKE). The proportion of commuters by walking (P_COM_WALK) and the proportion of commuters using bicycle (P_COM_BIKE) is positively associated with pedestrian-involved crash (PED) and bicycle-involved crash (BIKE) separately. It is worthy to note that the natural log of lake or pond area in square mile (LN_LAKE_AREA) is only significant in the fog-related crash (FOG) SPF and it has positive relationship with fog crashes.

Table 5-30 Fully specified SPFs by severity levels based on TADs

Parameters	KABCO	KABC	KAB	KA
Intercept	-5.7374 (<.0001)	-5.0316 (<.0001)	0.0602 (<.0001)	0.0628 (<.0001)
LN_HMTS_DENS	0.0359 (0.0023)	0.0394 (0.0003)		
P_LOCALROAD			0.3554 (0.0235)	
LN_INTER_MI	0.3141 (<.0001)	0.2162 (<.0001)		
LN_VMT	0.4093 (<.0001)	0.3938 (<.0001)	0.4123 (<.0001)	0.3579 (<.0001)
P_URBAN	0.3020 (<.0001)	0.2011 (<.0001)	0.1050 (0.0241)	-0.2571 (<.0001)
LN_SIDEWALK	0.0786 (<.0001)	0.1027 (<.0001)	0.1430 (<.0001)	0.1105 (<.0001)
LN_TOT_COM	0.3020 (<.0001)	0.4657 (<.0001)	0.3561 (<.0001)	0.3739 (<.0001)
k	0.1400	0.1161	0.1207	0.2177
LL	-4445.9	-3853.7	-3490.4	-2940.0
AIC	8907.7	7723.4	6996.8	5894.0
BIC	8942.8	7758.5	7031.9	5924.7
MAD	447.82	144.46	74.34	30.74
Adj_R2	0.755	0.785	0.692	0.492

Table 5-31 Fully specified SPFs by time periods based on TADs

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-10.1634 (<.0001)	-7.6954 (<.0001)	-9.5644 (<.0001)	-8.0165 (<.0001)	-4.4909 (<.0001)	-4.2791 (<.0001)
LN_HMTS_DENS		0.0378 (0.0071)		0.0480 (0.0002)	0.0430 (0.0055)	0.0529 (0.0004)
P_2AUTO				0.3859 (0.0136)		
P_FREEWAY		-2.6072 (0.0001)				
P_LOCALROAD			1.0507 (<.0001)	0.5004 (0.0162)		
LN_ROAD_DEN					0.1688 (<.0001)	0.2065 (<.0001)
LN_INTER_MI	0.3186 (<.0001)	0.4058 (<.0001)	0.5331 (<.0001)	0.4262 (<.0001)	0.2668 (<.0001)	0.3640 (<.0001)
LN_VMT	0.5042 (<.0001)	0.5328 (<.0001)	0.5361 (<.0001)	0.4387 (<.0001)	0.5873 (<.0001)	0.5619 (<.0001)
P_URBAN	0.5422 (<.0001)	0.3956 (<.0001)	0.3661 (<.0001)	0.1262 (0.0421)		-0.2494 (0.0103)
LN_SIDEWALK					0.1036 (<.0001)	0.1098 (<.0001)
LN_TOT_COM	0.6940 (<.0001)	0.5304 (<.0001)	0.5452 (<.0001)	0.6279 (<.0001)		
k	0.1994	0.1994	0.1832	0.1547	0.2278	0.2070
LL	-3075.7	-3822.1	-3288.0	-3665.9	-3370.2	-3277.4
AIC	6163.5	7660.1	6589.9	7349.8	6754.4	6568.7
BIC	6189.8	7695.2	6620.6	7389.3	6785.1	6599.4
MAD	44.79	158.38	62.55	121.42	74.32	65.64
Adj_R2	0.749	0.704	0.750	0.741	0.49	0.455

Table 5-32 Fully specified SPFs by collision types or special events based on TADs

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-6.6229 (<.0001)	-6.6746 (<.0001)	-0.8715 (0.0534)	-1.1564 (0.0294)	-10.2073 (<.0001)	-4.8288 (<.0001)	-3.5760 (<.0001)
LN_HMTS_DENS	0.0220 (0.0335)	0.0350 (0.0084)	0.0468 (0.0031)	0.0443 (0.0126)	0.0246 (0.0786)	-0.0814 (0.0005)	
P_0AUTO							0.5708 (0.0426)
P_2AUTO		0.3244 (0.0476)					
P_FREEWAY					1.7014 (0.0204)		
P_HIGHPSL						4.4416 (<.0001)	-1.2143 (0.0055)
LN_INTER_MI		0.3601 (<.0001)	0.3588 (<.0001)	0.3891 (<.0001)	0.3171 (<.0001)		0.1715 (<.0001)
LN_VMT	0.5998 (<.0001)	0.3728	0.0615 (0.0948)	0.0820 (0.0428)	0.6201 (<.0001)	0.4001 (<.0001)	0.2992 (<.0001)
P_URBAN	-0.3641 (<.0001)	0.5241 (<.0001)		0.3980 (<.0001)	0.3225 (<.0001)		-0.1803 (0.0098)
LN_BIKELANE				0.0708 (0.0027)			
LN_SIDEWALK	0.1020 (<.0001)	0.0720 (0.0013)	0.1803 (<.0001)				0.1976 (<.0001)
LN_TOT_COM	0.3103 (<.0001)	0.6972 (<.0001)			0.5554 (<.0001)		0.2218 (<.0001)
P_COM_PUB			0.1849 (<.0001)	0.1339 (<.0001)			
P_COM_BIKE				0.1958 (<.0001)			
P_COM_WALK			0.1017 (<.0001)				
LN_LAKE_AREA						0.0904 (0.0494)	
k	0.1158	0.1755	0.2103	0.2528	0.1898	0.4040	0.1579
LL	-3319.7	-4349.0	-2210.2	-2204.6	-3129.5	-1547.9	-2625.7
AIC	6653.4	8716.0	4436.4	4427.3	6274.9	3107.7	5269.4
BIC	6684.1	8755.5	4471.5	4466.7	6310.0	3134.0	5308.9
MAD	55.96	393.77	10.75	10.56	47.94	3.24	18.22
Adj_R2	0.724	0.763	0.636	0.584	0.748	0.355	0.498

Table 5-33 compares AIC, BIC, MAD and adjusted R^2 in base, semi-fully specified, and fully specified SPFs. Similarly in TAZ and TSAZ SPFs, the models are significantly improved if more explanatory variables are included.

Table 5-33 Comparison of goodness-of-fit measures between TADs SPFs

Crash types	AIC			BIC			MAD			Adj_R2		
	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full
KABCO	9496.9	9085.6	8907.7	9510.1	9112.0	8942.8	794.20	533.42	447.82	0.244	0.550	0.755
KABC	8195.3	7823.1	7723.4	8208.4	7849.5	7758.5	241.32	161.74	144.46	0.336	0.663	0.785
KAB	7290.0	7051.7	6996.8	7303.2	7078.1	7031.9	105.55	78.23	74.34	0.382	0.632	0.692
KA	6003.7	5951.0	5894.0	6016.8	5973.0	5924.7	105.55	32.51	30.74	0.382	0.400	0.492
WD_AMPEAK	6632.8	6327.4	6163.5	6645.9	6349.3	6189.8	73.31	53.05	44.79	0.267	0.576	0.749
WD_OFFPEAK	8150.7	7751.8	7660.1	8163.8	7778.1	7695.2	263.55	181.32	158.38	0.216	0.540	0.704
WD_PMPEAK	7110.2	6713.0	6589.9	7123.3	6739.3	6620.6	108.04	71.21	62.55	0.243	0.597	0.750
WD_NIGHT	7895.4	7535.5	7349.8	7908.6	7561.8	7389.3	204.38	147.13	121.42	0.227	0.518	0.741
WE_DAY	7023.6	6760.0	6754.4	7036.7	6786.4	6785.1	96.48	74.56	74.32	0.250	0.480	0.487
WE_NIGHT	6877.4	6552.3	6536.6	6890.5	6578.6	6571.7	85.11	63.07	62.89	0.219	0.474	0.498
SV	6785.7	6749.5	6653.4	6798.8	6771.5	6684.1	62.57	59.64	55.96	0.683	0.703	0.724
MV	9351.3	8906.0	8716.0	9364.5	8932.3	8755.5	733.08	487.58	393.77	0.198	0.530	0.763
PED	5030.2	4562.7	4436.4	5043.4	4589.1	4471.5	18.82	12.70	10.75	0.072	0.466	0.636
BIKE	5023.6	4636.2	4427.3	5036.8	4662.5	4466.7	18.25	12.86	10.56	0.036	0.372	0.584
RAIN	6661.3	6373.3	6274.9	6674.4	6399.7	6310.0	72.79	52.54	47.94	0.345	0.621	0.748
FOG	3215.0	3102.9	3107.7	3228.1	3129.2	3134.0	3.71	3.33	3.24	0.176	0.281	0.355
DUI	5485.5	5295.1	5269.4	5498.7	5321.4	5308.9	22.00	18.74	18.22	0.218	0.438	0.498

5.4 Development of Various SPFs for Counties

Florida has 67 counties as presented in Figure 5-4. Counties are the highest aggregation level of existing geographic units at the state-wide level. County-level analysis will allow practitioners to determine which counties have high traffic crash risks.

Figure 5-4 Counties in Florida

5-34 to 5-36 show the base SPFs based on counties by severity levels, time periods, and collision types or special events, respectively. The natural Log of VMT (LN_VMT) has a positive relationship with crash counts in all SPFs as expected.

Table 5-34 Base SPFs by severity levels based on counties

Parameters	KABCO	KABC	KAB	KA
Intercept	-11.5602 (<.0001)	-11.2109 (<.0001)	-10.4730 (<.0001)	-9.5433 (<.0001)
LN_VMT	1.2642 (<.0001)	1.1846 (<.0001)	1.0988 (<.0001)	0.9668 (<.0001)
k	0.1078	0.0805	0.0706	0.1119
LL	-566.5	-502.6	-463.6	-410.2
AIC	1138.9	1011.1	933.2	826.3
BIC	1145.5	1017.8	939.9	832.9
MAD	3776.45	1001.61	458.98	198.63
Adj_R2	0.806	0.927	0.954	0.891

Table 5-35 Base SPFs by time periods based on counties

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-14.9476 (<.0001)	-13.5951 (<.0001)	-14.8443 (<.0001)	-12.5182 (<.0001)	-12.8858 (<.0001)	-12.2888 (<.0001)
LN_VMT	1.3173 (<.0001)	1.3188 (<.0001)	1.3407 (<.0001)	1.2364 (<.0001)	1.2188 (<.0001)	1.1707 (<.0001)
k	0.1554	0.1392	0.1613	0.1122	0.1019	0.0974
LL	-405.4	-492.2	-435.7	-476.8	-432.3	-423.6
AIC	816.7	990.5	877.3	959.7	870.6	853.2
BIC	823.4	997.1	884.0	966.3	877.3	859.8
MAD	325.16	1376.73	502.47	1012.66	462.38	408.80
Adj_R2	0.811	0.802	0.853	0.771	0.801	0.763

Table 5-36 Base SPFs by collision types or special events based on counties

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-7.6383 (<.0001)	-14.1594 (<.0001)	-16.2434 (<.0001)	-19.6173 (<.0001)	-13.9063 (<.0001)	-7.5553 (<.0001)	-10.5092 (<.0001)
LN_VMT	0.9078 (<.0001)	1.4116 (<.0001)	1.3058 (<.0001)	1.5191 (<.0001)	1.2630 (<.0001)	0.6772 (<.0001)	1.0018 (<.0001)
k	0.0508	0.1622	0.1887	0.5013	0.1012	0.2068	0.1065
LL	-454.5	-550.4	-317.9	-324.5	-408.2	-278.7	-379.7
AIC	915.1	1106.9	641.8	655.0	822.3	563.4	765.4
BIC	921.7	1113.5	648.4	661.7	828.9	570.0	772.0
MAD	341.68	3631.55	65.82	103.10	332.73	21.12	110.20
Adj_R2	0.919	0.798	0.849	0.694	0.822	0.526	0.898

Tables 5-37 to 5-39 exhibit the semi-fully specified SPFs based on counties by severity levels, time periods, and collision or special events, correspondingly. Only few variables were significant in the semi-fully specified SPFs. It was discovered that the proportion of freeway/expressway (P_FREEWAY) is significant in many SPFs except for rain-related crash (RAIN) and fog-related crash (FOG) while the coefficient of the proportion of freeway/expressway (P_FREEWAY) has a negative sign all SPFs. The proportion of roadway length with Posted Speed Limit higher than 55 mph (P_HIGHPSL) was found only significant in fog-related crash (FOG) SPF and its coefficient has a negative sign.

Table 5-37 Semi-fully specified SPFs by severity levels based on counties

Parameters	KABCO	KABC	KAB	KA
Intercept	-12.6344 (<.0001)	-12.2210 (<.0001)	-11.4165 (<.0001)	-10.3284 (<.0001)
LN_VMT	1.3510 (<.0001)	1.2662 (<.0001)	1.1754 (<.0001)	1.0317 (<.0001)
P_FREEWAY	-13.7357 (<.0001)	-12.8572 (<.0001)	-12.2265 (<.0001)	-11.2267 (<.0001)
k	0.0753	0.0515	0.0440	0.0901
LL	-554.2	-487.8	-448.3	-403.1
AIC	1116.4	983.7	904.7	814.3
BIC	1125.2	992.5	913.5	823.1
MAD	3966.69	1019.78	452.19	165.99
Adj_R2	0.827	0.933	0.949	0.914

Table 5-38 Semi-fully specified SPFs by time periods based on counties

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-16.0627 (<.0001)	-14.8426 (<.0001)	-16.1529 (<.0001)	-13.4969 (<.0001)	-13.7159 (<.0001)	-13.1001 (<.0001)
LN_VMT	1.4072 (<.0001)	1.4197 (<.0001)	1.4456 (<.0001)	1.3153 (<.0001)	1.2866 (<.0001)	1.2367 (<.0001)
P_FREEWAY	-14.0677 (<.0001)	-16.2072 (<.0001)	-16.1894 (<.0001)	-12.1610 (<.0001)	-11.1334 (<.0001)	-10.5816 (<.0001)
k	0.1214	0.0934	0.1145	0.0873	0.0793	0.0782
LL	-397.3	-478.7	-424.4	-468.4	-424.1	-416.3
AIC	802.5	965.4	856.9	944.8	856.2	840.7
BIC	811.3	974.2	865.7	953.6	865.0	849.5
MAD	341.90	1359.50	549.39	1009.49	471.39	412.30
Adj_R2	0.839	0.826	0.855	0.786	0.825	0.784

Table 5-39 Semi-fully specified SPFs by collision types or special events based on counties

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-7.8940 (<.0001)	-15.6738 (<.0001)	-17.7818 (<.0001)	-22.0635 (<.0001)	-13.9063 (<.0001)	-8.4667 (<.0001)	-11.6458 (<.0001)
LN_VMT	0.9290 (<.0001)	1.5326 (<.0001)	1.4296 (<.0001)	1.7110 (<.0001)	1.2630 (<.0001)	0.7232 (<.0001)	1.0940 (<.0001)
P_FREEWAY	-3.6030 (<.0001)	-18.4901 (<.0001)	-19.5725 (<.0001)	-27.6716 (<.0001)			-14.8806 (<.0001)
P_HIGHPSL						2.6354 (0.0573)	
k	0.0485	0.1038	0.1142	0.3532	0.1012	0.1945	0.0682
LL	-453.0	-535.0	-304.1	-314.5	-408.2	-276.9	-365.8
AIC	914.1	1078.0	616.2	636.9	822.3	561.8	739.6
BIC	922.9	1086.8	625.1	645.7	828.9	570.6	748.4
MAD	339.30	3899.67	65.55	119.24	332.73	19.82	123.64
Adj_R2	0.923	0.816	0.888	0.387	0.822	0.574	0.857

Tables 5-40 to 5-42 present the fully specified SPFs based on counties by severity levels, time periods, and collision types or special events, respectively. Different from the fully specified SPFs based on other geographic units, trip production and attraction data were attempted in the SPFs. It was shown that the proportion of home-based shopping trip production (P_HBSHP) is significant in fatal and injury crash (KABC) and DUI-related crash (DUI) SPFs, and the proportion of home-based social and recreational trip production (P_HBSRP) is only significant in fatal and severe injury crash (KAB) SPF. The proportion of home-based social and recreational trip attraction (P_HBSRA) was found to be positively related to fatal and incapacitating injury crash (KA) while the proportion of home-based working trip attraction (P_HBWA) is positively associated with single-vehicle-involved crash (SV). Beside trip generation factors, only a few additional socio-demographic variables were included in the county-based SPFs since many variables highly correlated with each other at the county level.

The proportion of residents between 15 and 24 years old (P_AGE1524) is significant in total crash (KABCO), crash during weekday PM peak (WD_PMPEAK), crash during weekday nighttime (WD_NIGHT), crash during weekend daytime (WE_DAY), crash during weekend nighttime (WE_NIGHT), multiple-vehicle-involved crash (MV), pedestrian-involved crash (PED), rain-related crash (RAIN) and fog-related crash (FOG) and has positive relationship with the crash counts. The proportion of families with 2 vehicles (P_2AUTO) is only significant in fatal and incapacitating injury crash (KA) while the proportion of families with 0 vehicle (P_0AUTO) is significant in crash during weekday morning peak (WD_AMPEAK), crash during weekday off-peak (WD_OFFPEAK), crash during weekday nighttime (WE_NIGHT), single-vehicle-involved crash (SV), bicycle-involved crash (BIKE) and rain-related crash (RAIN).

Distance to the nearest urban area (DIST_TO_URBAN) is negatively related to the counts of crash during weekday AM peak (WD_AMPEAK) and weekday off-peak (WD_OFFPEAK). The proportion of commuters using bicycle (P_COM_BIKE) is only significant in bicycle-involved crash (BIKE) SPF and its coefficient has a positive sign. Unlike the previous three geographic units, the natural log of lake or pond area in square mile (LN_LAKE_AREA) is not significant in fog-related crash (FOG) SPF based on counties.

Table 5-40 Fully specified SPFs by severity levels based on counties

Parameters	KABCO	KABC	KAB	KA
Intercept	-12.8661 (<.0001)	-11.3801 (<.0001)	-11.5464 (<.0001)	-9.5353 (<.0001)
LN_VMT	1.3391 (<.0001)	1.2356 (<.0001)	1.1723 (<.0001)	1.0171 (<.0001)
P_FREEWAY	-13.5238 (<.0001)	-12.4242 (<.0001)	-11.6443 (<.0001)	-9.0780 (0.0003)
P_AGE1524	3.1498 (0.0014)			
P_HBSHP		-2.4285 (0.0811)		
P_HBSRP			1.5979 (0.0434)	
P_HBSRA				2.6316 (0.0012)
P_2AUTO				-1.6017 (0.0156)
k	0.0646	0.0492	0.0410	0.0687
LL	-549.1	-486.3	-446.3	-394.9
AIC	1108.2	982.7	902.6	801.7
BIC	1119.3	993.7	913.6	814.9
MAD	3510.50	988.77	384.08	130.07
Adj_R2	0.845	0.928	0.962	0.960

Table 5-41 Fully specified SPFs by time periods based on counties

Parameters	WD_AMPEAK	WD_OFFPEAK	WD_PMPEAK	WD_NIGHT	WE_DAY	WE_NIGHT
Intercept	-15.3257 (<.0001)	-14.0758 (<.0001)	-16.4342 (<.0001)	-13.7864 (<.0001)	-13.8722 (<.0001)	-13.5365 (<.0001)
LN_VMT	1.3469 (<.0001)	1.3626 (<.0001)	1.4277 (<.0001)	1.3022 (<.0001)	1.2794 (<.0001)	1.2227 (<.0001)
P_FREEWAY	-12.3654 (<.0001)	-14.6422 (<.0001)	-15.7641 (<.0001)	-11.9937 (<.0001)	-11.0175 (<.0001)	-10.0049 (<.0001)
P_0AUTO	3.9221 (0.0331)	2.6433 (0.0955)				3.9107 (0.0045)
P_AGE1524			4.1882 （0.0004）	3.7355 (0.0006)	2.0521 (0.0530)	3.0153 (0.0022)
DIST_TO_URBAN	-0.0879 (0.0559)	-0.0832 (0.0349)				
k	0.1076	0.0851	0.0930	0.0725	0.0744	0.0560
LL	-393.7	-475.6	-418.3	-462.6	-422.2	-406.4
AIC	799.5	963.1	846.5	935.2	854.4	824.7
BIC	812.7	976.4	857.5	946.2	865.4	837.9
MAD	284.47	1211.90	464.30	895.38	443.50	314.21
Adj_R2	0.897	0.869	0.888	0.807	0.835	0.885

Table 5-42 Fully specified SPFs by collision types or special events based on counties

Parameters	SV	MV	PED	BIKE	RAIN	FOG	DUI
Intercept	-9.1691 (<.0001)	-15.8922 (<.0001)	-18.4711 (<.0001)	-21.0607 (<.0001)	-14.5466 (<.0001)	-8.9723 (<.0001)	-10.5758 (<.0001)
LN_VMT	0.9696 (<.0001)	1.5181 (<.0001)	1.4111 (<.0001)	1.6571 (<.0001)	1.2494 (<.0001)	0.6757 (<.0001)	1.0560 (<.0001)
P_FREEWAY	-3.7276 (0.0219)	-18.0773 (<.0001)	-18.0406 (<.0001)	-21.9441 (<.0001)			-14.6544 (<.0001)
P_0AUTO	2.8055 (0.0174)			-9.5603 (0.0002)	4.8109 (0.0009)		
P_HBWA	2.4218 (0.0008)						
P_HBOA			2.0872 (0.0503)				
P_HBWP						4.2965 (0.0068)	
P_HBSHP							-3.1537 (0.0554)
P_AGE1524		3.3192 (0.0036)	2.5318 (0.0449)		4.1552 (<.0001)	4.6633 (0.0070)	
P_COM_BIKE				32.5969 (<.0001)			
k	0.0308	0.0912	0.0969	0.1469	0.0607	0.1642	0.0647
LL	-439.2	-530.8	-300.4	-295.7	-392.9	-271.9	-364.0
AIC	890.4	1071.5	612.8	603.4	795.8	553.8	738.0
BIC	903.6	1082.5	626.0	616.6	806.8	564.8	749.0
MAD	255.58	3384.69	46.33	62.45	214.29	19.99	116.05
Adj_R2	0.972	0.843	0.954	0.891	0.934	0.492	0.855

Table 5-43 shows the AIC, BIC, MAD, and adjusted R^2 in base, semi-fully specified, and fully specified SPFs. As shown in the table, County-based SPFs have good performance regarding adjusted R^2 and SPFs have larger R^2 value if more explanatory variables are contained in most of cases. However, MAD of the fully specified SPFs is smaller than that of the other two types of SPFs except for DUI-related crash (DUI) while MAD of the semi-fully specified SPFs is smaller than that of the base SPFs for fatal and severe injury crash (KAB), fatal and incapacitating injury crash (KA), crash during weekday off-peak (WD_OFFPEAK), crash during weekday nighttime (WD_NIGHT), single-vehicle-involved crash (SV), fog-related crash (FOG).

Table 5-43 Comparison of goodness-of-fit measures between counties SPFs

Crash types	AIC			BIC			MAD			Adj_R2		
	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full	Base	Semi	Full
KABCO	1138.9	1116.4	1108.2	1145.5	1125.2	1119.3	3776.45	3966.69	3510.50	0.806	0.827	0.845
KABC	1011.1	983.7	982.7	1017.8	992.5	993.7	1001.61	1019.78	988.77	0.927	0.933	0.928
KAB	933.2	904.7	902.6	939.9	913.5	913.6	458.98	452.19	384.08	0.954	0.949	0.962
KA	826.3	814.3	801.7	832.9	823.1	814.9	198.63	165.99	130.07	0.891	0.914	0.960
WD_AMPEAK	816.7	802.5	799.5	823.4	811.3	812.7	325.16	341.90	284.47	0.811	0.839	0.897
WD_OFFPEAK	990.5	965.4	963.1	997.1	974.2	976.4	1376.73	1359.50	1211.90	0.802	0.826	0.869
WD_PMPEAK	877.3	856.9	846.5	884.0	865.7	857.5	502.47	549.40	464.30	0.853	0.855	0.888
WD_NIGHT	959.7	944.8	935.2	966.3	953.6	946.2	1012.66	1009.49	895.38	0.771	0.786	0.807
WE_DAY	870.6	856.2	854.4	877.3	865.0	865.4	462.38	471.39	443.50	0.801	0.825	0.835
WE_NIGHT	853.2	840.7	824.7	859.8	849.5	837.9	408.80	412.30	314.21	0.763	0.784	0.885
SV	915.1	914.1	890.4	921.7	922.9	903.6	341.68	339.30	255.58	0.919	0.923	0.972
MV	1106.9	1078.0	1071.5	1113.5	1086.8	1082.5	3631.55	3899.67	3384.69	0.798	0.816	0.843
PED	641.8	616.2	612.8	648.4	625.1	626.0	65.82	65.55	46.33	0.849	0.888	0.954
BIKE	655.0	636.9	603.4	661.7	645.7	616.6	103.10	119.24	62.45	0.694	0.387	0.891
RAIN	822.3	822.3	795.8	828.9	828.9	806.8	332.73	332.73	214.29	0.822	0.822	0.934
FOG	563.4	561.8	553.8	570.0	570.6	564.8	21.12	19.82	19.99	0.526	0.574	0.492
DUI	765.4	739.6	738.0	772.0	748.4000	749.0	110.20	123.64	116.05	0.898	0.857	0.855

5.5 Summary of Macroscopic Safety Modeling Results

The research team has completed developing SPFs by severity levels, time periods, collision types, and special events based on different geographic units (TAZs, TSAZs, TADs, and counties). TAZs have been widely adopted for traffic safety analysis. However, TAZs have two possible limitations as previously mentioned. In order to overcome the limitations, the research team has developed TSAZs by combining current TAZs with comparable traffic crash rates into larger geographic units. In recent, TADs were developed for the large scale planning. Thus, it is believed that TADs are useful if practitioners wish to analyze crash patterns at the higher aggregate level. County is the highest aggregation level of existing geographic units at the state-wide level. County-level analysis will allow practitioners to determine which counties have high traffic crash risks.

Three types of SPFs by explanatory variables were estimated: base, semi-fully specified, and fully-Specified SPFs. Base SPFs only have the exposure variable: VMT (vehicle miles traveled). The base SPFs are easy to estimate since it has only one variable; however, their model performance is not good as other two types of SPFs. In the semi-fully specified SPFs, both traffic and roadway characteristic variables were used, it was shown that, in most of cases, semi-fully specified SPFs considerably perform better than base SPFs. Lastly, the fully specified SPFs have not only roadway and traffic variables but also socio-demographic and geography variables, which perform the best among the three types of SPFs. However, the fully specified SPFs need extensive data from multiple sources and require time and efforts to process the collected data. When very accurate predicted crash counts are required or have enough time and resources, fully specified SPFs are recommended to use. On the contrary, base SPFs or semi-fully specified SPFs can be used when time and resources are limited or only rough crash trends are required.

6 MACRO-LEVEL SCREENING

The main objective of Chapter 6 is to identify hot zones using the SPFs estimated in the previous Chapter 5. In order to achieve the objective, the optimal zone systems for selected crash type were determined. Potential for Safety Improvements (PSIs) were computed based on the best zone systems and zonal-level screening for each crash type were conducted. The comparative analysis of geographic units for macro-level analysis is described in section 6.1. In section 6.2, the PSIs were computed for different crash types and an example of zonal-level screening results was suggested. Lastly, the spatial distributions of hotspots for all crash types were presented in section 6.3.

6.1 Comparative Analysis of Geographic Units for Macro-level Screening

Among various geographic units, only SWTAZs and TADs are delineated for the purpose of transportation planning. Thus, SWTAZs and TADs have several advantages for crash modeling: first, the transportation planning related data (such as trip production/attraction, employments, car-ownership, households, etc.); second, it is easier to be integrated with the transportation planning process. There are 8,518 SWTAZs, and 594 TADs in Florida. Between the two geographic units, a TAD is considerably larger than a SWTAZ as shown in Figure 6-1. The average area of SWTAZs and TADs are 6.472 and 103.314 square miles, respectively, which indicates that a TAD is 16 times larger than a TAZ on average. As Lee et al. (2014) pointed out TAZs may have two limitations for safety analysis: 1) A TAZ is possibly too small for safety analysis; and 2) A TAZ may have a boundary crash issue. The authors cautiously concluded that a larger zone system can overcome these two limitations. Nevertheless, it is still necessary to compare the two geographic units because the data currently used are different from what Lee et al. (2014) used, and also the optimal zone system may be different by crash type.

In this Chapter 6, three most widely used crash types including total, severe, and non-motorized mode crashes are selected for the comparative analysis. A severe crash (KA) is defined as a combination of fatal and incapacitating injury crashes. A non-motorized mode crash refers to pedestrian or bicycle-involved crashes. In 2010-2012, a total of 901,235 crashes were recorded in Florida among which 50,039 (5.6%) were severe crashes and 31,547 (3.5%) were non-motorized mode crashes. Three fully specified SPFs for total, severe, and non-motorized mode crashes were estimated based on both SWTAZs and TADs. The fully specified SPFs have all the variables in their models including not only traffic and roadway related variables but also demographic, socio-economic, and geographic variables.

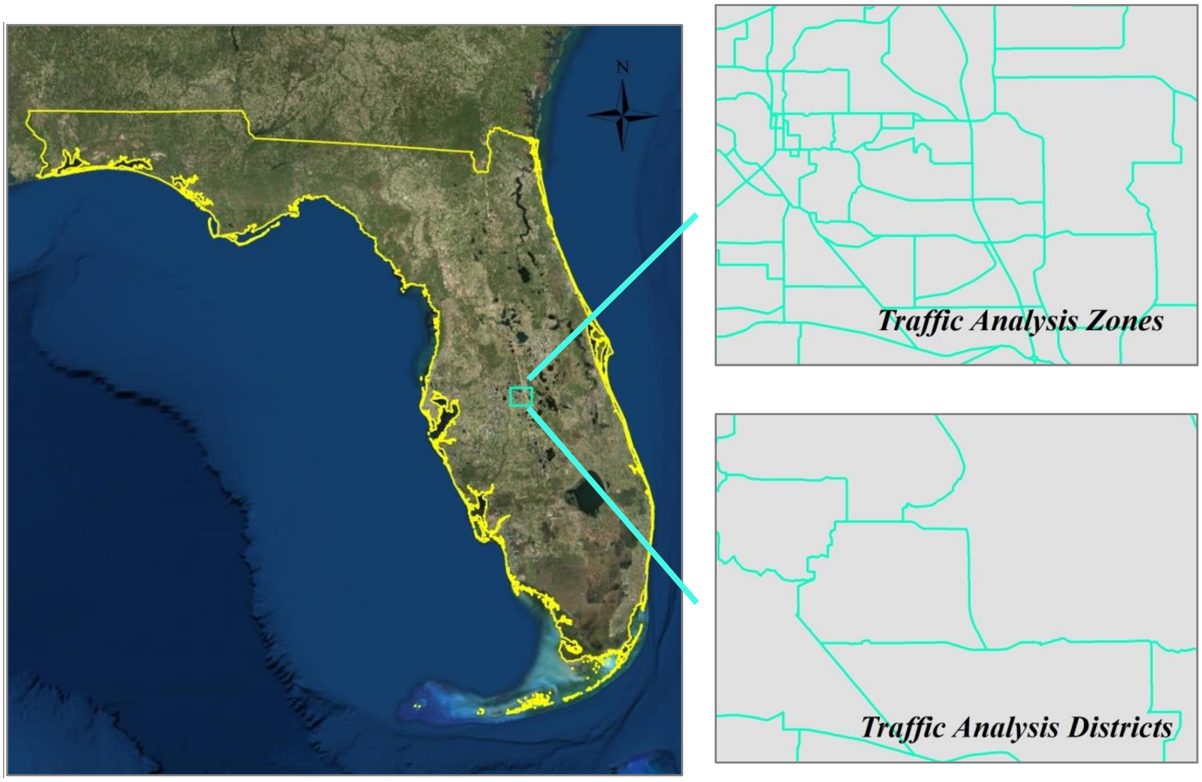


Figure 6-1 Comparison of SWTAZs and TADs

6.1.1 Statistical methodology

A Negative Binomial (NB) model was used for the SPFs in order to keep consistent with the current Highway Safety Manual (AASHTO, 2010). The number of crashes is non-negative integers, which are not normally distributed. Both Poisson and NB models can be used for crash frequency analysis. Nevertheless, Poisson model is based on the assumption that the mean is equal to the variance of distribution. The assumption of equal mean-variance is often violated when the variance is larger than mean, which is commonly observed in crash data. NB models relax the variance assumption by adding an independently distributed error term to the mean of the Poisson model. The mean-variance relationship in NB distribution is as follows:

$$Var\ (Y) = \mu + \alpha\mu^2 \tag{1}$$

where, Y is response variable, μ is mean response of the observation, and α is dispersion parameter. The existence of over-dispersion is adjusted by the log-linear relationship between the expected number of crashes and covariates.

$$ln(\mu_i) = \beta_0 + \sum \beta X_i + \varepsilon_i \tag{2}$$

where, i is an observation unit, μ_i is the expected number of crashes per year at site i, X_i is covariates, β_0 is the intercept, β is the estimated coefficient vector and ε_i is the random error term. $exp(\varepsilon_i)$ is assumed to be gamma-distributed with mean 1 and variance α so that the variance of the crash frequency distribution becomes $\mu_i(1 + \alpha\mu_i)$ and different from the mean μ_i. The NB model for the crash count y_i of entity i is given by

$$P(y_i) = \frac{\Gamma\left(y_i + \frac{1}{\alpha}\right)}{\Gamma(y_i+1)\Gamma\left(\frac{1}{\alpha}\right)} \left(\frac{\alpha\mu_i}{1+\alpha\mu_i}\right)^{y_i} \left(\frac{1}{1+\alpha\mu_i}\right)^{\frac{1}{\alpha}} \tag{3}$$

where y_i is the number of crashes in zone i and $\Gamma(\cdot)$ refers to the gamma function.

The SPFs of the three crash types (i.e., total, severe, and non-motorized mode crashes) were developed by employing NB model based on SWTAZs and TADs. Generally, one simple method to compare the SPFs based on SWTAZs and TADs is to analyze the difference directly between the observed and predicted crash counts of each geographic unit. However, this method may result in biased conclusion since the geographic units have different sample sizes. Thus, a new method using a grid structure as surrogate geographic unit was proposed in this task to compare the SPFs based on different geographic units.

6.1.2 Grids for comparing different geographic units

As shown in Figure 6-2, the grid structure, unlike the SWTAZ and TAD, is a neutral geographic unit that evenly overlay the whole state. Hence, it should be more reasonable if the comparison can be conducted based on the same grid structure. The observed crash counts in each grid can be determined directly by using Geographic Information System (GIS). The predicted crash counts of SPFs based on SWTAZs and TADs can be transformed to the same grid structure by the method as introduced in the following part.

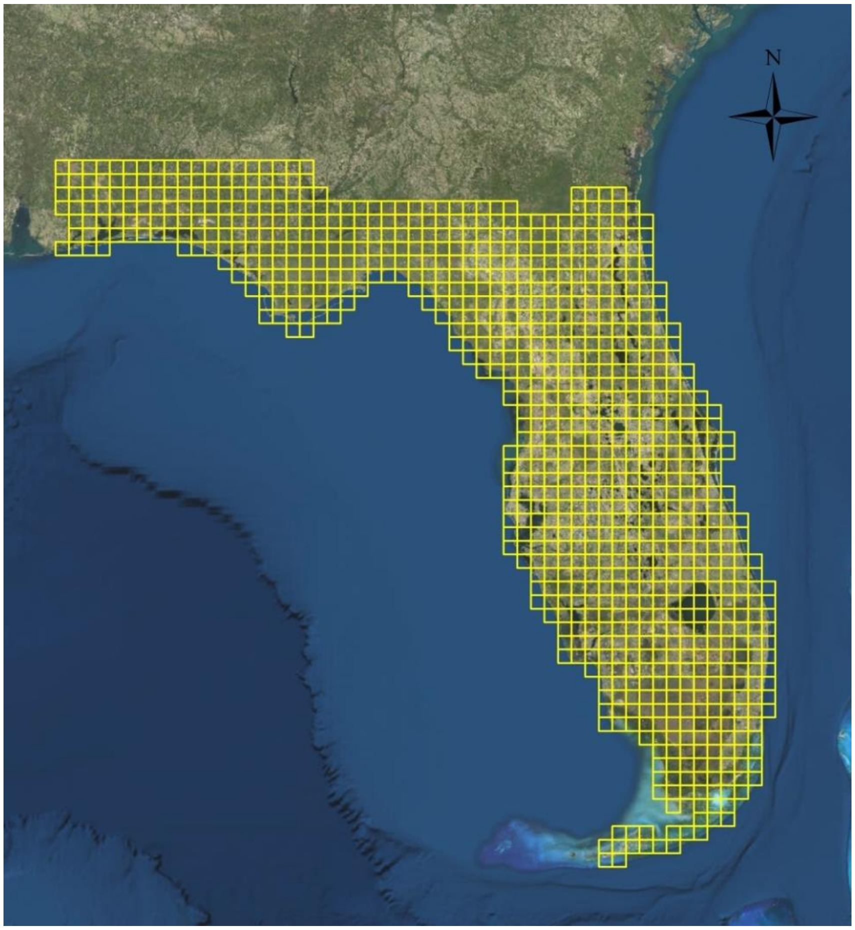


Figure 6-2 Grid structure of Florida (10×10 mile^2)

The method of transforming predicted crashes into grid is introduced by taking Grid 10×10 mile^2 as an example. As shown in Figure 6-3, the red square is one grid (named as Grid A) which intersects with four SWTAZ/TAD units (named as SWTAZ/TAD 1, 2, 3, and 4) with four regions (named as Region 1, 2, 3, and 4). For each SWTAZ/TAD, it is assumed that the crashes are evenly distributed so that the predicted crash counts for each region can be determined by:

$$y'_{Ri} = y'_{Ti} * P'_{Ri} \quad (4)$$

where y'_{Ri} and y'_{Ti} are the predicted crash counts in Region i and SWTAZ/TAD i, P'_{Ri} is the proportion of Region i's area by SWTAZ/TAD i's area.

Obviously, the crashes happened in Grid A should be equal to the sum of crashes happed in the four intersected regions. Then the predicted crash counts of the four SWTAZs/TADs can be partly transformed into Grid A by adding the predicted crash counts of all the four intersected regions. Based on this method, the predicted crash counts of SWTAZs and TADs can be transformed into the same grids. For each grid, one observed crash number and two different values of the transformed predicted crash counts can be obtained. The difference between observed and transformed predicted crash numbers of the grid structure will be analyzed. Finally, by comparing the difference of SWTAZs and TADs, the superior geographic unit can be obliquely identified for crash analysis.

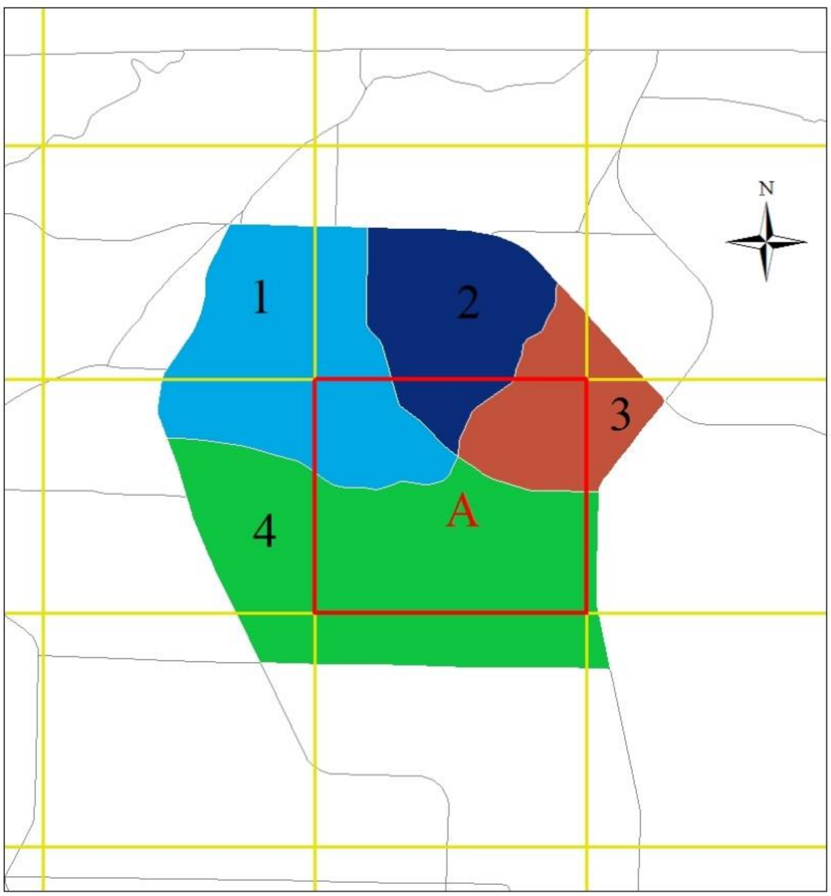


Figure 6-3 Method to transform predicted crash counts

Additionally, the comparison results should be more reasonable if grids of different sizes are employed since the areas of SWTAZs and TADs are quite different. In consideration of the average area of the two geographic units, ten levels of grid structures with side length from 1 to 10 miles were created. Table 6-1 summarizes average areas and observed crash counts of SWTAZs, TADs, and different grid structures. The Grid L×L means the grid structure with side length of L miles. Based on the average area and crash counts, it can be concluded that the SWTAZs and TADs are separately comparable with Grid 3×3, and Grid 10×10.

Three types of measures, Mean Absolute Error (MAE), Root Mean Squared Errors (RMSE), and R^2 were employed to compare the difference of observed and transformed predicted crash values based on SWTAZs and TADs. The three measures can be computed by:

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|y_i - y_i'| \tag{5}$$

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - y_i')^2} \tag{6}$$

$$R^2 = 1 - \frac{\sum_{i=1}^{N}(y_i - y_i')^2}{\sum_{i=1}^{N}(y_i - \bar{y})^2} \tag{7}$$

where N is the number of observations, y_i and y_i' are the observed and transformed predicted values of crashes for entity i, and $\bar{y}$ is the average of the observed values of crashes.

The MAE and RMSE with smaller values reveal better performance while larger R^2 value corresponds to superior result. In comparison of MAE and RMSE, RMSE is sometimes more preferred because RMSE is more sensitive to larger errors.

Table 6-1 Crash statistics of SWTAZs, TADs, and grids

Geographic units	Area ($mile^2$)	Number of zones	Total crash				Severe crash				Non-motorized mode crash			
			Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
SWTAZ	6.472	8518	105.804	142.253	0	1507	5.875	7.944	0	111	3.704	6.084	0	121
TAD	103.314	594	1517.230	1603.290	188	15094	84.241	60.344	4	534	53.109	60.093	1	562
Grid 1×1	1	76640	11.759	61.598	0	2609	0.653	2.614	0	90	0.412	2.484	0	182
Grid 2×2	4	19652	45.860	206.461	0	5321	2.546	8.513	0	271	1.605	7.862	0	209
Grid 3×3	9	8964	100.539	425.753	0	10531	5.582	17.295	0	448	3.519	15.634	0	310
Grid 4×4	16	5124	175.885	712.317	0	16307	9.766	28.997	0	650	6.157	26.161	0	609
Grid 5×5	25	3355	268.624	1084.990	0	25230	14.915	42.962	0	727	9.403	39.150	0	914
Grid 6×6	36	2364	381.233	1459.970	0	24617	21.167	57.821	0	749	13.345	52.004	0	842
Grid 7×7	49	1766	510.326	1889.670	0	29553	28.335	74.121	0	715	17.864	65.854	0	985
Grid 8×8	64	1362	661.700	2465.000	0	41463	36.739	95.446	0	966	23.162	84.708	0	1107
Grid 9×9	81	1094	823.798	2956.390	0	50371	45.739	114.678	0	1218	28.836	103.396	0	1352
Grid 10×10	100	907	993.644	3637.200	0	50989	55.170	141.544	0	1592	34.782	128.862	0	2185

6.1.3 Results and discussion

The modeling results of the three crash types based on SWTAZs and TADs have been presented in the previous report. Based on the results, the predicted crash counts for each crash types of the three geographic units can be computed and then transformed into the correspondingly intersected grids. MAE, RMSE and R^2 for each grid structure were calculated with the observed crash counts and different transformed predicted crash counts based on different geographic units. As shown in Table 6-2, it can be seen that: (1) in total and severe crash models, for most grid structures, the *MAE* indicates SWTAZs based models perform better than the models based on TADs while the *RMSE* and R^2 show the opposite results. With the defined square term, RMSE as well as R^2 should be more sensitive with larger difference than MAE. Hence, SWTAZs based models for total and severe crashes are more likely to offer predicted results with larger errors. Therefore, TADs seems to provide better models than SWTAZs for total and severe crashes. (2) in non-motorized mode crash model, the results of all the grid structures indicate that SWTAZs based models can offer better results than models based on TADs. The result is not surprising since the non-motorists should have much shorter trip distance, leading that non-motorized mode crashes area more likely to be located quite close to the non-motorists' residence area (Lee et al., 2015).

In summary, TADs based models for total and severe crashes performed better than the models based on SWTAZs. On the other hand, SWTAZs can provide better model for non-motorized mode-involved crashes compared with TADs. In Florida, most crash types except non-motorized mode crashes should be more likely to involve motors. Considering this, SWTAZs are suggested for non-motorized mode (i.e., pedestrian and bicycle) crash modeling while TADs are recommended for other crash types analysis.

Table 6-2 Comparison results based on grids

Grids	Total Crash						Severe Crash						Non-motorized Mode Crash					
	MAE		RMSE		R^2		MAE		RMSE		R^2		MAE		RMSE		R^2	
	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs	TAZs	TADs
Grid 1×1	9.24	10.61	43.47	46.42	0.50	0.43	0.61	0.7	1.99	2.08	0.42	0.37	0.34	0.42	1.62	2.07	0.58	0.30
Grid 2×2	27.67	32.46	126.5	133.3	0.62	0.58	1.74	2.09	5.51	5.83	0.58	0.53	0.93	1.27	3.97	5.66	0.74	0.48
Grid 3×3	52.97	60.72	237.68	228.51	0.69	0.71	3.17	3.84	10.09	10.42	0.66	0.64	1.71	2.37	6.99	9.35	0.80	0.64
Grid 4×4	84.42	89.41	362.96	323.13	0.74	0.79	5.02	5.93	15.9	15.84	0.70	0.70	2.66	3.59	10.37	13.52	0.84	0.73
Grid 5×5	117.77	121.17	511	443.09	0.78	0.83	7.01	8.31	21.48	21.15	0.75	0.76	3.55	4.88	13.87	16.28	0.87	0.83
Grid 6×6	158.18	171.85	686.08	644.76	0.78	0.80	9.21	11.08	26.72	27.06	0.79	0.78	4.65	6.82	16.88	24.73	0.89	0.77
Grid 7×7	206.72	203.29	881.43	718.44	0.78	0.86	11.75	13.41	33.22	30.88	0.80	0.83	5.89	8.22	20.9	28.73	0.90	0.81
Grid 8×8	252.04	250.25	1120.99	916.29	0.79	0.86	14.32	16.88	42.26	40.25	0.80	0.82	6.89	9.62	23.26	28.35	0.92	0.89
Grid 9×9	305.1	295.67	1257.77	967.33	0.82	0.89	17.41	20	46.85	46.9	0.83	0.83	7.98	10.74	26.84	31.5	0.93	0.91
Grid 10×10	350.89	335.93	1552.45	1270.53	0.82	0.88	19.6	23.18	54	51.44	0.85	0.87	9.42	12.95	30.27	36.06	0.94	0.92

6.2 Identification of Hot Zones

PSI (Potential for Safety Improvements), or excess crash frequency using SPF (Safety performance function), was applied as the performance measure in the study to define a hot zone. The PSI refers to the difference between the expected crash count and the predicted crash count of each zone. The expected number of crashes is the estimate of long-term average crash frequency of an area based on a given set of characteristics of zones in a specific time period. Since a traffic crash is a random event, the observed crash frequency at an area will naturally fluctuate over time and cannot be a reliable indicator of what crash frequency is expected under the same condition over a long time period (AASHTO, 2010). In contrast, the expected number of crashes accounting for the regression-to-the-mean problem can provide more dependable expected number of crash. Meanwhile, the predicted number of crashes is the average number of crashes in the area with similar characteristics. Thus, the PSI can be an effective performance measure to identify those zones experiencing more crashes than others with similar characteristics. The zone with positive PSI is regarded as hazardous since it has more crashes than others with similar characteristics. Also, a zone is considered safe if its PSI is smaller than zero, indicating it has less crashes compared with other zones have.

The calculation of the expected number of crashes using Empirical Bayes (HSM 2010; Girasek & Taylor, 2010) method is as follows:

$$N_{expected} = W \times N_{predicted} + (1 - W) \times N_{observed} \quad (1)$$

where $N_{expected}$ is the expected number of crash, W is the EB weight, $N_{predicted}$ is the predicted number of crash, and $N_{observed}$ is the observed crash counts. The predicted number of crash can be obtained from the SPF while the weighted adjustment are calculated using the following equation.

$$W = \frac{1}{1 + k \times N_{predicted}} \quad (1)$$

where k is the over-dispersion parameter of the SPF.

All zones in this study area were classified into two categories based on their PSIs: hot and normal zones. The hot zones are defined as zones with a top 10% PSI while normal zones are the other zones. Table 6-3 exhibits a part of the screening results of total crashes based on TADs. In cased of TAD with ID number 486, its PSI is 6273.586 which is in the top 0.17%. Thus, the TAD was categorized as “Hot” zone, indicating that the zone had serious traffic safety problems compared with other similar TADs. The PSI of TAD with ID number 261 is 681.824 and it is in the top 10.10% PSI. The TAD was categorized as “Normal” zone, which has a traffic safety problem not as severe as “Hot” zone.

Table 6-3 Example of the screening results: total crashes based on TADs

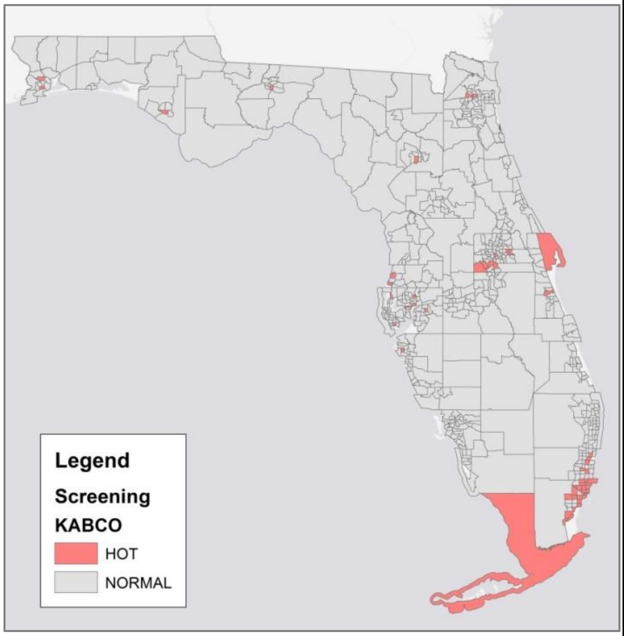
Rank	ID	Observed Number	Predicted Number	Expected Number	PSI	Percentile	Category
1	486	14648	8369	14628	6259	0.17%	HOT
2	484	13288	7303	13253	5950	0.34%	HOT
:	:	:	:	:	:	:	:
60	261	2872	2188	2868	680	10.10%	NORMAL
:	:	:	:	:	:	:	:
594	142	3873	6404	3886	-2518	100.00%	NORMAL

6.3 Macro-level Screening for Various Crash Types

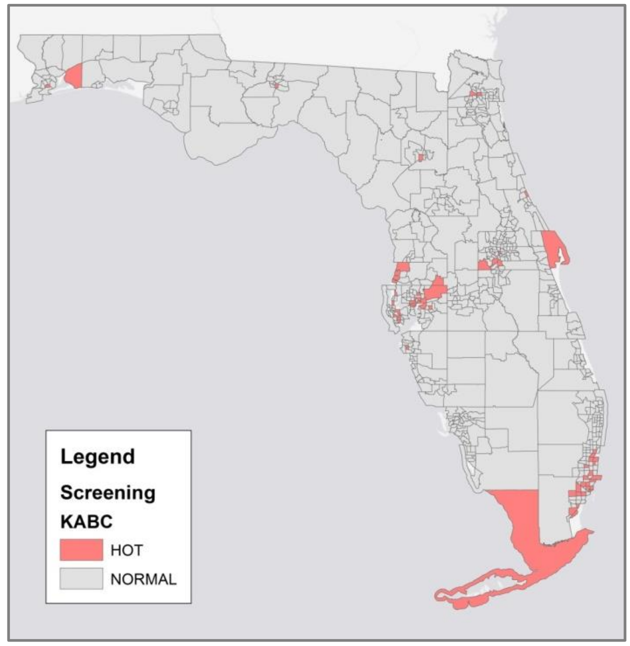
Using the method above, the PSI by each crash type were calculated based on selected analysis zone and categorized based on the PSI value. In research, SWTAZs were selected for screening analysis of non-motorized mode (i.e., pedestrian and bicycle) crashes while TADs were adopted for other crash types screening. The screening results of different crash types are shown as follows.

6.3.1 Screening results by severity levels based on TADs

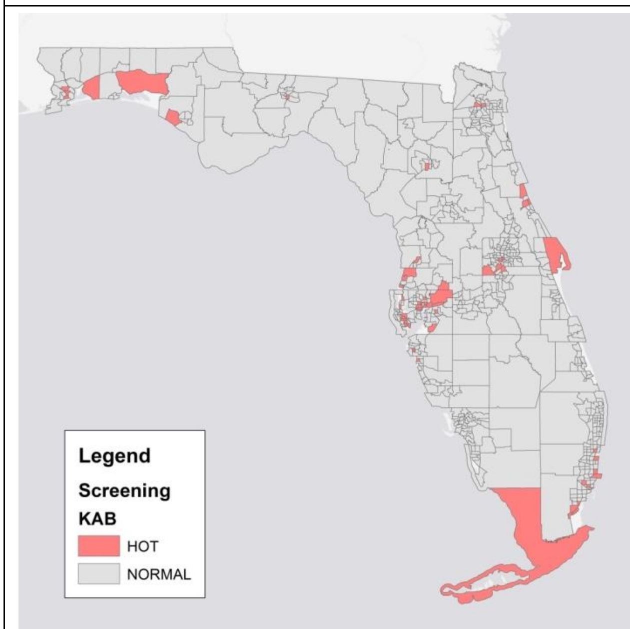
Figure 6-4 exhibits the screening results of total (KABCO), fatal-and-injury (KABC) crashes, fatal-and-injury crashes without possible injury (KAB), and fatal-and-severe injury (KA) crashes based on TADs. It was revealed that the spatial distribution of hot zones of different crash severities is different. The hot zones of total and fatal-and-injury crashes are concentrated in urban area in which has higher traffic exposure and population. In contrast, fatal-and-severe injury crash hot zones are more often observed in rural areas. This was also confirmed in the SPF for fatal-and-severe injury crash (KA), as it was found that the proportion of urban area is negatively associated with fatal-and-severe crash occurrence.



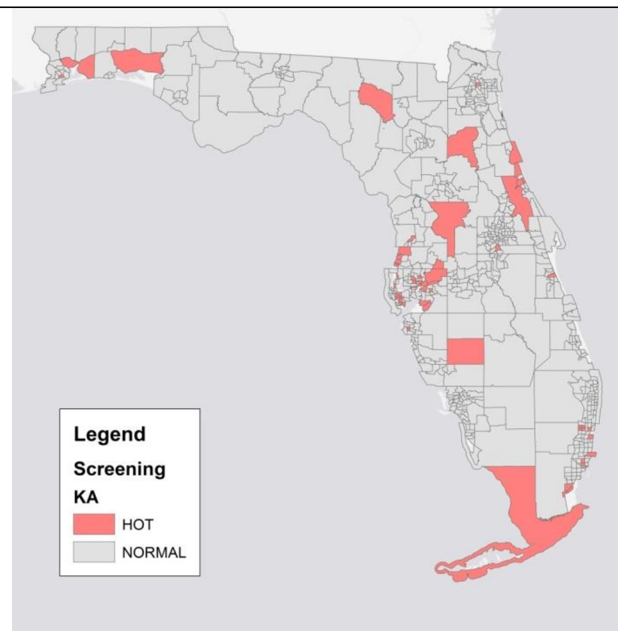
Total Crashes (KABCO)



Fatal and Injury Crashes (KABC)



Fatal-and-injury Crashes without Possible Injury (KAB)

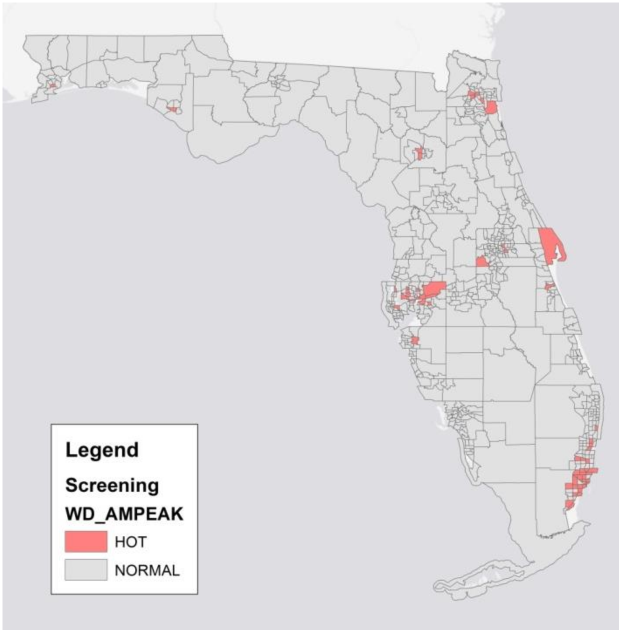


Fatal-and-severe Injury Crashes (KA)

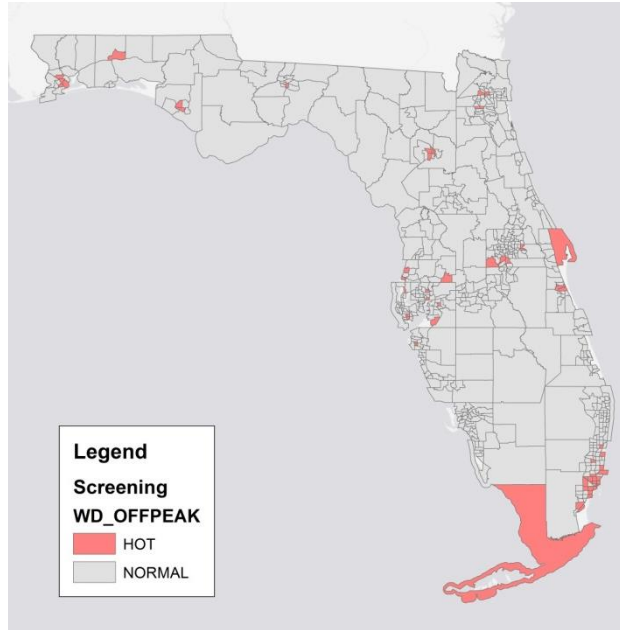
Figure 6-4 Hot zone identification by severity levels using PSI based on TADs

6.3.2 Screening results by time period based on TADs

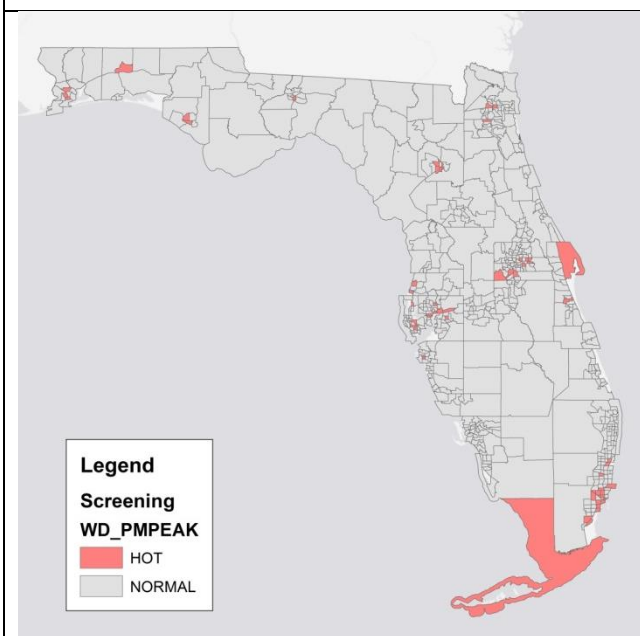
The screening results by time period on weekdays are presented in Figure 6-5. Most hot zones of crash during different time period on weekdays are found in urban area. However, the hot zones disseminate in different pattern by time period. It was shown that most hot zones of crash during weekday AM peak are concentrated in east and middle parts of Florida. The hot zones of crash during weekday off-peak and PM peak have similar spatial distribution, locating at the peripheral areas. Moreover, the hot zones of crashes during weekday nighttime are located in middle-east and southeast areas.



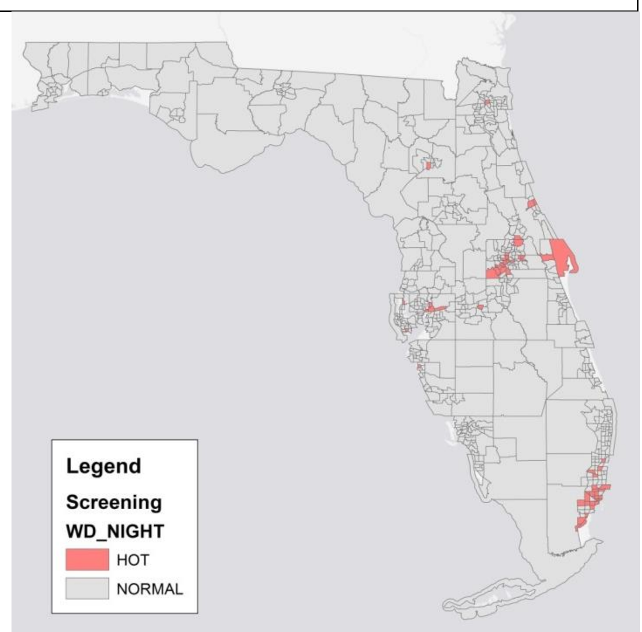
Crashes during Weekday AM Peak (WD_AMPEAK)



Crashes during Weekday Off-Peak (WD_OFFPEAK)



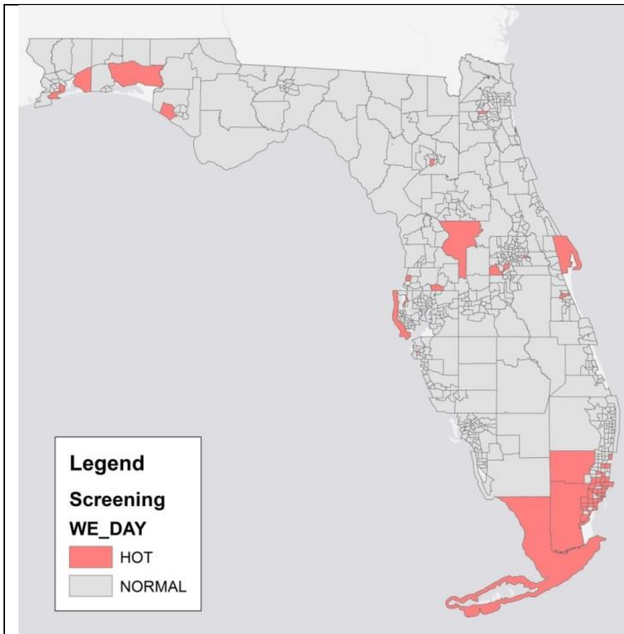
Crashes during Weekday PM Peak (WD_PMPEAK)



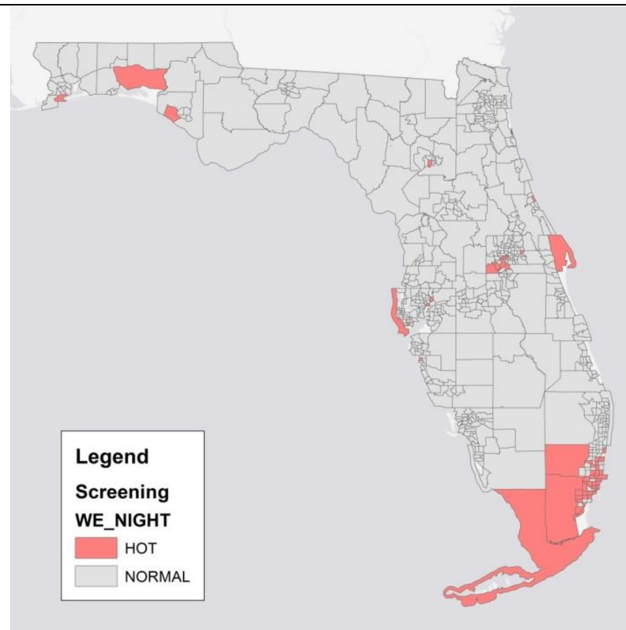
Crashes during Weekday nighttime (WD_NIGHT)

Figure 6-5 Hot zone identification by time period on weekday using PSI based on TADs

The spatial distribution pattern can be found in Figure 6-6. It is revealed that hot zones of crashes during daytime and nighttime on weekend are in similar areas. Most zones are found in urban areas which attract more recreational activities on weekend. However, compared with total crashes and crashes during weekday AM peak, the crashes on weekend are more likely to have hot zones in rural areas.



Crashes during Weekend Daytime (WE_DAY)

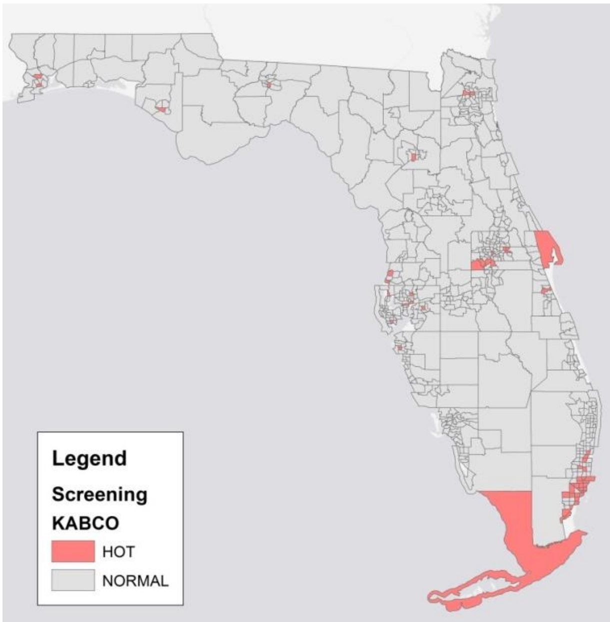


Crashes during Weekend Nighttime (WE_NIGHT)

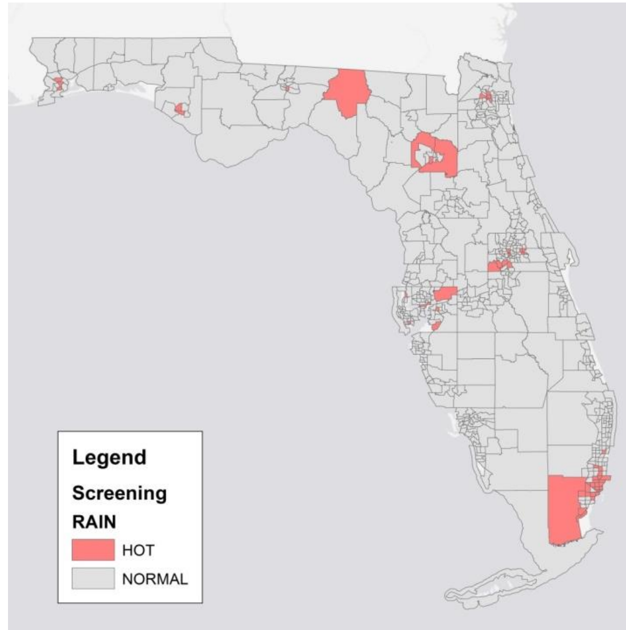
Figure 6-6 Hot zone identification by time period on weekend using PSI based on TADs

6.3.3 Screening results by special events based on TADs

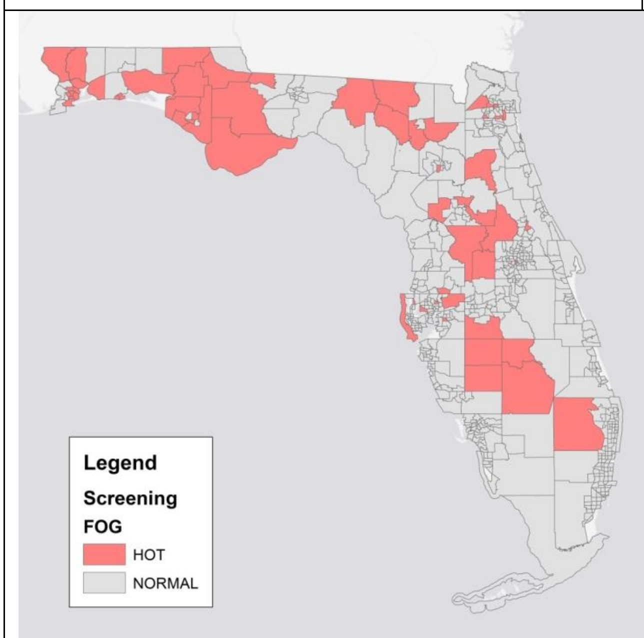
The hot zones of special event (i.e., adverse weather and DUI) crashes together with total crashes (KABCO) are exhibited in Figure 6-7. It was revealed that the distribution of hot zones for the four crash types is not similar. It is also noteworthy to mention that crashes related to the two different adverse weather types (rain and fog) have different hot zone distribution. The crashes related to fog have more hot zones in rural area compared with rain-related crashes. The rural area should have more lakes and forests and may result in high fog occurrence. Lastly, it was found that the hot zones of DUI-related crashes are mainly in rural area which is also consistent with the SPF estimation result.



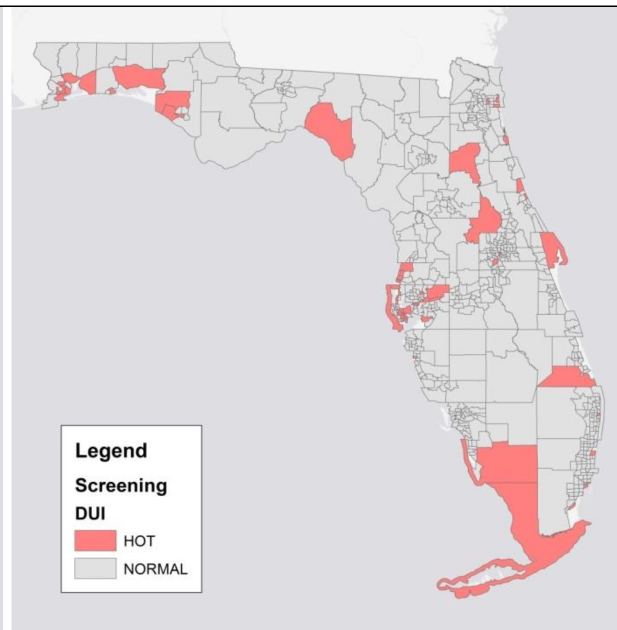
Total Crashes (KABCO)



Crashes under Rainy Condition (RAIN)



Crashes under Foggy Condition (FOG)

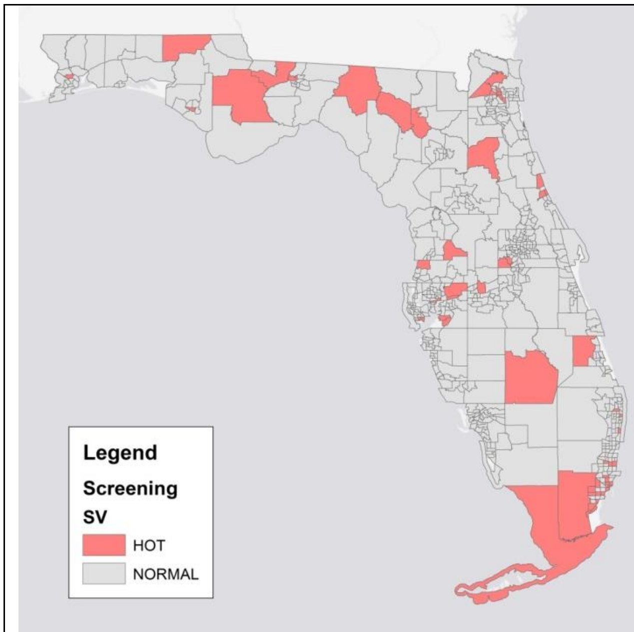


Crashes due to Driving under the Influence of alcohol or Drugs (DUI)

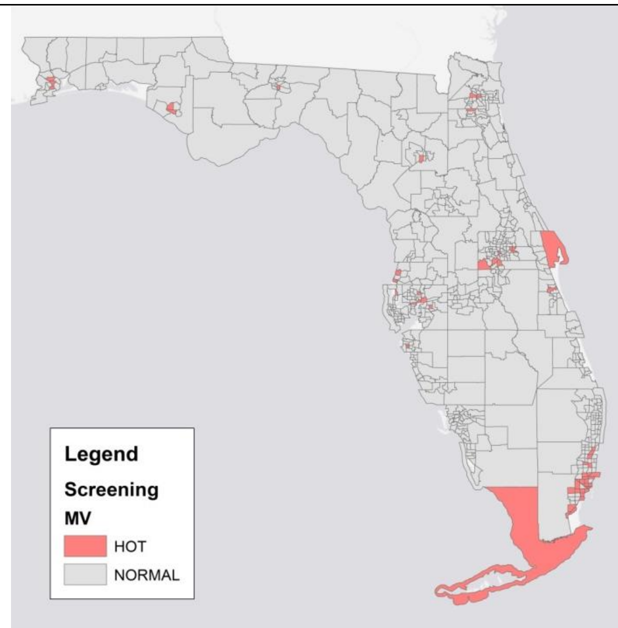
Figure 6-7 Hot zone identification by special events together with using PSI based on TADs

6.3.4 Screening results by collision types based on TADs/SWTAZs

Figure 6-8 summarizes the hot zones of single-vehicle and multiple-vehicle crashes based on TADs. It indicates that the hot zones of the two collision types have quite different spatial distribution. For the single-vehicle crashes, the hot zones more easily to be observed in rural areas since the driving speeds in this area are higher. Unlike single-vehicle crashes, the multiple-vehicle crashes hot zones are more likely to be placed in urban areas where traffic exposure is higher and vehicle-to-vehicle conflicts are more frequent.



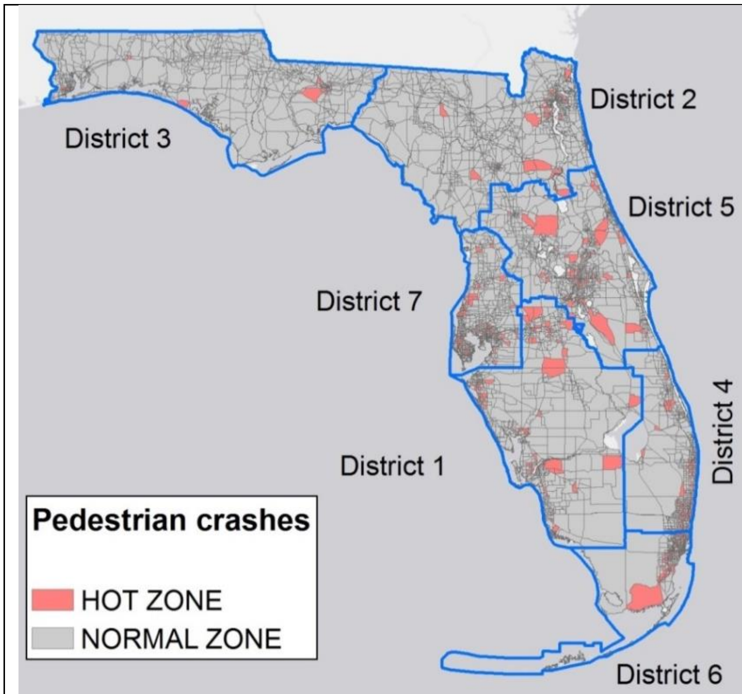
Single-vehicle Crashes (SV)



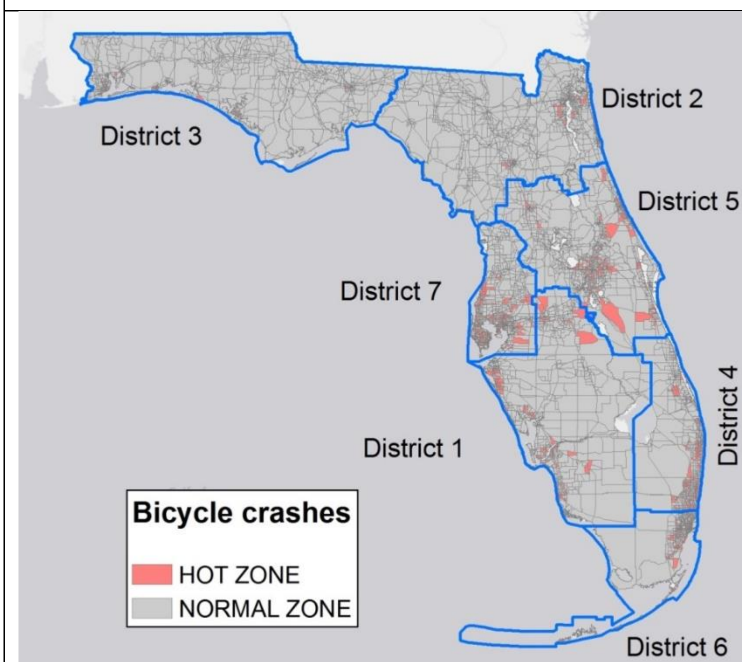
Multiple-vehicle Crashes (MV)

Figure 6-8 Hot zone identification for vehicles involved only using PSI based on TADs

The hot zones of non-motorized mode (i.e., pedestrian and bicycle) crashes are displayed in Figure 6-9 and the detailed spatial distribution for each district is shown in Figure 6-10. For the two crash types, they have similar spatial distributions of the hot zones. Districts 2, 4-7 have more hot zones of the non-motorized mode crashes. Moreover, the hot zones in these areas always are located in urban areas because pedestrians as well as bicyclists are prevalent mostly in urban areas.

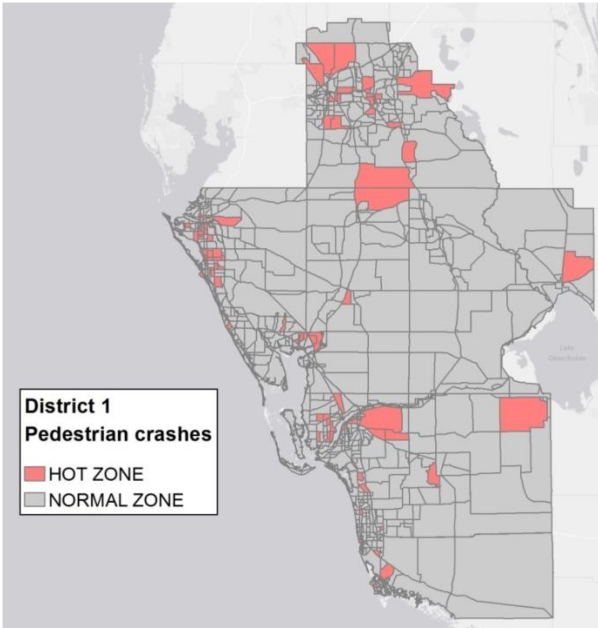


Pedestrian-involved Crashes (PED)

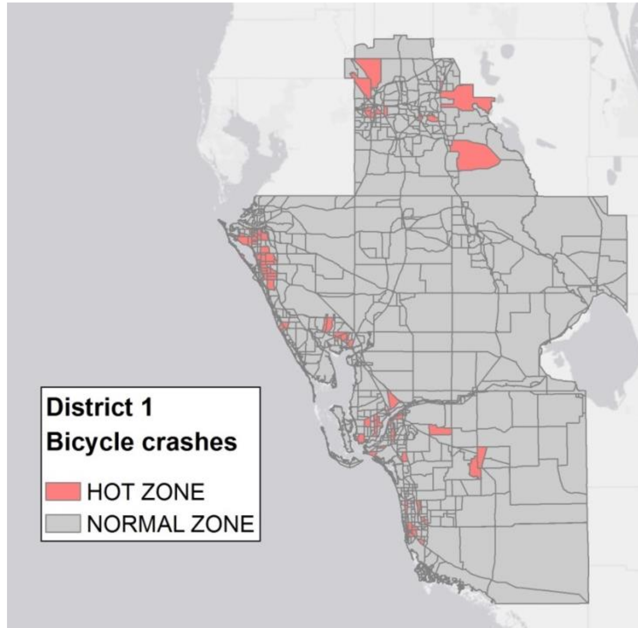


Bicycle-involved Crashes (BIKE)

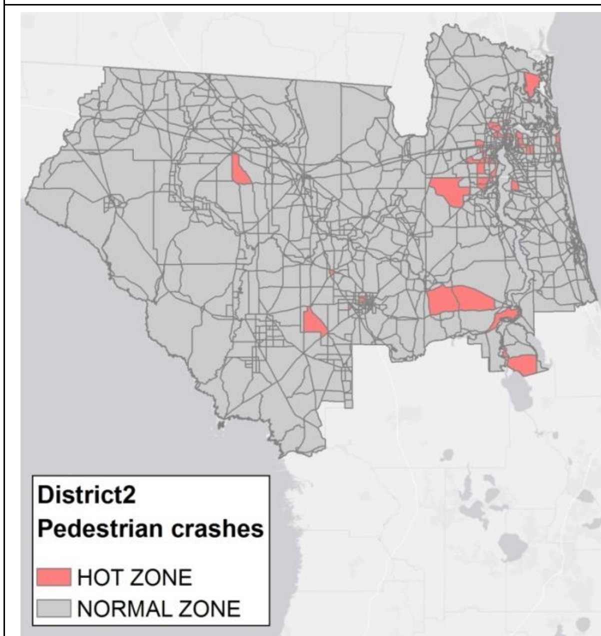
Figure 6-9 Hot zone identification for non-motorized mode-involved crashes using PSI based on SWTAZs



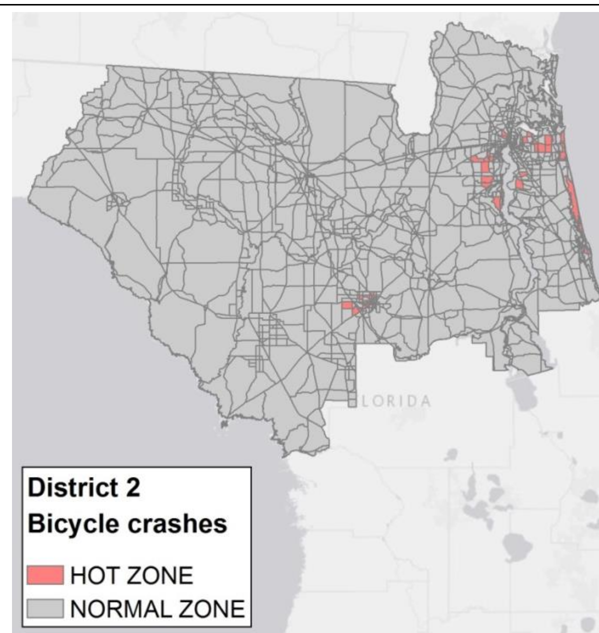
Pedestrian-involved Crashes (PED) in District 1



Bicycle-involved Crashes (BIKE) in District 1

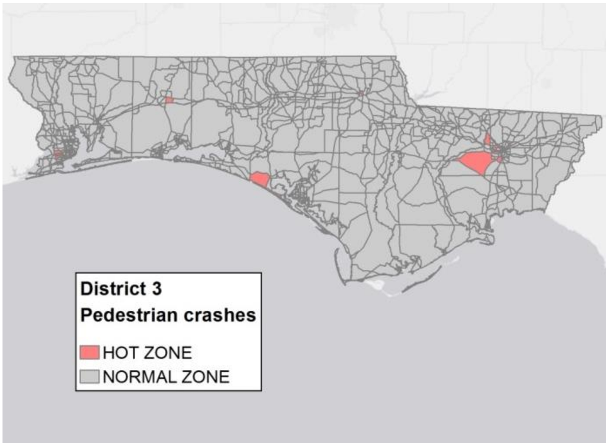


Pedestrian-involved Crashes (PED) in District 2

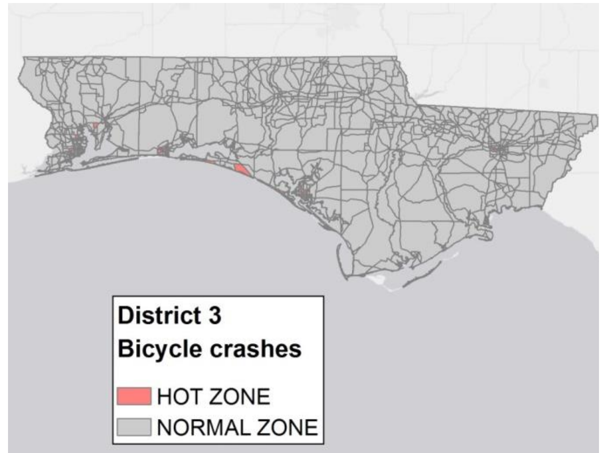


Bicycle-involved Crashes (BIKE) in District 2

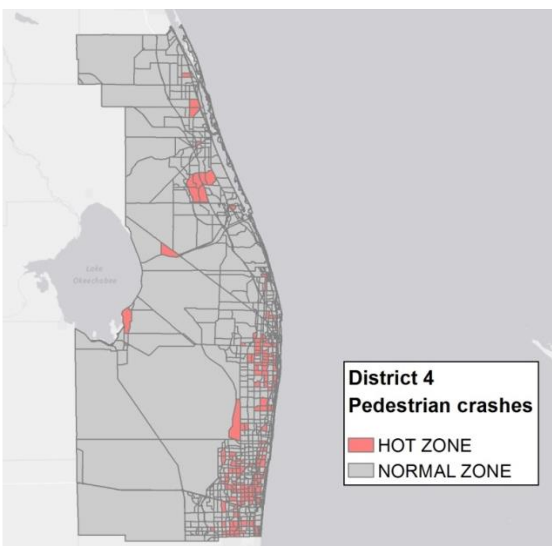
Figure 6-10 Hot zone identification for pedestrian/bicycle-involved crashes (PED/BIKE) using PSI based on SWTAZs in each District



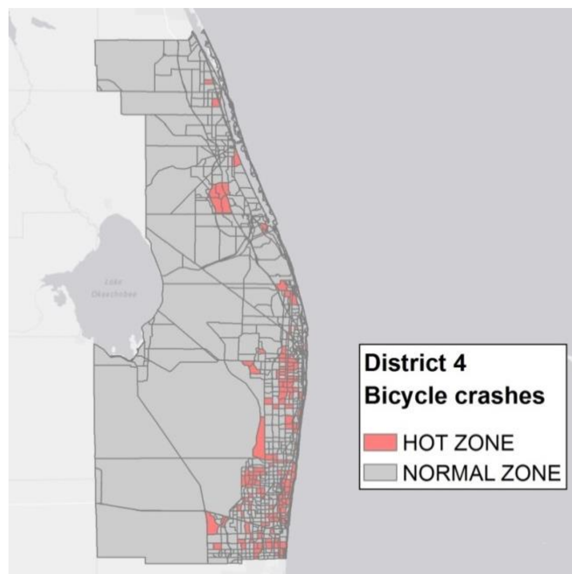
Pedestrian-involved Crashes (PED) in District 3



Bicycle-involved Crashes (BIKE) in District 3



Pedestrian-involved Crashes (PED) in District 4



Bicycle-involved Crashes (BIKE) in District 4

Figure 6-10, continued. Hot zone identification for pedestrian/bicycle-involved crashes (PED/BIKE) using PSI based on SWTAZs in each District

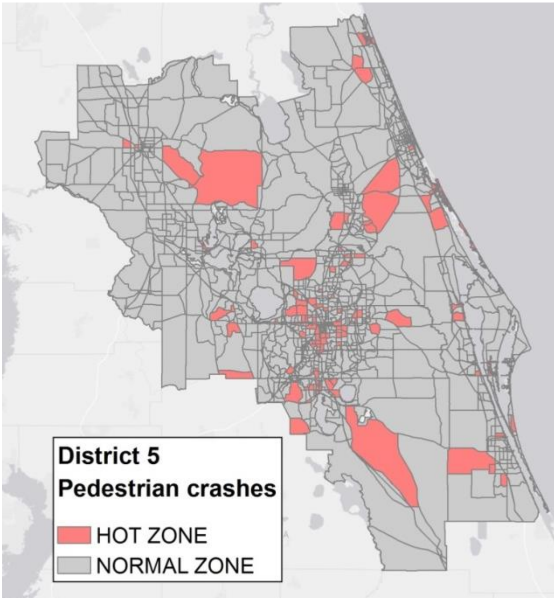
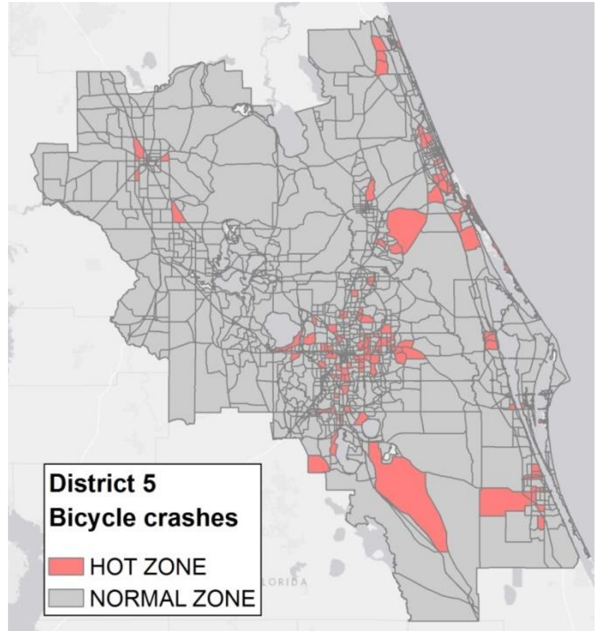
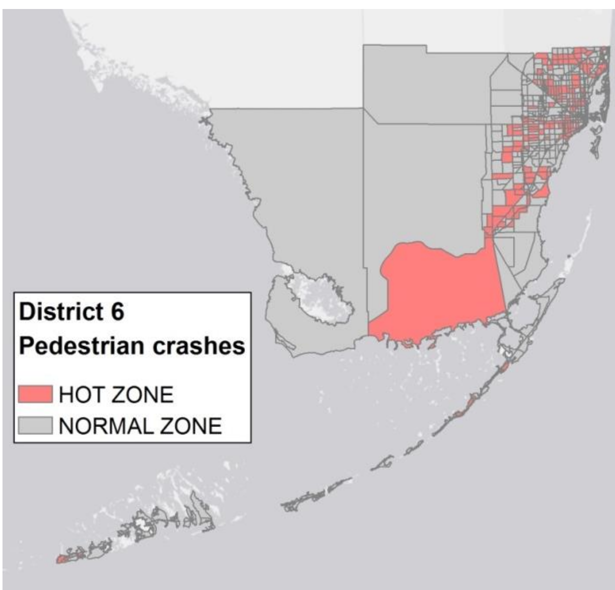
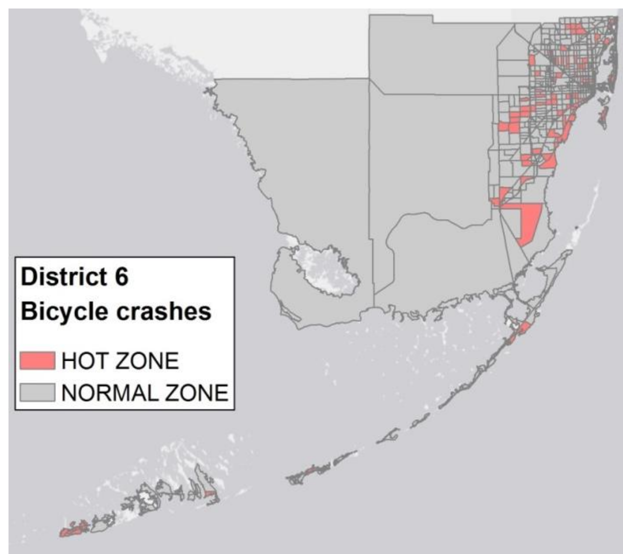
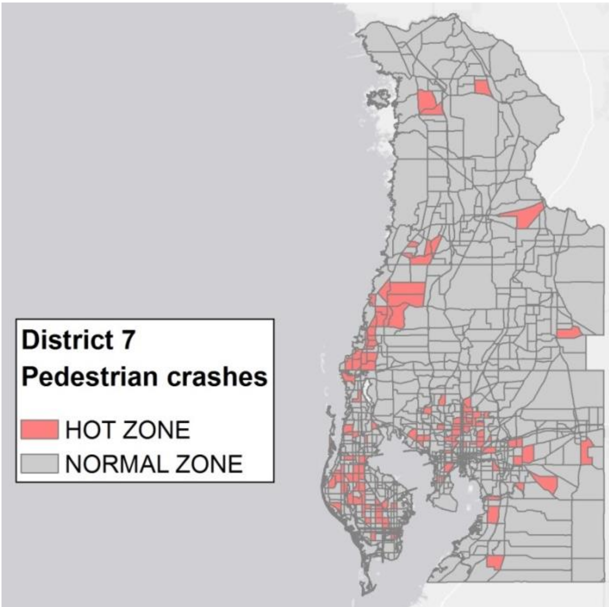
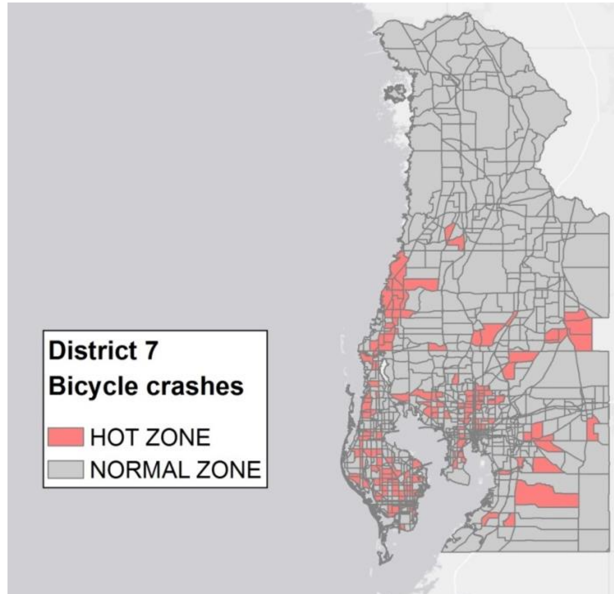
	
Pedestrian-involved Crashes (PED) in District 5	**Bicycle-involved Crashes (BIKE) in District 5**
	
Pedestrian-involved Crashes (PED) in District 6	**Bicycle-involved Crashes (BIKE) in District 6**

Figure 6-10, continued. Hot zone identification for pedestrian/bicycle-involved crashes (PED/BIKE) using PSI based on SWTAZs in each District



Pedestrian-involved Crashes (PED) in District 7



Bicycle-involved Crashes (BIKE) in District 7

Figure 6-10, continued. Hot zone identification for pedestrian/bicycle-involved crashes (PED/BIKE) using PSI based on SWTAZs in each District

6.4 Summary of Macroscopic Screening Results

The research team has completed macro-level crash screening by severity levels, time periods, collision types, and special events. A comparative analysis between SWTAZs and TADs was conducted to determine the best zone system for different crash types. The comparison results showed that the SWTAZs-based models perform better for non-motorized mode-involved crashes whereas the TADs-based models provide better performance for total and severe crashes. Therefore, SWTAZs and TADs are selected for screening of non-motorized mode crashes and other crash types, respectively. Then Potential for Safety Improvements (PSIs) were applied as a performance measure to identify hot zones. It was revealed that the hot zones of different crash types have diverse spatial distribution. It is expected that the macroscopic screening results are useful for policy-makers and practitioners understand hot zones of specific crash types in a broad perspective. Once they realize a particular zone has a specific safety problem, they can zoom in the problematic zones and find out individual hotspot intersections or segments with safety issues.

7 DEVELOPMENT OF VARIOUS SPFS AT THE MICRO-LEVEL

7.1 Segment and Intersection Facility and Crash Types

In Chapter 6, the research team developed a wide array of the SPFs for different types of segments and intersections. As shown in Table 7-1, Segments were categorized into 13 facility types based on the locations (i.e., urban or rural), number of lanes, access controls (i.e., full or no access control), and median division. In case of intersections, they were classified into 16 facility types based on the location, number of legs, and control types (i.e., stop or signal).

Initially, the research team developed SPFs by severity level such as KABCO (total), KABC (fatal-and-injury crashes), KAB (fatal-and-injury crashes without possible injury) and KA (fatal-and-severe injury crashes). Secondly, the research team has built SPFs by time period. The research team divided crashes into weekday and weekend crashes. The weekday crashes were classified into morning peak (07:00-08:59), off-peak (09:00-15:59), evening peak (16:00-17:59), and nighttime (18:00-06:59). In case of the weekend crashes, since it is known that there is no significant variation in traffic volume during the daytime as during weekdays, only daytime (07:00-17:59) and nighttime (18:00-06:59) were considered. Four major collision types: single-vehicle, multiple-vehicle, pedestrian involved, and bicycle-involved collision SPFs were estimated. Lastly, SPFs for special crash events including adverse weather conditions (i.e., rain and fog) and DUI (Driving under the influence of alcohol or drugs) were built. The abbreviations of the variables used in the modeling results are described in Table 7-2.

These SPFs enable practitioners to calculate the predicted and expected number of crashes by each specific facility type. Thus, practitioners can identify intersections and segments with high crash risks based on the SPFs. In Chapter 10, micro-level network screening for each crash type will be conducted using the developed SPFs.

Table 7-1 Abbreviations of types of segments and intersections

Category	Abbreviations	Meaning
Segment	R2U	Rural 2-lane undivided
	R2D	Rural 2-lane divided
	RMU	Rural multi-lane undivided
	RMD	Rural multi-lane divided
	U2U	Urban 2-lane undivided
	U2D	Urban 2-lane divided
	UMU	Urban multi-lane undivided
	UMD	Urban multi-lane divided
	3TL	3-lane two-way left-turn lane
	5TL	5 –lane two-way left-turn lane
	4FR	4-lane full access control
	6FR	6-lane full access control
	8FR	8-lane full access control
Intersections	U_3SG	Urban 3-leg signalized
	U_4SG	Urban 4-leg signalized
	U_4SG_1OW	Urban 4-leg signalized: one of the road is one-way
	U_4SG_2OW	Urban 4-leg signalized: both roads are one-way
	U_5_6SG	Urban 5or 6 leg signalized
	U_3ST_1S	Urban 3-leg stop controlled: 1-way stop
	U_3ST_1SD	Urban 3-leg stop controlled: 1-way stop- divided
	U_3ST_3S	Urban 3-leg stop controlled: 3-way stop
	U_4ST_2S	Urban 4-leg stop controlled: 2-way stop
	U_4ST_2S_1OW	Urban 4-leg stop controlled: 2-way stop: one of the road is one-way
	U_4ST_4S	Urban 4-leg stop controlled: 4-way stop
	R_4SG	Rural 4-leg signalized
	R_3ST_1S	Rural 3-leg stop controlled: 1-way stop
	R_4ST_2S	Rural 4-leg stop controlled: 2-way stop
	R_4ST_4S	Rural 4-leg stop controlled: 4-way stop
	ROUNDABOUT	Roundabouts

Table 7-2 Abbreviations used in model estimation

Category	Abbreviations	Meaning
Crash types (Target variables)	K	Fatal crash
	A	Incapacitating injury crash
	B	Non-incapacitating injury crash
	C	Possible injury crash
	O	Property damage only crash
	WD_AMPEAK	Crash occurred during weekday AM Peak (07:00-08:59)
	WD_OFFPEAK	Crash occurred during weekday off-peak (09:00-15:59)
	WD_PMPEAK	Crash occurred during weekday PM Peak (16:00-17:59)
	WD_NIGHT	Crash occurred during weekday nighttime (18:00-06:59)
	WE_DAY	Crash occurred during weekend daytime (07:00-17:59)
	WE_NIGHT	Crash occurred during weekend daytime (18:00-06:59)
	SV	Single-vehicle collision
	MV	Multiple-vehicle collision
	PED	Pedestrian-involved collision
	BIKE	Bicycle-involved collision
	RAIN	Crash under rainy condition
	FOG	Crash under foggy condition
	DUI	Crash due to driving under the influence of alcohol or drugs
Explanatory variables	ln(AADT)	Natural Log of AADT of segments
	ln(MJ_AADT)	Natural Log of AADT of major road of intersections
	ln(MN_AADT)	Natural Log of AADT of minor road of intersections
	ln(TEV)	Natural Log of total entering vehicles of intersections

Micro-level facility types used in the analysis are classified as in Figure 7-1.

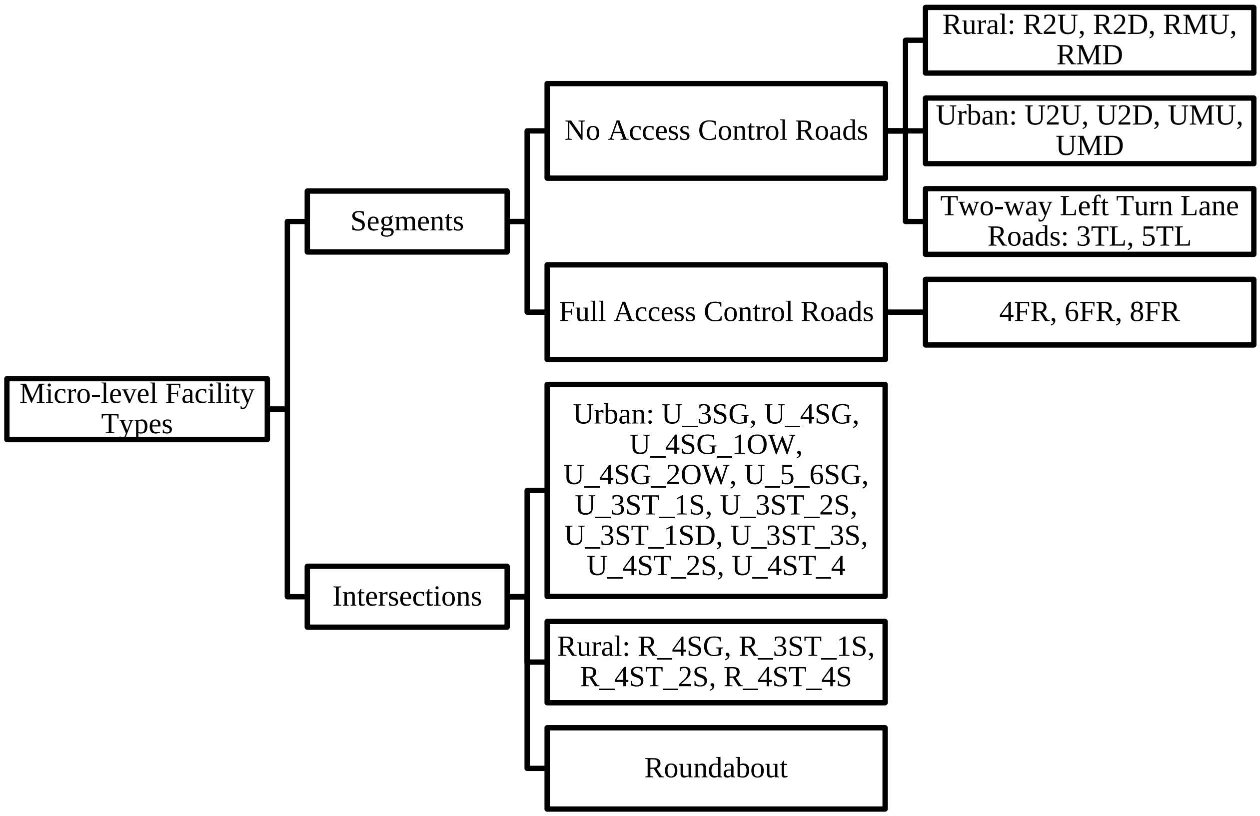


Figure 7-1 Micro-level facility types

7.2 Statistical Modeling Methodology

A negative binomial (NB) model was used to be consistent with the current Highway Safety Manual (AASHTO, 2010). The number of crashes is non-negative integers, which are not normally distributed. Poisson or NB models have the abilities to develop the crash frequencies with explanatory variables; however, Poisson model has been criticized because of its implicit assumption that the variance equals mean. This assumption is often violated especially in the crash data. Most of crash data have a greater variance than their mean and therefore the data is over-dispersed. NB models can relax the over-dispersion issue. The mean-variance relationship in NB distribution is as follows:

$$Var\ (Y) = \mu + \alpha\mu^2 \qquad (1)$$

where, Y is response variable, μ is mean response of the observation, and α is over-dispersion parameter. Thus, if the dispersion parameter α is zero, the variance is also equal to the mean, which is the basic assumption of Poisson distribution. The existence of over-dispersion is adjusted by the log-linear relationship between the expected number of crashes and covariates.

The formula showing the relationship between expected number of crashes and variables (i.e., AADT, segment length) for segment SPFs is as follows:

$$\log(\mu_i) = \beta_0 + \beta_1 \ln(AADT) + \ln(length) + \varepsilon_i \qquad (2)$$

where, i is an observation unit, μ_i is the expected number of crashes per mile per year on segment i, β_0 is the intercept, β_1 is the estimated coefficient and ε_i is the random error term.

Over-dispersion parameter in segment SPFs is a function of segment length. It can be calculated using the following equation:

$$\alpha = {}^{1}/_{\exp(c + \ln(length))} \qquad (3)$$

where, α = over-dispersion parameter, and c = a regression coefficient used to compute the over-dispersion parameter.

Furthermore, the equations showing the relationship between expected number of crashes and variables (i.e., major/minor AADT, TEV) for intersection SPFs are as follows:

$$\log(\mu_i) = \beta_0 + \beta_1 \ln(MJ\_AADT + \beta_2 \ln(MN\_AADT) + \varepsilon_i \quad (4)$$

or

$$\log(\mu_i) = \beta_0 + \beta_3 \ln(TEV) + \varepsilon_i \quad (5)$$

where, i is an observation unit, μ_i is the expected number of crashes per year on intersection/roundabout i, β_0 is the intercept, β_1, β_2 and β_3 are the estimated coefficients and ε_i is the random error term. Equation (7) was used if either the natural log of AADT of major road of intersections: ln(MJ_AADT) or the natural log of AADT of minor road of intersections: ln(MN_AADT) is not significant in Equation (6).

7.3 Explanatory Analysis of the Prepared Data

The collected data were processed for segments and intersections. A descriptive statistics of the processed segments and intersection data are summarized in Tables 7-3 to 7-6 and Tables 7-7 to 7-10, accordingly.

Table 7-3 Descriptive statistics of rural area segment data

Segment Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
R2U: Rural 2-lane undivided (N=4145)	Length	2.505	2.934	0.1	28.919	-
	AADT	3808.693	3777.64	20	38759	-
	KABCO	2.884	4.492	0	47	11954
	KABC	1.531	2.713	0	30	6346
	KAB	1.073	1.976	0	27	4448
	KA	0.485	1.097	0	18	2010
	WD_AMPEAK	0.214	0.591	0	7	885
	WD_OFFPEAK	0.658	1.289	0	13	2728
	WD_PMPEAK	0.270	0.662	0	8	1121
	WD_NIGHT	0.854	1.567	0	16	3540
	WE_DAY	0.419	0.901	0	8	1737
	WE_NIGHT	0.503	1.027	0	14	2086
	FOG	0.066	0.299	0	6	274
	RAIN	0.314	0.835	0	12	1301
	SV	1.728	2.918	0	38	7163
	MV	1.130	2.260	0	29	4682
	PED	0.036	0.199	0	2	148
	BIKE	0.021	0.158	0	3	87
	DUI	0.254	0.650	0	11	1053
R2D: Rural 2-lane divided (N=1375)	Length	0.275	0.283	0.1	5.014	-
	AADT	6679.075	4675.548	250	39000	-
	KABCO	1.068	2.893	0	65	1469
	KABC	0.388	1.097	0	18	534
	KAB	0.231	0.686	0	12	318
	KA	0.091	0.377	0	6	125
	WD_AMPEAK	0.113	0.509	0	10	156
	WD_OFFPEAK	0.298	1.038	0	22	410
	WD_PMPEAK	0.128	0.464	0	6	176
	WD_NIGHT	0.247	0.707	0	13	340
	WE_DAY	0.151	0.601	0	12	207
	WE_NIGHT	0.134	0.456	0	7	184
	FOG	0.015	0.123	0	1	21
	RAIN	0.113	0.426	0	5	155
	SV	0.327	0.748	0	8	450
	MV	0.726	2.501	0	60	998
	PED	0.014	0.123	0	2	19
	BIKE	0.005	0.071	0	1	7
	DUI	0.060	0.269	0	3	82
RMU: Rural multi-lane undivided (N=38)	Length	0.357	0.282	0.118	1.283	-
	AADT	7986.842	3646.707	2200	17100	-
	KABCO	2	3.587	0	19	76
	KABC	0.632	1.172	0	5	24
	KAB	0.368	0.883	0	4	14

Table 7-3, continued.

RMU: Rural multi-lane undivided (N=38)	KA	0.184	0.512	0	2	7
	WD_AMPEAK	0.184	0.512	0	2	7
	WD_OFFPEAK	0.763	1.852	0	11	29
	WD_PMPEAK	0.211	0.741	0	4	8
	WD_NIGHT	0.342	0.878	0	4	13
	WE_DAY	0.263	0.503	0	2	10
	WE_NIGHT	0.263	1.083	0	6	10
	FOG	0.026	0.162	0	1	1
	RAIN	0.158	0.437	0	2	6
	SV	0.500	1.109	0	5	19
	MV	1.395	2.964	0	17	53
	PED	0.079	0.359	0	2	3
	BIKE	0.000	0.000	0	0	0
	DUI	0.053	0.226	0	1	2
RMD: Rural multi-lane divided (N=767)	Length	1.881	2.4	0.102	23.446	-
	AADT	12951.86	8322.777	650	58000	-
	KABCO	6.609	17.571	0	323	5069
	KABC	2.108	6.038	0	91	1617
	KAB	1.213	3.433	0	48	930
	KA	0.425	1.213	0	8	326
	WD_AMPEAK	0.602	1.883	0	30	462
	WD_OFFPEAK	1.969	5.537	0	90	1510
	WD_PMPEAK	0.824	2.477	0	42	632
	WD_NIGHT	1.707	4.793	0	82	1309
	WE_DAY	0.853	2.555	0	50	654
	WE_NIGHT	0.673	1.847	0	31	516
	FOG	0.064	0.255	0	2	49
	RAIN	0.658	2.186	0	41	505
	SV	1.533	2.804	0	22	1176
	MV	4.884	15.214	0	293	3746
	PED	0.073	0.319	0	3	56
	BIKE	0.059	0.355	0	5	45
	DUI	0.235	0.765	0	8	180

Table 7-4 Descriptive statistics of urban area segment data

Segment Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
U2U: Urban 2-lane undivided (N=7908)	Length	0.615	0.617	0.1	6.665	-
	AADT	7313.206	5726.32	20	86500	-
	KABCO	4.489	8.294	0	176	35499
	KABC	1.665	2.877	0	63	13167
	KAB	0.914	1.671	0	29	7228
	KA	0.275	0.677	0	9	2175
	WD_AMPEAK	0.362	0.885	0	18	2863
	WD_OFFPEAK	1.352	2.937	0	73	10688
	WD_PMPEAK	0.559	1.303	0	22	4420
	WD_NIGHT	1.167	2.372	0	75	9229
	WE_DAY	0.552	1.298	0	26	4367
	WE_NIGHT	0.563	1.350	0	32	4453
	FOG	0.020	0.151	0	4	156
	RAIN	0.358	0.939	0	23	2828
	SV	0.961	1.730	0	35	7596
	MV	3.342	7.190	0	163	26432
	PED	0.115	0.400	0	5	909
	BIKE	0.100	0.395	0	7	794
	DUI	0.236	0.608	0	9	1869
U2D: Urban 2-lane divided(N=4289)	Length	0.292	0.286	0.1	3.99	-
	AADT	9736.059	6560.497	140	110000	-
	KABCO	3.885	6.995	0	149	17051
	KABC	1.366	2.556	0	47	5995
	KAB	0.687	1.361	0	26	3015
	KA	0.201	0.556	0	9	882
	WD_AMPEAK	0.355	0.931	0	19	21579
	WD_OFFPEAK	1.189	2.404	0	44	1558
	WD_PMPEAK	0.575	1.425	0	31	5220
	WD_NIGHT	0.939	1.952	0	34	2525
	WE_DAY	0.475	1.121	0	22	4122
	WE_NIGHT	0.382	0.883	0	12	2084
	FOG	0.012	0.108	0	1	52
	RAIN	0.311	0.809	0	11	1367
	SV	0.569	1.072	0	13	2496
	MV	3.162	6.247	0	134	13879
	PED	0.078	0.342	0	8	341
	BIKE	0.072	0.321	0	6	318
	DUI	0.155	0.473	0	7	679
UMU: Urban multi-lane undivided (N=579)	Length	0.39	0.339	0.1	3.165	-
	AADT	14533.82	8695.054	350	49500	-
	KABCO	10.149	20.956	0	347	5876
	KABC	3.247	5.296	0	66	1880
	KAB	1.644	2.962	0	36	952
	KA	0.437	0.927	0	7	253

Table 7-4, continued.

UMU: Urban multi-lane undivided (N=579)	WD_AMPEAK	0.772	1.657	0	23	447
	WD_OFFPEAK	3.527	6.714	0	104	2042
	WD_PMPEAK	1.382	2.999	0	53	800
	WD_NIGHT	2.316	5.598	0	76	1341
	WE_DAY	1.238	3.198	0	57	717
	WE_NIGHT	1.028	3.034	0	41	959
	FOG	0.009	0.093	0	1	5
	RAIN	0.772	1.976	0	32	447
	SV	0.955	1.521	0	14	553
	MV	8.627	19.279	0	333	4995
	PED	0.328	1.001	0	15	190
	BIKE	0.212	0.541	0	4	123
	DUI	0.264	0.629	0	6	153
UMD: Urban multi-lane divided (N=7039)	Length	0.721	0.731	0.1	8.799	-
	AADT	27985.98	15545.27	350	140000	-
	KABCO	24.244	36.016	0	453	170654
	KABC	7.894	11.144	0	131	55566
	KAB	3.812	5.422	0	69	26833
	KA	1.158	2.088	0	33	8151
	WD_AMPEAK	1.989	3.370	0	42	14003
	WD_OFFPEAK	8.076	12.852	0	190	56845
	WD_PMPEAK	3.455	5.721	0	76	24319
	WD_NIGHT	5.802	9.525	0	167	40843
	WE_DAY	2.891	5.065	0	76	20350
	WE_NIGHT	2.126	3.589	0	60	14962
	FOG	0.052	0.242	0	3	366
	RAIN	2.042	3.585	0	43	14371
	SV	2.221	3.033	0	32	15633
	MV	20.950	32.877	0	424	147469
	PED	0.427	1.004	0	16	3007
	BIKE	0.442	1.009	0	17	3112
	DUI	0.664	1.212	0	14	4673

Table 7-5 Descriptive statistics of two-way left-turn road segment data

Segment Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
3TL: 3-lane two-way left-turn lane (N=857)	Length	0.374	0.349	0.1	3.109	-
	AADT	9566.181	5511.588	200	48000	-
	KABCO	5.375	8.453	0	83	4606
	KABC	1.807	3.23	0	35	1549
	KAB	0.888	1.577	0	16	761
	KA	0.235	0.555	0	5	201
	WD_AMPEAK	0.456	1.056	0	11	391
	WD_OFFPEAK	1.742	2.960	0	26	1493
	WD_PMPEAK	0.826	1.664	0	15	708
	WD_NIGHT	1.242	2.279	0	28	1064
	WE_DAY	0.669	1.370	0	13	573
	WE_NIGHT	0.485	1.021	0	9	416
	FOG	0.011	0.102	0	1	9
	RAIN	0.385	0.956	0	9	330
	SV	0.625	1.087	0	9	536
	MV	4.393	7.418	0	76	3765
	PED	0.130	0.436	0	5	111
	BIKE	0.110	0.351	0	3	94
	DUI	0.182	0.453	0	3	156
5TL: 5-lane two-way left-turn lane (N=755)	Length	0.572	0.571	0.1	6.767	-
	AADT	23191.056	14429.21	450	148000	-
	KABCO	17.585	24.798	0	273	13277
	KABC	5.932	9.324	0	114	4479
	KAB	2.996	4.699	0	50	2262
	KA	0.883	1.66	0	21	667
	WD_AMPEAK	1.293	2.131	0	21	976
	WD_OFFPEAK	6.690	10.585	0	117	5051
	WD_PMPEAK	2.689	4.559	0	37	2030
	WD_NIGHT	3.687	5.567	0	51	2784
	WE_DAY	1.934	3.098	0	35	1460
	WE_NIGHT	1.359	2.057	0	21	1026
	FOG	0.037	0.209	0	2	28
	RAIN	1.286	2.209	0	19	971
	SV	1.310	1.867	0	15	989
	MV	15.215	22.582	0	255	11487
	PED	0.475	1.019	0	11	359
	BIKE	0.391	0.855	0	8	295
	DUI	0.531	1.064	0	8	401

Table 7-6 Descriptive statistics of full access control road segment data

Segment Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
4FR: 4-lane full access control (N=494)	Length	2.388	3.524	0.1	30.906	-
	AADT	42868.328	27520.884	3100	187000	-
	KABCO	43.176	52.567	0	309	21329
	KABC	18.271	22.592	0	147	9026
	KAB	10.312	13.586	0	108	5094
	KA	3.828	5.501	0	41	1891
	WD_AMPEAK	4.342	6.557	0	47	2145
	WD_OFFPEAK	11.063	14.501	0	87	5465
	WD_PMPEAK	4.960	6.682	0	54	2450
	WD_NIGHT	11.123	13.468	0	79	5495
	WE_DAY	6.619	9.594	0	77	3270
	WE_NIGHT	5.202	6.752	0	51	2570
	FOG	0.377	0.790	0	6	183
	RAIN	9.348	13.809	0	108	4618
	SV	19.368	25.929	0	151	9568
	MV	23.636	30.014	0	223	11676
	PED	0.150	0.461	0	4	74
	BIKE	0.014	0.118	0	1	7
	DUI	1.350	1.999	0	14	667
6FR: 6-lane full access control (N=480)	Length	1.571	1.807	0.101	10.232	-
	AADT	95642.89	44510.404	7500	275000	-
	KABCO	88.463	79.812	0	441	42462
	KABC	33.088	29.951	0	179	15882
	KAB	15.742	13.878	0	71	7556
	KA	4.969	5.17	0	31	2385
	WD_AMPEAK	10.308	12.565	0	82	4948
	WD_OFFPEAK	22.510	22.169	0	152	10805
	WD_PMPEAK	11.971	13.802	0	103	5746
	WD_NIGHT	22.790	20.318	0	122	10939
	WE_DAY	11.223	10.982	0	71	5387
	WE_NIGHT	9.904	V	0	69	4754
	FOG	0.377	0.838	0	7	181
	RAIN	17.256	17.397	0	114	8283
	SV	26.513	25.049	0	141	12726
	MV	61.615	62.943	0	404	29575
	PED	0.210	0.461	0	3	101
	BIKE	0.008	0.091	0	1	4
	DUI	2.115	2.309	0	14	1015

Table 7-6, continued.

8FR: 8-lane full access control (N=218)	Length	0.833	0.87	0.102	5.623	-
	AADT	156195.968	61349.913	7500	301000	-
	KABCO	149.417	165.59	0	801	32573
	KABC	55.867	63.675	0	289	12179
	KAB	25.982	29.831	0	149	5664
	KA	6.789	8.81	0	46	1480
	WD_AMPEAK	19.326	25.338	0	134	4213
	WD_OFFPEAK	36.995	42.637	0	211	8065
	WD_PMPEAK	21.307	28.781	0	195	4645
	WD_NIGHT	38.954	40.083	0	186	8492
	WE_DAY	15.839	18.384	0	90	3453
	WE_NIGHT	17.271	19.846	0	89	3765
	FOG	0.101	0.358	0	2	22
	RAIN	24.683	29.150	0	197	5381
	SV	31.248	34.383	0	166	6812
	MV	117.376	138.306	0	645	25588
	PED	0.376	0.795	0	4	82
	BIKE	0.005	0.068	0	1	1
	DUI	3.280	4.002	0	20	715

Table 7-7 Descriptive statistics of urban signalized intersections

Intersection Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
U_3SG: Urban 3-leg signalized (N=807)	MN_AADT	8561.10	5941.93	200	39500	-
	MJ_AADT	26320.26	13992.26	2600	84500	-
	TEV	30600.81	15411.62	2825	95250	-
	KABCO	15.7397	16.1110	0	151	12702
	KABC	7.6480	7.0157	0	58	6172
	KAB	3.6047	3.3761	0	25	2909
	KA	0.9491	1.3844	0	11	766
	WD-AMPEAK	1.2032	1.6568	0	15	971
	WD-OFFPEAK	4.5935	5.3884	0	52	3707
	WD-PMPEAK	1.9033	2.5303	0	22	1536
	WD-NIGHT	4.4560	5.9647	0	75	3596
	WE-DAY	1.7881	2.2758	0	18	1443
	WE-NIGHT	1.7930	2.4445	0	24	1447
	DUI	0.6109	0.9683	0	6	493
	FOG	0.0520	0.2435	0	2	42
	RAIN	1.4907	2.0760	0	19	1203
	SV	1.3940	1.6651	0	12	1125
	MV	13.7645	14.9891	0	143	11108
	PED	0.2416	0.6079	0	6	195
U_4SG: Urban 4-leg signalized (N=4352)	MN-AADT	9397.57	8019.31	100	56000	-
	MJ-AADT	26776.59	15433.46	700	92000	-
	TEV	36174.16	20687.34	1380	144000	-
	KABCO	26.7964	28.6739	0	260	116618
	KABC	12.51930	11.4283	0	89	54484
	KAB	5.7178	5.2434	0	46	24884
	KA	1.4731	2.0515	0	26	6411
	WD-AMPEAK	1.9988	2.6676	0	29	8699
	WD-OFFPEAK	8.3959	10.0654	0	108	36539
	WD-PMPEAK	3.0962	3.7671	0	31	13475
	WD-NIGHT	7.0926	8.5079	0	156	30867
	WE-DAY	3.1755	4.0930	0	50	13820
	WE-NIGHT	3.0337	3.7512	0	46	13203
	DUI	0.9044	1.2930	0	11	3936
	FOG	0.0615	0.2507	0	2	268
	RAIN	2.2162	2.9536	0	31	9645
	SV	1.2281	1.4722	0	16	5345
	MV	24.4710	27.1639	0	253	106498

Table 7-7, continued.

U_4SG: Urban 4-leg signalized (N=4352)	PED	0.5471	1.0750	0	13	2381
U_4SG_1OW: Urban 4-leg signalized: one of the roads is one-way (N=192)	MN-AADT	6232.04	5251.57	350	27000	-
	MJ-AADT	15878.65	11933.54	2100	76500	-
	TEV	22110.69	15543.87	2750	97000	-
	KABCO	20.3437	22.4022	0	183	3906
	KABC	7.6197	7.0321	0	44	1463
	KAB	3.2916	3.2582	0	13	632
	KA	0.6562	1.0317	0	5	126
	WD-AMPEAK	1.4427	2.0913	0	16	277
	WD-OFFPEAK	6.3072	7.8389	0	74	1211
	WD-PMPEAK	2.2031	2.9525	0	19	423
	WD-NIGHT	5.4114	6.3015	0	35	1039
	WE-DAY	2.1666	2.8438	0	20	416
	WE-NIGHT	2.8020	3.7947	0	24	538
	DUI	0.5104	0.8249	0	4	98
	FOG	0.0104	0.1017	0	1	2
	RAIN	1.6562	2.3793	0	12	318
	SV	1.0625	1.4850	0	8	204
	MV	18.3020	21.3252	0	178	3514
	PED	0.5885	0.9934	0	5	113
	BIKE	0.4010	0.7593	0	4	77
U_4SG_2OW: Urban 4-leg signalized: both roads are one-way (N=90)	MN-AADT	6163.89	3867.40	350	19000	-
	MJ-AADT	13934.44	6850.54	2300	36000	-
	TEV	20098.33	9253.78	3100	47000	-
	KABCO	19.6000	16.9160	0	78	1764
	KABC	7.3777	6.1013	0	30	664
	KAB	3.4444	3.3690	0	14	310
	KA	0.7555	1.1447	0	6	68
	WD-AMPEAK	1.4333	1.8726	0	9	129
	WD-OFFPEAK	6.9555	6.4562	0	28	626
	WD-PMPEAK	2.1222	2.6892	0	15	191
	WD-NIGHT	4.1666	3.6635	0	15	375
	WE-DAY	2.5222	2.8372	0	12	227
	WE-NIGHT	2.4000	2.9175	0	15	216
	DUI	0.2555	0.5312	0	2	23
	FOG	0.0777	0.2693	0	1	7

Table 7-7, continued.

U_4SG_2OW: Urban 4-leg signalized: both roads are one-way (N=90)	RAIN	1.2444	1.5815	0	7	112
	SV	0.9111	1.3791	0	8	82
	MV	17.7777	16.263	0	76	1600
	PED	0.6888	1.0016	0	5	62
	BIKE	0.2222	0.5358	0	3	20
U_5_6SG: Urban 5or 6 leg signalized (N=29)	MN-AADT	6767.24	7564.19	350	35500	-
	MJ-AADT	20496.55	12972.92	2500	57500	-
	TEV	31656.90	23588.71	5125	106500	-
	KABCO	30.7586	49.4928	0	216	892
	KABC	8.2413	9.3222	0	46	239
	KAB	3.7931	5.0665	0	25	110
	KA	0.9655	1.2672	0	6	28
	WD-AMPEAK	1.7931	3.0281	0	15	52
	WD-OFFPEAK	9.75862	16.3786	0	67	283
	WD-PMPEAK	3.1379	5.2828	0	22	91
	WD-NIGHT	8.8965	14.472	0	62	258
	WE-DAY	3.7586	6.0571	0	26	109
	WE-NIGHT	3.4137	5.4479	0	24	99
	DUI	0.7931	1.2643	0	4	23
	FOG	0.0689	0.2578	0	1	2
	RAIN	2.3448	4.6002	0	20	68
	SV	1.3793	1.6564	0	6	40
	MV	28.2068	47.8654	0	208	818
	PED	0.7586	1.1543	0	3	22
	BIKE	0.4137	0.8667	0	3	12

Table 7-8 Descriptive statistics of urban stop controlled intersections

Intersection Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
U_3ST_1S: Urban 3-leg stop controlled: 1-way stop (N=880)	MN_AADT	3211.84	3356.01	100	32000	-
	MJ_AADT	13539.23	11483.93	600	76500	-
	TEV	15145.15	12183.43	850	86500	-
	KABCO	3.9613	5.6242	0	74	3486
	KABC	2.0500	2.9038	0	26	1804
	KAB	1.0704	1.6795	0	13	942
	KA	0.3545	0.7847	0	7	312
	WD_AMPEAK	0.3227	0.7029	0	8	284
	WD_OFFPEAK	1.1238	1.8392	0	17	989
	WD_PMPEAK	0.5147	1.0949	0	12	453
	WD_NIGHT	1.0977	1.8681	0	24	966
	WE_DAY	0.4375	0.9104	0	9	385
	WE_NIGHT	0.4613	0.9627	0	11	406
	DUI	0.2022	0.5070	0	4	178
	FOG	0.0443	0.2367	0	3	39
	RAIN	0.3488	0.7749	0	8	307
	SV	0.6454	1.0193	0	7	568
	MV	3.1625	5.0755	0	70	2783
	PED	0.0727	0.3461	0	6	64
	BIKE	0.0806	0.2847	0	2	71
U_3ST_1SD: Urban 3-leg stop controlled: 1-way stop- divided (N=31)	MN_AADT	4654.84	5257.14	600	29500	-
	MJ_AADT	42433.32	20858.96	4700	87000	-
	TEV	44760.74	21580.00	5425	88250	-
	KABCO	13.9677	11.7259	0	43	433
	KABC	6.1612	5.4166	0	18	191
	KAB	3.3225	3.4194	0	13	103
	KA	0.9032	1.4457	0	6	28
	WD_AMPEAK	1.0967	1.4457	0	6	34
	WD_OFFPEAK	3.8387	4.0504	0	15	119
	WD_PMPEAK	1.2258	1.5855	0	7	38
	WD_NIGHT	5.2580	6.9568	0	29	163
	WE_DAY	0.6451	0.9503	0	3	20
	WE_NIGHT	1.8709	2.3627	0	7	58
	DUI	0.7096774	1.1602743	0	5	22
	FOG	0	0	0	0	0
	RAIN	1.4516	1.9636	0	6	45
	SV	1.5806	1.8578	0	8	49

Table 7-8, continued.

U_3ST_1SD: Urban 3-leg stop controlled: 1-way stop- divided (N=31)	MV	11.7419	10.2207	0	36	364
	PED	0.2903	0.6425	0	3	9
	BIKE	0.3548	0.7978	0	4	11
U_3ST_3S: Urban 3-leg stop controlled: 3-way stop (N=37)	MN_AADT	3075.68	1574.04	350	6300	-
	MJ_AADT	6991.89	5748.69	1000	32000	-
	TEV	8529.73	6187.90	1475	35000	-
	KABCO	1.8648	2.8979	0	14	69
	KABC	0.7027	1.6810	0	9	26
	KAB	0.3243	0.6260	0	2	12
	KA	0.0540	0.2292	0	1	2
	WD_AMPEAK	0.1351	0.6733	0	4	5
	WD_OFFPEAK	0.2972	0.8776	0	5	11
	WD_PMPEAK	0.2972	0.5708	0	2	11
	WD_NIGHT	0.5405	0.8025	0	3	20
	WE_DAY	0.3783	0.7207	0	3	14
	WE_NIGHT	0.2162	0.7123	0	4	8
	DUI	0.2702	0.5601	0	2	10
	FOG	0	0	0	0	0
	RAIN	0.0810	0.2767	0	1	3
	SV	0.2972	0.7017	0	3	11
	MV	1.4864	2.7751	0	14	55
	PED	0.0270	0.1643	0	1	1
	BIKE	0.0540	0.2292	0	1	2
U_4ST_2S: Urban 4-leg stop controlled: 2-way stop (N=676)	MN_AADT	2522.72	2766.68	20	32000	-
	MJ_AADT	11987.65	10608.78	350	72000	-
	TEV	14510.38	11781.79	500	76000	-
	KABCO	4.7233	5.8023	0	61	3193
	KABC	2.6671	3.2913154	0	24	1803
	KAB	1.4393	1.8509	0	12	973
	KA	0.4171	0.8813	0	7	282
	WD_AMPEAK	0.3698	0.7419	0	7	250
	WD_OFFPEAK	1.4778	2.1897	0	24	999
	WD_PMPEAK	0.6997	1.51243	0	25	473
	WD_NIGHT	1.1464	1.7505	0	18	775
	WE_DAY	0.6065089	1.1784	0	12	410
	WE_NIGHT	0.4230	0.7433	0	5	286
	DUI	0.1582	0.4715	0	4	107

Table 7-8, continued.

U_4ST_2S: Urban 4-leg stop controlled: 2-way stop (N=676)	FOG	0.0133	0.1146	0	1	9
	RAIN	0.3461	0.7688	0	6	234
	SV	0.4585	0.8656	0	7	310
	MV	4.0384	5.4483	0	61	2730
	PED	0.0843	0.3131	0	3	57
	BIKE	0.1420	0.4656	0	4	96
U_4ST_2S_1OW: Urban 4-leg stop controlled: 2-way stop: one of the road is one-way (N=17)	MN_AADT	1914.71	1348.47	500	5200	-
	MJ_AADT	7900.00	3765.14	3900	18000	-
	TEV	9814.71	4355.91	5500	21500	-
	KABCO	5.4117	7.7302	0	30	92
	KABC	2.3529	3.6045	0	13	40
	KAB	1.2941	2.4689	0	8	22
	KA	0.2352	0.5622	0	2	4
	WD_AMPEAK	0.5294	1.0073	0	4	9
	WD_OFFPEAK	1.9411	3.325	0	12	33
	WD_PMPEAK	0.7058	1.4901	0	5	12
	WD_NIGHT	0.8823	1.2187	0	3	15
	WE_DAY	0.5882	1.1213	0	4	10
	WE_NIGHT	0.7647	1.0325	0	4	13
	DUI	0.1176	0.3321	0	1	2
	FOG	0	0	0	0	0
	RAIN	0.2352	0.7524	0	3	4
	SV	0.5294	1.1788	0	4	9
	MV	4.5882	6.7180	0	25	78
	PED	0.1764	0.3929	0	1	3
	BIKE	0.1176	0.3321	0	1	2
U_4ST_4S: Urban 4-leg stop controlled: 4-way stop (N=221)	MN_AADT	2885.07	2260.17	150	17700	-
	MJ_AADT	6227.38	4330.20	500	25500	-
	TEV	9112.44	5860.98	850	39200	-
	KABCO	2.9864	3.3743	0	24	660
	KABC	1.4660	1.8178	0	8	324
	KAB	0.7194	1.0587	0	5	159
	KA	0.1266	0.3467	0	2	28
	WD_AMPEAK	0.2262	0.5252	0	3	50
	WD_OFFPEAK	0.8371	1.2138	0	8	185
	WD_PMPEAK	0.3710	0.6089	0	3	82
	WD_NIGHT	0.7782	1.2138	0	7	172
	WE_DAY	0.3981	0.8117	0	4	88

Table 7-8, continued.

U_4ST_4S: Urban 4-leg stop controlled: 4-way stop (N=221)	WE_NIGHT	0.3710	0.6861	0	4	82
	DUI	0.1402	0.4191	0	3	31
	FOG	0.0045	0.0672	0	1	1
	RAIN	0.1447	0.4009	0	3	32
	SV	0.3529	0.6956	0	5	78
	MV	2.4253	3.0733	0	24	536
	PED	0.0859	0.2809	0	1	19
	BIKE	0.1221	0.3548	0	2	27

Table 7-9 Descriptive statistics of rural intersections

Intersection Types	Variables	Mean	Stdev	Min	Max	Total Crash Counts
R_4SG: Rural 4-leg signalized (N=54)	MN_AADT	4115.63	3814.02	300	24144	-
	MJ_AADT	9433.91	6250.83	1200	26500	-
	TEV	13549.54	9155.95	1850	50408	-
	KABCO	6.6851	5.4628	0	26	361
	KABC	3.4259	3.1718	0	14	185
	KAB	1.8518	2.0958	0	10	100
	KA	0.4259	0.6896	0	3	23
	WD_AMPEAK	0.7407	0.9553	0	4	40
	WD_OFFPEAK	2.0740	2.0173	0	6	112
	WD_PMPEAK	1	1.1816	0	5	54
	WD_NIGHT	1.5185	1.7455	0	7	82
	WE_DAY	0.7222	1.0888	0	4	39
	WE_NIGHT	0.6296	0.9172	0	5	34
	DUI	0.2407	0.5472	0	2	13
	FOG	0.0185	0.1360	0	1	1
	RAIN	0.5740	1.0920	0	6	31
	SV	0.5555	0.8392	0	3	30
	MV	6.0925	5.1258	0	23	329
	PED	0.0370	0.1906	0	1	2
	BIKE	0	0	0	0	0
R_3ST_1S: Rural 3-leg stop controlled: 1-way stop (N=509)	MN_AADT	984.349	1107.76	20	10500	-
	MJ_AADT	3370.60	3129.92	70	23000	-
	TEV	3862.77	3485.73	80	24350	-
	KABCO	1.2966	2.1691	0	21	660
	KABC	0.7917	1.4280	0	13	403
	KAB	0.5579	1.1043	0	13	284
	KA	0.2455	0.5924	0	6	125
	WD_AMPEAK	0.0962	0.3444	0	3	49
	WD_OFFPEAK	0.3084	0.8563	0	10	157
	WD_PMPEAK	0.1237	0.4283	0	5	63
	WD_NIGHT	0.3732	0.8193	0	7	190
	WE_DAY	0.1669	0.4454	0	4	85
	WE_NIGHT	0.2278	0.5878	0	4	116
	DUI	0.1080	0.3409	0	2	55
	FOG	0.0550	0.3151	0	5	28
	RAIN	0.0923	0.3512	0	3	47
	SV	0.5874	1.1271	0	9	299

Table 7-9, continued.

R_3ST_1S: Rural 3-leg stop controlled: 1-way stop (N=509)	MV	0.6935	1.6518	0	19	353
	PED	0.0058	0.0766	0	1	3
	BIKE	0.0098	0.0987	0	1	5
R_4ST_2S: Rural 4-leg stop controlled: 2-way stop (N=357)	MN_AADT	948.8767	839.1242	50	6500	-
	MJ_AADT	3482.33	3552.20	150	37500	-
	TEV	4431.20	4026.35	210	39600	-
	KABCO	1.8599	2.4671	0	17	664
	KABC	1.1848	1.6792	0	11	423
	KAB	0.8151	1.2382	0	8	291
	KA	0.3893	0.7206	0	3	139
	WD_AMPEAK	0.1596	0.4677	0	4	57
	WD_OFFPEAK	0.4761	0.9287	0	8	170
	WD_PMPEAK	0.2492	0.6594	0	6	89
	WD_NIGHT	0.4789	0.7951	0	6	171
	WE_DAY	0.2913	0.6036	0	4	104
	WE_NIGHT	0.2044	0.5301	0	3	73
	DUI	0.0980	0.3248	0	2	35
	FOG	0.0196	0.1388	0	1	7
	RAIN	0.1120	0.3575	0	2	40
	SV	0.3669	0.7284	0	4	131
	MV	1.4705	2.2303	0	17	525
	PED	0.0168	0.1287	0	1	6
	BIKE	0.0056	0.0747	0	1	2
R_4ST_4S: Rural 4-leg stop controlled: 4-way stop (N=37)	MN_AADT	1272.73	1148.85	150	5100	-
	MJ_AADT	3842.46	3526.38	350	12500	-
	TEV	5115.19	4356.15	500	15500	-
	KABCO	1.8108	1.8979	0	7	67
	KABC	1.0540	1.2898	0	4	39
	KAB	0.5945	0.7978	0	3	22
	KA	0.1621	0.3736	0	1	6
	WD_AMPEAK	0.1891	0.4617	0	2	7
	WD_OFFPEAK	0.5405	0.8364	0	3	20
	WD_PMPEAK	0.1621	0.4418	0	2	6
	WD_NIGHT	0.4864	0.7681	0	3	18
	WE_DAY	0.2162	0.5838	0	2	8
	WE_NIGHT	0.2162	0.4793	0	2	8
	DUI	0.1621	0.4418	0	2	6

Table 7-9, continued.

R_4ST_4S: Rural 4-leg stop controlled: 4-way stop (N=37)	FOG	0.1081	0.3148	0	1	4
	RAIN	0.0540	0.2292	0	1	2
	SV	0.3243	0.4745	0	1	12
	MV	1.4054	1.5716	0	6	52
	PED	0	0	0	0	0
	BIKE	0.0810	0.3634	0	2	3

Table 7-10 Descriptive statistics of roundabouts (N=134)

Variable	Mean	Stdev	Min	Max	Total Crash Counts
TEV	15446.28	13212.28	300	107500	-
KABCO	1.985	2.739	0	20	266
KABC	0.672	0.932	0	4	90
KAB	0.328	0.623	0	3	44
KA	0.045	0.241	0	2	6
WD_AMPEAK	0.164	0.462	0	2	22
WD_OFFPEAK	0.477	1.001	0	6	64
WD_PMPEAK	0.239	0.590	0	3	32
WD_NIGHT	0.560	0.938	0	5	75
WE_DAY	0.254	0.558	0	3	34
WE_NIGHT	0.313	0.676	0	4	42
SV	0.679	1.128	0	7	91
MV	1.231	2.247	0	17	165
PED	0	0	0	0	0
BIKE	0.089	0.312	0	2	12
RAIN	0.179	0.488	0	3	24
FOG	0.007	0.086	0	1	1
DUI	0.119	0.348	1	2	16

7.4 Development of Various SPFs for Roadway Segments

Tables 7-11 to 7-23 present the SPFs by severity levels, time periods, collision types, and special events for different types of segments in rural/urban area. The coefficients of the natural log of AADT (ln(AADT)) have a positive sign in all the SPFs.

Table 7-11 SPFs for rural two-lane undivided segments (R2U)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-5.33 (<.0001)	0.5638 (<.0001)	-0.4465 (<.0001)	-8187.5
	KABC	-5.6213 (<.0001)	0.5214 (<.0001)	-0.837 (<.0001)	-6176
	KAB	-5.7035 (<.0001)	0.4871 (<.0001)	-0.8055 (<.0001)	-5157
	KA	-6.0514 (<.0001)	0.4309 (<.0001)	-1.1602 (<.0001)	-3325.05
Time Period	WD_AMPEAK				
	WD_OFFPEAK	-7.8453 (<.0001)	0.6922 (<.0001)	-0.6385 (<.0001)	-4046.3
	WD_PMPEAK	-8.6499 (<.0001)	0.6817 (<.0001)	-0.6782 (<.0001)	-2454.3
	WD_NIGHT	-5.9540 (<.0001)	0.4896 (<.0001)	-0.6135 (<.0001)	-4614.4
	WE_DAY	-7.2283 (<.0001)	0.5601 (<.0001)	-0.6133 (<.0001)	-3152.8
	WE_NIGHT	-5.9997 (<.0001)	0.4290 (<.0001)	-0.5668 (<.0001)	-3472.5
Collision Types	SV	-4.3258 (<.0001)	0.3735 (<.0001)	-0.6146 (<.0001)	-6346
	MV	-9.0913 (<.0001)	0.9084 (<.0001)	-0.7590 (<.0001)	-5419
	PED	-9.1392 (<.0001)	0.4910 (<.0001)	12.3295 (0.7747)	-624
	BIKE	-12.6793 (<.0001)	0.8610 (<.0001)	12.2812 (0.7770)	-395.4
Special Events	FOG	-6.6250 (<.0001)	0.2492 (<.0001)	12.4026 (0.9274)	-910.6
	RAIN	-8.6749 (<.0001)	0.7042 (<.0001)	-1.3147 (<.0001)	-2628.8
	DUI				

Table 7-12 SPFs for rural two-lane divided segments (R2D)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-4.6322 (<.0001)	0.5539 (<.0001)	0.6533 (<.0001)	-1812.55
	KABC	-4.3331 (<.0001)	0.4077 (<.0001)	0.2829 (0.0209)	-1063.4
	KAB	-4.1456 (<.0001)	0.3283 (0.0009)	0.2897 (0.0981)	-776.65
	KA	-6.4015 (<.0001)	0.4775 (0.0013)	0.09788 (0.7753)	-399.35
Time Period	WD_AMPEAK	-10.5442 (<.0001)	0.9606 (<.0001)	0.009046 (0.9721)	-449.2
	WD_OFFPEAK	-7.2740 (<.0001)	0.7064 (<.0001)	0.1179 (0.3939)	-853.5
	WD_PMPEAK	-6.1874 (<.0001)	0.4914 (<.0001)	0.2408 (0.3536)	-516.2
	WD_NIGHT	-4.5434 (<.0001)	0.3807 (<.0001)	0.5877 (0.0011)	-820.8
	WE_DAY	-7.7207 (<.0001)	0.6797 (<.0001)	0.06116 (0.7744)	-549.2
	WE_NIGHT	-6.1605 (<.0001)	0.4935 (<.0001)	0.6539 (0.0277)	-527.7
Collision Types	SV				
	MV	-7.1744 (<.0001)	0.7921 (<.0001)	0.2754 (0.0023)	-1391.4
	PED				
	BIKE				
Special Events	FOG				
	RAIN	-9.0013 (<.0001)	0.7906 (<.0001)	0.1244 (0.6391)	-457.9
	DUI	-5.2997 (0.0003)	0.3056 (0.0638)	0.2218 (0.6601)	-294.5

Table 7-13 SPFs for rural multi-lane undivided segments (RMU)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-10.2255 (-0.0222)	1.1997 (0.0159)	0.8109 (0.0507)	-65.9
	KABC	-16.9734 (0.0032)	1.8127 (0.0037)	16.5211 (0.7446)	-34.15
	KAB	-31.6499 (0.0013)	3.3348 (0.0015)	13.1706 (0.9685)	-19.1
	KA	-25.8363 (0.0371)	2.6373 (0.0474)	2.7652 (0.7297)	-14.3
Time Period	WD_AMPEAK				
	WD_OFFPEAK	-11.5374 (0.0880)	1.2412 (0.0971)	0.3827 (0.4263)	-43.9
	WD_PMPEAK				
	WD_NIGHT	-19.1158 (0.0494)	1.9716 (0.0621)	0.3142 (0.7980)	-22.6
	WE_DAY				
	WE_NIGHT	-35.5742 (0.0721)	3.6990 (0.0821)	-0.9052 (0.4437)	-14.1
Collision Types	SV	-13.2548 (0.0545)	1.3809 (0.0677)	0.8585 (0.3710)	-29.4
	MV	-11.9950 (0.0224)	1.3541 (0.0199)	0.6700 (0.1090)	-57.8
	PED				
	BIKE				
Special Events	FOG				
	RAIN				
	DUI				

Table 7-14 SPFs for rural multi-lane divided segments (RMD)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-11.5288 (<.0001)	1.2186 (<.0001)	-1.2138 (<.0001)	-1983.35
	KABC	-13.2908 (<.0001)	1.2797 (<.0001)	-2.1308 (<.0001)	-1194.8
	KAB	-13.9787 (<.0001)	1.2967 (<.0001)	-2.0649 (<.0001)	-955.95
	KA	-15.4538 (<.0001)	1.3493 (<.0001)	-1.9330 (<.0001)	-564.7
Time Period	WD_AMPEAK	-18.5182 (<.0001)	1.6911 (<.0001)	-1.4171 (<.0001)	-655.1
	WD_OFFPEAK	-13.7606 (<.0001)	1.3281 (<.0001)	-1.3723 (<.0001)	-1233.4
	WD_PMPEAK	-17.3602 (<.0001)	1.6057 (<.0001)	-1.2520 (<.0001)	-794.5
	WD_NIGHT	-13.3626 (<.0001)	1.2701 (<.0001)	-1.3612 (<.0001)	-113.1
	WE_DAY	-15.7969 (<.0001)	1.4525 (<.0001)	-1.1869 (<.0001)	-850.9
	WE_NIGHT	-15.0885 (<.0001)	1.3554 (<.0001)	-1.0564 (<.0001)	-721.5
Collision Types	SV	-9.1908 (<.0001)	0.8349 (<.0001)	-0.5704 (<.0001)	-1159.9
	MV	-14.1587 (<.0001)	1.4556 (<.0001)	-1.6377 (<.0001)	-1698.7
	PED	-24.9543 (<.0001)	2.1359 (<.0001)	-0.1354 (0.9001)	-160.2
	BIKE	-30.3062 (<.0001)	2.6525 (<.0001)	-2.2773 (<.0001)	-120.4
Special Events	FOG	-13.7123 (<.0001)	0.9766 (<.0001)	10.5828 (0.9370)	-174.7
	RAIN	-15.7849 (<.0001)	1.4229 (<.0001)	-1.3143 (<.0001)	-698.1
	DUI	-18.1004 (<.0001)	1.5604 (<.0001)	-1.3331 (<.0001)	-389.1

Table 7-15 SPFs for urban two-lane undivided segments (U2U)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-4.2842 (<.0001)	0.5933 (<.0001)	0.5991 (<.0001)	-19297
	KABC	-5.3281 (<.0001)	0.6004 (<.0001)	0.7081 (<.0001)	-12598.5
	KAB	-5.7943 (<.0001)	0.5859 (<.0001)	0.7341 (<.0001)	-9309
	KA	-7.2289 (<.0001)	0.6126 (<.0001)	0.7560 (<.0001)	-4605.55
Time Period	WD_AMPEAK	-7.9211 (<.0001)	0.7201 (<.0001)	0.2327 (0.0006)	-5727.5
	WD_OFFPEAK	-5.8330 (<.0001)	0.6330 (<.0001)	0.2021 (<.0001)	-11798.5
	WD_PMPEAK	-7.7389 (<.0001)	0.7479 (<.0001)	0.1143 (0.0201)	-7353
	WD_NIGHT	-5.3205 (<.0001)	0.5593 (<.0001)	0.4440 (<.0001)	-10849
	WE_DAY	-7.1950 (<.0001)	0.6857 (<.0001)	0.2853 (<.0001)	-7238.5
	WE_NIGHT	-5.8849 (<.0001)	0.5410 (<.0001)	0.1704 (0.0005)	-7337.5
Collision Types	SV	-3.4847 (<.0001)	0.3291 (<.0001)	0.8204 (<.0001)	-9604.5
	MV	-5.4876 (<.0001)	0.6945 (<.0001)	0.2549 (<.0001)	-17293.5
	PED	-5.8732 (<.0001)	0.3595 (<.0001)	-0.3157 (0.0172)	-2801.3
	BIKE	-6.4853 (<.0001)	0.4139 (<.0001)	-0.7974 (<.0001)	-2496.3
Special Events	FOG	-8.1466 (<.0001)	0.4180 (<.0001)	-0.9490 (0.0630)	-704.5
	RAIN	-8.2029 (<.0001)	0.7505 (<.0001)	0.009467 (0.8808)	-5577
	DUI	-5.7097 (<.0001)	0.4232 (<.0001)	0.3507 (0.0008)	-4366.5

Table 7-16 SPFs for urban two-lane divided segments (U2D)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	**KABCO**	-3.7784 (<.0001)	0.5758 (<.0001)	1.1747 (<.0001)	-10356.5
	KABC	-5.3960 (<.0001)	0.6386 (<.0001)	1.2854 (<.0001)	-6567.5
	KAB	-5.8365 (<.0001)	0.6125 (<.0001)	1.5198 (<.0001)	-4598.45
	KA	-7.7685 (<.0001)	0.6887 (<.0001)	1.3875 (<.0001)	-2178.7
Time Period	**WD_AMPEAK**	-7.2768 (<.0001)	0.6963 (<.0001)	0.6883 (<.0001)	-3196.1
	WD_OFFPEAK	-4.7901 (<.0001)	0.5576 (<.0001)	0.8656 (<.0001)	-6245.5
	WD_PMPEAK	-7.4649 (<.0001)	0.7675 (<.0001)	0.6867 (<.0001)	-4157.2
	WD_NIGHT	-5.2578 (<.0001)	0.5832 (<.0001)	0.9890 (<.0001)	-5517.5
	WE_DAY	-7.1139 (<.0001)	0.7097 (<.0001)	0.9590 (<.0001)	-3760.6
	WE_NIGHT	-6.3874 (<.0001)	0.6085 (<.0001)	1.1454 (<.0001)	-3344.9
Collision Types	**SV**	-4.0701 (<.0001)	0.4004 (<.0001)	1.5540 (<.0001)	-4167.7
	MV	-4.4076 (<.0001)	0.6211 (<.0001)	0.9101 (<.0001)	-9532.5
	PED	-6.6110 (<.0001)	0.4604 (<.0001)	-0.00347 (0.9868)	-1146.7
	BIKE	-5.0851 (<.0001)	0.2862 (0.0014)	0.1235 (0.6127)	-1088.6
Special Events	**FOG**	-11.3202 (<.0001)	0.7661 (0.0008)	12.6704 (0.9636)	-273.6
	RAIN	-7.9890 (<.0001)	0.7587 (<.0001)	0.7855 (<.0001)	-2913.2
	DUI	-7.5127 (<.0001)	0.6328 (<.0001)	1.2593 (<.0001)	-1818

Table 7-17 SPFs for urban multi-lane undivided segments (UMU)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-2.8471 (<.0001)	0.5292 (<.0001)	1.2686 (<.0001)	-1849.35
	KABC	-2.4790 (<.0001)	0.3713 (<.0001)	1.3840 (<.0001)	-1233.3
	KAB	-2.9216 (<.0001)	0.3464 (<.0001)	1.2602 (<.0001)	-926.15
	KA	-4.1593 (<.0001)	0.3375 (0.0025)	0.8898 (0.0011)	-469.2
Time Period	WD_AMPEAK	-3.1731 (0.0003)	0.2933 (0.0018)	0.5950 (0.0001)	-652
	WD_OFFPEAK	-4.7341 (<.0001)	0.6166 (<.0001)	1.0331 (<.0001)	-1294.3
	WD_PMPEAK	-5.2430 (<.0001)	0.5719 (<.0001)	1.0016 (<.0001)	-863.2
	WD_NIGHT	-4.7988 (<.0001)	0.5791 (<.0001)	0.9343 (<.0001)	-1079
	WE_DAY	-5.4384 (<.0001)	0.5807 (<.0001)	0.7257 (<.0001)	-814.3
	WE_NIGHT	-5.2982 (<.0001)	0.5463 (<.0001)	0.3403 (0.0054)	-717.4
Collision Types	SV	-1.5953 (0.0210)	0.1488 (0.0428)	1.3522 (<.0001)	-713.4
	MV	-3.7084 (<.0001)	0.6023 (<.0001)	1.1453 (<.0001)	-1761.2
	PED	-6.0492 (<.0001)	0.5059 (0.0005)	0.2874 (0.2411)	-386.3
	BIKE				
Special Events	FOG				
	RAIN	-5.5897 (<.0001)	0.5467 (<.0001)	0.4984 (0.0011)	-620.9
	DUI	-5.4876 (<.0001)	0.4245 (0.0017)	1.5249 (0.0073)	-341.7

Table 7-18 SPFs for urban multi-lane divided segments (UMD)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	**KABCO**	-6.1612 (<.0001)	0.8374 (<.0001)	0.7576 (<.0001)	-28500
	KABC	-7.8932 (<.0001)	0.8983 (<.0001)	1.0508 (<.0001)	-20192
	KAB	-8.0250 (<.0001)	0.8420 (<.0001)	1.2352 (<.0001)	-15418.5
	KA	-9.2842 (<.0001)	0.8492 (<.0001)	0.8869 (<.0001)	-9160.5
Time Period	**WD_AMPEAK**	-10.1054 (<.0001)	0.9798 (<.0001)	0.5587 (<.0001)	-12299.5
	WD_OFFPEAK	-8.3386 (<.0001)	0.9424 (<.0001)	0.5927 (<.0001)	-20989.5
	WD_PMPEAK	-10.0816 (<.0001)	1.0294 (<.0001)	0.5510 (<.0001)	-15488
	WD_NIGHT	-8.1870 (<.0001)	0.8967 (<.0001)	0.6482 (<.0001)	-18643.5
	WE_DAY	-9.9106 (<.0001)	0.9959 (<.0001)	0.5029 (<.0001)	-14285.5
	WE_NIGHT	-9.2653 (<.0001)	0.9047 (<.0001)	0.6230 (<.0001)	-12604.5
Collision Types	**SV**	-4.5474 (<.0001)	0.4515 (<.0001)	1.3581 (<.0001)	-12355.5
	MV	-6.8521 (<.0001)	0.8893 (<.0001)	0.5756 (<.0001)	-27652
	PED	-10.9194 (<.0001)	0.9113 (<.0001)	-0.1022 (0.1028)	-5546
	BIKE	-10.2677 (<.0001)	0.8518 (<.0001)	0.08548 (0.1953)	-5727
Special Events	**FOG**	-10.3445 (<.0001)	0.6513 (<.0001)	0.2253 (0.6109)	-1303.8
	RAIN	-11.2474 (<.0001)	1.0917 (<.0001)	0.6312 (<.0001)	-12319.5
	DUI	-8.5663 (<.0001)	0.7258 (<.0001)	1.1103 (<.0001)	-6951

Table 7-19 SPFs for 3-lane TWLTL segments (3TL)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-4.4558 (<.0001)	0.6560 (<.0001)	1.1292 (<.0001)	-2197.35
	KABC	-6.1345 (<.0001)	0.7192 (<.0001)	1.1370 (<.0001)	-1393.55
	KAB	-6.6977 (<.0001)	0.7040 (<.0001)	1.2278 (<.0001)	-1008.45
	KA	-6.7423 (<.0001)	0.5657 (<.0001)	2.0546 (0.003)	-474.1
Time Period	WD_AMPEAK	-8.6738 (<.0001)	0.8449 (<.0001)	0.9232 (<.0001)	-666.3
	WD_OFFPEAK	-5.8767 (<.0001)	0.6878 (<.0001)	0.9124 (<.0001)	-1405
	WD_PMPEAK	-9.2451 (<.0001)	0.9691 (<.0001)	0.7568 (<.0001)	-953.5
	WD_NIGHT	-4.4581 (<.0001)	0.4987 (<.0001)	0.8698 (<.0001)	-1223.7
	WE_DAY	-8.3084 (<.0001)	0.8469 (<.0001)	0.7703 (<.0001)	-856.4
	WE_NIGHT	-5.2242 (<.0001)	0.4799 (<.0001)	0.8193 (<.0001)	-759.4
Collision Types	SV	-3.2498 (<.0001)	0.2928 (0.0002)	2.1748 (<.0001)	-829.6
	MV	-5.2896 (<.0001)	0.7237 (<.0001)	0.8832 (<.0001)	-2027.6
	PED	-6.0382 (0.0004)	0.4250 (0.0227)	0.01406 (0.9662)	-317.5
	BIKE	-5.9601 (0.0003)	0.3985 (0.0261)	2.9532 (0.4394)	-273.1
Special Events	FOG				
	RAIN	-7.4290 (<.0001)	0.6930 (<.0001)	0.4784 (0.0106)	-629.2
	DUI	-6.2970 (<.0001)	0.4901 (0.0006)	4.0555 (0.4203)	-395.2

Table 7-20 SPFs for 5-lane TWLTL segments (5TL)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	**KABCO**	-3.8903 (<.0001)	0.6185 (<.0001)	0.6814 (<.0001)	-2914.1
	KABC	-5.6582 (<.0001)	0.6862 (<.0001)	0.7249 (<.0001)	-2064.65
	KAB	-6.1622 (<.0001)	0.6687 (<.0001)	0.8483 (<.0001)	-1575.6
	KA	-7.5084 (<.0001)	0.6806 (<.0001)	0.7549 (<.0001)	-879.9
Time Period	**WD_AMPEAK**	-4.6355 (<.0001)	0.4342 (<.0001)	0.6543 (<.0001)	-1119
	WD_OFFPEAK	-6.5090 (<.0001)	0.7816 (<.0001)	0.5873 (<.0001)	-2179.6
	WD_PMPEAK	-8.2979 (<.0001)	0.8680 (<.0001)	0.4152 (<.0001)	-1541.5
	WD_NIGHT	-3.0854 (<.0001)	0.3844 (<.0001)	0.6210 (<.0001)	-1801.4
	WE_DAY	-5.9700 (<.0001)	0.6064 (<.0001)	0.5552 (<.0001)	-1360.3
	WE_NIGHT	-5.3199 (<.0001)	0.5071 (<.0001)	0.7233 (<.0001)	-1167
Collision Types	SV	-3.1821 (<.0001)	0.2912 (<.0001)	1.1743 (<.0001)	-1090.5
	MV	-4.4521 (<.0001)	0.6597 (<.0001)	0.5515 (<.0001)	-2818.6
	PED	-5.5044 (<.0001)	0.4213 (0.0007)	0.2545 (0.1744)	-644.1
	BIKE	-4.8192 (<.0001)	0.3336 (0.0064)	0.4409 (0.0670)	-593.1
Special Events	**FOG**				
	RAIN	-7.9105 (<.0001)	0.7574 (<.0001)	0.6189 (<.0001)	-1079.2
	DUI	-4.8645 (<.0001)	0.3688 (0.0014)	0.4612 (0.0181)	-688.9

Table 7-21 SPFs for 4-lane freeway segments (4FR)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-11.9299 (<.0001)	1.3092 (<.0001)	0.6646 (<.0001)	-2111.3
	KABC	-13.0659 (<.0001)	1.3381 (<.0001)	0.909 (<.0001)	-1656.3
	KAB	-11.5515 (<.0001)	1.1426 (<.0001)	0.9614 (<.0001)	-1375.6
	KA	-10.6661 (<.0001)	0.9651 (<.0001)	0.6596 (<.0001)	-972.5
Time Period	WD_AMPEAK	-22.4301 (<.0001)	2.0769 (<.0001)	0.1521 (0.1458)	-1144.4
	WD_OFFPEAK	-13.5139 (<.0001)	1.3326 (<.0001)	0.5596 (<.0001)	-1454
	WD_PMPEAK	-18.0869 (<.0001)	1.6846 (<.0001)	0.4949 (<.0001)	-1129.3
	WD_NIGHT	-14.3667 (<.0001)	1.4133 (<.0001)	0.9531 (<.0001)	-1440.2
	WE_DAY	-12.4672 (<.0001)	1.1873 (<.0001)	0.7675 (<.0001)	-1174.6
	WE_NIGHT	-14.7317 (<.0001)	1.3772 (<.0001)	0.9762 (<.0001)	-1138.6
Collision Types	SV	-9.6951 (<.0001)	1.0265 (<.0001)	0.8198 (<.0001)	-1661.2
	MV	-16.3303 (<.0001)	1.6625 (<.0001)	0.4663 (<.0001)	-1873.8
	PED	-20.5668 (<.0001)	1.5943 (<.0001)	-0.8526 (0.1346)	-190.2
	BIKE				
Special Events	FOG	-13.5397 (<.0001)	1.0183 (<.0001)	0.08609 (0.8624)	-334.1
	RAIN	-13.5426 (<.0001)	1.3199 (<.0001)	-0.04751 (0.5703)	-1455
	DUI	-15.4945 (<.0001)	1.3235 (<.0001)	0.6928 (0.0122)	-682.1

Table 7-22 SPFs for 6-lane freeway segments (6FR)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-7.9867 (<.0001)	0.9627 (<.0001)	0.4958 (<.0001)	-2598.7
	KABC	-11.9034 (<.0001)	1.2219 (<.0001)	0.9003 (<.0001)	-2057.05
	KAB	-12.401 (<.0001)	1.205 (<.0001)	1.5676 (<.0001)	-1587.4
	KA	-12.2565 (<.0001)	1.0926 (<.0001)	1.3373 (<.0001)	-1100.45
Time Period	WD_AMPEAK	-23.0601 (<.0001)	2.0942 (<.0001)	0.3617 (<.0001)	-1566.8
	WD_OFFPEAK	-9.7015 (<.0001)	0.9947 (<.0001)	0.5375 (<.0001)	-1906.7
	WD_PMPEAK	-14.3113 (<.0001)	1.3416 (<.0001)	0.2994 (0.0002)	-1689.1
	WD_NIGHT	-11.8927 (<.0001)	1.1877 (<.0001)	0.6906 (<.0001)	-1937.5
	WE_DAY	-8.9192 (<.0001)	0.8674 (<.0001)	0.7500 (<.0001)	-1566.9
	WE_NIGHT	-15.5547 (<.0001)	1.4388 (<.0001)	1.0908 (<.0001)	-1490.1
Collision Types	SV	-7.2321 (<.0001)	0.7968 (<.0001)	1.2074 (<.0001)	-1848.1
	MV	-9.2344 (<.0001)	1.0366 (<.0001)	0.1385 (0.0230)	-2496.1
	PED	-17.3401 (<.0001)	1.2623 (<.0001)	14.0458 (0.7218)	-250.7
	BIKE				
Special Events	FOG	-8.3313 (0.0002)	0.5184 (0.0087)	-0.2513 (0.5153)	-337.6
	RAIN	-7.9111 (<.0001)	0.8157 (<.0001)	0.1988 (0.0001)	-1885.2
	DUI	-17.4497 (<.0001)	1.4738 (<.0001)	1.5747 (<.0001)	-795.1

Table 7-23 SPFs for 8-lane freeway segments (8FR)

Crash Type		Intercept	ln(AADT)	c	LL
Severity Level	KABCO	-9.4829 (<.0001)	1.1258 (<.0001)	1.3391 (<.0001)	-1187.75
	KABC	-14.5888 (<.0001)	1.4686 (<.0001)	1.5046 (<.0001)	-948.25
	KAB	-15.7044 (<.0001)	1.4994 (<.0001)	1.9459 (<.0001)	-752.55
	KA	-17.2269 (<.0001)	1.5144 (<.0001)	1.6706 (<.0001)	-509.5
Time Period	WD_AMPEAK	-19.7453 (<.0001)	1.8086 (<.0001)	1.1831 (<.0001)	-726.1
	WD_OFFPEAK	-15.6644 (<.0001)	1.5228 (<.0001)	1.3605 (<.0001)	-880.4
	WD_PMPEAK	-16.1751 (<.0001)	1.5177 (<.0001)	1.0021 (<.0001)	-777.4
	WD_NIGHT	-13.1209 (<.0001)	1.3188 (<.0001)	1.5777 (<.0001)	-896.9
	WE_DAY	-11.2613 (<.0001)	1.0884 (<.0001)	1.1211 (<.0001)	-736.5
	WE_NIGHT	-17.8351 (<.0001)	1.6414 (<.0001)	1.8998 (<.0001)	-681.8
Collision Types	SV	-8.4964 (<.0001)	0.9192 (<.0001)	1.5426 (<.0001)	-841.4
	MV	-10.4387 (<.0001)	1.1830 (<.0001)	1.0659 (<.0001)	-1149
	PED	-26.0678 (<.0001)	2.0045 (<.0001)	2.1389 (0.2768)	-138.6
	BIKE				
Special Events	FOG				
	RAIN	-9.9295 (<.0001)	1.0166 (<.0001)	1.0960 (<.0001)	-840.4
	DUI	-14.8501 (<.0001)	1.2592 (<.0001)	2.7826 (<.0001)	-388.7

7.5 Development of Various SPFs for Intersections and Roundabouts

Tables 7-24 to 7-39 exhibit the SPFs by severity levels, time periods, collision types, and special events for 15 types of intersections and roundabouts. It was revealed that both the natural log of AADT of major road of intersections (ln(MJ_AADT)) and the natural log of AADT of minor road of intersections (ln(MN_AADT)) are significant in all SPFs for urban 4-legged signalized intersections (i.e., U_4SG), and these exposure variables are significant in most SPFs such as urban 3-legged signalized intersections (U_3SG), urban 3-legged stop controlled intersections: 1-way stop (U_3ST_1S), urban 4-legged signalized intersections: one of the road is one-way (U_4SG_1OW), urban/rural 4-legged stop controlled intersections: 2-way stop (U_4ST_2S/R_4ST_2S), and rural 3-legged stop intersections 1-way stop (R_3ST_1S).

On the other hand, sometimes, ln(MN_AADT) is not significant in several SPFs for rural 4-leg stop controlled intersections such as 4-way stop (R_4ST_4ST) and urban 4-leg stop controlled intersections including 2-way stop: one of the road is one-way (U_4ST_2S_1OW). For these intersection types, the natural log of total entering vehicles of intersections (ln(TEV)), was applied s an exposure variable. However, there are a few crash types neither ln(MJ_AADT) nor ln(TEV) was significant in the models, or the models are not converged. These crash types were marked with shaded gray in the following tables.

Table 7-24 SPFs based on urban 3-leg signalized intersections (U_3SG)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-11.3241 (<0.0001)	0.8741 (<0.0001)	0.2426 (<0.0001)	-	0.3791	-2804.715
	KABC	-11.8992 (<0.0001)	0.8789 (<0.0001)	0.2222 (<0.0001)	-	0.3063	-2262.857
	KAB	-11.3647 (<0.0001)	0.7989 (<0.0001)	0.1713 (<0.0001)	-	0.2797	-1773.376
	KA	-12.0436 (<0.0001)	-	-	0.8719 (<0.0001)	0.6953	-1048.216
Time Period	WD_AMPEAK	-13.0685 (<0.0001)	0.8552 (<0.0001)	0.1738 (0.0055)	-	0.5043	-1152.189
	WD_OFFPEAK	-13.2786 (<0.0001)	0.9888 (<0.0001)	0.1926 (<0.0001)	-	0.5222	-1963.999
	WD_PMPEAK	-14.2448 (<0.0001)	0.9237 (<0.0001)	0.2763 (<0.0001)	-	0.6015	-1404.435
	WD_NIGHT	-13.7857 (<0.0001)	0.9089 (<0.0001)	0.3347 (<0.0001)	-	0.5321	-1931.944
	WE_DAY	-12.1080 (<0.0001)	0.7209 (<0.0001)	0.2644 (<0.0001)	-	0.5559	-1389.08
	WE_NIGHT	-13.5651 (<0.0001)	0.7928 (<0.0001)	0.3427 (<0.0001)	-	0.4683	-1362.454
Collision Types	SV	-9.9863 (<0.0001)	0.2849 (<0.0001)	0.4948 (<0.0001)	-	0.3699	-1239.936
	MV	-12.1180 (<0.0001)	0.9530 (<0.0001)	0.2256 (<0.0001)	-	0.4383	-2721.457
	PED	-14.5929 (<0.0001)	-	-	0.9845 (<0.0001)	1.5024	-472.868
	BIKE	-13.4067 (<0.0001)	0.6900 (<0.0001)	0.2600 (0.0170)		0.9107	-590.515
Special Events	FOG	-14.0164 (<0.0001)	-	-	0.7825 (0.0208)	2.5243	-163.6118
	RAIN	-15.9330 (<0.0001)	0.9793 (<0.0001)	0.3713 (<0.0001)	-	0.4597	-1231.094
	DUI	-12.5291 (<0.0001)	-	-	0.8762 (<0.0001)	0.6249	-829.9565

Table 7-25 SPFs based on urban 4-leg signalized intersections (U_4SG)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	α	LL
Severity Level	KABCO	-10.3764 (<0.0001)	0.8138 (<0.0001)	0.2606 (<0.0001)	0.4199	-17191.7146
	KABC	-10.8353 (<0.0001)	0.8063 (<0.0001)	0.2379 (<0.0001)	0.3014	-13906.4336
	KAB	-10.8251 (<0.0001)	0.7570 (<0.0001)	0.2076 (<0.0001)	0.2948	-11079.7818
	KA	-12.6172 (<0.0001)	0.8029 (<0.0001)	0.2037 (<0.0001)	0.5162	-6741.5377
Time Period	WD_AMPEAK	-12.9119 (<0.0001)	0.7817 (<0.0001)	0.2919 (<0.0001)	0.5875	-7661.1377
	WD_OFFPEAK	-11.6247 (<0.0001)	0.8455 (<0.0001)	0.2347 (<0.0001)	0.5549	-12794.7541
	WD_PMPEAK	-12.9465 (<0.0001)	0.8560 (<0.0001)	0.2597 (<0.0001)	0.5179	-9064.8405
	WD_NIGHT	-12.2803 (<0.0001)	0.8296 (<0.0001)	0.3059 (<0.0001)	0.4525	-11937.1115
	WE_DAY	-13.6709 (<0.0001)	0.9166 (<0.0001)	0.2722 (<0.0001)	0.5386	-9077.354
	WE_NIGHT	-13.0551 (<0.0001)	0.7799 (<0.0001)	0.3539 (<0.0001)	0.4563	-8897.6407
Collision Types	SV	-9.0588 (<0.0001)	0.4210 (<0.0001)	0.2240 (<0.0001)	0.3718	-6348.826
	MV	-10.8452 (<0.0001)	0.8447 (<0.0001)	0.2668 (<0.0001)	0.4592	-16864.72
	PED	-14.6531 (<0.0001)	0.8847 (<0.0001)	0.2238 (<0.0001)	1.0646	-4062.43
	BIKE	-13.0601 (<0.0001)	0.7320 (<0.0001)	0.2245 (<0.0001)	0.6196	-4145.56
Special Events	DUI	-13.4850 (<0.0001)	0.7807 (<0.0001)	0.2697 (<0.0001)	0.4206	-5293.03
	FOG	-12.2796 (<0.0001)	0.4503 (0.0002)	0.2163 (0.0078)	0.1745	-1000.9920
	RAIN	-14.0231 (<0.0001)	0.9024 (<0.0001)	0.2875 (<0.0001)	0.5126	-7854.9948

Table 7-26 SPFs based on urban 3-leg stop-controlled intersections: 1-way stop (U_3ST_1S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-10.3050 (<0.0001)	0.6526 (<0.0001)	0.3193 (<0.0001)	-	0.6361	-2015.138
	KABC	-10.9552 (<0.0001)	0.6773 (<0.0001)	0.2887 (<0.0001)	-	0.6649	-1557.018
	KAB	-11.0617 (<0.0001)	0.6819 (<0.0001)	0.2155 (<0.0001)	-	0.7391	-1168.559
	KA	-13.4048 (<0.0001)	-	-	0.9741 (<0.0001)	0.9167	-626.7936
Time Period	WD_AMPEAK	-12.8079 (<0.0001)	0.6551 (<0.0001)	0.3156 (0.0055)	-	0.6562	-598.3452
	WD_OFFPEAK	-12.0804 (<0.0001)	0.7985 (<0.0001)	0.2070 (0.0002)	-	0.7478	-1172.531
	WD_PMPEAK	-12.5753 (<0.0001)	0.6251 (<0.0001)	0.3821 (<0.0001)	-	1.4663	-787.1786
	WD_NIGHT	-11.3347 (<0.0001)	0.6217 (<0.0001)	0.3241 (<0.0001)	-	0.8689	-1178.725
	WE_DAY	-11.9820 (<0.0001)	0.6507 (<0.0001)	0.2557 (0.0009)	-	0.9968	-746.5112
	WE_NIGHT	-11.9387 (<0.0001)	0.5604 (<0.0001)	0.3654 (<0.0001)	-	0.8901	-746.5112
Collision Types	SV	-6.4950 (<0.0001)	0.1359 (0.0423)	0.2309 (0.0002)	-	0.7234	-955.4602
	MV	-12.0890 (<0.0001)	0.7794 (<0.0001)	0.3600 (<0.0001)	-	0.7698	-1815.65
	PED	-16.1967 (<0.0001)	-	-	1.0958 (<0.0001)	2.8978	-213.097
	BIKE						
Special Events	DUI	-10.9826 (<0.0001)	0.5342 (<0.0001)	0.1752 (0.0772)	-	0.9703	-460.4672
	FOG	-10.8588 (<0.0001)	-	-	0.5004 (0.0360)	5.1679	-156.5399
	RAIN	-13.3866 (<0.0001)	0.6659 (<0.0001)	0.3849 (<0.0001)	-	1.0585	-623.6122

Table 7-27 SPFs based on urban 3-leg stop-controlled intersections: 1-way stop- divided (U_3ST_1SD)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-8.0071 (0.0040)	-	-	0.7167 (0.0063)	0.5993	-110.1206
	KABC	-6.8479 (0.0256)	-	-	0.5324 (0.0654)	0.6771	-87.8934
	KAB	-8.2909 (0.0174)	-	-	0.6093 (0.0628)	0.6865	-70.6704
	KA	-15.5362 (0.0172)	-	-	1.1593 (0.0558)	1.1309	-38.4498
Time Period	WD_AMPEAK						
	WD_OFFPEAK						
	WD_PMPEAK	-11.8299 (0.0117)	-	-	0.8456 (0.0531)	0.5214	-45.2385
	WD_NIGHT	-11.5490 (0.0009)	-	-	0.9534 (0.0036)	0.8008	-81.5077
	WE_DAY	-5.7414 (<0.0001)	0.7898 (0.0985)	-0.7605 (0.0530)	-	0.2838	-31.6060
	WE_NIGHT	-11.7779 (0.0062)	-	-	0.8778 (0.0288)	0.9148	-55.0579
Collision Types	SV	-12.3808 (0.0073)	-	-	0.9208 (0.0324)	0.5475	-50.868
	MV	-7.7255 (0.0056)	-	-	0.6741 (0.0103)	0.6130	-105.2922
	PED						
	BIKE						
Special Events	DUI	-17.4088 (0.0021)	-	-	1.3071 (0.0297)	0.5278	-33.2147
	FOG						
	RAIN						

Table 7-28 SPFs based on urban 3-leg stop-controlled intersections: 3-way stop (U_3ST_3S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-15.8893 (<0.0001)	0.7697 (0.0270)	0.8268 (0.0502)	-	0.5925	-59.6643
	KABC	-21.1581 (<0.0001)	-	-	1.9278 (<0.0001)	0.4344	-32.0998
	KAB	-15.5183 (0.0002)	-	-	1.2517 (0.0044)	0.0001	-23.7800
	KA						
Time Period	WD_AMPEAK	-40.7671 (0.0002)	-	-	3.7262 (0.0005)	0.0001	-6.5280
	WD_OFFPEAK	-25.8300 (<0.0001)	-	-	2.3180 (<0.0001)	0.0001	-16.6136
	WD_PMPEAK	-13.3469 (0.0021)	-	-	1.0089 (0.0308)	0.0001	-23.1302
	WD_NIGHT						
	WE_DAY	-16.3302 (<0.0001)	-	-	1.3548 (0.0015)	0.0236	-25.5592
	WE_NIGHT						
Collision Types	SV						
	MV	-17.8691 (<0.0001)	0.9016 (0.0384)	0.8908 (0.0819)	-	0.9412	-52.8766
	PED						
	BIKE						
Special Events	DUI						
	FOG						
	RAIN						

Table 7-29 SPFs based on urban 4-leg signalized intersections: one of the roads is one-way (U_4SG_1OW)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	**KABCO**	-6.7412 (<0.0001)	0.5024 (<0.0001)	0.2246 (<0.0001)	-	0.6433	-742.4806
	KABC	-6.2950 (<0.0001)	-	-	0.5374 (<0.0001)	0.5659	-573.2380
	KAB	-6.1832 (<0.0001)	-	-	0.4425 (<0.0001)	0.6082	-436.0745
	KA	-11.0729 (<0.0001)	0.5513 (0.0042)	0.2748 (0.0531)	-	0.5453	-201.1478
Time Period	**WD_AMPEAK**	-12.4706 (<0.0001)	0.6419 (<0.0001)	0.4193 (0.0003)	-	0.4639	-285.0464
	WD_OFFPEAK	-7.9547 (<0.0001)	0.5261 (0.0009)	0.2804 (0.0156)	-	0.6616	-529.4660
	WD_PMPEAK	-9.6758 (<0.0001)	0.5261 (0.0009)	0.2804 (0.0156)	-	1.0969	-361.5036
	WD_NIGHT	-7.3753 (<0.0001)	-	-	0.6105 (<0.0001)	0.9109	-518.3719
	WE_DAY	-10.4338 (<0.0001)	0.4516 (0.0008)	0.4465 (<0.0001)	-	0.5640	-349.2275
	WE_NIGHT	-9.3674 (<0.0001)	0.6360 (<0.0001)	0.1494 (0.1003)	-	0.8474	-399.8447
Collision Types	**SV**	-7.8668 (<0.0001)	-	-	0.4976 (0.0004)	0.7077	-267.8497
	MV	-6.9997 (<0.0001)	0.5032 (<0.0001)	0.2410 (0.0009)	-	0.7126	-724.3959
	PED	-10.3829 (<0.0001)	0.4442 (0.0498)	0.3030 (0.0645)	-	1.0588	-192.364
	BIKE	-8.8801 (<0.0001)	-	-	0.5020 (0.0155)	0.8184	-158.073
Special Events	**DUI**	-6.8204 (<0.0001)	-	-	0.3194 (0.0764)	0.7051	-183.7545
	FOG						
	RAIN	-11.6531 (<0.0001)	-	-	0.9166 (<0.0001)	1.0534	-316.1947

Table 7-30 SPFs based on urban 4-leg signalized intersections: both roads are one-way (U_4SG_2OW)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-6.6592 (<0.0001)	0.3840 (0.0159)	0.3472 (0.0003)	-	0.4911	-344.3775
	KABC	-6.6579 (<0.0001)	-	-	0.5739 (0.0010)	0.4614	-264.9940
	KAB						
	KA						
Time Period	WD_AMPEAK	-11.4674 (<0.0001)	0.4462 (0.0960)	0.5290 (0.0035)	-	0.5001	-139.4001
	WD_OFFPEAK	-7.4570 (<0.0001)	0.3473 (0.0497)	0.3600 (0.0016)	-	0.5047	-258.4608
	WD_PMPEAK	-10.3206 (<0.0001)	-	-	0.8150 (0.0005)	0.7569	-170.3757
	WD_NIGHT	-8.2538 (<0.0001)	-	-	0.6766 (0.0002)	0.4504	-218.8326
	WE_DAY	-7.8103 (<0.0001)	-	-	0.5817 (0.0159)	0.7730	-186.0850
	WE_NIGHT	-10.8033 (<0.0001)	0.5624 (0.0251)	0.3861 (0.0138)	-	0.7034	-177.4407
Collision Types	SV	-11.9814 (<0.0001)	-	-	0.8977 (0.0043)	0.6823	-114.8256
	MV	-6.7804 (<0.0001)	0.3777 (0.0261)	0.3568 (0.0005)	-	0.5676	-338.8264
	PED	-8.6811 (0.0052)	-	-	0.5384 (0.0859)	0.5518	-100.928
	BIKE						
Special Events	DUI						
	FOG						
	RAIN	-13.5589 (<0.0001)	0.8323 (0.0020)	0.3285 (0.0602)	-	0.4160	-128.9371

Table 7-31 SPFs based on urban 4-leg stop-controlled intersections: 2-way stop (U_4ST_2S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-8.3872 (<0.0001)	0.5690 (<0.0001)	0.2189 (<0.0001)	-	0.6242	-1677.870
	KABC	-8.9049 (<0.0001)	0.5575 (<0.0001)	0.2267 (<0.0001)	-	0.6050	-1357.984
	KAB	-9.5413 (<0.0001)	0.5904 (<0.0001)	0.1898 (0.0002)	-	0.5650	-1042.420
	KA	-11.0736 (<0.0001)	0.6170 (<0.0001)	0.1953 (0.0213)	-	1.0969	-547.3104
Time Period	WD_AMPEAK	-10.6658 (<0.0001)	0.5278 (<0.0001)	0.2355 (0.0046)	-	0.7393	-512.3009
	WD_OFFPEAK	-9.6131 (<0.0001)	0.5829 (<0.0001)	0.2106 (0.0003)	-	0.8056	-1059.830
	WD_PMPEAK	-10.9352 (<0.0001)	0.5992 (0.0001)	0.2643 (0.0004)	-	1.0496	-724.6289
	WD_NIGHT	-9.9610 (<0.0001)	0.5887 (<0.0001)	0.2149 (0.0002)	-	0.6316	-934.0691
	WE_DAY	-11.0798 (<0.0001)	-	-	0.7948 (<0.0001)	1.0039	-671.5561
	WE_NIGHT	-9.9268 (<0.0001)	0.5422 (<0.0001)	0.1398 (0.0521)	-	0.4323	-555.5116
Collision Types	SV	-7.8396 (<0.0001)	0.2708 (0.0016)	0.2095 (0.0094)	-	1.0359	-600.9222
	MV	-8.9973 (<0.0001)	0.5920 (<0.0001)	0.2493 (<0.0001)	-	0.7718	-1587.956
	PED	-13.6166 (<0.0001)	-	-	0.8534 (<0.0001)	0.9620	-189.449
	BIKE	-13.3673 (<0.0001)	-	-	0.8801 (<0.0001)	1.9783	-269.441
Special Events	DUI	-9.2273 (<0.0001)	0.2950 (0.0303)	0.2225 (0.0804)	-	1.9434	-304.6535
	FOG						
	RAIN	-12.1822 (<0.0001)	0.6768 (<0.0001)	0.2395 (0.0091)	-	1.1102	-481.4118

Table 7-32 SPFs based on urban 4-leg stop-controlled intersections: 4-way stop (U_4ST_4S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-9.3696 (<0.0001)	0.6102 (<0.0001)	0.2753 (0.0063)	-	0.5611	-465.4672
	KABC	-10.3581 (<0.0001)	0.6312 (<0.0001)	0.2867 (0.0108)	-	0.4668	-342.0106
	KAB	-10.7906 (<0.0001)	0.5975 (0.0005)	0.2889 (0.0447)	-	0.4783	-242.8931
	KA						
Time Period	WD_AMPEAK						
	WD_OFFPEAK	-11.7375 (<0.0001)	0.7913 (<0.0001)	0.2115 (0.0984)	-	0.4291	-258.2825
	WD_PMPEAK	-9.7539 (<0.0001)	-	-	0.6369 (0.0004)	0.0001	-166.7555
	WD_NIGHT	-12.2565 (<0.0001)	0.7816 (<0.0001)	0.2778 (0.0628)	-	0.5461	-248.3580
	WE_DAY	-10.0369 (<0.0001)	-	-	0.6758 (0.0026)	1.4721	-178.5800
	WE_NIGHT	-11.3874 (<0.0001)	-	-	0.8140 (<0.0001)	0.3437	-167.9759
Collision Types	SV	-10.4499 (<0.0001)	-	-	0.7072 (0.0007)	0.6131	-165.4974
	MV	-10.0669 (<0.0001)	0.6243 (<0.0001)	0.3208 (0.0061)	-	0.7303	-429.585
	PED						
	BIKE	-13.1173 (<0.0001)	-	-	0.8812 (0.0069)	0.0001	-81.1580
Special Events	DUI	-10.0704	-	-	0.5652 (0.0739)	1.4781	-92.0625
	FOG						
	RAIN	-10.1827 (0.0002)	-	-	0.5810 (0.0481)	0.3908	-93.8832

Table 7-33 SPFs based on urban 4-leg stop-controlled intersections: 2-way stop and one of the roads is one-way (U_4ST_2S_1OW)

Crash Type		Intercept	ln(TEV)	α	LL
Severity Level	KABCO	-13.0206 (<0.0001)	1.2638 (0.0227)	0.9054	-44.5381
	KABC				
	KAB				
	KA	-24.1502 (<0.0001)	2.1223 (0.0964)	0.2686	-8.9272
Time Period	WD_AMPEAK				
	WD_OFFPEAK	-15.4238 (<0.0001)	1.4115 (0.0873)	1.6978	-29.1749
	WD_PMPEAK				
	WD_NIGHT				
	WE_DAY	-28.1593 (<0.0001)	2.6387 (0.0006)	0.0001	-13.6575
	WE_NIGHT				
Collision Types	SV				
	MV	-14.8252 (<0.0001)	1.4390 (0.0116)	0.8449	-41.4515
	PED				
	BIKE				
Special Events	DUI				
	FOG				
	RAIN				

Table 7-34 SPFs based on urban 5- or 6-leg signalized intersections (U_5_6 SG)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	**KABCO**	-17.7276 (<0.0001)	-	-	1.7257 (<0.0001)	0.5001	-108.3355
	KABC	-13.9459 (<0.0001)		-	1.2553 (<0.0001)	0.3156	-79.5164
	KAB	-14.5902 (<0.0001)	-	-	1.2407 (<0.0001)	0.3381	-61.0568
	KA	-12.6856 (<0.0001)	-	-	0.9328 (0.0024)	0.0915	-34.0071
Time Period	**WD_AMPEAK**	-19.3051 (<0.0001)	-	-	1.6083 (<0.0001)	0.1232	-40.5047
	WD_OFFPEAK	-18.8426 (<0.0001)	-	-	1.7208 (<0.0001)	0.7200	-79.6412
	WD_PMPEAK	-20.6547 (<0.0001)	-	-	1.7840 (<0.0001)	0.4337	-51.9562
	WD_NIGHT	-19.7551 (<0.0001)	1.6375 (<0.0001)	0.2754 (0.0730)	-	0.4375	-75.1182
	WE_DAY	-18.0053	-	-	1.5554 (<0.0001)	0.3689	-57.6375
	WE_NIGHT	-19.0285 (<0.0001)	-	-	1.6406 (<0.0001)	0.1711	-53.4997
Collision Types	**SV**	-8.1777 (0.0177)	-	-	0.5362 (0.1097)	0.6113	-45.5946
	MV	-18.8313 (<0.0001)	-	-	1.8193 (<0.0001)	0.5362	-104.6365
	PED	-16.7704 (<0.0001)			1.2941 (0.0001)	0.0129	-29.6938
	BIKE	-21.4895 (0.0142)	-	-	1.6889 (0.0432)	1.3598	-21.4025
Special Events	**DUI**						
	FOG						
	RAIN	-24.3403 (<0.0001)	-	-	2.0946 (<0.0001)	0.8755	-43.2967

Table 7-35 SPFs based on rural 4-leg signalized intersections (R_4SG)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-7.8831 (<0.0001)	0.4670 (0.0077)	0.3106 (0.0169)	-	0.2811	-145.7414
	KABC	-8.5846 (<0.0001)	-	-	0.7204 (<0.0001)	0.3711	-119.2818
	KAB	-9.8663 (<0.0001)	-	-	0.7897 (0.0005)	0.4552	-93.9224
	KA						
Time Period	WD_AMPEAK	-10.4192 (<0.0001)	-	-	0.7524 (0.0066)	0.1116	-59.2258
	WD_OFFPEAK	-7.8356 (<0.0001)	-	-	0.5902 (0.0064)	0.4591	-100.4501
	WD_PMPEAK	-9.2075 (<0.0001)	-	-	0.6573 (0.0071)	0.1747	-69.7185
	WD_NIGHT	-11.1182 (<0.0001)	-	-	0.8986 (<0.0001)	0.2461	-83.1989
	WE_DAY	-14.0515 (<0.0001)	0.7554 (0.0414)	0.4590 (0.0955)	-	0.1742	-55.5850
	WE_NIGHT	-12.2172 (<0.0001)	-	-	0.9216 (0.0010)	0.0001	-52.7337
Collision Types	SV	-9.0792 (0.0022)	-	-	0.5819 (0.0612)	0.2961	-52.8363
	MV	-8.2824 (<0.0001)	0.5147 (0.0055)	0.2947 (0.0299)	-	0.3098	-142.3328
	PED						
	BIKE						
Special Events	DUI						
	FOG						
	RAIN	-10.5581 (0.0047)	-	-	0.7400 (0.0597)	1.2845	-53.5540

Table 7-36 SPFs based on rural 3-leg stop-controlled intersections: 1-way stop (R_3ST_1S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-9.8921 (<0.0001)	0.5503 (<0.0001)	0.4011 (0.0063)	-	0.6581	-717.2297
	KABC	-10.2925 (<0.0001)	0.5473 (<0.0001)	0.3901 (<0.0001)	-	0.5387	-559.8856
	KAB	-10.1966 (<0.0001)	0.5298 (<0.0001)	0.3482 (0.0003)	-	0.6091	-471.2726
	KA	-10.2717 (<0.0001)	0.4841 (0.0012)	0.2958 (0.0234)	-	0.5522	-294.2935
Time Period	WD_AMPEAK	-12.7205 (<0.0001)	-	-	0.8982 (<0.0001)	1.2139	-154.9257
	WD_OFFPEAK	-14.8088 (<0.0001)	0.8179 (<0.0001)	0.5689 (<0.0001)	-	0.7782	-299.0490
	WD_PMPEAK	-13.8807 (<0.0001)	0.5771 (0.0099)	0.5977 (0.0023)	-	0.9555	-174.3479
	WD_NIGHT	-9.7713 (<0.0001)	0.4216 (0.0023)	0.3596 (0.0033)	-	1.1473	-382.4453
	WE_DAY	-10.3989 (<0.0001)	0.3796 (0.0311)	0.3831 (0.0117)	-	0.4095	-229.2737
	WE_NIGHT	-10.3238 (<0.0001)	0.4718 (0.0049)	0.3087 (0.0358)	-	1.4082	-281.7930
Collision Types	SV	-7.5783 (<0.0001)	0.1872 (0.1083)	0.3855 (0.0003)	-	1.1631	-511.5449
	MV	-13.9082 (<0.0001)	0.9260 (<0.0001)	0.4305 (0.0061)	-	0.7975	-479.637
	PED						
	BIKE						
Special Events	DUI	-10.1169 (<0.0001)	-	-	0.6019 (0.0005)	0.3923	-173.8016
	FOG	-11.4611 (<0.0001)	-	-	0.6843 (0.0306)	8.3558	-101.9792
	RAIN	-10.8007 (<0.0001)	-	-	0.6659 (0.0024)	2.8311	-153.9354

Table 7-37 SPFs based on rural 4-leg stop-controlled intersections: 2-way stop (R_4ST_2S)

Crash Type		Intercept	ln(MJ_AADT)	ln(MN_AADT)	ln(TEV)	α	LL
Severity Level	KABCO	-8.9344 (<0.0001)	0.3843 (<0.0001)	0.5138 (<0.0001)	-	0.5939	-608.4482
	KABC	-9.7152 (<0.0001)	0.4950 (<0.0001)	0.4309 (<0.0001)	-	0.7111	-496.6845
	KAB	-9.3225 (<0.0001)	0.3672 (0.0022)	0.4712 (<0.0001)	-	0.6943	-416.5167
	KA	-9.3339 (<0.0001)	0.2946 (0.0562)	0.4516 (0.0020)	-	0.7119	-279.4013
Time Period	WD_AMPEAK	-12.2487 (<0.0001)	-	-	0.8884 (<0.0001)	1.5660	-155.4890
	WD_OFFPEAK	-9.4021 (<0.0001)	0.2727 (0.0794)	0.5153 (0.0002)	-	0.9516	-312.2733
	WD_PMPEAK	-12.7764 (<0.0001)	-	-	1.0009 (<0.0001)	1.7031	-203.6704
	WD_NIGHT	-9.4737 (<0.0001)	0.2599 (0.0388)	0.5412 (<0.0001)	-	0.1993	-306.0617
	WE_DAY	-9.0385 (<0.0001)	-	-	0.5816 (<0.0001)	0.6408	-237.9695
	WE_NIGHT	-11.6721 (<0.0001)	0.4728 (0.0223)	0.4840 (0.0211)	-	1.3096	-182.2347
Collision Types	SV	-8.8027 (<0.0001)	0.3751 (0.0177)	0.2705 (0.0658)	-	0.9040	-273.6664
	MV	-9.4821 (<0.0001)	0.3635 (0.0005)	0.5825 (<0.0001)	-	0.7391	-546.2581
	PED						
	BIKE						
Special Events	DUI						
	FOG						
	RAIN	-11.0666 (<0.0001)	-	-	0.7073 (0.0012)	0.8166	-124.3319

Table 7-38 SPFs based on rural 4-leg stop-controlled intersections: 4-way stop (R_4ST_4S)

Crash Type		Intercept	ln(TEV)	α	LL
Severity Level	KABCO	-9.2666 (<0.0001)	0.8095 (<0.0001)	0.1195	-59.2275
	KABC	-9.5802 (<0.0001)	0.7830 (0.0002)	0.0272	-46.7195
	KAB	-8.9349 (<0.0001)	0.6428 (0.0160)	0.0001	-34.9318
	KA				
Time Period	WD_AMPEAK				
	WD_OFFPEAK				
	WD_PMPEAK	-14.2103 (0.0054)	1.0959 (0.0553)	0.0095	-15.4130
	WD_NIGHT	-9.3389 (0.0007)	0.6668 (0.0372)	0.1694	-32.2395
	WE_DAY	-15.4865 (<0.0001)	1.2752 (0.0590)	2.1844	-18.1681
	WE_NIGHT				
Collision Types	SV				
	MV	-9.7273 (<0.0001)	0.8334 (<0.0001)	0.1111	-52.5261
	PED				
	BIKE				
Special Events	DUI				
	FOG				
	RAIN				

Table 7-39 SPFs based on roundabouts

Crash Type		Intercept	ln(TEV)	α	LL
Severity Level	KABCO	-6.1468 (<0.0001)	0.6017 (<.0001)	0.6859	-242.14
	KABC	-6.7741 (<0.0001)	0.5553 (0.0002)	0.2006	-141.46
	KAB	-5.0240 (0.0070)	0.4769 (0.1264)	0.4769	-98
	KA	-4.4169 (0. 4178)	0.0228 (0.9688)	8.2248	-24.1
Time Period	WD_AMPEAK				
	WD_OFFPEAK	-10.0542 (<0.0001)	0.6619 (0.0029)	1.5774	-117.8428
	WD_PMPEAK	-8.7723 (<0.0001)	0.5462 (0.0019)	0.6875	-131.1794
	WD_NIGHT	-11.2106 (<0.0001)	0.7094 (0.0121)	1.5705	-77.0225
	WE_DAY	-10.5644 (<0.0001)	0.6492 (0.0069)	0.3843	-80.4862
	WE_NIGHT	-12.4505 (<0.0001)	0.8637 (0.0006)	0.6006	-89.6110
Collision Types	SV	-8.4579 (<0.0001)	0.5346 (0.0022)	0.8053	-146.630
	MV	-8.2814 (<0.0001)	0.5755 (0.0001)	1.3236	-195.399
	PED				
	BIKE	-17.3863 (0.0003)	1.2341 (0.0097)	0.3657	-36.8756
Special Events	DUI				
	FOG				
	RAIN				

7.6 Summary of Microscopic Safety Modeling Results

The research team has completed developing SPFs by severity level, time period, collision type, and special event at the microscopic level. Various SPFs were estimated for each type of micro-level facility. The research team adopted a negative binomial (NB) model to be consistent with the current Highway Safety Manual (HSM). In case the number of crash cases is extremely small, the exposure variable is not significant or the model was not converged. Other than these cases, all the SPFs were developed and summarized in Chapter 7.

With the developed SPFs in Chapter 7 will be used to compute the predicted and expected number of crashes, which will be utilized to calculate a screening performance measure, PSI (Potential for Safety Improvements). In the following Chapter 8, the research team will conduct a micro-level screening for all crash types based on PSI using the developed SPFs.

8 MICRO-LEVEL NETWORK SCREENING

8.1 Identification of Hot Sites

PSI (Potential for Safety Improvements), or excess crash frequency using SPF (Safety performance function), was applied as a performance measure in the study to identify a hotspot. The PSI is the difference between the expected crash count and the predicted crash counts of each site. The PSI is an effective performance measure to identify those sites experiencing more crashes than others with similar characteristics. PSIs were calculated for each facility type and crash type and all the segments and intersections were ranked based on the computed PSI. A site is considered safe if its PSI is smaller than zero, indicating it has less crashes compared with other sites with comparable features. In contrast, a site is considered dangerous if the PSI value is greater than zero since it has more crashes than other sites with similar characteristics.

The formula for PSI is as follows:

$$PSI = N_{expected} - N_{predicted} \tag{1}$$

where $N_{expected}$ is the expected number of crashes and $N_{predicted}$ is the predicted number of crashes. The predicted number of crash can be obtained from SPFs.

The calculation of the expected number of crashes using Empirical Bayes (Girasek and Taylor, 2010) method is as follows:

$$N_{expected} = W \times N_{predicted} + (1 - W) \times N_{observed} \tag{2}$$

where, W is the Empirical Bayes weight and $N_{observed}$ is the observed crash counts. The weighted adjustments are calculated using the following equation:

$$W = \frac{1}{1 + \alpha \times N_{predicted}} \quad (3)$$

where α is the over-dispersion parameter of the SPF.

The sites with PSI greater than 10 percentile are defined as hotspots while the other sites are considered normal spots. Tables 1 and 2 show examples of hotspots for segments and intersections, respectively.

In Table 8-1, the six-lane freeway segment located at Roadway 87200000 between 4.653 and 5.441 mileposts has the PSI of 335.760, which is the segment with the largest PSI. As shown in Table 8-2, the urban signalized 4-legged intersection located at Roadway 86000078 with milepost 1.681 has the PSI of 194.913, which is the one with the highest PSI. As mentioned earlier, a site with PSI greater than 10 percentile was identified as a “Hot” spot. On the other hand, a site having PSI smaller than 10 percentile was categorized as a “Normal” site.

Table 8-1 Example of the screening results: total crashes (KABCO) segments

Rank	Segment Type	Roadway ID	Begin Mile Post	End Mile Post	Observed Crashes	Predicted Crashes	Expected Crashes	PSI	Percentile	Category
1	12_6FR	87200000	4.653	5.441	441	100.936	436.696	335.760	0.003%	HOT
2	13_8FR	87270000	9.696	10.697	629	289.117	624.569	335.452	0.007%	HOT
:		:	:	:	:	:	:	:	:	:
14179	01_R2U	47040000	15.795	16.416	0	0.656	0.247	-0.408	49.281%	NORMAL
:		:	:	:	:	:	:	:	:	:
28772	13_8FR	15190000	14.712	19.677	257	676.855	268.431	-408.424	100.000%	NORMAL

Table 8-2 Example of the screening results: total crashes (KABCO) for intersections

Rank	Intersection Types	Roadway ID	Mile Post	Observed Crashes	Predicted Crashes	Expected Crashes	PSI	Percentile	Category
1	U_4SG	86000078	1.681	260	56.934	251.847	194.913	0.012%	HOT
2	U_4SG	15080500	1.532	232	75.643	227.228	151.585	0.024%	HOT
:	:	:	:	:	:	:	:	:	:
4497	U_4ST_4S	10000372	0.000	3	4.404	3.404	-0.999	53.434%	NORMAL
:	:	:	:	:	:		:	:	:
8416	U_4SG	15150000	18.332	56	116.121	57.208	-58.913	100.000%	NORMAL

8.2 Micro-level Screening for Various Crash Types based on Segments

ESRI ArcMap® was used to visualize the crash risks of each segment based on the category results. In the following sections, segments in Leon County were chosen as an example to show the screening results for selected crash types. Figure 1 depicts the statewide spatial distribution of hotspot segments for total crashes (KABCO). The most of hot segments are clustered in metropolitan areas such as Miami, Orlando, Tampa-St. Petersburg, Jacksonville, and so forth, as expected. Nonetheless, at a statewide level it is not able to specifically find hotspot segments. So it is necessary to zoom in to an area of interest in order to take a look at particular segments with problems.

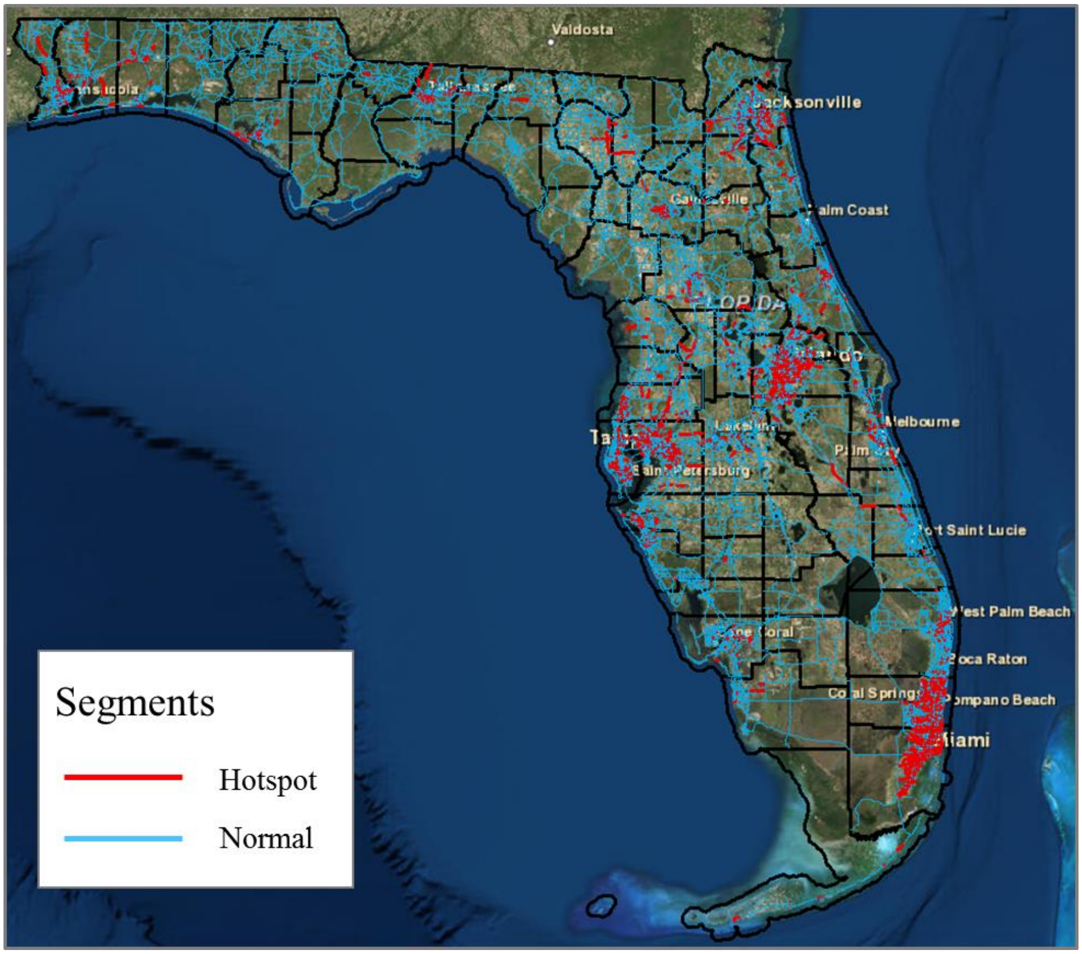


Figure 8-1 Statewide spatial distribution of hotspot segments for total crashes (KABCO)

Figures 8-2 and 8-3 present the screening results of total (KABCO) and fatal-and-severe injury (KA) crashes based on all segments in Leon County, respectively. It was revealed that the spatial distribution pattern of hot segments for the two types is quite different. Total crashes (KABCO) hotspot segments are more collected in the center of Leon County and also some major arterials in rural areas are identified as a hotspot segment. On the contrary, fatal-and-severe crashes (KA) are spread out to rural areas and mostly on major arterials with high speed limit.

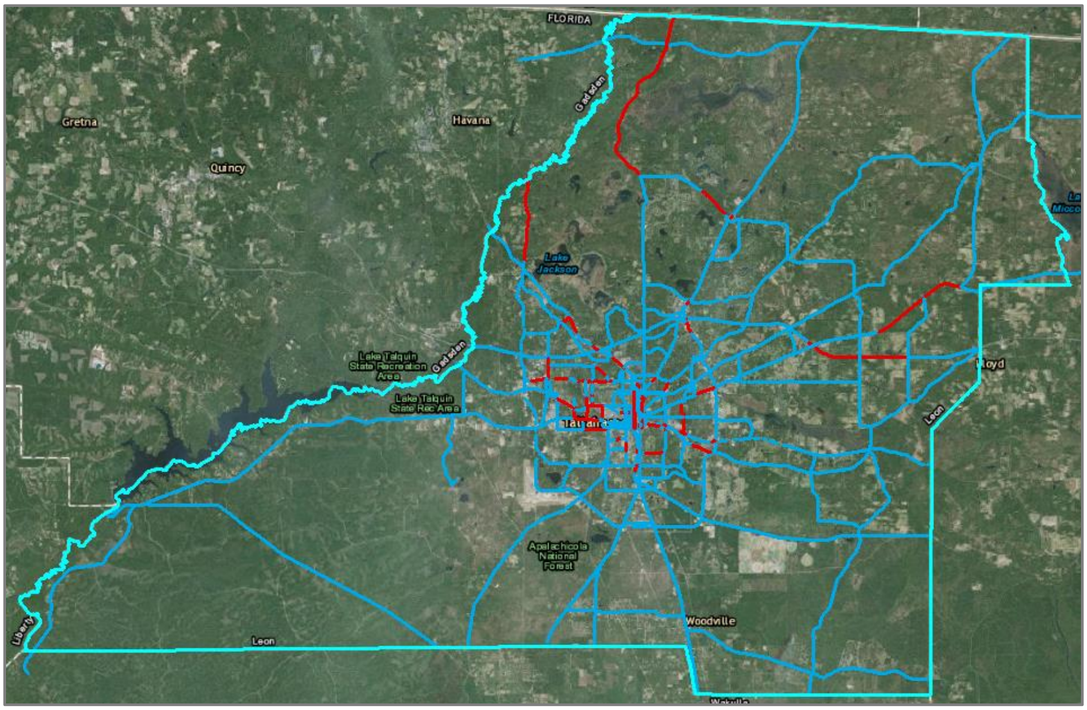


Figure 8-2 Hotspot segments in Leon county for total crashes (KABCO)

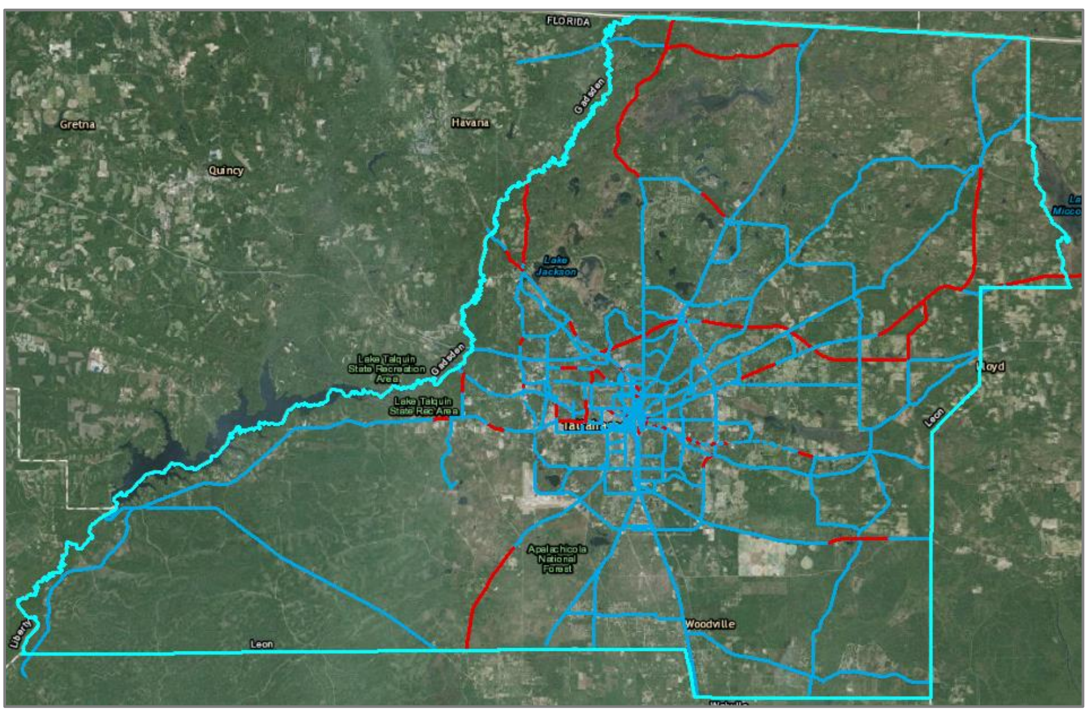


Figure 8-3 Hotspot segments in Leon County for severe crashes (KA)

Figures 8-4 exhibits hotspot segments in Leon County for pedestrian-involved crashes. As shown in Figure 8-4, a majority of pedestrian crash hotspot segments are collected in the center of Tallahassee, and there are no hotspots for pedestrian crashes in rural areas. It is as expected because pedestrian activities usually very high in the urban areas.

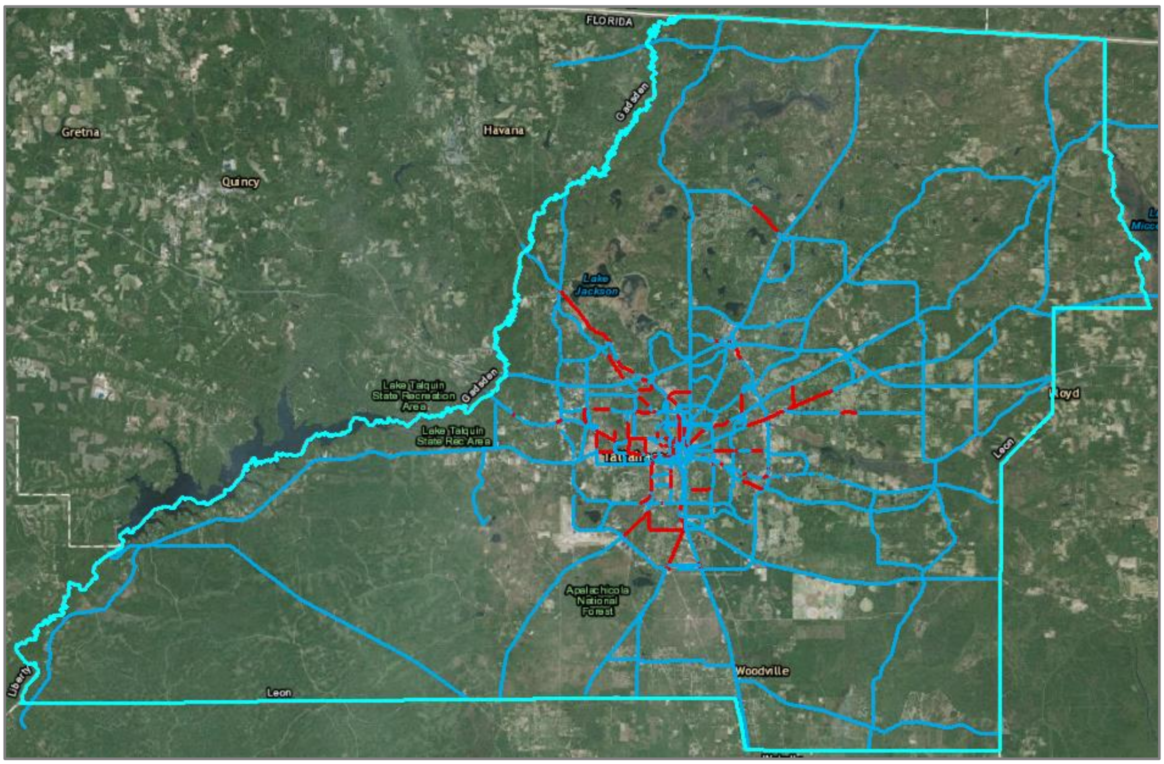


Figure 8-4 Hotspot segments in Leon County for pedestrian crashes (PED)

8.3 Micro-level Screening for Various Crash Types based on Intersections

Figure 8-6 shows the statewide distribution of hotspot intersections for total crashes (KABCO). The screening result is very comparable with segment hotspot identification for total crashes. Most of hotspot intersections are located in large urban areas: Miami, Jacksonville, Tampa-St. Petersburg, Orlando, et cetera.

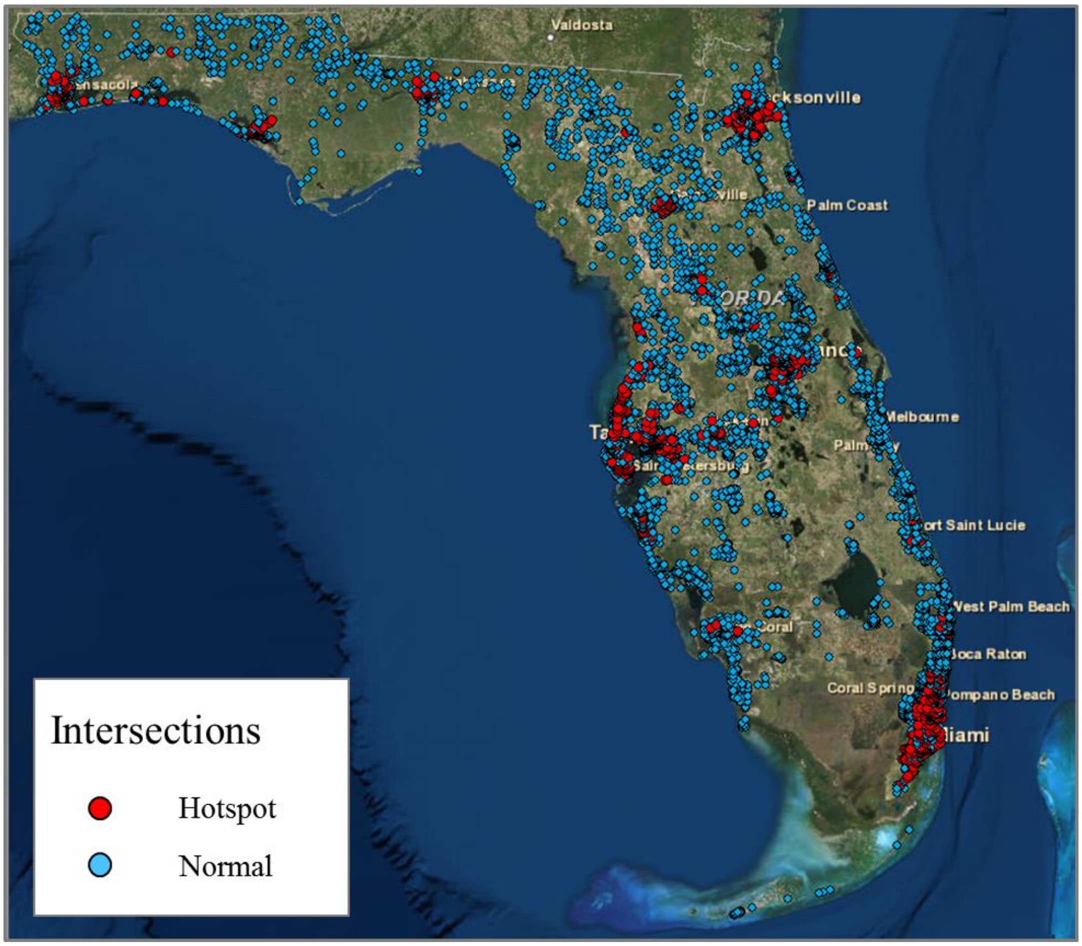


Figure 8-5 Statewide spatial distribution of hotspot intersections for total crashes (KABCO)

Figure 8-7 displays the hotspot intersections in Leon County for total crashes (KABCO). There are many hotspot intersections for total crashes in the urban area and several hotspot intersections are placed in rural areas. Nevertheless, only few hotspot intersections for severe crashes were observed in Leon County and most of them are located in the center of Tallahassee (Figure 8-8).

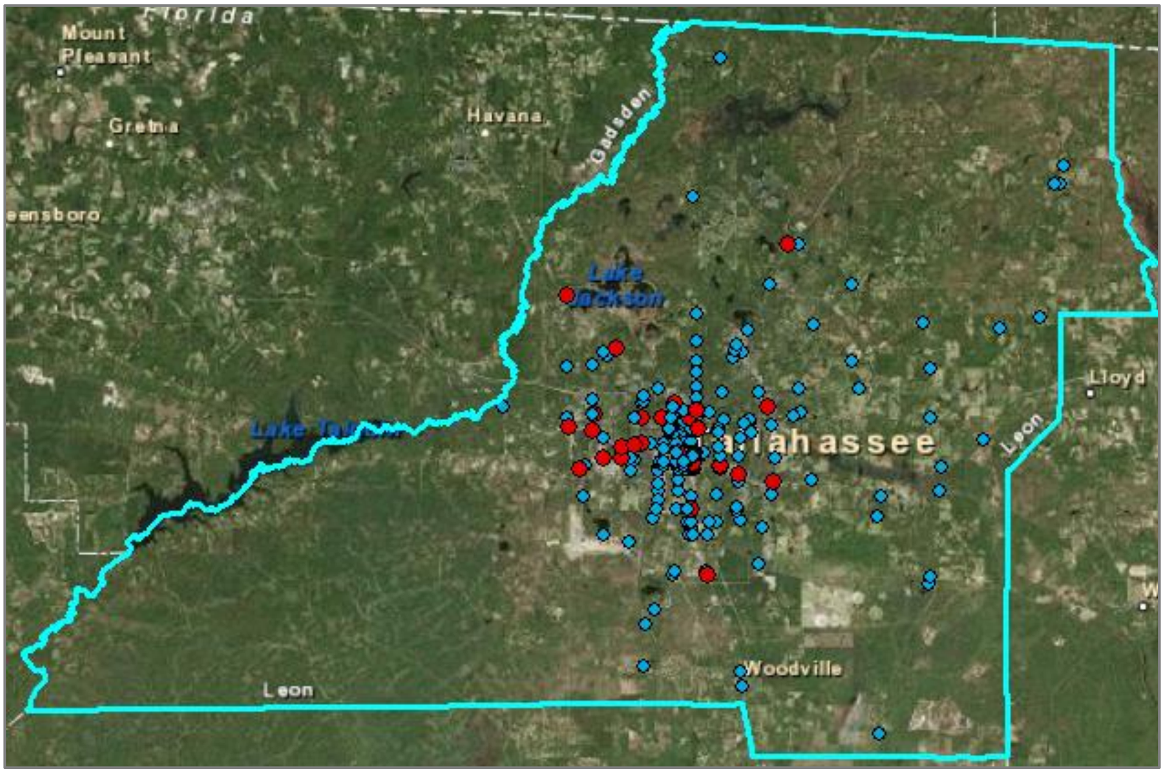


Figure 8-6 Hotspot intersections in Leon County for total Crashes (KABCO)

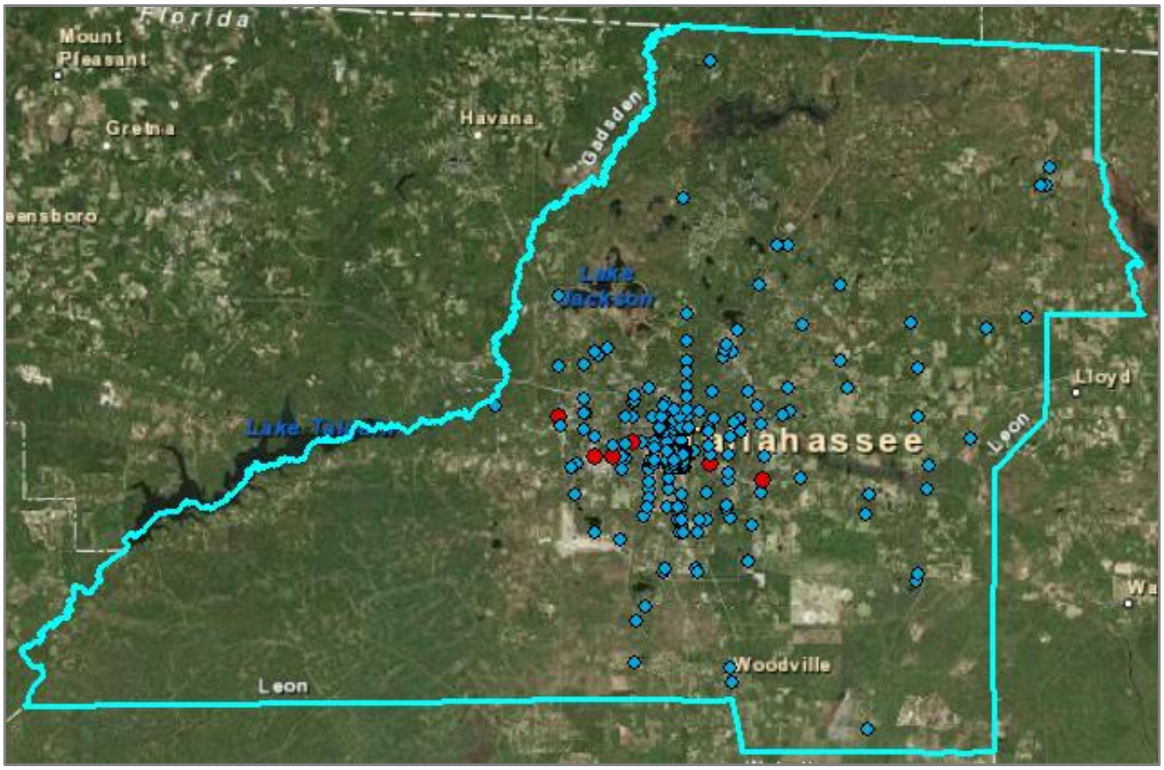


Figure 8-7 Hotspot intersections in Leon County for severe crashes (KA)

Figure 8-10 shows that the pedestrian crash hotspot intersections were mostly found in the center of Tallahassee.

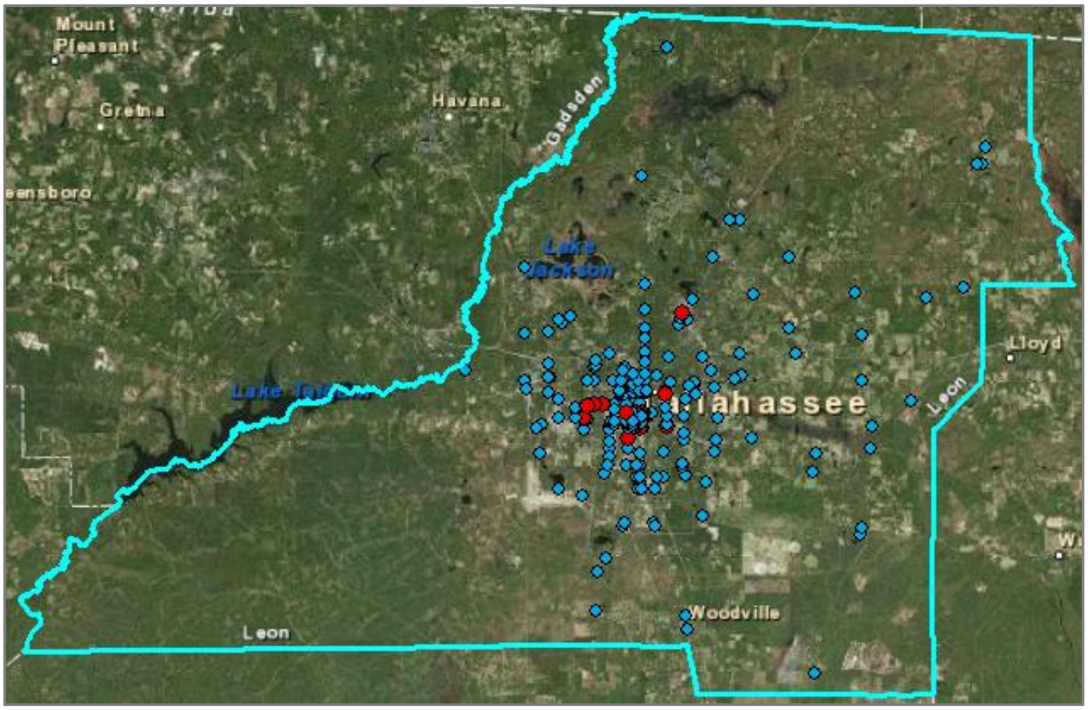


Figure 8-8 Hotspot intersections in Leon County for pedestrian crashes (PED)

8.4 Summary of Microscopic Screening Results

The research team has completed calculation of the PSIs of all segments and intersections based on the SPFs by crash type. All the segments and intersections are screened as a hot or normal site by the ranking them based on the PSIs. Some examples of the screening results were provided for several crash types for a statewide level and Leon County. The results indicated that there is a significant difference in hotspot distribution by crash type. With the screening results, it is expected that policy makers and practitioners can understand the sites with safety problems by crash severity, time period, collision type, and special event, and also appropriate safety countermeasures to reduce such crash types can be provided to the hotspots with priority.

9 INTEGRATION OF MACRO-LEVEL AND MICRO-LEVEL SCREENING RESULTS

In Chapters 6 and 8, the research team identified hot zones and hotspots using PSIs in macroscopic and microscopic levels, respectively. As in Phase I of this project, it is expected that the two-level integration results can provide transportation planner and engineers a comprehensive perspective for traffic safety and then more strategic and efficient improvement can be planned and designed. In this chapter, an integration strategy is described in section 9.1. In section 9.2, the macro-level and micro-level based integration procedures are discussed, separately.

9.1 Integration Strategy

Various studies have been conducted to analyze transportation crashes for two levels: micro and macro-level. At micro-level, crashes on segments or intersections are investigated and locations with high traffic safety risk can be identified by screening with the objective of offering engineering solutions (such as installing sidewalk, bike lane, etc.). Meanwhile, the macro-level crashes from a spatial aggregation such as a TAZ or county are analyzed and the dangerous zones can be recognized based on screening results so as to provide countermeasures from a planning perspective. Since the micro and macro-level analysis and screening can reduce crashes with different solutions, the combination of screening results based on two levels can provide a comprehensive perspective and therefore develop more appropriate and efficient traffic safety treatments.

In Phase I of this project, the integration was conducted by combining micro-level results into macro-level and then classified zones into different categories based on both micro and macro-level. By this approach, safety issues at the macro- and/or microscopic levels for a zone can be simultaneously identified. However, the approach is limited since it is hard to identify safety issues by intersection or segment at microscopic level. Thus, a new integrated screening approach is required to overcome the shortcomings of the previous screening techniques, and to achieve a balance between details and efficiency.

In this chapter, the research team proposed two approaches for integration from both macroscopic and microscopic perspectives. The two integration approaches were conducted based on the macroscopic and microscopic screening results illustrated in the previous tasks (see Figure 9-1). In the previous tasks, the zones or sites are only classified into two categories: hot and normal. In the integration process, "cold" category was added for zones or sites with bottom 10% PSIs to offer better comparison and analysis for screening. At the macro-level, zones (Transportation Analysis District (TAD) and Statewide traffic analysis zone (STAZ)) were ranked by their zonal PSIs: zones with top 10% PSIs were classified as "Hot" zones; zones with bottom 10% PSIs were classified as "Cold" zones, and other zones were categorized as "Normal". It should be noted that these percentile can be changed as needed. At the microscopic level, sites (segment and intersection) were also ranked by their PSIs and classified into "Hot", "Normal", and "Cold" categories based on their ranking results. The integration process of two different levels is introduced in the following parts.

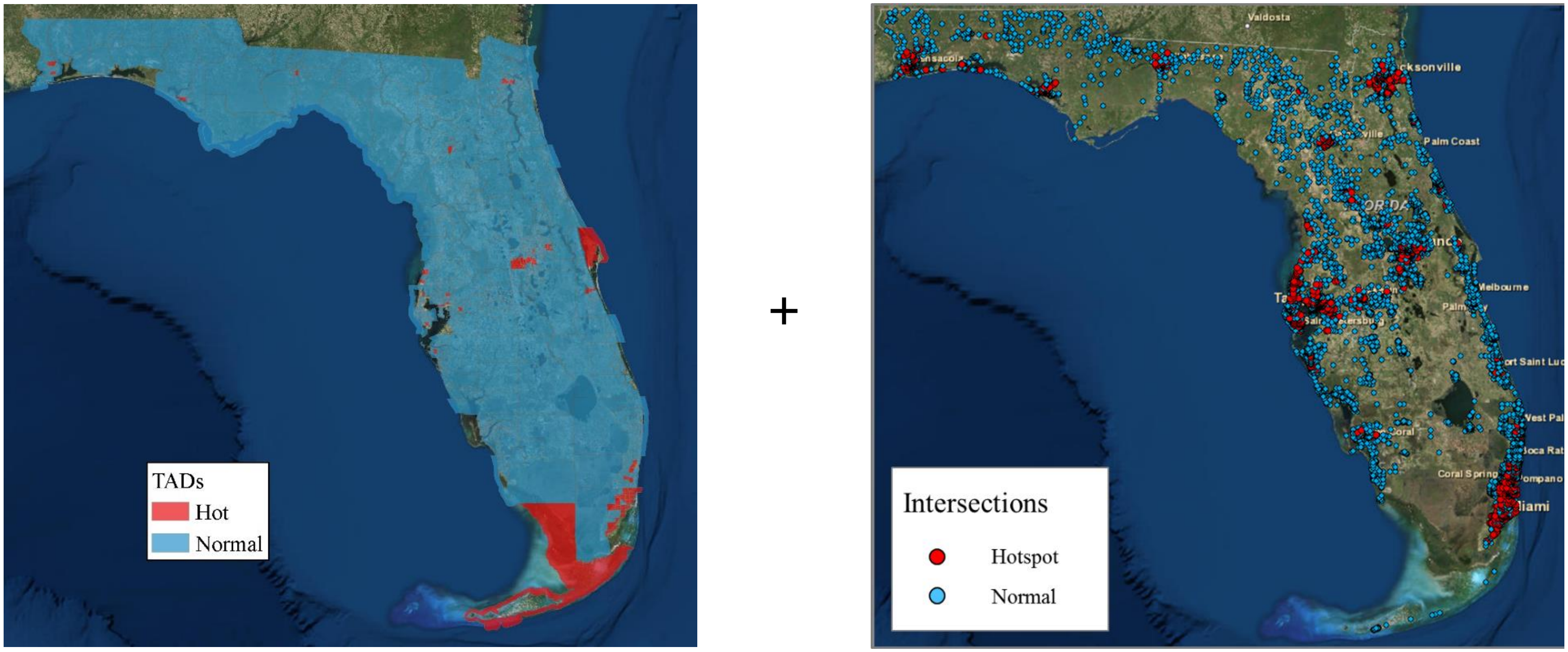


Figure 9-1 Results of macroscopic hot zone screening (left) and microscopic hotspot screening (right)

9.2 Integration Procedure

9.2.1 Macro-level based integration

The macro-level based integration procedure is summarized in Figure 9-2. Both macro-level zones and micro-level sites are classified into three categories: “Hot”, “Normal”, and “Cold”. For each zone, the number of total segments and intersections can be determined by using GIS, and meanwhile the number of hot segments and intersections can be identified based on their category results. Thus, the proportion of hot segments and intersections can be determined for all zones. In order to identify whether a zone has safety issues and which site (segment or intersection) has high risk, all zones (TADs and STAZs) are classified in the form of “ZSI”. The first character, “Z” of the classification illustrates the macroscopic safety risk which can be “H”, “N”, or “C”. The “S” and “I” are numbers representing the proportion range of hot segments and intersections for each zone (Table 9-1). Thus, it is clear that which part should be paid attention based on the combination results. For example, a zone categorized as “H27” means the zone has crash issue at macroscopic level and most of intersections have safety problems.

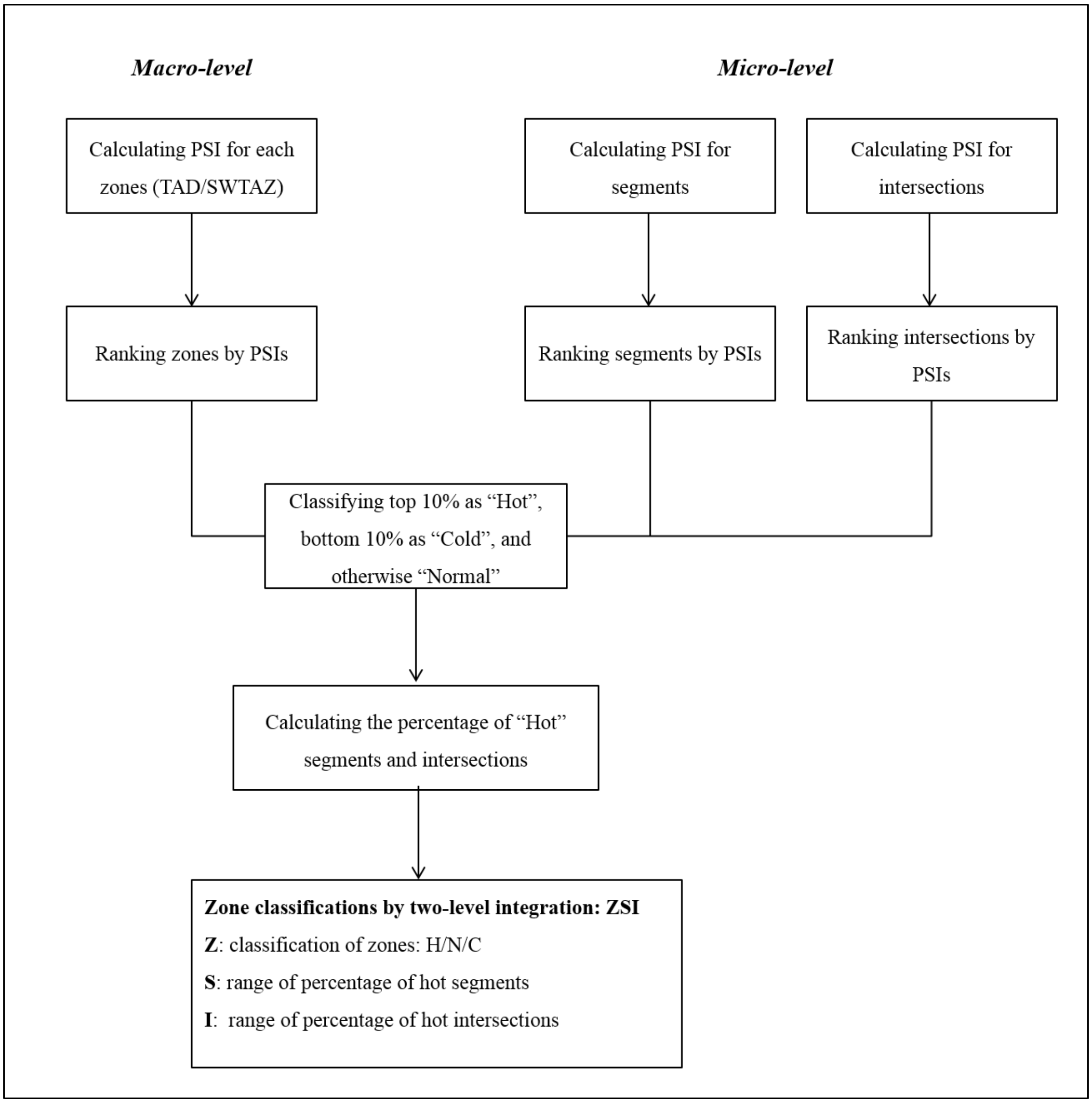


Figure 9-2 Macro-based integration process

Table 9-1 Range of proportion for segments and intersections

Segment / Intersection	Range of proportion
0	>=0%, <=10%
1	>10%, <=20%
2	>20%, <=30%
3	>30%, <=40%
4	>40%, <=50%
5	>50%, <=60%
6	>60%, <=70%
7	>70%, <=80%
8	>80%, <=90%
9	>90%, <=100%

9.2.2 Micro-level based integration

The micro-level based integration is illustrated in Figure 9-3. In order to provide appropriate countermeasures to reduce crashes, all sites (segments and intersections) are classified into nine categories including two scale groups (micro and macro) and three safety levels (hot, normal, and cold). These categories are: HH, HN, HC, NH, NN, NC, CH, CN, and CC (see Table 9-2). Thus, HH indicates a site itself has safety problems and it locates in a zone with safety issues; HN means a site is risky and the risk of the zone where the site locates is moderate; HC illustrates a site faces high crash risk while it is in a safe zone; NH suggests that a site has moderate crash risk and the nearest zone are dangerous; NN represents that both the site and the zone it locates have moderate crash problems; NC specifies that a site has a moderate risk but the safety risk at the macro-level is low; CH indicates that the site is safe while it locates at a dangerous zone; CN means that a safe site locates in a zone with moderate crash problems; CC suggests that both the site itself and the zone is also safe.

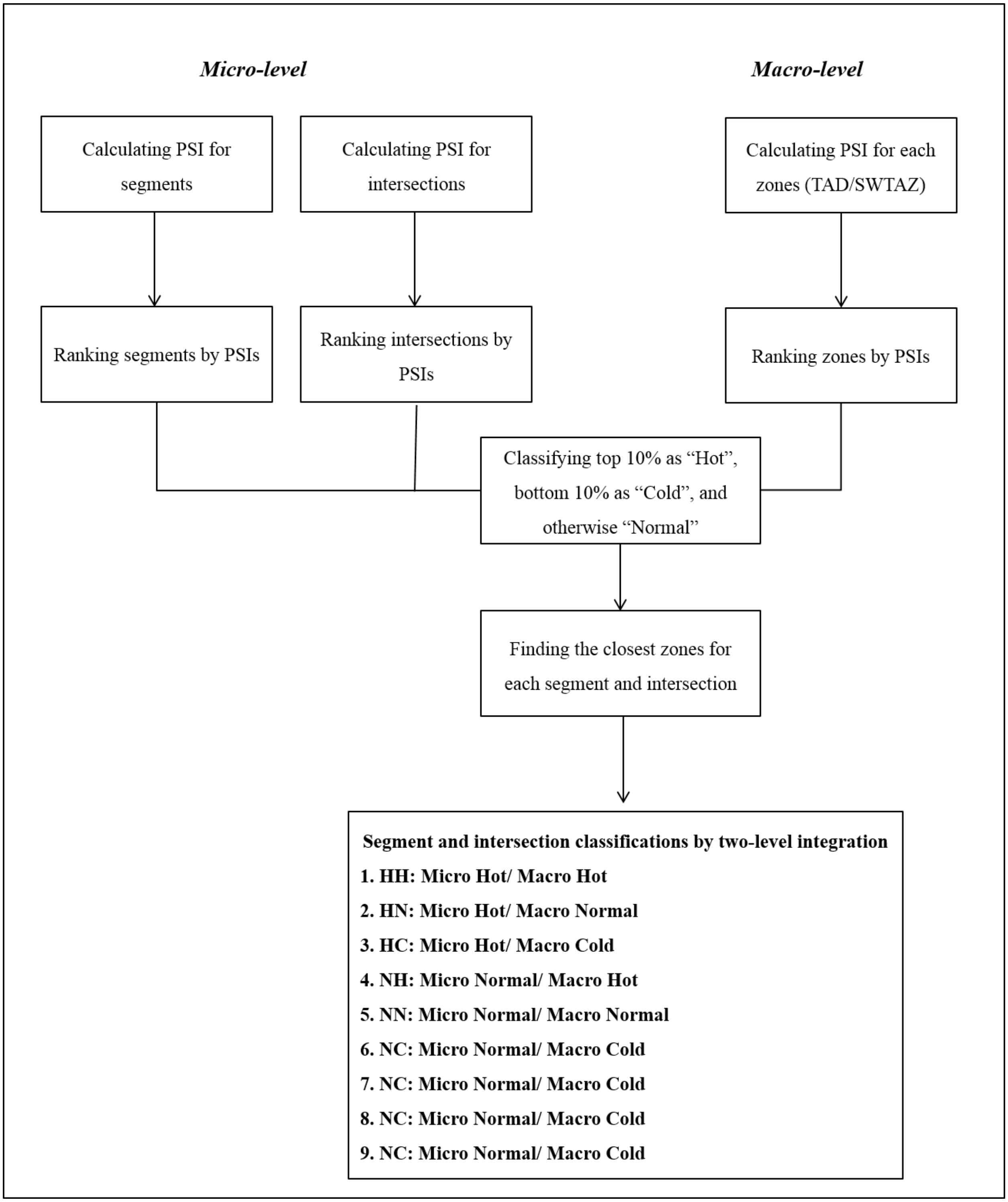


Figure 9-3 Micro-based integration process

Table 9-2 Hot zone classifications (micro-based integration)

		Macro-level		
		Hot	Normal	Cold
Micro-level	Hot	HH	HN	HC
	Normal	NH	NN	NC
	Cold	CH	CN	CC

9.3 Summary

In this chapter, the research team suggested novel methodologies to combine macro-level and micro-level screening results. Two methodologies were proposed: macro-based and micro-based integrations. All crash types analyzed in the previous chapters can be consolidated with the proposed methods, which can provide comprehensive perspective to understand traffic safety issues.

10 INTEGRATION RESULTS

In this chapter, both macro-level and micro-level based integration screening results were computed based on the integration procedure introduced in Chapter 9. The integration results for total, severe, and pedestrian crashes in the selected five areas were illustrated and discussed. ESRI ArcMap® was used to visualize the macro and micro-level based combination results. In the following sections, Total (KABCO) and severe crashes (KA) were integrated based on TADs while Pedestrian crashes were combined based on SWTAZs. The total crash hot TADs screening results display the overall crash distribution in Florida, whereas the severe crash hot zone integration screening results exhibit the distribution of traffic crashes with severe injury or fatality. The pedestrian crash hot zone screening was also conducted since it is based on different zonal system. The macro-and micro-level based integration screening results are exhibited in Sections 10.1 and 10.2, respectively.

10.1 Macro-level Based Integration Screening Results

10.1.1 Total crashes (KABCO)

Figure 10-1 shows the spatial distribution of TADs by hot zone classification for total crashes in the whole state. The most of hot zones are clustered in metropolitan areas such as Tallahassee, Jacksonville, Tampa, Orlando, Miami, and so forth, as expected. Nonetheless, at a statewide level it is not able to specifically analyze the integration results. So it is necessary to zoom into several areas of interest in order to take a close look. Five areas in Florida (Leon County, Duval

County, Hillsborough County, Orange-Seminole-Osceola Counties, and Miami-Dade County) were chosen as examples to show our screening results.

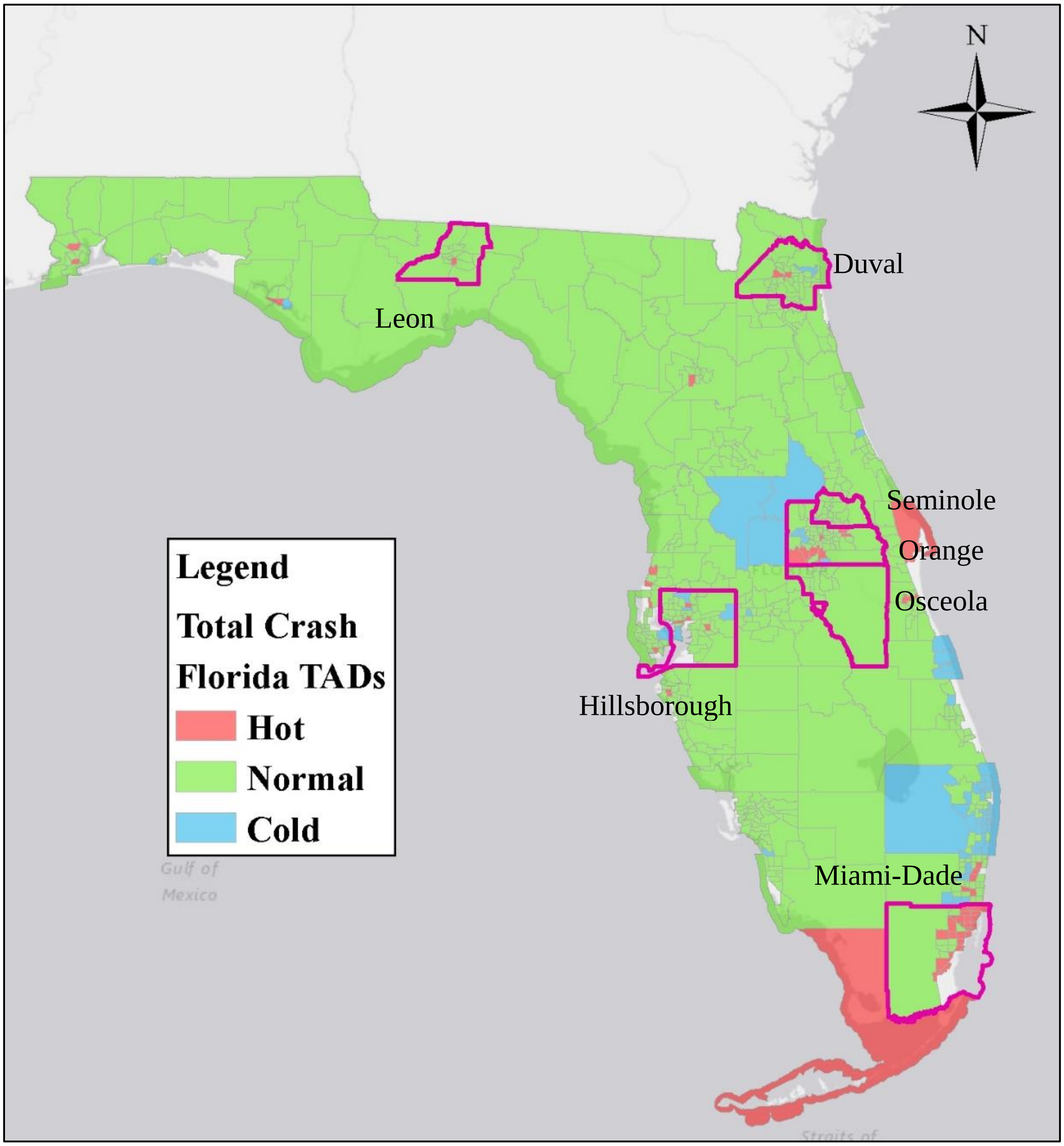


Figure 10-1 Screening results for total crashes in Florida (TADs)

Figures 10-2 to 10-6 show the integration screening results for total crash based on TAD in five selected areas. In Leon and Duval Counties, only one or two TADs were identified as hot zones and the proportion of hot segments and intersection is not high, indicating that these hot zones had macro-level safety problems. In Hillsborough and Orange-Seminole-Osceola Counties, several TADs were classified as hot zones among which had high proportion of hot segments and intersections. For example, in Orange-Seminole-Osceola Counties, one TAD was labelled as "H51", indicating the zone was risky at macro-level and also has a lot of dangerous segments. Meanwhile, a close look for these segments is also needed. Moreover, half of zones in Miami-Dade County were hot zones at macro-level. Meanwhile, most of the hot zones have high proportion of hot segments and intersections. Thus, in Miami-Dade County, both countermeasures from a planning perspective and engineering solutions should be provided to reduce crash risks.

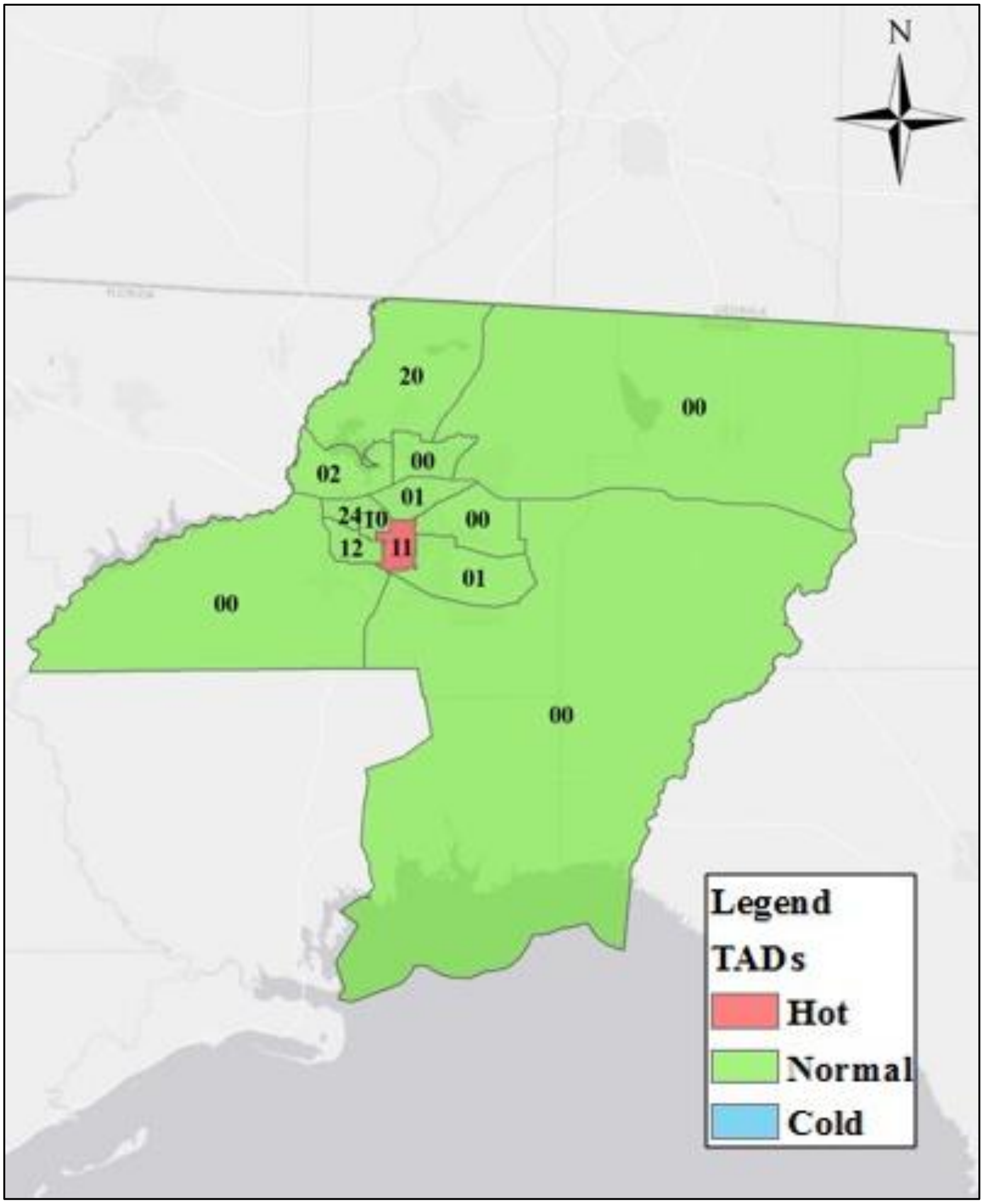


Figure 10-2 Macro-level based integration results based on TADs for total crashes in Leon County

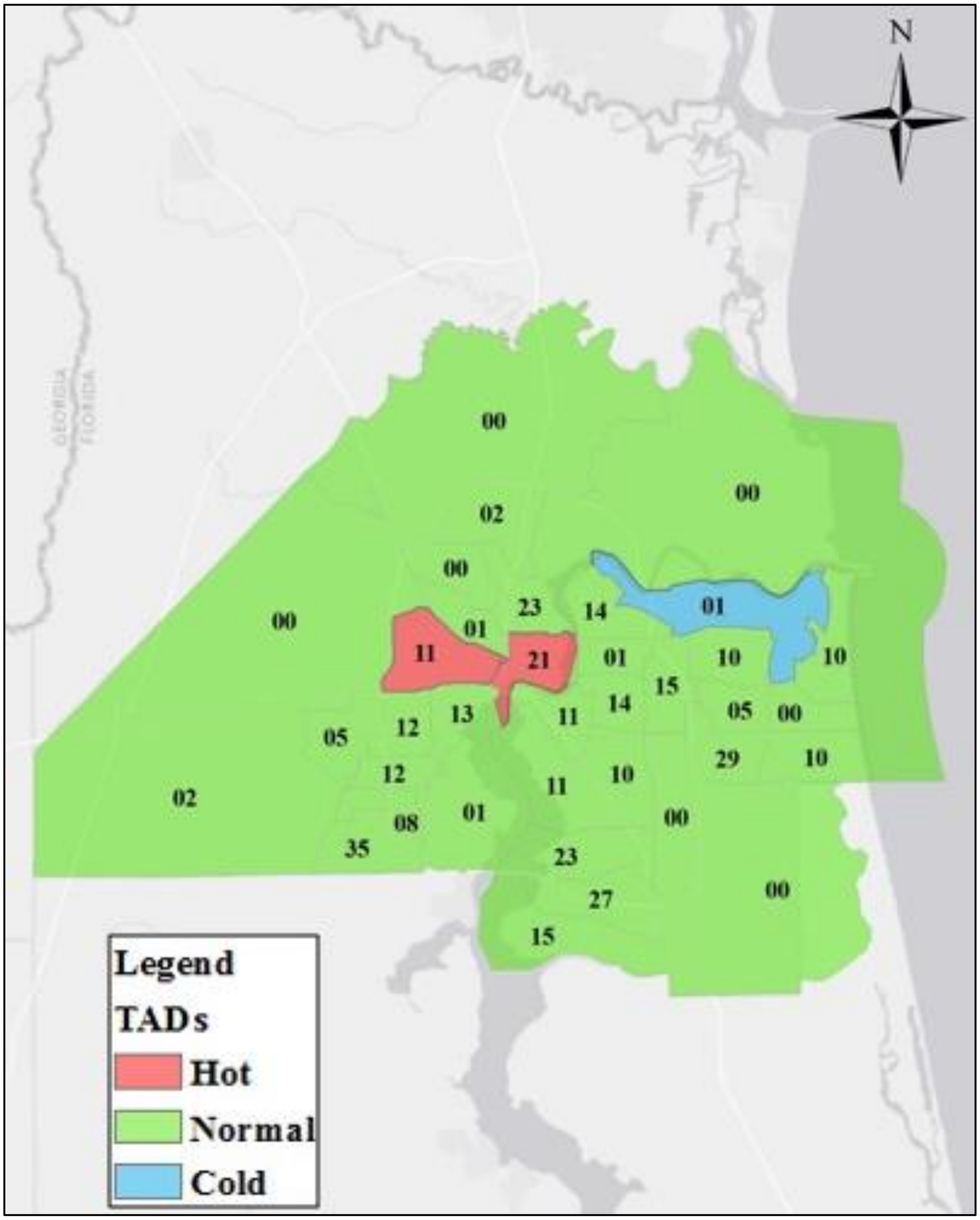


Figure 10-3 Macro-level based integration results based on TADs for total crashes in Duval County

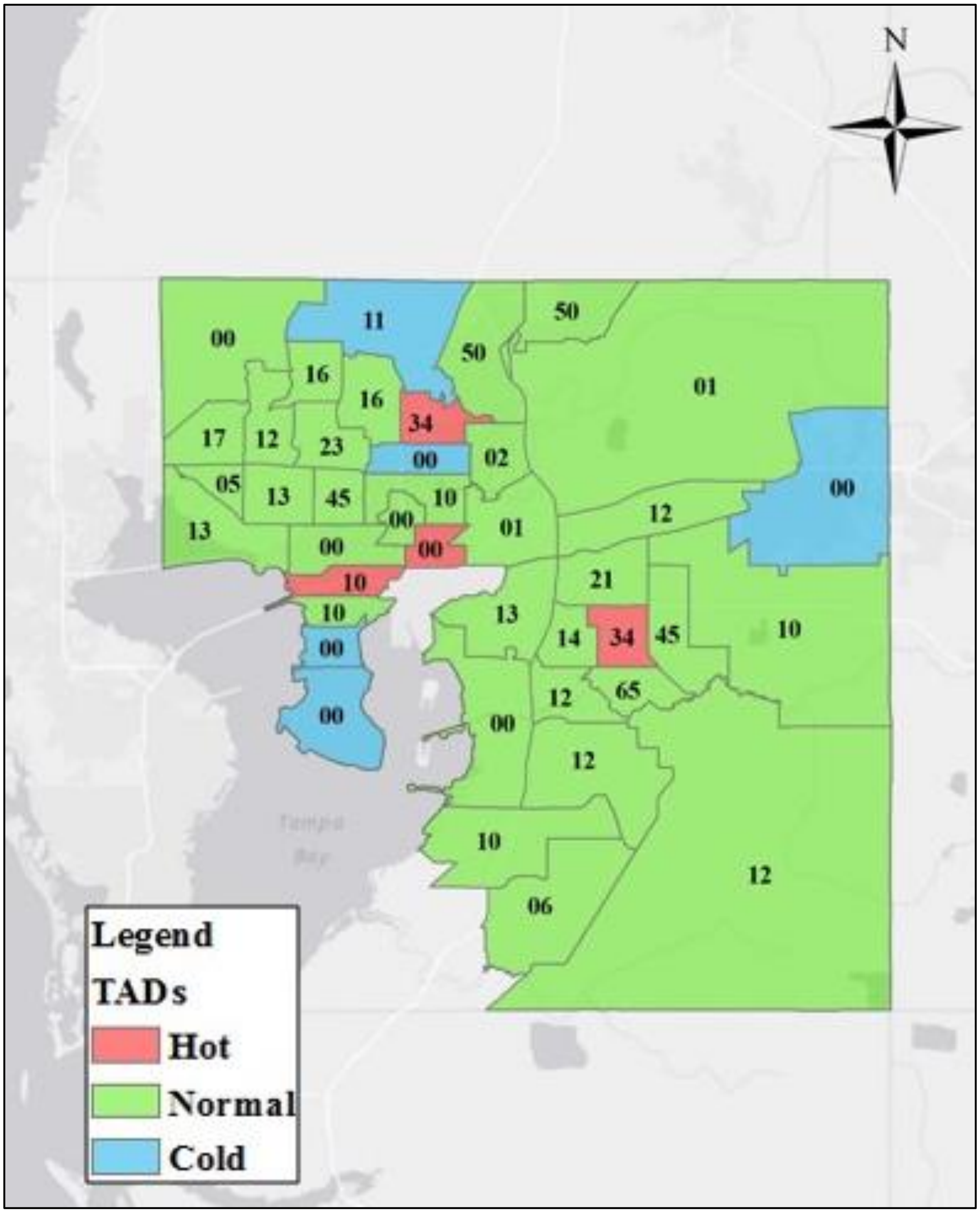


Figure 10-4 Macro-level based integration results based on TADs for total crashes in Hillsborough County

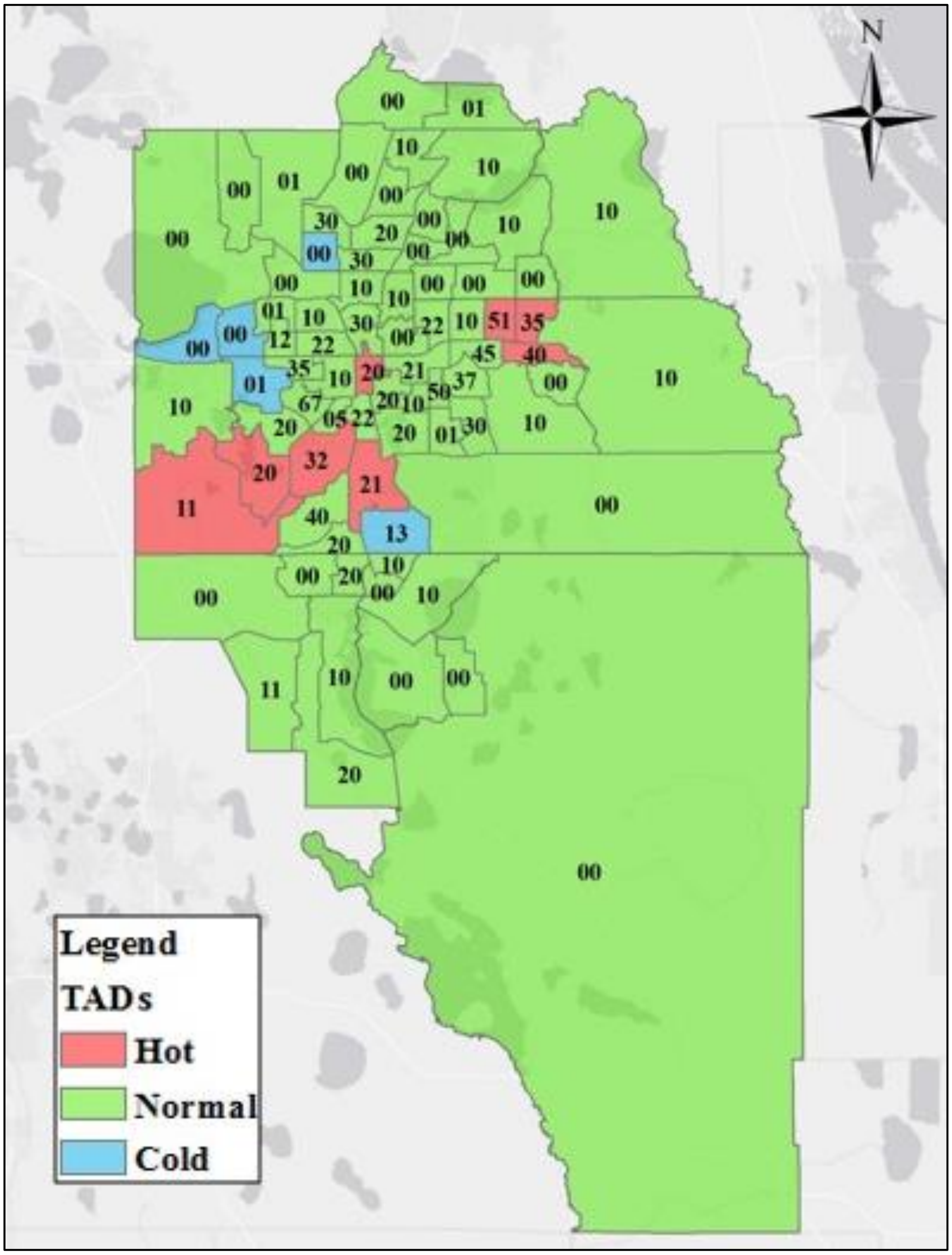


Figure 10-5 Macro-level based integration results based on TADs for total crashes in Orange-Seminole-Osceola Counties

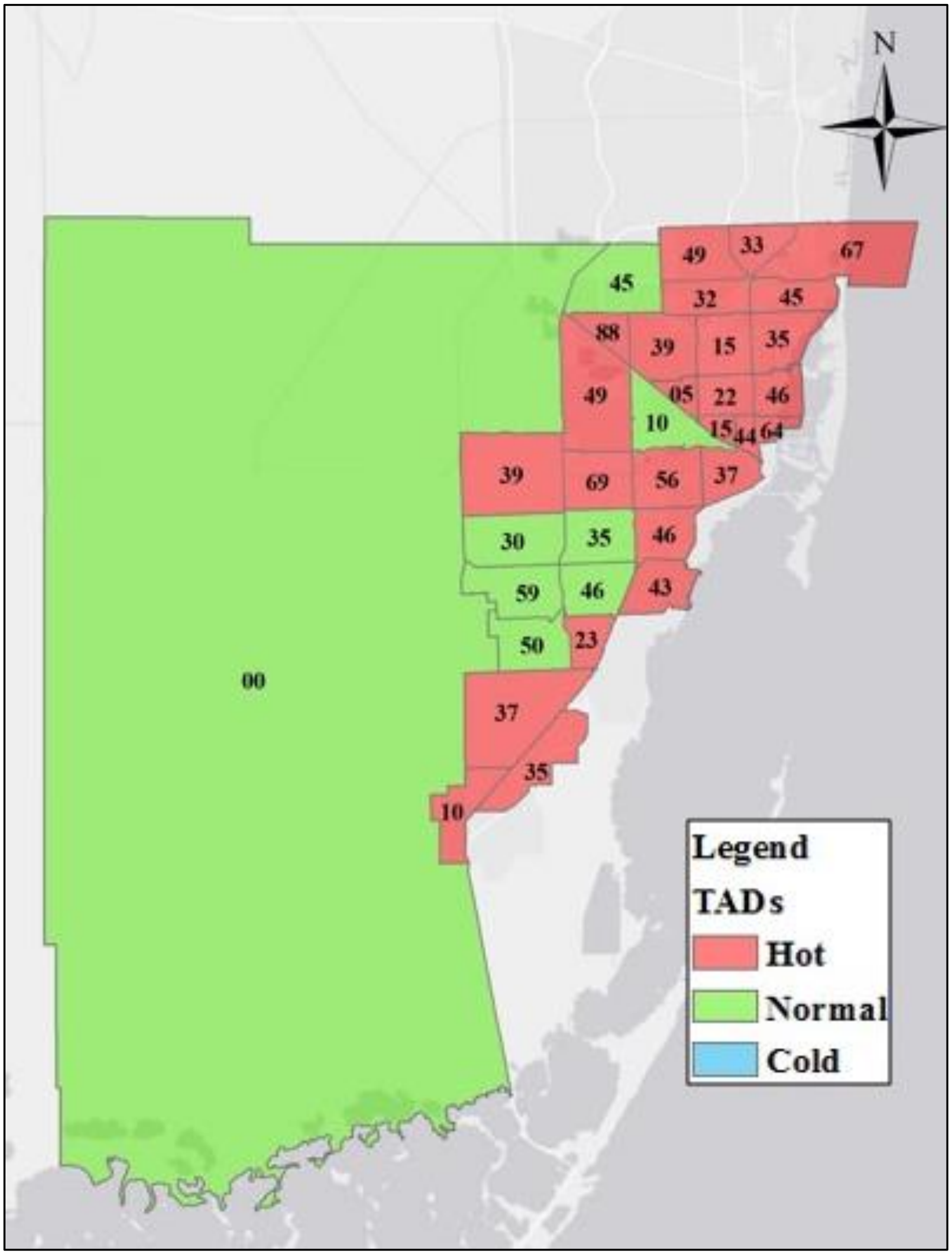


Figure 10-6 Macro-level based integration results based on TADs for total crashes in Miami-Dade County

10.1.2 Severe crashes (KA)

Figure 10-7 exhibits the spatial distribution of hot TADs for severe crashes in Florida. It was shown that severe crashes have the quite different distribution pattern from total crashes. Compared to the total crashes, the hot zones for severe crashes are spread out to more rural areas. In order to make a comparison with total crashes, the selected five regions were zoomed in to show the integrated screening results for severe crashes.

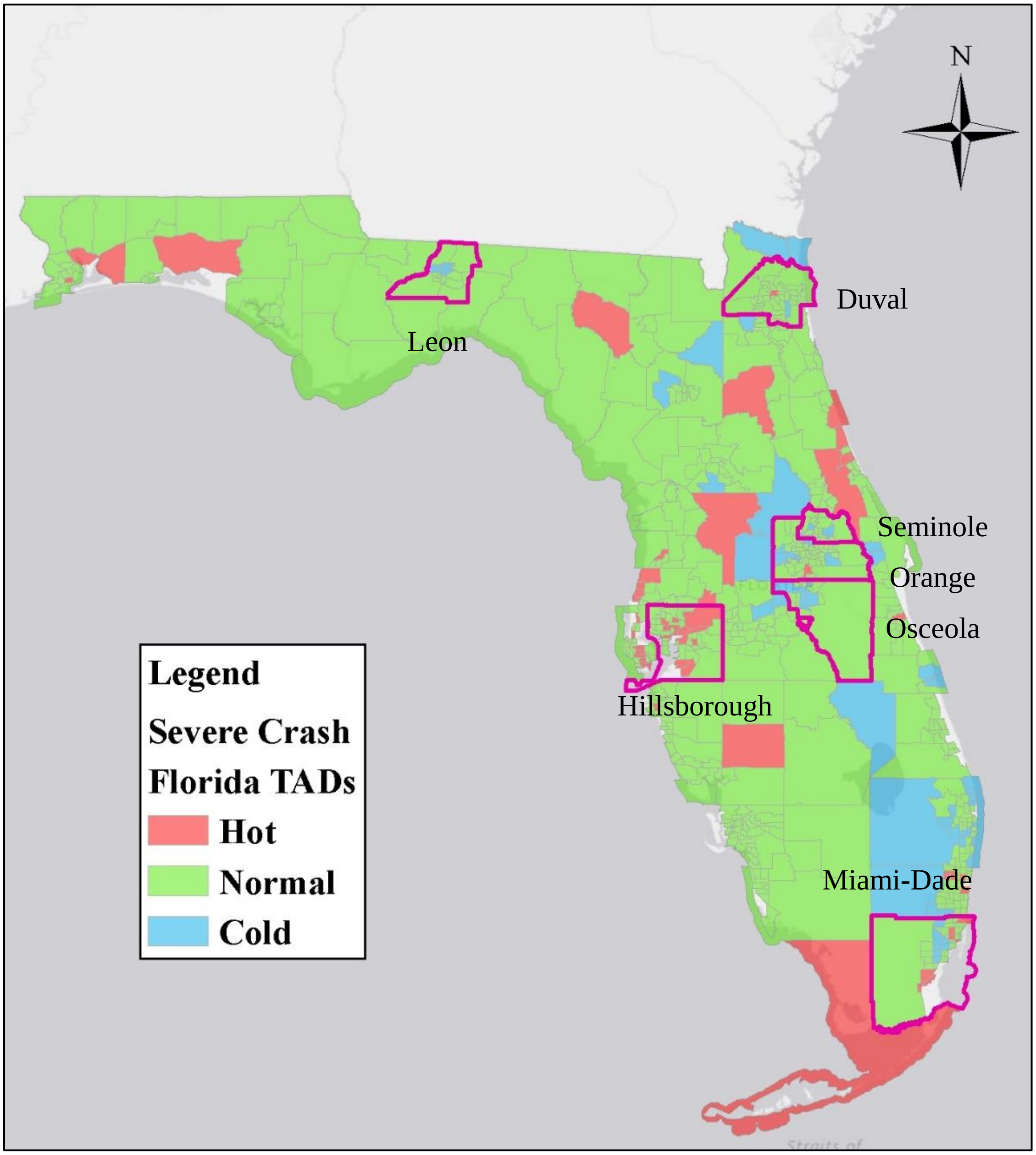


Figure 10-7 Screening results for severe crashes in Florida (TADs)

Figures 10-8 to 10-12 exhibit the integration screening results for severe crash based on TADs in the five selected areas. In Leon County, no hot zones were observed and all TADs have low proportion of hot segments and intersection. In Duval County, only one hot zone was identified and was labeled as “H00”. Thus, this zone has only macro-level safety problem although no safety risks were observed at micro-level. On the other hand, there is a large cluster of severe crash hot zones in Hillsborough County. Some of the zones have only macro-level safety problems while some zones are risky at both levels. Moreover, the numbers of hot zones for severe crashes in Orange-Seminole-Osceola and Miami-Dade counties have reduced whereas more number of cold zones with a low proportion of hot segments and intersections are observed in the two areas.

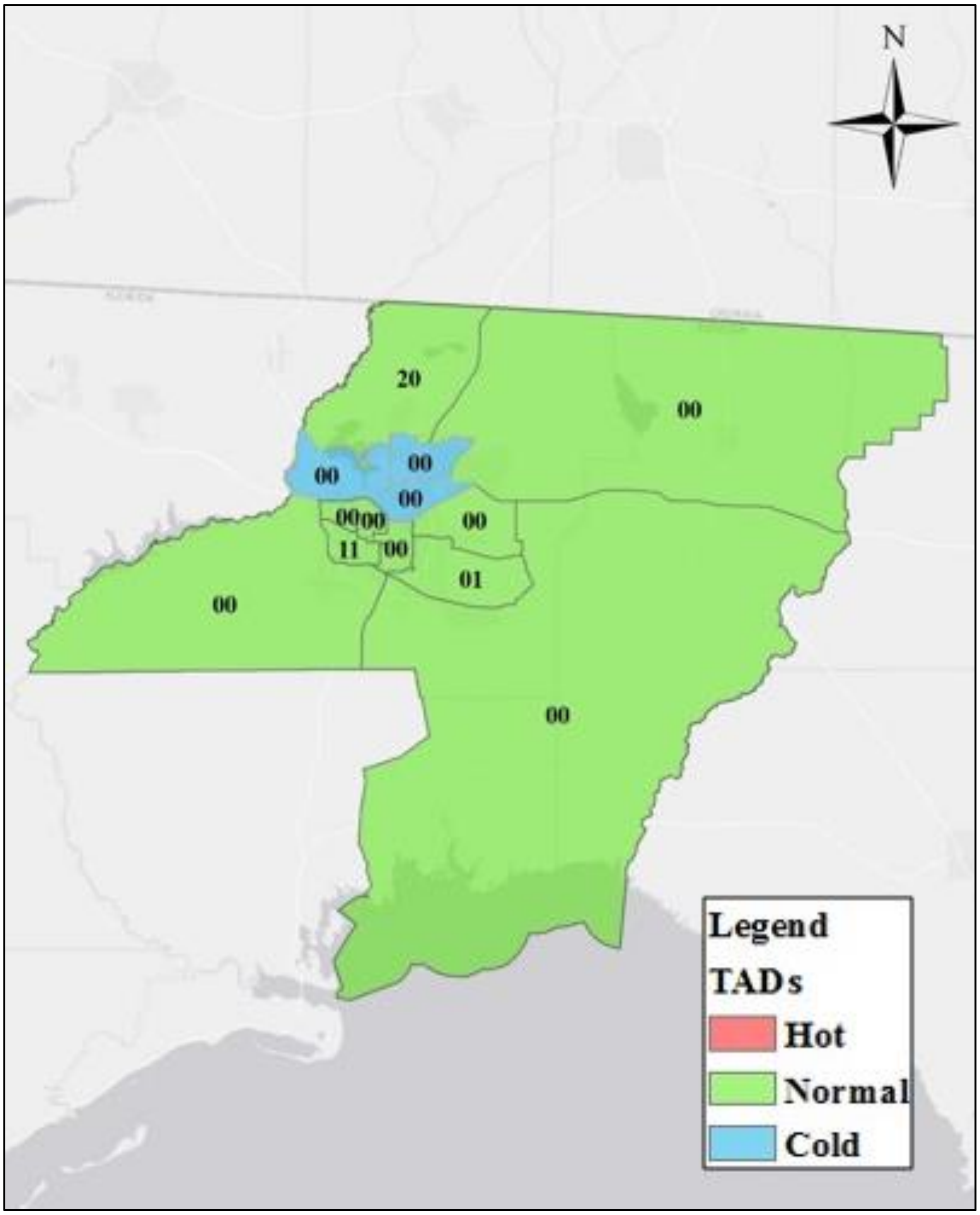


Figure 10-8 Macro-level based integration results based on TADs for severe crashes in Leon County

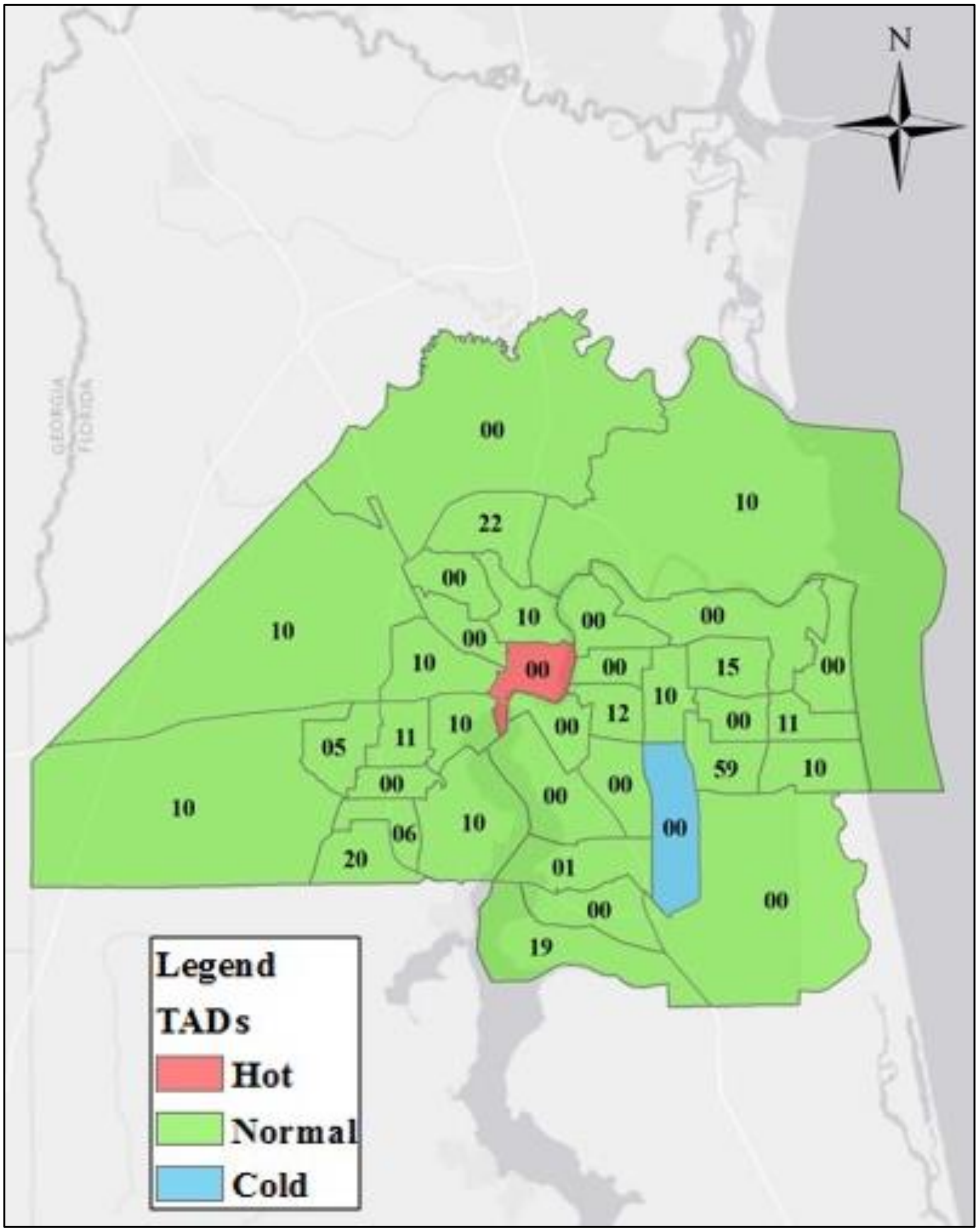


Figure 10-9 Macro-level based Integration Results based on TADs for severe crashes in Duval County

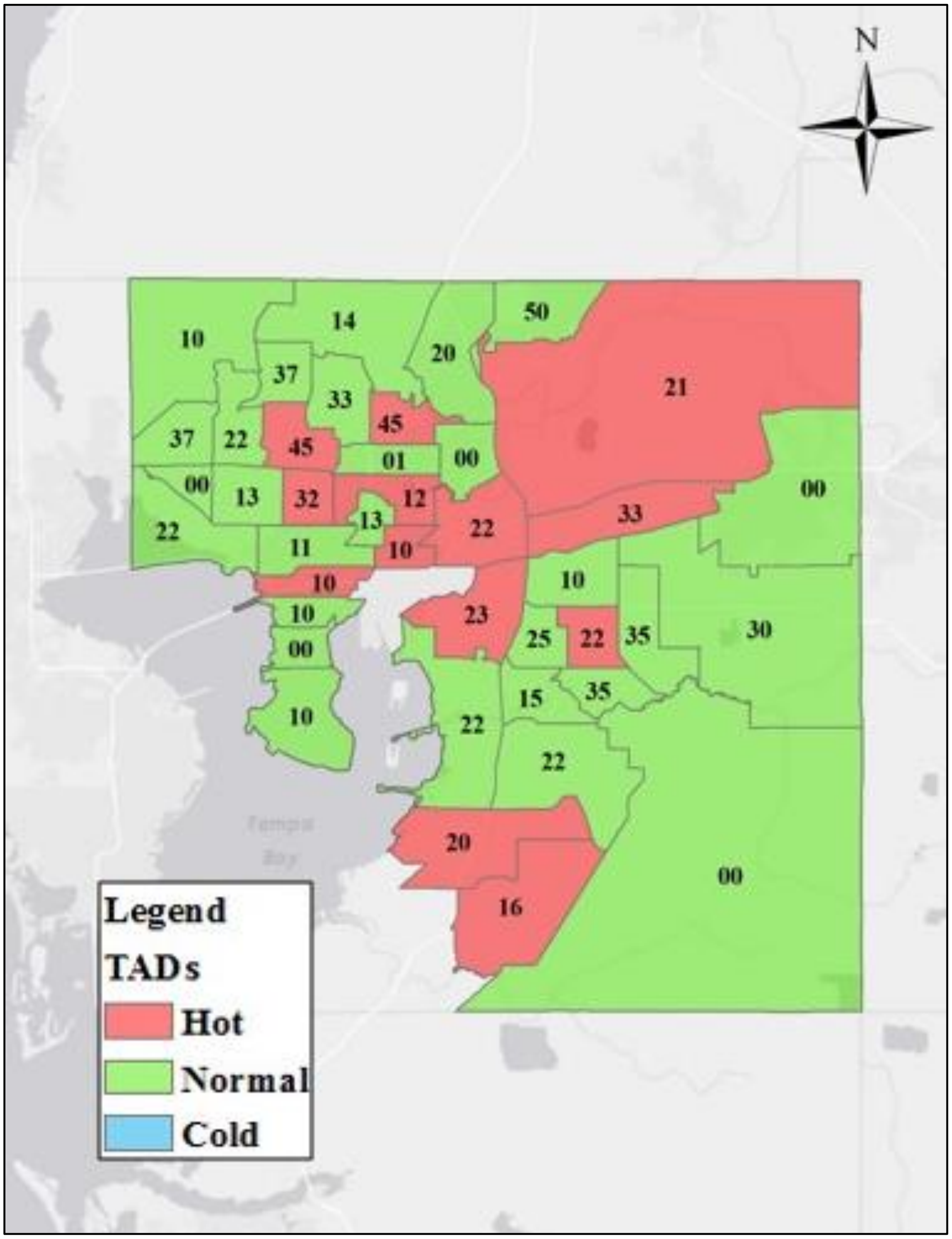


Figure 10-10 Macro-level based integration results based on TADs for severe crashes in Hillsborough County

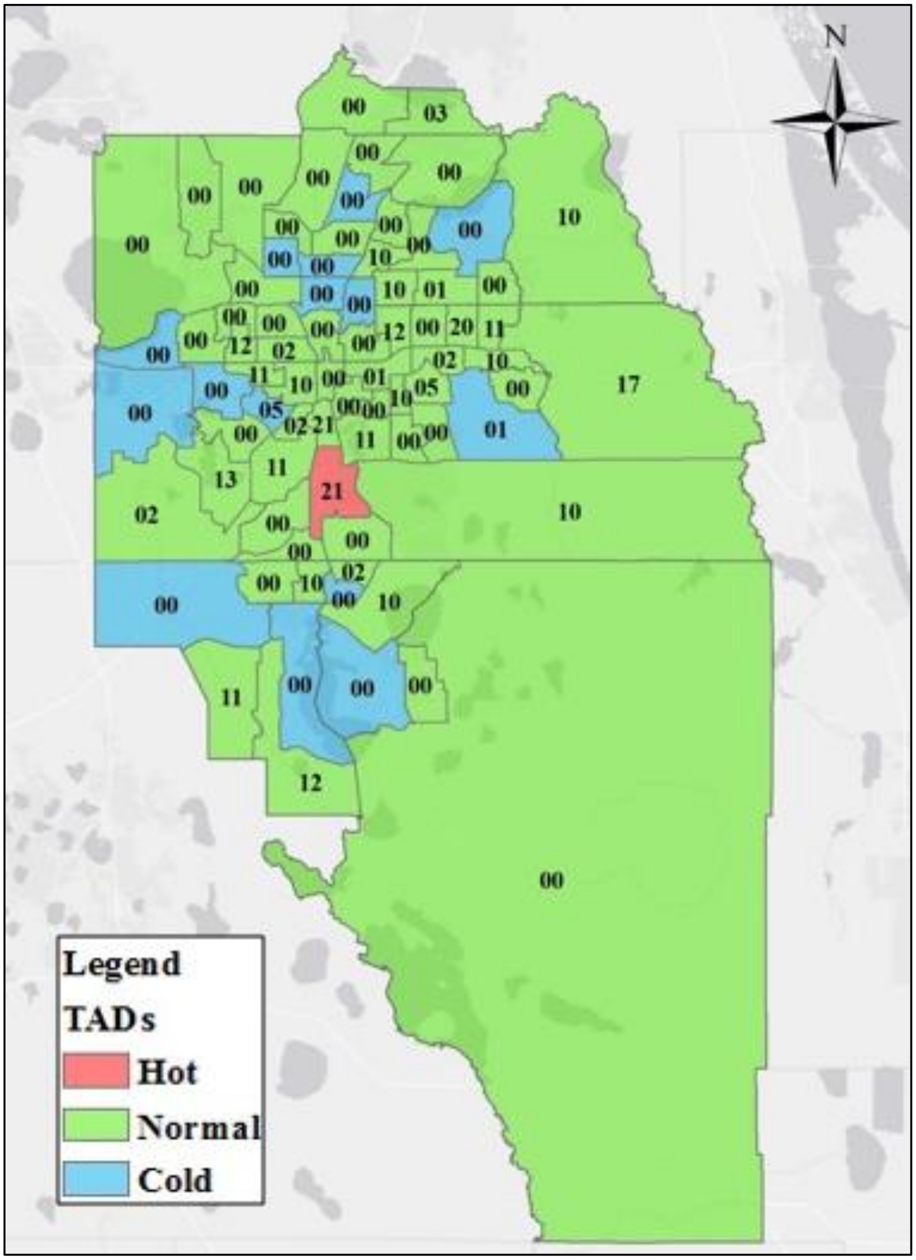


Figure 10-11 Macro-level based Integration Results based on TADs for severe crashes in Orange-Seminole-Osceola Counties

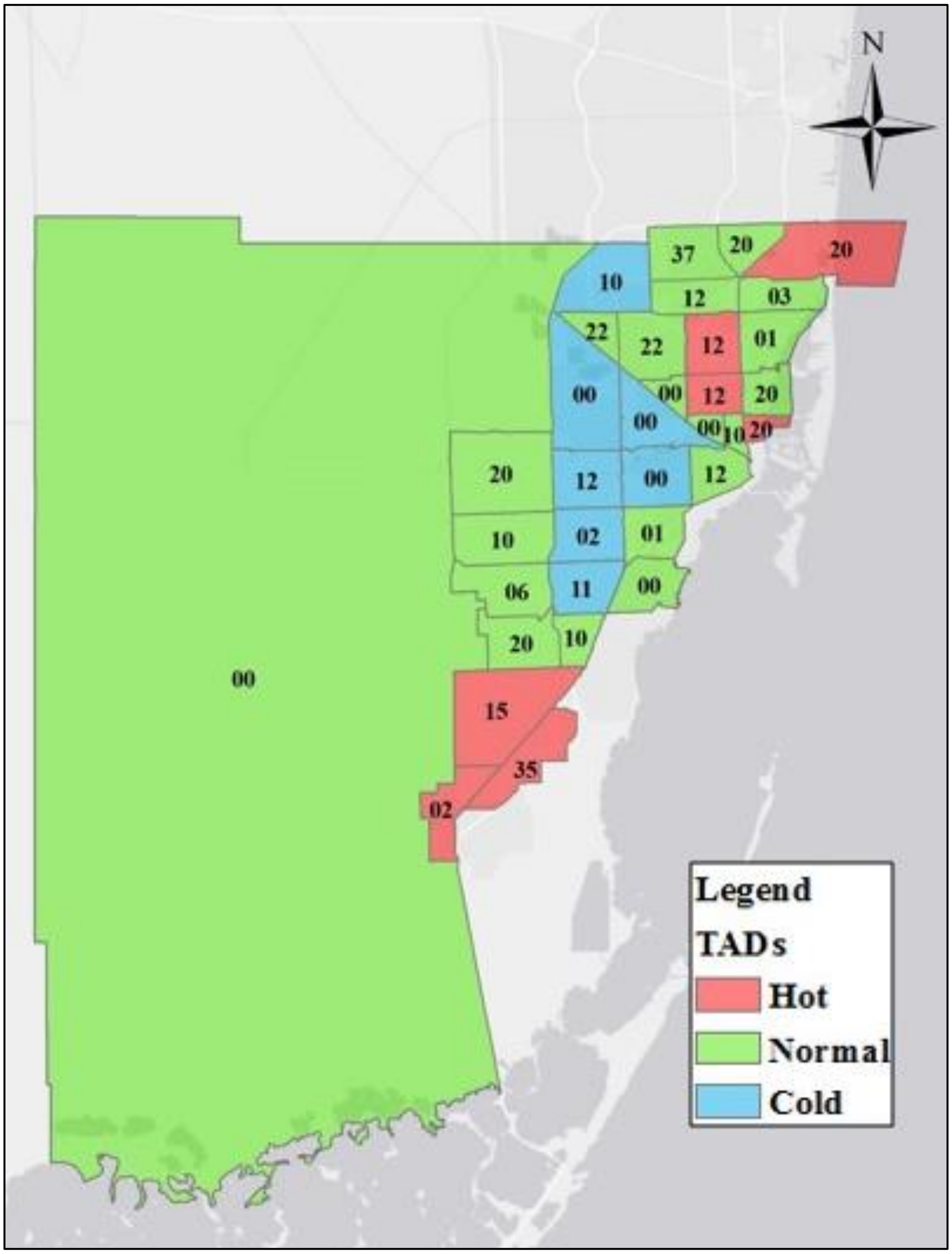


Figure 10-12 Macro-level based integration results based on TADs for severe crashes in miami-dade county

10.1.3 Pedestrian crashes (PED)

Figure 10-13 presents the spatial distribution of SWTAZs by hot zone classification for pedestrian crashes in Florida. Similar to total crashes, most of hot zones were concentrated in metropolitan areas. SWTAZs in Leon County, Duval County, Hillsborough County, Orange-Seminole-Osceola Counties, and Miami-Dade County were selected to provide an example of the integration screening results for pedestrian crashes.

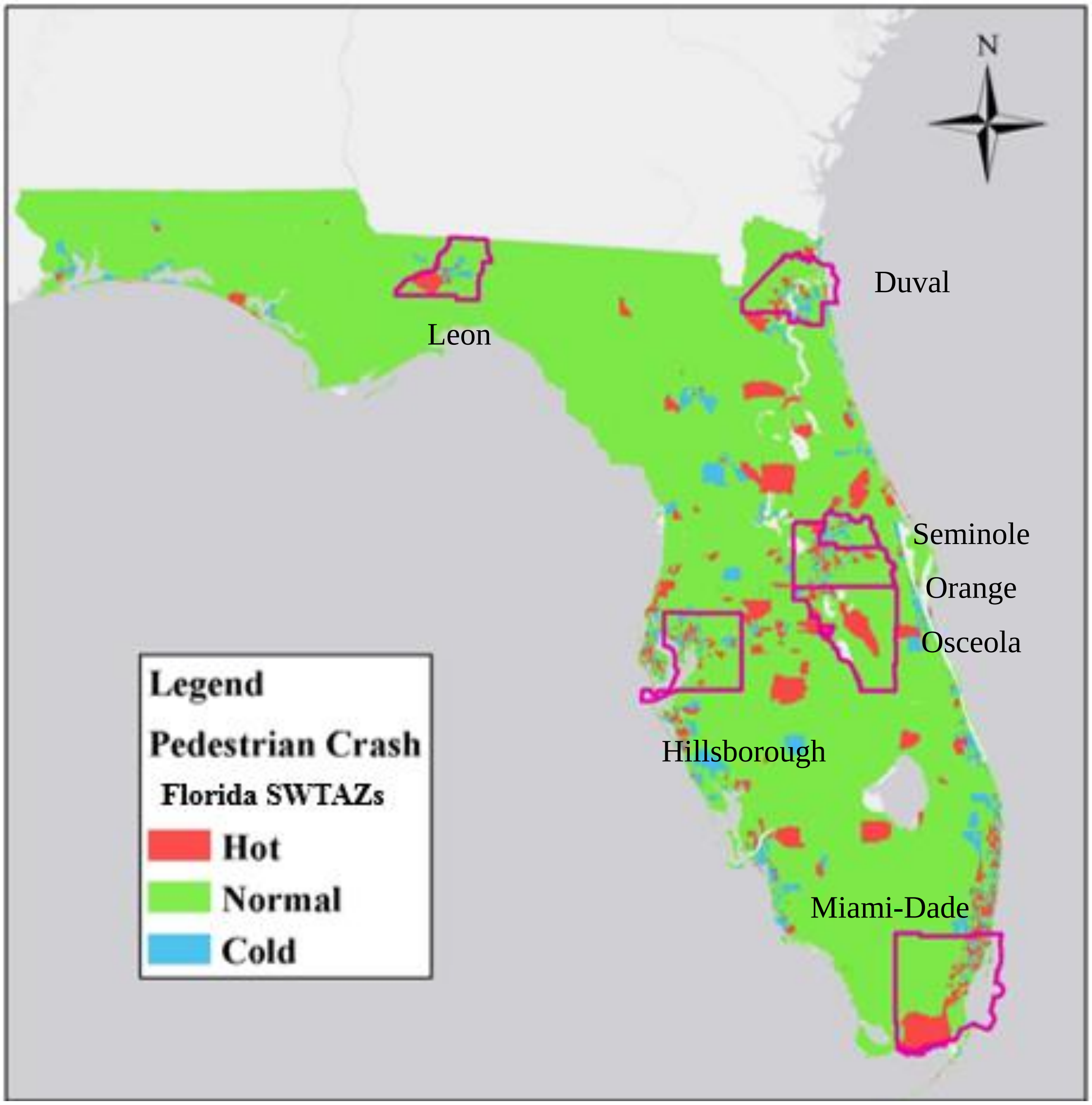


Figure 10-13 Screening results for pedestrian crashes in Florida (SWTAZs)

Figures 10-14 to 10-18 show the integration screening results for pedestrian crash based on SWTAZs in the five selected areas. It should be noted that not all the zones can be labeled due to the scale of the report. For the detailed integration results of each zone, the readers are referred to the attached spreadsheets. It was indicated that most of the hot zones located in the center of the chosen urbanized areas. It was as expected because pedestrian activities usually take place in the urban areas. Most zones with moderate safety problem for pedestrians were observed in suburban areas. A majority of the zones have zero proportion of hot intersections and segments, especially in rural areas due to the very low pedestrian activities in the areas.

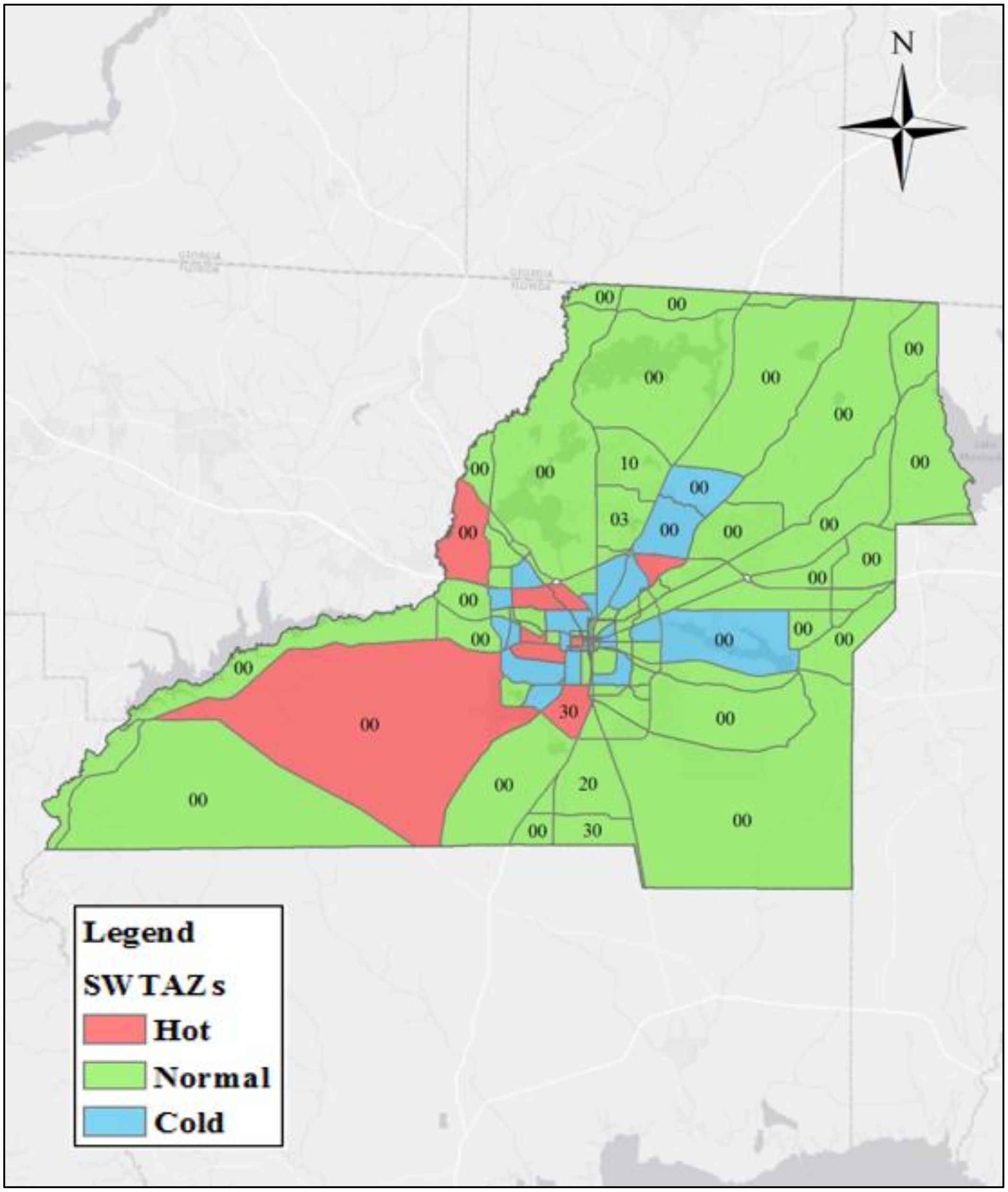


Figure 10-14 Macro-level based integration results based on SWTAZs for pedestrian crashes in Leon County

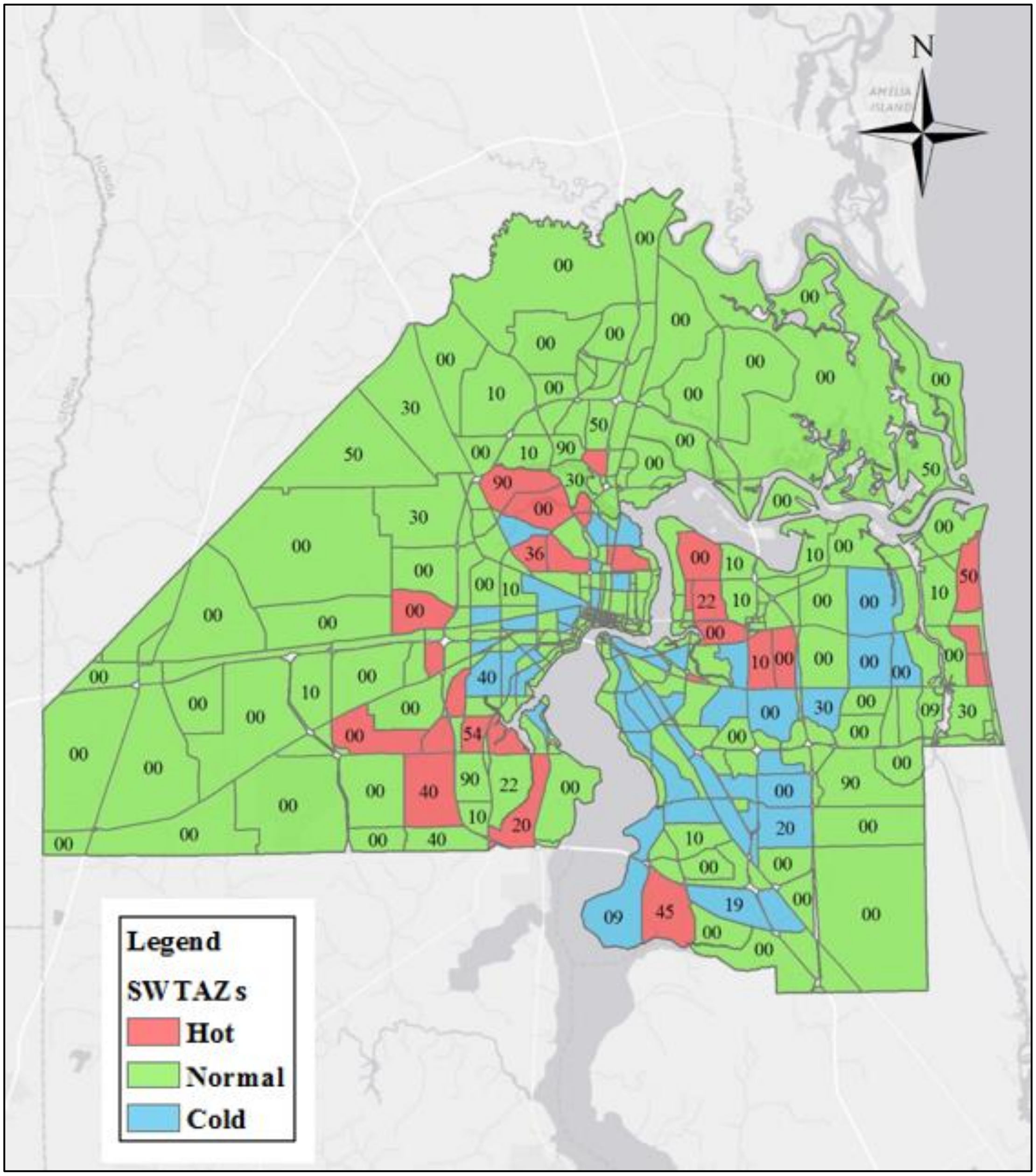


Figure 10-15 Macro-level based integration results based on SWTAZs for pedestrian crashes in Duval County

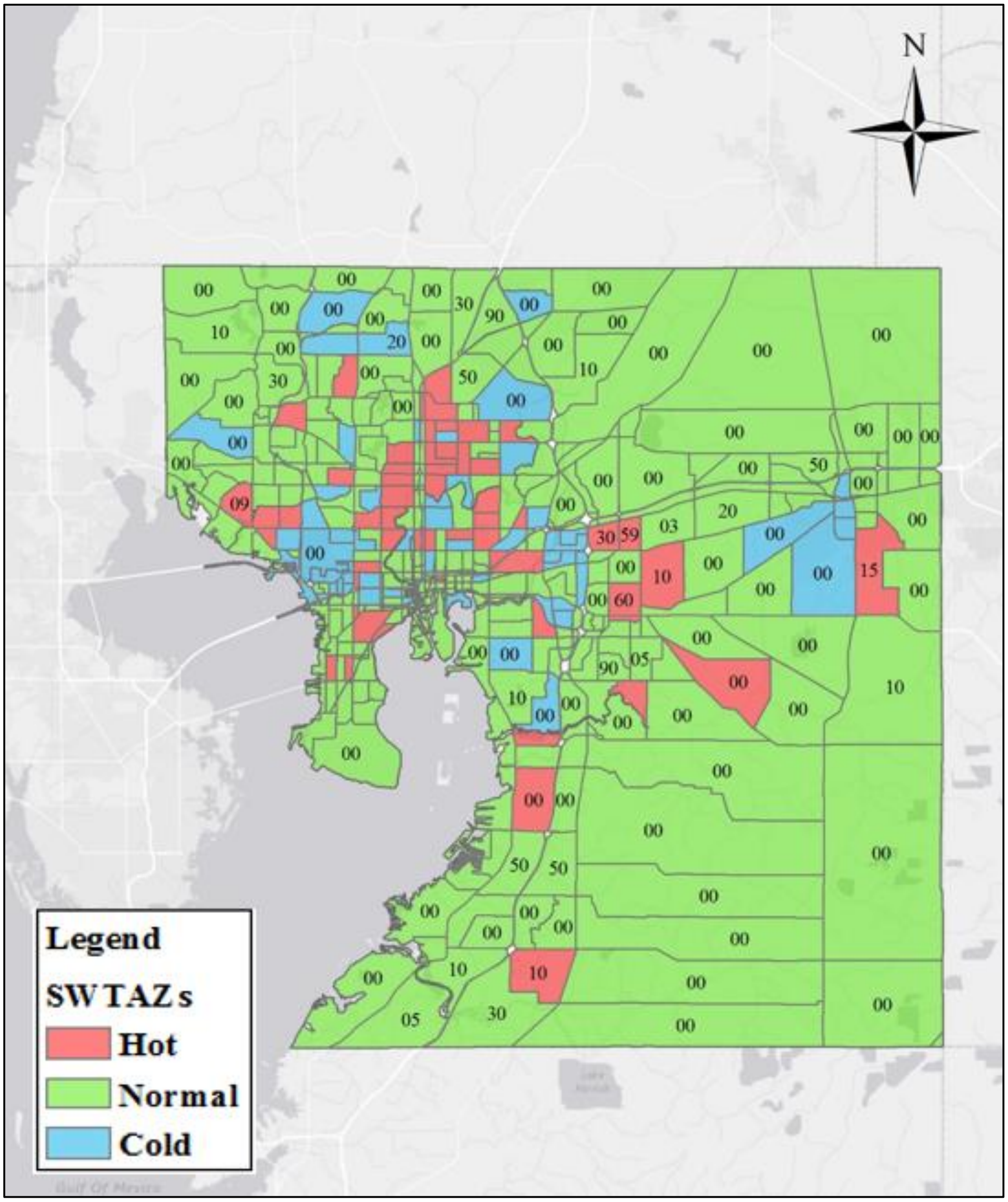


Figure 10-16 Macro-level based integration results based on SWTAZs for pedestrian crashes in Hillsborough County

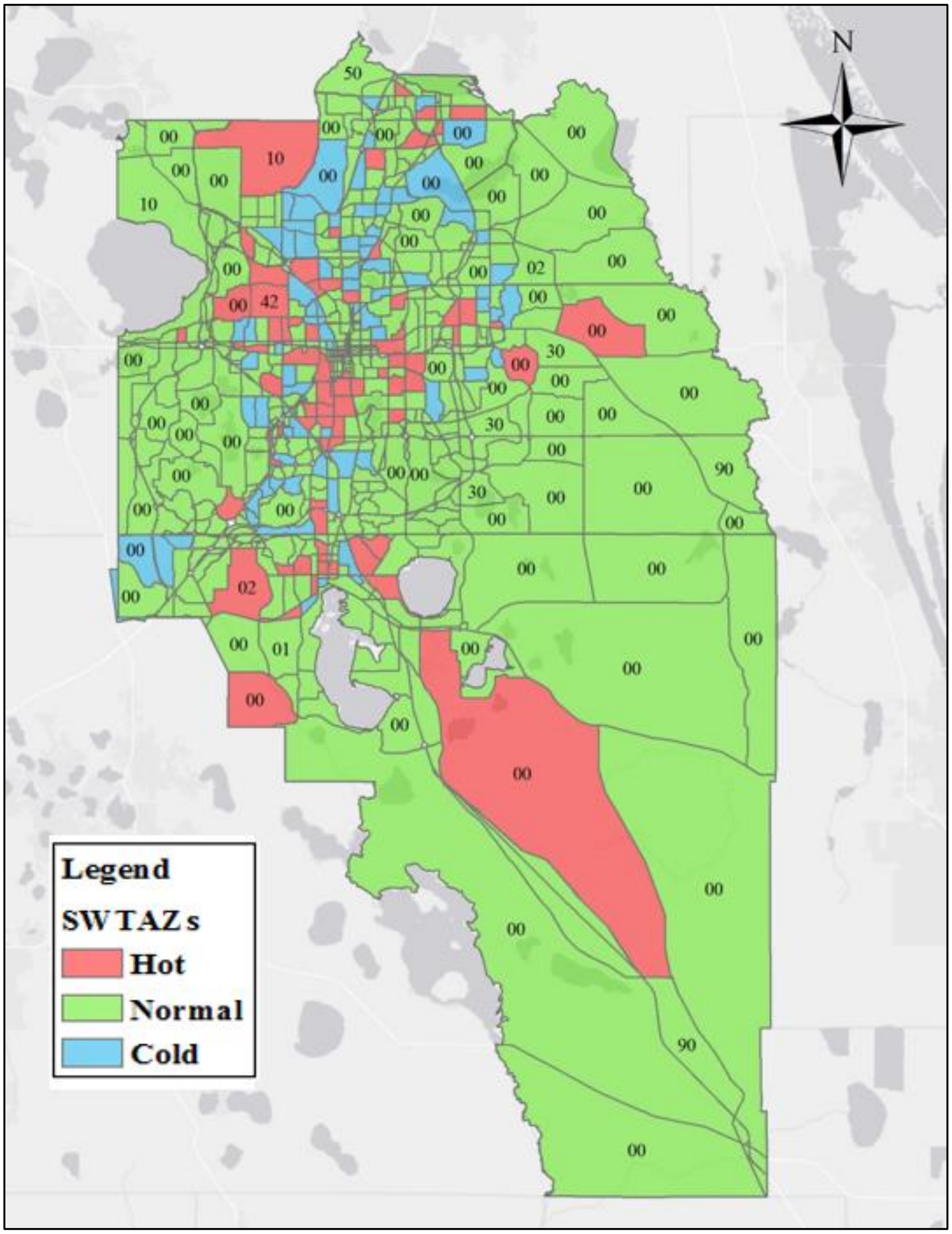


Figure 10-17 Macro-level based integration results based on SWTAZs for pedestrian crashes in Orange-Seminole-Osceola Counties

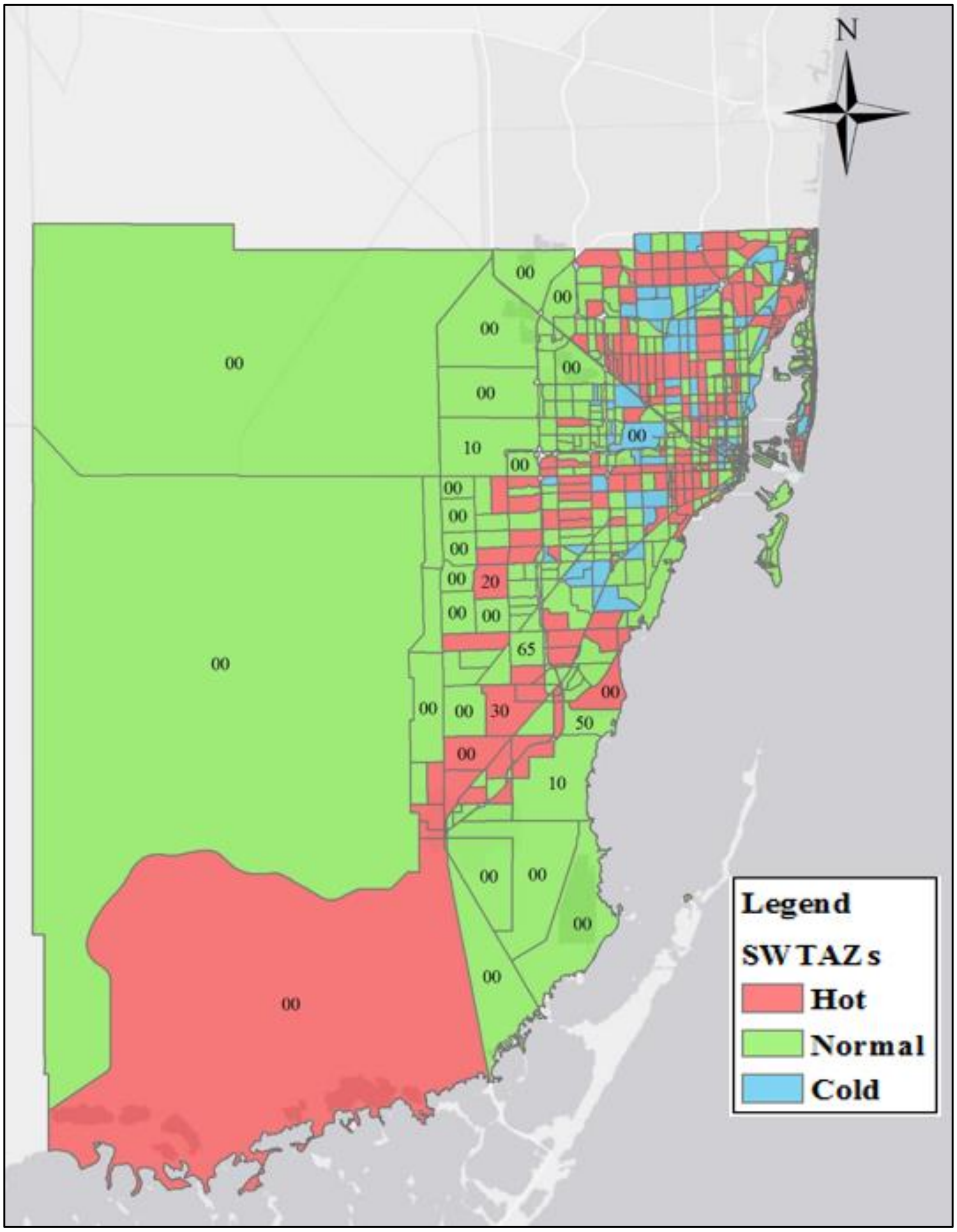


Figure 10-18 Macro-level based integration results based on SWTAZs for pedestrian crashes in Miami-Dade County

10.2 Micro-level Based Integration Screening Results

In order to show examples of micro-level based integration screening results, one of the hot and cold zones (SWTAZ for pedestrian crashes and TAD for all other crash types) were chosen and zoomed in to display the location and screening results of segments and intersections.

10.2.1 Total crashes (KABCO)

Figures 10-19 to 10-23 exhibit the micro-level based integration results based on the chosen TAD (i.e., the zone with the highest PSI) for total crashes in the five areas. For the hot segment or intersection in these areas, safety should be improved by not only specific engineering solutions but also macro-level countermeasure such as education and enforcement.

In the selected hot TAD of Leon County, serval hot segments and intersection were found in the northwest part and also along the Apalachee Parkway (Figure 10-19). It is indicated that the TAD had micro-level safety problem not only for segment but also intersection. Figure 10-20 shows that the selected hot TAD in Duval County had segments with high risks on Interstate 95, State Road 115, and State Road 10 while only one dangerous intersection was found in this TAD.

In Hillsborough County (Figure 10-21), the hot TADs had several hot segments and intersection were observed on Interstate Road 275 and State Road 580. It was shown that multiple hot intersections and segments are on State Road 441 in the hot TAD in Orange-

Seminole-Osceola Counties (Figure 10-22). In Miami-Dade County, the selected hot TAD has several hot intersections and segments on State Road 441 and State Road 9.

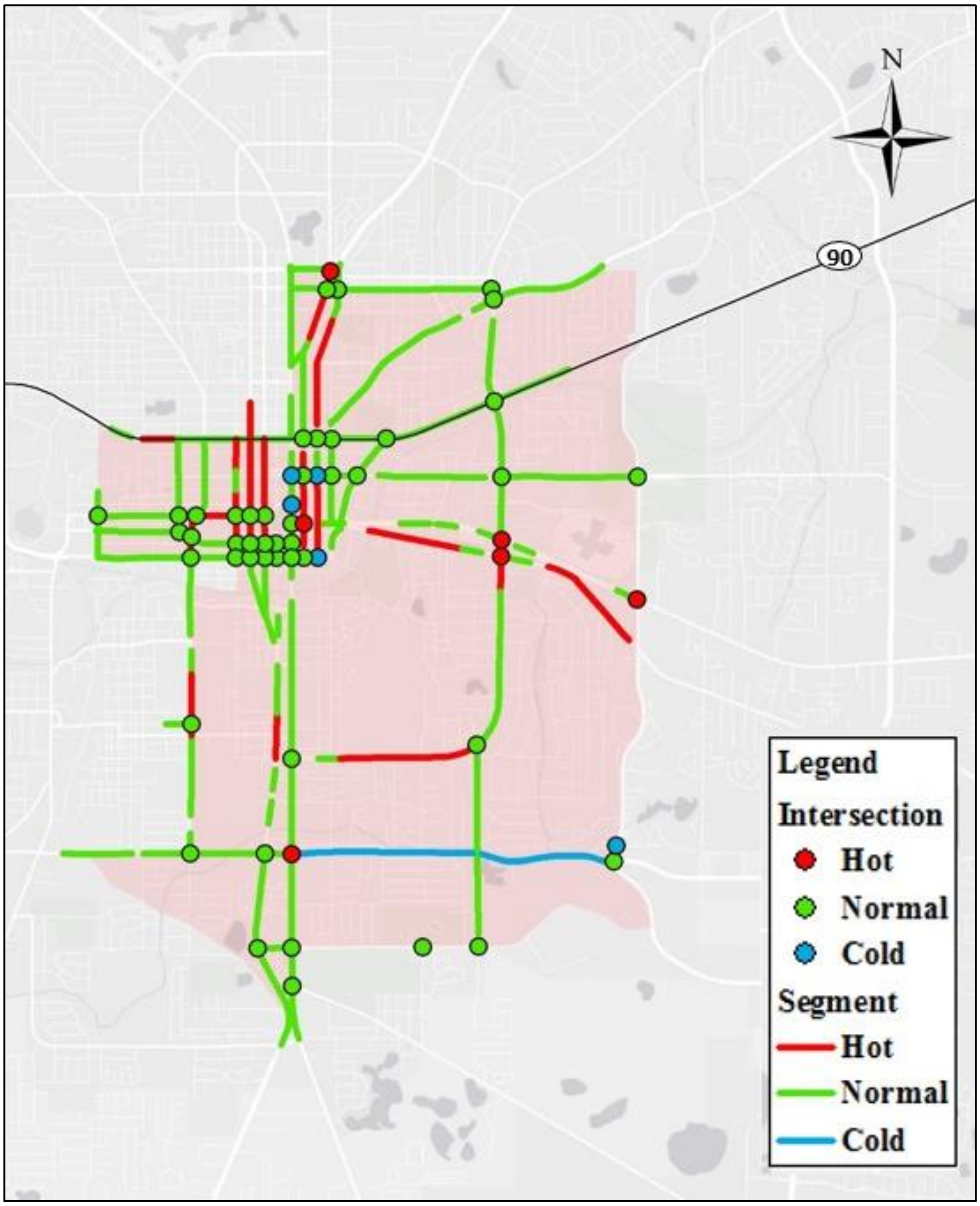


Figure 10-19 Micro-level based integration results based on the selected hot TAD for total crashes in Leon County

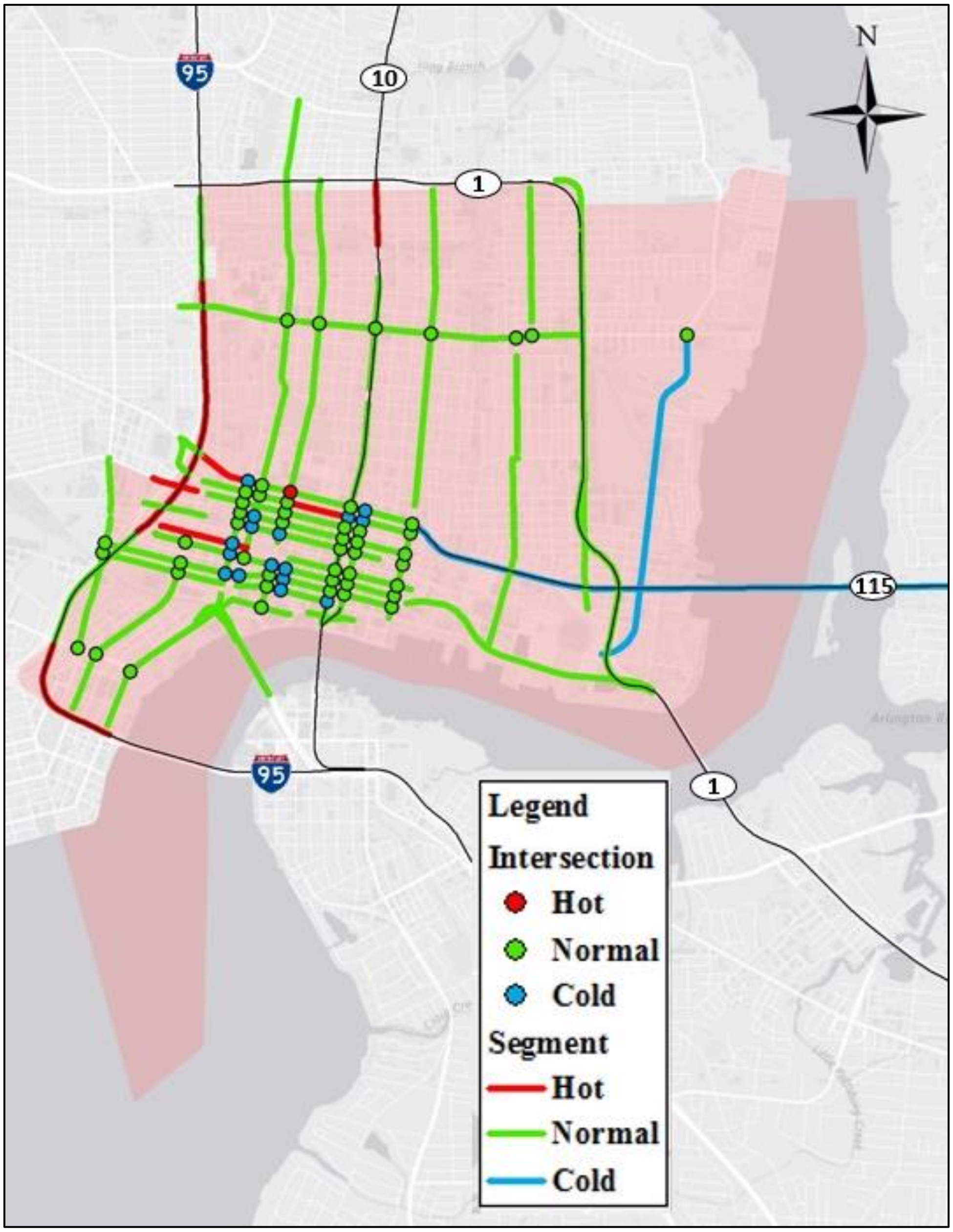


Figure 10-20 Micro-level based integration results based on the selected hot TAD for total crashes in Duval County

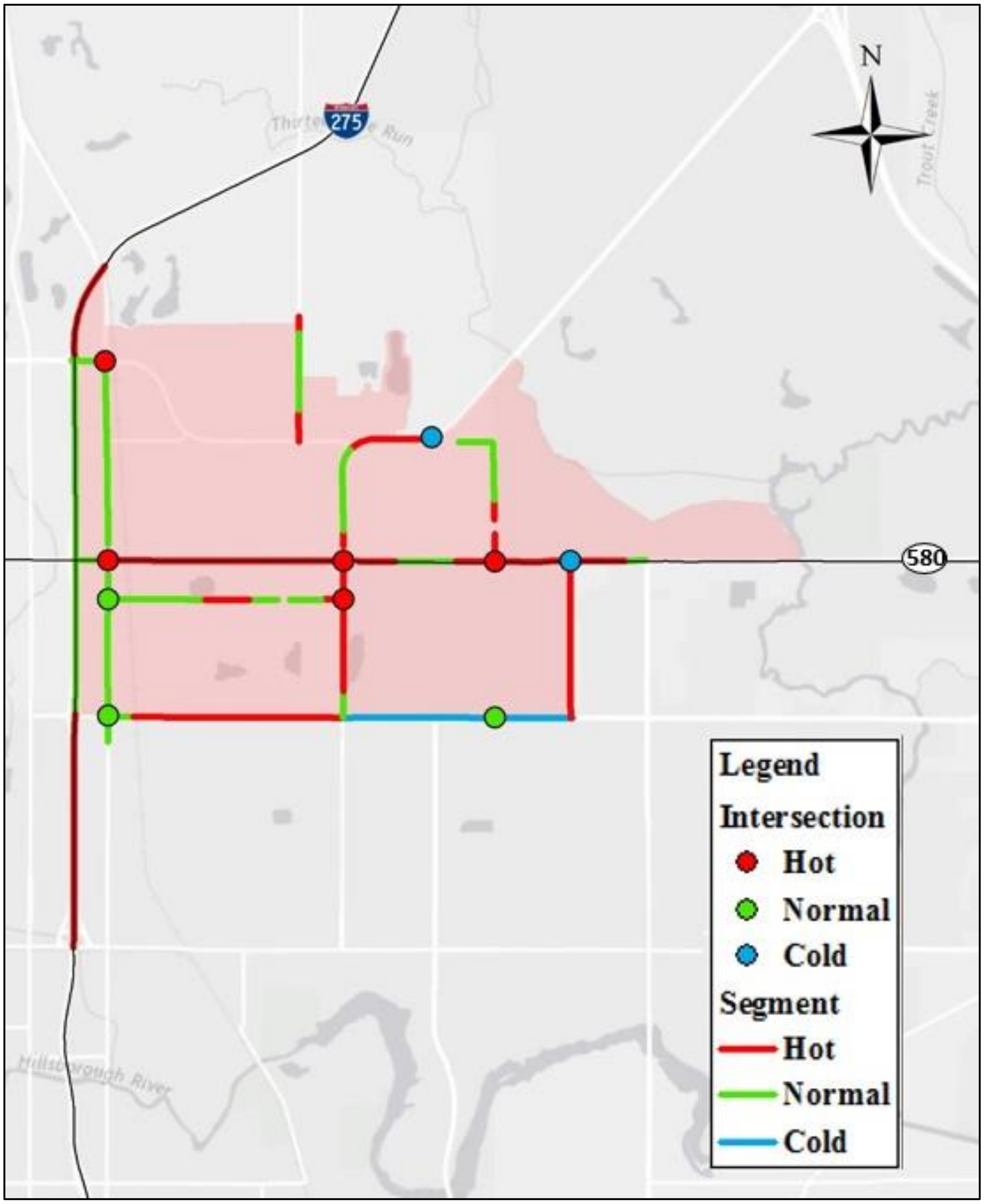


Figure 10-21 Micro-level based integration results based on the selected hot TAD for total crashes in Hillsborough County

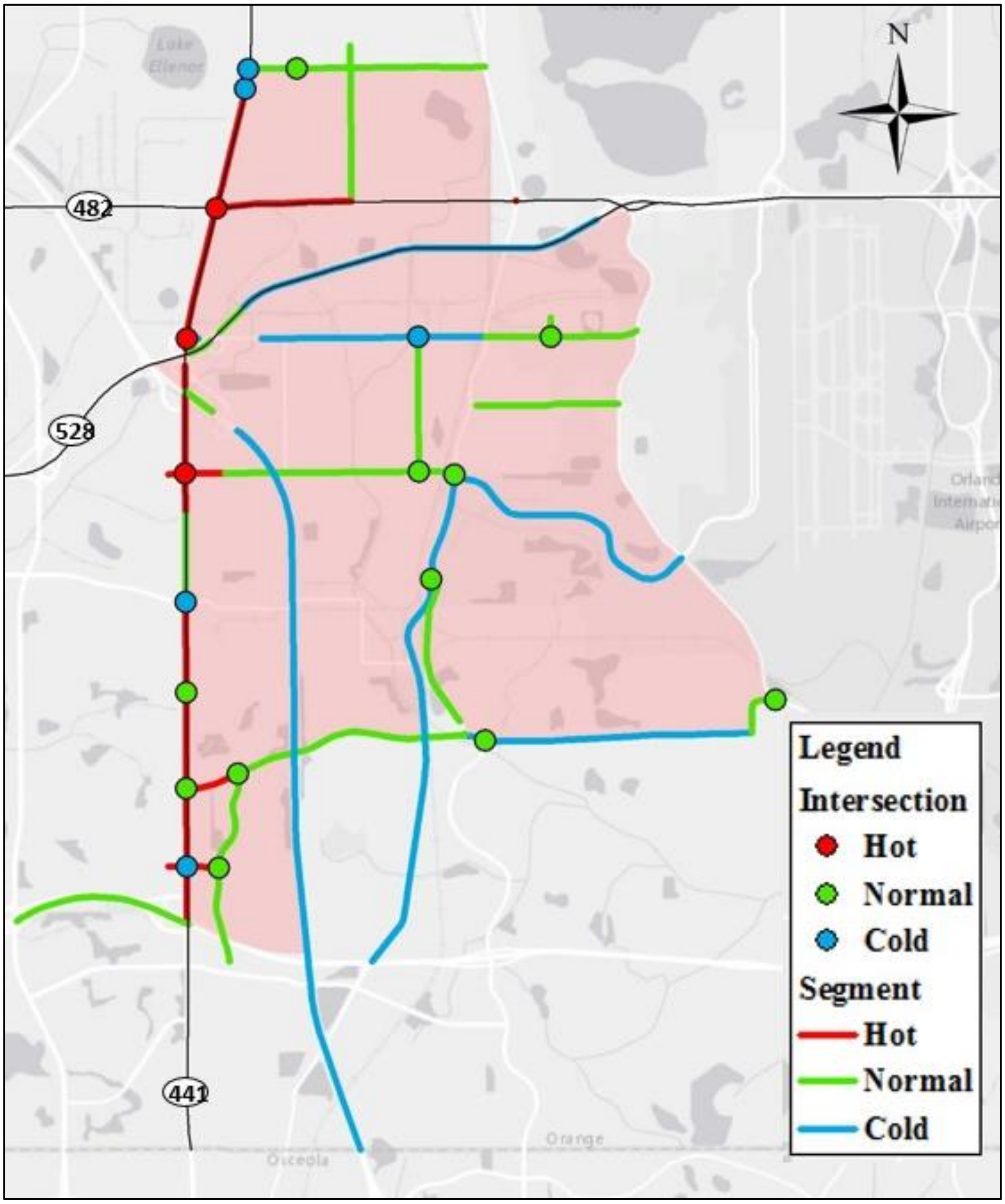


Figure 10-22 Micro-level based integration results based on the selected hot TAD for total crashes in Orange-Seminole-Osceola Counties

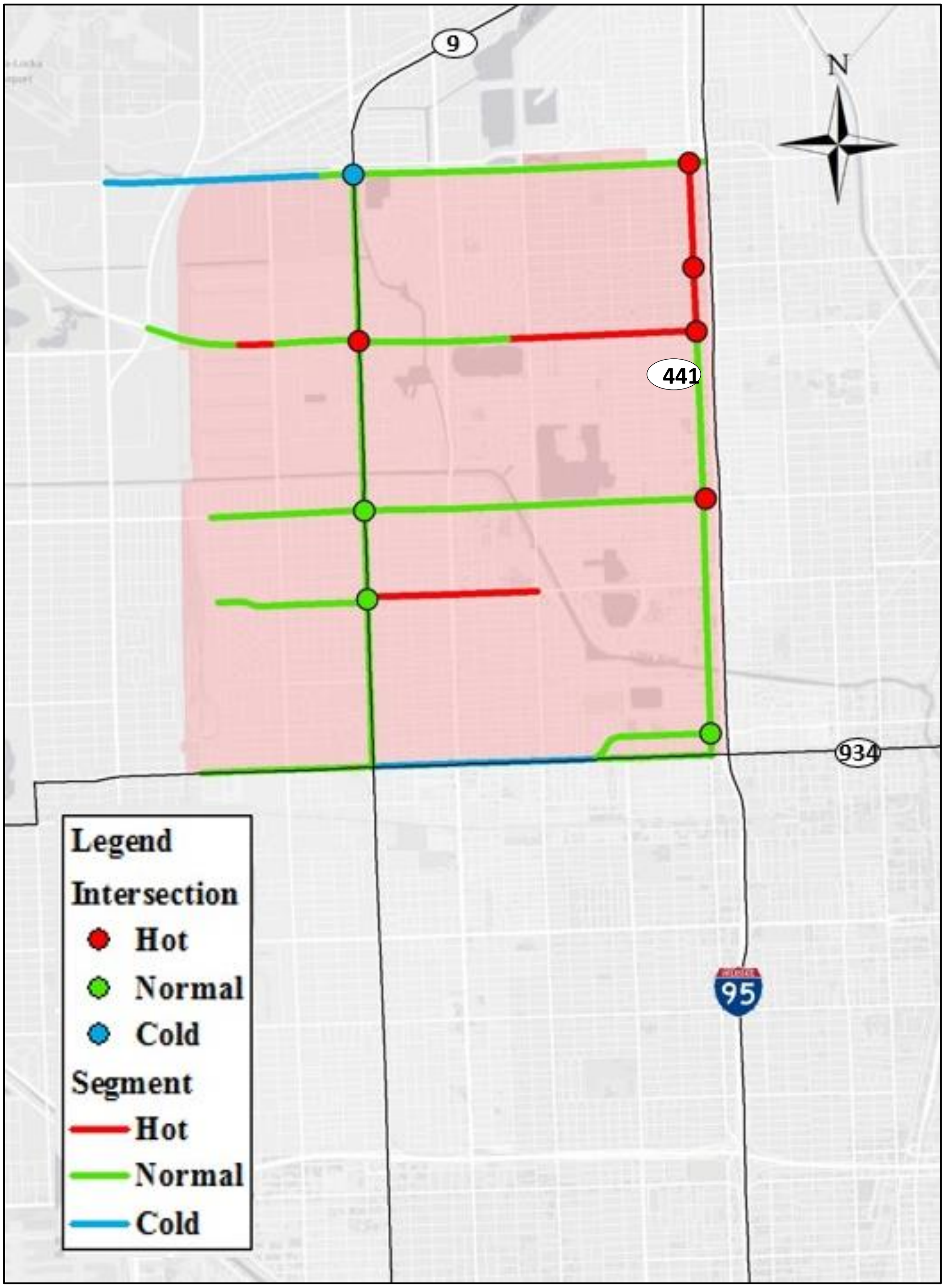


Figure 10-23 Micro-level based integration results based on the selected hot TAD for total crashes in Miami-Dade County

Figures 10-24 to 10-26 exhibit the micro-level based integration results based on the selected cold TAD for total crashes in Duval County, Hillsborough County, and Orange-Seminole-Osceola Counties. For Leon and Miami-Dade Counties, there is no “Cold” TAD for total crashes. In these TADs, several dangerous segments or intersections are observed. For these hot segments and intersection in cold TADs, only engineering solutions are needed to reduce crashes since all of them located in zones without traffic safety problems at macroscopic level.

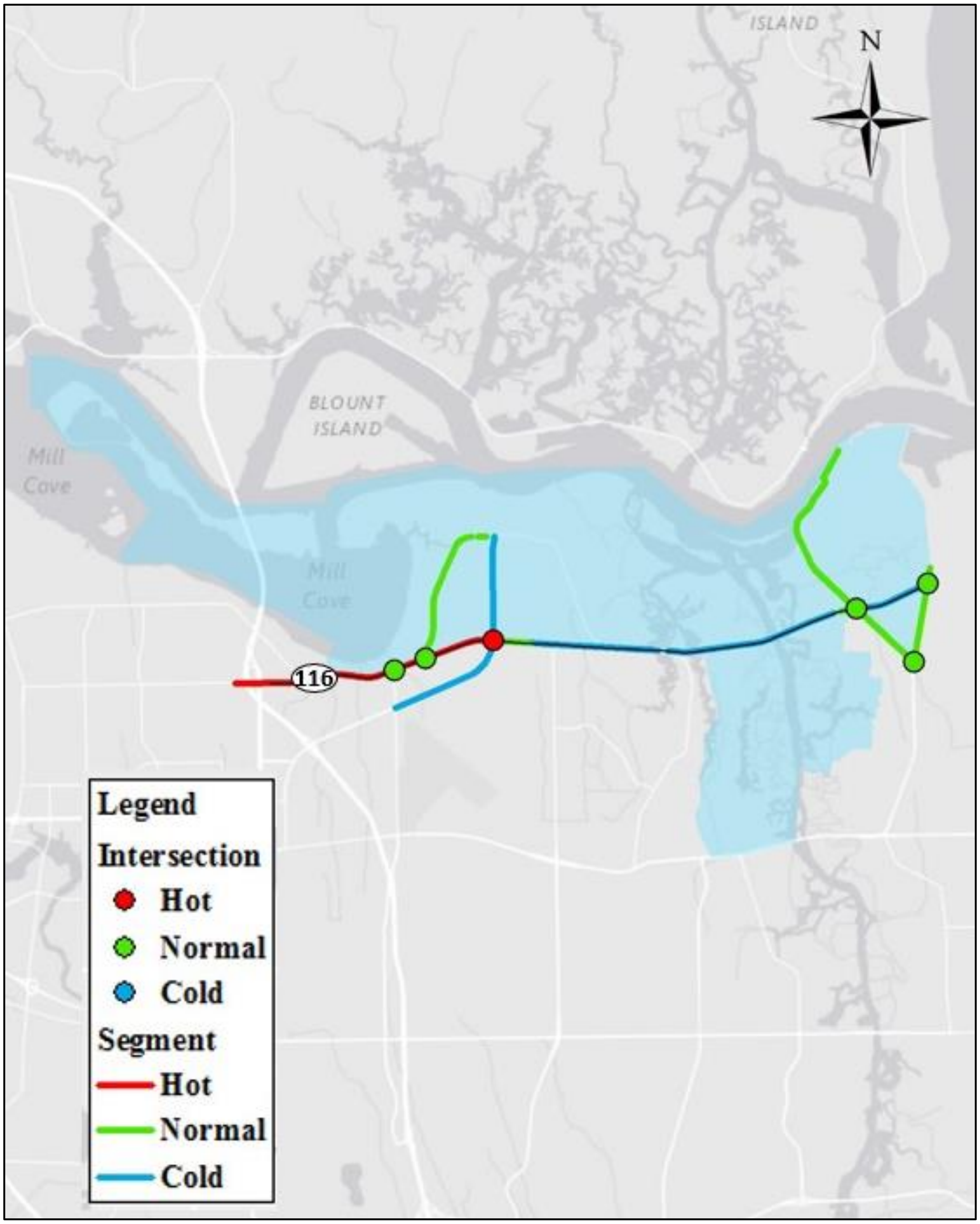


Figure 10-24 Micro-level based integration results based on the selected cold TAD for total crashes in Duval County

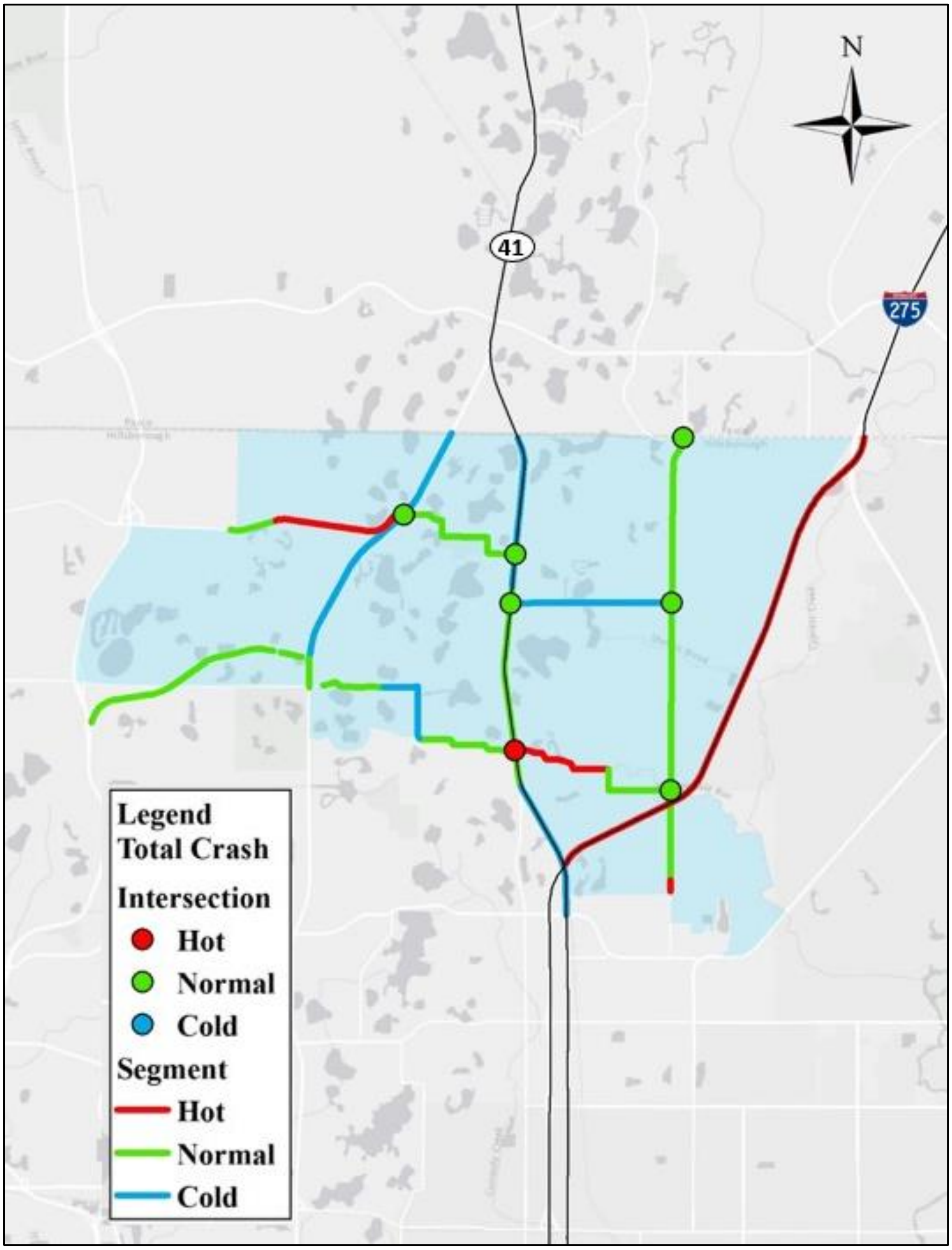


Figure 10-25 Micro-level based integration results based on the selected cold TAD for total crashes in Hillsborough County

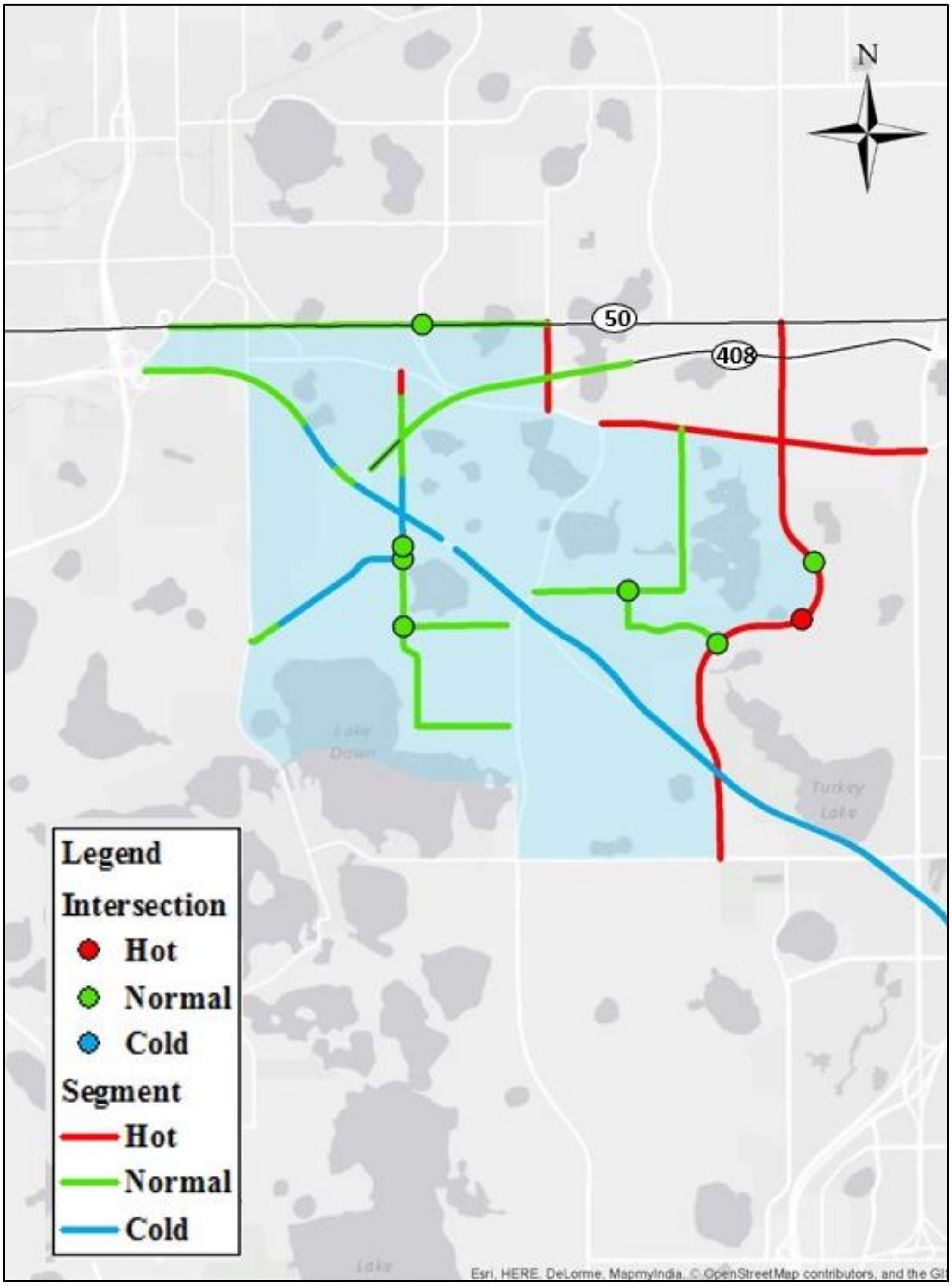


Figure 10-26 Micro-level based integration results based on the selected cold TAD for total crashes in Orange-Seminole-Osceola Counties

10.2.2 Severe crashes (KA)

Figures 10-27 to10-30 exhibit the micro-level based integration results based on the selected hot TADs for severe crashes in the five selected areas except Leon County since no hot TAD was observed in this area. The TADs shown in the following figures are the same TADs for total crashes. It is noteworthy that these TADs have the same hot segments and intersections for total and severe crashes. Thus, as mentioned above, both macro-level and micro-level countermeasures should be simultaneously offered to reduce traffic crash risks in the areas.

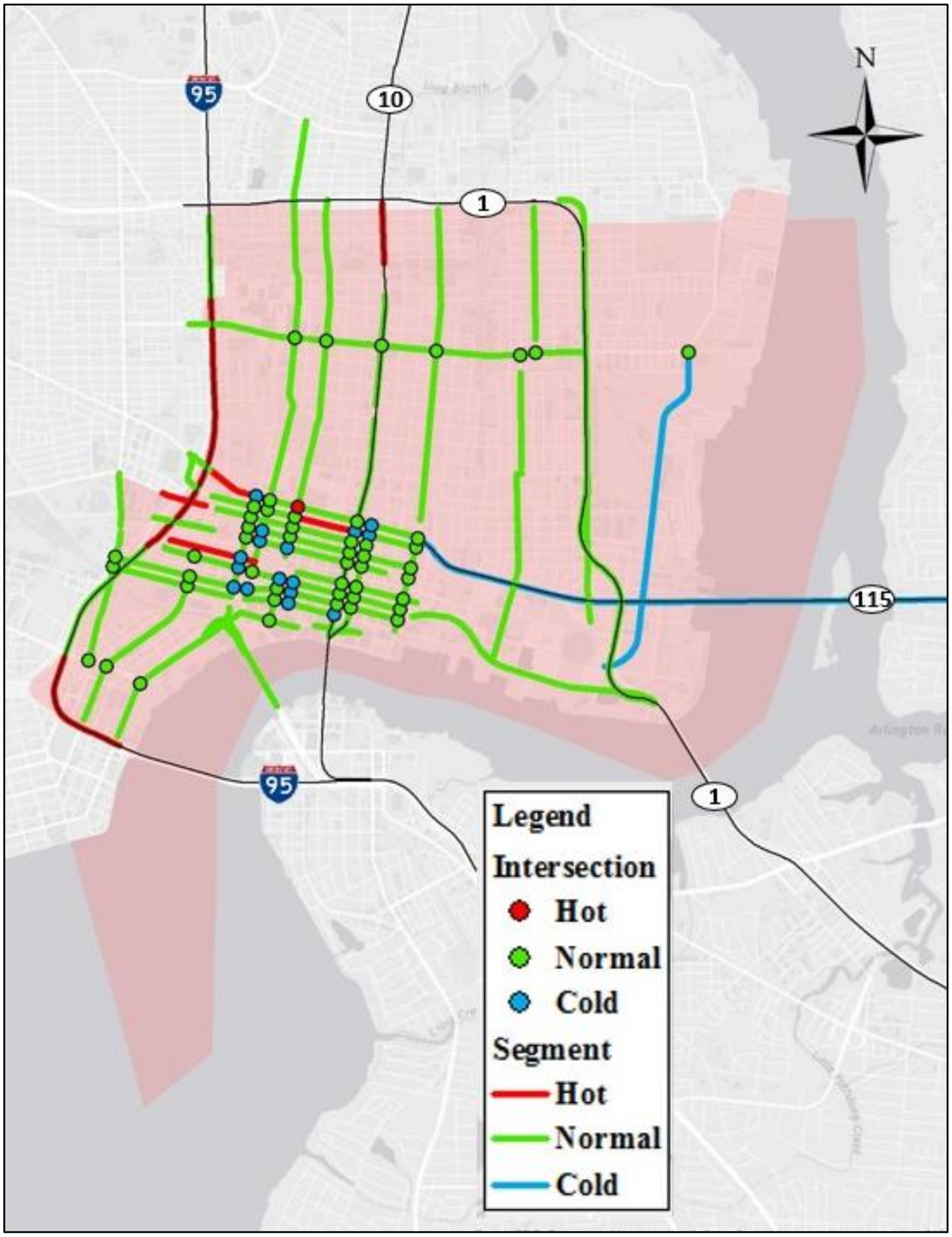


Figure 10-27 Micro-level based integration results based on the selected hot TAD for severe crashes in Duval County

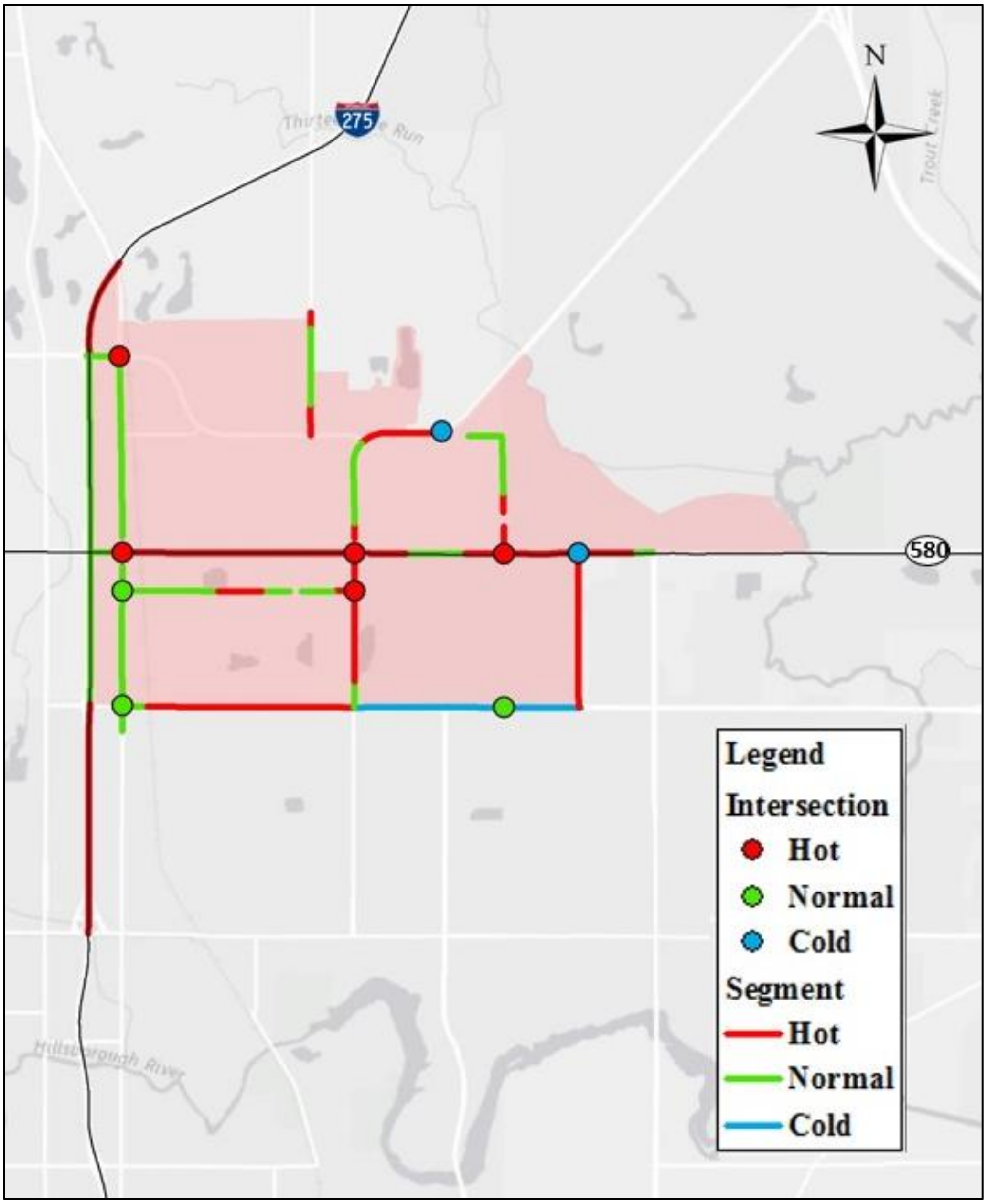


Figure 10-28 Micro-level based integration results based on the selected hot TAD for severe crashes in Hillsborough County

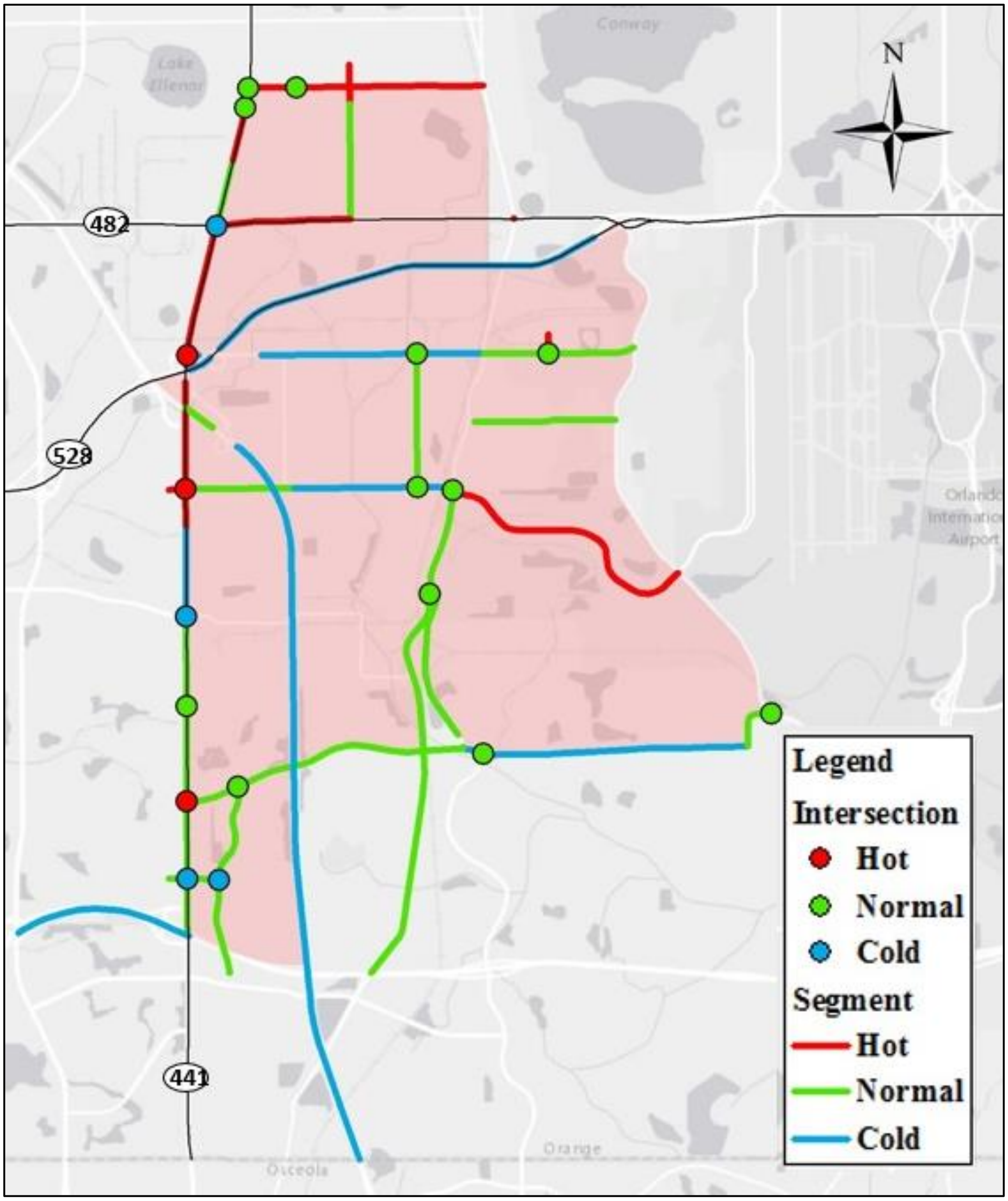


Figure 10-29 Micro-level based integration results based on the selected hot TAD for severe crashes in Orange-Seminole-Osceola Counties

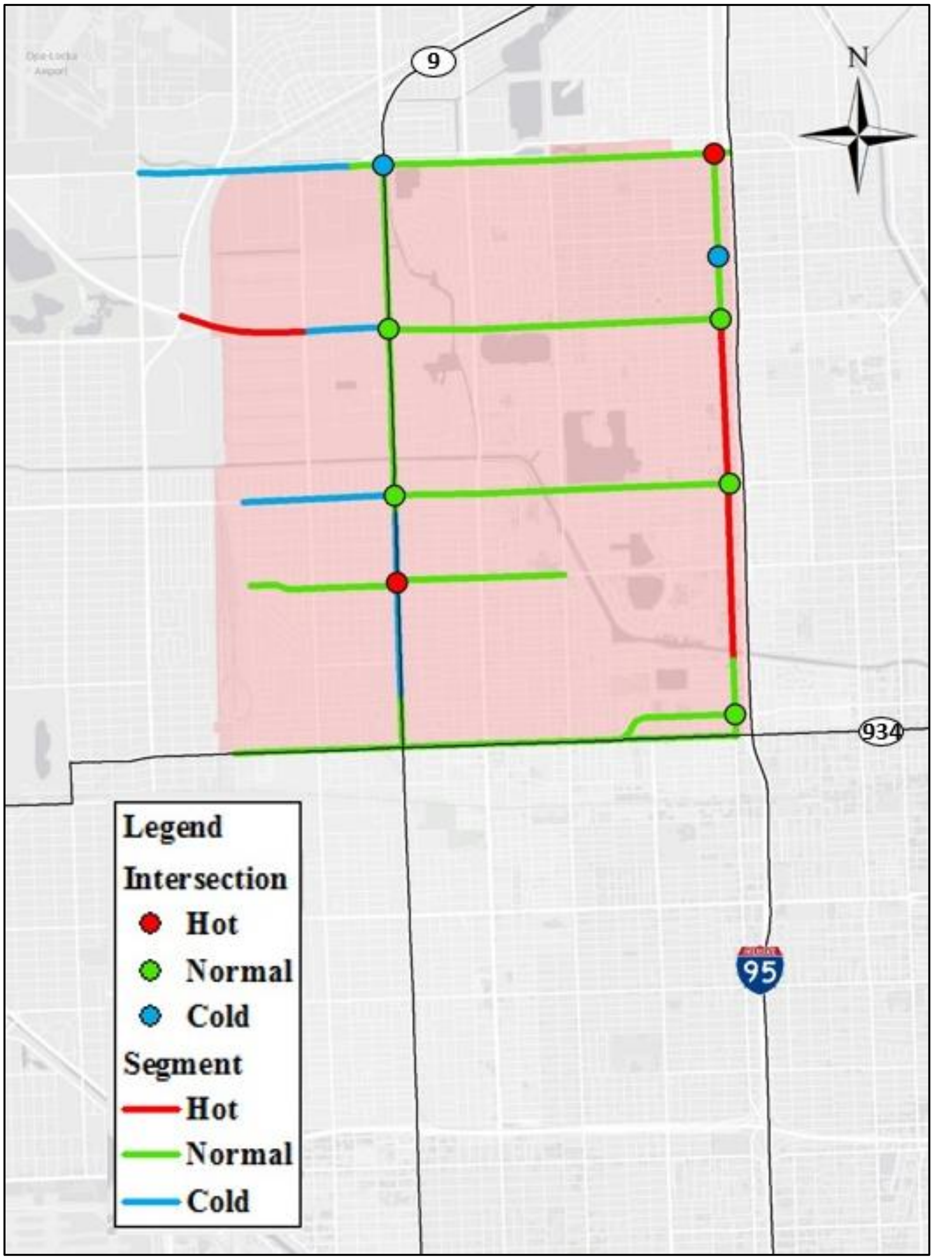


Figure 10-30 Micro-level based integration results based on the selected hot TAD for severe crashes in Miami-Dade County

Figures 10-31 to 10-35 display the micro-level based integration results based on the selected cold TAD for severe crashes in the five areas. Except for the selected cold TAD in the Hillsborough County, the TADs in other areas have only one or two hot segments. However, in the selected cold TAD in the Hillsborough County, three hot intersections were revealed. It may be because other intersections or segments are exceptionally safe (in other words, very low PSIs) in the selected cold TAD for severe crash. Hence, special engineering countermeasures should be applied to solve the safety problems for these intersections.

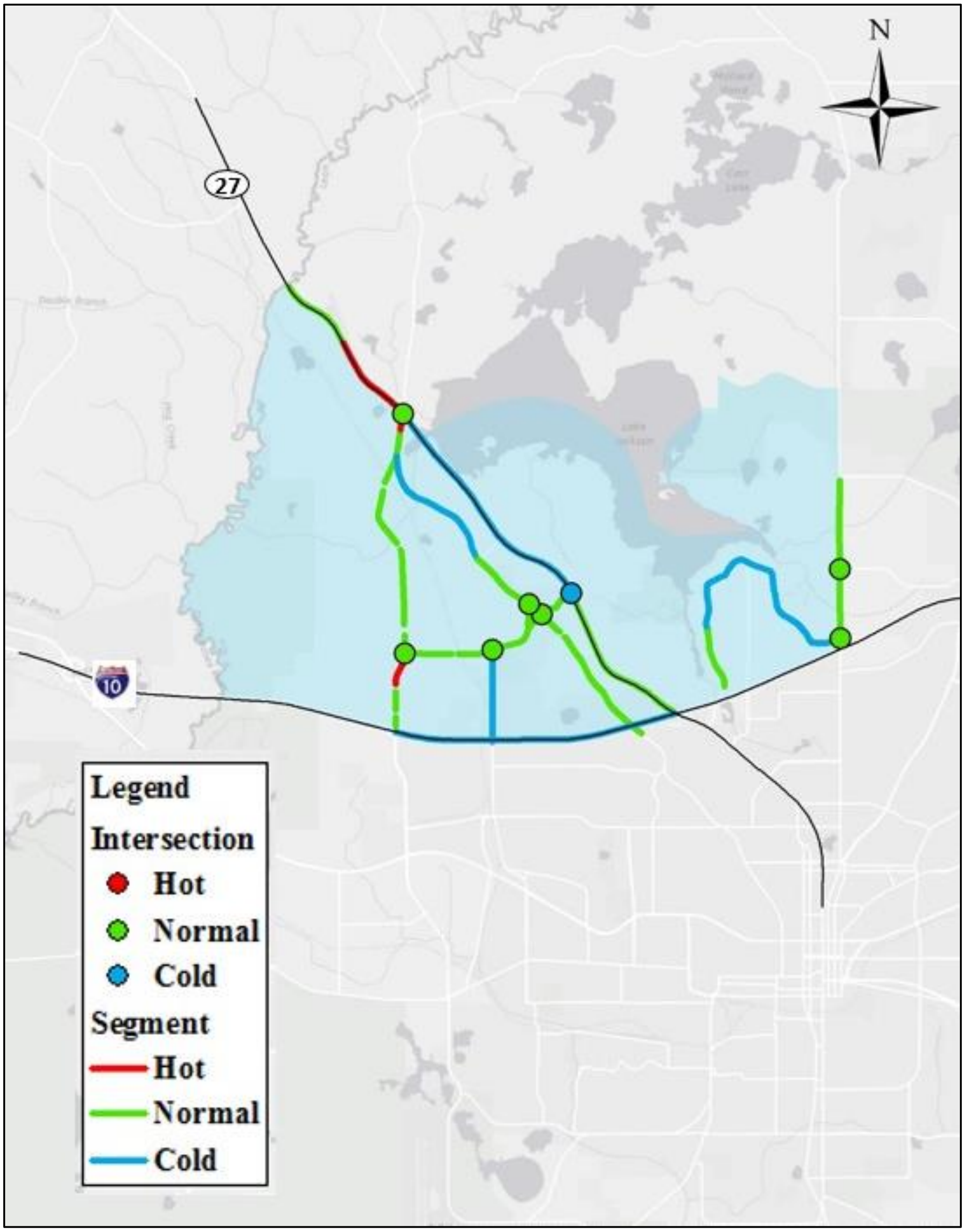


Figure 10-31 Micro-level based integration results based on the selected cold TAD for severe crashes in Leon County

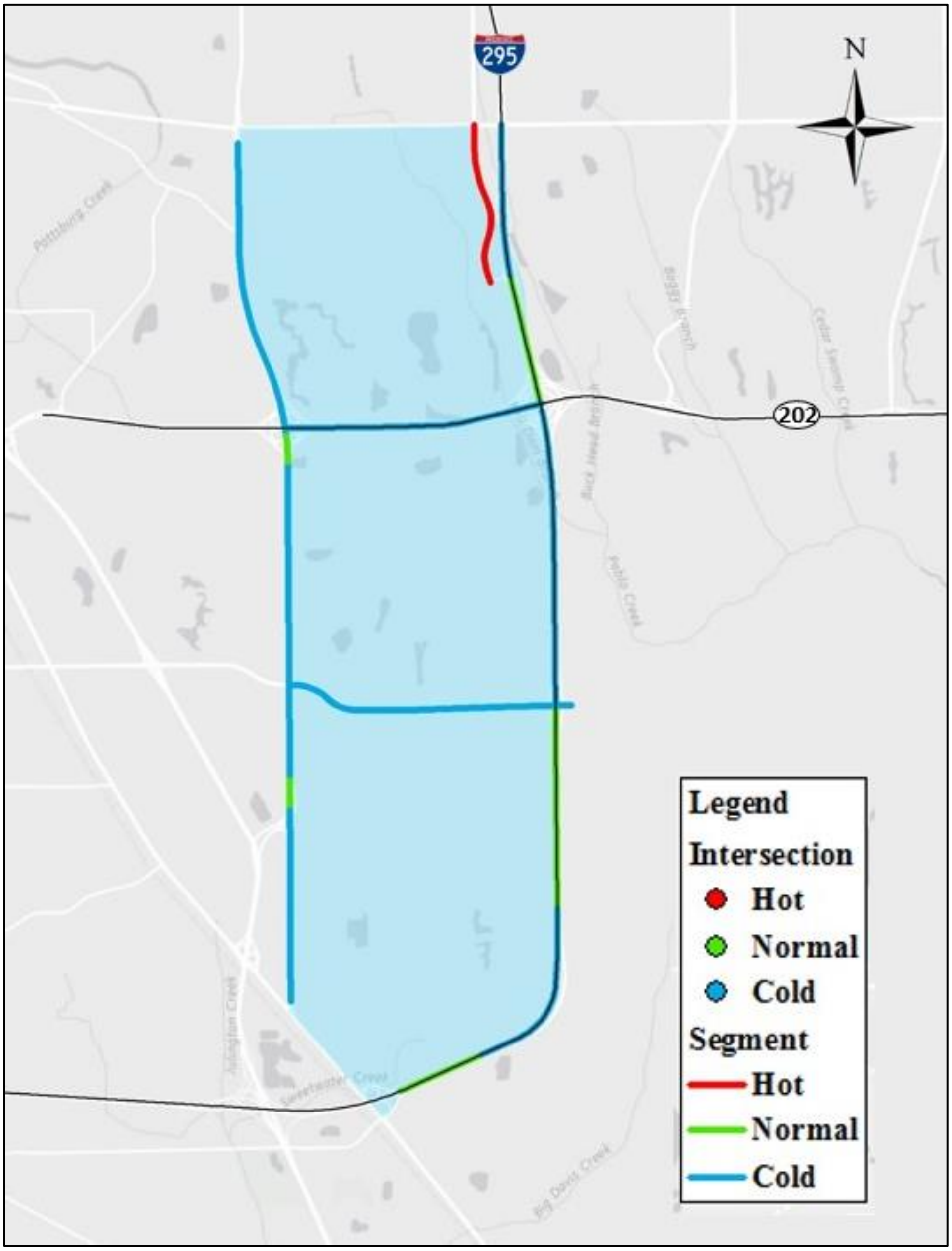


Figure 10-32 Micro-level based integration results based on the selected cold TAD for severe crashes in Duval County

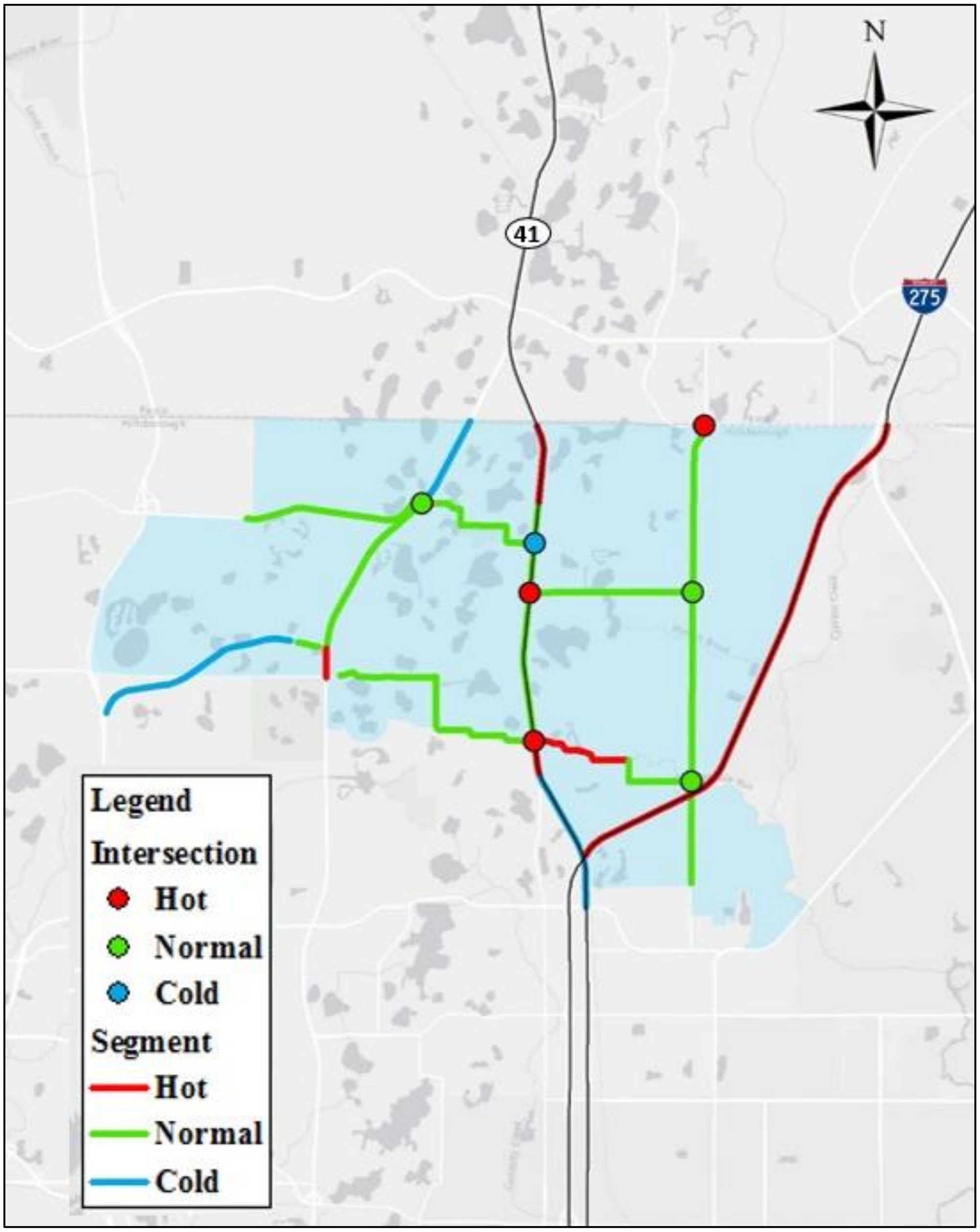


Figure 10-33 Micro-level based integration results based on the selected cold TAD for severe crashes in Hillsborough County

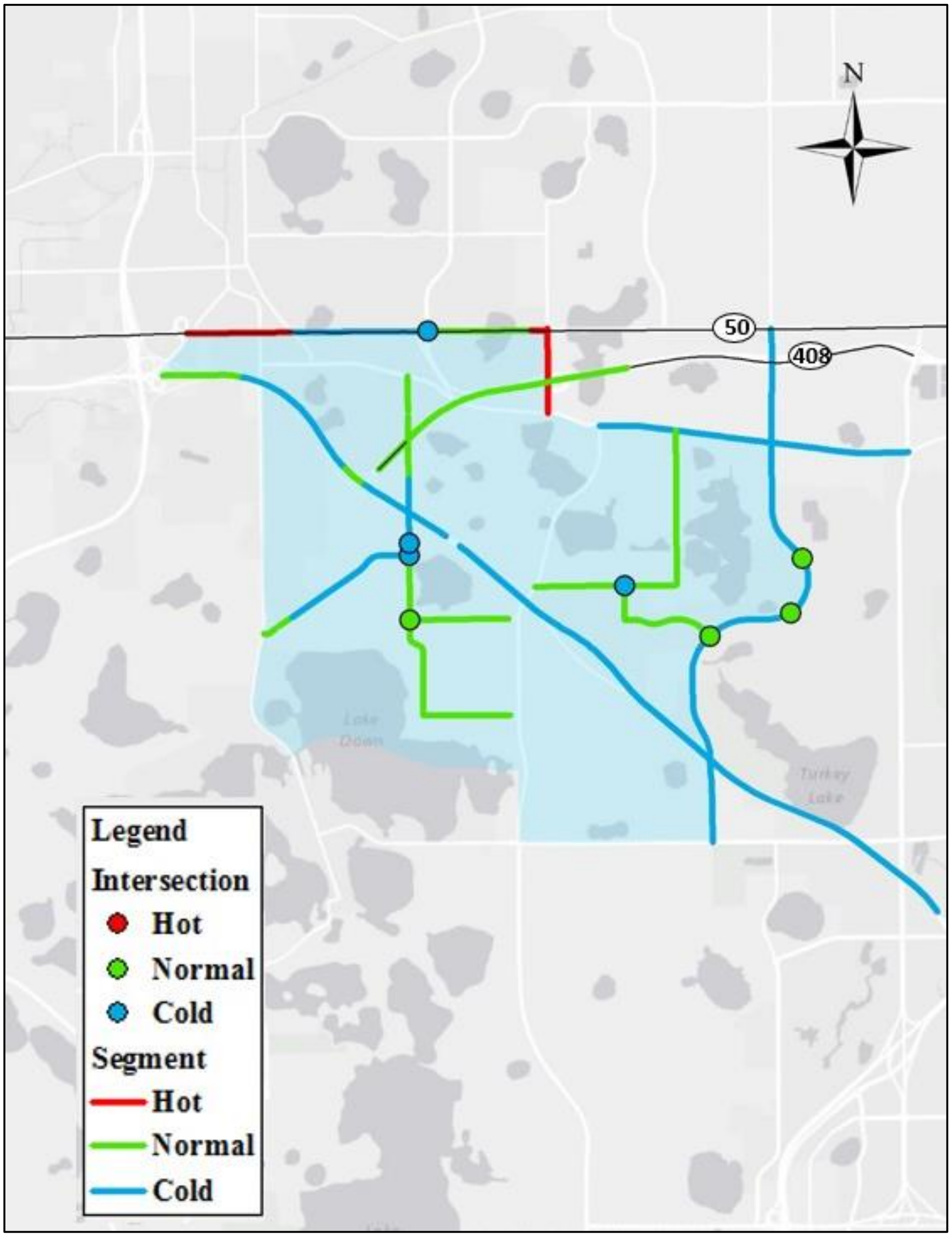


Figure 10-34 Micro-level based integration results based on the selected cold TAD for severe crashes in Orange-Seminole-Osceola Counties

Figure 10-35 Micro-level based integration results based on the selected cold TAD for severe crashes in Miami-Dade County

10.2.3 Pedestrian crashes (PED)

The integration results for the selected hot SWTAZ in the five areas were shown in Figures 10-36 to 10-40. As shown in these figures, the SWTAZs have less segments and intersections inside compared with TADs since the area of SWTAZs is much smaller. Nevertheless, hot segments or intersections could be still found in these zones except for the SWTAZ in Orange-Seminole-Osceola Counties. That indicated that this SWTAZ has overrepresented pedestrian crash risks only at macro-level problem.

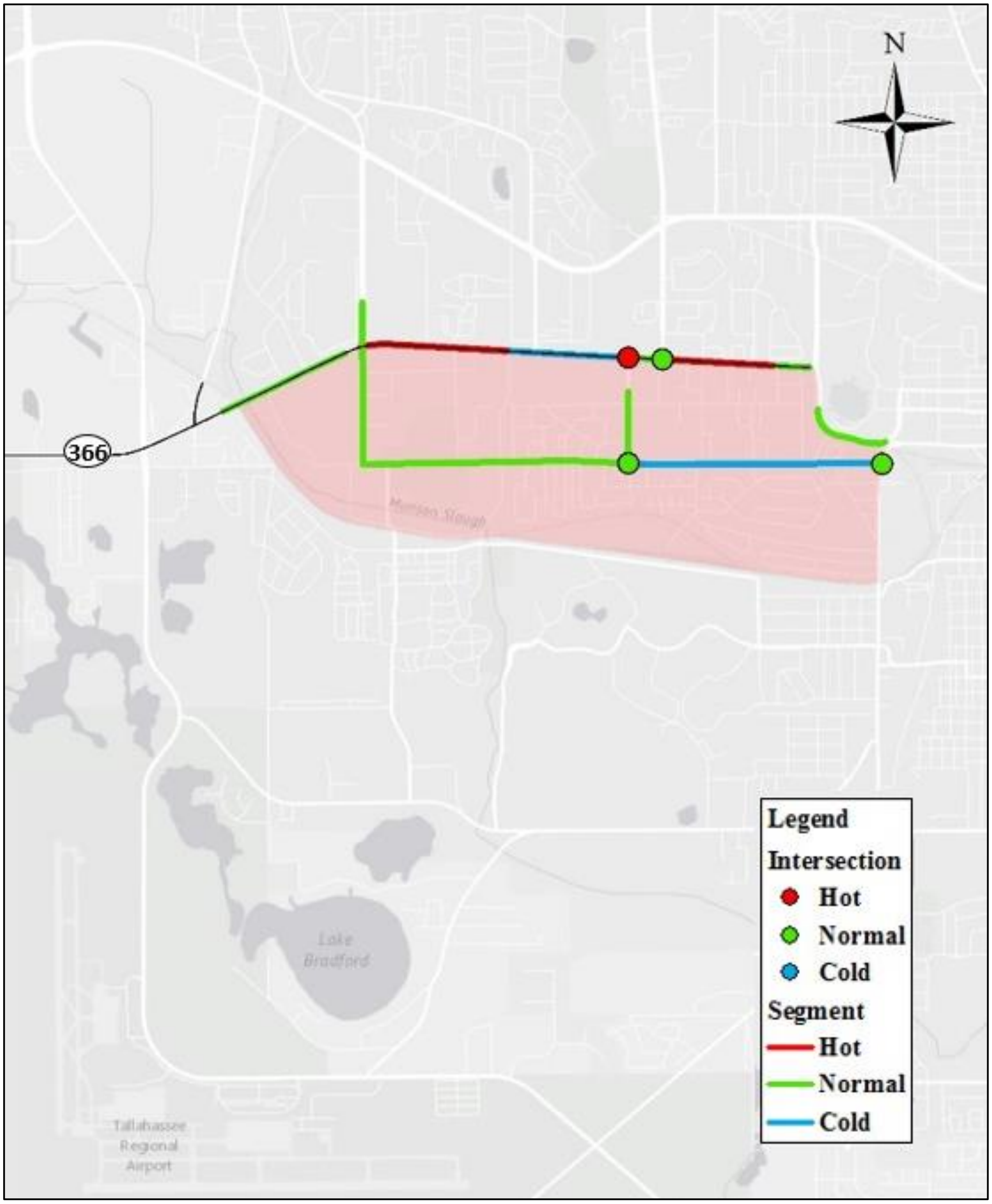


Figure 10-36 Micro-level based integration results based on the selected hot swtaz for pedestrian crashes in Leon County

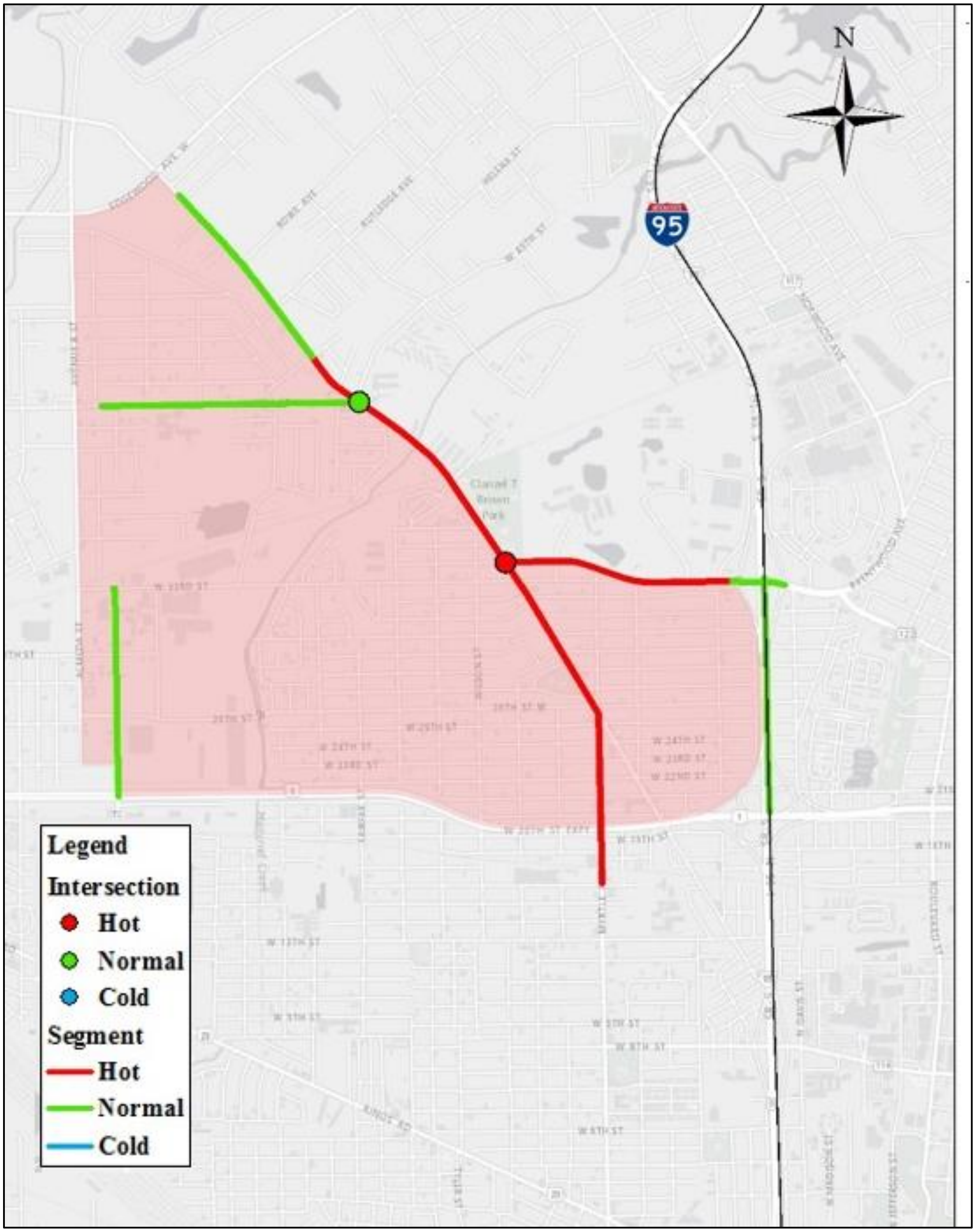


Figure 10-37 Micro-level based integration results based on the selected hot SWTAZ for pedestrian crashes in Duval County

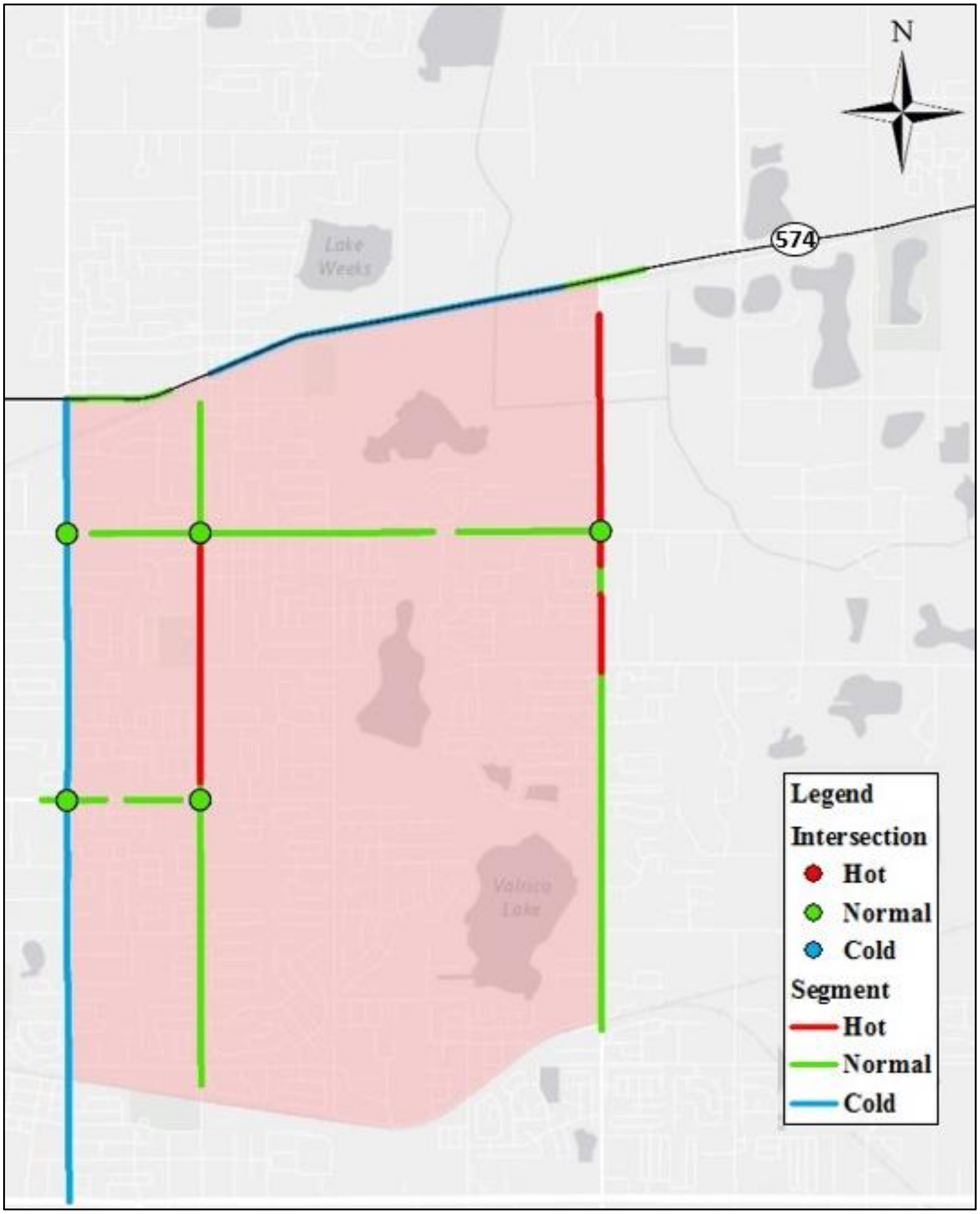


Figure 10-38 Micro-level based integration results based on the selected hot SWTAZ for pedestrian crashes in Hillsborough County

Figure 10-39 Micro-level based integration results based on the selected hot SWTAZ for pedestrian crashes in Orange-Seminole-Osceola Counties

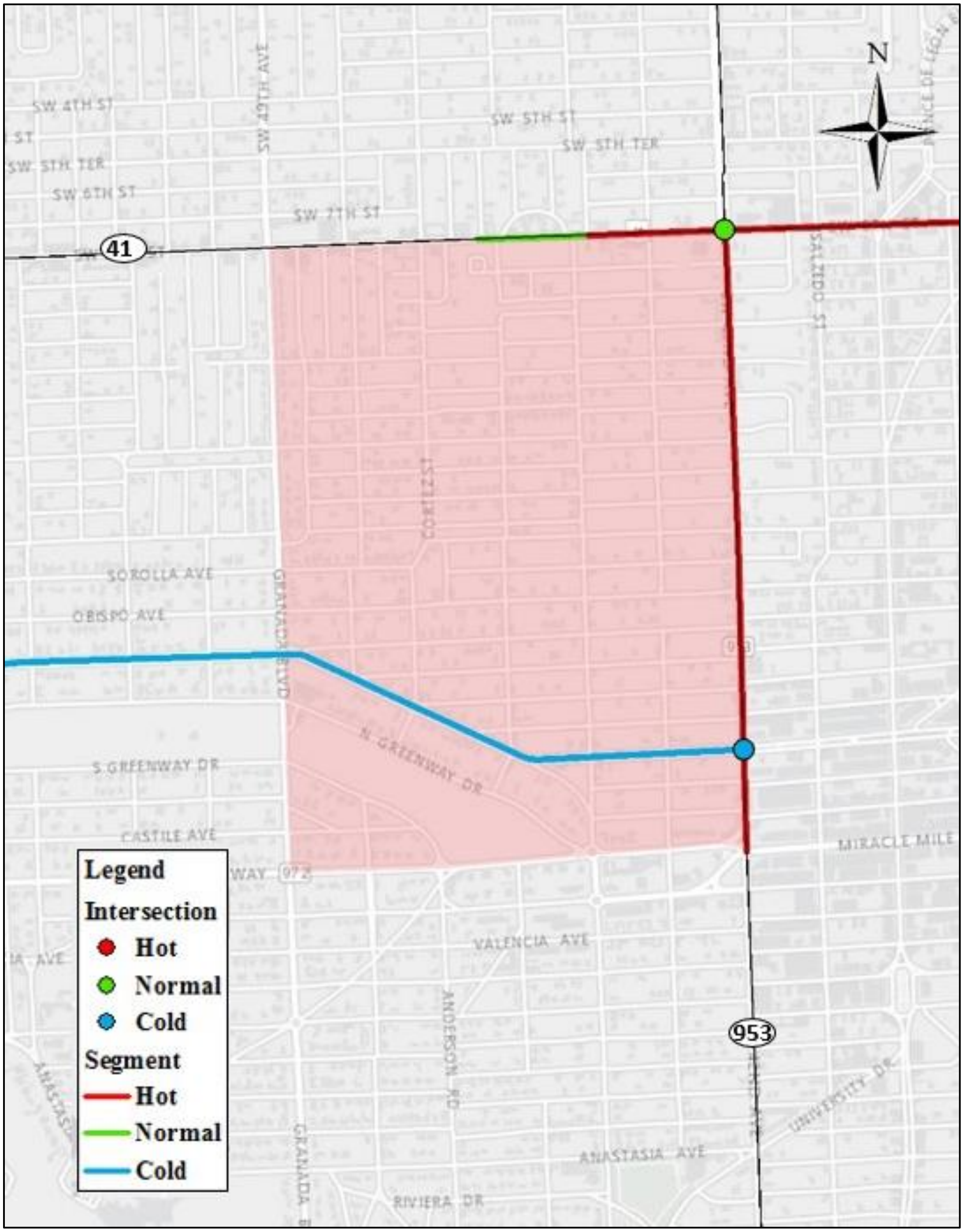


Figure 10-40 Micro-level based integration results based on the selected hot SWTAZ for pedestrian crashes in Miami-Dade County

The integration results for the selected cold SWTAZ in the five areas were exhibited in Figures 10-41 to 10-45. The integration screening results indicated that the macro and micro-level results of pedestrian crashes are consistent based on cold SWTAZs. There was no hot segment and intersection in the cold TADs as shown in the following five figures.

Figure 10-41 Micro-level based integration results based on the selected cold SWTAZ for pedestrian crashes in Leon County

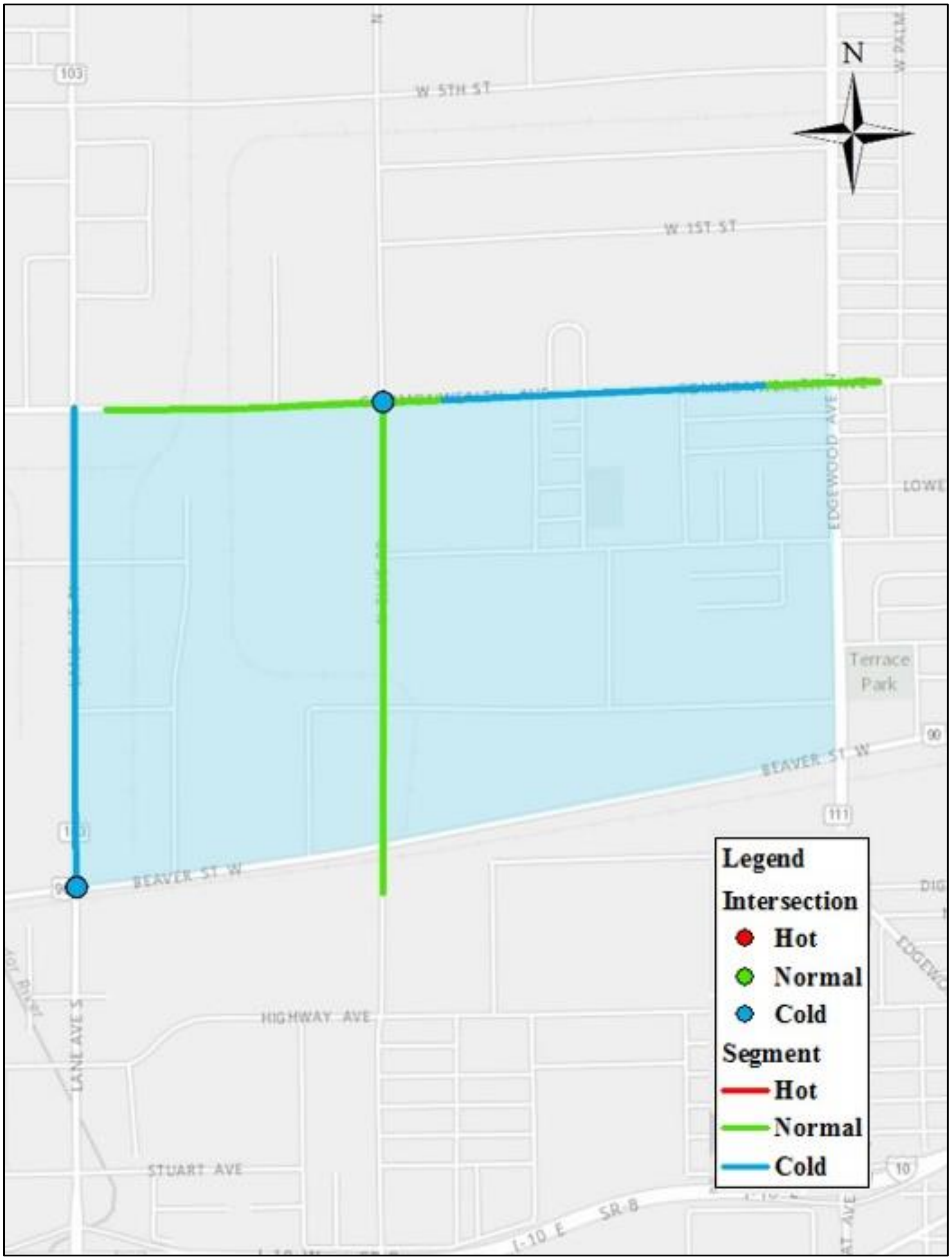


Figure 10-42 Micro-level based integration results based on the selected cold SWTAZ for pedestrian crashes in Duval County

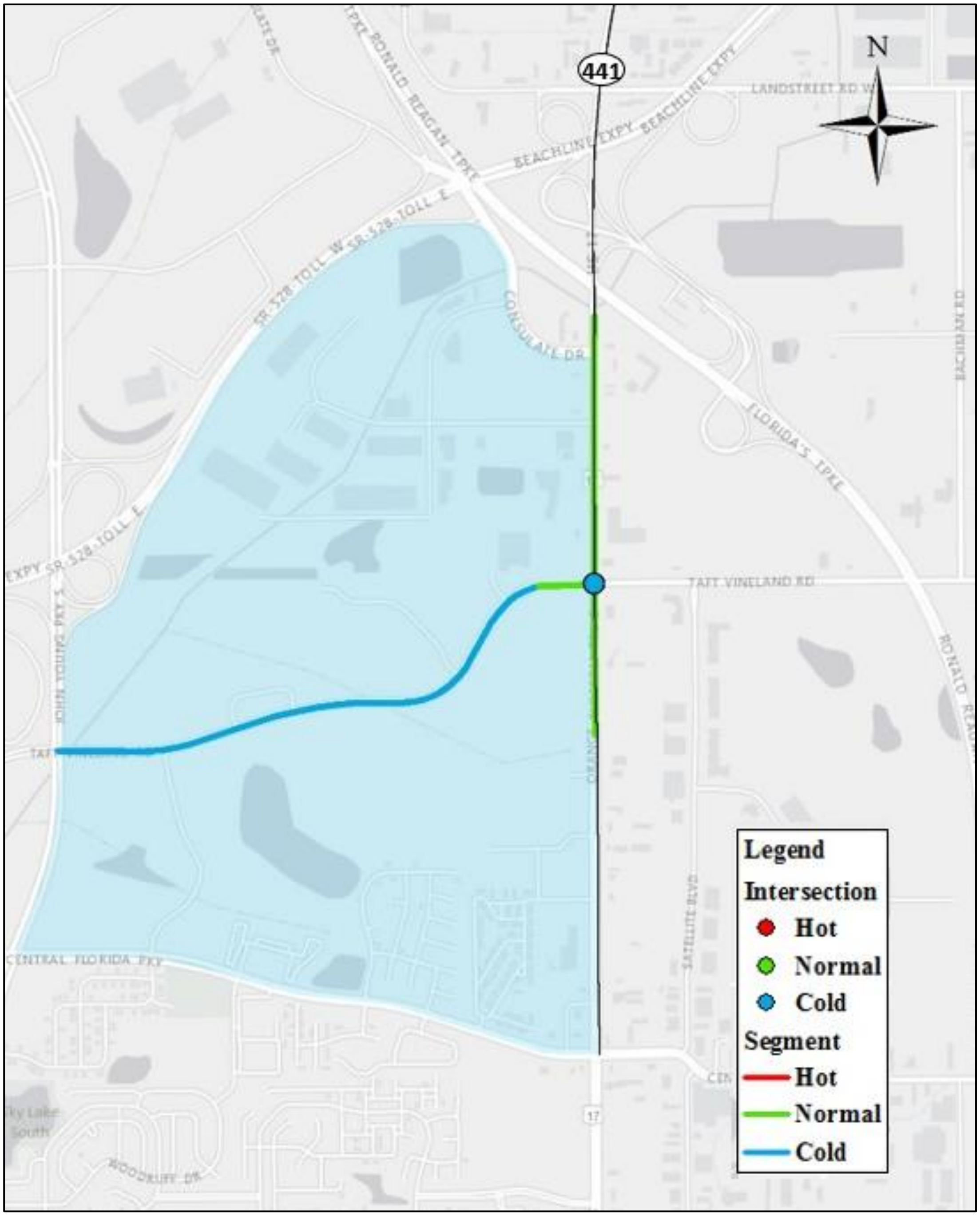


Figure 10-43 Micro-level based integration results based on the selected cold SWTAZ for pedestrian crashes in Hillsborough County

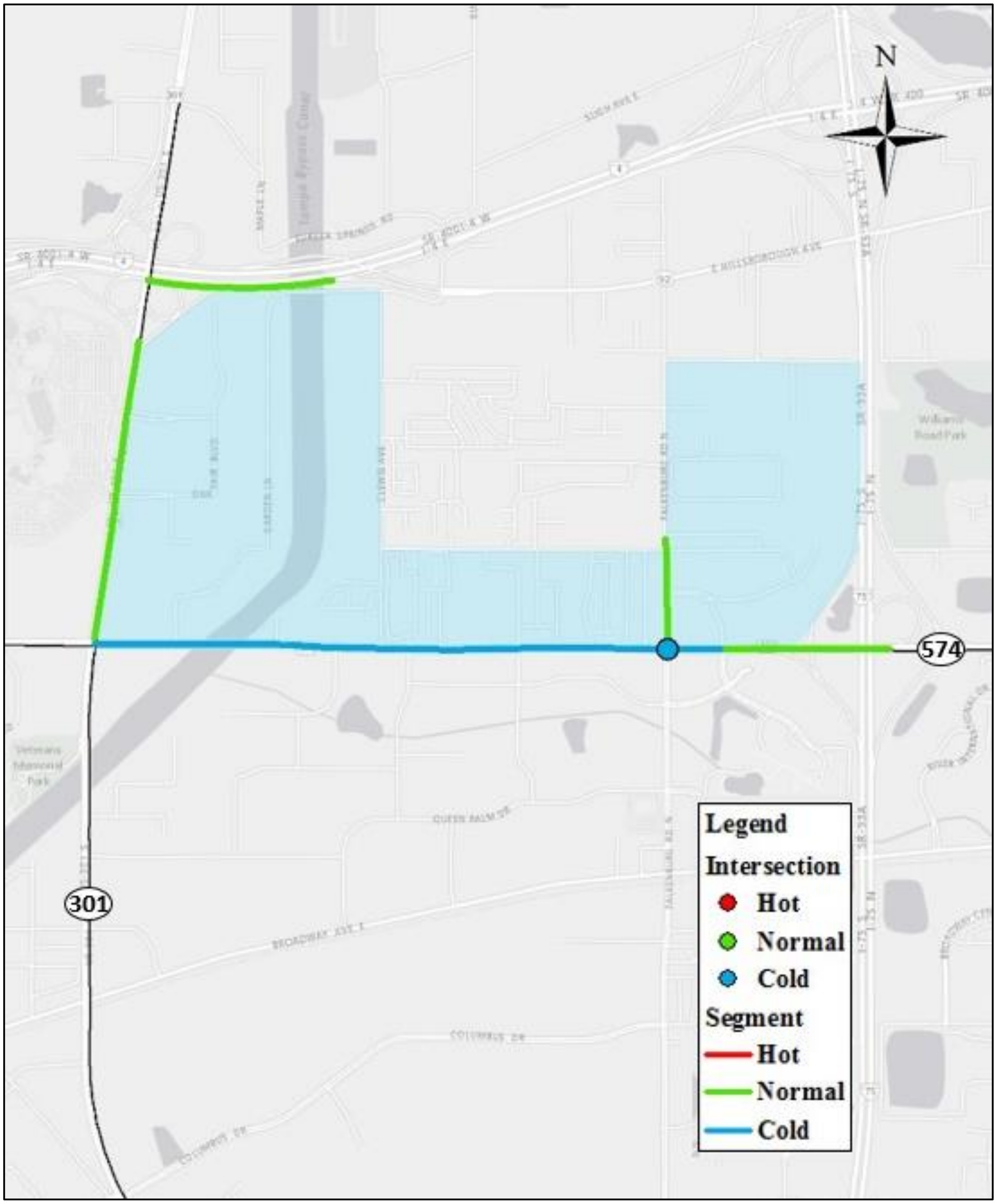


Figure 10-44 Micro-level based integration results based on the selected cold SWTAZ for pedestrian crashes in Orange-Seminole-Osceola Counties

Figure 10-45 Micro-level based integration results based on the selected cold SWTAZ for pedestrian crashes in Miami-Dade County

10.3 Summary

The research team has completed the combination of the two levels from both macroscopic and microscopic perspectives. All zones were integrated with the segments and intersections inside at macro-level while all segments and intersections were integrated with zones at micro-level. Some examples of the integration screening results were provided for several crash types for five selected metropolitan areas. With the two-level screening results, it is expected that comprehensive understanding about transportation safety can be obtained so that the efficient safety planning as well as engineering countermeasures can be provided.

11 DEVELOPMENT OF SPREADSHEETS

Based on the integrated screening analysis in Chapter 9, six Excel spreadsheet files were prepared as follows:

- Macroscopic level based integrated screening:
    1. SWTAZs: pedestrian and bicycle crashes
    2. TADs: all other 15 crash types
- Microscopic level based integrated screening:
    3. Segments combined with SWTAZs (for pedestrian and bicycle crashes)
    4. Segments combined with TADs (all other 15 crash types)
    5. Intersection combined with SWTAZs (for pedestrian and bicycle crashes)
    6. Intersections combined with TADs (all other 15 crash types)

The macroscopic level based integrated screening results for several major crash types: total, severe, and pedestrian crashes were summarized in Appendices B, C, and D, respectively. The prepared spreadsheets will be sent along with the Final Deliverable.

Each spreadsheet is explained in sections 11.1 and 11.2.

11.1 Macroscopic Level Based Integrated Screening

11.1.1 SWTAZs based integration (for pedestrian and bicycle crashes)

As shown in Table 11-1, five columns were included in the spreadsheet of SWTAZs based integration: SWTAZ ID, number of segments in each SWTAZ, number of intersections in each SWTAZs, integration results for pedestrian and bicycle crashes. There were totally 8,518 SWTAZs in Florida employed for the integration. As for the integration for pedestrian and bicycle crashes, the results were shown in the form of "ZSI", the first character "Z" presents the safety risk SWTAZs which can be "H", "N", and "C"; the "S" and "I" are numbers representing the proportion range of hot segments and intersections for each zone (Table 11-2). For example, the pedestrian integration result for SWTAZ 1 was labeled as "H00", which means that this SWTAZ has hot safety risk for pedestrian crashes while the percentages of hot segments and intersections were between 0 to 10%.

Table 11-3 Spreadsheet for SWTAZs based integration for pedestrian and bicycle crashes

SWTAZ	No of Segments	No of Intersections	PED	BIKE
1	6	0	H00	N00
:	:	:	:	:
109	8	3	C00	N10
:	:	:	:	:
8518	0	0	N00	N00

Table 11-4 Range of proportion for segments and intersections

Segment / Intersection	Range of proportion
0	>=0%, <=10%
1	>10%, <=20%
2	>20%, <=30%
3	>30%, <=40%
4	>40%, <=50%
5	>50%, <=60%
6	>60%, <=70%
7	>70%, <=80%
8	>80%, <=90%
9	>90%, <=100%

11.1.2 TADs based integration (for other 15 crash types)

The integration results based on TADs for 15 other types of crashes such as KABCO (total crashes), KA (severe crashes) were as shown in Table 11-3. There are 594 TADs included for the integration. As shown in the following columns, the numbers of segments and intersections in each TAD are presented. Meanwhile, the integration screening index, "ZSI" was employed for the TADs based integration and the ranges for the "S" and "I" are same as SWTAZs based integration. For example, the first TAD in Table 3, TAD 0 is a "Normal" zone with hot segments and intersections for total crashes are less than or equal to 10%. On the other hand, TAD 0 is a "Hot" zone for severe crashes with the hot segments are greater than 10% and less than or equal to 20%; but no hot intersections.

Table 11-5 Spreadsheet for TADs based integration for 15 other types of crashes

TAD	No of Segments	No of Intersections	KABCO	..	KA	..	DUI
0	76	25	N00	..	H10	..	H10
:	:	:	:	:	:	:	:
98	56	10	C02	..	N22	..	H11
:	:	:	:	:	:	:	:
593	20	4	N10	..	N10	..	N00

11.2 Microscopic Level Based Integrated Screening

As for the microscopic level based integrated screening, each segment and intersection is consolidated with macroscopic-level zone screening results.

11.2.1 Segments combined with SWTAZs (for pedestrian and bicycle crashes)

As shown in Table 11-4, six columns were included in the spreadsheet of segments combining with SWTAZ: ROADWAY (Roadway ID), BEGMP (Beginning milepost) ENDMP (ending milepost), SWTAZ a segment belongs to, categories of integrated screening results for pedestrian and bicycle crashes. Totally 29,011 segments in Florida were screened along with 8,518 SWTAZs. Nine categories were classified by considering two scale groups (micro and macro-levels) and three safety levels (hot, normal, and cold). These categories are: HH, HN, HC, NH, NN, NC, CH, CN, and CC (see Table 11-5). For example, the segment with Roadway ID 01000003 (MP: 0 to 0.17) was identified as "CN", indicating that the segment was very safe whereas it is located in a SWTAZ having a moderate risk for pedestrian crash.

Table 11-6 Spreadsheet for segments based integration for pedestrian and bicycle crashes

ROADWAY	BEGMP	ENDMP	SWTAZ	PED	BIKE
01000003	0	0.17	789	CN	CN
01000003	1.26	2	152	NC	NC
01000010	0	0.47	3076	HN	HH
01000017	0.71	0.86	821	CC	HC
01000022	1.22	1.36	8283	CH	CN
01000024	0.09	0.4	4614	NH	NH
01000024	0.47	0.59	2050	HH	NH
:	:	:	:	:	:
94819000	0.49	0.98	1626	NN	NN

Table 11-7 Hot zone classifications (micro-based integration)

		Macro-level		
		Hot	Normal	Cold
Micro-level	Hot	HH	HN	HC
	Normal	NH	NN	NC
	Cold	CH	CN	CC

11.2.2 Segments combined with TADs (for other 15 crash types)

The integrated screening results based on segments consolidated with TADs for 15 crash types are shown in Table 11-6. All segments were combined with 594 TADs based on the locations. As shown in Table 6, Roadway ID, beginning milepost, ending milepost, TAD where a segment is located, and integration results for 15 other types of crashes were provided. The same integration method and nine categories were employed for the combination process. For example, the first segment (Roadway ID 01000003 / MP: 0 to

0.17) was classified as “NH” for total crashes, which means that this segment has a moderate crash risk for total crashes while it is located in a TAD with a high total crash risk for total crashes.

Table 11-8 Spreadsheet for segments based integration for 15 other types of crashes

ROADWAY	BEGMP	ENDMP	TAD	KABCO	..	KA	..	DUI
01000003	0	0.17	525	NH	:	CN	:	NH
01000003	0.33	0.72	527	CN	:	HN	:	CN
01000003	0.72	0.99	525	CH	:	CN	:	CH
01000003	0.99	1.26	229	NN	:	NN	:	NN
01000010	0	0.47	272	HN	:	HH	:	HH
01000057	0	2.24	292	NC	:	NN	:	HN
:	:	:	:	:	:	:	:	:
94819000	0.49	0.98	591	NN	..	NN	..	NN

11.2.3 Intersection combined with SWTAZs (for pedestrian and bicycle crashes)

The integrated screening results based on intersections combined with SWTAZs for pedestrian and bicycle crashes are presented in Table 11-7. Five columns were included in the table: Roadway ID, intersection milepost, SWTAZ, pedestrian and bicycle crash screening results. Totally 8,347 intersections in Florida were analyzed.

Table 11-9 Spreadsheet for intersections based integration for pedestrian and bicycle crashes

ROADWAY	BEGMP	SWTAZ	PED	BIKE
01000003	0	9	NN	NN
01000003	1.122	8093	NN	CN
01000009	0	6287	NN	CC
01000035	0	8455	CN	HH
01000035	1.276	8456	NN	NH
:	:	:	:	:
94819000	0	1264	NN	CH

11.2.4 Intersections combined with TADs (all other 15 crash types)

Table 11-8 shows the integration results for intersections combining TADs for 15 other types of crashes. The same integration process was adopted and Roadway ID, milepost of intersection, TAD, and integrated screening results for 15 other crash types.

Table 11-10 Spreadsheet for intersections based integration for 15 other types of crashes

ROADWAY	BEGMP	TAD	KABCO	KA	..	DUI
01000003	0	372	NN	NN	..	NN
01000017	0	372	CN	NN	..	NN
02030000	14.652	28	HN	CN	..	NN
02030000	8.058	24	HN	NN	..	NN
02040000	0.137	27	NN	NN	..	NN
:	:	:	:	:	:	:
94819000	0	571	NC	NN	..	NC

12 SUMMARY AND CONCLUSIONS

12.1 Summary

In this research project, there were eight major objectives. All the main objectives of this second phase of the project have been achieved as follows:

1. Develop TSAZs for other areas in Florida

TSAZs have been developed for the whole Florida. The developed TSAZs are recommended for metropolitan areas (Chapter 4).

2. Develop SPFs for 17 crash types based on micro-level (i.e., intersection and segment) and macro-level (i.e., SWTAZs, TSAZs, TADs, counties)

A series of SPFs for the following 17 crash types were developed at the micro-level and macro-level:

- Total crashes;
- Crashes by severity: KABC, KAB, and KA;
- Crashes by time period: weekday-morning peak, weekday-off peak, weekday-evening peak, weekday-nighttime, weekend-daytime, and weekend-nighttime;
- Crashes in adverse weather conditions: rainy, foggy conditions;
- Crash types: single-vehicle, multiple-vehicle, pedestrian, and bicycle involved; and
- DUI crashes

Overall 404 SPFs were estimated for 13 segments and 16 intersection facility types. Also, 204 SPFs were developed for SWTAZs, TSAZs, TADs, and county (Chapters 5 and 7).

3. Identify hot zones at different spatial scales, such as SWTAZ, TAD and county: The macroscopic screening analyses were conducted at different spatial scales (Chapter 6).

4. Identify hot intersections and sections

The microscopic screening investigations were performed for intersections and segments in Florida (Chapter 8).

5. Use and adapt the HSM screening procedures

All the screening procedure followed the HSM (Chapters 6 and 8).

6. Develop practical and user-friendly spreadsheets for the integrated screening

The integrated screening results were prepared in the form of spreadsheets (Chapter 11).

7. Provide a stepwise procedure for integrating micro and macro screening results with transportation planning

The stepwise procedures to consolidate micro and macro screening results were provided in Chapter 9.

8. Analyze hot sites/zones by various crash types, times, and conditions: The analysis results were provided in Chapters 5-11.

12.2 Conclusion

In recent, many studies have been conducted for traffic safety problems at both microscopic and macroscopic levels. Base on the HSM Part B (AASHTO, 2010), specific locations such as segments and intersections with high crash risks can be identified with a microscopic screening analysis and then proper engineering solutions (such as signalization, installing sidewalk, street lighting) are provided considering the sites' particular problems. In Phase I of the project, the research team followed the screening procedure in HSM and extended it to macroscopic level using Orange, Seminole, and Osceola Counties data. The research team extended these efforts to a statewide level. Thus, zones such as SWTAZs and TADs having particular transportation safety problems can be recognized by a macroscopic screening investigation and then countermeasures from a planning perspective such as educations, outreaches and enforcements can be suggested. The research team proposed a methodology to consolidate the screening results from the two levels.

In the macroscopic safety analysis, TAZs (Traffic analysis zones) have been most widely used as a spatial unit as they are directly related to transportation planning procedures. However, there are two major disadvantages for TAZs using in traffic safety analysis: 1) small size in urban area and 2) high percentages of boundary crashes. In order to overcome these issues, the research team provided two solutions. The first way is to use regionalization to develop a new study unit TSAZs (Traffic safety analysis zones) for TAZs based on the crash rate. The other way is to apply larger geographic units such as TADs (Transportation Analysis Districts) and counties. In this study, statewide zonal systems: SWTAZs (Statewide TAZs), TSAZ, TADs, and counties were employed for macroscopic crash analysis. As for the TSAZs, the research team Brown-Forsythe test to select the optimal scale (one-fifth of number of SWTAZs), which reduces boundary crashes and zones without including rare types of crashes. The developed TSAZs are recommended applying in urban areas, which often have extremely small TAZs.

Overall, Florida-specific macro-level 204 SPFs were developed based on the four types of geographic units for 17 crash types by severity levels, time periods, collision types, and special events. We compared the predictability of SPFs of different zonal system for different crash types by employing neutral grid systems. Based on the comparison results, the best geographic units for screening analysis were determined: SWTAZs are the optimal zonal system for non-motorized mode crash (such as pedestrian and bicycle crashes) analysis while TADs were the most appropriate spatial unit for all other crash types.

Concerning microscopic crash analysis, one major challenge was that there are too many facility types of segments and intersections in the whole Florida. Basically, the research team used the facility types suggested in the HSM, and we have added more facility types which were not covered by the HSM. Hence, segments were categorized into 13 facility types based on location (urban or rural), number of lanes, access control (full or no access control), and median division. Meanwhile intersection were classified into 16 facility types based on the location (urban or rural), number of legs (3, 4, 5, or 6), control types (stop or signal controlled), and one-way roads. Totally 404 Florida-specific micro-level SPFs were estimated for 17 crash types based on each segment and intersection facility type.

Subsequently, a series of screening analyses were performed for the two levels by the ranking results based on the PSI (Potential for Safety Improvement). At the macroscopic level, a statewide screening analysis was conducted based on SWTAZs (for pedestrian and bicycle crashes) and TADs (for all other crash types). At the microscopic level, a statewide screening analysis was conducted for segments and intersections for various crash types. Both macro-level zones and micro-level sites are classified into three categories: “Hot”, “Normal”, and “Cold”. Then, a two-stage integration of the screening results from macroscopic and microscopic perspectives was employed. As for the macro-level based integration, the selected geographic units (i.e., SWTAZs and TADs) were labelled in the form of “ZSI”. The first character “Z” of the classification illustrates the macroscopic safety risk which can be “H”, “N”, and “C”. The subsequent categories: “S” and “I” are numbers representing the proportion range of hot segments and intersections for each zone, respectively. On the other hand, the micro-level based integration was developed to identify whether a segment or intersection has safety issues at micro- and/or macroscopic levels. All segments and intersections were classified into nine categories that include two scale groups (micro and macro) and three safety levels (hot, normal, and cold) for 17 crash types. These categories are: HH, HN, HC, NH, NN, NC, CH, CN, and CC. The first character of the classification represents the microscopic safety risk, and the second character indicates the macroscopic safety levels.

Finally, five representative metropolitan areas in Florida were selected to show the integrated screening results for total, severe, and pedestrian crashes. The TAD-based total crash screening results display the overall crash distributions within the whole state and the selected five areas. The result indicated that the hot zones for total crashes are concentrated in metropolitan areas as expected. Meanwhile, the TAD-based severe crash screening result presents the distribution of dangerous areas for crashes with fatality or severe injuries. Compared to the total crash screening result, they have a tendency to be spread out to rural areas. Moreover, the integration screening results for pedestrian based on SWTAZs would show the spatial distribution of pedestrian-vehicle crashes. The hot zones for pedestrian crashes are mostly located in urban areas and also some suburban areas.

To sum up, the research team has proposed two approaches to combine the macro-level and micro-level screening results. In order to conduct a screening, we have developed 608 Florida-specific SPFs for various crash types by facility types and geographic units, which will be very useful for the Florida Department of Transportation, MPOs, and regional governments. Furthermore, the integration results can provide a comprehensive perspective for the statewide transportation safety and then more appropriate and efficient treatment can be offered to reduce crash risks. Also, different macroscopic zonal systems are recommended for the integration for different crash types. SWTAZs are suggested to explore pedestrian and bicycle crashes and TADs are recommended for all other crash types. Based on the two integration results, distinct strategies should be adopted since different problems could be observed for different categories. In this report, a series of the spreadsheets also provided to help practitioners to employ the integrated screening results from this research.

Nevertheless, it is worth to note that there are several limitations to this study. First, the integration results were presented with maps which are hard to display result in detail for the whole Florida. It is suggested that an interactive GIS software application (e.g. ArcGIS Online) can be employed to better show the integration results for the whole state and the specified areas. Second, only an exposure variable (i.e., traffic) was used for the microscopic SPF estimation due to the complicacy of the categories of segments and intersections. The performance of the estimated SPFs and screening results can be improved if more detailed information can be added into models. Thus, more appropriate treatment can be proposed to specific zones and sites. Third, SPFs were developed for only segments and intersections with observed AADT. Thus, most local streets were not used to estimate SPFs. Lastly, the integration process was only conducted for the two-level screening results in this research. It may be possible to have more reliable screening results if the combination process can be accounted from the modeling perspectives. Thus, the effects of variables (such as traffic volume) can be also integrated for both macroscopic and microscopic levels.

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APPENDIX A

TSAZ-SWTAZ TABLES

1. Miami-Dade MPO

TSAZ	SWTAZ
7	4726, 5917, 4450, 8517
8	3729, 2582, 8064, 2581, 8036
9	2580, 3727
10	4558
11	3725, 3731, 3724, 5920, 3723
12	2974, 3720, 5921
13	5922
14	7584, 3732, 3722, 3719, 3738, 3737
15	3717
16	8052
17	5006
18	8156, 2759
19	7597, 3715, 3689, 5925, 8158, 2575, 8139, 5929, 3084, 7576
20	3743, 5930, 3085, 7588
21	2770, 8059, 2766
22	3538
23	7592
24	5952, 5963, 5941, 7585, 8026, 8027, 3541, 3542, 5943, 4820, 4819, 5947, 4817, 4818, 5951, 5953, 5954, 8028, 4821, 7593, 5956, 4852
25	5993
26	3086, 3087, 3089, 3748, 8144, 2771, 2569, 8172, 2773, 1750, 2572, 8173, 8174, 8175, 3896, 3899, 2774, 8177, 2571, 8149
27	5961, 5977, 2576, 5924, 7586, 3745, 5926, 8054, 2769, 3083, 3744, 8056, 5927, 5928, 2768, 8051, 5931, 5932, 5005, 2765, 8057, 5935, 2550, 5936, 8029, 8143, 1757, 2549, 5938, 5939, 3448, 3449, 3450, 3539, 1761, 2547, 7590, 3540, 5942, 8142, 2419, 8140, 2548, 3443, 8141, 3444, 3445, 3446, 3447, 2554, 5944, 3535, 5945, 5946, 5948, 5949, 5950, 2573, 5955, 1752, 3537, 1758, 5957, 2566, 3547, 5959, 3536, 5960, 3548, 3549, 3550, 5967, 5968, 5972, 5975, 5976, 2562, 2567, 2568, 2564, 2570, 2557, 3545, 3544, 3546, 2561, 4352, 3895, 8170, 2559, 2454, 2565, 2563
28	6004, 5000
29	5298, 5973, 5982, 5958, 6017, 6008, 4854, 5964, 5965, 5966, 7594, 5970, 5971, 5974, 5978, 5979, 5980, 4853, 5986, 3543, 5989, 5990, 5991, 5992, 3533, 3534, 5994, 5995, 4851, 5996, 5998, 5999, 6000, 6001, 6002, 4847, 3532, 4359, 6009, 4850, 6012, 6013, 6014, 6015, 6018, 6019, 6022, 3531, 3530
30	8042, 7595, 5001, 6010, 6033
31	5969, 5981, 4350, 5997, 3529, 6016, 4349, 3528, 6029, 6036
32	7561
33	4999, 7565
34	7575
35	6037, 7635, 6021, 6023, 6024, 6030, 6031, 6032, 4849, 4848, 3525, 3526, 3527, 4683, 2551, 3524, 3522, 3523, 4992, 8040, 7636, 3521, 7634
36	6047, 6026, 6027, 4356, 4354, 8025, 2552, 4353, 4355, 2558, 2556, 8023, 8024, 6041, 3988, 3513, 3517, 3519, 6045, 2542, 3989, 2540, 2543, 3516, 3520, 6046, 3518, 2545, 2443, 2444,

	3944, 3515, 3514
37	7632, 2546, 2544
38	6051, 4986, 6055
39	2165
40	7596, 7563, 7558, 8161, 2167, 2168, 8163, 8164, 8162, 8129, 4147, 4362, 2166, 8103, 8102, 8165, 8065, 8110, 2574, 8114, 8115, 8099, 8070, 3902, 8116, 8118
41	7630, 6064, 6065, 6069
42	4561, 7606
43	7631, 7628
44	3573, 1767
45	7589, 7638
46	7626, 7625, 7624
47	4559
48	7633, 4802, 4991, 4993, 4102, 4990, 1766, 6062, 4989, 6071, 2533, 2532, 4994, 3949, 6074, 6075, 6076, 2534
49	6083
50	7574
51	2164
52	2779, 2782
53	4980
54	7587, 2453, 7559, 2455, 2560, 3451, 8105, 4360, 8104, 4361, 8087, 8101, 3993, 2440, 2442, 2515, 2517, 2516, 2441, 6057, 3440, 3995, 2520, 6063, 2518, 3571, 2521, 8127, 3439, 8096, 8136, 2513, 2514, 8109, 3572, 2519, 3438, 3498, 2527, 2537, 2512, 2523, 2524, 7572, 2525, 2777, 2510, 8107, 2511, 3437, 7571, 2522, 4401, 2509, 2753
55	4400, 3759
56	4143, 6099
57	4995, 5962, 5983, 5985, 5987, 5988, 6003, 4547, 6006, 4551, 6007, 6020, 6025, 4548, 8179, 6028, 6038, 4549, 4550, 6039, 6040, 6042, 6043, 6044, 4552, 6048, 6049, 6050, 6052, 6053, 4984, 4987, 6056, 4554, 6067, 6068, 8169, 6077, 6078, 6079, 6080, 4555, 6081, 6084, 4556, 6085, 6086, 6088, 6089, 6090, 6098, 6100
58	2751
59	4988, 6054, 6059, 6060, 6061, 6070, 6072, 3946, 6073, 3947, 2536, 3442, 2784, 6091, 6092, 6093, 6094, 2790, 6095, 6096, 6097, 6102, 6103
60	6104
61	3512, 2755, 8131
62	2787
63	3974
64	8135, 1762, 8133, 8137, 1751, 2754, 8134, 3900, 3901, 2744
65	1756, 3975, 8128, 2752, 3979, 3980, 3096, 3978, 2748, 2750, 2745, 3097
66	3973, 4245, 3098, 7917, 3986, 7935, 3100
67	4560, 6108, 6111
68	8176, 4446, 8151, 8152, 8153, 3094, 8147, 4725, 8117, 3961
684	5919, 8035
685	4454
686	2579
687	3716
688	8055
689	2763
690	2578, 8069, 3736, 3741, 3735, 8097, 4546, 8082, 8060, 8048, 3742, 8081, 3718, 8047, 2577, 3746, 8053, 2764, 4682, 8049
691	3088, 8146, 8150, 3093, 3090, 8145

692	8159, 5933, 5934
693	8084, 3728, 8083, 8037, 8038, 3726, 3730, 8039, 3733, 3734, 3721, 8022, 8080, 8043, 3740, 8041, 8050, 2760, 8046, 3739, 5923, 4447, 8045, 2761, 8148, 8044, 8154, 8155, 3091, 8157, 3092, 2758, 2772
694	3095
695	8031, 5940
696	8171
697	5937, 5003
698	2553
699	2767, 2762, 8058, 3747, 3898, 3897, 8168
700	2555
701	4351
702	6005
703	7567
704	6011
705	7557
706	6034
707	6035
708	4997
709	7564, 5004
710	4998, 7566
711	8062
712	4996, 7568
713	7627
714	7608
715	3570
716	3994
717	2445
718	1763, 8108
719	8113, 8111
720	4553
721	6066
722	3945, 1753, 2529, 6058, 2528, 2530, 3551, 2538, 2526, 2163, 3948, 6082, 2535, 3441
723	7570
724	7569
725	7573, 4557, 7963
726	2789
727	8106, 1760, 6087, 2734, 8178
728	3950, 2531, 2775, 2781, 4982, 2778, 3552, 2785, 2783, 2780, 4144, 6101, 2796
729	8130, 2757, 2756
730	2507, 2539, 2786, 2508, 3554, 2791, 3555, 8132, 3553, 8125, 2788
731	8124
732	8119
733	3977, 3976
734	3511, 8138
735	8121, 8166, 4170
737	8123
738	7619
740	3981, 3982
741	3985
1325	2975, 1755

1326	8100
1327	7706
1328	7722
1329	5002
1330	5984
1331	7560
1332	4684
1333	7562
1334	2541
1335	7629
1336	8112
1337	3992
1338	7621
1339	7637
1340	7591
1341	2776
1342	4981
1343	8126
1344	7613
1345	4979
1346	7620
1347	7622
1348	7623
1351	7603
1352	4974
1361	4545, 4606, 4457, 4611, 4445, 8303, 4658, 8304, 6129, 8221, 8211, 8215, 4462, 8213, 4459, 8275, 16, 28, 3960, 6143, 5915, 4451, 4610, 4765, 4727, 8033, 7962, 8034, 4449, 4685, 4448, 4442

2. Broward MPO

TSAZ	SWTAZ
69	3984
70	2735
71	3951
72	4972, 6112, 4973, 6113
73	6115, 6116
74	2810, 7186, 2809, 7219, 7166, 2805, 7287, 3559, 7288, 3557, 7285, 7284, 2733, 2801, 2452, 6122, 7283, 2465
75	3971
76	6125
77	6126
78	2746, 4148, 3991, 7197, 2740, 7190, 2739, 3556, 3749, 3750, 2803, 4010, 2738, 7196, 2798, 3698, 2814, 2817, 2815, 2811, 2449, 2451, 2446, 2464, 7279, 2447
82	4042, 7174, 2853, 7602
84	7297, 4107
85	6119, 2501, 6120, 7605, 6123, 6153, 6154, 6149, 2505, 2502, 4971, 4209, 1184, 1174, 7185, 7599, 7600, 1183, 7238, 1182, 7286, 2818, 6118, 2821, 4967, 5038, 4966, 5039, 3560, 5090, 7300, 6133, 6134, 4963, 2827, 7282, 2822, 1185, 7277, 6137, 4241, 2823, 1186, 7275, 6146, 2488, 2496, 7276, 6150, 2494, 4983, 8122, 1765, 1749, 8120, 8160, 1754, 4142, 2797, 2792, 4978, 6105, 2795, 8167, 2793, 6107, 4977, 2794, 7914, 7913, 7918, 1764, 4976, 3972, 2504, 2506, 4975
86	1759, 7252
87	2448, 7302, 2457, 2461, 2462, 2459, 7290, 1280, 4455, 7280, 4468, 1273
88	7615, 7264, 2863
91	7254, 2489, 6159, 2829, 2837, 2828
92	6132, 4965, 6136, 5106, 4958, 4956
94	1197, 1178, 1177, 7249, 7250
95	5392
97	4229, 2842
98	2868, 3568, 1192, 2865, 2731, 7242, 1194, 1289, 2729, 1288
99	2330, 3713
100	6152, 2466, 2333, 7306, 2500, 3987, 2826, 7301, 7303, 7304, 3565, 1181, 2497, 2499, 7292, 7293, 2498, 6148, 7294, 2858, 2485, 2495, 6151, 2859, 2492, 2493, 6155, 1189, 2484, 2833, 2834, 7243, 1195, 2866, 2864, 2832, 2838, 2727, 2836, 2730, 2726, 2161, 3777, 1196, 3778, 2473, 2160, 2476, 2479, 2480, 2475, 2478
101	2725
739	2749
743	2742
744	2503
746	3955, 2736, 5353
747	2741
748	3983, 3665, 1290, 2802, 2808
749	3664, 7187, 3099, 2806, 2807
750	2804, 7189, 1191, 2799
751	7616, 4970, 7215, 4968, 4679
752	3953, 3952, 2737, 3954, 7194, 6114, 6117
753	7281
754	7188, 6121
755	2800, 7273, 2450, 3558

756	4969, 4680, 4681
757	2813, 3697, 2812, 2816, 2456, 2463, 2460, 2458, 7195
758	7278
759	7305, 2819, 2825
760	2820, 6127, 6128, 3561, 7289, 5037, 6130, 6131, 2824
761	2977, 6135, 7183, 7191, 7200
763	4964, 4960
764	3959
765	6147
766	2486
767	1279, 2857
768	2162
769	2732, 8067, 2860, 3567
770	2490, 6156, 2491, 2831
771	5107
772	2835
773	2830
774	6160
775	3957
776	2332, 7199, 7198, 1172, 4464, 4843, 3564, 7299, 7308, 3563, 2852, 2851, 4840, 7253, 7295, 2854, 2743, 7296, 3562, 2850, 2861, 7307, 2862, 7251, 1274, 2855, 2867, 3566, 4829, 2856, 1180, 1179, 7247, 1175, 2469, 2468, 7245, 2728, 3714, 1176, 2467, 2471, 2472, 2470, 7248
777	3779
778	2159
779	5105
781	3709
782	1187, 4959, 7298, 7274, 5394, 4961, 2487, 5393, 1188, 4962, 4957, 1190, 4955, 1193, 2843, 2840, 7237
784	3711
1349	2747
1353	7617, 7598
1354	7610
1355	7611
1356	7607, 7609, 7612
1357	8066, 7172, 5352
1358	3990
1359	6124
1360	1173, 7193, 3696
1365	6168, 6178

3. Palm Beach MPO

TSAZ	SWTAZ
102	6179, 7614, 6180, 2481, 4952, 6185, 4950, 7269, 2839, 2841, 4954, 6173, 4953, 2482, 3849
103	2157, 7239
104	2155
105	7241, 7240, 7267
108	3710, 6188, 2156, 2844, 7265, 7266, 2846, 7255, 7268, 1281
109	2849
111	7259, 2847, 7258, 6191, 4943, 6194
112	1247, 3679, 7257
116	4937
118	1285
119	7184
120	6198
122	2878, 2876
123	1246, 7066
124	1283
125	1241, 6204, 6205, 6206, 3580, 6207, 1272, 3579
129	5389
131	4934
132	7069, 7067
133	6226
134	6227
135	6229, 6230
136	6235
139	6240, 6231, 6234, 6237, 6238, 6239, 6242, 6243, 6244
140	1231
141	1251
142	6251, 7082
143	7721, 7083, 3102, 6228, 6236, 3101, 2896
144	6252, 7077
145	6246, 2336, 7080, 6255
146	1219, 3582, 7056, 6210, 3581, 1218, 1220, 1171, 7086, 7073, 1230, 2339, 7583, 1296, 1229, 3577, 2338, 1233, 3576, 3575, 1254, 1295, 2892, 2893, 5249, 1215, 2895
148	3677
149	6258
150	4567
151	7780
152	3675, 3674, 1235, 7046
153	1300
154	7784
155	7062, 7035
156	6267, 6268, 4772
157	5388, 7078, 7024
158	7034, 2897, 2898
161	6279
165	4778, 5149, 6280, 4512, 4777, 7788, 4776
787	2474, 2477, 5391, 7271, 7246, 2158
788	2845, 7260
791	4941

792	3848, 7270, 4949, 6186, 8068, 3850, 4129, 4948, 4947, 2483, 4946, 2848, 4944, 4942, 4940
793	6184, 7262, 3712, 7244, 7263, 7170, 7038, 2331, 6174, 6177, 3695
796	4931
800	3681, 2880, 7272, 4938, 3678, 3680, 2882, 2883, 2881, 4933, 1249, 6203
803	2724
804	7081, 7088, 1223, 1221, 1222
806	1226, 4928, 1224, 4927, 1284, 3578, 1297, 1250, 2337, 4686
807	7085, 1253
808	5390, 1260, 1259, 1217, 2875, 7147, 7261, 7256, 2879, 2870, 1277, 7061, 7060, 2871, 2877, 7072, 1228, 7055, 7063, 3584, 1258, 1227, 2872, 2873, 2884, 7059, 1245, 3691, 7058, 7087, 2889, 2891, 7089, 7084, 2888, 3569, 1244, 3103
810	6241
811	6200, 6202, 4935, 4687, 4565, 6245
814	5250, 1287
818	3676
819	3692, 7070, 7064, 2890, 7068, 7171, 7182, 2887, 7091, 2885, 4037, 7079, 4036
820	4566
821	2903
822	1239, 1170, 5293, 1238, 1243, 1242, 1240, 6265
823	6263, 6247, 6248, 6249, 6250, 3799, 1236, 1232, 1248, 1256, 1257, 1302, 1304, 1301, 6259, 1298, 7076, 7075, 1234, 3574, 6264, 4803, 7090
824	1214, 1255, 1237, 5387, 3585, 2904
830	6288
831	2906
832	6294
833	6269, 4513, 6270, 6271, 4563, 7033, 2899, 1252, 7031, 1168, 1216, 2901, 7030, 7029, 4775
1366	4951
1368	4945
1369	2874
1372	6195
1376	4936, 4939
1378	3583
1379	4932, 7010
1385	1225, 4930, 4929
1386	3690
1387	2886
1389	7781
1391	6232
1392	6233
1393	3765
1394	7173
1395	4564
1396	2894
1398	6260, 6262
1399	8079
1404	4562
1408	6278, 7032, 6289
1417	4773, 4774, 7027, 1303, 4739, 4502, 4742, 4511
1418	4779, 4925, 4740, 6300, 4741

4. Hillsborough MPO

TSAZ	SWTAZ
230	7936
234	7933, 4175
238	6476, 4015
239	4527
246	6488
249	7778
251	5196
252	6496, 6501
254	7751
255	3628, 2982, 3630, 4008, 2984
256	7869, 3757
257	5193
258	3755, 3756
260	6540
261	6500, 6499, 6503, 6504, 6507, 7766, 3622, 7767, 7769, 6538, 5199, 5195
262	7908, 7876, 3629, 6495, 1834, 2085, 7927, 1787, 1815, 7881, 3632, 7889, 7924, 7880, 3636
263	4709
265	6543, 4467, 6505, 6506, 6509, 6510, 2962, 2961, 2959, 6511, 7893, 5171, 6513, 7884, 6514, 3620, 6515, 6516, 6517, 6518, 6519, 6520, 6521, 7895, 6523, 4710, 4711, 6524, 6525, 7898, 6526, 6527, 6528, 6529, 6530, 6531, 6532, 6533, 6534, 2965, 6536, 4712, 6542, 3608, 6544, 3609, 2960, 6545, 3617, 6549, 2979, 5197, 2968, 2969, 6553, 6555, 6556, 4005, 6557, 6558, 6559, 2978, 4004, 3612
266	7775, 2990, 3625, 3626
267	6562
268	6567
269	2956
270	6564, 6572
271	6575
272	6546, 6551, 6554, 2967, 6566, 6579, 2971
273	3631, 7868, 2987, 5201, 2983, 2638, 7873, 3635
275	6583
277	1831
278	2973, 7777, 3615, 3614, 7763, 7822, 6569, 6570, 6578, 6581, 6585, 3613
280	6587
283	6591
285	2016, 3073
286	6595
287	7892
289	6594, 5211
290	6599
294	2948
295	6601
297	7915, 7996, 3752
298	7841, 3355
299	7840
305	3075, 3077, 6598, 3074, 3076, 3654, 2014, 2017
306	3686, 3684
307	3683

308	4717
310	7863, 6610, 4133, 7856
311	1884, 1804, 8073, 1816, 3652, 3064
312	4718
315	4273
316	6600, 5212
318	4395
322	6613
324	6614
327	3751, 7987, 6612, 2938, 7980, 3606
333	3062, 3063, 1807, 3048, 3065, 7979, 4278, 7967, 3051, 4280, 7969, 4281
335	4277, 4279, 1989, 4282
336	7890, 7870, 7883, 2951, 3753, 7912, 7900, 7872, 4270, 2946, 2950, 2947, 7811, 7997, 7998, 8088, 6622, 7907, 6625, 7905
340	6632
341	3061, 6633, 7973
343	3603, 2943
359	7975, 3056, 3060, 7943, 3058, 7977, 8404
892	4668
898	4669, 4670, 4176, 7932, 4747
917	1994
926	7866, 8078
927	2985
928	7886, 4530, 2964, 2963
929	6498, 6502
930	5191
931	4508, 6470, 4172, 4661, 4662, 7877, 1992, 1788, 2981, 5192, 5200, 4663, 7871
932	4525, 4526, 6482, 7711, 7891, 4608, 2009, 2007, 7874, 2008, 4674, 2010, 7867, 6512, 2954
933	3619
934	2980, 4664
935	6539
936	7772, 7770
937	7771
938	7885, 4713
939	3618
940	2988
941	6541, 2986
942	6552
943	6550, 3610
944	6560
945	2966, 5169
946	2955, 7888, 2953, 7897, 7882
949	4715
953	2989, 2972, 3634, 7864, 3627, 7875, 3633
954	2952, 3758
957	5170, 2957, 2958, 4149, 6586, 5173, 6588, 4003, 5174, 5175, 5176, 5177, 3685, 3688, 3682
958	3687, 7911
959	2015
961	3072, 5214
963	7965, 8506, 3067
964	3624, 6571, 6573, 2434, 2116, 2435, 3623, 3616, 2011, 2012, 1802, 4007, 1803, 7957, 2970,

	7988, 7958, 8002, 1805, 4226, 8019, 2013, 4272, 1806, 4274, 1808, 7966, 4276
966	7964, 3066, 7961, 7960, 3069, 3050, 7972, 7971, 3647
968	7934, 1829, 4180, 7910, 4171, 1812, 4178, 4173, 7938, 4174, 1833, 4177, 4232, 7926, 1885, 7928, 1789, 1786, 7940, 1801, 7925, 7878, 1785, 7879, 1783, 7923, 7922, 1810, 7930, 1819, 7921, 7887, 7842, 1813, 1811, 1809, 7920, 1814, 4132, 7838, 175, 1865, 8451, 8381, 8482, 6493, 8367, 8483, 157, 8241, 8504, 8481, 172, 1781, 161, 209, 6563, 213, 212, 8032, 1784, 210, 8422, 8485, 1777, 176, 1861, 8513, 7837, 8479, 6597, 1856, 8374, 3892, 169, 8480, 7708, 6602, 211, 141, 1779, 8376, 2186, 177, 1863, 7845, 3702, 8495, 155, 1855, 3701, 8505, 3700, 154, 8379, 8515, 8389, 167, 6623, 8498, 2718, 8503, 3114, 4120, 3113, 8489, 4181
976	6636, 1990, 4275, 4269, 2945, 7999, 3607, 4268, 2949, 7919, 2944, 7909, 7906, 1988, 6626, 7902, 3602, 7904, 7903, 3045, 3049, 7901, 3053, 3047, 7929, 3030, 7976, 3052, 3029, 7959, 7944, 7946, 7945, 7942
978	3656, 1873, 3659, 3655, 2097, 3068, 3653, 5213, 1836, 1832, 7974, 3706, 8409, 3071, 6637, 7968, 7949, 1817, 4131, 4140, 4139, 4577, 2184, 8448, 3704, 8475, 6653
1457	4667, 4506
1462	7937
1466	7754
1471	4507
1476	6475
1478	4524, 7712
1481	1993
1483	4531
1484	4529, 4528, 6489, 6492, 2427
1485	6490, 3489
1486	4541
1487	7764
1489	6497
1490	6508
1493	3621
1495	6522
1497	7768
1498	6535
1499	4216
1500	6537
1501	7773
1502	6548
1503	3611
1504	3754
1505	6547, 4708
1506	7776
1507	4002, 5172
1521	7939
1522	5189
1527	8003
1528	7970
1529	4271
1530	3658, 3657, 1883, 1872, 3893
1539	2936
1540	4267
1541	8030

1542	6611, 6616, 1818
1543	1874, 6620, 1868
1549	3057
1553	2931, 2941

5. Pinellas MPO

TSAZ	SWTAZ
212	5101
215	5103
217	7794, 5102
218	7792, 4534
219	6386
220	7899
221	6387
222	7753
223	7865
224	3417, 2053, 3416, 3411, 2432
225	7756
226	6444, 2136, 6453
227	2140, 6456
228	6457
229	6423, 6459
231	6416, 6414, 6391, 4845, 6392, 6393, 6394, 6395, 6396, 4303, 4300, 6397, 4299, 4298, 3419, 6399, 6400, 6401, 4304, 6402, 6403, 6404, 6405, 6415, 6417, 6418, 6419, 6420, 6422, 4297, 6431, 6433, 4302, 4301, 4296, 6434, 2143, 6436, 6437, 6438, 6439, 6441, 6442, 6443, 6447, 4306, 6450, 4305, 2081
233	6468
235	6388, 2431, 3412, 3414, 6398, 6406, 6407, 6408, 6409, 6410, 6411, 6412, 6413, 6421, 6424, 6425, 6426, 6427, 6429, 6430, 6432, 6435, 6446, 6454, 6455, 5210, 2052, 2091, 6469, 3431, 2106, 2129, 6471, 3427, 3428
236	2103
237	2075, 2073, 4295
240	4435, 5030, 2142, 6477
241	4284
242	6480
243	5128
244	6479, 4648, 7984, 7985
245	4313, 7983, 6478, 6481, 5093, 4314
247	2090, 7759, 7760, 7761, 6491, 7762, 2058
248	6461, 2065, 6466, 2101, 5029, 2064, 6472, 2051, 2066, 6485, 2109, 2127, 7990, 6487, 2433
253	2089, 8011, 2049, 2050, 2046
264	2087
274	2037, 2063, 6561, 6565, 6576, 3346, 1991, 2044, 3348, 4223, 6582
276	6584
279	7847
281	2057, 2151, 8000, 2070, 6568, 6580, 2088, 4288, 2146, 2436
288	7846
303	6596, 2437, 2132, 6605, 2071, 6608, 2133
304	6606, 2028
309	6609
326	4769
328	6621
329	7815, 7816, 7818, 7819, 4321, 8007, 2111, 2079
334	4293, 5180, 7992, 6615, 2932
346	8005, 5204, 2940, 2153, 5182

894	6379, 6380
895	6382
899	5025, 6389
900	2429
901	4533, 6383, 4676, 4532, 1997, 3418, 3422, 7894, 4678, 3421, 3420, 4677
902	6428
903	7755, 7757
904	3423
905	6440
906	6451, 6448
907	6452
908	2112, 2135, 2134
909	4540
910	6449, 6460
911	6464
913	3430
914	6458, 4308, 2430, 2137, 2054, 2055, 2068, 5100, 2074, 3424, 3425, 1996, 4311, 2426, 4312, 5098
915	7896, 4675, 3413, 3937, 3476, 4213, 5027, 3477, 2098, 2084, 2139, 2141, 2100, 2131, 2148, 2154, 2092, 2099, 2428, 3435, 2072, 6463, 8009, 2105, 2104, 2102, 2093, 2128, 2094, 8016, 3429, 3426, 8017
916	4285
918	6483
919	4286
920	6484
921	4383, 5028, 2107, 8018, 2110, 4151, 2069
922	4266
923	7981, 2056
924	2062, 4653, 2080, 2126, 2095, 4287, 2048, 8086, 2047
925	5094, 7982
947	5031, 5116, 5033, 5127, 6574
948	4317
950	7852
955	4543, 4542
965	7823
970	7774, 2147, 2096, 2150, 8013, 2125, 2119, 2039, 2038, 2076, 2041, 8085, 6577, 3859, 3347, 2035, 2034, 2043, 2144, 3349, 2036, 6592, 2145, 2120, 2121, 6593, 4290, 2438, 2149, 4289, 4771, 2122, 2123, 3350, 2032, 8010, 4291, 3351, 2029, 2033, 2082, 4292, 5202, 4714, 4294, 2067, 2078, 5178, 5179, 2061, 2059, 2060, 8008, 8020, 7817, 4768, 2138, 3352, 3393, 4767, 4338, 8006, 3392, 2439, 4749, 4522, 8004, 3353, 7993, 5203, 5181, 5183, 5187, 4716, 5188, 2006, 5190, 7991, 2935, 2934, 8001, 7986, 2937, 7989, 3605, 3604, 2942, 7994, 7995, 2933, 5386
1453	7804
1454	5104
1455	7805
1456	7765
1458	7752
1459	4535, 1827
1460	5115
1461	4537
1463	5024

1464	5026
1465	3415
1467	5021
1468	6445
1469	2130
1470	5022, 5023
1472	4307
1473	6462
1474	4309, 6465, 5096, 4310, 6467, 5097, 5099
1477	8014
1479	8015, 4283
1480	2108
1482	7758
1488	8012
1491	2042, 2040
1494	1995, 5032, 5034, 5035, 2045
1508	7839
1509	7851
1510	7850
1512	6590
1513	4544
1517	4770
1519	7855
1520	7844
1524	2031, 2118, 2030, 2124
1525	6604
1547	6635
1554	5184
1564	5186, 6638, 5185, 4750, 4523

6. Pasco MPO

TSAZ	SWTAZ
347	6639
348	3044, 3046
349	3070
351	7950
352	2939, 7956, 2020
353	7014
357	2021, 2117, 5385
360	3651, 6647
363	8403, 3059, 8402
366	3032, 6658, 6661
377	4751, 4844
382	6674
393	4325
990	7978, 8405, 4242, 6657, 3646
994	3055, 2019, 3705, 8406, 4190, 1826, 4189, 1824, 8400, 6662, 1886, 6672, 1825, 2023
1001	3037
1004	2152, 6640, 2930, 5207, 4316, 7955, 2025, 8394, 8393, 2026, 2027, 7953, 1987, 8395, 8396, 5384, 7952, 2083, 2086, 4315, 2022, 2024, 8397, 2077, 8421, 4009, 2929, 8423
1007	6693
1013	6711
1555	7941
1558	7954
1559	2018
1561	8407, 7951, 8408, 8446, 8445
1562	7948, 3054
1567	3650, 7916, 7947
1569	7015, 7695, 1822, 8390, 1823, 8410, 3041, 6660
1570	3649, 6663
1580	3031

7. MetroPlan Orlando (Orange, Seminole, and Osceola)

TSAZ	SWTAZ
214	4150
216	6381
232	4013, 4024
337	6628
350	7479, 3672
354	1738
358	3830, 3335, 3331
361	7854, 6645, 3824
364	7441
365	7481
367	1744
368	7825, 2636
369	1474, 7466, 2364, 2365, 6648, 3670, 4584, 6649, 3905, 1742, 3323, 3907, 3334, 6652, 7473, 3906, 3324, 7477, 1584, 6659, 3829, 3770, 3768, 2415, 3769, 7467, 1739, 7474
370	3764
372	7834, 7832, 7833
373	6670, 6665, 7826
375	7835, 2643, 2644
376	7443
378	7497
379	7494, 1700
380	3908, 7489, 3910, 1473, 3909, 3911
383	7830, 6675, 3825, 6666, 3782
384	3761, 7496, 7495
385	7438, 7437, 6676, 7436, 7456
386	2640
387	7444, 7447
391	7492, 7491, 2635, 1641, 7493, 1639, 2416
392	1703, 3432, 1478, 7485, 7490, 1479, 7665
394	7483, 2400, 2399
395	6703, 6683, 6691, 3916, 1487, 7439, 6698, 2390, 7449
396	4126, 2393, 4125, 2391
397	1697, 6715, 6702, 1696, 6712, 6716
398	6695, 7532, 1701, 6696, 4375, 3405, 7533, 3403, 3402, 4376, 3400, 6706, 7674, 1748, 2366, 7676, 3399
399	7673, 6707, 6709, 6710, 1702, 1472, 1470, 7536
403	7670, 7534, 6705, 6708, 6713, 7678, 4377, 3398, 3397, 2362, 6720
404	7672, 7470, 6681, 6689, 7488, 7469, 7468, 7314, 2976, 7124
406	2652
407	7668, 3404, 7671, 1476, 2389, 7458, 3914, 7716, 7717, 2665, 2670, 7715, 1482, 7675, 7677, 3912, 2667, 7531, 2668, 2669, 7680, 2672, 2671, 3928, 3927, 2676, 2677, 7686, 2673, 7552, 2674, 7687, 7550, 3932, 2686
408	4823, 3925, 3923, 3924, 3919, 3920, 2678, 2680, 3504, 3918
409	7690
410	7651
411	7645
412	1468, 1477, 1469, 1466, 1662
413	6721, 3121

414	2654
416	7641, 3464, 2687
417	7657
418	7650, 3120
419	6718, 3124, 6722, 3470, 6725, 3123, 3473, 3128, 3127, 6727, 3471
420	7694, 7667, 7682, 2666, 7553, 7556, 4378, 7554, 7555, 2656, 2657, 2660, 2402, 2658, 2659
421	6729
422	2629
423	2691
424	3783, 6730, 3938, 2710
425	7724
428	7123, 4215, 2352, 7120, 7110, 2351, 4214, 7127, 7116
429	5403
430	7729
432	4366
436	7643, 7646, 7642, 7691, 3931, 4824, 7644, 2690, 3466, 7647, 3468, 3934, 3465, 7654, 7655, 2689, 2694, 7656, 7661, 7662, 7663, 2696, 2697, 2699, 7696, 2693, 1449, 7681, 4363, 3930, 2411, 1455, 7725, 2692, 4369, 7726, 7727, 4364, 1448, 7546, 3939, 7549, 3118, 2417, 4370, 1483, 1599, 7510, 4371, 7452, 1451, 2704, 2703, 2702, 1454, 1446, 7548, 3137, 7547, 2706, 1447, 7512, 7730, 1488, 1317, 1481
437	3472, 7461, 4236, 3131, 3129, 7530, 3125, 7451, 1445, 7538, 7545
438	1490, 7448
440	2681, 2682, 2679, 7649, 7666, 2663, 7659, 7660, 7664, 2653, 3459, 2650, 2661, 2662, 2664, 8071, 1699, 3463, 7509, 1663, 1475, 6736, 1457, 7507, 1491, 1698, 7513, 1465, 1458, 2711, 6745
441	7732
442	1314
443	6749
444	7731, 8516, 1503, 3861
445	6750
447	3390, 3389
448	1633
449	6751, 6752, 4337, 7736
450	6759
452	7506, 7523, 3860, 1601, 7521
453	2709, 7500, 2708, 7514, 7522, 1612
454	7740, 6763, 6764
455	7484
457	7350
458	7743
459	2343, 7737
460	6772
461	3844
462	6774
463	1613, 7515
464	6777
465	3840
466	3383, 1497
467	5129
469	6785
471	1602
474	3841, 3842, 6792, 1706, 7344

974	3669, 3330, 4607, 1587, 1581, 3832, 3333, 3322, 3321, 3332
975	3826
977	4000, 3328, 3329, 7478, 3671, 3325, 8493, 3811, 8492, 5236
979	3780
980	3827
981	7475, 3326, 6651, 1585, 7476
982	1741, 1740, 1583, 1743, 2418, 4719
983	6664
984	3767
985	7827
986	3760
987	6650, 5235, 7112, 8494
988	7829, 6667
991	3763
993	7434, 2647, 3904, 2649, 2646, 3458, 2648
995	7472, 3781
996	6680
1005	7487, 7482, 1610, 1640, 3883
1006	7440, 4121
1009	2642, 3941, 7445, 7446, 3940, 2641, 2639, 2401, 2403, 3915
1010	6704
1011	3401
1012	1471
1015	7544
1017	7684
1018	7459, 7450
1020	3922, 3921
1021	2637
1022	7692
1023	1609, 3913, 7543, 1443, 7541, 1467, 3122, 1441, 7460, 1442, 2675, 3933, 3936, 3117, 3469
1024	2363, 2655
1026	7652
1027	7714, 2630, 2634
1028	7648, 3467, 7639, 2695, 2698
1029	2632, 4379, 7535, 3785, 7291, 4228, 6723, 2633, 7688, 7125, 7126
1030	7683, 3462, 3926, 3917, 2398
1031	3460, 3461
1032	7640
1033	6731
1034	2410
1036	7462, 3130
1038	2631, 2367, 2358, 1484, 1456, 2716
1040	3119, 3126, 3134
1042	7733, 7734
1043	6753, 7689, 3929, 2685, 2683, 7720, 2688, 2684, 2713, 2700, 7728, 4227, 2712, 2714, 7505, 2715, 7498, 7508, 2701, 4365, 7503, 4367, 3505, 3506, 2705, 6740, 4374, 1464, 7501, 6748, 1463, 4373, 7502, 3509
1044	1502
1051	6760, 3510
1052	6762
1054	3784, 6697, 6701, 4348, 4030, 7121, 1594, 1338, 7122, 7118, 1843, 1352, 1336, 2628, 7114,

	1335, 3454, 5198, 1334, 2356, 2375, 3456
1055	7741, 3508, 6754, 5296
1058	6755, 1312, 1459, 1489, 1462, 1660, 1461, 6775, 1311, 1313, 1505, 1460, 1611, 1354
1059	6776
1062	7353, 7354
1063	4372, 7542, 1450, 3139, 7504, 6746, 1453, 2707, 1493, 3138, 1452, 1480, 1316, 1315, 1506, 3391, 3388, 1492, 1508, 1507, 1632, 7527, 1600, 7525, 6765, 1707, 7518, 7517, 1659, 1500, 7325, 7351, 1626, 7352, 3387, 1704, 1684, 1501, 7347, 1509, 1705, 6781
1065	1657, 1658
1069	7744, 2342
1071	1485, 7457, 4123, 7453, 7465, 1661, 3136, 3133, 4239, 3135, 3132, 1444, 7537, 7540, 7551, 1681, 6761, 1504, 4237, 5131, 3386, 3384, 3385, 1499, 7340, 1496, 1498, 6783, 7516, 3843, 1603, 7345, 1591, 2340, 1552, 2341, 1511, 1709
1544	7836, 7820
1552	7480
1563	7111, 4654, 7071, 7435, 4609
1565	6654
1568	3828, 7471
1571	1586
1572	3766
1573	4032
1574	7828
1575	2645
1581	7669
1582	6699
1583	6694, 6700, 7464, 7463
1587	7685
1588	6714, 4246
1589	7455, 4124, 7454
1592	7693
1593	3935
1595	2651, 6726
1596	7658
1597	4368
1598	7511
1600	7750
1602	7499
1603	7738, 7739
1604	7529
1605	7526
1606	7524
1607	2413, 7528, 1627
1608	7520
1609	3507, 8061, 4605, 5297
1611	1494, 1495
1612	7742, 1355
1613	6768, 6778, 1842
1614	1310
1616	7355
1632	7539, 7349, 5126, 4238, 1655, 1551, 1708, 1652, 1654, 1651, 1550, 1711, 1653, 1578, 7346, 1650, 4127, 1649, 7362, 7368, 3833, 1735, 6719, 1486, 6742, 3494, 4240, 6769, 4128

8. North Florida TPO (Duval, Clay, Nassau, and St. Johns)

TSAZ	SWTAZ
529	6910
533	6916
538	2264
541	6933
543	5848
544	7697, 6932, 6934, 6935, 4859, 6936
545	6938, 6941, 6942, 6943, 6949, 6950
546	6953
548	5842, 660
549	5833
550	4693
551	5838, 4815
552	5843, 5841
553	653
555	650
556	7577, 7578, 4045, 7320
557	646, 5260
559	6965, 3179
561	4086
562	5871
565	4047, 6966
566	500, 7415
567	7698, 4072, 651, 5872, 5828, 4071, 386, 507, 506, 7328, 5873, 4720, 392, 5874, 7331
571	6948, 4155, 2615, 4046, 7579, 4159, 4753, 4358, 4158, 7411
572	7335, 7329, 7339, 5263
573	7413, 4051, 7430, 7431
575	4156
576	4579, 7428, 4345
577	4344
578	5876, 5875
579	6971, 419
580	5870, 427, 276, 7699, 7386
581	5264
582	6974, 7424
583	6972, 4049, 7418
584	2251
585	6967, 558
586	2187, 5867
587	436, 3184
588	429, 3178, 655, 4048, 7416, 6973, 3187, 2258
589	4485, 4484
590	4078
591	5863, 5864
592	4738
593	4069
594	4060
595	4066, 6986, 5777

596	5774, 5773
597	5272, 431, 5868, 6985, 275, 5770, 5772, 5771, 5268, 5768, 5769
598	5775, 5776, 5239, 7009
599	1966, 1981, 5861, 1983, 3216, 2192, 5860, 5859
600	5273, 4825
601	5865
602	4067
604	5856, 5855, 4064
605	5766, 5767, 4058, 5765, 5237, 4057, 5683
606	5761, 4230, 5763, 4056, 4054
607	5759
608	5685
609	5757
610	4097, 7406, 7410, 7405, 7432, 4243, 7700, 7701, 7702, 4094, 7407, 473, 4099, 4826, 4098, 4096, 3183, 4095
611	434, 417
612	2421
613	5702, 5741, 5694, 5732, 5728, 5737, 5735, 5755, 5749, 4065, 5734, 5238, 5748, 5718, 5733, 4165, 5725, 5753, 5710, 5754, 5717, 5752, 5709, 5701, 4166, 5747, 5740, 5731, 5708, 5723, 5700, 5739, 5730, 5716, 5751, 5699, 5715, 5707, 4162, 5750, 5714, 5698, 5738, 5729, 5745, 5688, 5687, 5721, 5697, 4163, 5744, 5720, 5713, 4160, 5705, 5712, 5704, 5711, 5695, 5678, 5703, 5682, 5679, 5681, 5680, 3792, 3193, 3786, 3788
614	6988
616	7423
617	413
618	3774, 3202
620	3205
621	5668, 6990
622	5853, 5854
623	4382
624	5074
625	4387, 4386
629	3210
630	3209
631	5667
633	5851, 5852
651	3797, 440, 4092
657	6999
664	5150
1130	4154
1131	6922
1133	4866
1135	458
1136	410
1143	4869, 4865, 657, 658, 7419, 4860
1145	5148, 6937, 6939, 6940, 4861
1149	7315, 4043, 460, 4218, 5847, 4862, 490, 3174, 6952, 3175, 476
1152	2238
1153	7486
1154	4878
1157	4816

1158	661, 7580
1159	5844, 5840, 5837, 456
1162	5256, 4342
1163	7318
1164	4721
1165	3181
1166	3177, 3176, 4331
1167	7326
1168	509, 5836, 5832, 5834, 5258, 7321, 396, 6963, 5829, 7330, 645, 4872, 652, 666, 508, 5262, 4332, 7334, 388, 389, 644, 390
1170	7209, 7414, 4330
1173	6968
1175	7324, 4070, 7333
1176	3180, 7412, 1980, 2425, 7429, 510
1179	426
1187	7214, 5265
1190	5831, 4081, 4073, 4080, 7337, 2193
1192	5827
1194	3185, 418, 425, 3186, 424
1196	6984
1197	2252
1198	1965, 3219, 3218, 7421
1199	4052, 7408, 4050, 1974, 6982, 3190, 5274, 7213, 5229
1200	2253, 5140, 5676
1201	422, 435, 438, 437, 4704, 5267, 1978, 4705, 5270, 1967, 411, 5271, 5269, 5866, 421, 2190, 3436, 5862, 430, 1985, 3189
1203	3188, 4059
1204	7703
1205	4884
1206	4690
1207	5746
1208	5691, 5693, 5684
1209	5758
1210	5722
1211	4055, 5756
1213	5706
1214	5686
1215	5696, 4161
1216	7212
1217	3182
1218	5736, 5727, 5760, 3195, 3793, 3791, 3197, 6987, 3789, 3787
1220	5825
1221	5826
1222	4100, 7704, 4101, 7210, 7211, 4384
1223	5073, 5670, 2424, 7427, 4828, 4068, 7425, 4622, 8072, 4621, 7433, 7201, 5076
1224	5764, 3194, 5230, 1964, 3201, 432, 423, 505, 3204, 5231, 5138, 5139
1225	474, 7403, 659, 2220, 6969, 6970, 7012, 4827, 420, 7409, 7417, 4620, 273, 4483, 5075
1226	5674
1229	4389, 654
1230	6991, 6989, 5849, 5137
1231	5232

1232	4167, 5857, 5858, 2250, 2191, 4063, 4062, 2249, 5677, 3191, 472, 274, 3198, 3199, 4168, 416, 7404, 439, 414, 4061, 7422, 415, 3200, 511, 2423, 4381, 504, 5673, 5672, 3208, 4380, 7373, 7375, 4385, 428, 2257, 7374
1251	5850, 7380, 4093, 3211, 4090, 441
1252	3215, 3217, 2247, 412, 2422, 3203, 3207, 7376
1260	7378, 7379, 5134, 7382
1263	6994
1273	5664
1274	4688, 656, 6998
1279	5663, 5659, 5660
1285	5132, 4689, 4091, 7705, 3212, 3213, 7007
1666	6917, 4868
1667	6918, 4867, 5069, 5072, 6894, 6915, 4870
1670	4864, 6931, 7313
1671	3173, 4863, 3773
1672	459, 6945
1673	6947
1675	5259
1676	5839
1677	4333
1678	6958, 5846, 7317, 4406
1679	5845, 2613
1680	5835, 387, 7322, 5877
1681	649
1682	5257, 457, 7319, 5830, 2614
1683	406
1685	7323, 7357
1686	408, 5261, 647
1687	7327
1689	391
1690	464
1693	4079
1694	4157
1695	6955, 6956, 6961, 6959, 6954, 6957, 6960, 1979, 4405, 4343
1699	4706
1701	5266
1702	5869
1704	7336
1705	4329, 5194, 4324, 4734
1706	4623
1707	2248
1708	5742, 5743
1709	5726
1710	5141
1711	5762, 5675
1712	5724
1713	5692
1714	5690, 4164, 5689
1715	4053
1716	5719
1717	3192

1719	3790
1720	3196
1722	442
1723	5671
1724	7719
1726	512, 3796
1727	5669
1728	4388
1729	4390, 3206, 5233
1730	6992
1733	5135, 5666, 5136
1738	7377
1741	7383
1742	5665, 447
1743	7006, 7005, 7002, 7001, 7003, 7004, 6996, 6997, 5662, 5661, 5657, 5658, 4574, 4575
1748	7000, 5151

9. Sarasota-Manatee MPO

TSAZ	SWTAZ
170	6298
171	6299
172	6301, 4641
175	6309
176	4839
181	6323
186	6331
188	5014, 6335
189	4756, 8245, 8248
190	6339
192	4626, 6338, 8244, 8255, 8243, 6340, 8181, 8223, 133, 8212
193	6343
195	131
200	8226, 127
201	7799
202	5017
204	5163
205	8195, 8194, 8180, 5013, 1851, 8262, 137, 1852, 134, 8261, 8260, 7797, 1853, 3663, 7806, 4187, 5165, 8187
206	8185
209	4985
837	5376, 8236, 4652, 4758
838	8240
841	6305
843	6312
846	4841
855	8230
856	6333
857	4631, 4634, 5009
859	6334
862	8235, 4496, 8222, 8234, 3080, 4642, 3081, 6303, 8238, 6308, 6310, 6311, 4643, 4842, 183, 4489, 6325, 3078, 8251, 182, 4632, 181, 8250, 4755, 8076, 4624, 4625, 8249, 179, 8247, 180, 8246, 178, 8256, 135, 8253
863	5010
864	5015
865	8227
868	6349
874	7824
875	5114
876	5016, 6360
877	8192, 8200, 8188, 130, 129, 128, 8190, 6359, 4539
878	8196, 4335, 8198, 132, 4336, 8258, 8257, 8197, 7798, 8259, 5167, 5168, 138, 5166, 8233
884	4188, 8184, 8186, 4186, 8183, 8182, 4665, 4184
885	8228, 4392, 8224, 3662, 4185, 8231, 193
889	1850
890	4182, 1854, 4666
1410	4639, 4651, 5108, 5109, 8237, 5110, 5007, 4637, 4760, 4759, 5008, 4629
1411	6293, 4640, 4745, 4801, 4493, 4645, 4494, 4495

1412	3079
1413	6297, 6291, 4649, 4650, 2177, 8370, 2180, 2182, 2179, 4647, 8239, 4492, 8454, 4490, 4733, 8458, 8077, 4491, 4627, 8456, 8459, 11, 2178, 2181, 4628, 2183, 8202
1414	4644, 4646, 4498, 4497, 5113
1420	8232, 3082
1422	8263
1428	4487, 4488
1429	4757
1431	6332
1432	4633
1433	6336
1434	6337
1438	8193
1440	5011, 5012
1442	5020
1444	8074, 4538
1445	6361
1446	8075, 5164
1447	5018
1448	4536, 5208, 5209, 4509
1449	136
1450	4505
1451	4179

10. Alachua County

TSAZ	SWTAZ
530	2222, 2223
532	523
534	513, 514, 538
535	519, 532, 520, 537
536	1934
537	6907, 3903, 7735, 3311, 6889, 7384, 3452, 7385, 2612, 7398, 6890, 2224, 6893, 7393, 2609, 1931, 6895, 6896, 6897, 6899, 7399, 6901, 5363, 6902, 6903, 6904, 6905, 6906, 279, 7400, 6908, 6909, 5362, 6912, 6913, 289, 288, 292, 291, 297, 6914, 2225, 7395, 503, 293, 495, 310, 296, 7392
539	6924
540	6927
542	5808
1119	3942, 7397
1121	6898, 1932
1122	544, 6911
1123	1941
1124	494
1126	7394
1127	536
1128	531, 298, 527, 496, 1933, 7402, 534, 2233, 533
1132	300, 1923, 287, 7387, 2221, 7372, 2226, 2232
1138	539, 2610, 302, 306, 290, 1930, 1947, 6900, 305, 525, 526, 1940, 528, 522, 524, 515, 529, 521, 1946, 516, 3642, 304, 6925
1140	5814, 1935
1141	2228, 2603, 5810, 480, 541
1146	5809, 282
1178	2230, 7391, 2227, 3855, 3307, 3305, 3302, 2219, 2215, 2213, 2212, 477, 579, 5807, 328, 1968, 2210, 7389, 3233, 3227, 5803, 5802, 3491, 3228, 4076
1665	530
1668	299
1674	3857, 3856, 3304

11. Leon County

TSAZ	SWTAZ
626	728
628	5574
636	956
637	5576
639	2295
642	5573, 872, 1017, 5572, 5571, 1015, 5575, 3867, 5552, 5551, 5624, 5549, 5548, 5547, 5546, 5543, 5550, 3866, 5545, 5542, 3366, 3864, 1016, 879, 863, 5541, 5540, 3865, 5539, 5538, 5617, 5537, 5535, 3862, 5534, 5533, 3863, 5531, 5530, 5529, 5527, 5526, 5528, 5524, 5523, 864, 5522, 1012, 5520, 5521, 3364, 871, 865, 868, 1011, 876, 5516, 3365, 5511, 867, 5515, 869, 5514, 5513, 5512, 5577, 1010, 870, 866, 954, 1113, 884, 877, 2319, 2321, 2323, 3806, 3805
643	2320
646	4822
648	1008
1235	5544
1236	878, 1960, 880, 3868, 1957
1237	5536
1238	5532
1239	5519
1240	5525
1243	5517
1245	1959
1247	1009
1250	1013
1262	5649, 2281
1287	2322, 2324, 3409, 881, 1984, 2294, 2297, 5642, 3808, 5644, 5621, 1007, 738, 3363, 4413, 3362
1731	5518
1744	862

APPENDIX B

IDENTIFIED HOT ZONES FOR TOTAL CRASHES (TADs)

TAD ID	No of Segments	No of Intersections	TAD Index	Segment Index	Intersection Index	Integrated Screening
485	11	5	H	8	8	H88
468	48	4	H	6	9	H69
470	35	4	H	6	7	H67
487	51	15	H	6	4	H64
486	41	15	H	5	6	H56
214	14	6	H	5	1	H51
461	34	2	H	4	9	H49
467	29	4	H	4	9	H49
464	57	9	H	4	6	H46
490	40	8	H	4	6	H46
494	45	15	H	4	6	H46
489	22	10	H	4	5	H45
475	59	29	H	4	4	H44
472	20	8	H	4	3	H43
218	7	1	H	4	0	H40
481	23	2	H	3	9	H39
484	39	8	H	3	9	H39
460	44	4	H	3	7	H37
477	79	23	H	3	7	H37
215	22	6	H	3	5	H35
483	40	6	H	3	5	H35
491	43	16	H	3	5	H35
561	53	15	H	3	5	H35
264	44	10	H	3	4	H34
269	56	15	H	3	4	H34
471	13	3	H	3	3	H33
198	70	22	H	3	2	H32
469	27	5	H	3	2	H32
87	39	10	H	2	6	H26
307	78	15	H	2	6	H26
506	27	4	H	2	5	H25
303	68	19	H	2	4	H24
333	66	31	H	2	3	H23

473	25	9	H	2	3	H23
478	15	7	H	2	2	H22
60	102	65	H	2	1	H21
194	44	19	H	2	1	H21
174	20	3	H	2	0	H20
193	114	75	H	2	0	H20
476	15	2	H	1	5	H15
492	31	9	H	1	5	H15
34	108	43	H	1	3	H13
306	73	14	H	1	3	H13
79	63	20	H	1	2	H12
498	20	20	H	1	2	H12
67	54	19	H	1	1	H11
121	124	57	H	1	1	H11
175	61	13	H	1	1	H11
302	74	21	H	1	1	H11
510	30	17	H	1	1	H11
525	77	20	H	1	1	H11
259	111	60	H	1	0	H10
334	169	24	H	1	0	H10
361	53	12	H	1	0	H10
482	26	4	H	1	0	H10
479	19	4	H	0	5	H05
254	108	46	H	0	0	H00
355	105	30	H	0	0	H00
519	130	71	H	0	0	H00

APPENDIX C

IDENTIFIED HOT ZONES FOR SEVERE CRASHES (TADs)

TAD ID	No of Segments	No of Intersections	TAD Index	Segment Index	Intersection Index	Integrated Screening
323	33	12	H	7	9	H79
324	14	5	H	7	9	H79
326	19	9	H	6	6	H66
327	11	4	H	6	5	H65
264	44	10	H	4	5	H45
283	34	9	H	4	5	H45
493	63	30	H	4	2	H42
535	21	7	H	4	5	H45
87	39	10	H	3	5	H35
91	30	18	H	3	6	H36
257	45	11	H	3	2	H32
274	89	16	H	3	3	H33
483	40	6	H	3	5	H35
494	45	15	H	3	5	H35
506	27	4	H	3	7	H37
4	72	0	H	2	0	H20
80	41	24	H	2	5	H25
194	44	19	H	2	1	H21
256	79	17	H	2	3	H23
261	92	21	H	2	2	H22
269	56	15	H	2	2	H22
272	85	9	H	2	1	H21
279	26	4	H	2	0	H20
320	129	60	H	2	1	H21
334	169	24	H	2	2	H22
452	51	6	H	2	0	H20
470	35	4	H	2	0	H20
487	51	15	H	2	0	H20
497	76	20	H	2	3	H23
498	20	20	H	2	3	H23
0	76	25	H	1	0	H10
10	89	82	H	1	0	H10
15	55	41	H	1	1	H11

79	63	20	H	1	1	H11
82	67	23	H	1	0	H10
90	86	13	H	1	2	H12
92	32	20	H	1	4	H14
254	108	46	H	1	0	H10
259	111	60	H	1	0	H10
281	27	3	H	1	6	H16
293	48	17	H	1	2	H12
333	66	31	H	1	1	H11
350	140	56	H	1	0	H10
370	51	27	H	1	0	H10
378	78	12	H	1	3	H13
450	97	16	H	1	1	H11
451	37	6	H	1	6	H16
460	44	4	H	1	5	H15
478	15	7	H	1	2	H12
492	31	9	H	1	2	H12
496	115	30	H	1	0	H10
510	30	17	H	1	1	H11
60	102	65	H	0	0	H00
100	139	54	H	0	1	H01
251	336	50	H	0	0	H00
430	246	36	H	0	0	H00
455	61	38	H	0	0	H00
482	26	4	H	0	2	H02
519	130	71	H	0	0	H00

APPENDIX D

IDENTIFIED HOT ZONES FOR PEDESTRIAN CRASHES (SWTAZs)

SWTAZ ID	No of Segments	No of Intersections	SWTAZ Index	Segment Index	Intersection Index	Integrated Screening
1181	4	2	H	9	9	H99
2544	1	1	H	9	9	H99
3431	1	2	H	9	9	H99
3723	1	1	H	9	9	H99
4683	1	1	H	9	9	H99
5959	1	1	H	9	9	H99
6053	2	2	H	9	9	H99
6134	1	1	H	9	9	H99
7285	1	1	H	9	9	H99
7292	1	1	H	9	9	H99
864	4	2	H	9	5	H95
1749	2	2	H	9	5	H95
417	2	0	H	9	0	H90
1752	2	0	H	9	0	H90
2069	1	0	H	9	0	H90
2106	2	2	H	9	0	H90
2136	2	0	H	9	0	H90
2526	1	0	H	9	0	H90
2533	1	0	H	9	0	H90
2568	1	0	H	9	0	H90
2665	1	1	H	9	0	H90
2673	2	1	H	9	0	H90
2770	1	0	H	9	0	H90
2772	1	0	H	9	0	H90
2797	1	0	H	9	0	H90
2825	1	1	H	9	0	H90
3205	2	0	H	9	0	H90
3208	2	0	H	9	0	H90
3437	2	0	H	9	0	H90
3445	2	0	H	9	0	H90
3447	1	0	H	9	0	H90
3448	1	0	H	9	0	H90

3520	1	0	H	9	0	H90
3547	1	0	H	9	0	H90
3945	2	0	H	9	0	H90
3947	1	0	H	9	0	H90
3949	1	0	H	9	0	H90
4004	1	0	H	9	0	H90
4005	1	3	H	9	0	H90
4102	1	0	H	9	0	H90
4295	2	1	H	9	0	H90
4300	1	0	H	9	0	H90
4661	1	1	H	9	0	H90
4704	1	1	H	9	0	H90
4964	1	0	H	9	0	H90
5384	1	1	H	9	0	H90
5486	1	1	H	9	0	H90
5919	2	0	H	9	0	H90
5939	1	1	H	9	0	H90
5957	1	0	H	9	0	H90
5967	1	0	H	9	0	H90
6026	1	0	H	9	0	H90
6038	1	0	H	9	0	H90
6048	3	0	H	9	0	H90
6080	3	1	H	9	0	H90
6089	1	0	H	9	0	H90
6091	1	1	H	9	0	H90
6115	1	0	H	9	0	H90
6136	1	1	H	9	0	H90
6454	1	1	H	9	0	H90
7089	2	3	H	9	0	H90
7293	1	0	H	9	0	H90
7373	1	0	H	9	0	H90
7508	1	0	H	9	0	H90
8083	1	1	H	9	0	H90
8096	2	2	H	9	0	H90
8261	2	2	H	9	0	H90
8269	1	0	H	9	0	H90
8344	2	3	H	9	0	H90
8454	1	0	H	9	0	H90
3557	6	1	H	8	9	H89

7979	7	2	H	8	9	H89
1253	5	2	H	8	5	H85
4873	5	1	H	8	0	H80
3572	4	1	H	7	9	H79
3566	4	0	H	7	0	H70
5009	4	0	H	7	0	H70
5083	11	3	H	7	0	H70
2537	5	1	H	6	9	H69
2543	3	1	H	6	9	H69
2795	5	1	H	6	9	H69
3442	3	1	H	6	9	H69
3446	3	1	H	6	9	H69
3664	8	2	H	6	9	H69
4381	3	1	H	6	9	H69
1186	6	5	H	6	6	H66
3089	5	2	H	6	5	H65
4241	6	4	H	6	5	H65
7056	8	4	H	6	5	H65
7282	5	2	H	6	5	H65
7996	3	2	H	6	5	H65
8160	3	2	H	6	5	H65
2690	3	5	H	6	4	H64
1233	3	3	H	6	3	H63
3560	5	3	H	6	3	H63
2830	5	4	H	6	2	H62
965	5	2	H	6	0	H60
2086	5	3	H	6	0	H60
2101	3	1	H	6	0	H60
2521	3	1	H	6	0	H60
2548	5	2	H	6	0	H60
2653	3	0	H	6	0	H60
2882	3	1	H	6	0	H60
3636	3	4	H	6	0	H60
4689	3	0	H	6	0	H60
5403	3	2	H	6	0	H60
6108	3	0	H	6	0	H60
6146	3	0	H	6	0	H60
6423	3	0	H	6	0	H60
7075	3	2	H	6	0	H60

7300	5	1	H	6	0	H60
7303	3	1	H	6	0	H60
7507	3	3	H	6	0	H60
1021	4	1	H	5	9	H59
1254	2	1	H	5	9	H59
2389	2	1	H	5	9	H59
2554	4	1	H	5	9	H59
3074	12	1	H	5	9	H59
3125	2	1	H	5	9	H59
3400	2	2	H	5	9	H59
3732	2	1	H	5	9	H59
3979	2	1	H	5	9	H59
4598	2	1	H	5	9	H59
4916	2	2	H	5	9	H59
4992	2	1	H	5	9	H59
6867	2	1	H	5	9	H59
7305	6	1	H	5	9	H59
8156	2	1	H	5	9	H59
1457	6	5	H	5	6	H56
2843	7	3	H	5	6	H56
7509	6	3	H	5	6	H56
7715	6	3	H	5	6	H56
2343	2	2	H	5	5	H55
3563	2	2	H	5	5	H55
5090	6	2	H	5	5	H55
7275	4	2	H	5	5	H55
7280	2	2	H	5	5	H55
7307	6	2	H	5	5	H55
7308	7	2	H	5	5	H55
437	6	5	H	5	4	H54
2013	4	3	H	5	3	H53
1804	6	4	H	5	2	H52
2837	8	5	H	5	2	H52
2929	4	6	H	5	1	H51
506	4	3	H	5	0	H50
1039	8	2	H	5	0	H50
1229	2	0	H	5	0	H50
1630	6	4	H	5	0	H50
1756	4	0	H	5	0	H50

1805	2	0	H	5	0	H50
2147	2	2	H	5	0	H50
2402	2	1	H	5	0	H50
2478	4	1	H	5	0	H50
2755	2	0	H	5	0	H50
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2792	4	0	H	5	0	H50
2840	4	0	H	5	0	H50
2855	2	3	H	5	0	H50
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3450	2	0	H	5	0	H50
3516	2	0	H	5	0	H50
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3896	4	0	H	5	0	H50
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3950	2	0	H	5	0	H50
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4315	8	3	H	5	0	H50
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4468	4	3	H	5	0	H50
4483	2	1	H	5	0	H50
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5435	2	0	H	5	0	H50
6210	4	1	H	5	0	H50
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7060	2	1	H	5	0	H50
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7395	2	1	H	5	0	H50
7531	4	0	H	5	0	H50
7935	4	1	H	5	0	H50
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8248	2	3	H	5	0	H50
8418	2	0	H	5	0	H50
5443	5	1	H	4	9	H49
6745	7	3	H	4	6	H46
1761	5	2	H	4	5	H45
3176	5	2	H	4	5	H45
4003	7	2	H	4	5	H45
4836	11	6	H	4	5	H45
5385	7	4	H	4	5	H45
8036	17	2	H	4	5	H45
1273	5	5	H	4	4	H44
1554	5	3	H	4	3	H43
2806	7	3	H	4	3	H43
2827	17	3	H	4	3	H43
7077	7	3	H	4	3	H43
1967	7	4	H	4	2	H42
2052	7	4	H	4	2	H42
2711	12	8	H	4	2	H42
1468	5	6	H	4	1	H41
420	5	6	H	4	0	H40
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3975	10	0	H	4	0	H40
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2127	3	1	H	3	9	H39
2433	6	1	H	3	9	H39
2452	3	2	H	3	9	H39
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4107	3	1	H	3	9	H39
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7304	3	1	H	3	9	H39
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7506	6	2	H	3	9	H39
2488	12	5	H	3	6	H36
2670	8	6	H	3	6	H36
2823	6	3	H	3	6	H36
4061	10	3	H	3	6	H36
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6858	3	3	H	3	6	H36
436	3	2	H	3	5	H35
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1190	3	2	H	3	5	H35
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3385	3	2	H	3	5	H35
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2805	13	5	H	3	4	H34
2482	3	3	H	3	3	H33
3833	13	3	H	3	3	H33
5210	3	3	H	3	3	H33
1183	13	5	H	3	2	H32
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4455	8	4	H	3	2	H32
7247	11	7	H	3	2	H32
7081	6	6	H	3	1	H31
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120	6	2	H	3	0	H30
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1851	9	3	H	3	0	H30
1960	11	1	H	3	0	H30
2002	6	4	H	3	0	H30
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2956	10	2	H	3	0	H30
3077	10	3	H	3	0	H30
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3579	3	4	H	3	0	H30
3682	6	1	H	3	0	H30
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7046	9	3	H	3	0	H30
7083	10	1	H	3	0	H30
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8000	6	3	H	3	0	H30
8038	6	0	H	3	0	H30
8039	3	1	H	3	0	H30
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8426	3	2	H	3	0	H30
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8467	3	4	H	3	0	H30
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2826	15	5	H	2	6	H26
3906	4	3	H	2	6	H26
1192	5	2	H	2	5	H25
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2810	5	2	H	2	5	H25
3427	5	4	H	2	5	H25
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5177	4	2	H	2	5	H25
7253	4	2	H	2	5	H25
7422	10	2	H	2	5	H25
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8073	5	6	H	2	5	H25
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1219	7	5	H	2	4	H24
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868	5	3	H	2	3	H23
1187	18	9	H	2	3	H23
1241	7	6	H	2	3	H23
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2494	7	3	H	2	3	H23
2863	10	3	H	2	3	H23
7510	5	3	H	2	3	H23
178	14	4	H	2	2	H22
774	8	4	H	2	2	H22
817	4	4	H	2	2	H22
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2046	11	9	H	2	2	H22
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7185	8	5	H	2	2	H22
133	15	8	H	2	1	H21
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7238	7	7	H	2	1	H21
101	7	2	H	2	0	H20
142	5	0	H	2	0	H20
176	9	5	H	2	0	H20
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1295	4	0	H	2	0	H20
1855	9	2	H	2	0	H20
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2323	13	5	H	2	0	H20
2464	5	1	H	2	0	H20
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8383	15	2	H	2	0	H20
8395	14	6	H	2	0	H20
1277	8	1	H	1	9	H19
2332	8	1	H	1	9	H19
3429	6	1	H	1	9	H19
4962	9	2	H	1	9	H19
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276	7	3	H	1	6	H16
2822	6	3	H	1	6	H16
1990	10	4	H	1	5	H15
3334	9	2	H	1	5	H15

7930	7	2	H	1	5	H15
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7477	8	5	H	1	4	H14
527	8	3	H	1	3	H13
755	6	3	H	1	3	H13
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2951	11	3	H	1	3	H13
3559	26	10	H	1	3	H13
4010	6	3	H	1	3	H13
7258	11	6	H	1	3	H13
7473	7	3	H	1	3	H13
1424	14	7	H	1	2	H12
1463	9	8	H	1	2	H12
2041	17	5	H	1	2	H12
2049	15	4	H	1	2	H12
2451	6	4	H	1	2	H12
2456	17	4	H	1	2	H12
4269	9	5	H	1	2	H12
5617	15	4	H	1	2	H12
7899	8	4	H	1	2	H12
41	17	6	H	1	1	H11
1247	11	6	H	1	1	H11
8223	15	14	H	1	1	H11
8255	15	9	H	1	1	H11
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61	13	3	H	1	0	H10
408	11	2	H	1	0	H10
1170	16	16	H	1	0	H10
1205	10	5	H	1	0	H10
1249	11	3	H	1	0	H10
1260	6	1	H	1	0	H10
1455	8	2	H	1	0	H10
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1578	7	2	H	1	0	H10
1662	10	2	H	1	0	H10
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2000	6	3	H	1	0	H10

2048	16	7	H	1	0	H10
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2110	7	1	H	1	0	H10
2321	13	5	H	1	0	H10
2466	11	0	H	1	0	H10
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2888	6	0	H	1	0	H10
2912	8	1	H	1	0	H10
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2995	12	4	H	1	0	H10
3140	7	0	H	1	0	H10
3648	9	2	H	1	0	H10
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4180	7	3	H	1	0	H10
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4795	12	2	H	1	0	H10
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5616	7	5	H	1	0	H10
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6775	9	3	H	1	0	H10
7023	6	0	H	1	0	H10
7048	16	3	H	1	0	H10
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7466	11	3	H	1	0	H10
7502	14	2	H	1	0	H10
7905	9	2	H	1	0	H10
7923	26	5	H	1	0	H10
8199	7	2	H	1	0	H10

8245	19	2	H	1	0	H10
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8462	22	3	H	1	0	H10
105	4	1	H	0	9	H09
1024	3	1	H	0	9	H09
1180	3	2	H	0	9	H09
1476	0	1	H	0	9	H09
1750	3	1	H	0	9	H09
1816	5	1	H	0	9	H09
2514	0	1	H	0	9	H09
2527	3	1	H	0	9	H09
2748	6	1	H	0	9	H09
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3736	5	1	H	0	9	H09
4270	13	2	H	0	9	H09
4844	3	1	H	0	9	H09
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5992	0	2	H	0	9	H09
6073	0	1	H	0	9	H09
6086	0	1	H	0	9	H09
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7624	1	1	H	0	9	H09
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8097	0	1	H	0	9	H09
8143	0	1	H	0	9	H09
8194	5	1	H	0	9	H09
7556	2	3	H	0	6	H06
948	3	2	H	0	5	H05
1477	4	6	H	0	5	H05
1806	7	2	H	0	5	H05
2009	3	2	H	0	5	H05
2033	2	2	H	0	5	H05
2109	4	4	H	0	5	H05

2489	1	2	H	0	5	H05
2689	1	2	H	0	5	H05
3679	3	2	H	0	5	H05
3752	1	2	H	0	5	H05
3917	3	2	H	0	5	H05
4845	4	2	H	0	5	H05
4978	2	2	H	0	5	H05
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7957	2	2	H	0	5	H05
8185	3	2	H	0	5	H05
137	11	5	H	0	4	H04
146	7	3	H	0	3	H03
423	1	3	H	0	3	H03
833	8	3	H	0	3	H03
1815	6	3	H	0	3	H03
2828	11	3	H	0	3	H03
3849	2	3	H	0	3	H03
7058	6	3	H	0	3	H03
8249	16	3	H	0	3	H03
1559	2	4	H	0	2	H02
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2959	7	4	H	0	2	H02
3062	11	4	H	0	2	H02
3829	7	4	H	0	2	H02
7050	21	5	H	0	2	H02
7713	13	5	H	0	2	H02
7966	13	9	H	0	2	H02
8251	19	10	H	0	2	H02
8336	4	5	H	0	2	H02
1456	10	9	H	0	1	H01
2024	5	6	H	0	1	H01
3464	4	9	H	0	1	H01
4264	45	6	H	0	1	H01
7170	52	18	H	0	1	H01
7216	6	6	H	0	1	H01
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11	2	0	H	0	0	H00
34	1	0	H	0	0	H00
63	11	5	H	0	0	H00

135	12	6	H	0	0	H00
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157	3	2	H	0	0	H00
269	4	0	H	0	0	H00
300	10	0	H	0	0	H00
453	6	1	H	0	0	H00
473	2	1	H	0	0	H00
504	2	1	H	0	0	H00
538	3	2	H	0	0	H00
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820	10	3	H	0	0	H00
827	9	2	H	0	0	H00
887	24	6	H	0	0	H00
960	18	1	H	0	0	H00
1049	2	1	H	0	0	H00
1216	1	0	H	0	0	H00
1217	10	2	H	0	0	H00
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1228	5	3	H	0	0	H00
1230	4	3	H	0	0	H00
1240	17	4	H	0	0	H00
1250	4	0	H	0	0	H00
1290	3	0	H	0	0	H00
1310	7	1	H	0	0	H00
1321	9	8	H	0	0	H00
1336	15	3	H	0	0	H00
1385	5	2	H	0	0	H00
1412	28	8	H	0	0	H00
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1545	11	4	H	0	0	H00
1547	3	0	H	0	0	H00
1581	26	11	H	0	0	H00
1596	1	0	H	0	0	H00

1606	5	0	H	0	0	H00
1661	6	0	H	0	0	H00
1739	1	0	H	0	0	H00
1751	0	0	H	0	0	H00
1758	3	1	H	0	0	H00
1789	20	3	H	0	0	H00
1852	20	6	H	0	0	H00
1863	14	4	H	0	0	H00
1996	1	0	H	0	0	H00
2018	9	6	H	0	0	H00
2047	5	1	H	0	0	H00
2067	30	11	H	0	0	H00
2077	0	1	H	0	0	H00
2087	4	2	H	0	0	H00
2089	2	2	H	0	0	H00
2094	4	2	H	0	0	H00
2107	1	0	H	0	0	H00
2116	6	2	H	0	0	H00
2150	2	1	H	0	0	H00
2155	2	1	H	0	0	H00
2163	0	0	H	0	0	H00
2223	4	2	H	0	0	H00
2227	6	2	H	0	0	H00
2247	15	6	H	0	0	H00
2293	4	1	H	0	0	H00
2345	6	2	H	0	0	H00
2383	1	0	H	0	0	H00
2428	7	0	H	0	0	H00
2437	4	0	H	0	0	H00
2445	1	0	H	0	0	H00
2509	0	0	H	0	0	H00
2510	0	0	H	0	0	H00
2511	0	0	H	0	0	H00
2513	0	0	H	0	0	H00
2515	1	0	H	0	0	H00
2516	2	0	H	0	0	H00
2529	0	0	H	0	0	H00
2530	0	0	H	0	0	H00
2535	0	0	H	0	0	H00
2536	1	0	H	0	0	H00
2545	0	0	H	0	0	H00
2561	2	1	H	0	0	H00

2565	1	0	H	0	0	H00
2566	0	0	H	0	0	H00
2649	11	3	H	0	0	H00
2668	0	0	H	0	0	H00
2672	9	1	H	0	0	H00
2739	2	0	H	0	0	H00
2774	3	0	H	0	0	H00
2779	1	0	H	0	0	H00
2789	0	0	H	0	0	H00
2793	0	1	H	0	0	H00
2864	2	1	H	0	0	H00
2871	5	3	H	0	0	H00
2896	1	1	H	0	0	H00
2917	12	4	H	0	0	H00
2922	10	2	H	0	0	H00
2927	11	1	H	0	0	H00
2928	5	1	H	0	0	H00
2944	2	1	H	0	0	H00
2947	0	1	H	0	0	H00
2992	7	1	H	0	0	H00
3050	2	0	H	0	0	H00
3065	4	1	H	0	0	H00
3087	0	0	H	0	0	H00
3088	1	0	H	0	0	H00
3091	0	0	H	0	0	H00
3094	4	0	H	0	0	H00
3103	6	1	H	0	0	H00
3114	9	6	H	0	0	H00
3131	0	1	H	0	0	H00
3160	16	2	H	0	0	H00
3324	2	1	H	0	0	H00
3328	6	0	H	0	0	H00
3420	3	0	H	0	0	H00
3430	0	1	H	0	0	H00
3440	0	0	H	0	0	H00
3444	0	0	H	0	0	H00
3449	0	2	H	0	0	H00
3493	11	5	H	0	0	H00
3498	3	0	H	0	0	H00
3536	1	0	H	0	0	H00
3539	1	0	H	0	0	H00
3545	0	0	H	0	0	H00
3546	1	0	H	0	0	H00
3596	7	2	H	0	0	H00

3601	13	4	H	0	0	H00
3617	2	3	H	0	0	H00
3662	24	1	H	0	0	H00
3665	2	0	H	0	0	H00
3701	2	1	H	0	0	H00
3704	10	1	H	0	0	H00
3720	1	2	H	0	0	H00
3721	1	0	H	0	0	H00
3724	0	1	H	0	0	H00
3734	0	0	H	0	0	H00
3778	1	2	H	0	0	H00
3808	7	0	H	0	0	H00
3847	3	1	H	0	0	H00
3854	13	6	H	0	0	H00
3879	0	0	H	0	0	H00
3897	0	0	H	0	0	H00
3899	1	0	H	0	0	H00
3927	0	1	H	0	0	H00
3946	0	0	H	0	0	H00
3972	1	0	H	0	0	H00
3973	6	0	H	0	0	H00
3976	1	0	H	0	0	H00
3977	0	0	H	0	0	H00
3978	2	1	H	0	0	H00
3980	0	0	H	0	0	H00
3985	5	0	H	0	0	H00
3986	0	0	H	0	0	H00
3995	0	0	H	0	0	H00
4029	5	0	H	0	0	H00
4033	6	0	H	0	0	H00
4071	2	1	H	0	0	H00
4080	13	1	H	0	0	H00
4123	2	0	H	0	0	H00
4175	3	0	H	0	0	H00
4190	19	5	H	0	0	H00
4232	7	1	H	0	0	H00
4296	1	0	H	0	0	H00
4305	3	1	H	0	0	H00
4384	4	3	H	0	0	H00
4449	0	0	H	0	0	H00
4458	4	3	H	0	0	H00
4466	2	1	H	0	0	H00
4479	1	0	H	0	0	H00
4484	5	5	H	0	0	H00

4496	6	2	H	0	0	H00
4546	0	0	H	0	0	H00
4547	1	0	H	0	0	H00
4548	0	0	H	0	0	H00
4549	1	0	H	0	0	H00
4550	0	0	H	0	0	H00
4551	0	0	H	0	0	H00
4552	0	0	H	0	0	H00
4626	1	1	H	0	0	H00
4653	8	4	H	0	0	H00
4672	0	0	H	0	0	H00
4755	2	3	H	0	0	H00
4765	8	0	H	0	0	H00
4817	0	0	H	0	0	H00
4826	4	1	H	0	0	H00
4871	15	4	H	0	0	H00
4885	2	0	H	0	0	H00
4975	1	0	H	0	0	H00
4987	0	0	H	0	0	H00
5005	2	0	H	0	0	H00
5064	0	0	H	0	0	H00
5179	1	1	H	0	0	H00
5187	7	1	H	0	0	H00
5571	6	2	H	0	0	H00
5611	1	1	H	0	0	H00
5744	1	1	H	0	0	H00
5926	1	0	H	0	0	H00
5943	1	0	H	0	0	H00
5950	0	0	H	0	0	H00
6006	1	0	H	0	0	H00
6007	0	0	H	0	0	H00
6020	0	0	H	0	0	H00
6022	1	0	H	0	0	H00
6028	0	0	H	0	0	H00
6039	0	0	H	0	0	H00
6042	0	0	H	0	0	H00
6043	0	0	H	0	0	H00
6057	0	1	H	0	0	H00
6059	0	0	H	0	0	H00
6071	0	0	H	0	0	H00
6074	0	0	H	0	0	H00
6192	0	0	H	0	0	H00
6389	0	0	H	0	0	H00
6396	0	0	H	0	0	H00

6446	0	0	H	0	0	H00
6471	3	1	H	0	0	H00
6574	1	0	H	0	0	H00
6740	33	11	H	0	0	H00
6792	0	0	H	0	0	H00
6817	4	4	H	0	0	H00
6892	7	2	H	0	0	H00
7029	4	0	H	0	0	H00
7059	3	1	H	0	0	H00
7119	3	0	H	0	0	H00
7121	18	2	H	0	0	H00
7154	4	0	H	0	0	H00
7156	3	1	H	0	0	H00
7161	15	6	H	0	0	H00
7241	12	5	H	0	0	H00
7249	2	0	H	0	0	H00
7369	9	2	H	0	0	H00
7386	3	2	H	0	0	H00
7470	1	0	H	0	0	H00
7915	1	1	H	0	0	H00
7988	1	0	H	0	0	H00
8005	2	0	H	0	0	H00
8023	0	0	H	0	0	H00
8030	0	0	H	0	0	H00
8035	1	0	H	0	0	H00
8037	13	1	H	0	0	H00
8043	3	0	H	0	0	H00
8057	4	1	H	0	0	H00
8060	1	0	H	0	0	H00
8065	1	0	H	0	0	H00
8082	0	0	H	0	0	H00
8084	0	0	H	0	0	H00
8109	1	0	H	0	0	H00
8142	2	0	H	0	0	H00
8145	0	0	H	0	0	H00
8149	1	0	H	0	0	H00
8153	1	0	H	0	0	H00
8171	0	0	H	0	0	H00
8179	0	0	H	0	0	H00
8181	2	1	H	0	0	H00
8195	0	0	H	0	0	H00
8216	3	1	H	0	0	H00
8257	9	3	H	0	0	H00
8259	3	3	H	0	0	H00

8283	7	2	H	0	0	H00
8309	5	0	H	0	0	H00
8312	4	6	H	0	0	H00
8324	5	1	H	0	0	H00
8346	3	0	H	0	0	H00
8393	9	0	H	0	0	H00
8421	13	3	H	0	0	H00
8441	23	5	H	0	0	H00
8442	14	3	H	0	0	H00
8451	5	1	H	0	0	H00
8459	6	1	H	0	0	H00
8461	6	1	H	0	0	H00
8475	9	3	H	0	0	H00
8504	2	2	H	0	0	H00
8507	9	3	H	0	0	H00
8509	6	1	H	0	0	H00