Identification of AASHTO Context Classification

FINAL DRAFT REPORT

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SUMMARY

NCHRP Report 855 — *An Expanded Functional Classification for Highways and Streets* (Stamatiadis et al. 2018) — and the 7th Edition of the *Policy of Geometric Design for Highways and Streets* (*Green Book* (GB7)) laid out a framework for developing contextual multimodal solutions through the expansion of contexts and recognizing the needs of all roadway users. However, transportation agencies implementing the GB7 Context Classification System lack well-defined methodologies and measures to determine the roadway context and its influence on design and operations.

This research develops practical guidance state, regional, and local transportation agencies can use to identify the appropriate Context for an area or transportation project. The guidance establishes stratified measures to determine context categories at state, Regional/Metropolitan Planning Organizations (MPOs), and local corridor levels. The framework was developed using a two-phased approach. Phase I involved a review and synthesis of literature on expanded context classification systems, a survey of transportation agencies to understand what data are required for implementation and documenting challenges associated with implementation of expanded context classification systems, and development of a proposed set of contexts. Phase II refined the proposed contexts; established Transportation Expectations, which define how users expect to move in and around an area; evaluated potential measures for applying Context Classification; and developed an Application Manual to help agencies establish Context Classification systems.

The literature review identified state agencies that have developed expanded context classification systems, focusing on their approaches and how they define contexts. A key feature of expanded context classification systems is the identification of contexts and their operational definitions. Most agencies that have adopted an expanded context classification system use five or six context categories, except for the Florida Department of Transportation (DOT), which uses eight, and the Minnesota DOT, which uses nine. Some commonalities are evident among all agencies. A review of definitions adopted by each state agency serves as the foundation for definitions that other agencies can use when contemplating adoption of an expanded context classification system.

In general, agencies describe each context based on predominant land use, modal interaction and priorities, and quantitative and qualitative measures, including building setbacks, parking availability, access potential and driveway frequency, and building types, heights, and orientations. In addition to a general description of the context, some agencies provide a list of key characteristics that more sharply define the context. The review of state-specific definitions supported development of updated general context descriptions encompassing most of the measures and descriptors from several agencies.

The survey of the practice solicited information on whether agencies have adopted, are planning to adopt, or do not plan to adopt an expanded context classification system. Information requested by the survey included data used by agencies which have instituted an expanded system and reasons given by agencies which do not plan to use an expanded system. In total, 44 state responses were received. Ten states have adopted an expanded context classification system. Eighteen plan to implement one, and 16 plus Washington, D.C., do not plan implementation. California and Massachusetts have also implemented an expanded context classification but did not respond to the survey. A key barrier to implementation noted by agencies that have adopted expanded context classification systems is the need for better awareness of its impact throughout project development. This could be accomplished through training and/or better documentation. Responses indicated that there have been no overall issues when rolling out expanded classification. States planning implementation cited several barriers, including the need for better training on how expanded context classification impacts project development and the effects of institutional inertia. Two agencies do not anticipate any issues, and two others are just starting the process and have confronted no issues.

Of importance also is how the role of context classification in the project development process is defined. As demonstrated by NCHRP 855 and NCHRP Project 15-77, the purpose of expanded context classification is to help practitioners identify the project concept's starting point when the project is initialized and to

inform project decisions throughout planning and project development. This starting point can be adjusted and modified to fit the project's individual context and constraints. Expanded context classification therefore establishes and communicates the expectations for each context, which in turn sets in place guiding principles design teams can use to advance the project to the next stage of project development. As part of the research, the concept of *Transportation Expectations* was developed, which are fundamental concepts that define how users expect to move within a given context. For example, in Urban Cores users may expect to travel over short distances more easily by nonmotorized means than by vehicles. Conversely, in Rural settings higher speed, auto-based trips are expected due to longer travel distances. Five fundamental Transportation Expectations have been identified: 1) Users/Vehicles, 2) Movement, 3) Permeability, 4) Network, and 5) Speed.

Additional contexts beyond those in GB7 were evaluated to determine if they should be carried forward as part of this project and incorporated into GB8, or if they are more representative of individual state development patterns and contexts and should be excluded. These contexts were evaluated based on two criteria. First, whether the context presents a unique set of Transportation Expectations or informs design differently than established categories. This lets the practitioner determine if the context will better inform project development than existing contexts or decide if the context simply appears different. The second criterion was whether the described context occurs frequently enough across all agencies and within those agencies to justify a unique context. Using these criteria, a systematic evaluation of the Natural, Suburban Commercial, Suburban Residential, and Industrial/Port/Warehouse contexts was undertaken. The conclusions of the review are as follows:

- **Natural:** Based on Transportation Expectations being similar to Rural Contexts, the limited and varied need for use, and the minimal impact on geometric design needs, it should not be included as a separate Context. It can be addressed as a Special Context with limited use as needed.
- **Industrial/Port/Warehouse:** Based on the minimal changes in Transportation Expectations relative to surrounding Contexts, the limited potential use, and the absence of impact on geometric design needs, it should not be included a separate Context. It can be addressed as a Special Context within the surrounding context.
- **Suburban:** This Context should not be divided into Residential and Commercial Contexts. Instead, a single Context should be retained since minimal impacts on geometric design needs were identified. Project-specific considerations could be used to address the unique needs of predominant land uses.

The following contexts are included in the Context Classification system: Rural, Rural Town, Suburban, Urban, and Urban Core. The report defines each context and their associated Transportation Expectations. Context definitions were developed using a concise general template that foster clear communication among everyone involved in project development. The template defines the Context's predominant land use(s), typical population densities, and anticipated building densities and setbacks. These brief definitions do not contain information about users, vehicles, access, mobility, or other descriptors since these are documented in the Transportation Expectations. A set of images (aerials and street views) are included that visualize each Context.

Measures that can help agencies classify areas into the appropriate context were examined. Measures used by states currently employing an expanded context classification system served as the starting point for recommended measures. Two primary factors were used to determine the applicability of measures for the proposed system. First, measures were evaluated on how well they can inform the Transportation Expectations associated with each Context. This ensured that information the Context is intended to convey is applicable by directly relating measures to Transportation Expectations. Second, an evaluation of data availability for each measure within each state and an evaluation of which step of the project development process the data may be available were performed. The resulting measures used to define Contexts include intersection density (derived from roadway centerline mapping files) and building densities (derived from the nationwide Microsoft Bing Building Footprint dataset). Intersection density directly relates Movement,

Permeability, and Network Transportation Expectations. Building densities serve as a surrogate for development intensities, which can influence nonmotorized short trip opportunities and users.

An Application Manual was developed that agencies can use to facilitate Context Classification implementation. The Manual provides case studies that test the proposed Contexts, their measures, and establishes the basis for specifying the ranges of measures used to define each Context. The Manual includes a high-level review of the relationship between Context and design, a comprehensive list of measures used for classification, a review of data sources needed to derive the proposed measures, a discussion of issues relevant to the proposed Context Classification System related to implementation and implications for current practices, a detailed description of Contexts along with representative imagery, and case studies that demonstrate the application and implementation of Context Classification.

CHAPTER 1

Introduction and Research Approach

Problem Statement

NCHRP Report 855 — *An Expanded Functional Classification for Highways and Streets* (Stamatiadis et al. 2016) — and the 7th Edition of the *Policy of Geometric Design for Highways and Streets* (*Green Book* (GB7); AASHTO 2018) have laid the foundation for an expanded context classification system to assist transportation agencies in delivering multimodal contextual designs and operations. The move from functional classification to a context-based organizing framework enriches place-based understandings of roadways and their functions. This can be achieved by identifying likely roadway users during the early stages of project development to foster a more systematic and data-driven method of project programming and development. This philosophy has been tested and applied successfully by several State Departments of Transportation (DOTs) over the last 10 years, including those in Florida, Maryland, Massachusetts, Minnesota, Oregon, Pennsylvania, and Washington.

For the past five decades, highway projects in the United States have been anchored by the highway functional classification system (FCS). While initially developed as a funding classification system, the FCS eventually became a surrogate for design inputs, such as traffic demand and design speed. Standards based on the FCS often severely limit design choices when developing a transportation solution intended to: 1) meet the purpose and needs of today's transportation projects, and 2) be adapted to the context in which they are expected to be successful. The binary urban/rural context designation of the FCS lacks the necessary resolution to develop truly context sensitive designs. Because the FCS does not recognize nonmotorized and vulnerable users, they are deprioritized, even in contexts demanding their inclusion or primacy.

NCHRP Report 855 and GB7 have provided a framework for developing contextual multimodal solutions through the expansion of contexts and recognizing the needs of all roadway users. However, transportation agencies implementing the GB7 context classification lack well-defined methodologies and measures necessary to effectively determine the roadway context and its implications for design and operations. Context encompasses a spectrum of land use types, from natural lands to urban centers, and evolves over time. Current thinking about context classifications is also shifting from areawide definitions that employ an urban/rural dichotomy to a project-level definition based on the interaction of the roadway and its environment. These issues present significant challenges to agencies attempting to classify roadway context.

Research Objectives and Approach

The objective of this research is to develop practical guidance State, regional, and local transportation agencies can use to identify the appropriate Context for an area or transportation project. This guidance will:

- Define meaningful Contexts that can be used to inform the project development process, and
- Define measures that can be used to categorize environments adjacent to roadways into the established Contexts.

The guidance establishes stratified measures to determine Contexts at the State, Regional/Metropolitan Planning Organizations (MPOs), and local corridor levels. In addition, factors for determining context change and edge stability are established. Identifying roadway context can inform practitioners of potential roadway user needs and constraints and help them achieve balanced mobility and safety.

A two-phased approach has been adopted to develop this framework. The first phase involved a review and synthesis of literature on current uses of expanded context classifications; a survey of transportation agencies to define issues that had to be addressed during implementation of expanded context classifications and required data sources; and the development of a proposed set of contexts. During Phase II, the team refined the pertinent measures for each Context, further elaborated each, and developed an application Manual for states adopting the proposed Context Classification.

The required tasks, as outlined in the NCHRP Research Project Statement, to accomplish the research are presented in Table 1.

Table 1. Research tasks

Task 1-State of Practice Definition
Review existing literature to identify classification measures and their data requirements, catalogue other modal context classification approaches, and conduct surveys and interviews to establish the state of the practice for expanded context classification.
Task 2-Context Classification Definition
Develop a comprehensive list of recommended Contexts and elaborate their definitions, including visual representations.
Task 3-Context Measures Development
Develop a comprehensive list of measures for context classification and their required data.
Task 4-Interim Report Submission
Prepare an Interim Report summarizing the results of Tasks 1 through 3, including an outline of the guidance document for context classification. Meet with the NCHRP panel to discuss proposed measures and draft guide.
Task 5-Guidance Development
Upon panel approval, develop comprehensive context classification guidance including a set of case studies that demonstrate application and benefits.
Task 6-Final Report Submission
Prepare a final report that documents the entire research effort and recommends future research needs. The report includes the standalone guidance, webinar material, and infographic material for briefings for policymakers and decision makers.

Organization of the Report

This report documents the findings of research completed during development of the framework and the Manual. Research results are included along with recommendations for future research. The components of this report are as follows:

- Chapter 2 – Literature Synthesis – documents the state of practice for expanded context classification systems
- Chapter 3 – Survey of Practice – summarizes DOT survey and interview results from states implementing an expanded context classification system

- Chapter 4 – Context Classification Role – identifies the role of the proposed Context Classification System within the project development process, which identifies five key Transportation Expectations associated with each Context
- Chapter 5 – Context Classification Review – discusses an evaluation of new Contexts identified by other users
- Chapter 6 – Context Classifications – presents definitions and associated Transportation Expectations for each proposed Context
- Chapter 7 – Context Classification Measures – presents the methodology for selecting Context Classification measures and provides the application thresholds
- Chapter 8 – Context Classification Implementation – discusses the implementation of the proposed measures and the calibration of the thresholds for local application
- Chapter 9 – Application Manual – discusses the Application Manual and provides information on implementation steps
- Chapter 10 – Conclusions – summarizes study objectives, project findings, and recommendations for future research work.
- Appendices– present the complete data analysis of the Context measures considered and include the Manual for applying Context Classification, including case studies demonstrating its application.

CHAPTER 2

Literature Review

This review evaluates recent efforts at state DOTs to implement expanded context classification.

Evolution of Context Classification

Historically, agencies have classified roadways using a system with two categories — urban and rural. But these basic systems fail to convey an understanding of project expectations or constraints, which is needed to develop effective, contextually appropriate multimodal designs. Recognizing this shortcoming, many agencies have developed independent context classification systems. NCHRP Report 855 (Stamatiadis et al. 2018) built on work by these agencies and proposed a Context Classification system with five categories — Rural, Rural Town, Suburban, Urban, and Urban Core. This system was integrated into GB7 and carried into the *GB8 Vision and Roadmap*. The foundational efforts upon which this system was developed are discussed below.

SmartCode (CATS 2003) represented an early effort to devise an expanded context classification system and aimed to create a unified development ordinance based on the concepts of Smart Growth and New Urbanism. This approach is based on the transect concept and uses a rural-to-urban continuum divided into six zones — Natural, Rural, Suburban, General Urban, Urban Center, and Urban Core (Figure 1). A Special District category is used for special areas with characteristics that do not match any of the other zones. Zones are delineated based on land use and density, building setbacks, roadway network density, and the presence of pedestrian infrastructure.

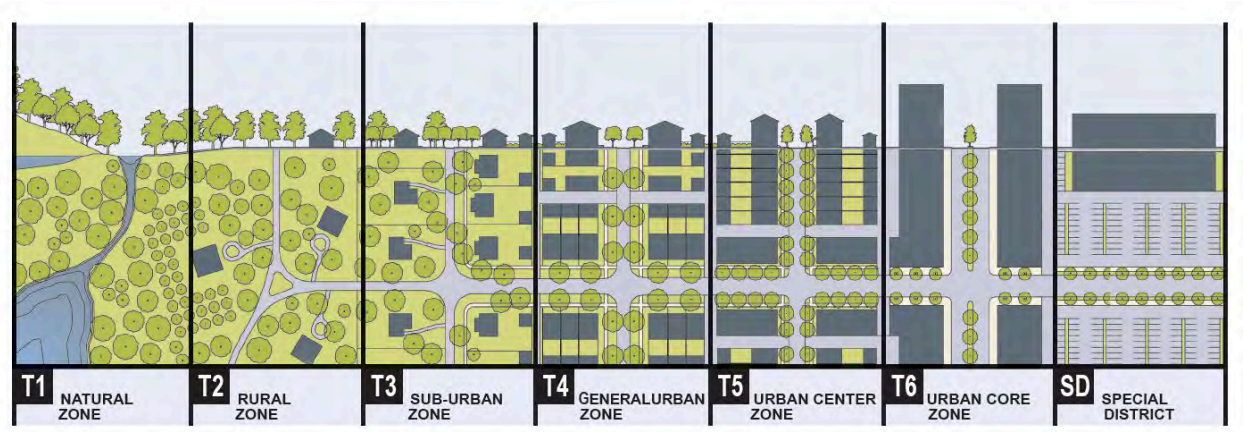

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Figure 1. Development continuity

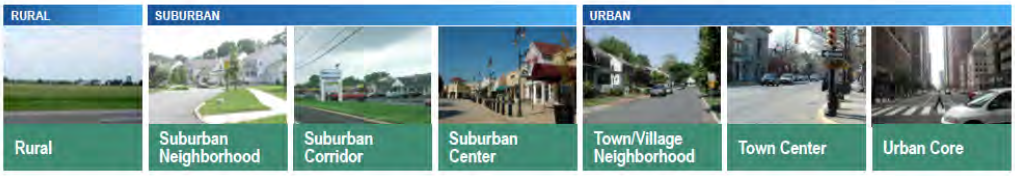
The Massachusetts Highway Department's *Project Development and Design Guide* (2006) drew a connection between context classes and design controls and established context based on level of development and surrounding land uses. Distinctions between community contexts (referred to as *area types*) are made based on built form, with a particular focus on building setbacks and property frontages.

As a result, the guide identifies a more diverse range of land use contexts, from low-intensity rural environments to high-density, high-population urban areas. The guide calls for the selection of area types before choosing a design based solely on roadway type. Context is the primary influence on modal considerations and the corresponding design elements required to meet activity needs for each mode.

Designing Walkable Urban Thoroughfares (ITE-CNU 2010) introduced a roadway design framework based on context zones that categorize urban development patterns based on density and intensity. Context is based on the transect concept and defined by 1) thoroughfare design, 2) adjacent buildings, 3) land use types, and 4) the surrounding district. Context zones are designated at the community level, but for the purposes of thoroughfare design are interpreted on a block-by-block basis to respond to specific physical and activity characteristics. Overall, seven context zones are defined: four urban (including suburban and low-density urban fringe uses), two rural, and a district category (which is assigned as needed).

The Pennsylvania and New Jersey DOTs introduced their *Smart Transportation Guidebook* in 2008 to implement Context Sensitive Solutions (PennDOT 2008) develop projects that are responsive to different community, environmental, and transportation contexts. The guidebook identifies principles such as multimodal planning and targeted contextual solutions. Context areas are defined according to land use and level of development (Figure 2). Categories include Rural, Suburban Neighborhood, Suburban Corridor, Suburban Center, Town/Village Neighborhood, Town Center, and Urban Core. Contexts are defined along a continuum because their boundaries can be fluid. The guidebook recommends that practitioners avoid adhering to a narrow definition of each context as this may lead to more frequent changes in design elements.

Figure 4.3 Defining Contexts



	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town Center	Urban Core
Density Units	1 DU/20 ac	1 DU/ac - 8DU/ac	2 - 30 DU/ac	3 - 20 DU/ac	4 - 30 DU/ac	8 - 50 DU/ac	16 - 75 DU/ac
Building Coverage	NA	< 20%	20% - 35%	35% - 45%	35% - 50%	50% - 70%	70% - 100%
Lot Size/Area	20 acres	5,000 - 80,000 sf	20,000 - 200,000 sf	25,000 - 100,000 sf	2,000 - 12,000 sf	2,000 - 20,000 sf	25,000 - 100,000 sf
Lot Frontage	NA	50 to 200 feet	100 to 500 feet	100 to 300 feet	18 to 50 feet	25 to 200 feet	100 to 300 feet
Block Dimensions	NA	400 wide x varies	200 wide x varies	300 wide by varies	200 by 400 ft	200 by 400 ft	200 by 400 ft
Max. Height	1 to 3 stories	1.5 to 3 stories	retail -1 story; office 3-5 stories	2 to 5 stories	2 to 5 stories	1 to 3 stories	3 to 60 stories
Min./Max. Setback	Varies	20 to 80 feet	20 to 80 ft	20 to 80 ft	10 to 20 ft	0 to 20 ft	0 to 20 ft

Figure 2. Context definitions (PennDOT 2008)

The National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* (2013) developed national street design guidelines for cities. The guide is a blueprint for designing 21st-century streets where people can walk, bike, drive, park, take transit, and socialize (Figure 3). While the guide does not posit a context-specific classification system for urban streets, it catalogues streets types based on context and function. The guide states that "context is a crucial, yet often overlooked, parameter in designing streets. Street design should both respond to and influence the desired character of the public realm" (page 7).

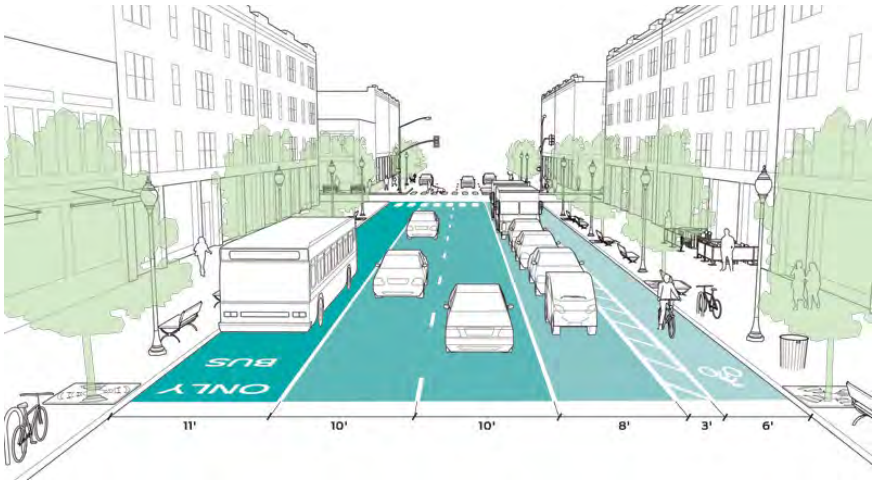


Figure 3. NACTO Urban Street Design Guide (NACTO 2013)

Responding to the need for additional context categories, the California Department of Transportation (Caltrans) *Highway Design Manual* (2020) presented an expanded set of contexts with classifications based on place type, which defines the adjoining built and natural environment; highway type, which considers the role of the highway in terms of its regional connectivity; and access control, which reflects the degree of separation between the highway and the surrounding land. Place types include three rural areas (Natural, Developing, or Rural Main Streets), two suburban areas (Low or High Density) and two urban areas (Low or High Density).

The Arizona DOT *Complete Transportation Guidebook* (ADOT; 2016) incorporates several new categories, including Rural, Suburban, and Activity Centers, Downtowns, and Urban Areas. Two special use areas are Open Spaces and Cultural and Historic Sites. Categories are defined based on area features and mobility expectations. Areas are characterized using data on economic activities, land use, and typical building types. Mobility is defined based on access levels, traffic volumes, and modal accommodation.

NCHRP Report 855 (Stamatiadis et al. 2018) proposes an expanded context classification system that builds on the work summarized above. The system improves the quality of information delivered to practitioners so they can develop appropriate contextual multimodal initial design concepts. This is achieved through documented prioritization of roadway users and understanding the roadway's function in the community and within the local and regional transportation network. The framework offers practitioners a practical tool for determining appropriate design elements and options and understand the tradeoffs necessary to balance user needs, safety, and address other community issues. The framework relies on system/network strategies to meet all user needs and allow the appropriate separation of conflicting needs. Once the context and roadway type are defined, users can be identified, which in turn allows for the identification of possible design element options. The presence of additional overlays (such as transit and freight) completes the required inputs and are used to refine the purpose and need document, thus establishing the framework for design development. The final balancing of facilities to accommodate user needs is integrated into project development principles.

NCHRP Report 855 presents a revised set of contexts that recognizes the multitude of differences and complexity of the built environment in urban and rural settings (Figure 4). Three urbanized categories are identified — Suburban, Urban, and Urban Core. At the same time, the frequent passage of roadways through small towns with populations less than the minimum thresholds for being classified as urban is recognized. Rural Town and Rural Contexts are included to capture these differences.

The five context categories:

1. Apply to a wide variety of States and agencies
2. Maintain the simplicity of the existing FHWA FCS to promote widespread adoption
3. Categorize distinctions that require wholly different geometric design practices in terms of desired operating speeds, mobility/access demands, and user groups

Qualitative measures were established for each context based upon density, land use, and building setback (Table 2).

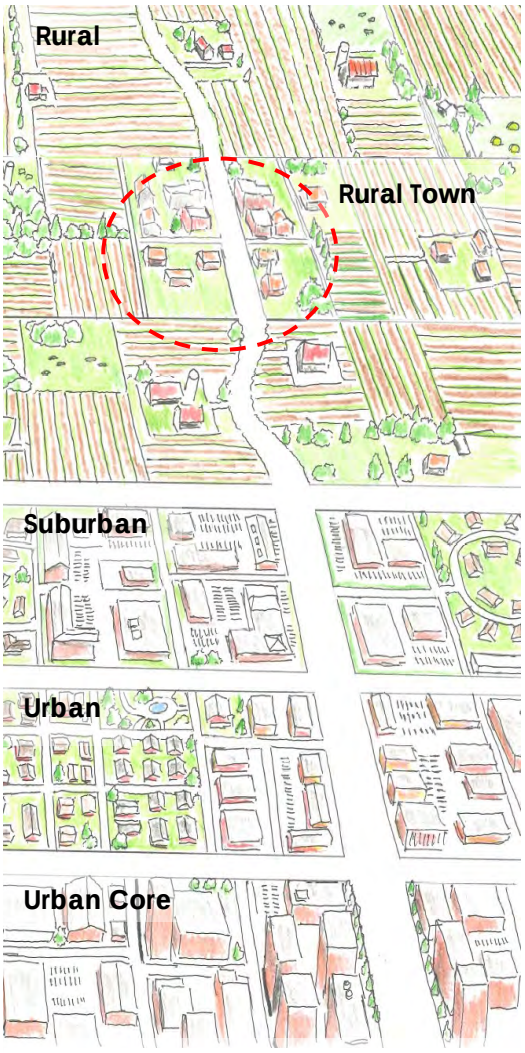


Figure 4. NCHRP Report 855 context categories

Table 2 Expanded context classification from NCHRP Report 855

Context	Density	Land Use	Setback
Rural	Lowest (few houses or other structures)	Agricultural, natural resource preservation, and outdoor recreation uses with some isolated residential and commercial	Usually large setbacks
Rural Town	Low to medium (single family houses and other single-purpose structures)	Primarily commercial uses along a main street (some adjacent single-family residential)	On-street parking and sidewalks with predominately small setbacks
Suburban	Low to medium (single and multi-family structures and multi-story commercial)	Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial, and light industrial)	Varied setbacks with some sidewalks and mostly off-street parking
Urban	High (multi-story, low-rise structures with designated off-street parking)	Mixed residential and commercial uses, with some institutional and industrial and prominent destinations	On-street parking and sidewalks with mixed setbacks
Urban Core	Highest (multi-story and high-rise structures)	Mixed commercial, residential, and institutional uses within and among predominately high-rise structures	Small setbacks with sidewalks and pedestrian plazas

The expanded context classification system also identifies user groups (including automobile drivers, pedestrians, bicyclists, and freight) and recommends that user needs be identified from the project's outset, as determined by roadway context. All users should be considered when making the tradeoffs between design elements. Correlating context, roadway types, and users resulted in the Expanded FCS matrix that identifies the potential primacy of user needs (Figure 5).

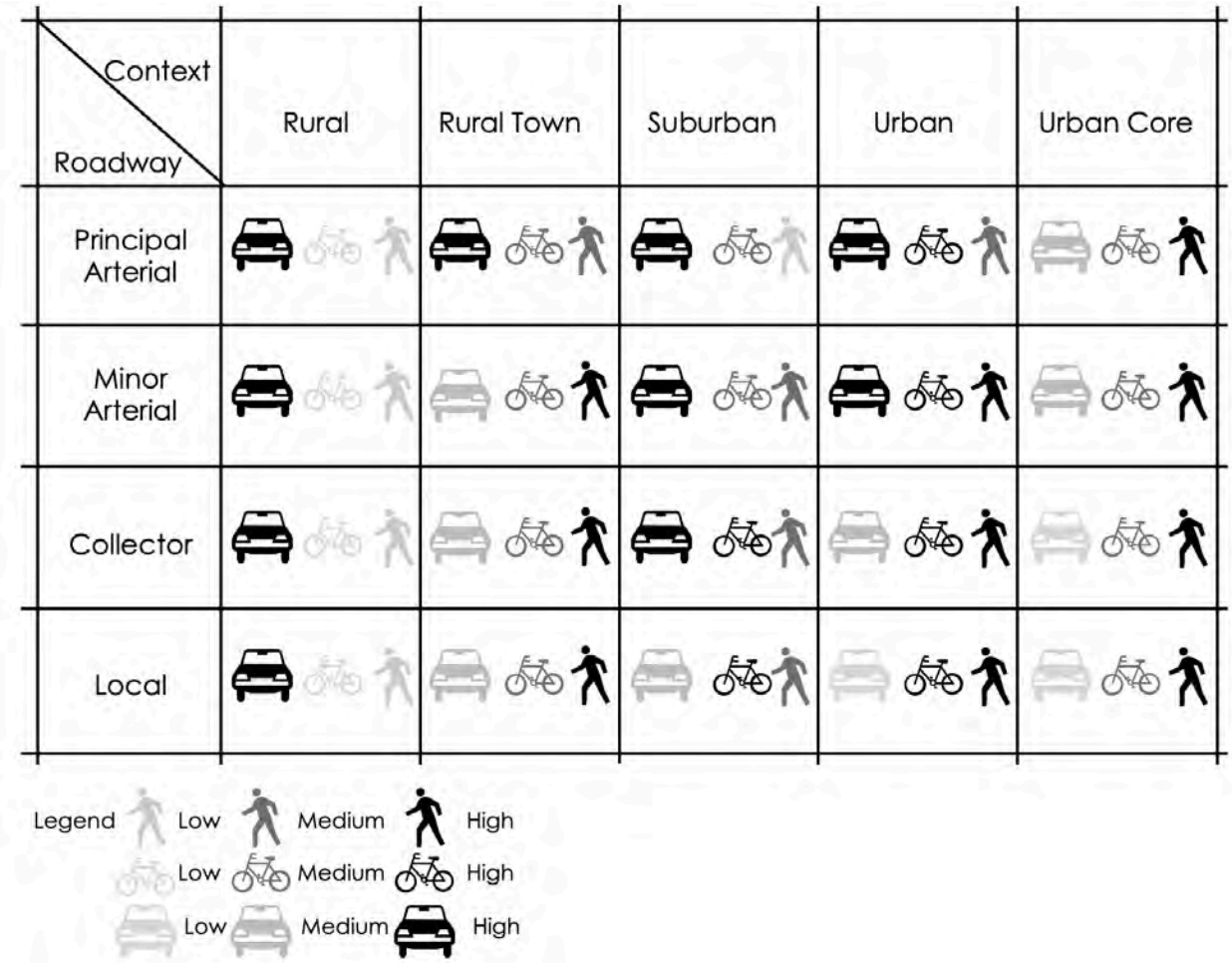


Figure 5. User primacy in NCHRP Report 855

This process dictates that the context classification decision become a key design consideration as it impacts safety, function, and design detail. Context establishes a possible starting point for geometric design choices as they are influenced by context and road type, which define the modes to be accommodated and their interactions.

GB7 adopted the five context categories in NCHRP Report 855; it included three additional contexts to address high-intensity commercial areas: Freight, Commercial, and Port Land. Going beyond the urban/rural classification system is a major philosophical change for AASHTO and the design community but is consistent with the *2016 Direction on Flexibility in Design Standards* resolution issued by AASHTO's Standing Committee on Highway (SCOH), which supports continued industry movement toward flexible, multimodal planning and design approaches. Since NCHRP Report 855 and GB7 were published, four States have moved forward independently to implement expanded context classification systems. These efforts provide insights into how such systems may need to be defined and refined to provide practical classification of roadways at all levels.

The **Florida DOT (FDOT)** *FDOT Context Classification Guide* incorporates eight contexts into its classification system with the goal of helping the agency build, operate, and maintain a context-sensitive system of Complete Streets (Figure 6; FDOT 2017). The system includes a natural context along with rural and rural town, two suburban designations (residential and commercial), two urban categories (general and center), and urban core. Context classifications define the framework for the context-based *Florida Design Manual* (FDM) and are integrated into FDOT's everyday practices. The agency has demonstrated how the

eight categories can be collapsed into the GB7's five categories (FDOT 2019). Under this approach, Natural and Rural are consolidated into Rural, while Suburban Residential and Suburban Commercial are combined into Suburban.

Figure 6. FDOT context classifications (FDOT 2017)

Contexts are defined using primary and secondary measures. Primary measures are land use, building height, building placement, fronting use, location of off-street parking, and roadway connectivity metrics (intersection density, block perimeter, and block length). Secondary measures are allowed residential density, allowed office/retail density, population density, and employment density.

Washington DOT (WSDOT) updated its *Design Manual* to incorporate the findings of NCHRP Report 855 (WSDOT 2017a; WSDOT 2017b). The first step in identifying a project's modal priorities is defining context (WSDOT 2017c). Context is defined based on land use, building setback, and density per NCHRP Report 855, and measures have been identified to aid context classification (Table 3). The agency adopted project-based approach with context defined for each project, rather than using state or areawide context definitions.

Table 3 Washington DOT context classification measures

Indicator	Relevance	Rural	Suburban	Urban/Town	Urban Core	Source (Current)	Source (Future)
Land Use	Within ½ mile of roadway	Agricultural uses with some isolated residential and commercial Current ☐ Future ☐	Single uses (divided into residential, commercial, institutional or industrial uses) Current ☐ Future ☐	Mixed-uses (includes 2+ residential, commercial, institutional and/or industrial uses) Current ☐ Future ☐	Mixed uses except industrial and agriculture Current ☐ Future ☐	Aerial Photos	City or County Comprehensive Plan. Zoning & Land Use Designations
Housing Units/Acre	Polygons adjacent to roadway	< 1 unit/acre Current ☐ Future ☐	1-4 units/acre Current ☐ Future ☐	4-15 units/acre Current ☐ Future ☐	15+ units/acre Current ☐ Future ☐	EPA Smart Location Database	City or County Comprehensive Plan
Jobs/Acre	Polygons adjacent to roadway	0-1 jobs/acre Current ☐ Future ☐☐	1-10 jobs/acre Current ☐ Future ☐	10-50 jobs/acre Current ☐ Future ☐	50+ jobs/acre Current ☐ Future ☐	EPA Smart Location Database	City or County Comprehensive Plan
Street Intersection Density	Polygons adjacent to roadway	< 15 intersections/ square mile Current ☐ Future ☐	15-75 intersections per square mile Current ☐ Future ☐	75-150 intersections per square mile Current ☐ Future ☐	150+ intersections/ square mile Current ☐ Future ☐	EPA Smart Location Database	City or County Comprehensive Plan
Typical Building Height	Visible from roadway	N/A Current ☐ Future ☐	Mostly 1 to 2 story Current ☐ Future ☐	Mostly 2 to 4 story Current ☐ Future ☐	Mostly 4+ stories Current ☐ Future ☐	Google Maps Streetview	City or County Zoning Code
Setbacks	Visible from roadway	Varies Current ☐ Future ☐	24 ft min (arterial) 12 ft min (non-arterial) Current ☐ Future ☐	6 ft min to 18 ft max Current ☐ Future ☐	2 ft min to 12 ft max Current ☐ Future ☐	Aerial Photos	City or County Zoning Code
Parking	Visible from roadway	Off-street (on-street rare) Current ☐ Future ☐	On-street residential, off-street commercial Current ☐ Future ☐	On-street common supplemented by off-street surface Current ☐ Future ☐	Mostly on-street with some off-street structures Current ☐ Future ☐	Aerial Photos	City or County Comprehensive Plan

Figure 7. MnDOT Context Classification (MnDOT n.d.)

Minnesota DOT (MnDOT) has recently developed a context classification system based on NCHRP Report 855 and the Florida DOT *Context Classification Guide* (MnDOT n.d.). This effort identified nine context categories (Figure 7):

- Natural
- Rural
- Rural Crossroad
- Suburban Residential
- Industrial-Warehouse-Port
- Suburban Commercial
- Urban Residential
- Urban Commercial
- Urban Core

Classification is based on land use, density of buildings and structures, building size, scale and setbacks, parking presence and location, presence of users, and traffic modal mix. No measures are used for context classification, and general qualitative descriptors are used for each context. This maintains flexibility in classification and avoids potential ill-fitting and illogical outcomes that could arise from using specific measures. No Rural Town context is included due to the nature of incorporated communities in Minnesota and the belief that these areas are captured by the Suburban and Urban categories. The Rural Crossings context reflects a Minnesota-specific condition in unincorporated areas that may require lower design speeds or multimodal attention but have a general rural design character. Classification is implemented using a project-based approach.

The **Oregon DOT (ODOT)** *Blueprint for Urban Design* adapted GB7's contexts to reflect the variety of urban areas and unincorporated communities in Oregon, resulting in six categories (Figure 8; ODOT 2020). This guide addresses only urban and suburban contexts as the agency's focus was on developing a context-sensitive approach to planning and designing roadways in urban areas.

Context is based on qualitative measures, similar to those in NCHRP Report 855. Parking and block size are also included as measures (Table 4). How context is viewed within the project type and its design horizon are discussed. For example, on resurfacing projects the current context is considered, while for projects with longer design lives future land use changes are accounted for when designating context. Implementation of the expanded classification is done on a project-by-project basis.

Figure 8. Oregon DOT context categories (ODOT 2020)

Table 4 Oregon DOT urban context matrix (ODOT 2020)

Land Use Context	Setbacks Distance from the building to the property line	Building Orientation Buildings with front doors that can be accessed from the sidewalks along a pedestrian path	Land Use Existing or future mix of land uses	Building Coverage Percent of area adjacent to right-of-way with buildings, as opposed to parking, landscape, or other uses	Parking Location of parking in relation to the buildings along the right-of-way	Block Size Average size of blocks adjacent to the right-of-way
Traditional Downtown/ CBD	Shallow/ None	Yes	Mixed (Residential, Commercial, Park/Recreation)	High	On-street/ garage/ shared in back	Small, consistent block structure
Urban Mix	Shallow	Some	Commercial fronting, residential behind or above	Medium	Mostly off-street/Single row in front/ In back/ On side	Small to medium blocks
Commercial Corridor	Medium to Large	Sparse	Commercial, Institutional, Industrial	Low	Off-street/In front	Large blocks, not well defined
Residential Corridor	Shallow	Some	Residential	Medium	Varies	Small to medium blocks
Suburban Fringe	Varies	Varies	Varied, interspersed development	Low	Varies	Large blocks, not well defined
Rural Community	Shallow/ None	Some	Mixed (Residential, Commercial, Institutional, Park/Recreation)	Medium	Single row in front/ In back/ On side	Small to medium blocks

The **Maryland DOT** State Highway Administration's (MDOT SHA) *MDOT SHA Context Driven: Access and Mobility for All Users Guide* incorporates six context categories: Urban Core, Urban Center, Traditional Town Center, Suburban Activity Center, Suburban, and Rural (MDOT 2019). Contexts are defined based on land use, density and type of buildings, activity types and intensity, mobility levels, and modal accommodation levels. The Guide describes each context, identifies their major characteristics, and provides possible locations and a schematic of sample scenario and safety countermeasures. MDOT SHA transitioned to statewide implementation of context-based classification to prioritize the delivery of safe and efficient multimodal transportation systems that balance access and mobility.

Interviews with State DOTs and Metropolitan Planning Organizations (MPOs) found that ADOT plans to adopt the GB7 context categories and that PennDOT has adopted GB7's five context categories.

Context Classification Definitions

When adopting an expanded context classification system, a key activity is identifying and defining contexts. Most agencies that have adopted expanded systems use five or six categories, although MnDOT uses nine and FDOT uses eight. Figure 9 compares how context categories employed by agencies relate to one another. Six states use categories different from the five NCHRP Report 855, and a few categories are common among all agencies. Reviewing each agency's definitions fostered development of a common set of definitions. Agencies contemplating expanded context classification systems could use these to inform their efforts.

Most agencies describe contexts in terms of predominant land use, modal interaction and priorities, and quantitative and qualitative measures, including building setbacks, parking availability, access potential and driveway frequency, and building types, height, and orientation. Some agencies also have lists of key characteristics and specific expectations for each context. The sections below synthesize this information and formulate general descriptions for each context.

Figure 9. Relationship among various context classification schemes

Rural

Rural contexts have little development and land uses such as outdoor recreation, agriculture, farms, and/or resource extraction. Common building types are residential units and farm buildings. Population and building densities are low. The dominant mode of transportation is vehicles, while there are few pedestrians or recreational bicyclists; transit that is limited or non-existent. Some descriptors change in the vicinity of small unincorporated communities (e.g., village or hamlet), and thus require special attention. Other descriptors include building setbacks, which are typically large, and driveway access, which is limited or sparse.

Some agencies have subdivided this context into two: Natural, which refers to areas with parks and recreational activities, and Rural, which encompasses all other rural areas. In these cases, the main distinction is the presence of natural resources, defined as "lands not suitable for habitation due to natural conditions" and which are preserved through conservation easements, regulatory constraints, and/or recreational uses (FDOT 2017). They are also defined as areas in "a natural condition, including places like wetlands, forests, meadows/prairies, lakes, rivers, scenic areas, steep slopes, wilderness, and some historic areas" (MnDOT n.d.).

A sample of agency definitions for the Rural context follows:

- Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands. (FDOT 2017)
- The rural category ranges from no development (natural environment) to some light development (structures), with sparse residential and other structures mostly associated with farms. The land is primarily used for outdoor recreation, agriculture, farms, and/or resource extraction. Occasionally non-incorporated communities will include a few residential and commercial structures. (WSDOT 2017b) (A list of characteristics follows but is omitted here).
- Rural areas have low traffic volumes and large distances between uses. Rural areas include agricultural land, desert, and areas developed at very low densities that may have outdoor storage, small-scale manufacturing, or other agriculture-based businesses on the same property as a residence. (ADOT 2016)
- The lowest density of the six context zones, rural areas are primarily a mix of agricultural uses and green space, with some scattered development in large-lot residential clusters. Trip distances are long as origins and destinations are few and far between. Mobility is the primary transportation need. This context zone represents the majority of the State's land (approximately 76%) but only a fraction of the total population. (MDOT SHA 2019)

Rural Town

Rural Towns blend development concentrated along a short length with residential and commercial land uses characteristic of urban areas. Residential and commercial buildings are common, while in some areas institutional services are present. Vehicles predominate, although pedestrian and bicyclist activity is more common than in Rural contexts. Transit is typically non-existent. Building setbacks are small while parking is usually available on or off street.

Some agencies define this context differently in response to local needs. MnDOT has a Rural Crossroad context, which is a "small, lightly developed area at the crossing or intersection of two rural roads, typically in an unincorporated or very small community" (MnDOT n.d.). WSDOT considers Rural Towns as part of its Main Street design, which is integrated into its suburban context. Similarly, MDOT SHA includes this context in its Traditional Town Center context.

A sample of agency definitions for the Rural Town context follows:

- Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns. (FDOT 2017)
- Small concentrations of developed areas immediately surrounded by rural, undeveloped areas. (ODOT 2020)

- While smaller and less dense than either of the urban zones, the traditional town center is still characterized by a high diversity of use types, including residential, office, retail, civic, and cultural facilities. Structures are typically late 19th to early 20th century mid- to low-rise buildings and are oriented toward the street with minimal setbacks. Parking is often provided on-street along the main thoroughfare, with additional parking at the rear of the building accessible by alleys or other minor streets. Typically laid out before the advent of the automobile, these areas often serve the dual purpose of accommodating both short trips around the commercial corridor as well as longer pass-through trips. While the need for mobility through these areas exists, it is somewhat exceeded by the need for internal circulation within the zone. These areas constitute roughly 1% of the land area within Maryland. While they are not an explicitly identified area within the context zone maps, they fall within the Suburban Activity Center boundary (MDOT SHA 2019).

Suburban

Suburban contexts feature low to medium development and residential, commercial, or office land uses. Building and population densities are low to medium. Block sizes are large. Along with vehicles, some bicyclists and pedestrians are present, and sometimes transit. Building setbacks are medium to large; driveway access is medium to high; and parking is often available off street and in dedicated lots.

FDOT and MnDOT subdivide the Suburban context into Residential (areas with mostly residential land use) and Commercial (areas with predominantly commercial or office land use). ODOT has three Suburban categories: Commercial Corridor, Residential Corridor, and Suburban Fringe (ODOT 2020). MDOT SHA has adopted a Suburban Activity Center context to address differences in land use, density, modal needs, and accommodation (MDOT 2019).

A sample of agency definitions for the Suburban context follows:

- Mostly residential uses within large blocks and a disconnected or sparse roadway network (Residential); mostly non-residential uses with large building footprints and large parking lots within large blocks and a disconnected or sparse roadway network (Commercial). (FDOT 2017)
- A Suburban Commercial land use is a medium (to large) size, moderately developed area of shops, restaurants, entertainment, office/work, and other activities, typically with medium to large areas of parking lots; a Suburban Residential land use is a medium to large size, lightly to moderately developed residential area, mostly of single-family (with some multi-family) housing, and occasional neighborhood parks and trails, and lakes and woodlands. (MnDOT n.d.) (A list of characteristics follows but is omitted here.)
- Locations classified as suburban include a diverse range of commercial and residential uses that have a low or — often — medium density. Suburban areas are usually (but not always) connected and closely integrated with an urban area. The buildings tend to be multi-story with off-street parking. Sidewalks are usually present and bicycle lanes may exist. These areas include mixed use town centers, commercial corridors, and residential areas. Big box commercial and light industrial uses are also common. The range of uses encompasses health services, light industrial (and sometimes heavy industrial), quick-stop shops, gas stations, restaurants, and schools and libraries. (WSDOT 2017b) (A list of characteristics follows but is omitted here).
- With a moderate to low diversity of uses, the suburban context typically contains primarily single-family residential development on lot sizes ranging from one-eighth of an acre to one acre. Office parks and small commercial strip retail are scattered throughout the area, along with neighborhood-level civic and cultural facilities. Developments are typically larger in area and single-use, discouraging non-automobile trips. Buildings are primarily oriented toward parking, which is usually provided off-street. (MDOT 2019)
- Mostly commercial and industrial uses with large building footprints and large parking lots set within large blocks and a disconnected or sparse roadway network (Commercial Corridor); mostly residential

uses within a well-connected or somewhat connected roadway network. May extend long distances. Single-family homes may have direct access to the state roadway. (Residential Corridor); and Sparsely developed lands, typically at the edge of an urban growth boundary. May be large lot residential, small-scale farms, or intermittent commercial or industrial uses. (Suburban Fringe) (ODOT 2020)

Urban

Urban contexts are highly developed with mainly residential, commercial, institutional, or office land uses. Building and population densities are high. Block sizes are small to medium. Medium to high numbers of bicyclists and pedestrians mix with vehicles. Transit is common. Building setbacks are small to medium; intersection frequency is medium to high; and parking is found on street and in dedicated lots.

FDOT and MnDOT subdivide the Urban context into Residential/General (predominantly residential land use) and Commercial/Center (predominantly commercial or institutional land use). Context is assigned based on population and employment densities and building heights.

A sample of agency definitions for the Urban context follows:

- Mix of uses set within small blocks with a well-connected roadway network. May extend long distances. The roadway network usually connects to residential neighborhoods immediately along the corridor or behind the uses fronting the roadway (General); mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of a civic or economic center of a community, town, or city (Center). (FDOT 2017)
- An Urban Commercial land use is a small to large size, highly developed area often of mixed commercial and other uses (Commercial); An Urban Residential land use is a medium to large size, highly developed residential area with local shops and parks (Residential). (MnDOT n.d.) (A list of characteristics follows but is omitted here).
- Urban locations are high density, consisting principally of multi-story and low- to medium-rise structures for residential and commercial use. Areas usually exist for light and sometimes heavy industrial use. Many structures accommodate mixed uses: commercial, residential, and parking. Urban areas usually include prominent destinations with specialized structures for entertainment, athletic and social events as well as conference centers, and may serve as a Main Street (see 1102.03(6)). (WSDOT 2017b)
- Mix of land uses within a well-connected roadway network. May extend long distances. Commercial uses front the street with residential neighborhoods on top or immediately behind land uses. (Urban Mix; ODOT 2020)
- Similar to Urban Core, the Urban Center zone is characterized by high diversity of uses — including multi-family residential, office, retail, entertainment, civic, and cultural facilities — while having a moderately high density of development. Urban center areas are typically characterized by mid-rise structures, varied setbacks, a variety of street wall frontages, and off-street parking. Urban centers may be either large commercial business districts in historic towns or newer transit-oriented developments centered around a metro station. Because of its development density and diversity of uses, this land-use pattern generates a moderate to high volume of nonmotorized trips. Additionally, while the need for mobility through these areas does exist, it is far exceeded by the need for internal circulation within the zone. These areas represent less than 0.1% of the land area in the State. (MDOT SHA 2019)

Urban Core

Urban Core contexts exhibit the highest levels of development, with mainly residential, commercial, or institutional land uses. Building and populations densities are high. Block sizes are small. Bicyclists and pedestrians are ubiquitous, and transit is present. Building setbacks are small; intersection frequency is high; and parking is available on street and in dedicated garages.

A sample of agency definitions for the Urban Core context follows:

- Areas with the highest densities and building heights, and within FDOT classified as Large Urbanized Areas (population >1,000,000). Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected roadway network. (FDOT 2017)
- An Urban Core land use is a compact, highly developed area of mixed uses, often stacked within buildings and structures. (MnDOT n.d.) (A list of characteristics follows but is omitted here).
- Urban core locations include the highest level of density with its mixed residential and commercial uses accommodated in high-rise structures. There is commonly on-street parking, although it is usually time restricted. Most parking is in multi-level structures attached or integrated with other structures. The area is accessible to automobiles, commercial delivery vehicles, biking, walking, and public transit. (WSDOT 2017b)
- Considered the typical downtown or central business district area, the Urban Core zone is defined by a high diversity of uses, including multi-family residential, office, retail, entertainment, civic, and cultural facilities, as well as a high density of development. Development includes high-rise structures with minimal setbacks, high street wall frontage, and minimal building gaps. Off-street parking is typically included. Because of its development density and diversity of uses, this land-use pattern generates a high prevalence of non-motorized trips, including walking, transit, and bicycling. While the need for mobility through these areas does exist, it is far exceeded by the need for internal circulation within the zone. (MDOT SHA 2019)
- Areas with the highest development and building heights in an urban area. Typically, a few square blocks. Buildings have mixed land uses, are built up to the roadway, and are within a well-connected roadway network. (ODOT 2020)

Industrial, Warehouse, Port

Introduced through the AASHTO Technical Committee on Geometric Design, this context has land uses related to industrial, warehouse, or port activities. Freight activity is abundant, and trucks make up a large percentage of the overall traffic volume. A specific-use or designated development area, the density and size of development vary. MnDOT includes a separate context to address this, while FDOT uses an overlay of a context to define these needs.

Context Classification Measures

Although precise measures of specific design needs may not be available for every roadway segment, DOTs can use surrogate measures that reasonably predict initial context concerns and inform initial design concepts. For instance, population density is a surrogate measure for activity levels, and building setbacks can act as a surrogate for pedestrian activity and separation from the roadway. The measures described below were identified though a review of context classification systems.

To identify informative measures, a review of the current context classification systems was undertaken. Findings are summarized below along with a short description of each measure used and associated issues that should be considered when selecting a candidate measure.

- ***Land use:*** A qualitative description of land use with no specific units noted. Possible issues are how the predominant use is identified and determination of a cohesive, yet compact, set of land uses proposed for inclusion in each context. This requires defining general categories to address variability in land use. Descriptive terms include conservation areas, open space, agricultural, residential (with distinctions between single- and multi-family), retail, office, institutional, and industrial. Information on land use can be extracted from land use plans (typically from planning divisions), comprehensive plans, zoning designations, and GIS data.
- ***Building height:*** A quantitative measure typically expressed as the number of stories that buildings adjacent to the roadway have. Data can be obtained from zoning designations or Google Street View.

Ranges are defined for each context level numerically (e.g., < 2 stories, 1-2 stories) or qualitatively (small, medium, and large).

- ***Building orientation:*** A qualitative measure that defines whether buildings have front access to the roadway or are attached/detached. This measure is also a surrogate for pedestrian activity, since it could imply direct access to the roadway and the need for sidewalks or other pedestrian facilities. Data can be obtained from zoning designations, GIS databases, or Google Street View.
- ***Setback:*** A measure that identifies the proximity of building fronts to the roadway. It can be quantitative (the actual distance from the road in feet) or qualitative (indicating proximity in general terms, such as small, medium, and large). For the quantitative approach, typically ranges are set for each context. Data can be obtained from comprehensive plans, aerial imagery, GIS parcel data, or permitted development regulations.
- ***Parking:*** A qualitative measure that identifies the presence of off-street parking and its location relative to the roadway. It can be used to estimate traffic activity in the vicinity of the roadway and used as a surrogate for pedestrian activity accommodation. Typical descriptions are on-street parking (with designations for residential or commercial), off-street parking (with indication of location), parking lots (that could be defined by size, such as small or large), onsite, and garage. Data can be obtained from comprehensive plans and aerial imagery.
- ***Block size:*** A quantitative measure of block dimension measured in feet. It can be also used as a surrogate measure for pedestrian activity and accommodation needs. It has been defined either as block length or block perimeter/size. Data can be obtained from aerial imagery, GIS data, or permitted development plans.
- ***Traffic volume:*** A qualitative measure that characterizes the roadway's average daily traffic. It is usually defined using general terms (e.g., low, medium, or high).
- ***Intersection density:*** A measure that captures the level of access provided along the roadway. It is typically quantified as the number of intersections per area and can be used as a surrogate to help predict nonmotorized transportation and transit connections. Data can be obtained from GIS data, aerial imagery, or permitted development plans.
- ***Population density:*** A quantitative measure expressed as people per acre or square mile. It can be obtained from census block or tract data and used as a surrogate for transportation activity levels, with ranges defined for each level.
- ***Employment density:*** A quantitative measure that captures employment levels and is typically expressed as jobs per acre. Data can be obtained from comprehensive plans and census block or tract data.
- ***Building density:*** A measure that defines the building density quantitatively as the number of units per area or which qualitatively characterizes development or housing density. It can be used as a surrogate for nonmotorized user transportation needs and transit accommodation. Data can be obtained from comprehensive plans.
- ***Allowed residential density:*** A quantitative measure that defines the maximum allowed residential density by zoning type. It is measured in dwelling units per acre. Data can be obtained from zoning code designations.
- ***Allowed office/retail density:*** A quantitative measure of the maximum allowed office or retail density expressed as a floor-area ratio (FAR), or as the ratio of total building floor area to the size of the property on which it is built. Data can be obtained from zoning codes or land development regulations.
- ***Short Trip Opportunity Area (STOA):*** MDOT SHA identified STOAs as a composite measure to predict areas where nonmotorized activity is expected and improve prioritization. It was developed based on population density, employment density, zero-car households, proximity to transit, and schools. Short trips relate directly to the need for multimodal accessibility and this analysis informed the identification of MDOT SHA's urban context zones.

Table 5 lists the measures used in each State. Almost all States have adopted land use as a measure (six) and building setback (six), followed by building orientation (five).

Table 5 Context classification measures

Measures	Florida	Washington	Oregon	Minnesota	Maryland	Pennsylvania	Arizona	California
Land use	X	X	X	X			X	X
Building height	X	X		X		X		
Building orientation	X		X	X		X		
Setback	X	X	X	X		X		X
Parking	X	X	X	X				
Block size	X		X			X		
Traffic volume				X			X	X
Intersection density	X	X					X	X
Population density	X							
Employment density	X	X						
Building density		X	X	X		X		
Allowed residential density	X							
Allowed office/retail density	X							
Short Trip Opportunity Area (STOA)					X			

CHAPTER 3

Survey of Practice

State of Practice on Context Classification

State DOTs and Metropolitan Planning Organizations (MPOs) were surveyed to:

- Establish the state of practice regarding the adoption of expanded context classification systems
- Document measures and data used to categorize contexts
- Determine impediments to implementation for agencies that have not adopted or are not planning to adopt an expanded context classification system
- Develop a lessons-learned database that can inform other agencies about what to avoid during future implementation efforts.

The survey asked respondents if their agencies have adopted, are planning to adopt, or do not plan to adopt an expanded context classification and collected related information. The survey was distributed to the AASHTO Committees on Design and Planning and at least two MPOs in each State. The survey was mailed to roughly 350 people; 111 responses were received. Survey responses are summarized in the following sections. Several State DOTs returned one response even though there may have been up to six or seven respondents identified from the initial lists. Forty-three States, Washington, D.C., and 24 MPOs responded to the survey (Figure 10). Ten States have adopted an expanded context classification system and 18 are planning implementation. Sixteen states and Washington, D.C., do not plan implementation. California and Massachusetts have adopted expanded context classification systems but did not respond to the survey.

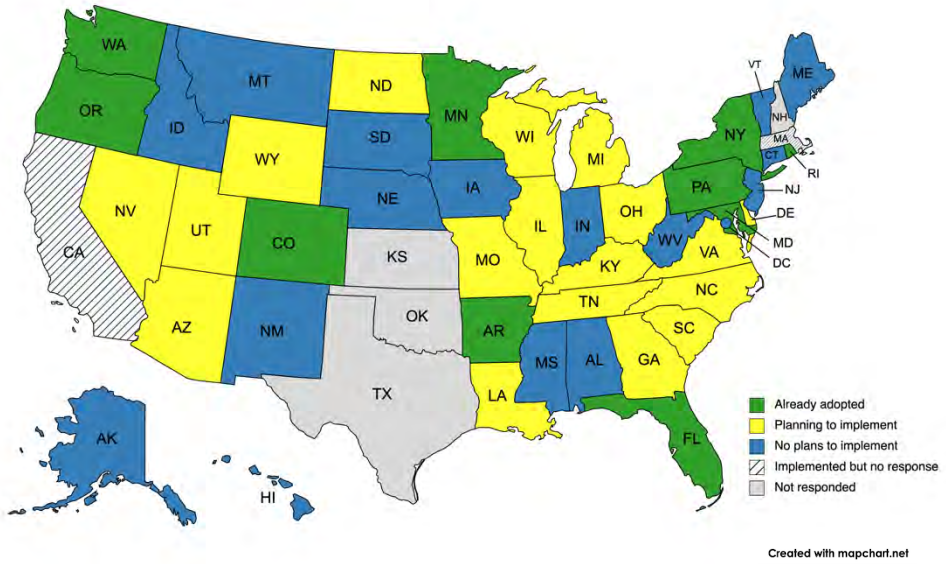


Figure 10 State of the practice regarding adoption of expanded functional classification

Participant Information

Respondents were widely distributed in their primary areas of practice, including design (54.8%), planning (38.1%), multimodal planning (16.7%), and programming (14.3%). Most respondents identified as transportation engineers (57.1%), transportation planners (20.2%), or administrators (17.9%).

Respondents rated their familiarity with GB7's expanded context classification system using a 5-point scale (with 1 indicating 'Never heard of it' and 5 'Very familiar'). Most are vaguely familiar (score of 2, 29.7%). Smaller fractions are familiar (score of 3, 27.0%) or somewhat familiar (score of 4, 16.2%). The overall (weighted) score was 2.88, indicating an overall general familiarity. Nine percent of respondents had never heard of it. This group, combined with those who indicated vague familiarity, accounts for almost 39% of the respondents.

Already Adopted

Measures for Classification

Respondents from agencies that have adopted expanded context classification systems listed measures they use to classify contexts (Table 6).

Table 6 Measures used for context classification

Metrics Used - Already Adopted	Responses
Pedestrian patterns	7
Bicyclist patterns	7
Land Use	6
Parking presence	6
Housing units	6
Building setback	6
Intersection density	6
Parking location	6
Housing units/area	5
Block size	5
Employment density	5
Presence of fronting uses	5
Roadway Network	5
Building height	4
Building coverage	4
Crash Data	4
Other vulnerable user patterns	3
Other (please specify)	3
Building orientation	0

The measures used most often include pedestrian and bicyclist patterns (seven agencies) followed by land use, parking presence, building setback, intersection density and parking location (six agencies), and then housing density, block size, employment density and roadway network (five agencies). The three most

frequently used metrics are associated with nonmotorized user travel needs, roadway network considerations, land use patterns, and built environment measures (setback, density, and parking). Responses in the Other category include funding, planning documents, and freight uses; curbed vs. open sections; population density; and scenic and recreational value.

Barriers in Implementation

Nine respondents provided insights on barriers to implementation. Their responses can be grouped into six categories:

- Expanded context classification systems should ensure that planning guidance translates into constructed projects.
- Uncertainty over how the expanded context classification is pertinent for projects and understanding its role in project development. Need for workshops/training to emphasize the role of context categories in project designs.
- Funding could be an issue (limited funding prevents rural needs from being addressed and creates a barrier).
- Adopting and documenting a data-driven approach for assigning each classification is challenging.
- The need exists for fewer categories — five at most.
- No issues noted (two responses); process was well received.

Most agencies recognize the need for practitioners to have better awareness of the impact of expanded context classification systems throughout the project development process and all agency activities. This can be accomplished through training or better documentation.

Planning to Implement

Classification Measures

Respondents whose agencies are planning to adopt expanded context classification systems identified measures that could be used to classify contexts. This information illuminates which measures are seen as most valuable among agencies pursuing adoption (Table 7).

Table 7 Measures used for Context Classification

Metrics Used - Already Adopted	Responses
Roadway Network	13
Land Use	11
Pedestrian patterns	9
Bicyclist patterns	8
Crash Data	8
Intersection density	7
Parking presence	6
Building setback	5
Parking location	5
Other (please specify)	5
Presence of fronting uses	4
Employment density	3
Housing units/area	2
Other vulnerable user patterns	2
Building coverage	2
Block size	1
Building orientation	1
Housing units	8
Building height	0

The measures cited most frequently include roadway network (13 agencies), land use (11 agencies), pedestrian patterns (nine agencies), and bicyclist patterns and crash data (eight agencies). The remaining measures have lower frequencies. The three most frequently used metrics are related to roadway network considerations, land use, and nonmotorized user travel needs. Crash data are typically considered when evaluating pedestrian and bicyclist safety-related issues.

Barriers in Implementation

Sixteen respondents gave feedback on barriers they anticipate during implementation of expanded context classification systems. Their responses can be grouped into five categories:

- Need for training and education on the process, commitment to agencywide implementation, institutional inertia, state DOT engineers' resistance
- Incompatibility of the expanded context classification with FHWA functional classification
- Experience with GB7 implementation has been challenging; anticipation of better guidance in the future (GB8 or other documents)
- Lack of designer familiarity with expanded context classification
- Reluctance to change, but the expanded context classification is much more representative of real-world situations

Most agencies underscore the need for better training on the impacts of expanded context classification systems throughout the project development process and all agency activities. Two agencies do not anticipate issues, and two others are starting the process and have not encountered problems. In addition,

WSDOT does not anticipate issues because staff believe that the expanded context classification works well with its Performance-Based Practical Design.

Not Planning to Implement

Respondents from agencies that are not considering adoption of expanded context classification systems provided reasons they are foregoing implementation (Table 8).

Table 8 Reasons for not considering adoption (percentages)

Reasons	Percent
Other	24.3
Not aware of current efforts	21.6
Current urban/rural context works for our agency	21.6
Lack of guidance	16.2
Our agency has not adopted GB 7th Edition	13.5
Better understanding of benefits	2.7
Too complicated to adopt	0.0
Would work only for design and not all other project development areas	0.0

Many responses identify reasons other than those available to select. Among the remaining reasons, lack of awareness of current efforts and satisfaction with current urban/rural context are the second most frequently cited reasons (each with 21.6%). Lack of guidance (16.2%) or adoption of GB7 is also cited. Among the Other reasons, four agencies are in discussions to incorporate expanded context classification into their processes, while one does “not see a need to add more classifications for design.” For another, it is “just not our highest priority to explore at this time.”

Implementation Findings

Follow-up calls were also conducted with representatives from agencies that have adopted an expanded context classification system. Five agencies participated in interviews. Key points from these discussions are summarized below:

- Overall, agencies are satisfied with expanded context classification systems and their role in facilitating the development of more context-appropriate designs.
- Implementation strategies have varied among agencies. Two agencies have implemented expanded context classification statewide and the other three use it on a project-by-project basis. Some agencies using a project-based approach lack the resources for statewide implementation, while some agencies using the statewide approach revisit context when more detailed information becomes available during the project.
- Three agencies are using the five general contexts from GB7; the other agencies have modified them to address local conditions (MDOT SHA added one context, FDOT three, and MnDOT four).
- Most agencies view speed along and multimodal accommodation and priorities as the most essential outputs of context classification.
- Most agencies consider several measures when identifying contexts, but all primarily rely on land use and built-form indicators (e.g., block size, building height, parking presence).
- Implementation of expanded context classification at most agencies has resulted in revisions to several other policies and manuals (e.g., design and complete street manuals, bike/ped guidance).

- Most interviewees agree that expanded context classification improves their ability to communicate roadway context to other agencies, especially local ones, and provides a common language to build upon during project development.

CHAPTER 4

The Role of Context Classification in Project Development Process

A critical issue when using an expanded context classification system is determining what role Context will play in project development. Although the binary urban/rural approach to context is not sufficient for understanding system needs, having too many categories may also limit design flexibility by being overly prescriptive and discounting the project's unique needs and context. Once the role Context is identified, context categories and measures can be defined to ensure that they fulfill this role.

The Context Classification system proposed in NCHRP Report 855 and included in GB7 (and soon GB8) helps practitioners from the outset of project development identify the project concept's starting point. It also informs project decisions throughout project development. The starting point can be adjusted and modified to fit the project's context and constraints. Context establishes and communicates expectations for each context, informing design principles and guidance throughout project development. NCHRP Project 15-77 is developing in parallel with this project design principles and guidance .

Context Classification characterizes roadways based on land use data and *Transportation Expectations*, which define how users expect to move in a context. For example, in Urban Cores users may expect that traveling short distances by nonmotorized means is easier than using a vehicle. Conversely, in Rural areas users may expect high-speed vehicle-based trips to be the norm due to longer travel distances. The five Transportation Expectations used to define Context are 1) Users/Vehicles, 2) Movement, 3) Permeability, 4) Network, and 5) Speed.

Establishing Transportation Expectations from project initialization lets planners and designers ensure the project is scoped to address all intended outcomes and verify that needs and users are not overlooked. As more detailed information becomes available, a deeper understanding of the unique project context is possible and design elements are selected for a comprehensive transportation solution to be evaluated using performance metrics. Figure 11 presents a conceptual project development process that integrates Context Classification. Relevant inputs from NCHRP 15-72 and 15-77 are shown. The left side of Figure 11 represents the performance-based framework from NCHRP Report 785 (Ray et al. 2014). The main project development stages include project initialization, concept development, and evaluation and selection. These stages were further elaborated as part of the two NCHRP Projects (15-72 and 15-77) to locate the placement of Context Classification and its importance in the early stages of project development.

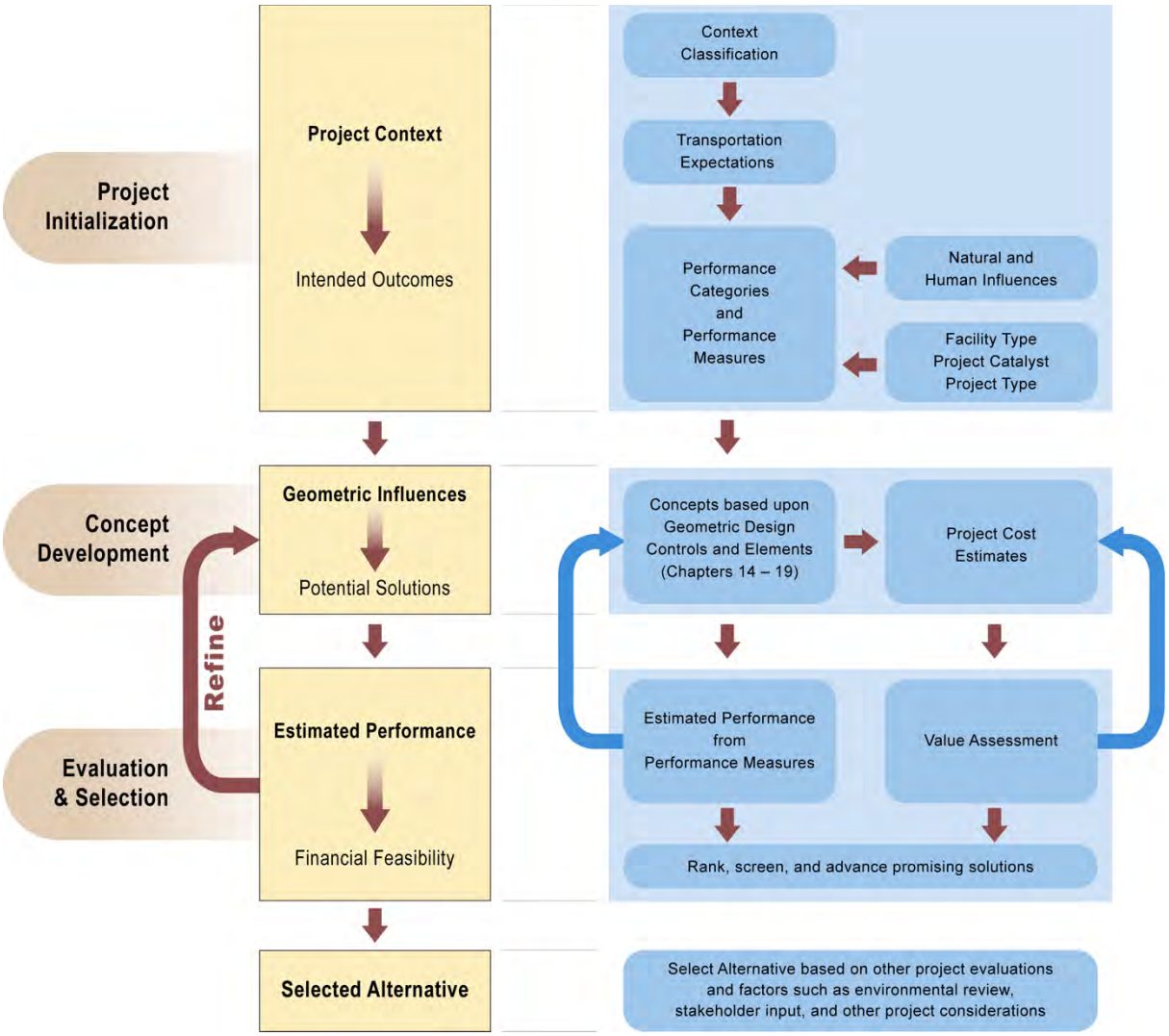


Figure 11 Project development process using the Context Classification System

Figure 11 illustrates how an agency can define and use contexts in developing project alternatives. Contexts in turn identify the Transportation Expectations for each roadway segment in its associated context. Design teams can use Transportation Expectations to establish intended outcomes for roadway segments in each context and, based on the project context (which includes additional, more-detailed information on roadway surroundings, community, environmental, and other elements) and facility type (functional class), establish initial project design elements. The next step considers project performance metrics to deliver a performance-based, refined solution that can be revised until a desirable solution is achieved, which then moves forward for other required evaluations (e.g., NEPA etc.).

Each Transportation Expectation is described below.

Users/Vehicles. *What is the anticipated range of users/vehicles within the context?* This expectation defines the types of users and vehicles anticipated for each context and their potential relative importance. Information about this expectation identifies potential elements for consideration and, in conjunction with the project context, could identify how the needs of various users/vehicles present could be addressed.

Movement (Mobility). *What is the ease of movement for each mode?* This expectation is defined as the ability of the system to allow for desired movements of the anticipated users/vehicles. This could define the manner in which users/vehicles move throughout and along/across the roadway as well as anticipated quality of service and impedance issues for different users/vehicles.

Permeability (Access). *How accessible are other elements of the transportation network and adjacent land use by mode?* This expectation defines the opportunities to integrate users/vehicles and their ability to access associated land uses surrounding the roadway and other facilities in the network. This includes types and frequency of intersections and pedestrian/bicycle crossings. Permeability also addresses how adjacent land uses connect with each mode through pedestrian-oriented development or auto-centric designs.

Network. *Are alternative routes available for each mode within the transportation system?* This expectation defines the availability of alternate transportation facilities to integrate the mobility needs of different users/vehicles within the network as a system. This expectation could define how users/vehicles can be distributed within the network to enable more efficient integration when space is not available within the project. Network expectations could include planning overlays that support a bicycle circulation plan, emergency response routes, or freight and delivery routes.

Speed. *What is the anticipated vehicular speed of the roadway?* This expectation defines the anticipated roadway speed for vehicles in relation to various users, and it could establish several of the design elements during later stages of the project development process. While the focus is on vehicle speeds, this expectation significantly impacts all users and should be considered in relation to each user group. This expectation could factor into daily or seasonal variation, such as understanding the differences between slower speeds during morning, mid-day, or afternoon peaks, and the resultant propensity for higher speeds off peak or off season.

Table 9 summarizes the Transportation Expectations for each of the contexts.

Table 9 Transportation Expectations by Context

Transportation Expectations	Context				
	Rural	Rural Town	Suburban	Urban	Urban Core
Users/Vehicles	• High frequency of motor vehicles/freight • Limited or no pedestrian activity • Potential for recreational cyclists • Potential for agricultural vehicles	• Regional vehicular/freight traffic • Moderate pedestrian activity • Potential for some bicyclists	• Regional traffic on primary roadways mixed with local vehicular traffic and transit • Low to moderate pedestrian activity, which may be concentrated around commercial areas and/or transit • Increased potential for recreational walking/running in residential areas • Increased potential for recreational/commuter bicyclists	• Moderate to high pedestrian activity • High potential for commuter bicyclists • High potential for transit interaction • Primarily local users	• High pedestrian activity with congregation and pedestrian activity zones • High potential for commuter bicyclists • High transit presence • High potential for micromobility • Primarily local traffic
Movement	• High desired movement (primarily for vehicles) with high quality of service • Minimal disruptions limited to peak times of day and/or seasons	• Moderate quality of service and slower traffic • Delays acceptable to local traffic • High quality of service for non-motorized users due to street-oriented development patterns	• Moderate to low vehicular quality of service during peak periods • Lower movement for non-motorized users due to higher vehicular speeds and longer travel distances	• Lower vehicular quality of service and slower travel speeds through majority of the day • Increased movement for non-motorized users due to increased activity densities and crossing opportunities	• Low vehicular quality of service and low travel speeds through most periods of the day • High mobility for non-motorized and micromobility users due to increased density, high crossing potential, and pedestrian-oriented development
Permeability	• Direct vehicular access to land uses • Lack of opportunities for pedestrian access • Minimal crossing opportunities for all users	• High vehicular, bicyclist, and pedestrian access opportunities • Direct pedestrian access to land uses • Vehicular and bicyclist access may be provided on adjacent roadways within the network	• Low to moderate access opportunities for all users • Primarily vehicle-oriented access with opportunities for localized pedestrian-oriented access	• High access opportunities for most users (vehicles, bicyclists, and pedestrians) • Access for freight movement may be restricted	• High access opportunities for non-motorized and micro-mobility users • Street-oriented businesses increase access for non-motorized users, while limited parking areas may decrease access for motorized users
Network	• No redundant roadway network • May have cross streets/ intersections accessing dispersed locations	• Expanded street network within a limited area serving immediate land uses • May include cross streets accessing dispersed areas in surrounding rural area(s) • Through traffic concentrated on primary roadway	• Limited supporting roadway network • Parallel streets may be present but disjointed • Alternative routes between destinations may exist but likely on different roadway types • Large intersection spacing (~1/2 mile)	• High level of supporting roadway network with parallel and cross streets • Network supports localized area, but may be disjointed due to natural/built boundaries • Alternative routes between destinations exist • Regional traffic may have bypass alternatives	• Cohesive and dense surrounding street network with multiple parallel and cross streets • Multiple alternative routes exist on similar roadway types • Regional traffic may have bypass alternative
Target Vehicular Speed (mph)	45+	25-35	30-45	20-35	<25

CHAPTER 5

Context Classification Review

Potential New Context Classifications

Each State that has adopted an expanded context classification system has generally followed NCHRP Report 855 (Figure 9; page 13). Six agencies have modified categories (e.g., introducing a Natural context, refining Urban and Suburban contexts). The AASHTO Technical Committee on Geometric Design's (TCGD) GB8 outline identifies Port/Industrial/Warehousing as a separate context, which MnDOT has adopted and FDOT recognizes as a Special District. Additional contexts (Natural and Port/Industrial/Warehousing) were evaluated to determine if they should be incorporated into Context Classification and GB8, or if they are more representative of individual state development patterns and contexts. Two questions drove evaluations of these contexts:

- Does the context present a different set of Transportation Expectations or inform the design differently than established categories?
- Does the context occur frequently enough across all agencies and within those agencies to justify a unique context?

When evaluating proposed contexts, it is critical to determine whether they would consequentially impact design and modal integration and thus warrant universal adoption. For example, roadway designs for commercial and residential areas may follow similar principles but require different geometric dimensions in response to the need for different design vehicle or target speeds. On the question of frequency, it is possible some agencies could benefit from a integrating a new context but that others would not. For example, agencies that manage a large number of roadway miles adjacent to natural areas could find utility in a Natural context. Agencies with few roadway miles in these areas would not need an additional context.

Evaluations were completed in a joint meeting of the NCHRP Projects 15-72 and 15-77 during a half-day conference. During the meeting, contexts were presented and discussed to determine whether the new contexts are needed. Participants addressed three questions:

- Do the refined Contexts aid geometric design and allow for a more appropriate modal integration?
- What are the unique Transportation Expectations for each Context?
- What is the potential frequency of use for each Context?

Results of these evaluations for Natural, Suburban Commercial, Suburban Residential, and Industrial/Port/Warehouse contexts are presented below.

Natural

California, Florida, Massachusetts, and Minnesota have introduced a Natural context that is reserved for areas where natural resources are adjacent to roadways and recreational nonmotorized users are more common than in Rural contexts. In Natural areas motorized vehicles predominate, and their speeds may need be lower to adapt to increased use by nonmotorized users. Relative to Rural contexts, Permeability, Movement, and Network expectations are the same, and the minor changes in the Users/Vehicles and Speed could be addressed at the project level. The frequency of Natural contexts will vary greatly among states.

Even within individual states the context may represent a small number of roadways under state management.

Based on the similarity to Transportation Expectations for Rural contexts, the limited and varied need for use, and minimal impact on geometric design needs, Natural should not be included as a separate Context, but rather addressed as a Special Context as needed.

Industrial/Port/Warehouse

The Industrial/Port/Warehouse context has been introduced to classify areas in which these facilities require special attention. Design elements in this context are crafted to accommodate larger vehicle types. However, larger vehicles do not impose design requirements different from Users/Vehicles expectations of the context in which these facilities are located. Additionally, design vehicles may also extend out into adjacent Contexts as they access the roadway network. To merit adoption of a new Context, 40 to 50 percent of the traffic volume would need to consist of heavy vehicles. Given the anticipated low frequency of the Industrial/Port/Warehouse context, it could be used only in a few locations. Therefore, it could be a state or regional decision whether to create a separate Context or consider it as a design issue at the project level.

Based on the minimal changes in Transportation Expectations relative to surrounding Contexts, the limited potential use, and absence of impact on geometric design needs, Industrial/Port/Warehouse should not be included as a separate Context, but rather addressed as a Special Context within the surrounding context.

Suburban Division

Some agencies have divided the Suburban Context into Residential and Commercial categories to denote the predominant land use adjacent to the roadway. This division could affect the Transportation Expectations and provide some differentiation between Residential and Commercial contexts. In suburban areas development patterns vary widely, with many roadways having have mostly commercial land uses on one side of the roadway while on the other side land use could be primarily residential, or there can be mixed uses on both sides of the roadway. Intensity of commercial and residential development can vary significantly throughout a corridor. As such Transportation Expectations can vary, from minimal demand for nonmotorized transportation due to isolated development patterns to localized areas of high demand near commercial activity centers or transit stops and having continuous demand throughout a corridor. Without clear dividing line between these expectations, individual project contexts should be considered within all Suburban areas to ensure needs are met.

Based on these considerations, the Suburban Context should not be divided into Residential and Commercial at this time. Agencies may subdivide this context where it helps them address local needs. This topic is further discussed in Chapter 8.

CHAPTER 6

Recommended Context Classification

This chapter reviews the definitions and Transportation Expectations for Rural, Rural Town, Suburban, Urban, and Urban Core Contexts. Context definitions were developed utilizing a general template and are concise to allow for simple communication among all involved in project development. For each Context, the predominant land use(s), typical population density, and anticipated building density and setbacks are defined. Information on users, vehicles, access, mobility, or other descriptors is omitted as this is provided in the Transportation Expectations. Aerial and street view imagery illustrate key features of each Context and demonstrate the diversity of locations sharing a common Context.

Rural

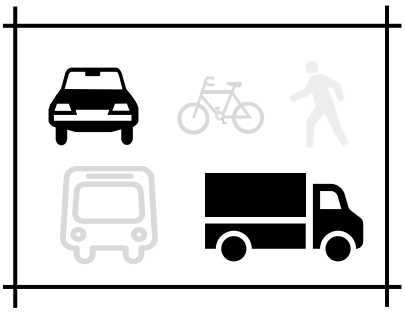
Definition

The level of development in Rural Contexts ranges from minimal (natural environment) to light (a few structures). Most land is used for outdoor recreation, agriculture, farms, and/or resource extraction, although some single-family residential homes may be present. Unincorporated areas may include a few residential and commercial structures. Building setbacks are typically large but can taper near intersections and/or crossroads where development is present. Population densities are low. Natural areas include public or private properties that may not be suitable for development. In natural areas designated for public use (e.g., parks, forest, wilderness), integrating roadways into surrounding areas to avoid or minimize disturbances may require sensitivity.

The appearance of Rural areas is contingent on landscape context. Regardless of setting (e.g., deserts, forests, orchards, fields) a Rural or natural area has minimal development. Both land use patterns and the range of users is often limited. The panels below illustrate how Rural Contexts vary in appearance.

Source: Google Maps

Transportation Expectations

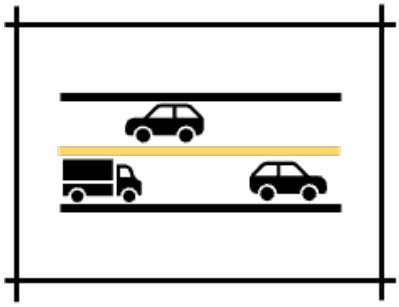


- **Users/Vehicles:** Motorized users predominate in Rural Contexts. Trucks and agricultural (farming and logging) vehicles may represent a higher percentage of large vehicles and could impose unique project requirements. There is typically a limited number of nonmotorized users including pedestrians and bicyclists, making short-distance trips or recreational (touring) riders. Bicyclists may occupy roadways or shoulders. A limited number of pedestrians may cross roadways (e.g., crossings by students who ride school buses, farm workers, hikers). Regional trail crossings may lead to a higher number of nonmotorized users. Parking near trailheads may require special attention. Even if the volume of nonmotorized users is low, their safety and quality of experience should remain a high priority. Intermodal connectivity is low. Recreation facilities may connect to the roadway or other managed interpretive features (e.g., pull outs, viewpoints, historical markers). Rural transit generally consists of vans and/or carpools, and park and ride facilities may be present.

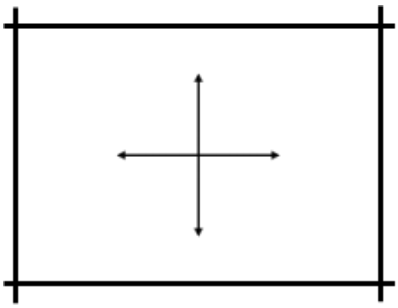
  Speed transitions and driver awareness features may be needed at transitions between Rural and natural areas, approaching developed areas, or at locations where driver workload or risk changes (i.e., intersections, pocket development, restricted speed areas).

  Transportation Expectations of users/vehicles are impacted when bicyclists are integrated. Practitioners need to document the unique needs of recreational bicyclists. For example, if most riders are experienced, they will ride next to or share lanes with higher-speed traffic. Recreational facilities surrounding parks or other attractions may elicit users of all abilities and require separation of facilities due to high vehicle speeds. In some areas trails and cycling destinations are more prevalent and where and how they cross roadways must be evaluated.

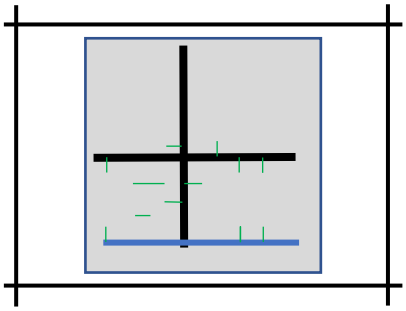
- **Movement:** There are typically general expectations of minimal congestion and high quality of service (primarily for motorized users and freight). Localized congestion is possible at limited times of day and/or in response to seasonal activities. Motorized users generally expect higher speeds and shorter travel times. Thus, delays at intersections may have a greater perceived negative impact compared to the same amount of delay in a different context. Nonmotorized users are affected by speed and proximity to roadways. Roadway crossings for all users could be a focus for quality of service and safety performance. Areas where trails are present, where nonmotorized users are more prevalent, and where roadways cross warrant additional consideration to ensure user safety.



- **Permeability:** Most facilities have a limited number of access points, with a focus on vehicle access. Different types of access can serve a high percentage of trucks or special vehicles and may include private access locations for farming vehicles to cross and/or travel short distances. Recreation area are characterized by a high percentage of recreational vehicles and drivers with different levels of experience and knowledge of the area as well as the potential for nonmotorized traffic. The lack of a network or grid may increase the difficulty of providing access to points away from the roadway. Therefore, greater importance should be placed on examining the effects of vehicle access to the roadway.



- **Network:** Rural Contexts typically have limited to no network or roadway grid. Most roadways assume a multi-role function, which often increases the emphasis of intersections on primary roadways. Limited presence of alternative routes or grid patterns may require designs that cater to a wider range of users, leading the roadway to serve a different role than ideal or intended. For example, in a limited network, a local roadway may serve lower traffic volumes at higher speeds than a local road in a different Context. Similarly, an arterial may need to serve short-distance trips with while also providing access to local developments. Without a roadway grid, certain facilities may have point loading, requiring a greater emphasis on the fewer roadways and intersections.



- **Speed:** Wide spacing between developments enables high speeds. Limited traffic congestion supports free flow conditions. Vehicles traveling longer distances at higher speeds can foster speed adaptation. Transitions from high to low speeds may be more prevalent in this Context. Reduced speed zones are more conspicuous relative to other Contexts due to natural features and constrained alignments. Although pedestrians and bicyclists are uncommon, they must utilize the roadway or available shoulders. Being close to high-speed vehicles or trucks degrades their quality of service. As roadway cross section width is sometimes limited, pedestrian and bicycle facilities may need to be established parallel to and separate from the roadway. Speeds may need to be lower than along upstream segments to integrate the presence and needs of nonmotorized users. Lower speeds could be considered for local roads, unlike with other roadway types.

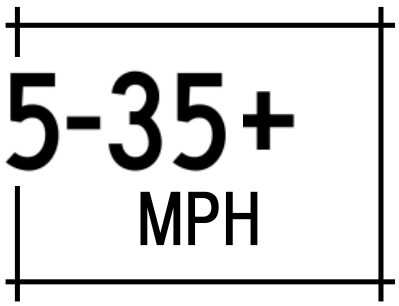
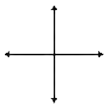
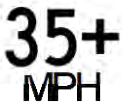


Table 10 summarizes Rural Context Transportation Expectations.

Table 10. Rural Transportation Expectations

	• **Users/Vehicles:** Limited or no pedestrian activity. Potential for recreational pedestrians (or hikers) and bicyclists. High frequency of motor vehicles/freight. Potential for agricultural vehicles.
	• **Movement:** High desired movement (primarily for vehicles) with high quality of service. Minimal disruptions limited to peak times of day and/or seasons.
	• **Permeability:** Direct vehicle access to land uses. Lack of opportunities for pedestrian access. Minimal crossing opportunities for all users.
	• **Network:** No redundant roadway network. May have cross-streets/intersections accessing dispersed locations.
	• **Speed**: Motorized 35+ mph.

Examples

The following examples demonstrate variability in Rural Contexts and their Transportation Expectations. Practitioners can use these examples along with Project Considerations to inform preliminary planning and design.

US 65, Iowa

A Rural Context with agricultural land use and isolated housing.

Transportation Expectations

- Predominantly vehicle traffic with some farm equipment
- Pedestrian and bicycle activity may be seasonal and partially the result of farm workers
- High quality of service for vehicle traffic
- Direct vehicle access to route
- No redundant network options
- High vehicle speed (55 mph)

Pine Center, Minnesota

A Rural Context with concentrated development along a crossroad, including residential and commercial properties.

Transportation Expectations

- Predominantly vehicle traffic
- High quality of service for vehicle traffic
- Direct vehicle access to route
- No redundant network options
- High vehicle speed (55 mph) that is lowered near developed areas.

Rural Town

Definition

Rural Town Contexts feature small concentrations of developed areas surrounded by rural areas, undeveloped areas, and natural areas, including historic towns. Building densities are typically low and consist of low-rise structures (one or two stories). Most land use is residential or commercial. Relatively compact residential uses are expected, and schools may be present. Building setbacks are small and much narrower than surrounding areas. A defined street network is in place. Rural Towns (or areas) typically have populations below the US Census Urbanized Cluster threshold of 2,500 residents. The panels below illustrate how Rural Town Contexts vary in appearance.

N Sherman Ave, Manderson, WY

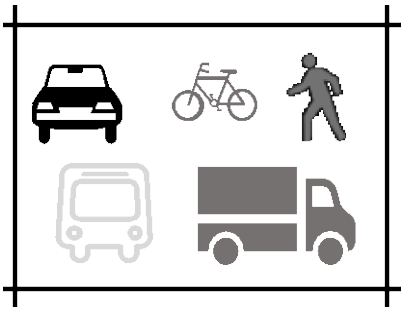

Main Street, Providence, KY


W. 3rd Ave. Keewatin, MN


Main Street, Clyde , NC

Source: Google Maps

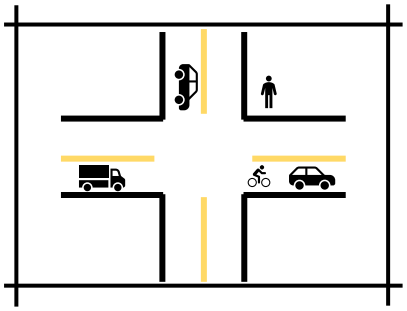
Transportation Expectations



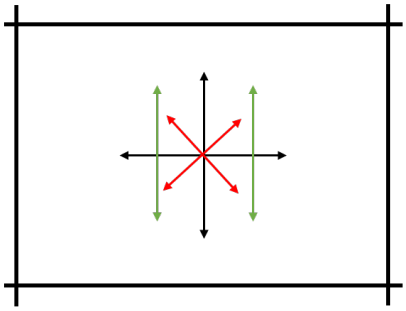
- **Users/Vehicles:** Rural Towns typically see a variety of roadway users. Motorized and nonmotorized users are often present and share the primary roadway. Freight, farm equipment, and special vehicles are typically present as the primary roadway serves regional traffic. Trucks carrying long-distance freight shipments may pass through Rural Towns, while other trucks support local needs by delivering goods. Roadways serving as Main Streets should balance the needs of local and long-distance travelers and address potential friction between these users. Bicycle integration may be needed; pedestrian

crossings should facilitate safe street crossings. Connectivity between modes and regional transit may be present.

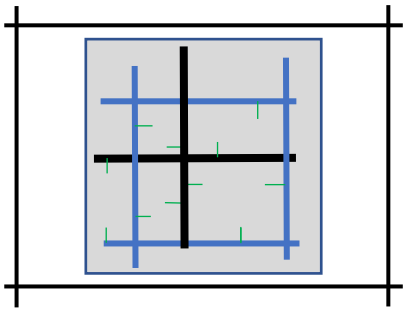
- **Movement:** Nonmotorized users are affected by the volume, speed, and composition of traffic as well as their proximity to roadways. The visibility of roadway crossings should be a focus for quality of service and safety performance, especially for nonmotorized users. Motorized users passing through a Rural Town must adjust to the lower speeds and anticipate longer travel times. Street-oriented development, higher activity densities, and greater intersection density facilitates the movements of local nonmotorized users.



- **Permeability:** Access issues require special attention because motorist expectations differ based on whether they are local or merely passing through town. Street- oriented businesses may also increase access for and attract nonmotorized users on the primary street. High variations in minor street-to-primary street access may result in complex side street or driveway movements during peak periods. With a limited roadway network or grid, it can be difficult to create access opportunities off the main roadway. The lack of networks increases the importance of addressing the operational effects of vehicles directly accessing the primary roadway.



- **Network:** The roadway network or grid can impact the relationship between through and local traffic. Through traffic is primarily served by the primary street, while other roadways serve local travel needs. As a result of pedestrian activity, sidewalks, sidewalk connectivity, and intersection crossings on primary roadways can garner increased importance. Regional highways that connect in a Rural Town generate higher traffic volumes and diverse user needs. This creates a situation where short and long trips on the same roadway segment overlap. Designs accordingly must address longer-distance connectivity while meeting the quality of service required by the local community. In terms of connections between facility types, there may be an increased focus on high-volume intersections at connecting highways or primary roadways. Configurations in limited networks may need to serve concentrated travel demand while simultaneously providing appropriate quality of service for nonmotorized users at that facility.



- **Speed:** The need to integrate all users requires lower speeds. Lower speeds help to preserve the safety of and quality of service of nonmotorized users. Higher numbers of pedestrians, bicyclists, and turning vehicles, along with on-street parking, could reduce speeds for motorized traffic. Pedestrian and bicyclist quality of service and speeds can benefit from dedicated facilities. Transitions from high to low speeds should be configured to let users attain appropriate speeds by the time they arrive in the Rural Town. Lower speeds may be considered for local roads, unlike with other roadway types.

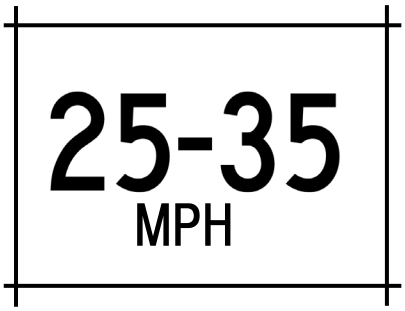
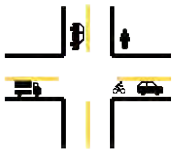
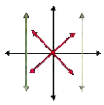
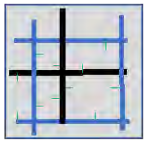


Table 11 summarizes Rural Town Transportation Expectations.

Table 11. Rural Town Transportation Expectations

	• **Users/Vehicles:** Regional vehicle/freight traffic. Moderate pedestrian activity. Potential for some bicyclists.
	• **Movement:** Moderate quality of service and slower vehicle speeds. Delays acceptable to local traffic. High quality of service for nonmotorized users due to street-oriented development patterns.
	• **Permeability:** High vehicle, bicyclist, and pedestrian access opportunities. Direct pedestrian access to land uses. Vehicular and bicyclist access may be provided on adjacent roadways within the network.
	• **Network:** Expanded street network within a limited area serving immediate land uses. May include cross streets accessing dispersed areas in surrounding rural area(s). Through traffic concentrated on primary roadway.
25-35 MPH	• **Speed**: Motorized 25 to 35 mph.

Examples

The following examples demonstrate variability in Rural Town Contexts and their Transportation Expectations. Practitioners can use these examples along with project considerations to inform preliminary planning and design.

Manderson, Wyoming

A Rural Town in which a state route enters a community (population 114) with a small street network.

Transportation Expectations

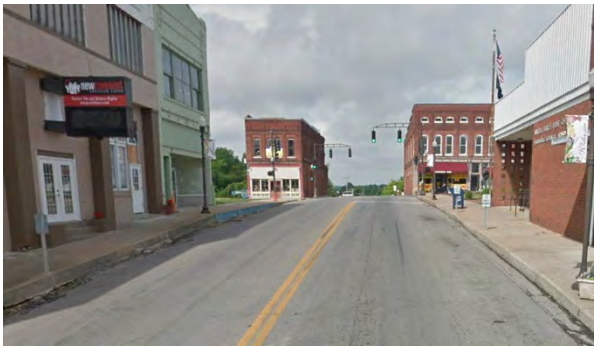
- Mainly vehicle traffic with some pedestrians
- Moderate quality of service for vehicle traffic
- Direct pedestrian access to land uses
- Some street network options
- Moderate vehicle speeds (35 mph)

Providence, Kentucky

A Rural Town with a state route entering a community with an established street network. This community represents the upper threshold of Rural Towns based on population (population 3,193).

Transportation Expectations

- Mainly vehicle traffic
- High potential for bicycle and pedestrian traffic
- Moderate quality of service for vehicle traffic
- Numerous access opportunities for vehicles, bicyclists, and pedestrians
- Direct pedestrian access to land uses
- Expanded street network options
- Moderate vehicle speeds (25 mph)

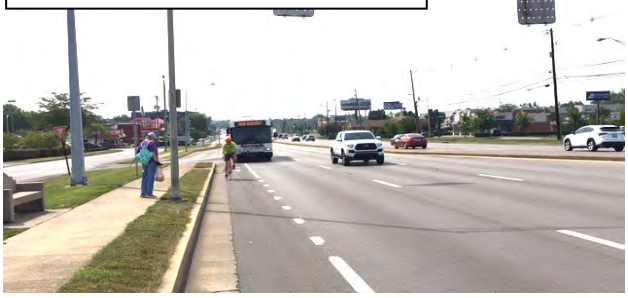


Suburban

Definition

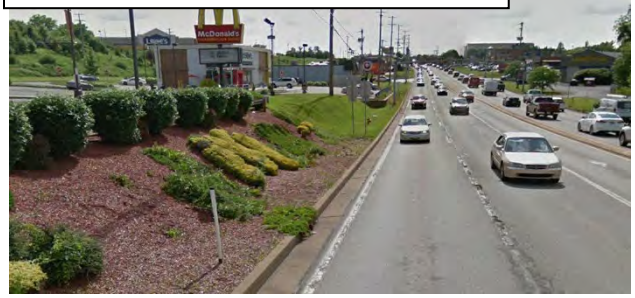
Suburban Contexts include an array of commercial and residential uses, low to medium densities, medium to large building setbacks (to accommodate off-street parking), and large block sizes. Suburban areas are usually connected to Urban areas. Buildings tend to be single story or low-rise structures, with off-street parking in commercial areas. Residential areas are populated by mostly single-family (with some multi-family) housing and some neighborhood parks. The panels below illustrate how Suburban Contexts vary in appearance.

Richmond Road, Lexington, KY

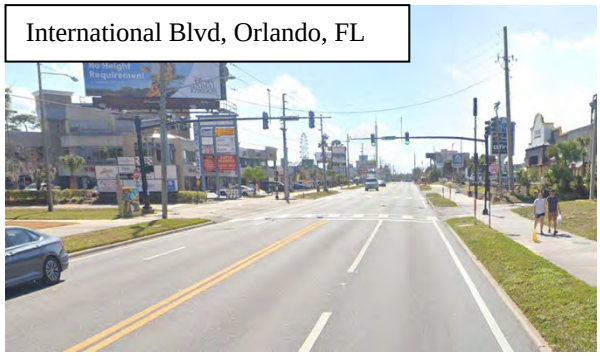


Bellcroft Dr, Lake Forest, CA

Lebanon Church Road, West Mifflin, PA



International Blvd, Orlando, FL

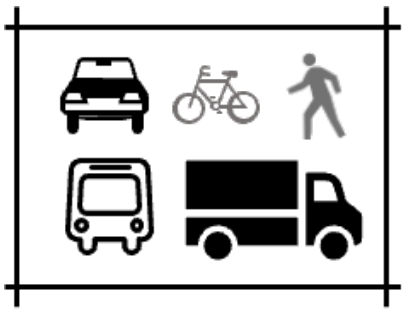


Sandbridge Rd., Virginia Beach, VA

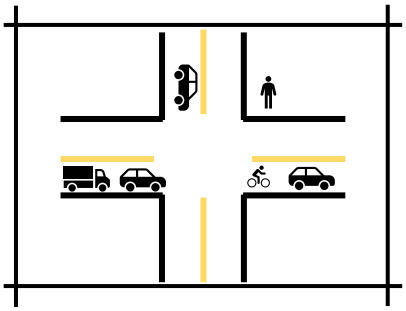
N Frontage Rd, Billings, MT

Source: Google Maps

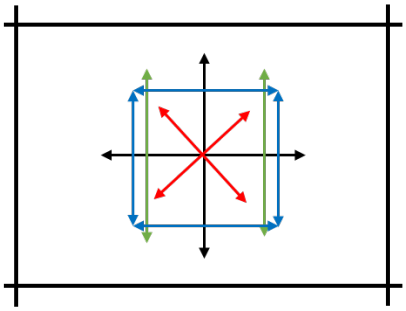
Transportation Expectations



- **Users/Vehicles:** Typically, all modes and a variety of vehicles are present. Motorized users tend to be most numerous, but bicyclists, pedestrians, and transit users are also present. Nonmotorized users are primarily associated with the area's residential and commercial development. Interactions between pedestrians, bicyclists, and motorists are probable. Pedestrian activity may not be present along the entire corridor; it can be localized around commercial and public activity centers and transit stops. Pedestrian activity may be constrained by the transportation facility and presence/type of accommodations due to high speeds and safety concerns as opposed to being purely a function of land use and development patterns. Roadway segments with long distances between intersections may require midblock crossings. Transit may be present, and pedestrian and bicyclist integration in the vicinity of transit stops should be a priority. Trucks serving long-distance freight needs may pass through Suburban Contexts. Commercial, light industrial, or warehousing sites which require truck deliveries may be present.



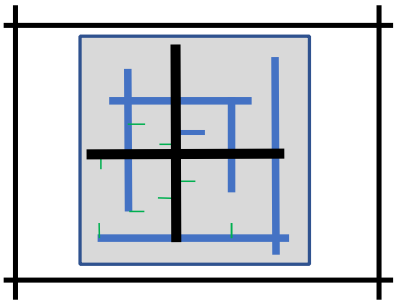
- **Movement:** Nonmotorized users are affected by the volume and speed of traffic as well as their proximity to roadways. Residential areas may have limited street lighting, and roadway crossing visibility could affect quality of service and safety performance. Motorized users include individuals accessing land uses along roadways and others passing between communities or areas within the community. Longer distances between destinations may contribute to drivers striving for higher speeds and lower travel times. Bicyclists, pedestrians, and transit users can be integrated by separating facilities from higher-speed traffic (bicycle lanes, sidewalks, bus stops). Transit quality of service is influenced the types of bus stops and the use of bus pull outs or bulb-outs. Bus stops at intersections may require modification of turning movements to ensure safe access. Midblock bus stops may require special attention to connect sidewalks, crossings, and refuge areas on wider street cross sections.



- **Permeability:** Block sizes tend to be larger, which limits the number of crossing points for bicyclists, pedestrians, and transit users. Turning volumes at these intersections create conflicts with pedestrians and bicyclists. There are frequently incomplete networks, missing sidewalks, and bicycle features that coincide with developing areas. Limited connections between land use types and between specific development patterns may increase travel times for pedestrians and bicyclists. High variations in minor street-to-primary street access can generate complex side street or driveway movements during peak periods. Suburban areas may have a limited public roadway network, which results in low-access density in some locations and clusters of high-access density in others (i.e., supporting commercial development). Given the range of users, more expansive development, and longer trip types, a special focus on integrating pedestrian and bicycle facilities with crossings may be warranted. Public and private access spacing may be inconsistent, with clusters and gaps along the roadway's length. With limited public streets, commercial areas may see high traffic volumes served by public and private driveways. Auto-oriented land development may increase barriers to nonmotorized

users because of larger lot sizes, incomplete bicycle facilities and sidewalks, disconnected land uses, and building setbacks.

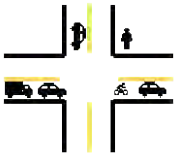
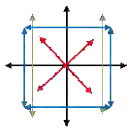
- **Network:** Roadway networks may have limited redundancy or assume the form of a disjointed grid system. Residential areas can have roadway networks that serve neighborhood uses but provide limited connectivity to other areas. This results in longer trips or out-of-direction travel for users who want to access other areas. A network-wide review of pedestrian and bicyclist activity can help ensure their needs are met. In some cases, roadways may be part of complete networks, which increases the potential for alternative routes and creates opportunities to address the needs and demands of the primary roadway through the available network. If these networks are lacking it may concentrate traffic on a few roadways, requiring large intersection configurations that degrade the safety performance and quality of service for nonmotorized users. Roadways in areas with limited networks may serve a role that is neither ideal nor intended. For example, in a limited network, a roadway with mixed commercial and residential development and high nonmotorized traffic may serve freight or delivery needs and require additional considerations to integrate all users.



- **Speed:** Roadways have historically been designed and posted at higher speeds, which creates significant conflicts and results in more severe crashes near commercial areas or activity centers; this pattern relates to vehicle crashes with pedestrians and bicyclists. Lower vehicle speeds are critical for preserving the safety and quality of service of nonmotorized users. During peak travel periods, traffic control and traffic congestion may significantly influence motorized vehicle speeds. Developing separated facilities for pedestrians and bicyclists can enhance their safety, quality of service, and the completeness of facilities, while also increasing their speeds. Lower speeds could be considered for local roads, unlike with other roadway types.

Table 12 summarizes Suburban Context Transportation Expectations.

Table 12. Suburban Transportation Expectations

	• **Users/Vehicles:** Regional traffic on primary roadways mixed with local vehicle traffic and transit. Pedestrian activity may vary from low to moderate in areas with isolated development patterns, to higher concentrations of activity near commercial centers, transit stops or other activity centers. Increased potential for recreational walking/ running and recreational/commuter bicyclists in residential areas.
	• **Movement:** Moderate to low vehicular quality of service during peak periods. Lower movement for nonmotorized users due to higher vehicle speeds and longer travel distances. It could be sporadic near activity centers.
	• **Permeability:** Low to moderate access opportunities for all users. Primarily vehicle-oriented access with opportunities for localized pedestrian-oriented access.
	• **Network:** Limited supporting roadway network. Parallel streets may be present but disjointed. Alternative routes between destinations exist but likely on a different roadway type. Wide intersection spacing (~0.50 miles).
30-45 MPH	• **Speed**: Motorized 30 to 45 mph.

Examples

The following examples demonstrate variability in Suburban Contexts and their Transportation Expectations. Practitioners can use these examples along with Project Considerations to inform preliminary planning and design.

Lexington, Kentucky

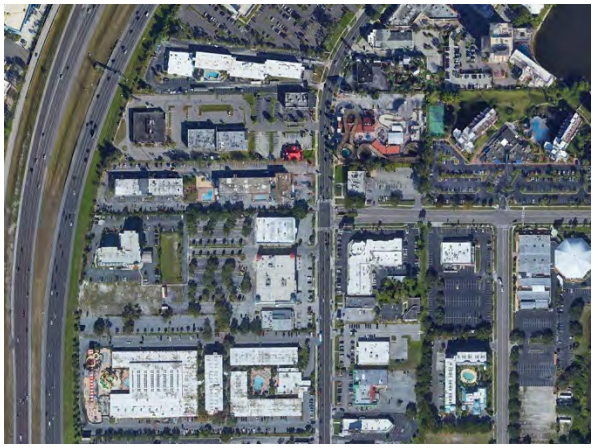
A primary roadway that supports multimodal options (transit and bicycle lane) along a commercial corridor.

Transportation Expectations

- Regional traffic mixed with local traffic
- Potential for moderate bicycle and pedestrian activity based on commercial land uses and transit activity. Prioritizes separated facilities for nonmotorized users.
- Primarily designed for vehicle-oriented access, but moderate access needs for all users
- Limited supporting street network
- Alternative routes available on other roads and frontage roads
- Moderate vehicle speeds (35 mph)

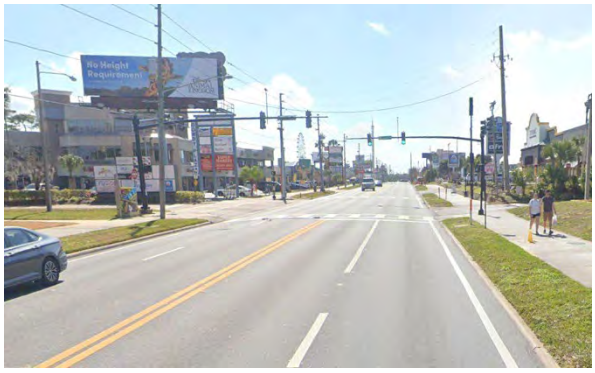
Orlando, Florida

A roadway in a high-density commercial area with significant multimodal activity.



Transportation Expectations

- Regional traffic mixed with destination-type local traffic
- High pedestrian and bicyclist activity along with transit
- Moderate movement for nonmotorized users due to varied destinations and numerous access points
- Primarily vehicle-oriented access, but moderate access opportunities for all users
- Limited supporting street network for alternative routes
- Moderate vehicle speeds (35 mph)



West Mifflin, Pennsylvania

A roadway in a moderately dense commercial area with big box stores adjacent to residential areas.

Transportation Expectations

- Mostly regional traffic mixed with some local traffic
- Some potential for pedestrians and bicyclists
- No transit presence
- High vehicle speeds (40 mph) demonstrate need for separated facilities
- Primarily vehicle-oriented access with low access opportunities for all users
- Limited supporting street network and few alternative routes
- High vehicle speeds (40 mph)

Virginia Beach, Virginia

A road that serves a residential area with some low-density commercial areas and schools.

Transportation Expectations

- Mostly regional traffic with some local traffic
- Presence of bicyclists and pedestrians with street crossings
- No transit presence
- Adequate opportunities for the movement of nonmotorized users due to the presence of crossings and varied destinations
- Primarily vehicle-oriented access with moderate access opportunities for all users
- Limited supporting street network for alternative routes
- High vehicle speeds (35 mph)

Billings, Montana

A local road that serves an industrial area.

Transportation Expectations

- Mostly regional traffic with higher presence of heavy trucks
- Limited pedestrian and bicyclist activity
- No transit presence
- Limited movement opportunities for nonmotorized users due to high vehicle speeds
- Primarily vehicle-oriented access and low access opportunities for all users
- No supporting street network for alternative routes
- High vehicle speeds (40 mph)

Orange County, California

A local road serving a residential area

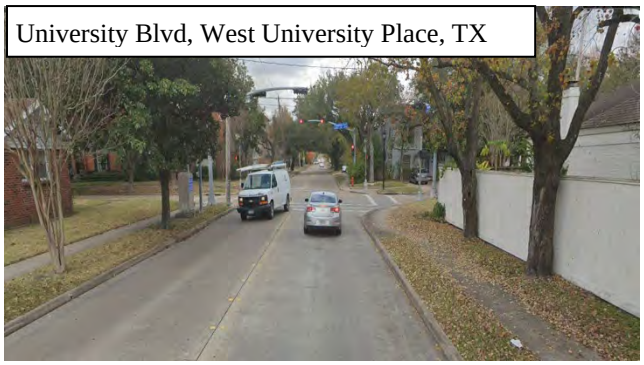
Transportation Expectations

- Mostly local traffic with delivery and occasional moving trucks
- High recreational pedestrian and bicyclist activity
- No transit presence
- On-street parking may be common
- Limited access points to the primary road
- Limited street network for alternative routes
- Low vehicle speeds (25 mph)

Urban

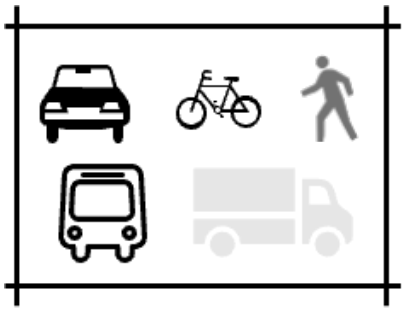
Definition

Urban Contexts are high density and consist mainly of multi-story and low- to medium-rise structures for residential, commercial, and institutional use. Many structures are mixed use: commercial, residential, and parking. Building setbacks are small with pedestrian-focused building orientations. The panels below illustrate how Urban Contexts vary in appearance.



Source: Google Maps

Transportation Expectations



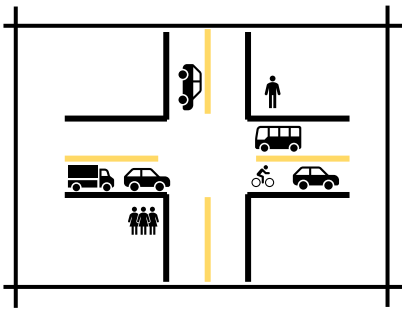
- **Users/Vehicles:** All modes are found in Urban Contexts. Numerous vehicle types are present, with most making localized trips. High levels of roadway activity result in a broad spectrum of vehicles, volumes, and speeds, with users of different modes occupying the same roadways and intersections. Motorized users primarily access land uses along roadways, although some pass between communities or areas within a community. Pedestrian and bicycle activity is typically high. Transit service is common, and appropriate facilities are available to ensure transit users are safely integrated. Transit stops must be integrated with pedestrian and bicyclist facilities. Freight vehicles may be present, and increased demand exists for curbside activities, delivery vehicles, and Transportation Network Company (TNC) vehicles (i.e., ride share).

  Increased pedestrian activity is associated with dense development patterns and results in the need for sidewalks and crosswalks on all roadways. Cross sections may integrate pedestrian-focused lighting

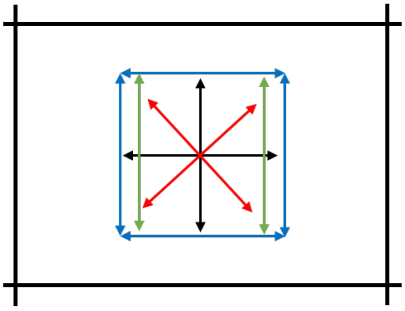
along and across roadways. Practitioners should pay close attention to issues such as safe routes to schools, safe routes for seniors, and special projects or programs to provide ramps and other installations that comply with the Americans with Disabilities Act (ADA) to support users with special needs.

Urban areas should provide connectivity for bicyclists of various experience levels as well as micromobility devices. Traffic volumes and patterns on lower-order streets may call for bicycle lanes or designated shared facilities (sharrows) to provide appropriate quality of service. Traffic volumes and patterns on higher-order streets may not be conducive to on-street bicycle lanes and there could be a greater need for separated facilities and parallel bicycle routes. Area bicycle and trail plans may describe the type of facility needed to integrate regional bicycle trails and longer bicycle routes. Bicycle routes should integrate access to common destinations (e.g., schools, libraries, civic centers, transit stops, mobility hubs).

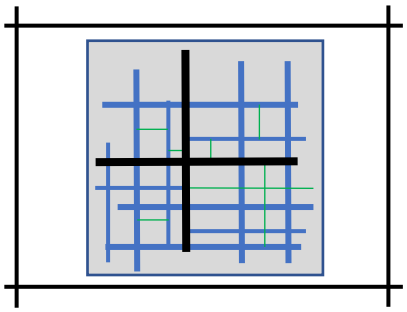
- **Movement:** Nonmotorized users are affected by the composition and volume of as well as by their proximity to roadways. Due to greater local access and curbside activities, motorized users expect delays and traffic congestion. Elements and facilities that help integrate bicyclists, pedestrians, and transit users are typically present (e.g., bicycle facilities, sidewalks, bus stop amenities). Higher intersection density offers increased crossing opportunities for most users. Most streets have a well-established sidewalk network, and slower vehicle speeds increase the potential for bicyclists to interact with motorized traffic. Motorized users primarily access land uses along roadways, but some motorists may only pass between communities or areas within a community.



- **Permeability:** Intersection and access density is typically higher as most trips terminate within the urban area. Turning volumes at intersections generate conflicts with pedestrians and bicyclists. An extensive roadway network or grid provides opportunities for multiple access alternatives. High variations in minor street-to-primary street access can result in complex side street or driveway movements during peak periods. Buildings are typically placed closer to the street than in other Contexts, with improved pedestrian access from adjacent roadways to activity centers. Relatively high intersection density opens up opportunities for nonmotorized users, but they require additional attention to ensure safe crossings are available.



- **Network:** Urban roadways are typically part of a connected system that takes the form of a dense roadway network or grid. This enables greater use of the full network and creates numerous access and circulation opportunities so that pedestrians, bicyclists, freight, and emergency responders can avoid passing through high-demand roadways or intersections. The presence of complete networks offers the potential for alternative routes that could address the needs and demands of the primary roadway via the entire available network. Increased pedestrian activity requires added emphasis on sidewalks, sidewalk connectivity, and intersection and midblock crossings. Residential areas may have additional needs to address, including safe routes for seniors and other road crossing needs.



- **Speed:** The presence of nonmotorized users requires lower vehicle speeds, which bolsters their safety and quality of service. Reduced building setbacks, shorter block lengths, and traffic control systems foster and demand low to moderate speeds. Slower speeds support pedestrians moving along and across Urban roadways. Lower speeds could be considered for local roads, unlike with other roadway types.

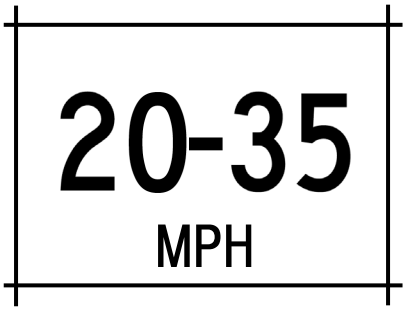
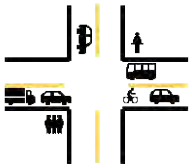
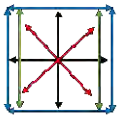
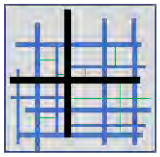


Table 13 summarizes Urban Context Transportation Expectations.

Table 13. Urban Transportation Expectations

	• **Users/Vehicles:** Moderate to high pedestrian activity. High potential for commuter bicyclists. High potential for transit interaction. Primarily local users.
	• **Movement:** Lower vehicle quality of service and slower travel speeds. Increased movement for nonmotorized users due to increased activity densities and crossing opportunities.
	• **Permeability:** High access opportunities for most users (vehicles, bicyclists, and pedestrians). Access for freight movement may be restricted.
	• **Network:** High level of supporting roadway network with parallel and cross streets. Network supports localized area but may be disconnected from adjacent areas due to natural/built boundaries. Alternative routes between destinations exist. Regional traffic may have bypass alternatives.
20-35 MPH	• **Speed**: Motorized 20 to 35 mph.

Examples

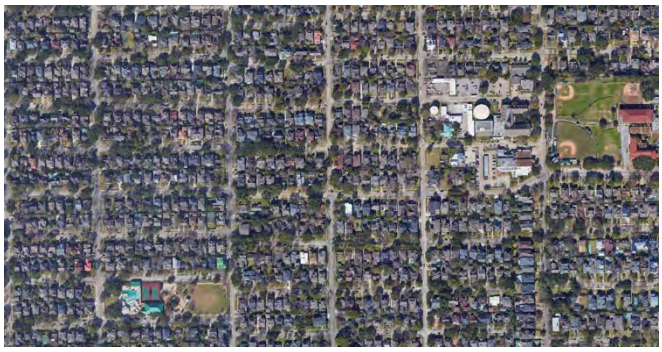
The following examples demonstrate variability in Urban Contexts and their Transportation Expectations. Practitioners can use these examples along with Project Considerations to inform preliminary planning and design.

West University Place, Texas

Local Urban streets that mainly serve a residential area adjacent to school.

Transportation Expectations

- Mix of vehicle, pedestrian, and bicycle traffic
- Vehicle traffic may encounter lower quality of service while pedestrians and bicyclists enjoy higher quality of service
- High access opportunities for all users
- Dense network of supporting streets that provides alternate routes between destinations
- Low vehicle speeds (20 mph)



River North Art District, Denver, Colorado

A large, more densely populated Urban context that joins commercial and residential areas

Transportation Expectations

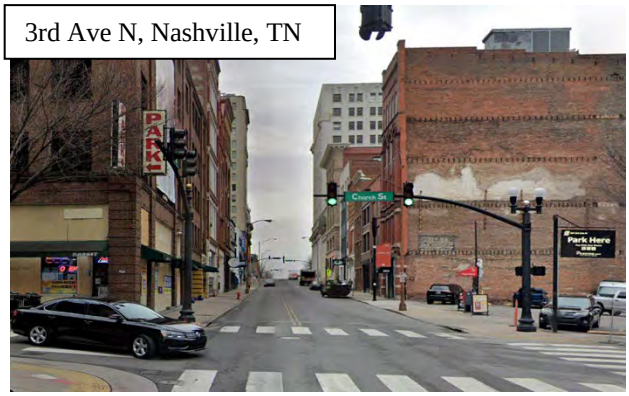
- Mix of vehicle, pedestrian, and bicycle traffic
- Vehicle traffic may encounter lower quality of service while pedestrians and bicyclists enjoy higher quality of service due to wide sidewalks and bicycle lanes
- High access opportunities for all users
- Dense network of supporting streets that provides alternate routes between destinations
- Low vehicle speeds (25 mph)

Urban Core

Definition

Urban Cores exhibit the highest level of density among all Contexts. Mixed residential and commercial uses are accommodated in multi-story structures. Most parking is housed in multi-level structures attached to or integrated with other structures; on-street parking may be present. Structures may have multiple uses. Building setbacks are smaller than in surrounding Urban areas. The panels below illustrate how Urban Core Contexts vary in appearance.


Downtown Crossing, Boston, MA

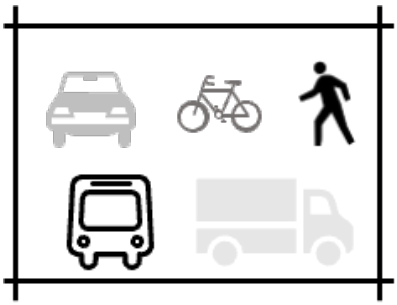


3rd Ave N, Nashville, TN


N Leroux St, Flagstaff, AZ

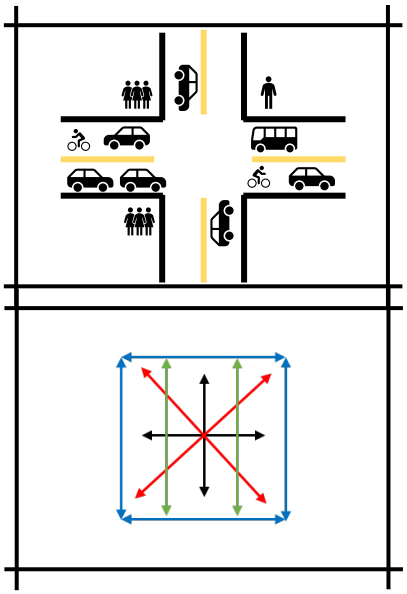
Source: Google Maps

Transportation Expectations



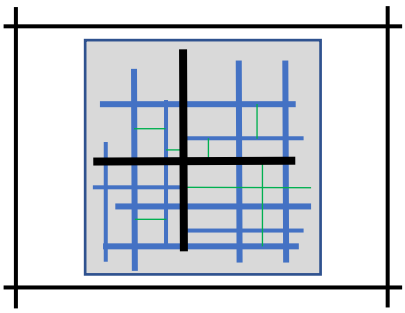
- **Users/Vehicles:** All user types are present, with transit, pedestrian, bicycle, and micromobility users in greater numbers than in other Contexts. Pedestrians dominate street crossings and can impede motor vehicle traffic at times. Increased pedestrian traffic requires sidewalks on all facilities. Bicyclists are integrated through options like bicycle lanes, separated facilities, and shared low-speed streets. Transit service is common; transit centers may be present. Integration of pedestrians and bicyclists in the vicinity of transit stops is

essential. Freight vehicles may be present for deliveries. There is an increased number of curbside activities, delivery vehicles, and Transportation Network Company (TNC) vehicles (i.e., ride share).

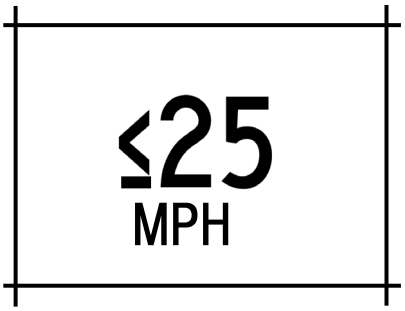


- **Movement:** The presence of nonmotorized users reduces the dominance of and focus on serving vehicle traffic. Motorized users expect delays and traffic congestion. Well-established sidewalk networks are present and bicycle facilities are typically available. Traffic volumes can affect transit quality of service.

- **Permeability:** Many access opportunities are available, and the existing network provides the widest array of route choices and overall connectivity. Vehicle congestion limits vehicle speeds and volumes. Street-oriented businesses increase access for nonmotorized users, while limited parking areas may reduce access for motorized users. The roadway network is relatively extensive, allowing access to and circulation of users and movements. One-way street systems can increase out-of-direction travel. Bicyclists that interact with motorized traffic take advantage of a full roadway network. But they can experience the same congestion issues as motorized users, except if separate bicycle facilities are present. Micromobility users are typically encouraged to use the same facilities and routes as bicyclists. Sometimes both use sidewalks, which increases conflicts with pedestrians.



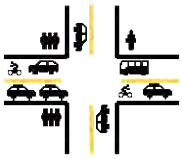
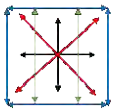
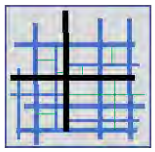
- **Network:** Roadways are typically part of a connected system that results in a dense roadway network or grid. The presence of a full network creates access and circulation opportunities so that pedestrians, bicyclists, freight, and emergency responders can avoid passing through other high-demand roadways or intersections. Urban Core roadways have complete networks that create multiple alternative routes.



- **Speed:** The volume of activity and friction between users results in slow speeds. The presence of nonmotorized users requires lower vehicle speeds and enhances their safety and quality of service. Signal systems and signal timing plans can impact speeds and traffic congestion. Transit vehicles influence traffic flow, especially where they exit and enter traffic at stops. Curbside activities also require slow speeds. Lower speeds could be considered for local roads, unlike with other roadway types.

Table 14 summarizes Urban Core Context Transportation Expectations.

Table 14. Urban Core Transportation Expectations

	• **Users/Vehicles:** High pedestrian concentrations associated with transit and other pedestrian activity zones. High potential for commuter bicyclists. High transit presence and micromobility users. Transit is ubiquitous. Primarily local traffic.
	• **Movement:** Low vehicle quality of service and low travel speeds during most periods of the day. High mobility for nonmotorized and micromobility users due to increased density, high crossing potential, and pedestrian-oriented development.
	• **Permeability:** Many access opportunities for nonmotorized and micromobility users. Street-oriented businesses increase access for nonmotorized users, while limited parking areas may decrease access for motorized users.
	• **Network:** Cohesive and dense surrounding street network with multiple parallel and cross streets. Cohesive network within the urban core. Multiple alternative routes exist on similar roadway types. Regional traffic may have bypass alternatives.
	• **Speed**: Motorized ≤25 mph.

Examples

The following examples demonstrate variability in Urban Core Contexts and their Transportation Expectations. Practitioners can use these examples along with Project Considerations to inform preliminary planning and design.

Nashville, Tennessee

The Urban Core of a mid-size city with commercial, residential, and institutional/administrative areas.

Transportation Expectations

- High pedestrian, bicyclist, and micromobility activity
- Presence of transit
- Vehicle traffic may encounter lower quality of service while pedestrians and bicyclists enjoy higher quality of service
- High access opportunities for nonmotorized users
- Reduced access for vehicle traffic
- Off-street parking
- Cohesive and dense network of supporting streets that provides alternate routes between destinations
- Low vehicle speeds (25 mph)

Flagstaff, Arizona

A compact Urban Core with commercial and administrative areas.

Transportation Expectations

- High pedestrian and bicyclist activity
- Presence of transit
- Vehicle traffic may endure lower quality of service while pedestrians and bicyclists enjoy higher quality of service
- Numerous access opportunities for nonmotorized users, but less access for vehicle traffic
- On-street parking
- Cohesive and dense network of supporting streets that provides alternate routes between destinations
- Low vehicle speeds (25 mph)

Special Contexts

Why Special Context

Some agencies have incorporated additional Contexts into their classification systems to address local needs (Figure 9). These were evaluated to determine whether they should be integrated into the Context Classification system reviewed in this report (and adopted by GB8), or if there is better strategy to handle unique situations. Two questions guided evaluations of these Contexts:

- Does the Context present a different set of Transportation Expectations or inform design differently than established Contexts?
- Does the Context occur frequently enough across all agencies and within those agencies to justify a unique Context?

Because Context Classification guides decisions throughout project development, it was essential to determine if adding a new Context will significantly impact design and modal integration — and thus warrant adoption. Ultimately, the project team decided the best way to address these areas is using Special Contexts (see Chapter 5).

Natural

Natural areas are public (e.g., parks, forest, wilderness) or private properties unsuitable for development. Configuring and integrating roadways into the surrounding areas while avoiding or minimizing disturbances may demand greater design sensitivity. To address the uniqueness of Natural areas, Transportation Expectations for Users/Vehicles, Permeability, and Speed may require adjustment. For example, in national forests or state parks, bicyclists and pedestrians occur in larger numbers than in Rural Contexts — and thus merit special consideration when a project is initiated in this Special Context.

Ozark National Forest, Arkansas

A Natural Context in a US National Forest with minimal development.

Transportation Expectations

- Predominantly vehicle traffic
- Vehicle traffic likely enjoys high quality of service
- Direct vehicle access to the route
- Absence of network redundancies
- High vehicle speeds (55 mph)

AR-21, Sherman Township, AR

Industrial/Port/Warehouse

Industrial/Port/Warehouse areas occur in all Contexts. They are often found at industrial centers, multimodal ports, and manufacturing and commercial parks. Where these areas are situated, Transportation Expectations for Users/vehicles and Speeds may require additional adjustments. For example, an industrial center in a Suburban area increases freight activity. Depending on other Users/Vehicles Expectations, practitioners may study the implications of using a larger design vehicle.

Toledo, Ohio

An Industrial area in a Suburban Context with residential and commercial development.

Transportation Expectations

- Predominantly vehicular traffic
- Low levels of pedestrian and bicycle traffic
- Heavy freight present
- Vehicle traffic may experience moderate quality of service while pedestrians and bicyclists may enjoy adequate quality of service
- Many access opportunities for vehicle traffic
- Few access opportunities for pedestrians
- Limited supporting street network
- Moderate vehicle speeds (30 mph)

Other

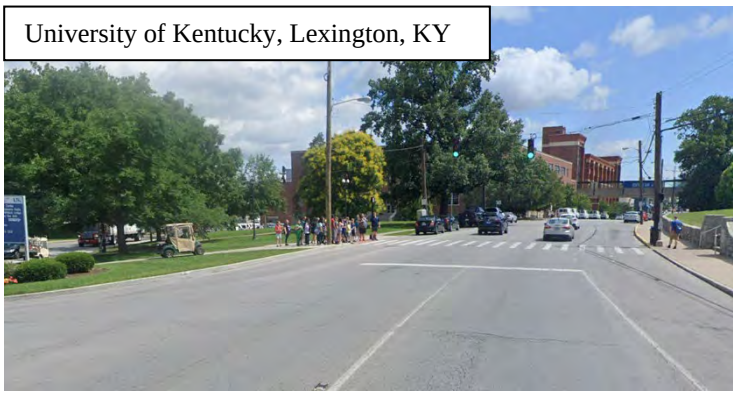
When other area types are present (e.g., university campuses, city parks, airports), they may conflict with the overall Context. Due to the differences between the Transportation Expectations of these areas and the surrounding Context, they are classified as Special Context. Transportation Expectations for Users/ Vehicles, Permeability, and Speed may require adjustments to address their unique attributes. For example, a city park or a university campus in a Suburban Context may increase the number of pedestrians and bicyclists above what is typically encountered. Practitioners must closely attend to these issues when a project is initiated.

Lexington, Kentucky

A university campus in an Urban Context with residential and commercial development.

Transportation Expectations

- Mix of vehicle traffic
- Increased pedestrian and bicycle traffic, especially in areas with wide sidewalks and bicycle lanes
- Presence of transit
- Lower quality of service for vehicle traffic
- Increased access opportunities for pedestrians and bicyclists
- Fewer access opportunities for vehicle traffic due to off-street parking
- Dense supporting street network that provides alternate routes between destinations
- Moderate vehicle speeds (35 mph)



University of Kentucky, Lexington, KY

CHAPTER 7

Context Classification Measures

GIS-Based Context Classification Measures

Context Measures

This section documents the methodology used to identify measures that may be employed to conduct an automated GIS-based Context Classification. This approach may be applicable for large-scale classification at the state or regional level. The initial measures evaluated are used by agencies which have adopted expanded context classification systems. Newly available datasets, such as the Microsoft Bing National Building Footprint, database were also used due to their potential to inform classification. Two primary factors were used to assess the applicability of measures. First, measures were evaluated for their ability to inform Transportation Expectations associated with each Context. Second, an evaluation of data availability for each measure across states and an assessment of which step of project development the data may be available were considered. For example, measures typically available at the state level with a consistent dataset (e.g., population or building density) may be preferred to measures for which data are absent or inconsistent (e.g., building setbacks). Another potential Context measure is walking distances. For example, Texas recently adopted the ITE *Designing Walkable Urban Thoroughfares* as part of its Context determination (ITE-CNU 2010).

Table 15 lists measures adopted by each state that use an expanded context classification system. All states employ Land Use in all Contexts. In terms of frequency, Land use is followed by Setback, Parking Availability (used by all states but California) and Building Density (used by all except California and Florida).

Table 15. Context measures by State and Context

Context	Measure	Land use	Building height	Building orientation	Setback	Parking	Block size-Length	Traffic volume	Intersection density	Population density	Employment density	Building density
Rural	FL	X	X	X	X	X	X		X	X	X	
	MN	X	X	X	X	X						X
	CA	X			X	X						X
	WA	X	X		X	X			X		X	
	OR											
	MD	X								X	X	
	AZ	X					X					X
Rural Town	FL	X	X	X	X	X	X		X	X	X	
	MN	X	X	X	X	X						X
	CA	X										X
	WA											
	OR	X		X	X	X	X					X
	MD	X	X	X	X	X				X	X	X
	AZ											
Suburban	FL	X	X	X	X	X	X		X			
	MN	X	X	X	X	X						X
	CA	X										
	WA	X	X		X	X			X		X	
	OR	X		X	X	X	X					X
	MD	X		X		X				X	X	
	AZ	X			X	X						X
Urban	FL	X	X	X	X	X	X		X	X	X	
	MN	X	X	X	X	X						X
	CA	X								X		X
	WA	X	X		X	X			X		X	
	OR	X		X	X	X	X					X
	MD	X	X		X	X				X	X	X
	AZ	X			X			X				X
Urban Core	FL	X	X	X	X	X	X		X	X	X	
	MN	X	X	X	X	X						X
	CA	X								X		X
	WA	X	X		X	X			X		X	
	OR	X		X	X	X	X					X
	MD	X	X		X	X				X	X	X
	AZ											

The project team evaluated context measures to determine how each context informs or relates to Transportation Expectations (Table 16).

Table 16. Context measures by Transportation Expectation

Measure	Users/ Vehicles	Movement	Permeability	Network	Speed
Land use	x	x	x		x
Building height	x				
Building orientation	x		x		
Setback	x	x	x		x
Parking		x	x		
Block size-Length	x	x	x	x	
Block size-Perimeter					
Traffic volume		x			
Intersection density	x	x	x	x	x
Population density	x				
Employment density	x				
Building density	x	x	x	x	x
Allowed residential density					
Allowed office/retail density					
Short Trip Opportunity Area	x			x	x

Land use is a frequently used measure that can be applied to most Transportation Expectations, except for assistance in determining network condition. Intersection density and Building density apply to all Expectations. Each measure is discussed below.

- **Land use** is a primary measure for establishing context, specifically in terms of determining user types and frequency of users. Evaluating the mix of land uses in an area can also help identify Short Trip Opportunities (STOs), as used by the MDOT SHA. While land use may not influence roadway network permeability, it directly relates to the ability of land uses to integrate nonmotorized travel.
- **Building height** can also serve as a proxy for activity density within a zone as it relates to the ability to support STOs.
- **Building orientation** is critical for determining the ability to support nonmotorized users as it relates to providing ease of access or permeability to users.
- **Setback** supports nonmotorized users as it relates to the proximity of the building and entrances to the transportation network. Additionally, building proximity to the roadway network can directly impact user speed and mobility, with both increasing as setback increases.
- **Traffic volume** can provide a measure of motorized users on the network, but variations may be more directly related to roadway type or roadway functional classification than the context zone.
- **Parking** gives an estimate of traffic activity in the vicinity of the roadway. It can also serve as a surrogate for pedestrian activity integration.
- **Block size/perimeter/Intersection density** are measures that relate to the movement and permeability of motorized and nonmotorized users, with increasing nonmotorized mobility and access associated with decreased block size or increased intersection density. This can be associated with increased crossing opportunities and access to adjacent street networks and directly impacts the vehicle speed of the adjacent roadway.
- **Population/Employment/Building density** are measures that identify the number of potential users in an area.

Table 17 indicates the availability of context measures for statewide, regional, and/or project-level data. Data availability was determined based on an informal review of 18 Midwest states.

Table 17. Data availability by project level

Measure	Statewide	Regional	Project
Land use	x	x	x
Building height			x
Building orientation			x
Setback			x
Parking		x	x
Block size-Length	x	x	x
Block size-Perimeter	x	x	x
Traffic volume	x	x	x
Intersection density	x	x	x
Population density	x	x	x
Employment density	x	x	x
Building density	x	x	x
Allowed residential density		x	x
Allowed office/retail density		x	x
Short Trip Opportunity Area	x	x	x

All states that have implemented expanded context classification systems rely on land use data. However, states that apply statewide Context Classification (Florida and Maryland) have extensive statewide land use databases. Not all states maintain such databases. In some states, land use coverage is maintained by local planning and/or zoning agencies, and data formats are inconsistent. Thus, other measures with nationwide availability were considered, including:

- Population density (based on the US Census data)
- Employment density (based on the US Census / Longitudinal Employer-Household Dynamics (LEHD) data)
- Building density (based on the Microsoft Bing Maps US Building Footprint database)
- Building area-density (based on the Microsoft Bing Maps US Building Footprint database)
- Street density (calculated from TIGER/Line Street Network)
- Intersection density block length (calculated from TIGER/Line Street Network)
- Block length (feet) (calculated from TIGER/Line Street Network)
- Block perimeter (feet) (derived from TIGER/Line Street Network)
- Building setback (feet) (derived from the Microsoft Bing Maps US Building Footprint database and TIGER/Line Street Network)

These measures were systematically evaluated using the process described in the next section.

Measure Evaluation

Context measures were calculated for a set of roadways which had been manually classified. Results were compared to the manual classification to determine appropriate thresholds to distinguish Contexts. This process enabled quantification of measurement accuracy and yielded a set of recommended set of measures for each context. Recommended measures were validated against another roadway set in another state to

ensure that regional land use and/or transportation development patterns did not impact the recommended measures.

A dataset containing all public roadways in Kentucky Transportation Cabinet (KYTC) District 7 was used for this process. KYTC District 7 encompasses the Lexington-Fayette County Metropolitan Area and surrounding counties. It was chosen because the project team has considerable knowledge of the roadway network, which facilitated manual classification. Once recommended measures and thresholds were developed using this dataset, they were validated against statewide preliminary Context Classifications of the Florida DOT's network.

In addition to evaluating measures and thresholds, roadway segmentation lengths and the influence areas of (buffer) measures surrounding the segmentation were evaluated through sensitivity analysis. Four segmentation and buffer scenarios were evaluated, including two segmentation options and two influence areas including:

- 0.25-mile segment length with 0.125-mile buffer
- 0.25-mile segment length with 0.25-mile buffer
- 0.50-mile segment length with 0.125-mile buffer
- 0.50-mile segment length with 0.25-mile buffer

Roadways from TIGER/Line roadway shapefiles were first separated into Non-Urbanized (including Rural and Rural Town Contexts) and Urbanized (Suburban, Urban, and Urban Core Contexts) areas based on the Urbanized Area/Urban Cluster boundaries from US Census Data. Roadway segments were split based on Urbanized area boundary lines; roadways parallel to an Urbanized Area/Cluster boundary were assigned to the Urbanized Area/Cluster. Non-Urbanized and Urbanized segments were split into 0.25- or 0.50-mile segments as appropriate. Because roadway lengths vary, some remainder road segments were created that were shorter than the 0.25- or 0.50-mile road segments; they were included in the analysis. Buffers of 0.125 and 0.25 miles were created and used to determine the associated measures within the defined influence area.

Manual Classification

KYTC District 7 has 7,234 miles state-maintained and locally owned roadways. The "All Roads" 2021 TIGER/Line Shapefile roadway network was used for classification. Roadways were first classified as Urbanized Contexts (Suburban, Urban, and Urban Core) or Non-Urbanized Contexts (Rural and Rural Town) using US Census Urbanized Area and Urban Cluster boundaries. Urban Clusters are areas with a population greater than 2,500, while Urbanized Areas have a population greater than 50,000. Roadways located on a boundary line with an Urbanized Area/Cluster were assigned to the Urbanized Area/Cluster.

Following network segmentation roadways were manually classified using aerial photos, Google Street view data, and local knowledge of the area. Each segment was then to assigned one of the five Contexts. Roadway segments were manually defined in ArcGIS and edited to set the appropriate context within the attribute table. Manual classification required approximately 8 hours of staff time. Table 18 summarizes mileage for each Context; Figure 12 is a map of the classified roadway network.

Table 18. Summary of road mileage by Context Classification

Assigned Context	Total Mileage
Rural	4342.0
Rural Town	72.9
Suburban	2436.6
Urban	332.1
Urban Core	50.8
Total	7234.3

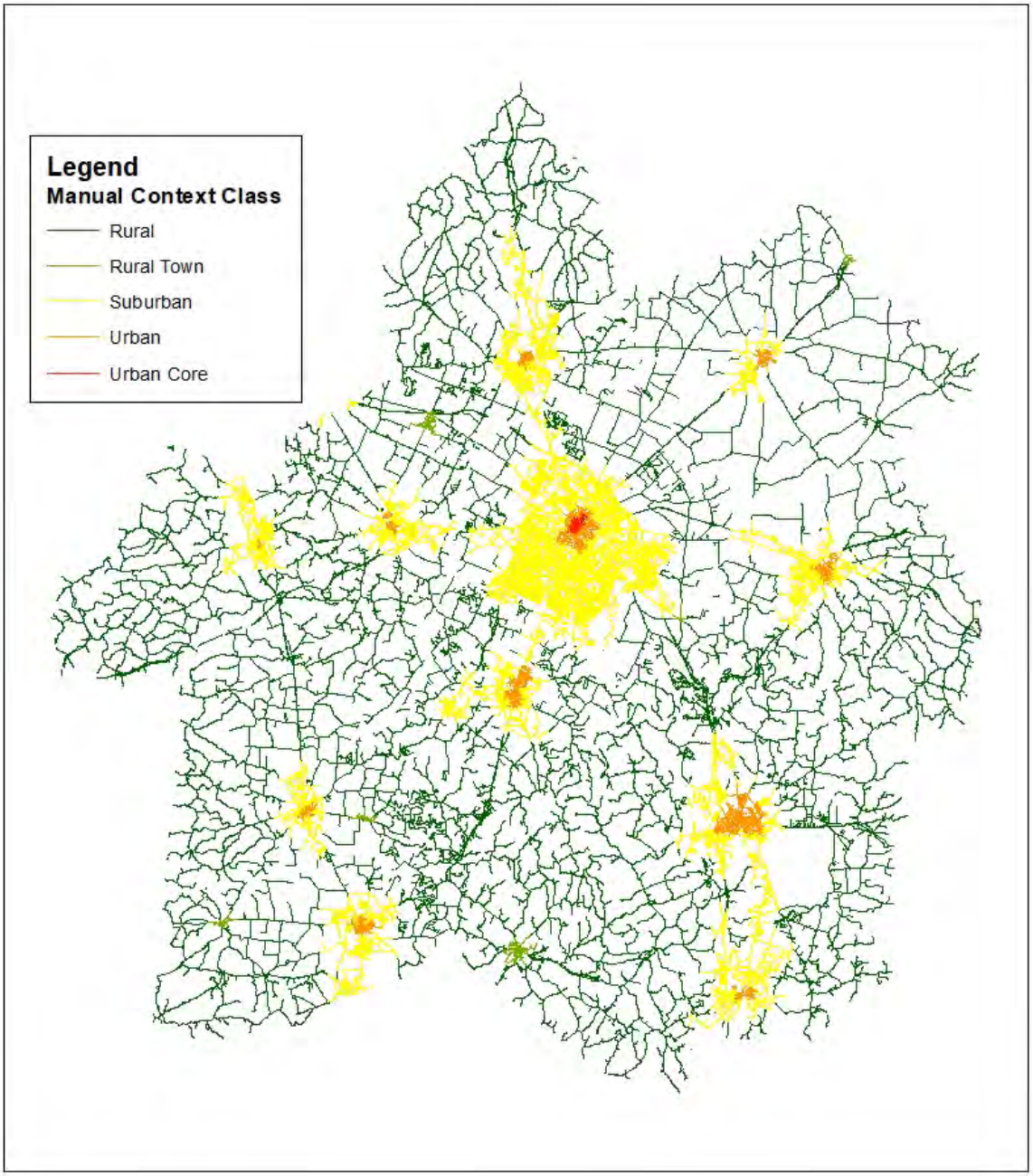


Figure 12. Manually classified roadway segments in KYTC District 7

Measure Appraisal

Once roadways were segmented, buffers established, and segments manually classified, the project team evaluated seven measures to determine the most efficient method for determining context. Measures were developed in ArcGIS using TIGER/Line roadway data, US Census urban-area data, US Census population and employment data at the tract level, building polygon data, and GIS-derived intersection and street data. The four roadway network scenarios were developed based on the roadway segment length and buffer. All eight measures were computed within the buffer polygons and appended as attributes to each segment.

Intersection Density (intersections/sq. mi.)

Intersection density was derived from the TIGER/Line data by creating points at each intersection in the All Roads shapefile utilizing the ArcGIS *Intersect (Analysis)* tool. This tool creates a point feature wherever two or more lines intersect for each line segment at the intersection (i.e., a four-way intersection creates four unique point features at the same location). Redundant intersection points were removed with the *Delete Identical* tool in ArcGIS. Intersection point features were joined to the roadway segment buffer using a spatial join. Intersection density was calculated by dividing the count of intersection point features by the area of the roadway segment buffer. Table 19 summarizes intersection density statistics for each scenario. Figure 13 illustrates intersection density for each road segment in the study area based on the 0.25-mile length and 0.25-mile buffer scenario.

Table 19. Intersection density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	0.0	0.0	0.0	0.0
Maximum	1,200.4	521.1	1200.4	528.8
Average	73.2	52.6	82.3	62.4
Standard Deviation	90.4	58.8	95.3	64.3

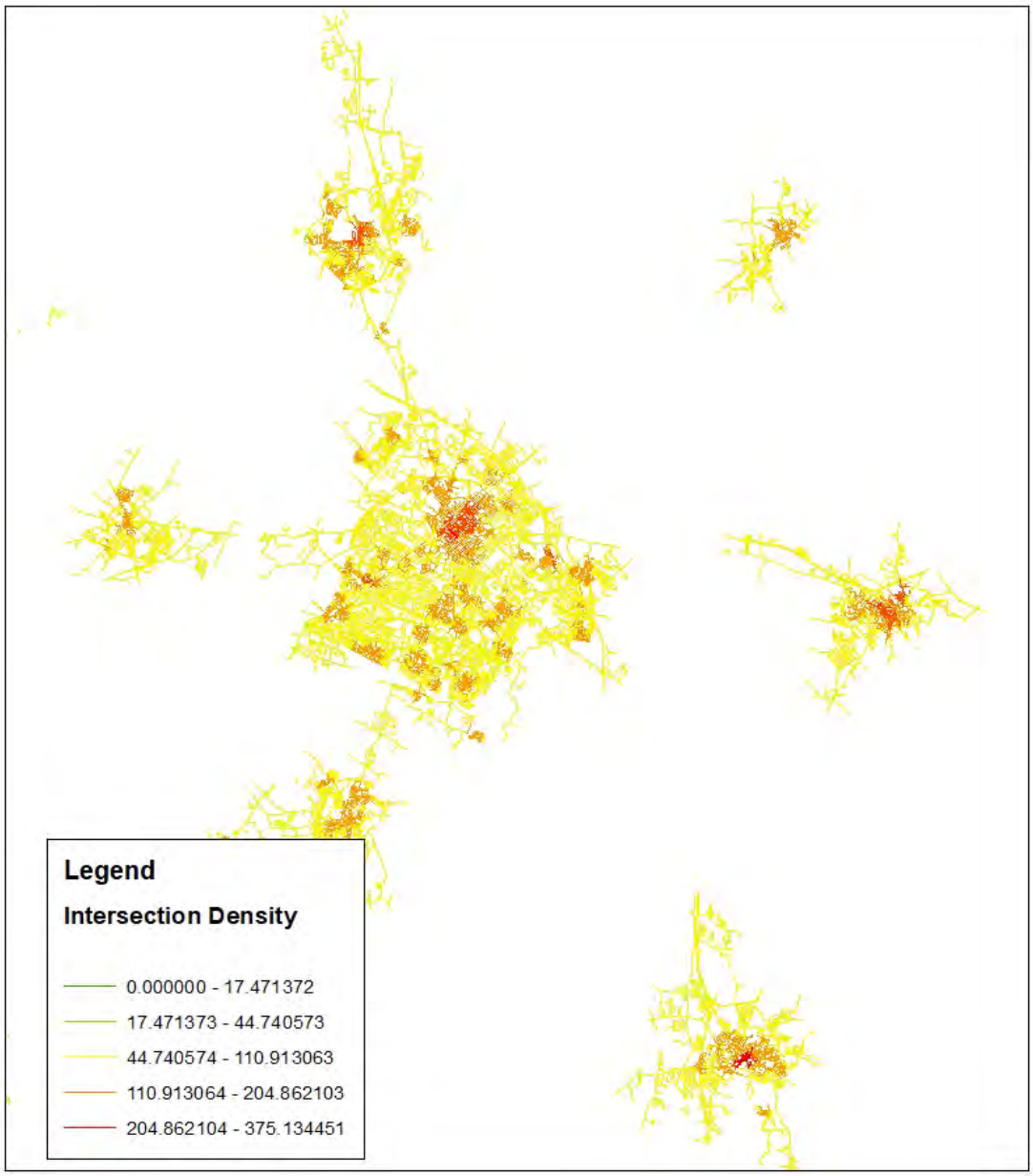


Figure 13. Intersection density (0.25-mile length and 0.25-mile buffer)

Building Density (buildings/sq. mi.)

Building density was derived using the Microsoft Maps US Building Footprint database. The building database and roadway segment buffer were merged using a spatial join. Building density was calculated by dividing the count of building features by the area of the roadway segment buffer. Table 20 lists building density statistics for each scenario. Figure 14 illustrates the building density for each road segment in the study area based on the 0.50-mile length and 10.125-mile buffer scenario.

Table 20. Building density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	0.0	0.0	0.0	0.0
Maximum	5,538.5	3,979.2	4864.3	3,616.5
Average	713.9	614.0	778.6	675.4
Standard Deviation	824.0	710.3	831.4	702.4

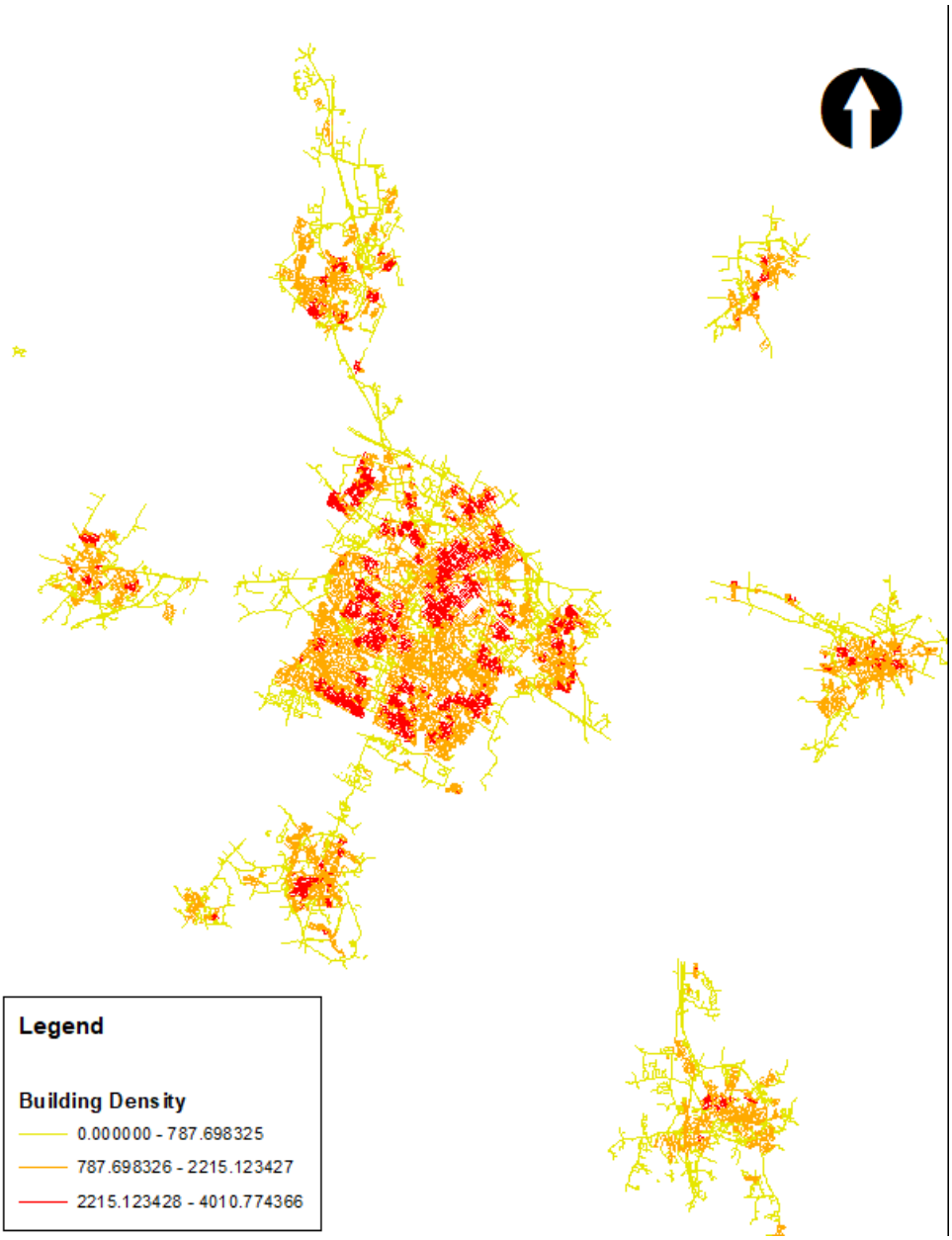


Figure 14. Building density (0.25-mile length and 0.125-mile buffer)

Building Area Density (sq. feet/sq. mi.)

Building area density was derived using the Microsoft Maps US Building Footprint database. This measure captures the denser building footprints typical of Urban and Urban Core Contexts. The building database and roadway segment buffer were merged using a spatial join ,and building area density was calculated by dividing the sum of building areas within the segment buffer by the roadway segment buffer area. Table 21 summarizes building area density statistics for each analysis scenario. Figure 15 illustrates the building area density for each road segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 21. Building area density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	0.0	0.0	0.0	0.0
Maximum	100,910,913.2	39,675,117.5	75,599,669.1	37,989,866.6
Average	2,013,916.1	1,704,223.7	2,190,361.9	1,886818.3
Standard Deviation	2,390966.2	1,921,529.7	2,251,270.7	1,878,663.1

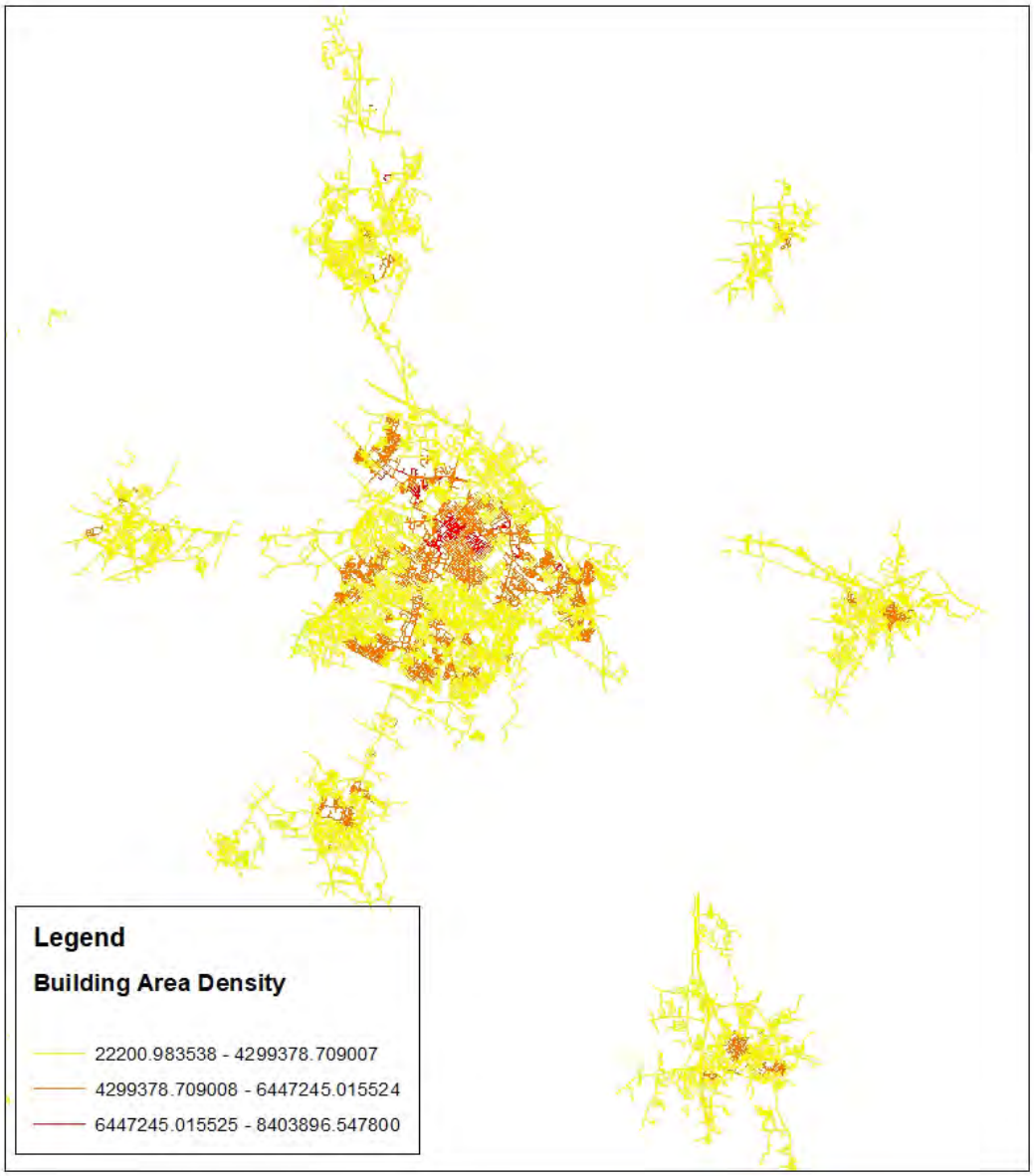


Figure 15. Building area density (0.50-mile length and 0.25-mile buffer)

Employment Density (employees/sq. mi.)

Employment data were derived using the Census Transportation Planning Products (n.d.) database and tract-level employment estimates. Employment density was first calculated for each census tract by dividing the number of employees by the census tract area. Employment density for each roadway segment was then calculated as the average employment density for all tracts within or partially within the roadway segment buffer. Table 22 summarizes employment density statistics for each scenario. Figure 16 illustrates the employment density for each road segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 22. Employment density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	12.9	12.9	12.9	12.9
Maximum	5,720.2	5,031.1	5,720.2	5,031.0
Average	530.2	548.0	577.6	571.0
Standard Deviation	829.9	829.2	853.2	822.4

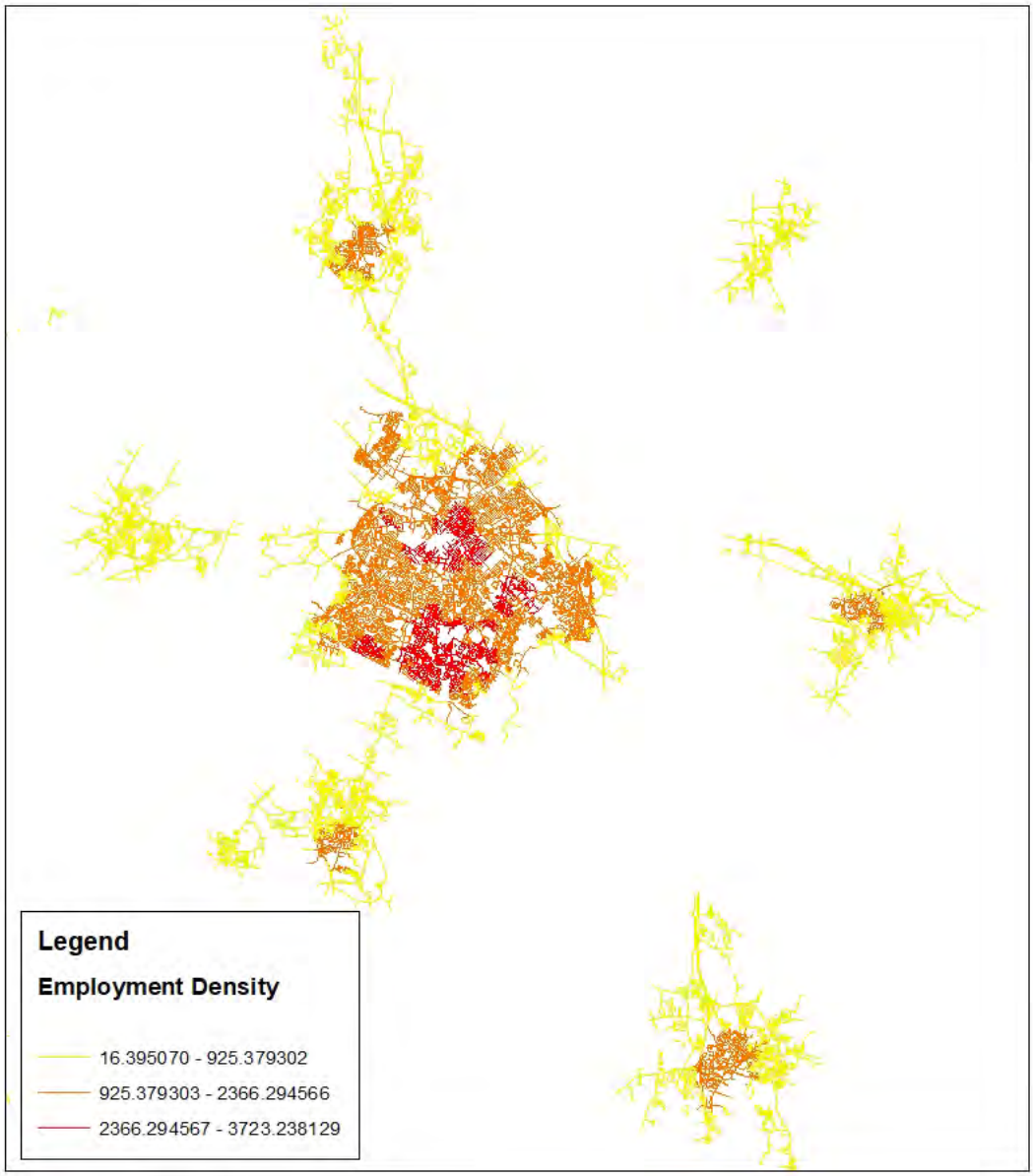


Figure 16. Employment density (0.50-mile length and 0.25-mile buffer)

Population Density (persons/sq. mi.)

Population data were derived using the Census Transportation Planning Products database and tract-level population estimates. Population density was first calculated for each census tract by dividing the number of residents by census tract area. Population density for the roadway segment was then calculated as the average employment density for all tracts within or partially within the roadway segment buffer. Table 23 summarizes population density statistics for each scenario. Figure 17 illustrates the population density for each road segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 23. Population density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	29.7	29.7	29.7	26.7
Maximum	12,125.2	11,343.9	12,125.2	11,343.9
Average	1,085.4	1,109.7	1,183.4	1,169.1
Standard Deviation	1,666.3	1,639.4	1,716.7	1,647.9

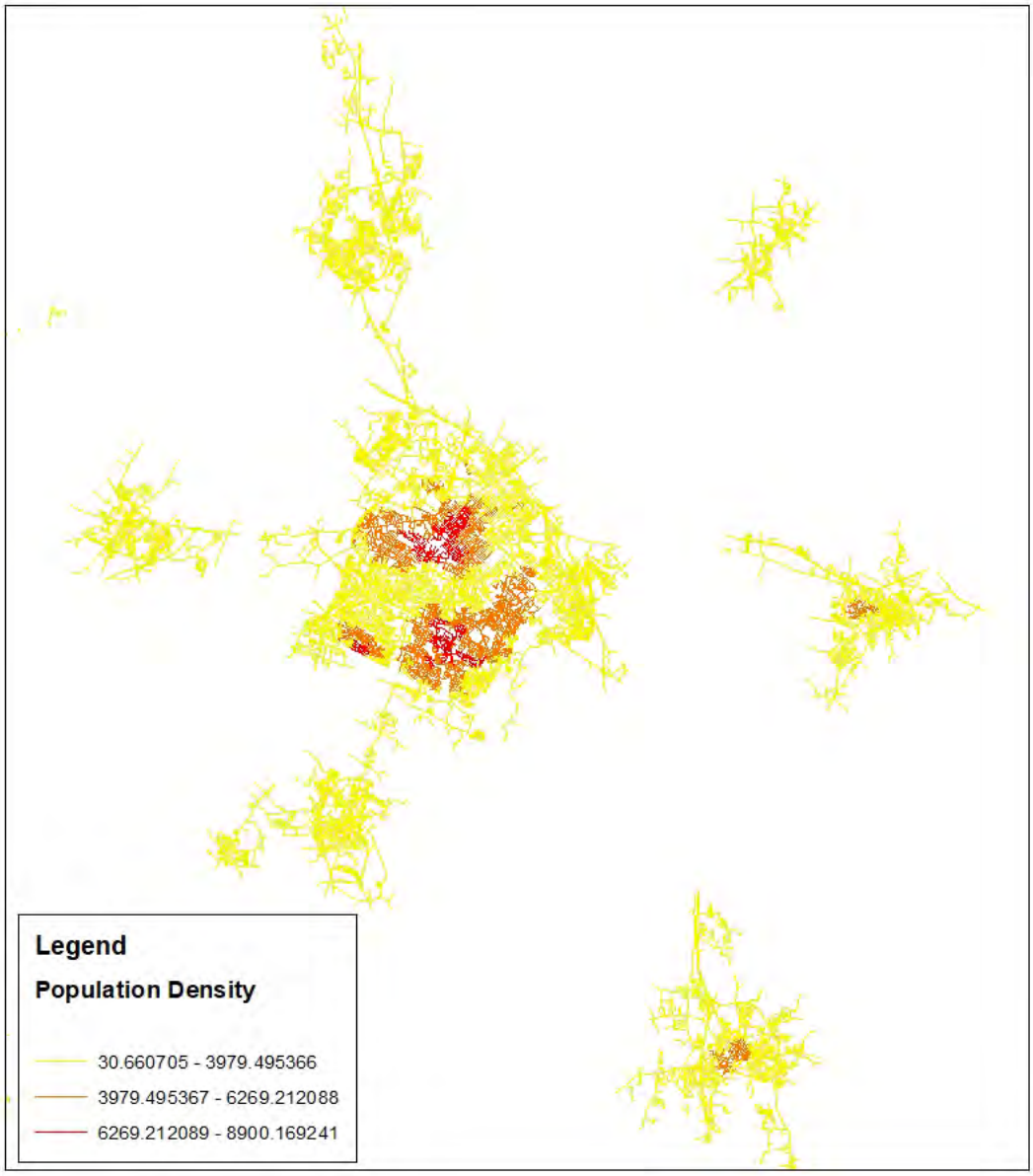


Figure 17. Population density (0.50-mile length and 0.25-mile buffer)

Block Length (feet)

Block length was calculated as the average length of each block. Blocks were created from KYTC centerline data using the *Split Line at Point* tool in ArcGIS. This tool splits a line feature wherever it intersects a point feature. Intersection points were used for this split. A column was then created in the attribute table to compute the length of each line segment using the *Calculate Geometry* tool. A spatial join was used to merge the split line features and roadway segment buffer; the option in the spatial join dialogue box to calculate the average of each attribute was selected. This generated a new column named "Avg_Length," which contained the average block length of each buffer. Table 24 summarizes block length statistics for each scenario. Figure 18 illustrates block length for each road segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 24. Block length statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	35.8	58.1	35.8	56.9
Maximum	30,152.7	30,152.7	30,152.7	30,152.7
Average	2,558.1	2,678.0	1,997.3	1,907.8
Standard Deviation	3,708.3	3,681.8	3,138.9	2,963.8

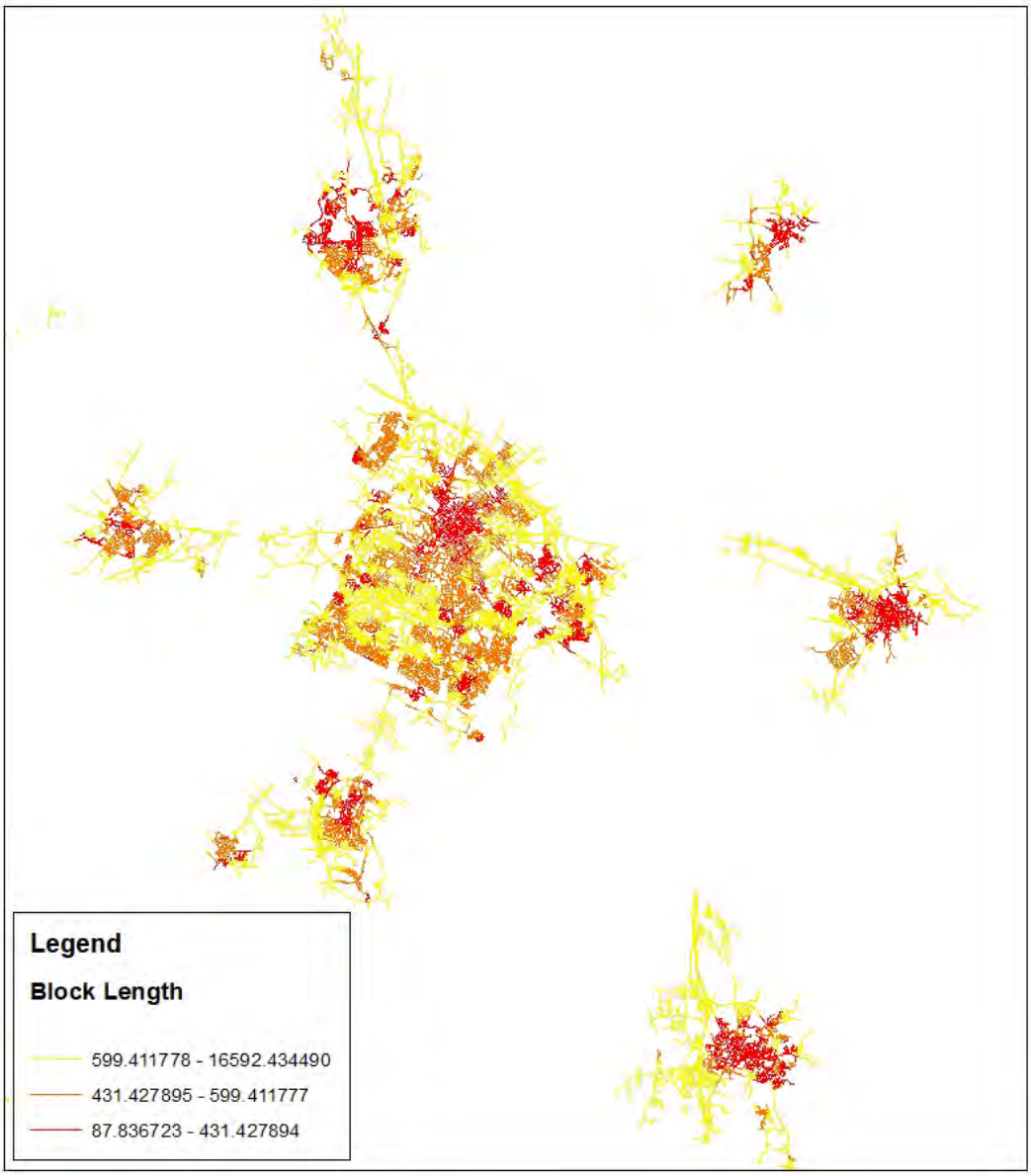


Figure 18. Block length (0.50-mile length and 0.25-mile buffer)

Street Density (number of streets/sq. mi.)

Street density was considered as an additional measure that could describe the Network and Movement Transportation Expectations. Street Density was derived directly from the TIGER/Line roadway network. A spatial join was used to count the number of unique roadways within the road segment buffer area, and density was calculated by dividing the number streets by the buffer area. Table 25 summarizes street density statistics for each scenario. Figure 19 illustrates the street density for each road segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 25. Street density statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	9.0	3.1	5.7	2.2
Maximum	416.8	222.8	3416.8	222.8
Average	70.5	43.9	75.2	48.7
Standard Deviation	61.5	42.8	65.6	43.3

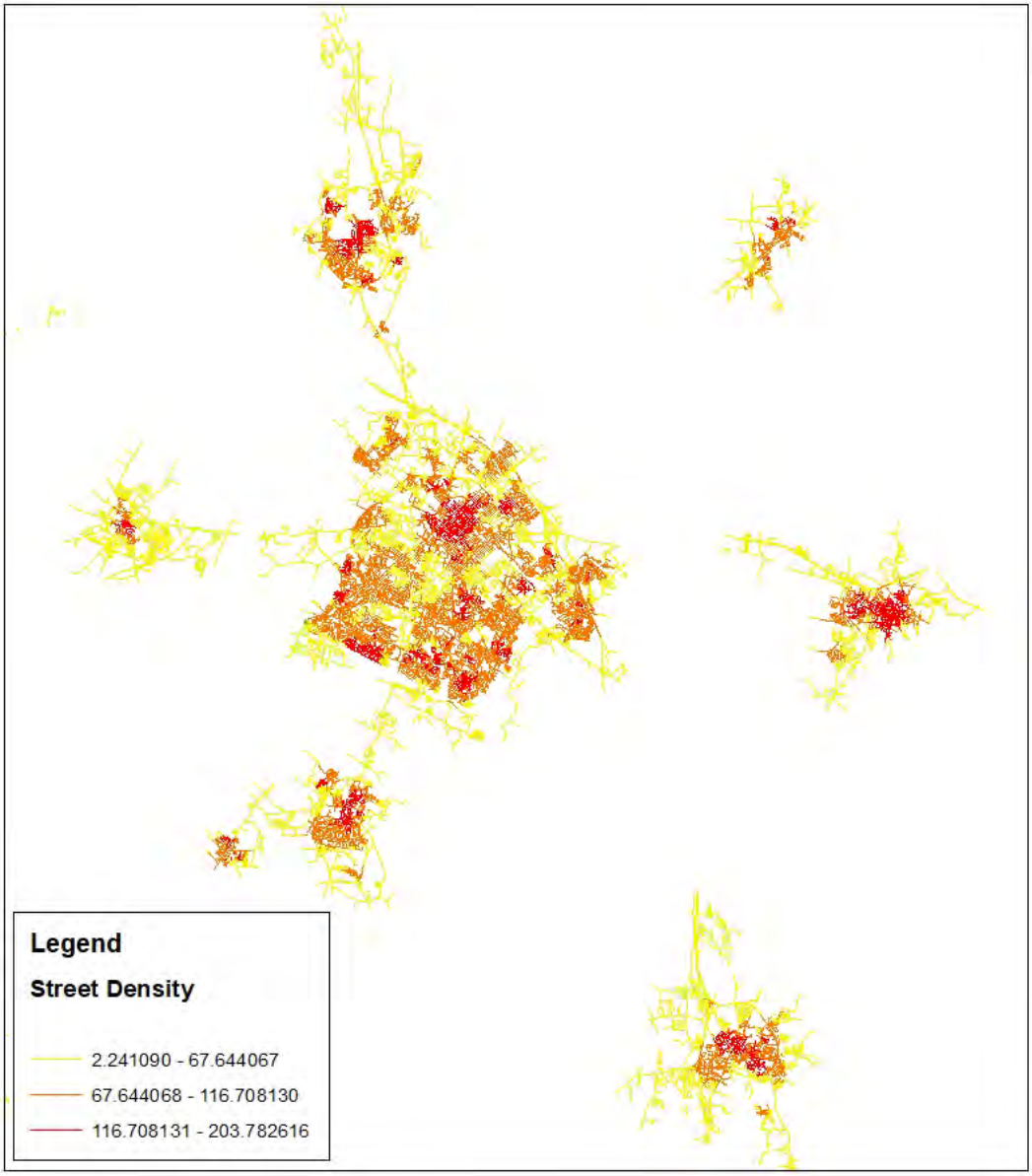


Figure 19. Street density (0.50-mile length and 0.25-mile buffer)

Building Setback (feet)

Building setback was considered due to the availability of the Microsoft Building footprint database and the relationship between building setback and built urban form. Setback from the roadway centerline was calculated for each building by performing a near spatial join of roadway data to the building dataset. Table 26 summarizes building setback statistics for each scenario. Figure 20 illustrates building setback for each road segment in the study area based on the 0.50-mile length and 0.125-mile buffer scenario.

Table 26. Average building setback statistics

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	0	0	0	0
Maximum	659.8	1304.9	650.3	1304.9
Average	124.7	170.3	117.2	156.0
Standard Deviation	96.9	151.2	89.0	141.1

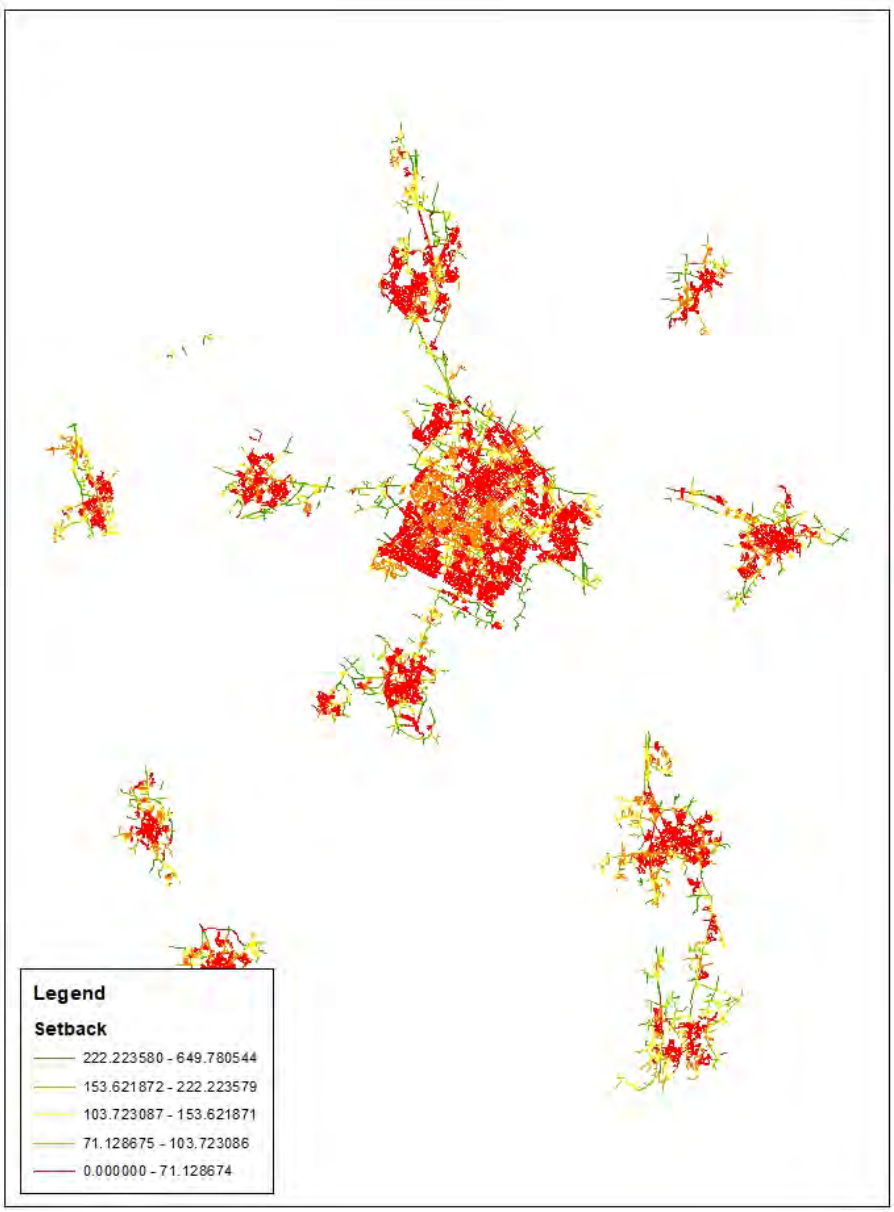


Figure 20. Average building setback (0.50-mile length and 0.125-mile buffer)

Block Perimeter (feet)

Block perimeter was used to estimate block area, with the understanding that block size decreases with increasing network connectivity as areas become more developed. Block perimeter was derived from the TIGER/Line Street Network by identifying blocks created by the street network and calculating the resulting perimeter. Average block perimeter was then calculated for each road segment within the buffer area using spatial analysis. Block perimeter was only analyzed for urbanized areas. Table 27 summarizes block perimeter statistics for each scenario. Figure 21 illustrates the block perimeter for each roadway segment in the study area based on the 0.50-mile length and 0.25-mile buffer scenario.

Table 27. Average block perimeter statistics (Length x Buffer)

Statistic	Length 0.25 mi x Buffer 0.125 mi	Length 0.25 mi x Buffer 0.25 mi	Length 0.50 mi x Buffer 0.125 mi	Length 0.50 mi x Buffer 0.25 mi
Minimum	0	0	0	0
Maximum	99,004	99,004	99,004	99,004
Average	12,695	10,279	12,153	9,756
Standard Deviation	12,727	10,413	12,112	9,686

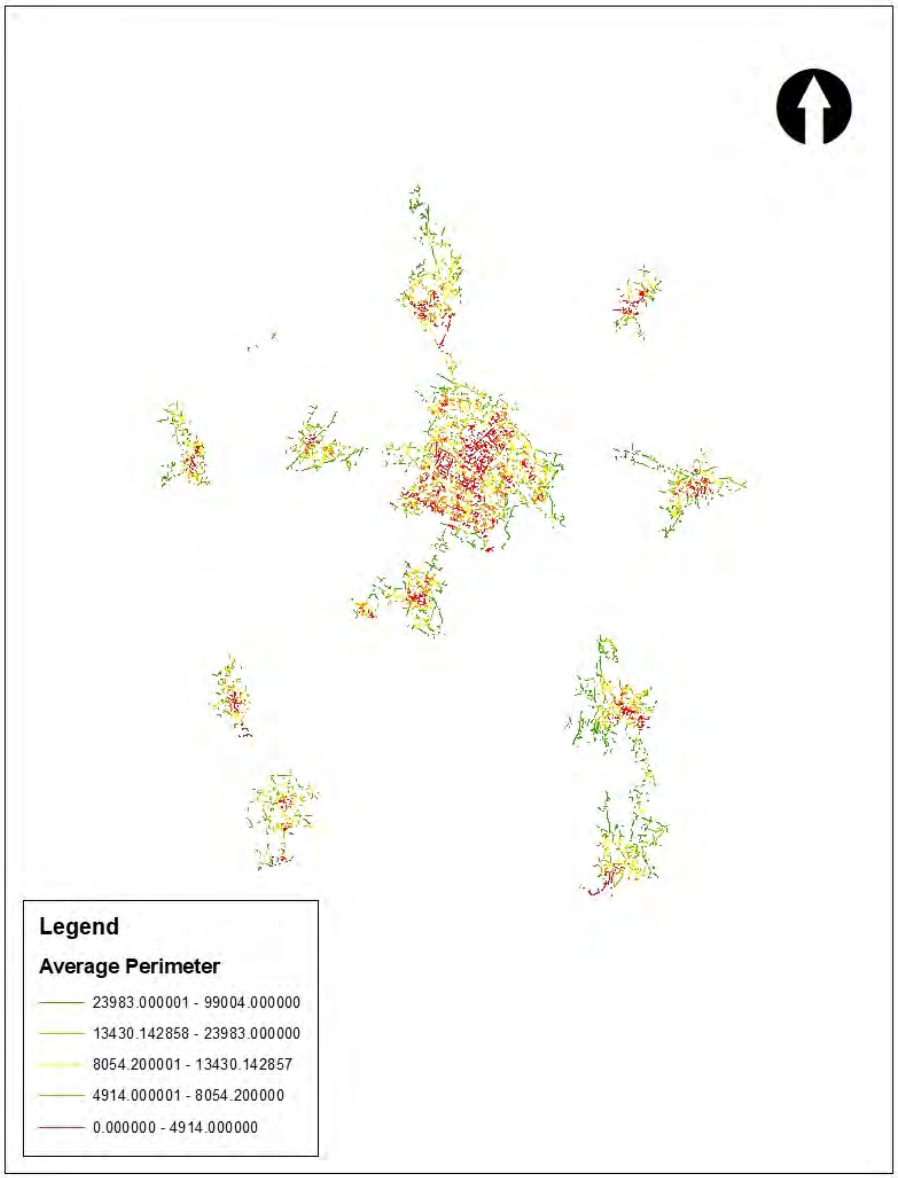


Figure 21. Average block perimeter (0.50-mile length and 0.25-mile buffer)

Each of the nine measures identified above and the manual context classification attributes were joined through spatial analysis to the roadway segment data for each scenario evaluated. The database was then exported from ArcGIS to enable statistical and sensitivity analysis and identify potential thresholds for each measure as well as the determination of measures having the highest degree of predictive agreement with the manual Context Classification. As noted, the roadway database was separated using the Urbanized Area/Urban Clusters to distinguish between general Rural and Urban Contexts. Measures were evaluated separately based on their potential to distinguish Rural from Rural Town roadways and Suburban, Urban, and Urban Core roadways from one another.

Measures were first evaluated individually to test how well they correctly identify Context. This analysis was performed by developing cumulative distribution plots for each Context and measure. These graphs plot the cumulative percentage of roadways identified correctly for each measure. Initial thresholds were

set at the value that maximized the sum of the correct percentage of roadways for the Contexts evaluated. For Urbanized areas, Urban Core was initially separated from Suburban/Urban; then Suburban and Urban were separated. The following figures are examples of this analysis and show the cumulative distribution plots based on intersection density for Rural and Rural Town (Figure 22), Urban Core and Suburban/Urban (Figure 23), and Suburban and Urban (Figure 24).

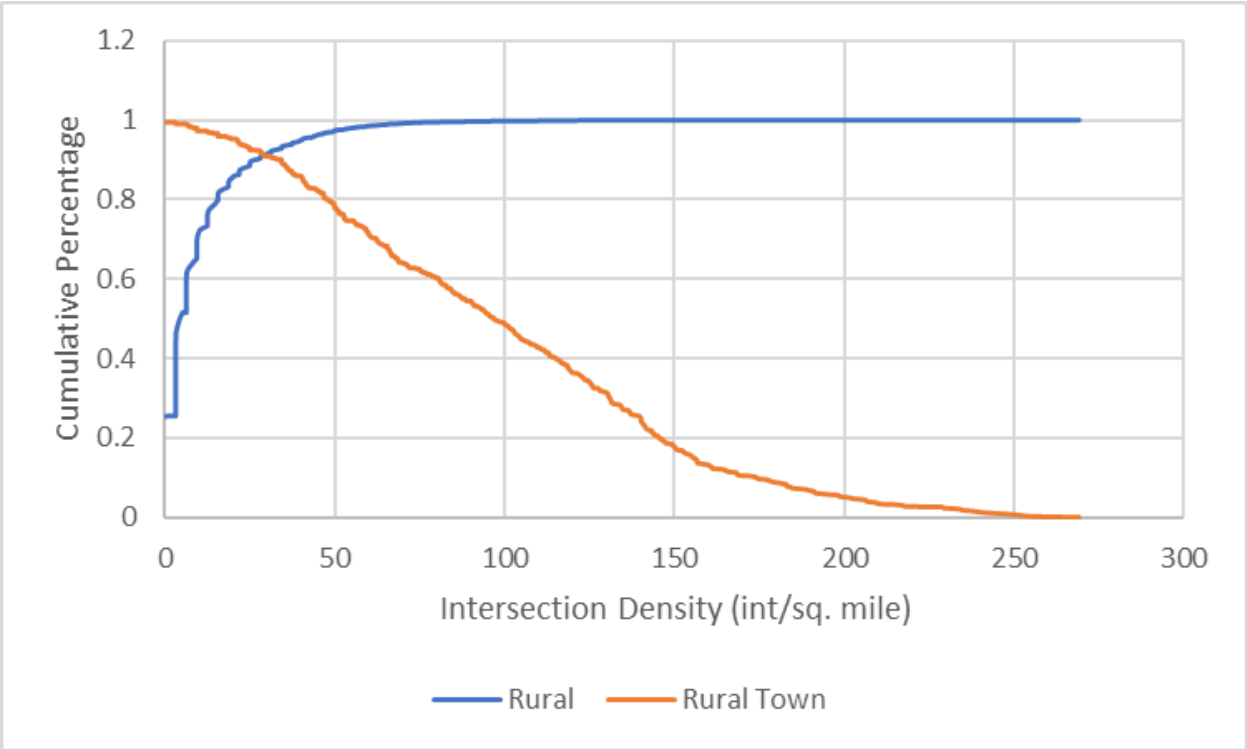


Figure 22. Cumulative distribution intersection density; Rural and Rural Town (0.25-mile length and 0.25-mile buffer)

For Rural and Rural Town roadways, using an intersection density of 32 intersections/sq. mi. correctly classified 92 percent of Rural roadways and 90 percent of Rural Town roadways.

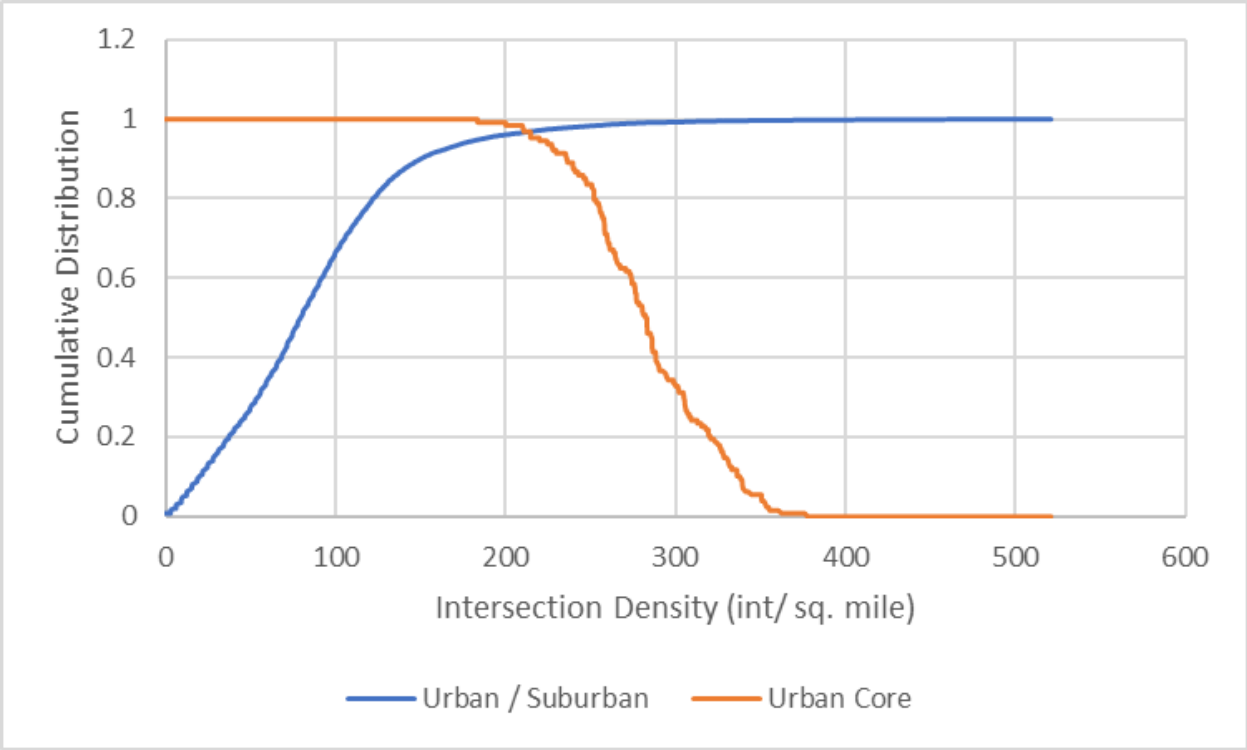


Figure 23. Cumulative distribution intersection density; Urban Core and Suburban/Urban (0.25-mile length and 0.25-mile buffer)

Ninety-six percent of Urban/Suburban roadways and 99 percent of Urban Core roadways were correctly classified using an intersection density threshold of 205 intersections/ sq. mi.

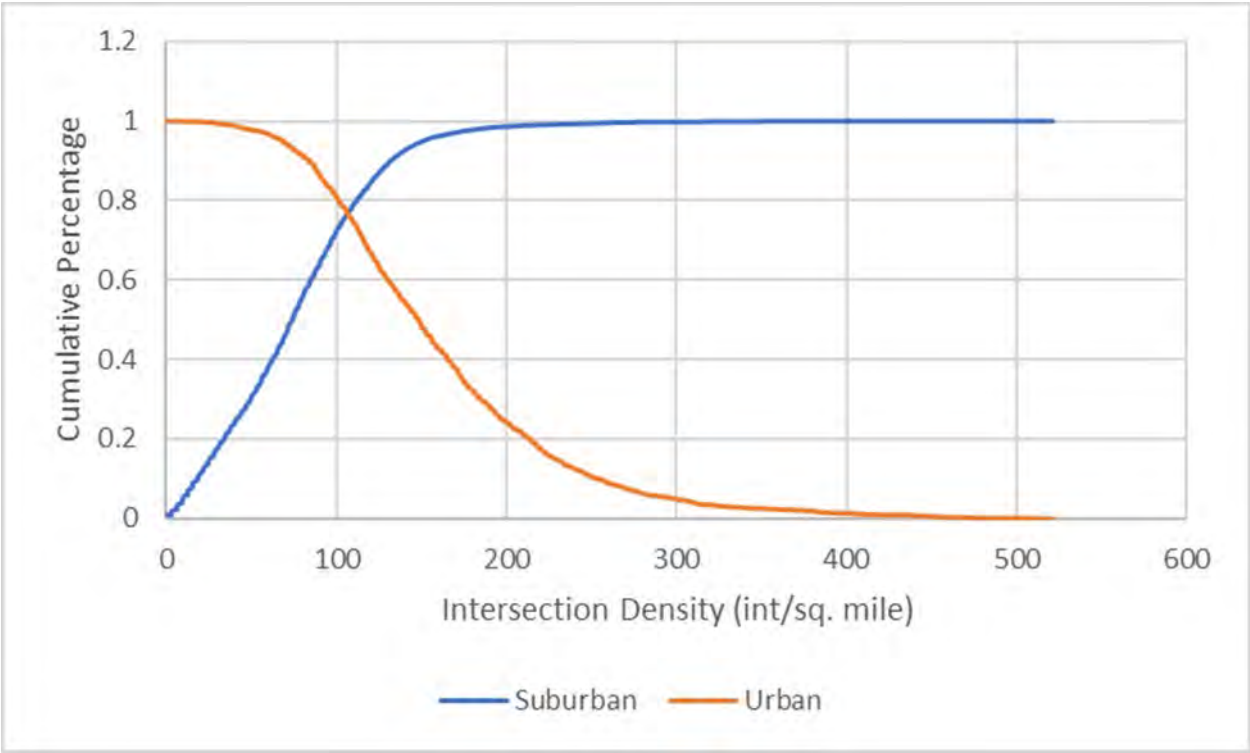


Figure 24. Cumulative distribution intersection density; Suburban and Urban (0.25-mile length and 0.25-mile buffer)

Suburban and Urban development patterns were the least effective context measure, correctly classifying 76 percent of Suburban roadways and 77 percent of Urban segments.

This analysis was completed for all nine Context measures proposed to separate 1) Rural from Rural Town, 2) Urban/Suburban from Urban Core and 3) Suburban from Urban roadway segments. Table 29, Table 30, and Table 31 list optimum threshold values and corresponding percent correct classification for each measure evaluated. Values in bold denote the highest level of correct classification for each scenario (length x buffer). Appendix A provides cumulative distribution plots and summary data for all threshold measures evaluated.

Table 28. Sensitivity analysis for Rural and Rural Town classification

Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	60	53%	60	**55%**	60	54%	60	55%
Employment Density	25	52%	40	**59%**	20	56%	40	58%
Building Density	400	90%	240	**93%**	360	87%	250	90%
Building Area Density (million)	0.95M	89%	0.59M	**93%**	1.0M	86%	0.69M	88%
Street Density	60	90%	25	**94%**	60	89%	30	92%
Intersection Density	40	85%	30	**92%**	40	84%	30	89%
Block Length	980	85%	960	**91%**	980	82%	940	86%
Building Setback	95	84%	115	**85%**	50	81%	100	**85%**
Block Perimeter	--	--	--	--	--	--	--	--

Table 29. Sensitivity analysis for Urban Core and Suburban/Urban classification

Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	5,900	98%	5,800	97%	6,000	95%	5,900	**99%**
Employment Density	2,800	94%	2,800	**96%**	2,800	96%	2,800	95%
Building Density	680	66%	1,000	**75%**	680	66%	1,000	**75%**
Building Area Density (million)	5.2M	91%	5.2M	**96%**	5.9M	92%	5.6M	**96%**
Street Density	180	89%	140	**97%**	170	91%	140	95%
Intersection Density	210	92%	210	**98%**	200	90%	200	97%
Block Length	380	85%	360	**92%**	380	82%	360	87%
Building Setback	45	90%	50	**95%**	50	88%	50	93%
Block Perimeter	2,500	95%	2,100	**98%**	2,500	95%	2,700	96%

Table 30. Sensitivity analysis for Suburban and Urban classification

Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	500	**63%**	600	56%	500	**63%**	500	**63%**
Employment Density	200	**63%**	200	61%	250	61%	250	61%
Building Density	1,000	62%	1,000	59%	1,000	60%	900	**63%**
Building Area Density (million)	2.8M	**64%**	2.9M	60%	2.7M	61%	2.1M	**64%**
Street Density	120	69%	90	61%	120	67%	90	**71%**
Intersection Density	130	71%	100	61%	120	69%	110	**73%**
Block Length	500	69%	480	58%	480	67%	490	**71%**
Building Setback	60	65%	65	**68%**	60	64%	65	66%
Block Perimeter	6,900	69%	5,400	69%	7,100	67%	5,300	**70%**

Measures such building density, building area density, intersection density, and street density correctly classified a high percentage of roadway segments for all scenarios in the Rural/Rural Town analysis. The 0.50-mile length with 0.25-mile buffer consistently returned the highest rate of correct classifications. Of the measures presented, promising results can be seen in Rural – Rural Town separation and Urban Core – Suburban/ Urban separation. However, the Urban – Suburban split has the most overlap among all measures evaluated.

Rural/Rural Town

One issue that arises with the Rural – Rural Town split is the number of roadways incorrectly flagged as Rural Town. While 92 percent of Rural roadways were classified correctly, 8 percent of the 4,650 miles of Rural roadway segments identified as Rural Town represents 372 miles of roadway incorrectly classified as Rural Town.

To address this issue, a cluster analysis method was used to further minimize the number of incorrect classifications by relying on a visual review of data. The measures were then used to highlight areas where Rural Towns may be present on the network. As a primary trait of Rural Towns is the existence of a definitive street network, Rural Town roadways occur in clusters. Figure 25 shows the six Rural Town clusters that were originally classified within the KYTC District 7 study area.

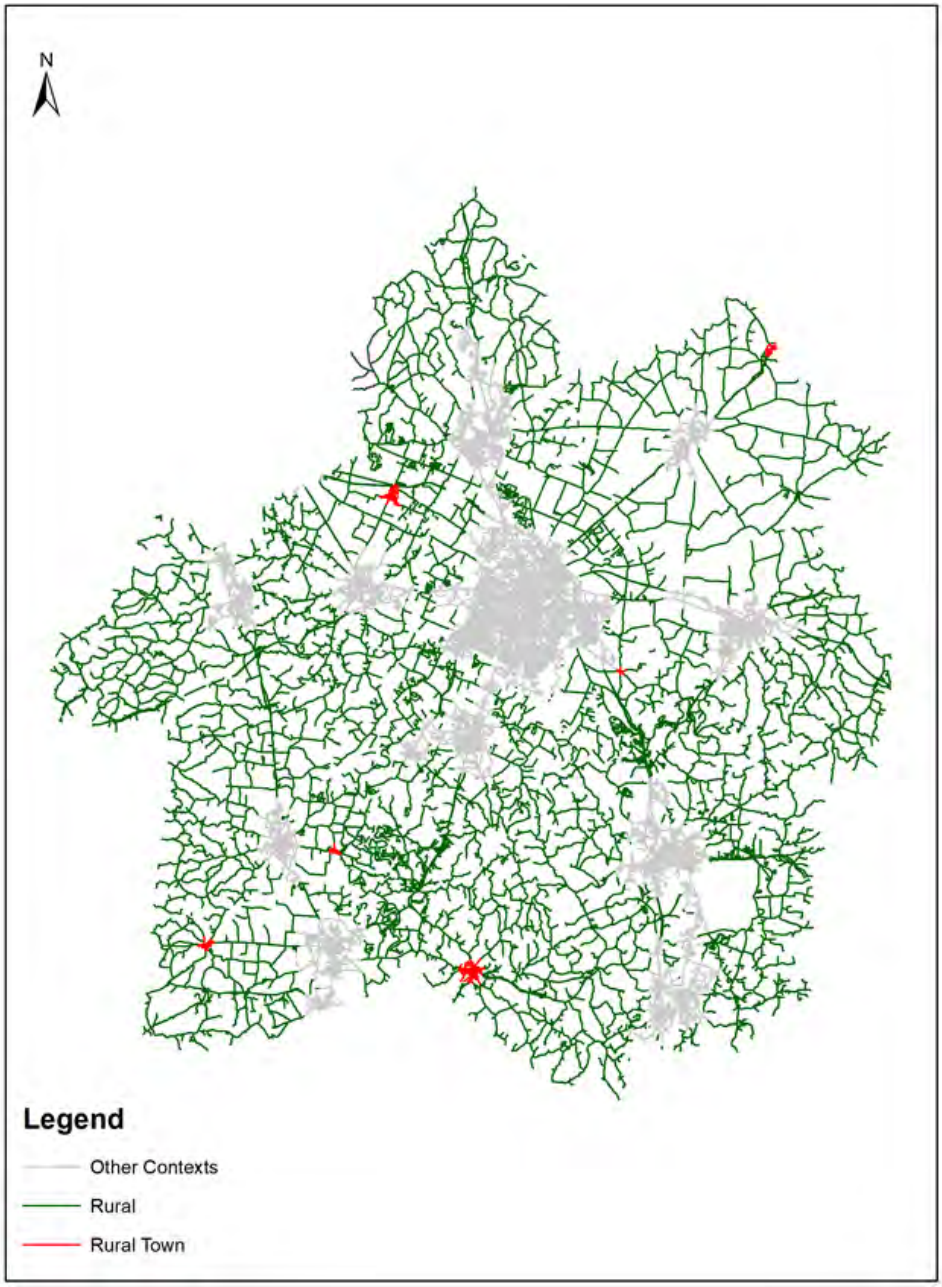


Figure 25. Rural Town locations; KYTC District 7

With cluster analysis, threshold levels were increased to minimize the number of Rural roads classified as Rural Town, while still identifying at least one roadway within each Rural Town cluster. Manual review identified remaining roadways within the Rural Town cluster. To set this threshold, the maximum value was identified for each cluster of Rural Town roadways and the lowest of these maximum values determined. The threshold was then set as the lowest of the maximum values. Setting the threshold at this level permitted identification of at least one roadway within each Rural Town cluster. When classifying roadways using this approach, roadways with measured values exceeding the cluster threshold are manually reviewed to determine the existence of a roadway network in their vicinity. Roadways within the network are then manually classified as Rural Town roads while those where no discernible road network is present are classified Rural. Using only intersection density and a threshold of 185 intersections per square mile, at

least one roadway in each Rural Town within the study area was identified; only 25 Rural roadways returned false positive identifications as a Rural Town Context (Figure 26). Figure 27 compares Rural Town and Rural roadways identified using this process.

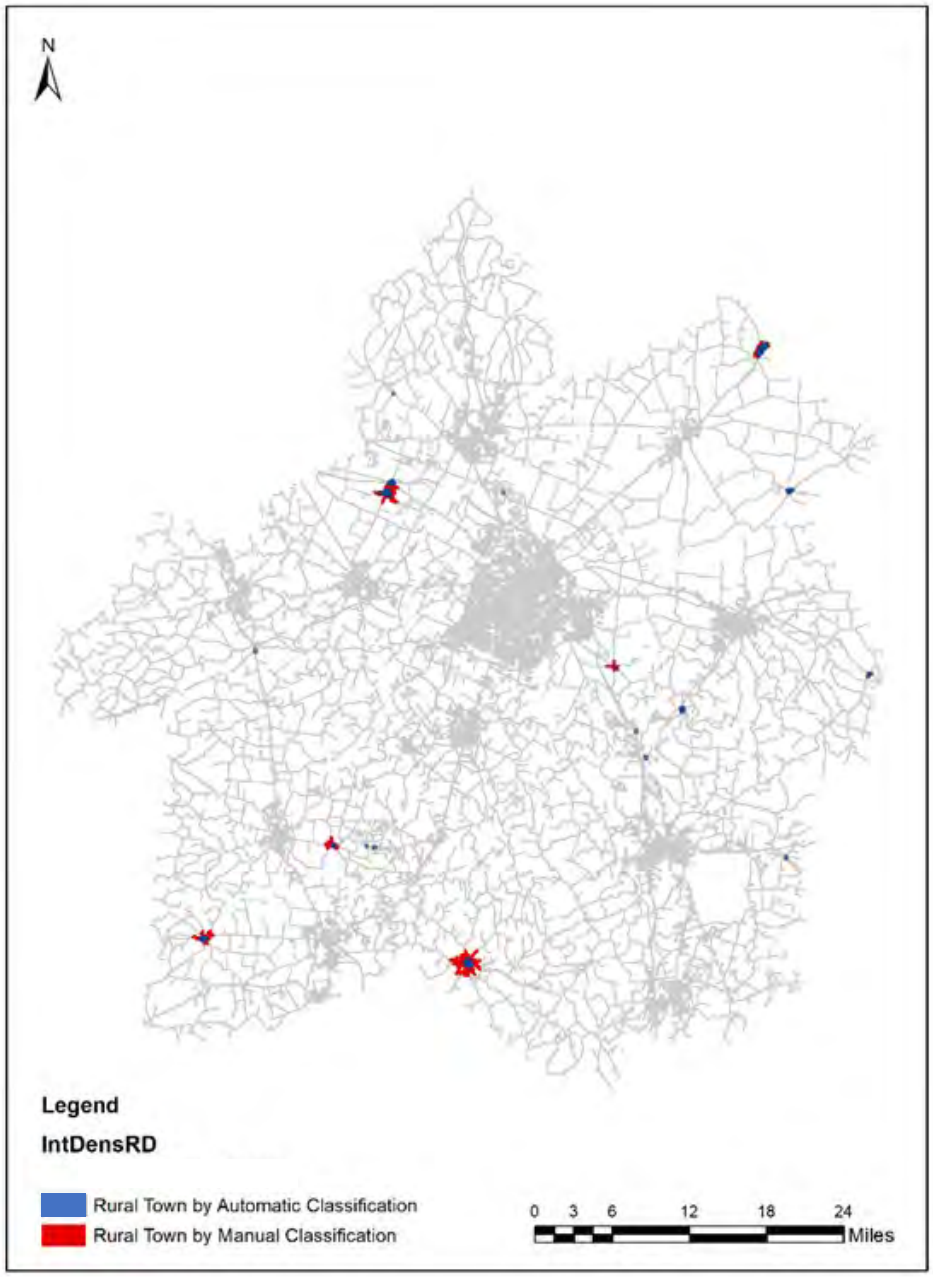


Figure 26. Rural roadways with intersection density > 185 intersections/sq. mi.

a. With defined street network

b. Without defined street network

Figure 27. Rural Town roadways

Figure 27 shows Rural Towns can be identified by visually confirming the presence of defined street network — a key characteristic of Rural Towns. Focusing on a limited number of street segments ensures manual classification is highly accurate and places low demands on staff. The key to this approach is setting the intersection density high enough to limit the number of Rural roadways identified while still identifying at least one street segment in each Rural Town (see Section 9.1 of the Application Manual for more details on how intersection density was set to determine this threshold).

All measures were tested for the four length/area scenarios. The key measure of effectiveness was the number of false positives identified among Rural roadways (Table 31). Setting intersection density at a threshold of 185 for the 0.25-mile length and 0.125-mile buffer proved optimal. Values in bold represent the highest percentages correctly classified.

Table 31. Sensitivity cluster analysis for Rural and Rural Town classification

Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	False +	Thresh.	False +	Thresh.	False +	Thresh.	False +
Population Density	35	Most map	35	Most map	35	Most map	35	Most map
Employment Density	15	Most map	15	Most map	15	Most map	15	Most map
Building Density	710	**25**	290	55	500	65	340	40
Building Area Density (Million)	1.4M	60	0.75M	55	1.1M	80	0.86M	**40**
Street Density	65	120	15	200	80	**50**	20	130
Intersection Density	185	**10**	50	35	135	30	60	25
Block Length	1,150	250	2,090	300	1,030	**150**	2,090	300

This process was refined by introducing building density as a second measure. Using intersection density (threshold: 185/intersections/sq. mi.) and building density (threshold 710: budlings/sq. mi.) identified at least one roadway in each Rural Town Cluster and returned only three false positive results.

Suburban/Urban/Urban Core

Using the Kentucky dataset, Urban Core roadways were distinguishable from Urban and Suburban areas based on several factors (e.g., intersection density, building density) (Table 29). However, the varied manifestations of suburban and urban development patterns presents issues for clear delineation as several measures overlap within the built form. Additionally, the goal of the approach is to classify all roadways within the Context, which includes lower-order facility types (e.g., local residential streets). In suburban residential areas lot sizes decrease and intersection density can increase, leading to overlap with some Urban development patterns. Figure 28 illustrates an example of a residential urban neighborhood and a classic suburban neighborhood in Lexington, Kentucky.

a. Suburban ***b. Urban***

Figure 28. Comparison of Urban and Suburban residential area

Both areas Figure 28 exhibit similar development patterns along the roadway, with closely spaced single family homes and small lot setbacks. However, when viewing the broader area, the development in Figure 28.b is near services, including hospitals, retail businesses, and a university. This proximity significantly changes the Transportation Expectations for that area, making nonmotorized travel a much stronger alternative. Conversely, the development in Figure 28.a coupled with longer distances could make nonmotorized travel less appealing. Residential development on the right is thus considered Urban, and consistent with Urban Transportation Expectations, while the development on the left is Suburban. Based on this example, additional measures for capturing the influence of adjacent development were evaluated to determine if they could better distinguish Urban from Suburban Contexts.

Employment and population estimates from the CTPP Program were obtained at the Traffic Analysis Zone (TAZ) or Census Block level for the study area. Employment data were used as a surrogate for businesses in each area to identify areas where services may be available. Population and employment data for each roadway segment were then gathered for 0.25-, 0.50-, and 0.75-mile radii, representative of walking distances for local residents. A composite employment-to-population ratio was developed to identify a mix of uses that separate urban and suburban development. Figure 29 shows the cumulative distribution plots for this measure. It achieves 62 percent accuracy in classifying Urban and Suburban roadways.

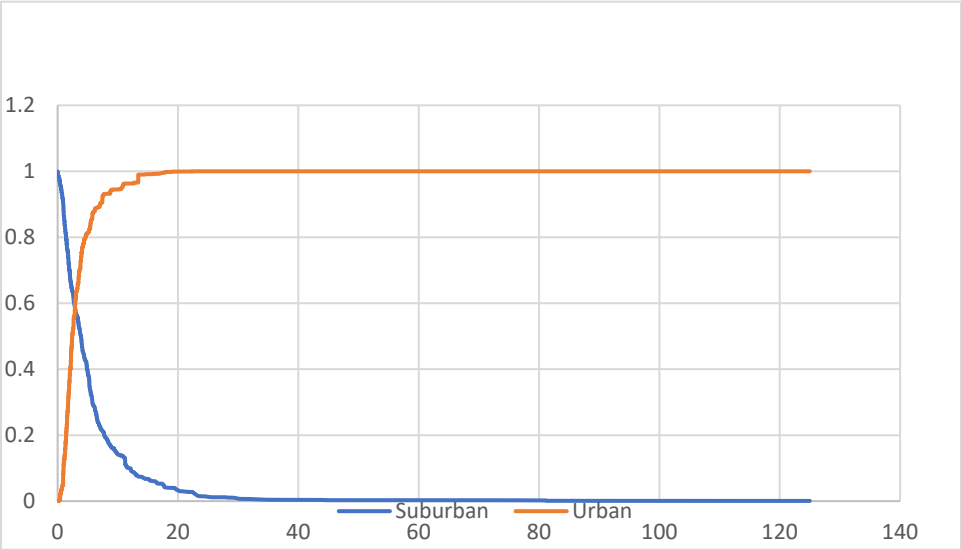


Figure 29. Employment to Population Ratio (Urban / Suburban; 0.25-mile length and 0.50-mile buffer)

Evaluation of data sources indicates that the US Census block sizes may be too large to accurately reflect the proximity of services within individual street segments as many draw from a single block. Analysis of this type would be feasible and potentially more informative if parcel land use data were available for a regional area.

To increase classification accuracy for Urban and Suburban Contexts, other multi-measure approaches were evaluated, including multiple thresholds and a combination of several measures (i.e., two or more). However, these approaches did not increase classification accuracy.

Intersection density correctly identified 73 percent of Urban and Suburban roadways (Figure 30), but for statewide implementation it is preferable to have a higher percentage of correct classifications. Therefore, a manual review of urbanized areas should be completed to identify Urban and Suburban areas more clearly and to establish boundaries for Urban Cores (see Chapter 8).

Figure 30. Lexington, KY urbanized areas; manual and measure classification (Intersection Density)

Context Classification Measure Validation

The measures discussed in the preceding sections were validated against the Florida DOT's existing Context Classification. This entailed applying the same processes and thresholds used with Kentucky data to a Florida dataset. Analysis focused on all roadways assigned a preliminary classification by the Florida DOT (Figure 31). This classification did not include all roadways in Florida; it primarily encompassed state roadways. Local roadways in Miami-Dade County and Ft. Lauderdale were included. Table 32 summarizes the conversion of the Florida DOT's Context Classification system to the proposed NCHRP Project 15-72 Context Classification terminology.

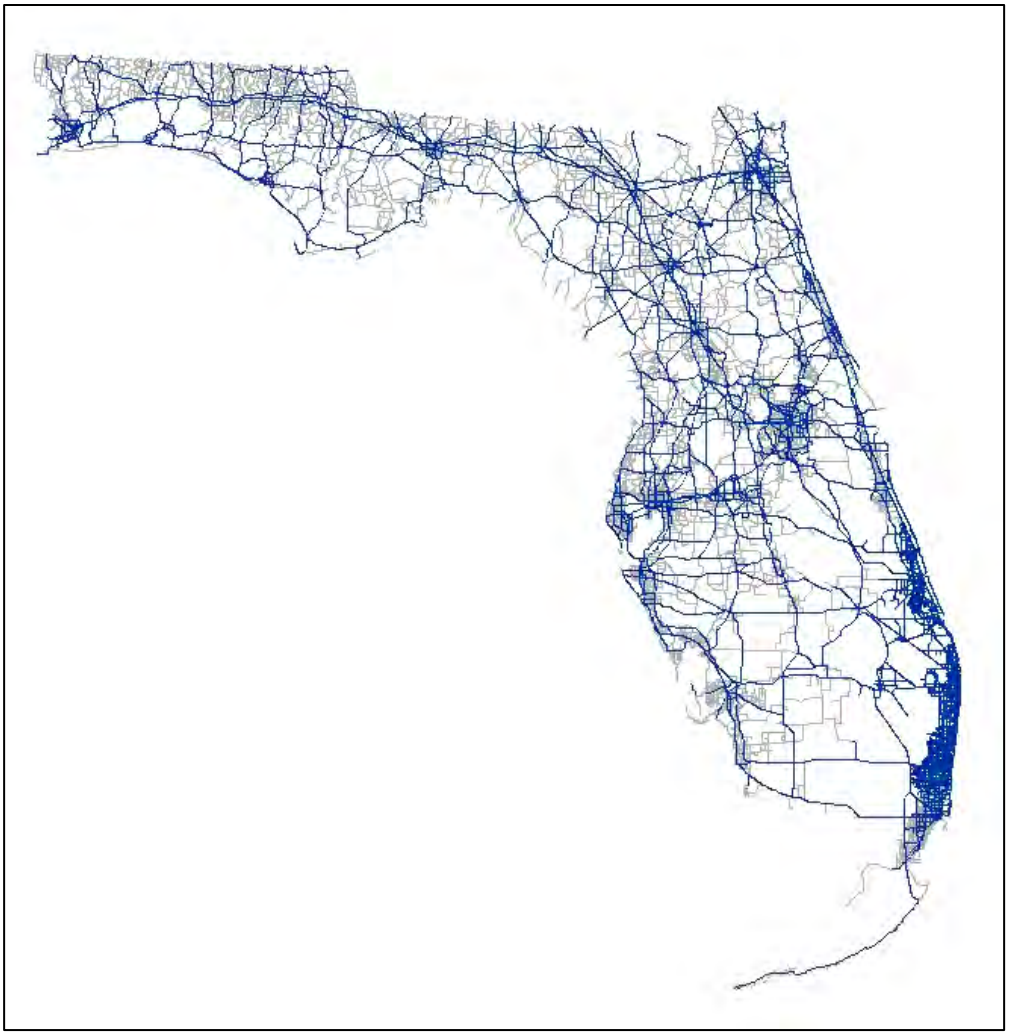


Figure 31. Florida DOT classified roadways

Table 32. FDOT Context Classification to NCHRP Project 15-72 transformation

FDOT Classification	NCHRP 15-72 Classification	Mileage
C1	Rural	5,056
C2	Rural	31,624
C2T	Rural Town	246
C3C	Suburban	7,799
C3R	Suburban	5,206
C4	Urban	5,278
C5	Urban	161
C6	Urban Core	77
Total		55,447

To limit the number of iterations performed, analysis focused on 0.50-mile segment length and a 0.25-mile influence area (buffer) as it showed the most promising performance with the Kentucky dataset. Results were compared to the Florida DOT Context Classification to assess the level of accuracy of both

approaches and to compare the level of consistency between thresholds. Table 33 and Table 34 summarize results of this analysis.

Table 33. Comparison of classification results; Urban Core/Other urban

Measure	KY		FL	
	Percent Correct	Threshold	Percent Correct	Threshold
Population Density	98%	5,892	81%	3,914
Building Density	75%	1,045	61%	290
Building Area Density	**97%**	5,349,985	**92%**	4,158,153
Intersection Density	97%	204	78%	146

Table 34. Comparison of classification results; Urban/Suburban

Measure	KY		FL	
	Percent Correct	Threshold	Percent Correct	Threshold
Population Density	63%	401	75%	2,368
Building Density	**63%**	867	**75%**	800
Building Area Density	64%	2,078,252	72%	2,957,566
Intersection Density	**73%**	111	**77%**	110

For the Kentucky dataset, intersection density had the highest overall accuracy for classifying Urban Core Contexts. This was not the case for Florida. Examining Florida development patterns reveals that block size increases and intersection density decreases in the densest Urban Cores compared to outlying urban development patterns. In some cities in Florida, superblocks created under Urban Renewal result in larger block sizes and lower intersection density in an otherwise dense area that would be considered urban core or urban. Nonetheless, building area density was highly effective for classifying both datasets. With thresholds for building area density and intersection density having the same magnitude, building density is suitable measure for both datasets. Utilizing an average threshold of 4,500,000 sq. ft./sq. mi. yielded an accuracy of 93 percent for the Kentucky and 87 percent for Florida.

For the Urban-Suburban split, intersection density performed well for both the Kentucky and Florida datasets, correctly classifying 73 and 77 percent of roadways, respectively. Moreover, threshold values were consistent, with a calculated threshold of 111 intersections/sq. mi. for Kentucky and 110 for Florida. A threshold of 110 intersections/ sq. mi. is recommended for all datasets.

Rural/Rural Towns were not fully evaluated based on the Florida datasets as most of the Rural Town roadways classified using Florida's system (C2T) fall inside urbanized boundaries and are classified as one of the urbanized contexts (Suburban, Urban, or Urban Core).

CHAPTER 8

Context Classification Implementation

This Chapter describes several methods — along with their benefits and drawbacks — for implementing Context Classification at stages throughout the transportation planning and project development process. These include statewide implementation, using measures and thresholds discussed above as well as regional and project-based classification approaches that may use higher resolution datasets.

Statewide Implementation

Statewide Context Classification is a good option for state agencies that want to perform a broad survey of their systems. It may be applied to the state roadway system or expanded to local agencies to achieve statewide consistency in classifications.

Statewide analysis lets state agencies proactively identity potential projects and think more systemically about multimodal issues (e.g., safety, accommodation). It can also help states identify areas of greatest need — geographically and programmatically — to assist with fiscal and work program planning. For example, states could use data on posted speeds to identify locations where they (and likely the operating speed) exceed speeds identified in Transportation Expectations or the target speed range specified in GB8. States can also review existing bicycle and pedestrian facilities and compare them to facilities recommended by the Transportation Expectations.

The Statewide Context Classification approach outlined here uses readily accessible national GIS datasets and can readily be applied by any agency. These datasets include:

- *Urbanized Area Boundaries*. Urbanized area boundaries identified by the US Census Bureau are used to distinguish Rural and Rural Town Contexts from Suburban, Urban, and Urban Core Contexts.
- *Intersection Density*. Intersection density captures the level of access provided along the roadway and can be used to detect variations in the level and character of development. It is the number of intersections per square mile and provides a measure of network connectivity and presence. It can be used as a surrogate for nonmotorized transportation as well as transit connections. For statewide analysis, network and spatial analysis tools can obtain this measure from GIS data, but it may also be derived from aerial photography, zoning codes, or long-range transportation and development plans.
- *Building Density/Building Area Density*. Nationwide building data are now available through the Microsoft Maps US Building Footprint database, which identifies building footprints across the county based on analysis of aerial photography. This measure defines the magnitude of urbanization and can be used as a surrogate measure for level of development. Building density can be expressed as either the number of units or area per square mile. It can be used also as a surrogate measure of nonmotorized user transportation needs and transit integration.

Approach Overview

Figure 32 diagrams the workflow for implementing Context Classification. The process can be automated through GIS procedures.

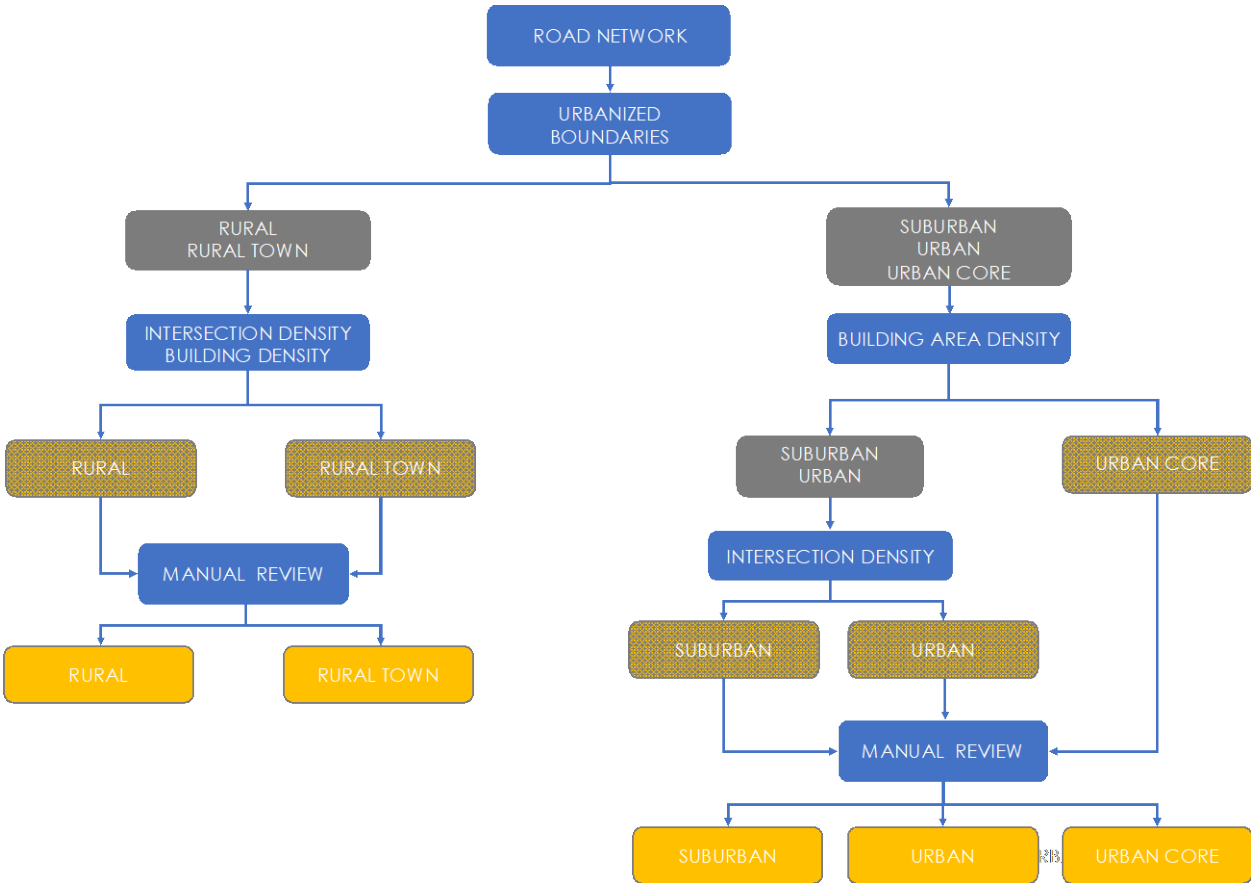


Figure 32. Context Classification approach

- **Step 1: Road Network Definition**: Identify the roadway network being classified. Most agencies maintain well-defined network databases that can serve as the basis for Context Classification.
- **Step 2: Urbanized Boundaries Delineation**: Delineate Urbanized and Non-Urbanized areas at the Census block level based on US Census data urban boundaries. Urbanized areas and urban clusters are used to define Suburban, Urban, and Urban Core Contexts while all other areas are used to define Rural and Rural Town Contexts. Urbanized areas have populations greater than 2,500. Urban boundaries should be reviewed prior to classification to ensure that urbanized growth has not extended beyond the boundary delineated following the last decennial census
- **Step 3.a: Rural/Rural Town Classification**: Rural Town Contexts are identified using a cluster analysis. Context measures and directed manual review are used to identify pockets of development within the Rural Context. Roadway segments of 0.25 miles are used for classifying Rural and Rural Towns, including segments at the end of a roadway that are less than 0.25-miles long.
  - **Building Density**: Estimate building density (buildings/sq. mi.) based on the Microsoft Maps US Building Footprint database using a 0.125-mile buffer along each roadway segment.
  - **Intersection Density**: Estimate intersection density (intersections/sq. mi.) based on roadway network GIS data using a 0.125-mile buffer along each segment.
  - **Classification**: Rural Towns are identified by evaluating building density and intersection density. Rural Town roadways are those where:
    - **Building Density** > 710 buildings/sq. mi. **AND**
    - **Intersection Density** > 185 intersections/sq. mi.

- **Step 3.b: Urban Core Classification**: Roadway segments of 0.50 miles are used for classifying urbanized Contexts.
  - **Building Area Density**: Estimate building area density (sq. ft/sq. mi.) based on the Microsoft Maps US Building Footprint database using a 0.25-mile buffer along each roadway segment. Urban Core roadways are those where:
    - **Building Area Density** > 4,500,000 sq. ft/sq. mi.
- **Step 3.c: Urban/Suburban Classification**: Urbanized roadways not classified as Urban Core are then assigned a Context based on intersection density.
  - **Intersection Density**: Estimate intersection density (intersections/sq. mi.) using roadway network GIS data and a 0.25-mile buffer along each segment. This provides the additional descriptor to refine Contexts and identify Urban (higher connectivity and intersection density) and Suburban (lower connectivity and intersection density than Urban and Urban Core) Contexts. Urban roadways are those where:
    - **Intersection Density** ≥110 intersections/sq. mi.

    Suburban roadways are those where:
    - **Intersection Density** <110 intersections/sq. mi.
- **Step 4.a: Non-urbanized Context Review:** This approach aims to identify a minimum of **one** roadway within each Rural Town while minimizing the number of instances where Rural roadways are incorrectly classified as Rural Town. A manual review of identified segments is used to classify additional segments within the Rural Town roadway network and remove incorrectly classified Rural roadways. This process is described below.
- **Step 4.b: Review Context Classification:** Manual review should be performed by practitioners familiar with the area being evaluated, such as a District Office or MPO staff, and with the general classification information based on intersection density (Figure 30). This enables a data-driven review of the urbanized area. ASTM Standard E2843-17, *Standard Specification for Demonstrating That a Building is in Walkable Proximity to Neighborhood Assets*, is recommended as an additional resource for manually evaluating this delineation. This standard identifies a building as walkable if the "primary building entrance [is] within 1/2-mile (800-m) walking distance, as measured over a continuous network of all-weather surfaced walkways and dedicated public rights-of-way, of a primary entrance of either: A minimum of six eligible neighborhood assets, or A minimum of four eligible neighborhood assets, including at least one with NAICS (North American Industry Classification System) Code 445110 (Grocery Stores—Supermarket and Other Grocery except Convenience)." Neighborhood assets are identified by their NAICS code but are generally classified as civic and community facilities, community-serving retail, food retail, and services or public parks. Using this standard of walkable proximity can help planners and transportation officials determine when the built environment can support nonmotorized Transportation Expectations. An expanded discussion and examples of the manual review process is provided in the Implementation Manual (*NCHRP Research Report 1022: Context Classification Application: A Guide*).

Practitioners must validate Context Classifications identified through statewide evaluations at the project level when additional measures are available for review. Data acquired during statewide evaluations can be used as a starting point to streamline project-level Contexts.

Advantages and Disadvantages

Statewide Context Classification carries the following advantages and disadvantages.

- Advantages
  1. Use of context measures that are widely available for most agencies and consistent across the entire state/nation.

2. Enables expansive use of Context Classification during transportation planning activities. Survey results from states having implemented context classification point to extensive use of statewide implementation for pedestrian/bicycle planning and complete street guidance.
3. Improves planning-level cost estimates by utilizing identified Contexts.
4. Informing interim deliberations from a planning and access management perspective.

- Disadvantages
    1. Micro-Contexts (spots) that require special consideration may be misclassified due to the use of aggregate data sources within statewide analysis (e.g., use of census blocks, compared to parcel level data).
    2. Segmentation may not accurately identify Context Boundaries (+/- 0.50 miles).
    3. Lower accuracy for Urban/Suburban delineation.
    4. Requires validation at the project level.

Regional Level

Cities, counties, metropolitan/transportation planning organizations (MPOs/TPOs), and state DOT district offices may pursue regional Context Classification. This is done to leverage fine-grained information available in local data sources and to refine preliminary Contexts. A regional Context Classification evaluation may include county and city roadways outside the state-owned system and can inform connections to and across the state network.

At the regional level, additional data on land use and future development plans are often available, in the form of current zoning and/or local comprehensive plans. Because these data are often maintained at the local level, aggregating them into a consistent statewide dataset is challenging. Nonetheless, they are useful for understanding a smaller, regional subarea or MPO. With detailed land use information, regional agencies can better understand the current and expected future Context(s) along a roadway. It is unlikely that measures of building form can be evaluated at the regional level. Regional-level Context Classification should be validated at the project level. With higher resolution data and detailed land use information, regional agencies can generate better knowledge of the current and expected future Context(s) along a roadway and identify sub-Contexts (e.g., the Florida DOT's suburban-residential and suburban-commercial uses). The primary advantage of land use data is the ability to identify nonmotorized travel options for short trips based on the availability of retail and community services within an area — as discussed in relation to ASTM Standard E2843-17, *Standard Specification for Demonstrating That a Building is in Walkable Proximity to Neighborhood Assets*. If statewide land use data are available, this level of analysis may be performed on a larger scale.

A few local agencies have opted for area-based Context Classification instead of classifying linear roadway segments. Figure 33 illustrates the area-based regional Context Classification adopted in Clearwater, Florida.

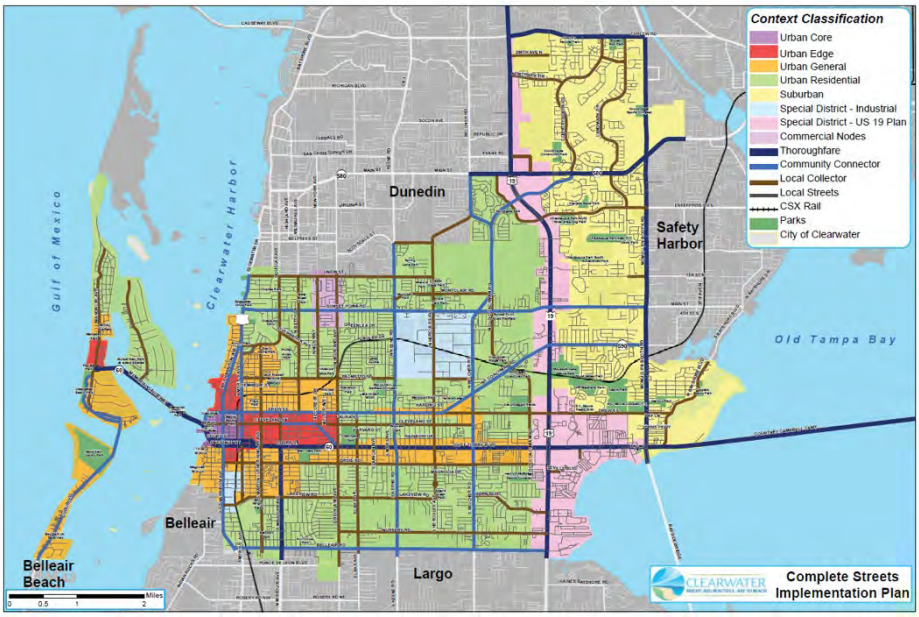


Figure 33. Example of Area-Based Context Classification

Advantages and Disadvantages

Regional Context Classification carries the following advantages and disadvantages.

- Advantages
  1. Uses more refined data (e.g., land use) to increase classification confidence.
  2. Enables expansive use of Context Classification during transportation planning activities. Survey results from states that have implemented Context Classification indicate the expanded context classification system has benefits for pedestrian/bicycle planning and complete street guidance.
  3. Allows consideration of network and areawide solutions by increasing awareness of surrounding land uses (e.g., commercial development immediately adjacent to the road with residential uses behind)
  4. Supports visualization of where Contexts differ on opposite sides of the roadway.
  5. Improves QA/QC by local/regional agencies which may be more familiar with local areas and able to identify boundary conditions and/or misclassifications.
  6. Increases opportunities to integrate cooperative forecasting process as a proxy for future land use.
- Disadvantages
  1. May provide inconsistent classification results across a state or neighboring regions.
  2. Relies on datasets that exclude building form and knowledge of user movement patterns may misclassify micro-Contexts that require special consideration.
  3. Context Classification should be validated at the project level.

Project Level

With data available for all measures, a project-level Context Classification has the most fine-grained resolution. It accounts for generalized development patterns observed from aerial data or windshield surveys (e.g., development type, density, building setbacks) that may not be available in regional or statewide databases.

Practitioners can review information, as well as local zoning maps and comprehensive plans, for ongoing and upcoming projects in the area to understand future network conditions.

Project-level Context Classification is the basis for GB8 design guidance. All projects, regardless of whether an agency has undertaken a regional or statewide evaluation, should examine the Project Considerations relative to the Context(s) for a project segment and associated Transportation Expectations to ensure they match. The Context Classification will remain as originally established, but Project Considerations shape project design. If a regional or statewide evaluation exists, practitioners can use the data compiled for those efforts to streamline project-level Context Classification.

- Advantages
  1. Allows full knowledge of roadway, users, and adjacent land uses, which is used to determine appropriate context and boundaries.
  2. Provides opportunity for project team to fully understand project considerations.
  3. Requires minimal data collection and processing.
- Disadvantages
  1. Limits ability for inclusion of Context Classification in high-level statewide transportation planning activities.
  2. May provide inconsistent classification within cities and/or regions.
  3. May limit the ability to consider network and areawide solutions by focusing on individual corridors.

Adapting to State/Regional Areas/Calibration

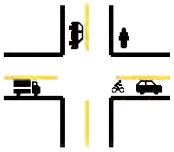
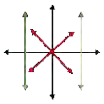
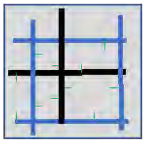
Agencies may confront development patterns that differ from those for which Context measures and thresholds were developed. Or they may lack the datasets required to calculate measures. When this happens, agencies can use Transportation Expectations as a starting point to devise and calibrate new thresholds and/or measures based on the intended mobility and mode of transportation. The following sections describe these scenarios and potential adaptations.

Threshold Calibration

Measurement thresholds provide good rules of thumb for delineating Contexts, but agencies should review these thresholds in relation to areas of known Contexts prior to final implementation. Development patterns and/or environmental constraints can affect thresholds and require they be adjusted. When this occurs, agencies should examine the area's Transportation Expectations and decide whether to modify Context thresholds based on local transportation needs, land use, and building form.

Carabelle, Florida, provides an example of adjusting Context thresholds in response to local conditions. The area is classified as a Rural Town despite having an intersection density of 73 intersection/sq. mi. (below the threshold 185 intersections/sq. mi.). Low intersection density is the product of development being restricted to one side of Saint James Avenue, the main roadway through town which doubles as a state highway. On the local street system intersection density is 173 intersections/sq. mi., much closer to the recommended threshold. When comparing the area's characteristics with Transportation Expectation for a Rural Town, high agreement is observed (Table 35).

Table 35. Rural Town Transportation Expectations assessment (Carabelle, Florida)

TRANSPORTATION EXPECTATIONS		CARABELLE, FL
	• **Users/Vehicles:** Regional vehicle/freight traffic. Moderate pedestrian activity. Potential for some bicyclists.	✓
	• **Movement:** Moderate quality of service and slower vehicle speeds. Delays acceptable to local traffic. High quality of service for nonmotorized users due to street-oriented development patterns.	✓
	• **Permeability:** High vehicular, bicyclist, and pedestrian access opportunities. Direct pedestrian access to land uses. Vehicle and bicyclist access may be provided on adjacent roadways within the network.	✓
	• **Network:** Expanded street network within a limited area serving immediate land uses. May include cross streets accessing dispersed areas in surrounding rural area(s). Through traffic concentrated on primary roadway.	✓
25-35 MPH	• **Speed**: Motorized 25 to 35 mph.	✓

Carabelle, Florida, falls outside of the US Census Urbanized Area and Urban Clusters boundary but has a defined street network (Figure 34). The area is surrounded by denser residential development with commercial uses along Saint James Avenue (Figure 35). These densities and field review (Figure 36) show a high potential for nonmotorized travel. In addition, because Saint James Avenue is the primary roadway — and a state roadway — it serves regional traffic through town, including freight and other uses. Reduced setbacks along Saint James Avenue reduce the separation of motorized and nonmotorized travel, necessitating a lower speed through the area.

Figure 34. Street network, Carabelle, Florida

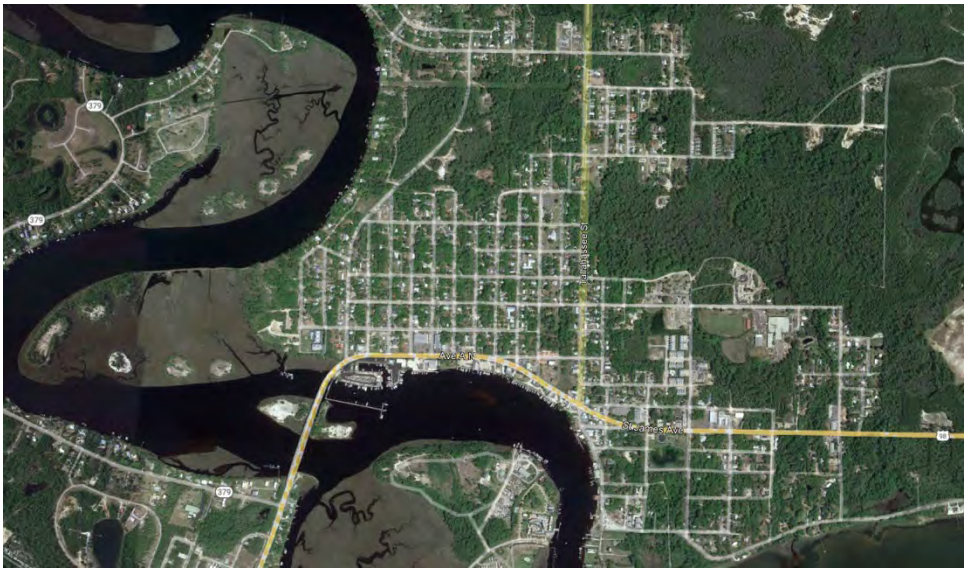


Figure 35. Aerial development patterns, Carabelle, Florida

Figure 36. Saint James Avenue street view, Carabelle, Florida

When agencies frequently encounter and document circumstances similar to those in Carabelle, Florida, adjusting Context measure thresholds for regional or statewide implementation may be warranted. For example, the intersection density threshold could be lowered to align with intersection densities common in Rural Towns. Taking this step will reduce false positives for Rural Towns during classification. If a condition is rare, the more appropriate strategy is to modify the assigned Context through manual review rather than lowering the threshold for the entire area.

All changes should be properly documented. Practitioners should avoid modifying thresholds on a case-by-case basis as this risks adopting a Context inconsistent with observed development patterns. States that previously developed an expanded Context Classification system will benefit from the calibration process as they can align their system with the proposed GB8 Contexts.

Subdivision of Contexts

Several states have implemented expanded Context Classification systems that include more than the 5 primary contexts described in this document and NCHRP 855 (See Figure 4). For example, Massachusetts, California, Florida, and Minnesota have Rural and Natural Contexts to distinguish places that may develop in the future from areas that are unlikely to develop. Similarly, Massachusetts, Pennsylvania, New Jersey, California, Florida, Minnesota, Maryland, and Oregon have variations on the Suburban Context to account for type and density of land use. These expanded Contexts and sub-Contexts are used to further refine the ultimate design guidance and are made possible by higher resolution data than are available at the national level.

State and local design manuals may provide guidance tailored to particular sub-Contexts identified by an agency. For example, Minnesota uses a Rural Crossroads Context because the state has numerous highway intersections with significant surrounding development, but which lack a supporting network structure common in Rural Towns. For these areas lower speed limits are prescribed in response to congested conditions but do not have the same level of multimodal users expected in Rural Towns. Similarly, targeted guidance may be needed by an agency to distinguish residential development areas from commercial areas within Suburban Contexts due to the higher number of nonmotorized users associated with commercial activity centers and need to reduce vehicular speeds.

The five Contexts outlined in this document are recommended because they are a starting point for most agencies and are easily distinguished using readily available data. Transportation Expectations associated with these contexts can also be readily distinguished. Agencies may subdivide Contexts to address local needs. The proposed five-Context framework lets agencies that adopt sub-Contexts or expanded Contexts to leverage the planning and design guidance of GB8. Examples in Figure 1 demonstrate how sub-Contexts

can roll up and clearly link to the proposed GB8 Contexts. Before introducing a new sub-Context, agencies should compare Transportation Expectations for each Context defined in this document to Transportation Expectations for the proposed sub-Context.

CHAPTER 9

Application Manual

This research culminated in an Application Manual that offers a broad overview of Context Classification and discusses how practitioners can use information on Context to develop appropriately contextual multimodal designs. *NCHRP Research Report 1002: Context Classification Application: A Guide* includes the full Manual; this chapter summarizes its contents. In addition to reviewing Context Classification, the Manual:

- Presents a case for using Context Classification throughout project development
- Surveys applications and use cases
- Discusses implementation and challenges which can arise during implementation
- Describes Contexts and Transportation Expectations
- Provides representative examples of each Context

A summary of each section of the Manual follows.

Context Classification Overview

This section introduces the Manual and implementation of Context Classification. A common language for practitioners, Context Classification provides a flexible framework to classify roadways, one that helps identify preliminary transportation network expectations while accounting for multimodal user needs and road functions. Brief summaries of context classification systems devised by other state DOTs are provided to demonstrate that Context Classification builds upon previous work. This section stresses that the goal of classification is to provide critical information to facilitate project development. Other highlights from this section include:

- An explanation of how Context Classification will be integrated into GB8 through the new Part IV chapters, along with a list of benefits of Context Classification.
- A discussion demonstrating that integration of Context Classification into project development lets practitioners address all roadway user needs (pedestrians, bicyclists, transit users, and motorists) and produce a design consistent with community needs and values.
- Definitions of each context along with an overview of their respective Transportation Expectations and their role in project development.
- A comparison of Context Classification and Project Considerations. While Context Classification establishes general parameters for describing a roadway's interactions with surrounding land uses and defining user expectations, Project Considerations are identified through project-specific data collection and site surveys focused on unique aspects of the roadway, surroundings, environment, and community.

Context Classification Implementation

This section describes methods for implementing Context Classification, presents the measures used to define Contexts, and discusses methods for negotiating and resolving potential conflicts or unclassified segments that need additional evaluation. The first part of the section focuses on application and outlines the steps and data needed to complete Context Classification (Figure 32). It also discusses implementation

of Context Classification at the state, regional, and project levels. Accompanying each approach is a short discussion of required data along with the approach's advantages and disadvantages.

Next, the section introduces calibration methods, which can assist agencies that (a) encounter development patterns different from those in which Context measures and thresholds were developed, or (b) lack required datasets. When these situations arise, agencies can use Transportation Expectations as a starting point to devise and calibrate new thresholds and/or measures based on the intended mobility and mode of transportation. Revising Context based on local Transportation Expectations is justifiable, but changes should be properly documented. In general, practitioners should avoid modifying thresholds on a case-by-case basis as this risks adopting a Context inconsistent with observed development patterns. If an agency decides to introduce a new sub-Context it must be defined clearly. Before introducing a new sub-Context, agencies must compare the Transportation Expectations for the proposed sub-Context to those of existing Contexts.

Methods for implementing and applying Context Classification throughout project development are discussed next (Table 36). Although this section presents applications for each phase of project development, Context Classification should be done during early phases — ideally prior to project scoping — to successfully leverage context-based design criteria.

Table 36. Potential Applications of Context Classification in Project Development

Project Development Phase	Applications
Regional Planning	• Identification of all users that will be served by future transportation network • Integration of the cost of serving all users into long-range cost estimates • Inclusion of metrics for all users into system evaluation and prioritization • Identification of need to create additional networks for users
Corridor/Project Planning	• Documentation of the travel and safety needs of all users • Aid in the development of performance metrics for each user • Incorporation of the needs of all users into design control decisions and the design of typical sections
Design	• Incorporation of all user needs into the final design control decisions • Development of design plans that serve each user — this applies from conceptual design to final design • Aid in the development of performance metrics for all users when evaluating how well the design meets intended expectations • Integration of needs of all users into value engineering process • Definition of target and design speeds
Construction	• Construction of a project that serves all intended users • Maintenance of safe access to adjacent land uses for all users
Operations and Maintenance	• Operating the facility to meet the needs of all users (e.g., signal cycle length and timing) • Maintaining safe facilities for all users (e.g., maintain clear bicycle lanes)

Next, the section addresses issues that arise during implementation and offers strategies to achieve a resolution. The first point of discussion is Context transitions. Two types of transitions introduce significant challenges in terms of identifying the transition zone and potential treatments:

- Rural to Rural Town, where all Transportation Expectations are typically affected. In Rural Towns there are more pedestrians and bicyclists, greater permeability, lower speeds, and greater network options than in Rural Contexts. These issues have implications for design and could be addressed over the transition zone.
- Rural to Suburban Transitions, which typically involve speed reductions, major cross section changes, and can introduce closed drainage. Separated facilities for nonmotorized users may be introduced.

Another issue practitioners must pay close attention to is the potential impacts of future land use changes on Context Classification. Information on these impacts can be found in state, regional, and local planning documents. Interviewing local stakeholders and officials can also help practitioners assess the likelihood of future changes. A discussion of quality assurance and quality review follows both of which are essential for proper implementation of Context Classification. Agencies can rely on interdisciplinary teams to help establish or validate Context Classifications. Throughout project development these teams should evaluate projects to verify Context Classification remains integral to decision making.

The next section of the chapter addresses potential implications of Context Classification for all user types and focuses on issues that shape Transportation Expectations for each Context as well as interactions between user groups. Key points and considerations related to each mode are highlighted below:

- **Motorized Users:** Practitioners should seek community input to differentiate between regional and local traffic and modify the initial Transportation Expectations accordingly. Other issues highlighted include the need to address speed in transition zones, especially in developed Contexts where land uses support higher pedestrian and bicyclist volumes, as well as attending to interactions between motorized and nonmotorized users.
- **Bicyclists:** As bicyclists are present in all Contexts, it is important to make decisions that preserve their safety and quality of service. Separating bicyclists from other users is one option, however, it is critical to address potential conflicts with access points. Another issue practitioners must focus on relates to crossing paths and intersection designs, especially in urbanized areas. Potential concerns should be resolved during design in light of Movement and Permeability Transportation Expectations.
- **Pedestrians:** Pedestrians occur in all contexts, and designs must keep them safe and their quality of service high. Key points of discussion include the level of separation of pedestrian facilities from other traffic, encounters with bicyclists on multi-use paths, localized pedestrian accommodation, and interactions between pedestrians, bicyclists, and motorists. These can be addressed through Movement and Permeability Transportation Expectations.
- **Transit Users:** Practitioners must be attentive to transit users in Contexts where they are present and their interactions with other users so they can modify designs accordingly. Designs must include proper connections between transit stops and other roadway components; these issues can be addressed through Users/Vehicles and Permeability Transportation Expectations.
- **Freight:** Because freight vehicles are found in all Contexts practitioners need to understand their implications for specific design elements as well as the concepts of design and control vehicles.
- **Micromobility Users:** Despite the surge in micromobility users, national guidance on their operations remains lacking. Nonetheless, practitioners must account for interactions between micromobility vehicles and other users, especially pedestrians.
- **Other Users:** Future user types could potentially influence Transportation Expectations. Factors to consider include a mode's range, speed, and vulnerability as well as integration with other uses and necessary accommodations.

The next section addresses the relationship between roadway types and Context Classification. During development of the guidance, Context Classification and Transportation Expectations focused on major collectors and arterials and the user expectations for these facilities. Bearing this in mind, practitioners should refine Transportation Expectations for specific facilities accordingly. This is an area in which

functional classification (sometimes referred to as Roadway or Facility Type) may shape a facility's final Transportation Expectations. For example, relative to arterials local facilities could serve a higher percentage of nonmotorized users while having lower speeds. This knowledge can be used to refine Transportation Expectations and allow different levels of separation between motorized and nonmotorized users. Another area where roadway type can play a role is target speeds, where local roads are toward the lower end of the ranges noted in the Speed Transportation Expectation.

The chapter closes with a brief discussion of environmental implications. It is incumbent upon practitioners to deliver equitable transportation choices, especially in communities with low rates of automobile ownership. Environmental considerations should be a focus when refining a Context's Transportation Expectations.

Context Classifications

Ensuing chapters review each Context and discuss their associated Transportation Expectations. They also provide examples to demonstrate the variability of individual Contexts. The Manual includes the information found in Chapter 6 of this report; each Context is presented in a separate chapter.

Case Studies

The last chapter in the Manual presents three case studies that demonstrate implementation of Context Classification and describes how to address potential implementation issues.

CHAPTER 10

Conclusions

The primary outcome of this research effort was practical guidance state, regional, and local agencies can use to identify the appropriate Context for an area or transportation project. This was achieved by defining meaningful Contexts that can be used to inform project development and identifying measures that can be used to categorize environments adjacent to roadways into the established Contexts. The Context Classification system defined here builds on earlier efforts and provides a framework where roadway Context can inform practitioners of potential roadway user needs and constraints so they can prepare designs that balance mobility and safety.

Recent efforts to transition from binary highway functional classification to context classification have been motivated by the recognition that current practices do not capture the multimodal needs of roadway design or deliver transportation solutions fully attuned to context. The Context Classification system proposed here is an innovative framework that brings together context and user expectations to guide multimodal design and achieve context-sensitive, enhanced solutions.

Context Classification gives transportation professionals the necessary foundation to develop context-appropriate transportation solutions and deliver multimodal designs adapted to the needs of all users. Transportation Expectations provide a more detailed description of how users anticipate moving within Contexts. They can also help practitioners establish user needs at the network level from the earliest stages of project development.

Transportation Expectations require understanding modal needs and the roadway's role and place in the network. This knowledge underwrites efforts to address competing user needs, balance modal requirements, and craft a more holistic, network-wide transportation solution that satisfies all demands. Balancing modal needs may require investigating solutions that place users on alternative routes more compatible with their specific needs. Context Classification and Transportation Expectations can assist in developing designs that more closely mirror the purpose and need document, which establishes the design framework, and help create a starting point for identifying more contextually appropriate planning and design elements.

By establishing Transportation Expectations from project initialization, planners and designers can ensure that projects are scoped to address all intended outcomes and verify no needs or users are overlooked. Once more detailed project information is available, a deeper understanding of the unique project context is possible and design elements are selected for a comprehensive transportation solution. Transportation Expectations are thus a critical outcome of the Context Classification since they establish the intended outcomes for roadway segments in each Context and — based on the Project Considerations (which include additional, more-detailed information on roadway surroundings, community, environmental, and other elements) and facility type (functional class) — could establish the initial project design elements.

The Application Manual provides a high-level overview of Context Classification, makes the case for using Context Classification throughout the project development process, reviews its application, discusses the implementation process and implementation issues, reviews each Context and their Transportation Expectations and provides representative examples, and presents case studies that demonstrate Context Classification implementation and how to address possible implications. The Manual provides measures agencies can use determine the appropriate Contexts at any scale.

Context Classification and the Application Manual deliver a practical framework for identifying Context and developing multimodal contextual designs until GB8 is published. Several state agencies have already

invested significant efforts in implementing the GB7 Context Classification. The Manual provides direction on the measures to be used and utilizes measures that can be developed based on readily available, national databases. The findings of this research provide an opportunity to enhance the relevant chapters of GB8 so they account for the importance of adopting a uniform approach when defining measures and addressing issues related to Context Classification.

Future Research

The work completed here also identified areas where additional research is needed to answer questions that were posed but not addressed due to resource limitations. The following areas of future research are recommended:

1. Case studies can be undertaken to further examine the application of Context Classification. This requires collaboration with agencies planning to implement Context Classification to identify areas where additional information is needed to complete the process. This work will also allow for continued refinement of the Manual and provide the foundation for updates to measures and their associated thresholds. Even though the project team attempted to identify the potential implications of Context Classification, this was not exhaustive. Further work on this front (i.e., measures and their thresholds) could be invaluable to other agencies considering application of Context Classification. This could be even more critical for smaller agencies or MPOs.
2. Another effort could explore potential additional measures developed from new and emerging databases. While the project team relied on the Microsoft Building Footprint data, other databases could become available that would allow for use of additional measures that could improve the accuracy of automated classification and reduce the level of effort required for manual review. These efforts should focus on refining classification procedures for Urban and Suburban roadways, capturing the higher potential for nonmotorized travel to community services within urban areas.
3. A third effort could review Context Classification rollouts both at agencies that have already done so and those planning implementation. Each agency that has implemented Context Classification has customized their approach and some have developed training for their employees. This effort would allow for documentation of lessons learned and steps required to implement Context Classification. Other agencies considering implementation could review these materials and proceed accordingly.
4. Another effort could focus on incorporating Context-related considerations into *Highway Capacity Manual* procedures and methods to address multimodal designs. Context Classification is founded on understanding who roadway users are and creating facilities that meet each user group's needs. This could have implications for operations and thus affect *Highway Capacity Manual* procedures.

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APPENDIX A

Context Classification Measure Sensitivity Analysis

The following sections present the detailed sensitivity analysis summarized in Chapter 7. Each measure was evaluated individually to test how well they correctly identify Contexts. Analysis was performed by developing cumulative distribution plots for each Context and measure. Segment analysis graphs plot the cumulative percentage of roadways identified correctly with each measure. Initial thresholds were set at the value that maximized the sum of the correct percentage of roadways for the Contexts evaluated. Segment analysis for Urban Core/Suburban-Urban, Urban-Suburban, and Rural/Rural Town are presented. A cluster analysis method was used to minimize incorrect classifications of Rural Towns by relying on a visual review of data. The key measure used to judge the effectiveness of Context measures was the number of false positives for Rural roadways; those are documented in the Cluster Analysis section.

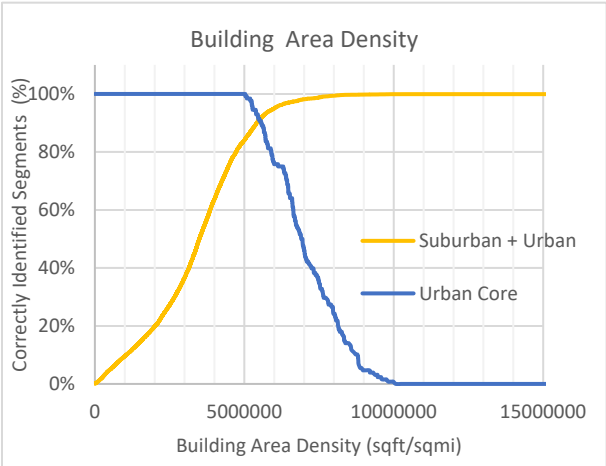
Segment Analysis Urban Core/Suburban-Urban Separation

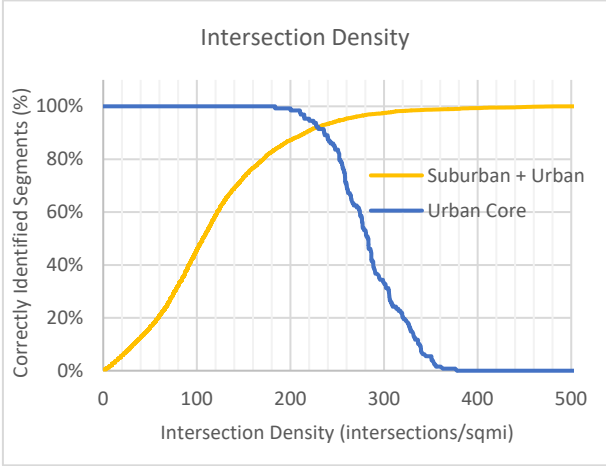
Threshold values for analysis were presented in Table 29 and are reproduced here. Values in bold denote the highest level of correct classification for each scenario (length x buffer).

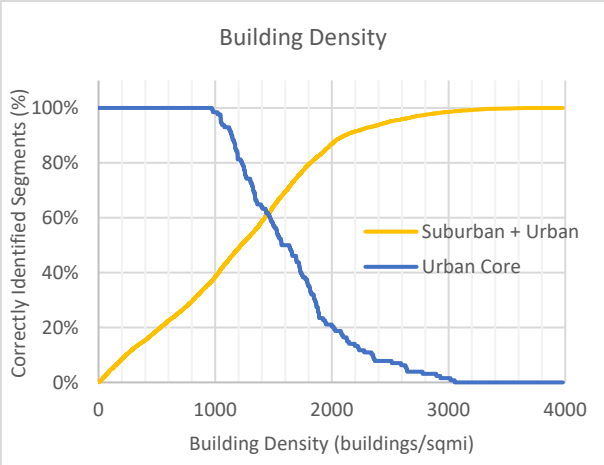
Table 37. Sensitivity analysis for Urban Core and Suburban/Urban classification

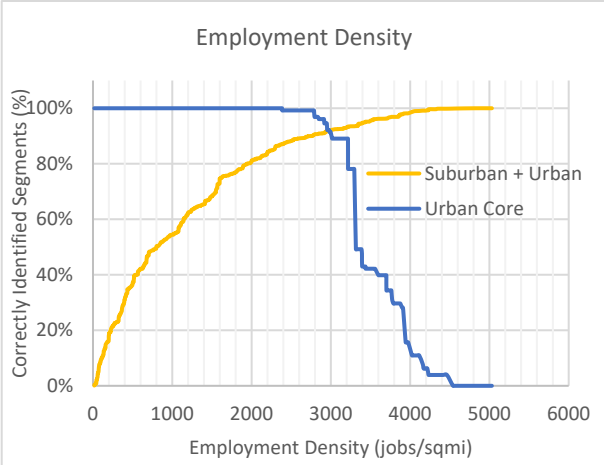
Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	5,900	98%	5,800	97%	6,000	95%	5,900	**99%**
Employment Density	2,800	94%	2,800	**96%**	2,800	96%	2,800	95%
Building Density	680	66%	1,000	**75%**	680	66%	1,000	**75%**
Building Area Density (million)	5.2M	91%	5.2M	**96%**	5.9M	92%	5.6M	**96%**
Street Density	180	89%	140	**97%**	170	91%	140	95%
Intersection Density	210	92%	210	**98%**	200	90%	200	97%
Block Length	380	85%	360	**92%**	380	82%	360	87%
Building Setback	45	90%	50	**95%**	50	88%	50	93%
Block Perimeter	2,500	95%	2,100	**98%**	2,500	95%	2,700	96%

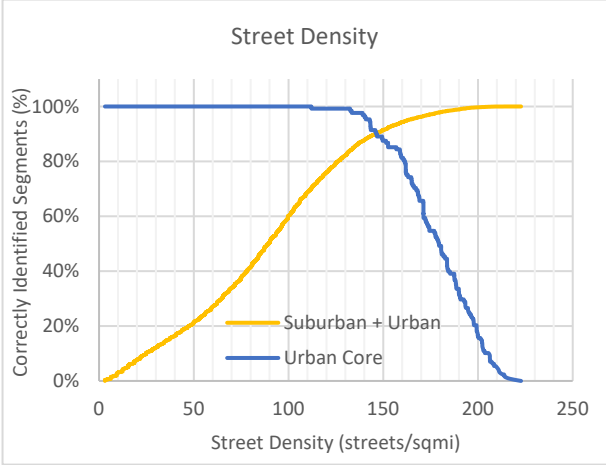
0.25-mile Length x 0.25-mi Buffer

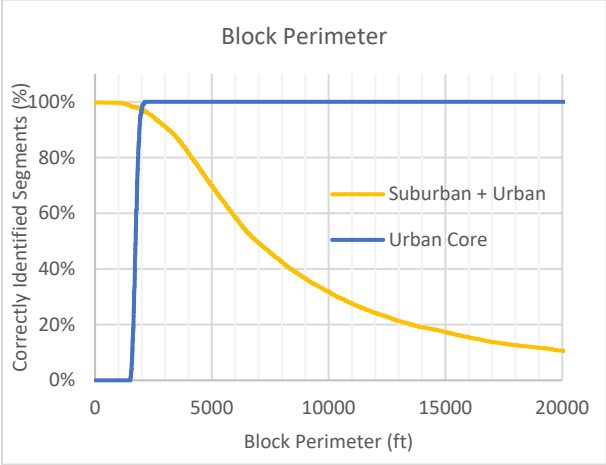


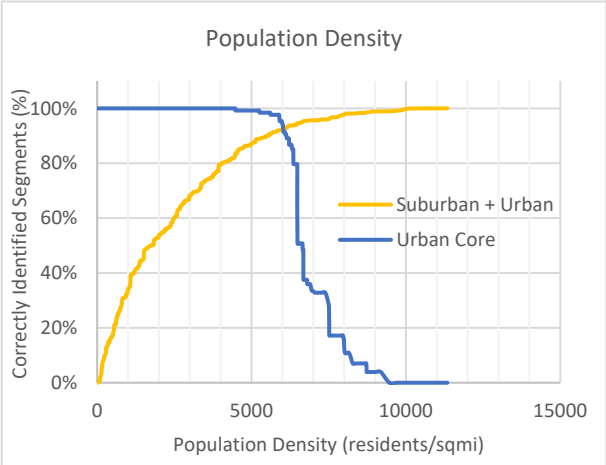


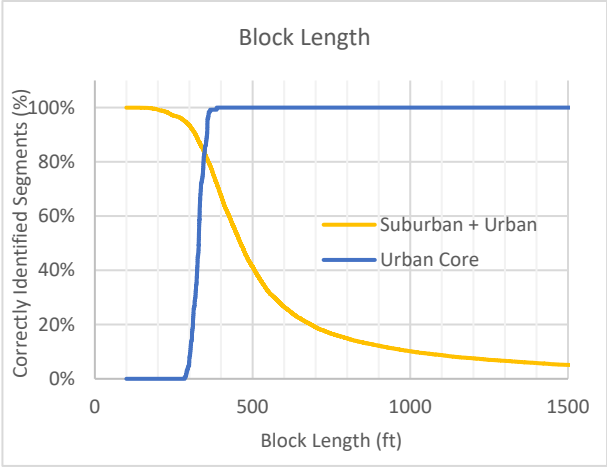


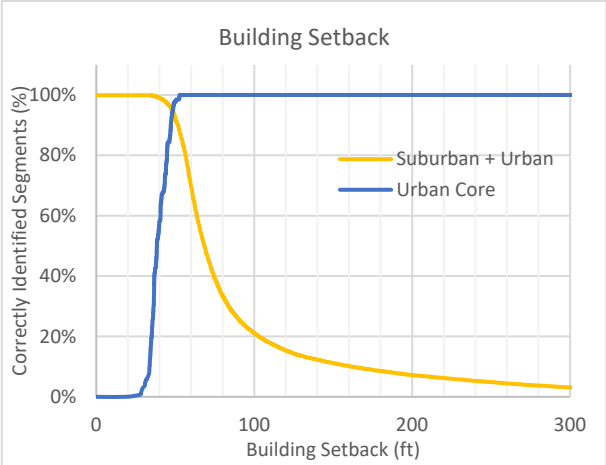




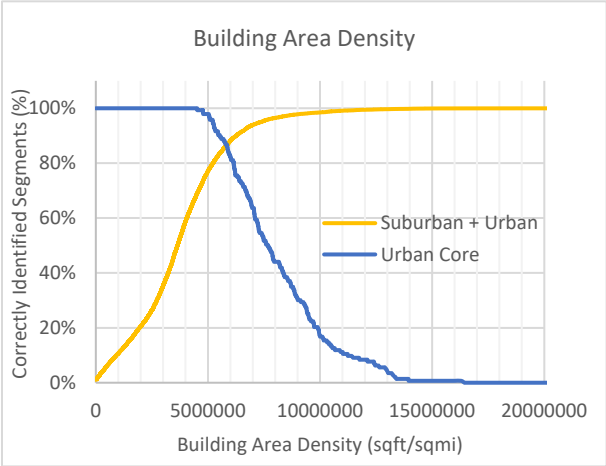


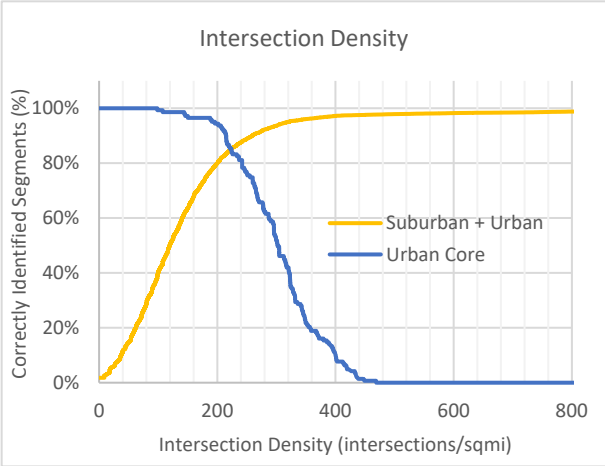

Population Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
5000
10000
15000
Population Density (residents/sqmi)
Suburban + Urban
Urban Core

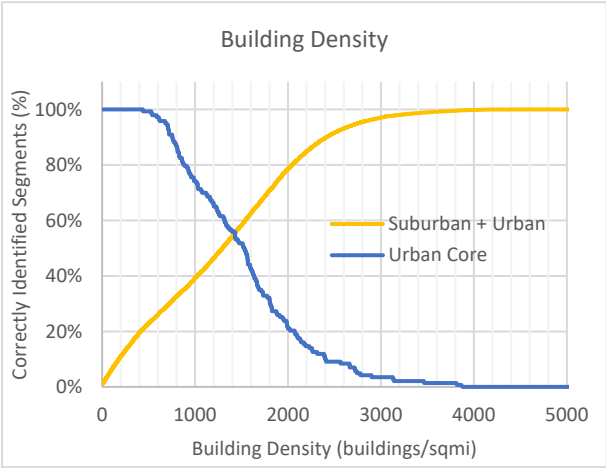

Block Length
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
500
1000
1500
Block Length (ft)
Suburban + Urban
Urban Core

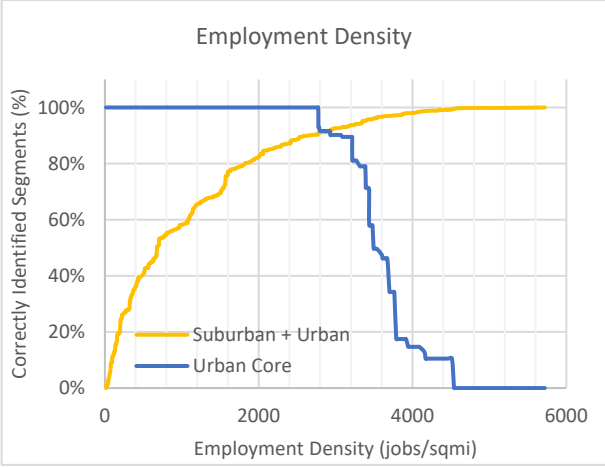

Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
Building Setback (ft)
Suburban + Urban
Urban Core

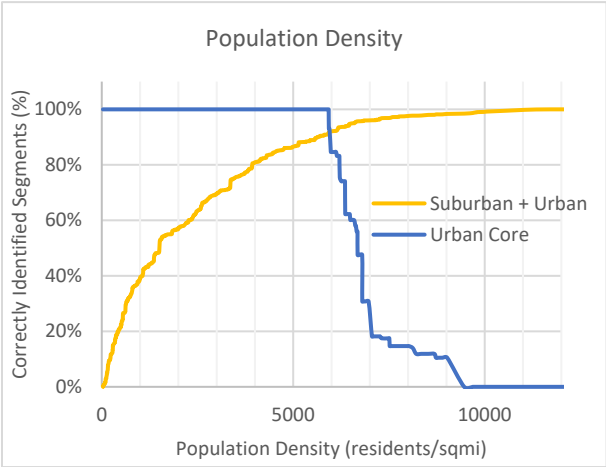
0.50-mile Length x 0.25-mile Buffer

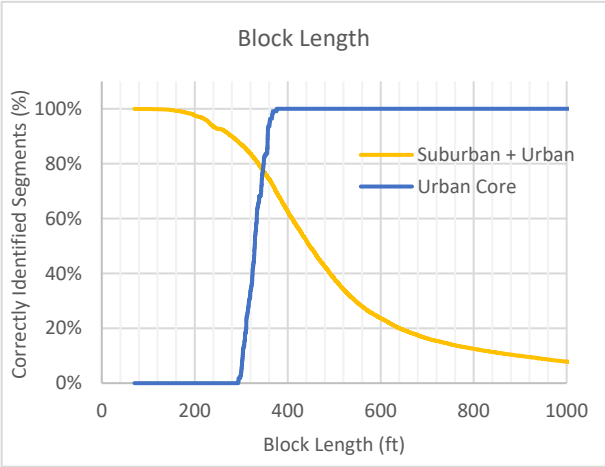


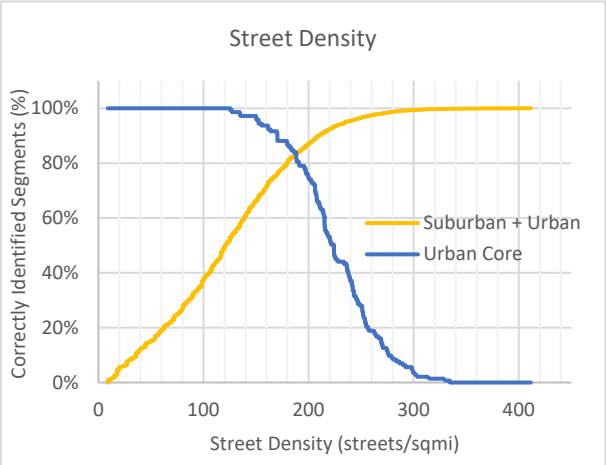


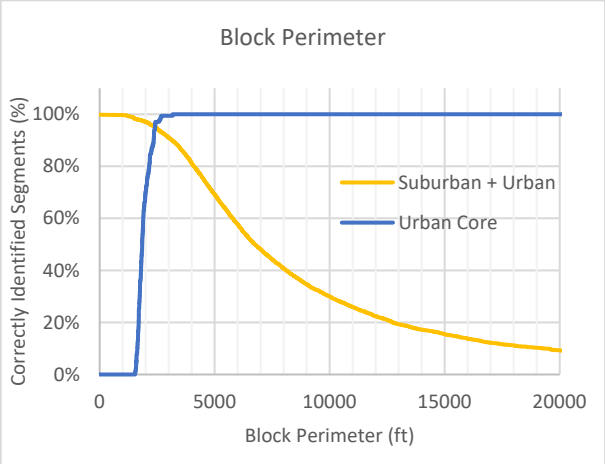


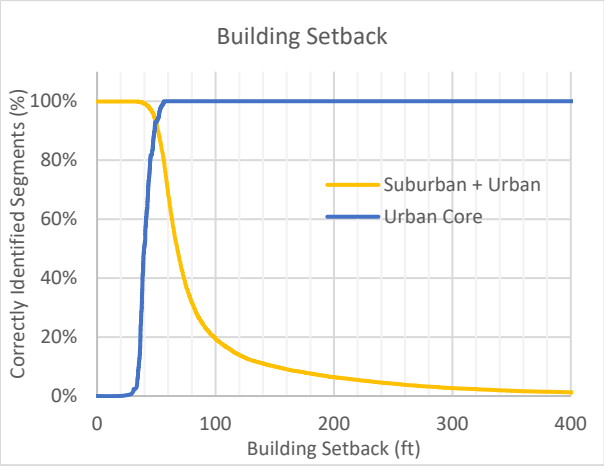




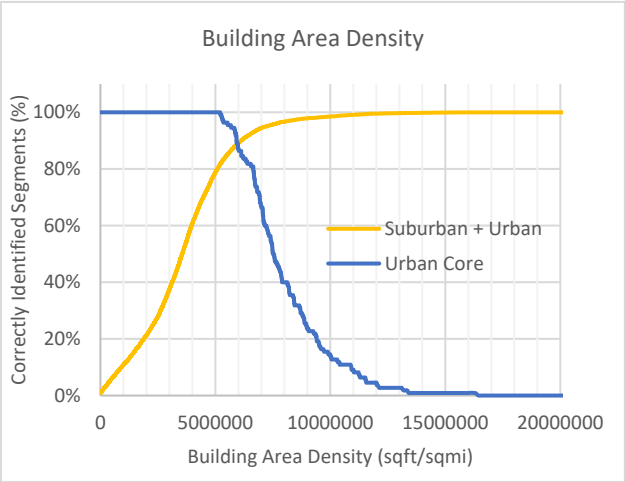


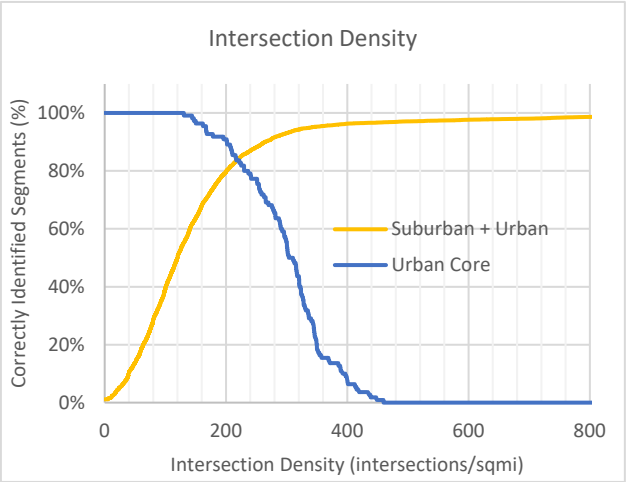

Street Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
Street Density (streets/sqmi)
Suburban + Urban
Urban Core

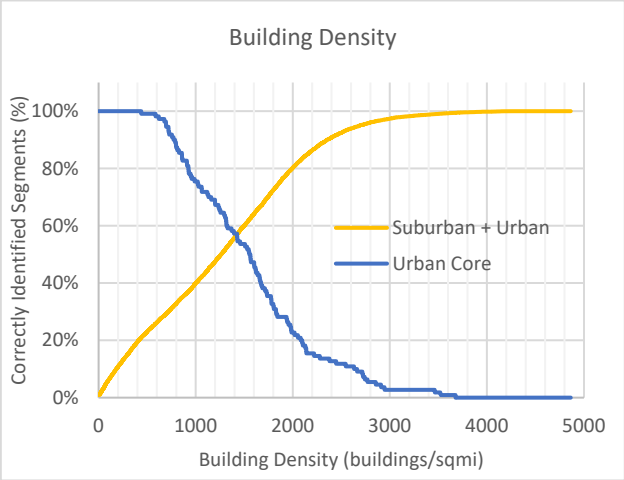

Block Perimeter
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
5000
10000
15000
20000
Block Perimeter (ft)
Suburban + Urban
Urban Core

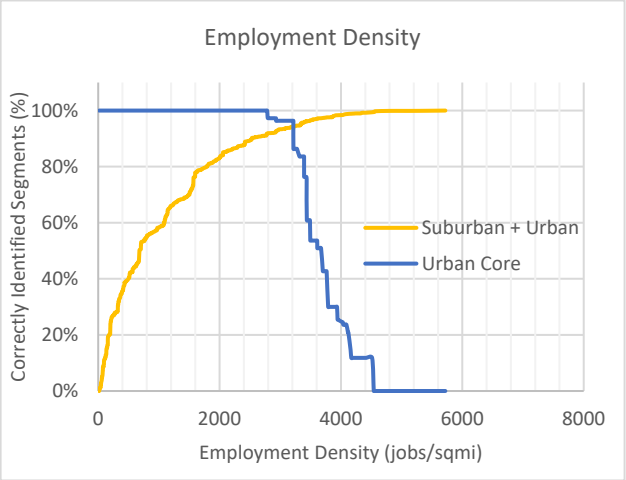

Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
Building Setback (ft)
Suburban + Urban
Urban Core

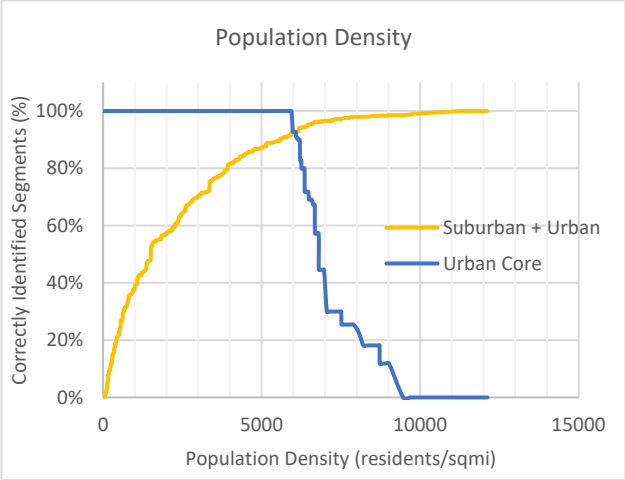
0.50-mile Length x 0.125-mile Buffer

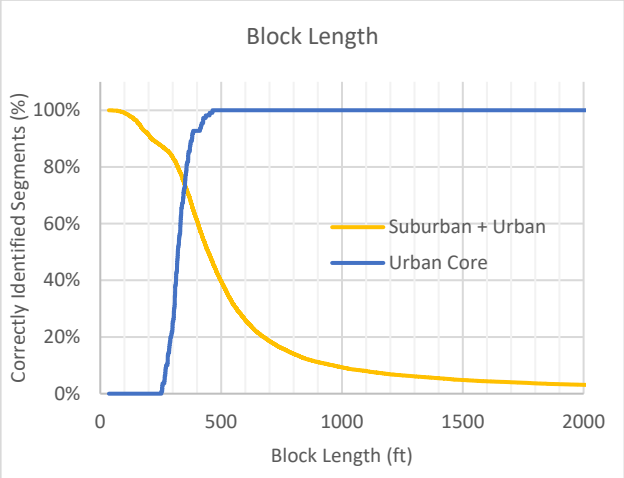


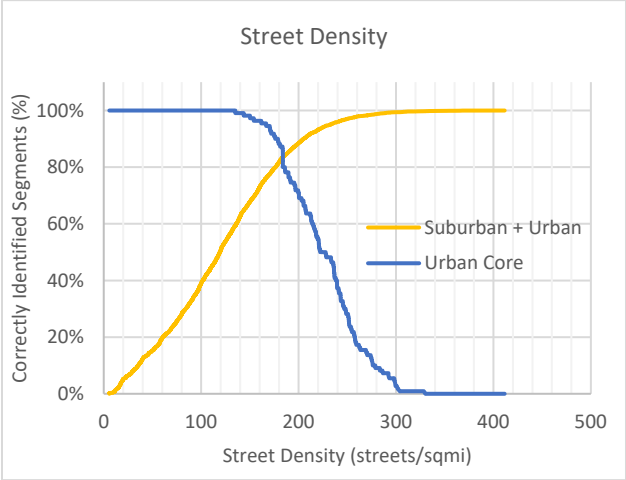


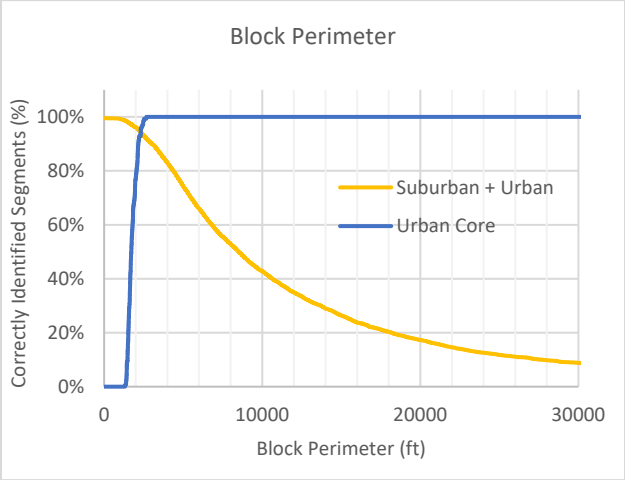


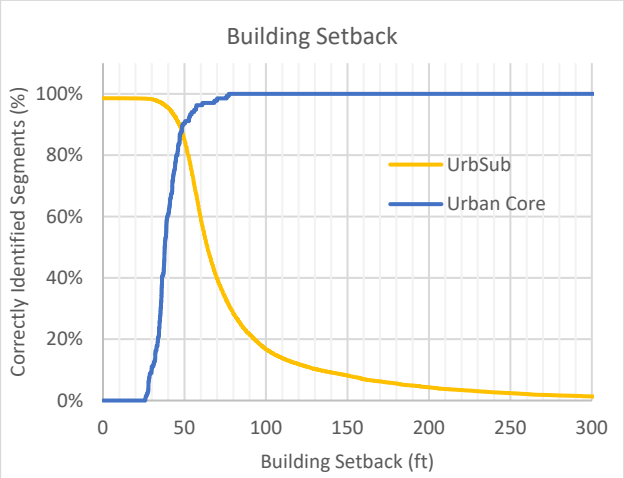




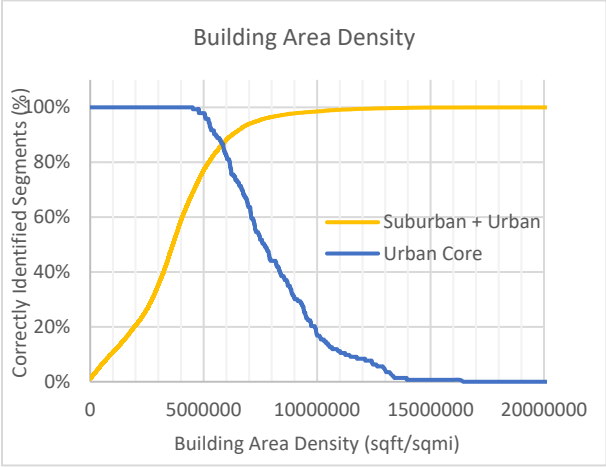


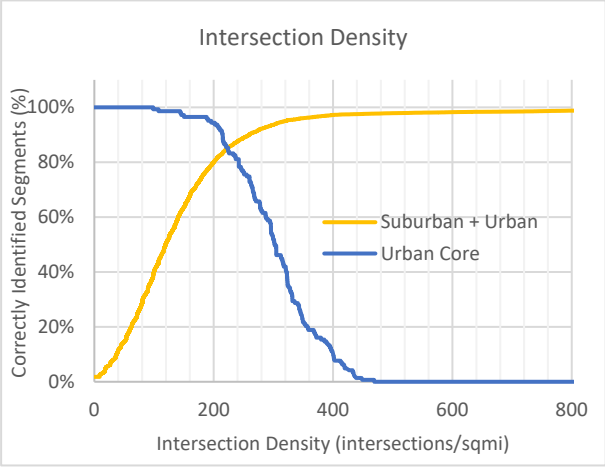


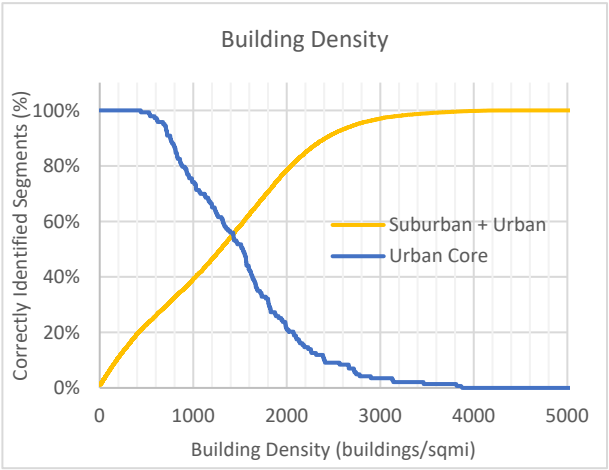


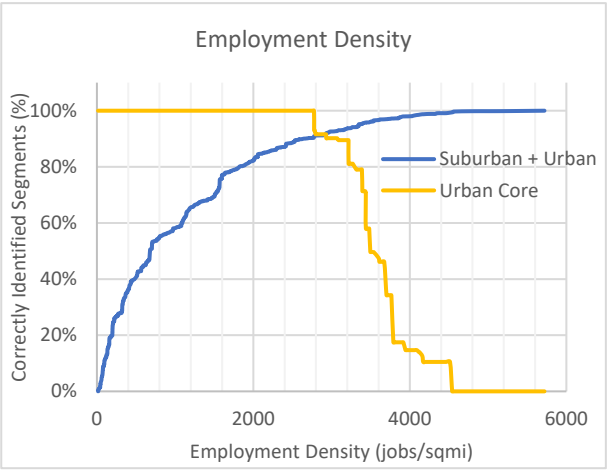


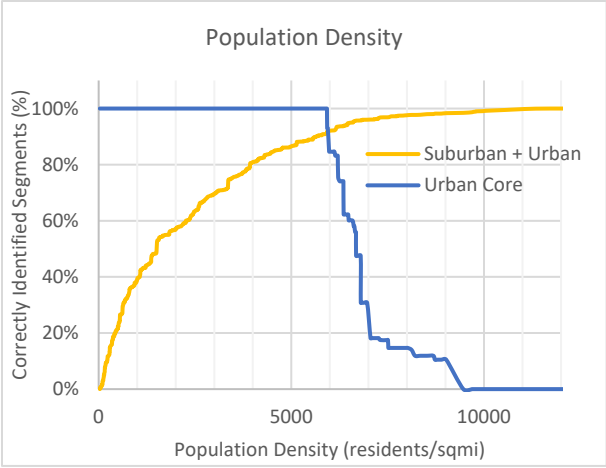
0.25-mile Length x 0.125-mile Buffer

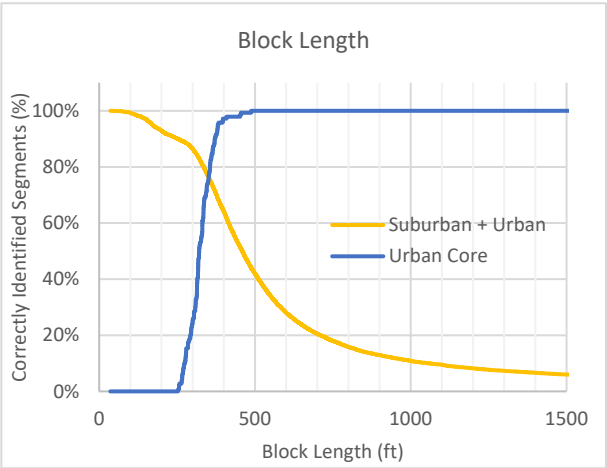


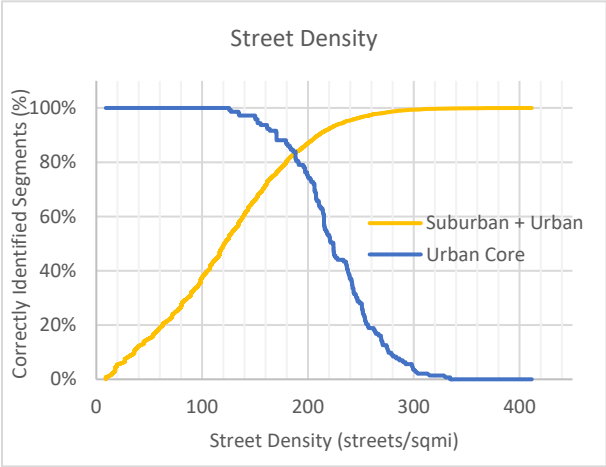


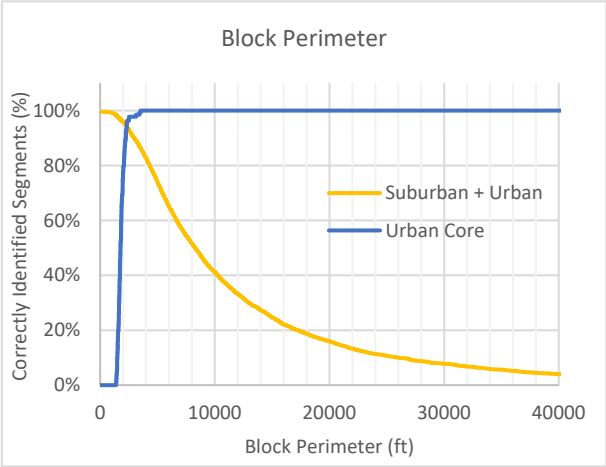

Building Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
1000
2000
3000
4000
5000
Building Density (buildings/sqmi)
Suburban + Urban
Urban Core

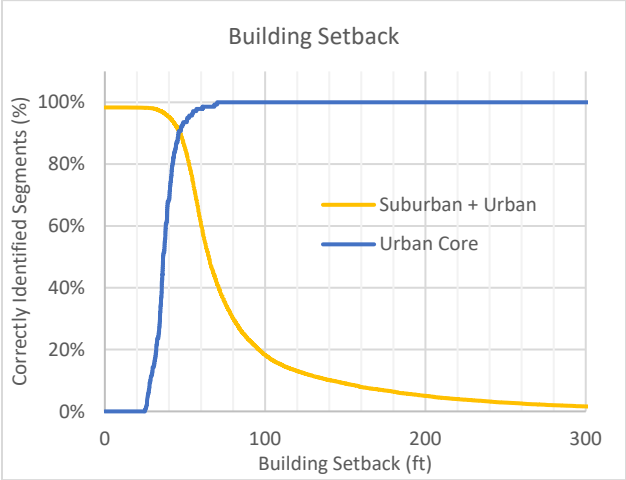

Employment Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
2000
4000
6000
Employment Density (jobs/sqmi)
Suburban + Urban
Urban Core


Population Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
5000
10000
Population Density (residents/sqmi)
Suburban + Urban
Urban Core


Block Length
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
500
1000
1500
Block Length (ft)
Suburban + Urban
Urban Core


Street Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
Street Density (streets/sqmi)
Suburban + Urban
Urban Core


Block Perimeter
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
10000
20000
30000
40000
Block Perimeter (ft)
Suburban + Urban
Urban Core



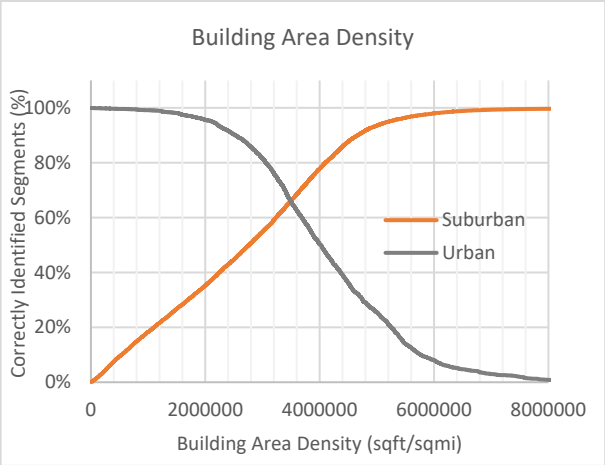
Segment Analysis Urban/Suburban Separation

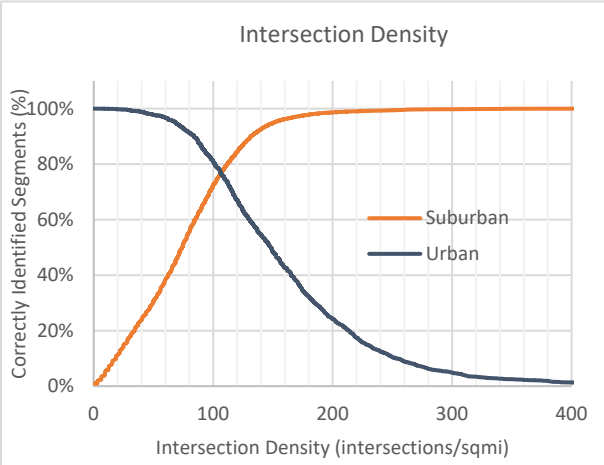
Threshold values for analysis were presented in Table 30 and are reproduced here. Values in bold denote the highest level of correct classification for each scenario (length x buffer).

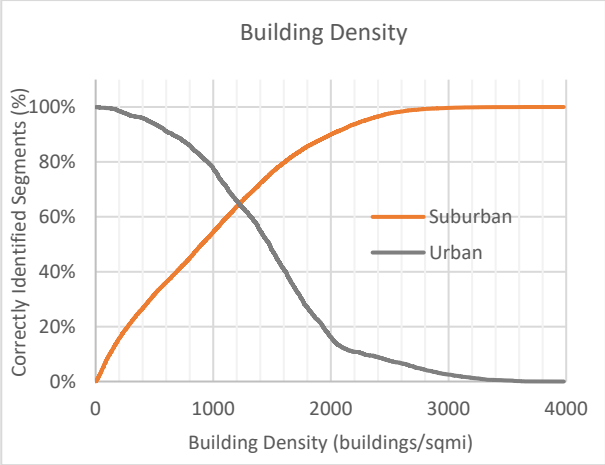
Table 38. Sensitivity analysis for Suburban and Urban classification

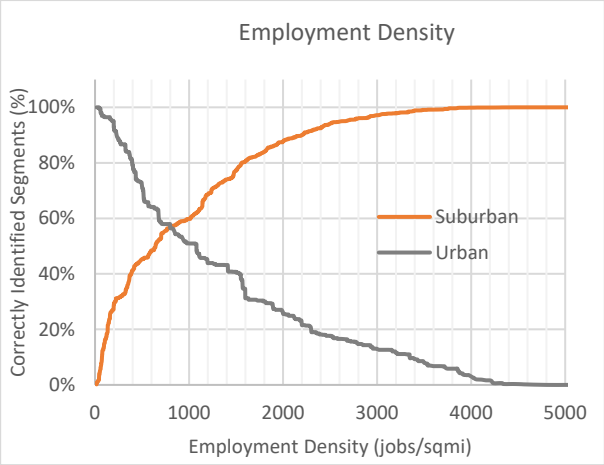
Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	500	**63%**	600	56%	500	**63%**	500	**63%**
Employment Density	200	**63%**	200	61%	250	61%	250	61%
Building Density	1,000	62%	1,000	59%	1,000	60%	900	**63%**
Building Area Density (million)	2.8M	**64%**	2.9M	60%	2.7M	61%	2.1M	**64%**
Street Density	120	69%	90	61%	120	67%	90	**71%**
Intersection Density	130	71%	100	61%	120	69%	110	**73%**
Block Length	500	69%	480	58%	480	67%	490	**71%**
Building Setback	60	65%	65	**68%**	60	64%	65	66%
Block Perimeter	6,900	69%	5,400	69%	7,100	67%	5,300	**70%**

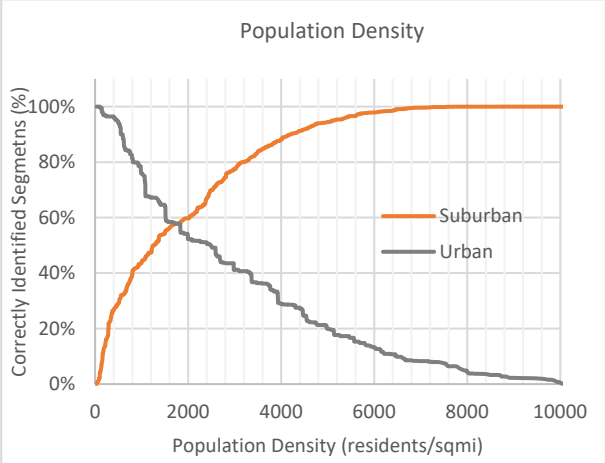
0.25-mile Length x 0.25-mi Buffer

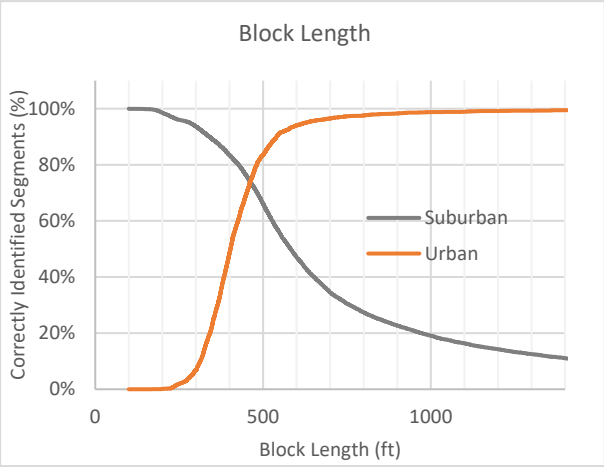


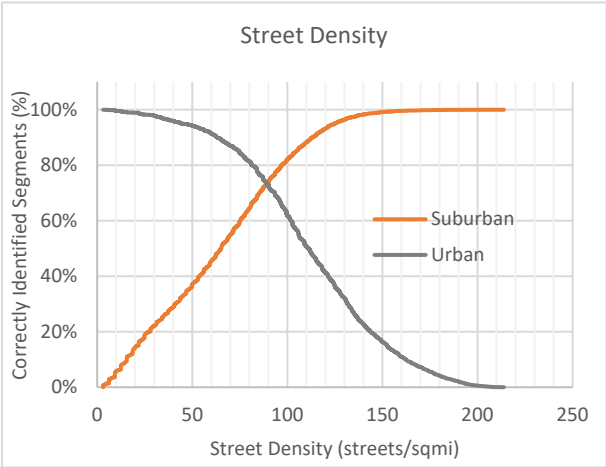


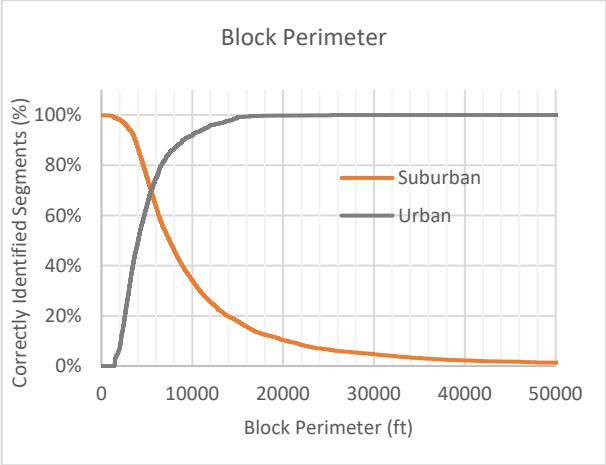


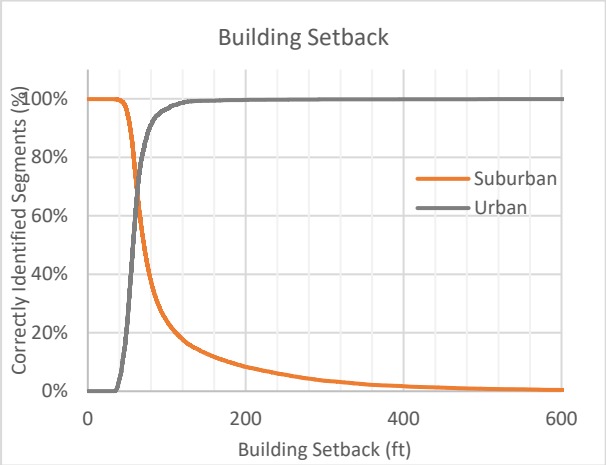


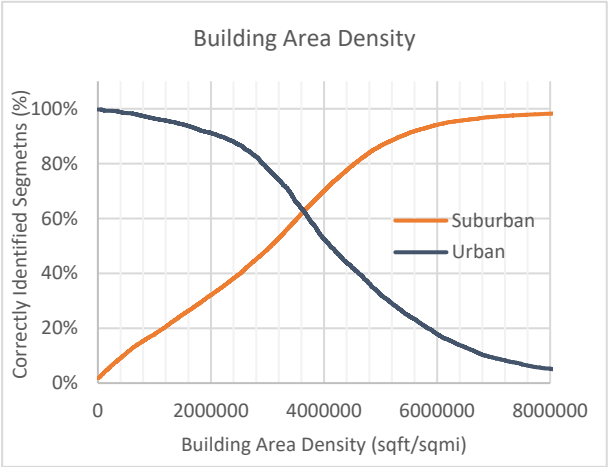


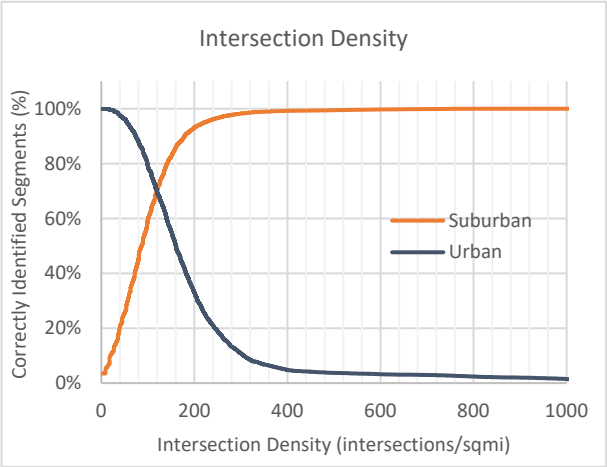


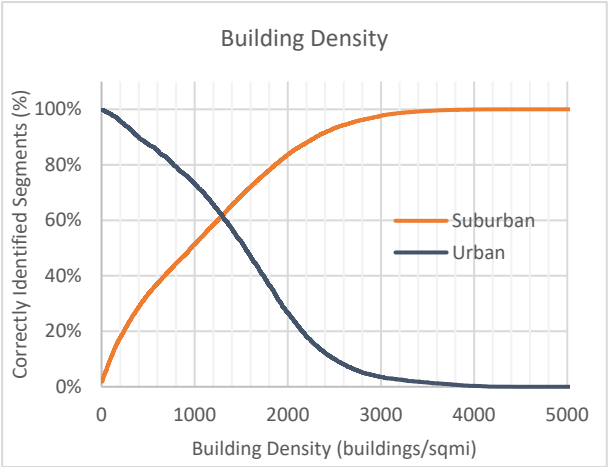

Street Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
50
100
150
200
250
Street Density (streets/sqmi)
Suburban
Urban

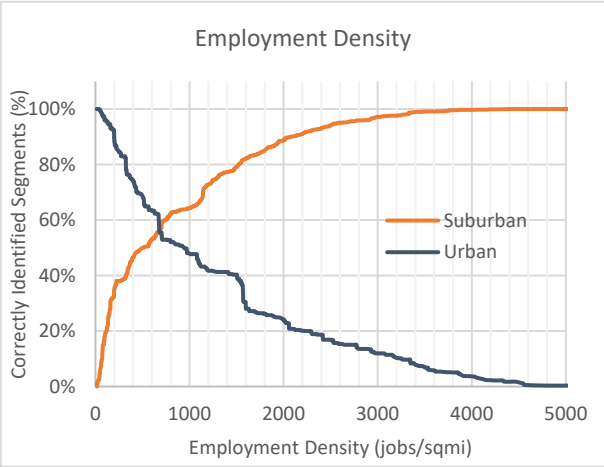

Block Perimeter
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
10000
20000
30000
40000
50000
Block Perimeter (ft)
Suburban
Urban

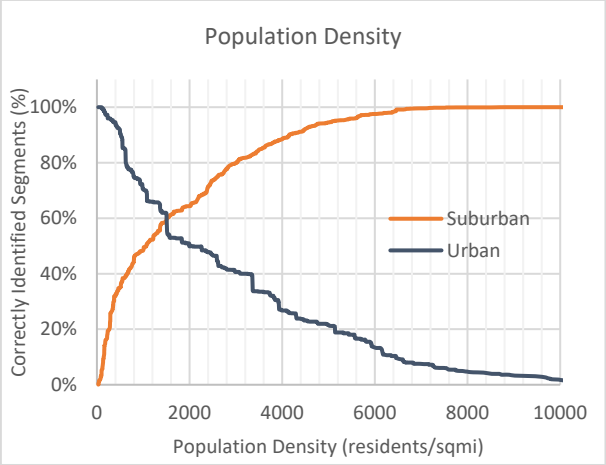

Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
200
400
600
Building Setback (ft)
Suburban
Urban

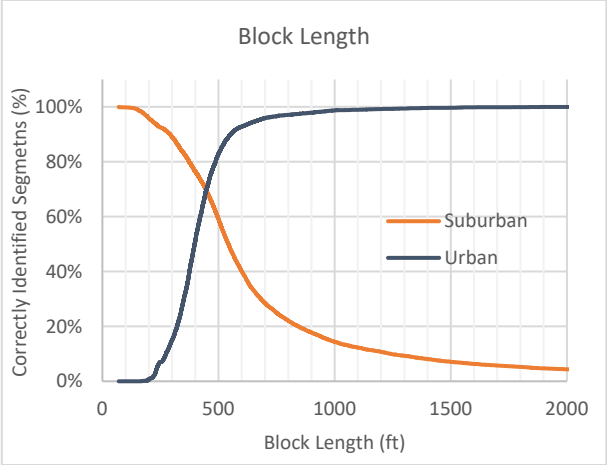




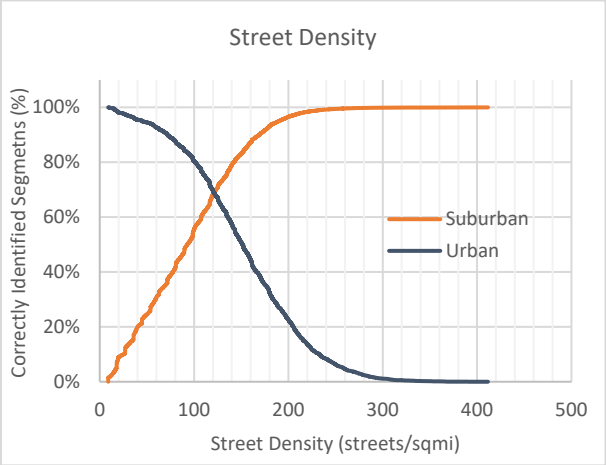


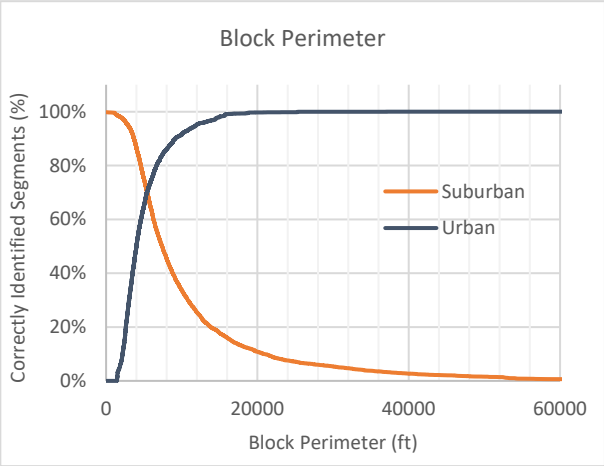


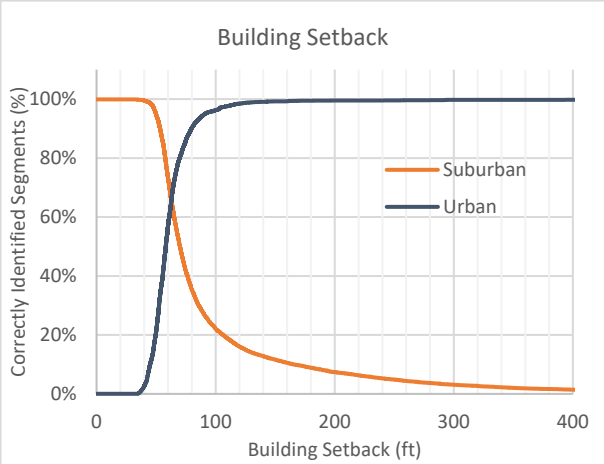




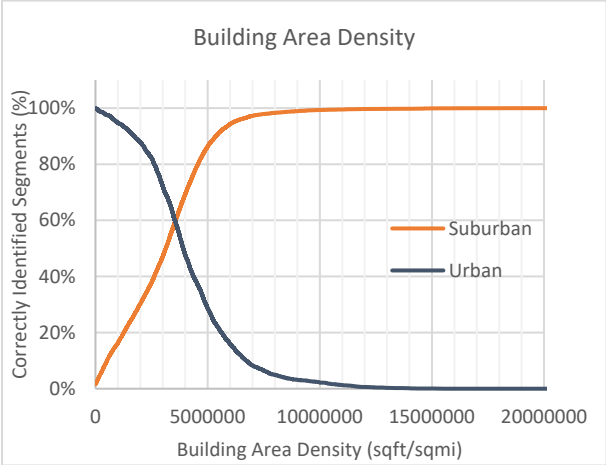
0.50-mile Length x 0.25-mile Buffer

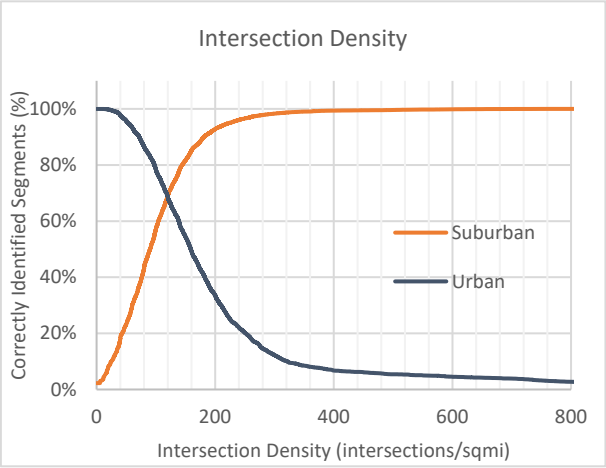

Street Density
Correctly Identified Segmetns (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
500
Street Density (streets/sqmi)
Suburban
Urban

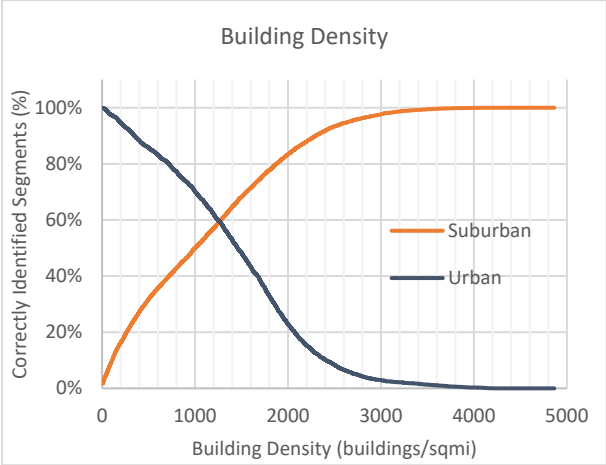

Block Perimeter
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
20000
40000
60000
Block Perimeter (ft)
Suburban
Urban

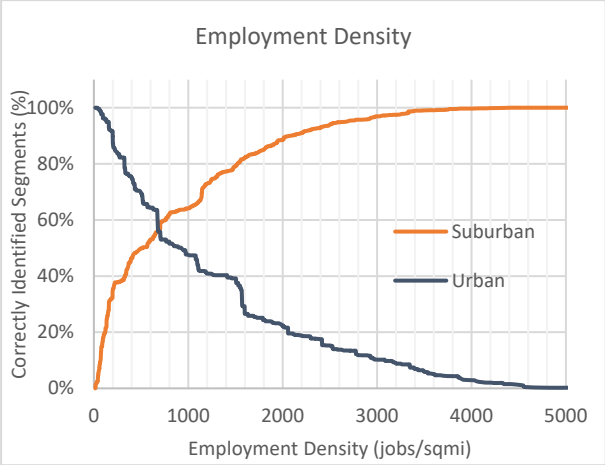

Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
Building Setback (ft)
Suburban
Urban

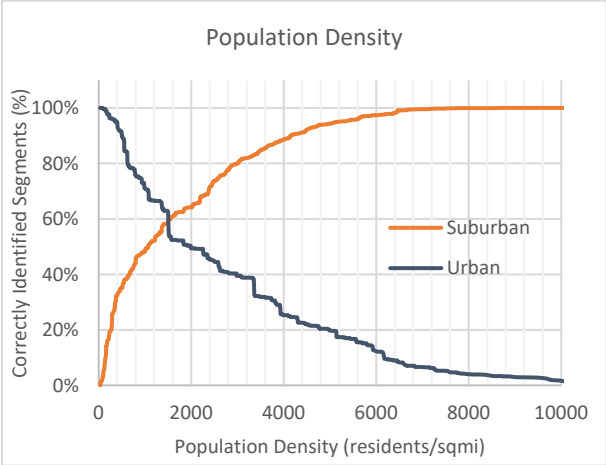
0.50-mile Length x 0.125 Buffer

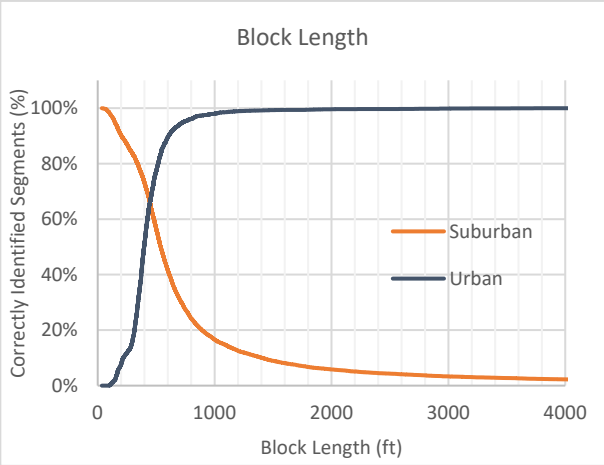


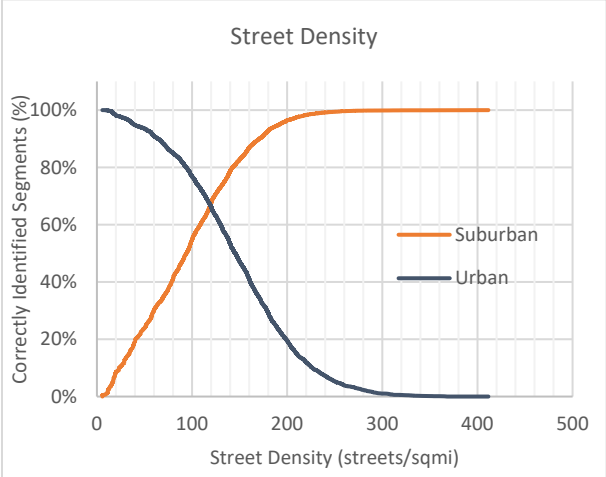


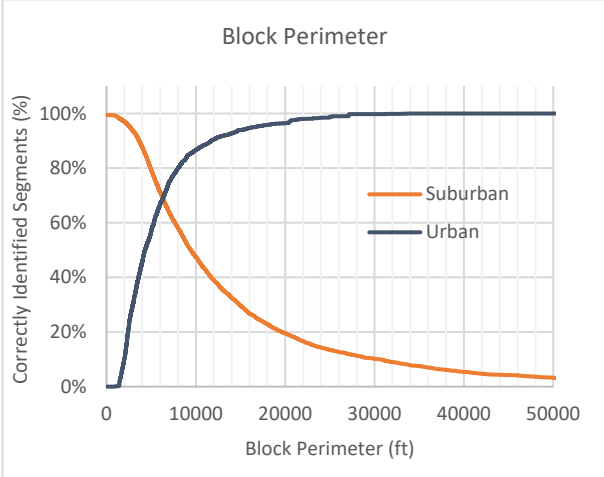

Building Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
1000
2000
3000
4000
5000
Building Density (buildings/sqmi)
Suburban
Urban

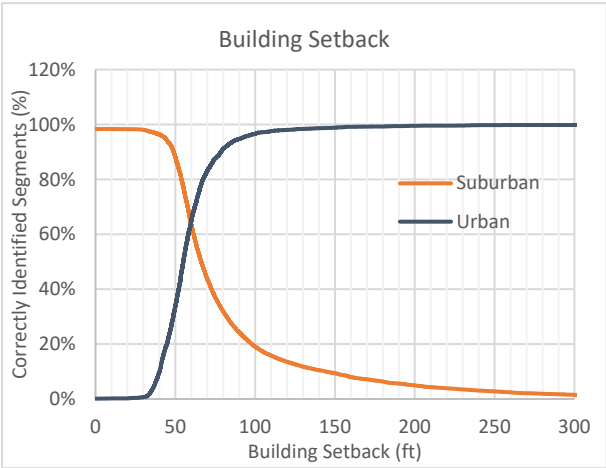

Employment Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
1000
2000
3000
4000
5000
Employment Density (jobs/sqmi)
Suburban
Urban


Population Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
2000
4000
6000
8000
10000
Population Density (residents/sqmi)
Suburban
Urban

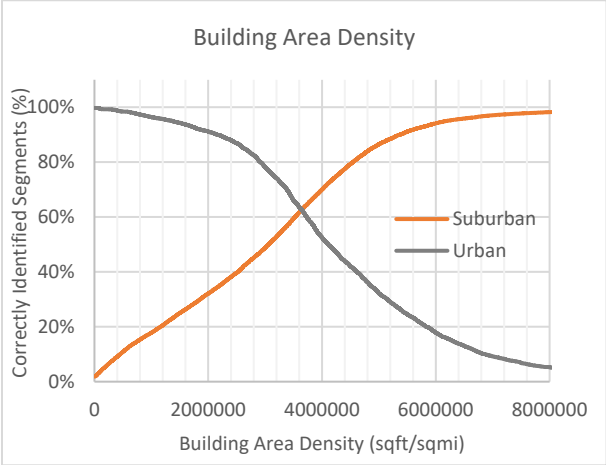

Block Length
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
1000
2000
3000
4000
Block Length (ft)
Suburban
Urban

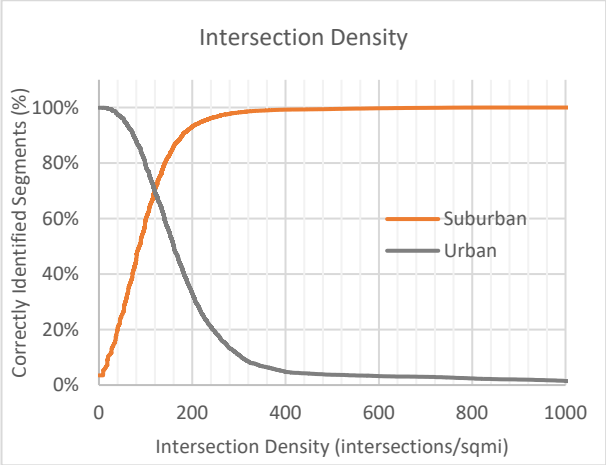

Street Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
500
Street Density (streets/sqmi)
Suburban
Urban

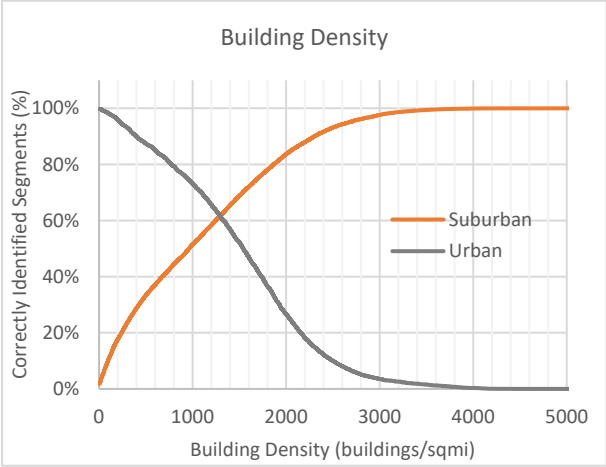

Block Perimeter
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
10000
20000
30000
40000
50000
Block Perimeter (ft)
Suburban
Urban

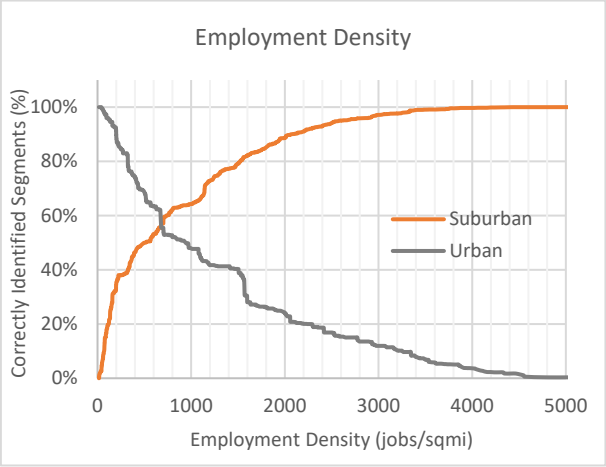


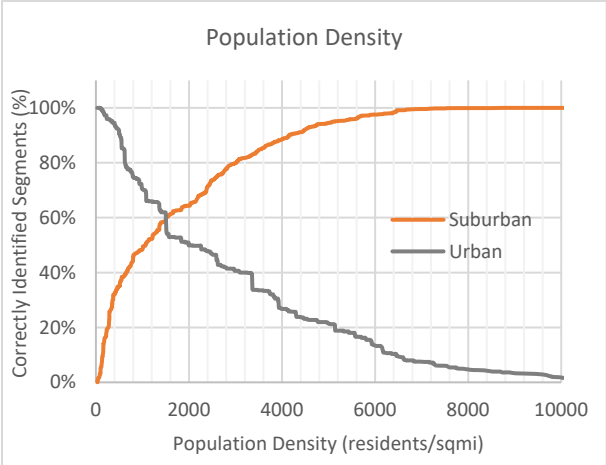
0.25-mile Length x 0.125-mile Buffer

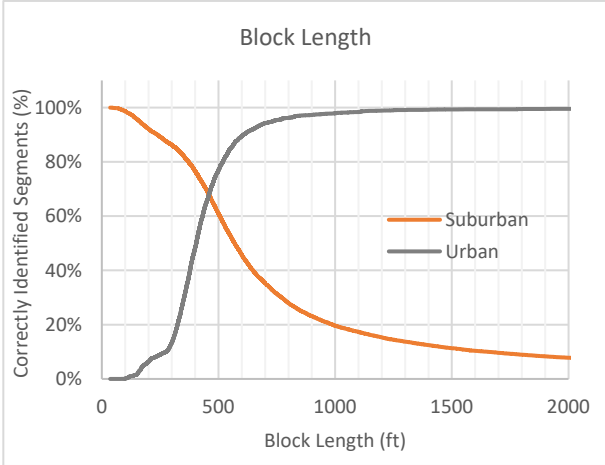


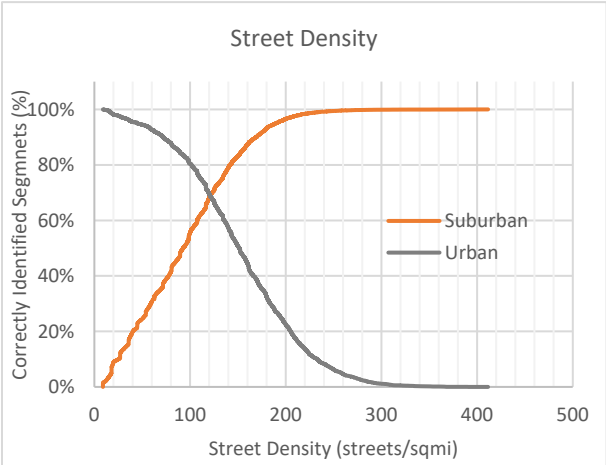


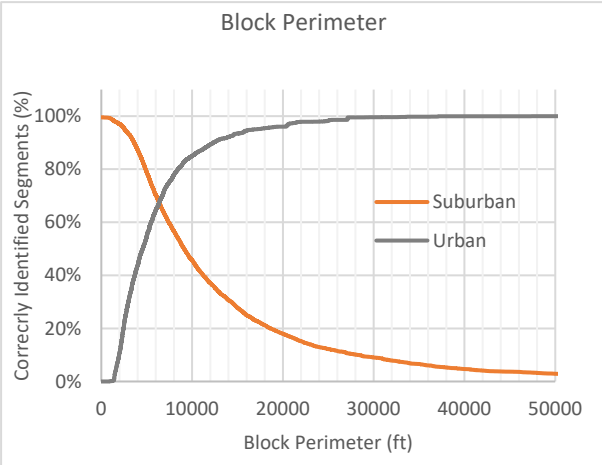


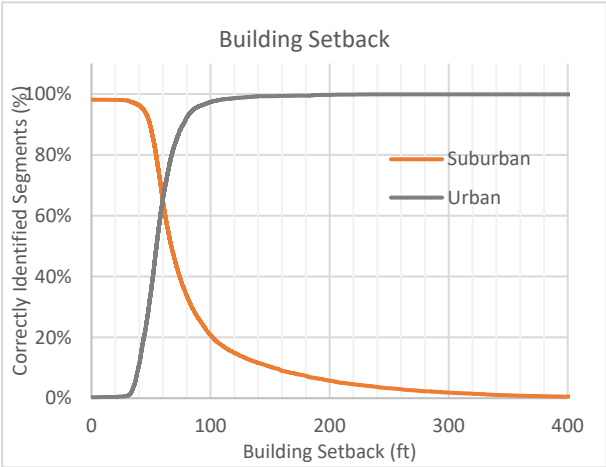



Population Density
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
2000
4000
6000
8000
10000
Population Density (residents/sqmi)
Suburban
Urban


Block Length
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
Block Length (ft)
Suburban
Urban


Street Density
Correctly Identified Segmnets (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
500
Street Density (streets/sqmi)
Suburban
Urban


Block Perimeter
Correcrly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
10000
20000
30000
40000
50000
Block Perimeter (ft)
Suburban
Urban


Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
100
200
300
400
Building Setback (ft)
Suburban
Urban

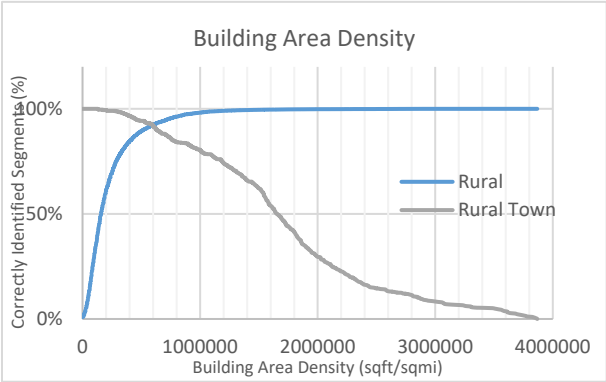
Segment Analysis Rural/Rural Town Separation

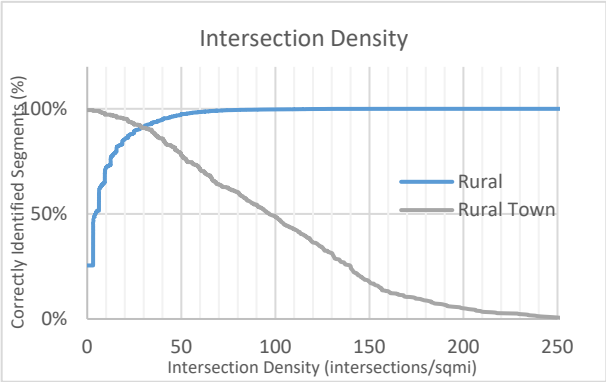
Threshold values for analysis were presented in Table 28 and are reproduced here. Values in bold denote the highest level of correct classification for each scenario (length x buffer).

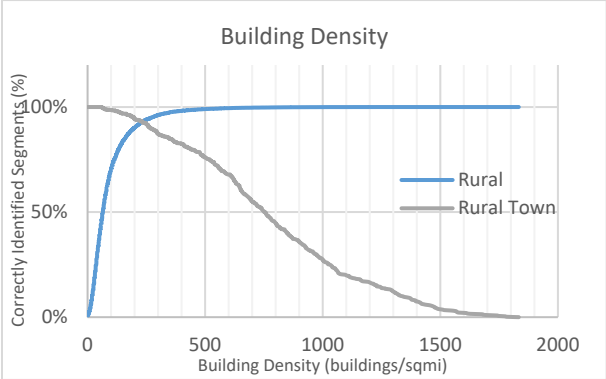
Table 39. Sensitivity analysis for Rural and Rural Town classification

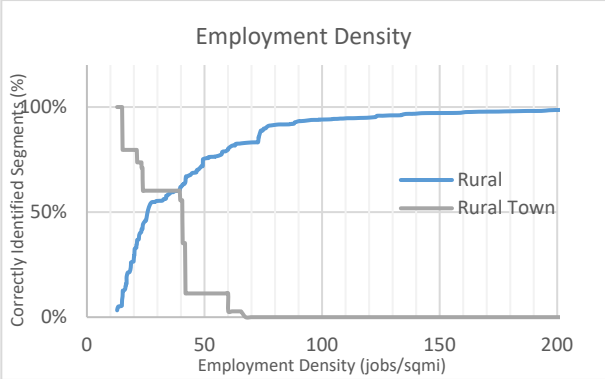
Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct	Thresh.	Percent Correct
Population Density	60	53%	60	**55%**	60	54%	60	55%
Employment Density	25	52%	40	**59%**	20	56%	40	58%
Building Density	400	90%	240	**93%**	360	87%	250	90%
Building Area Density (million)	0.95M	89%	0.59M	**93%**	1.0M	86%	0.69M	88%
Street Density	60	90%	25	**94%**	60	89%	30	92%
Intersection Density	40	85%	30	**92%**	40	84%	30	89%
Block Length	980	85%	960	**91%**	980	82%	940	86%
Building Setback	95	84%	115	**85%**	50	81%	100	**85%**
Block Perimeter	--	--	--	--	--	--	--	--

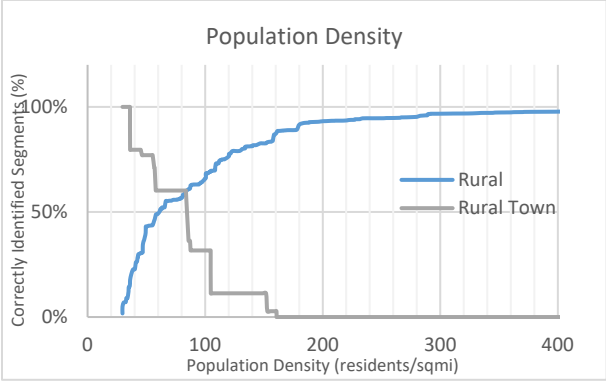
0.25-mile Length x 0.25-mi Buffer

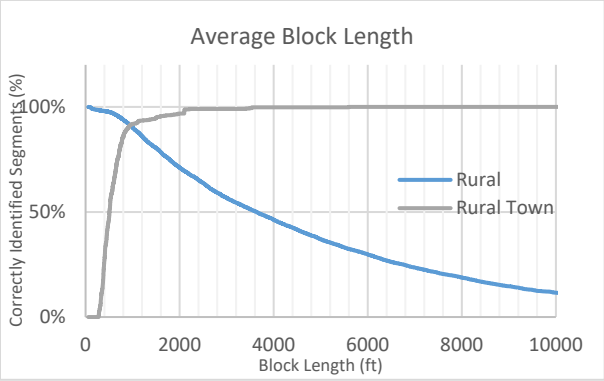


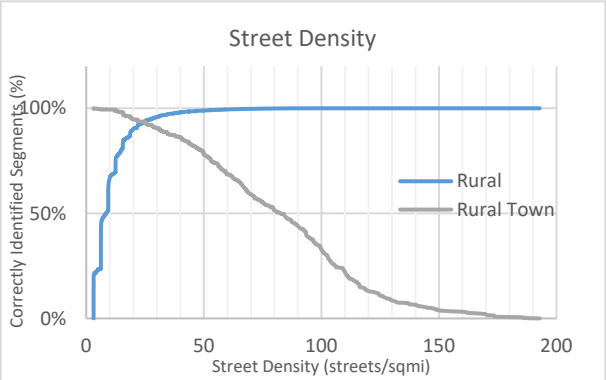


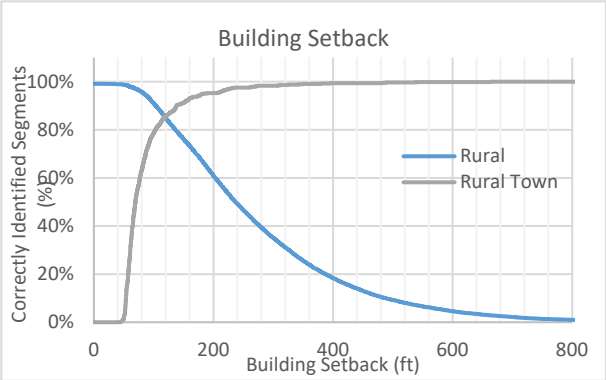




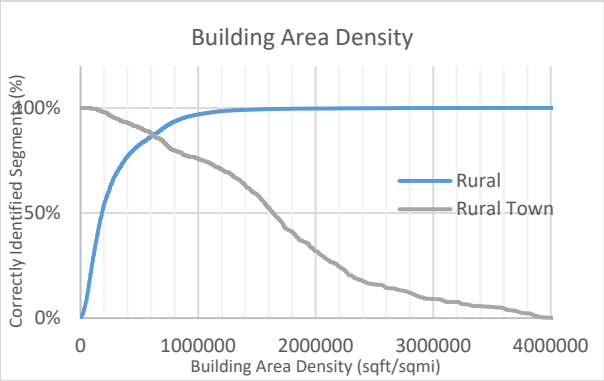


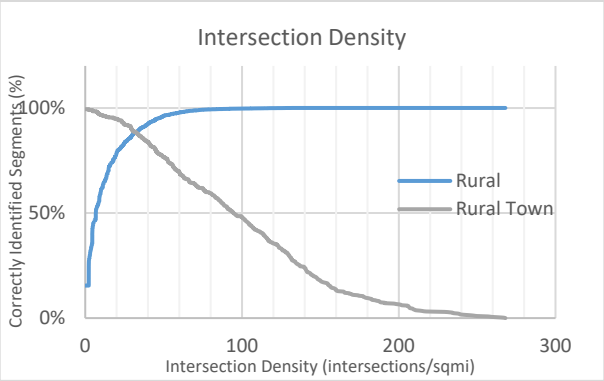


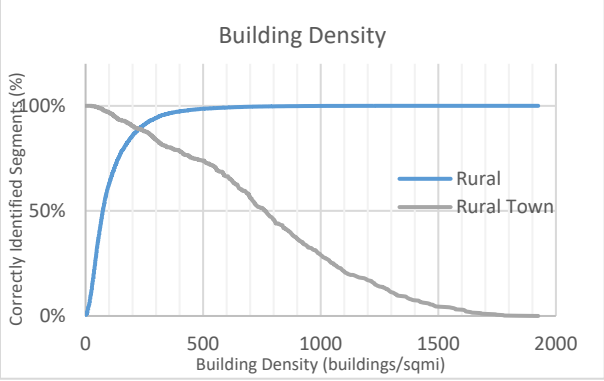


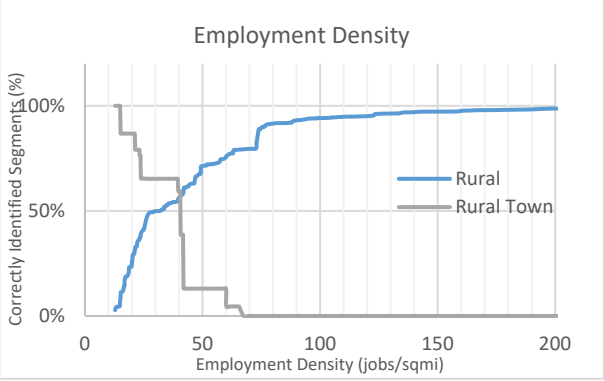


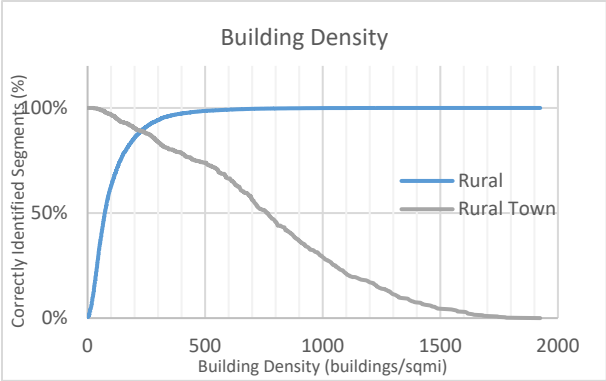
0.50-mile Length x 0.25-mile Buffer

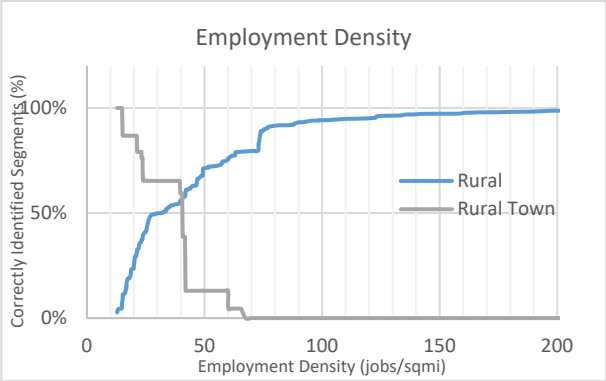


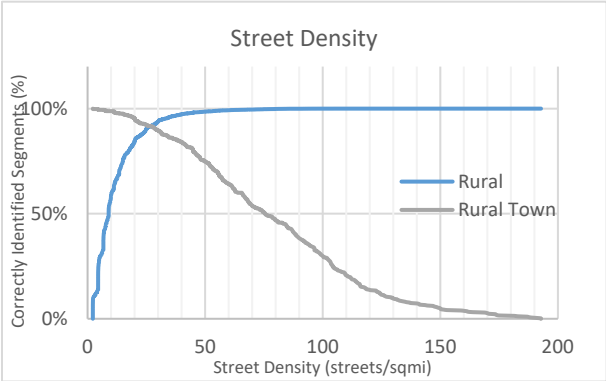


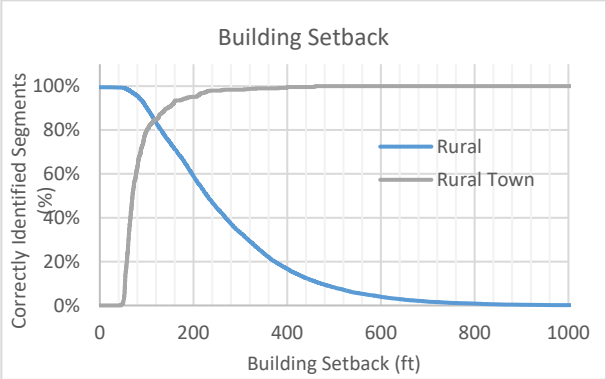




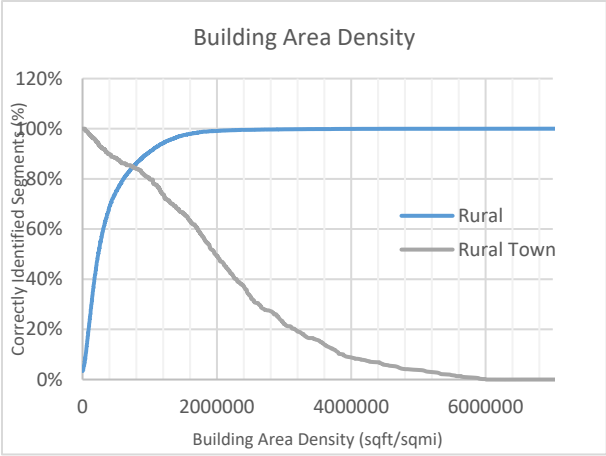


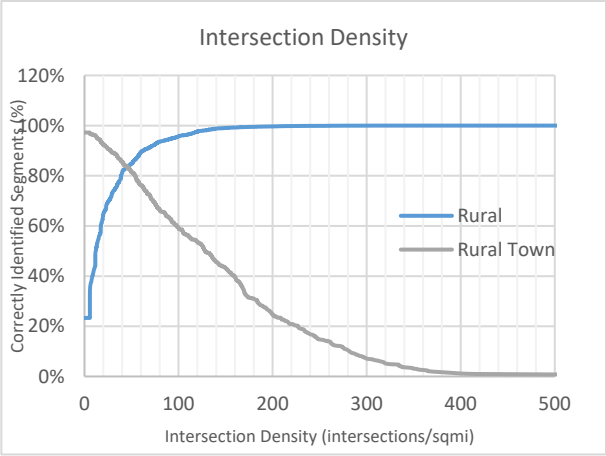


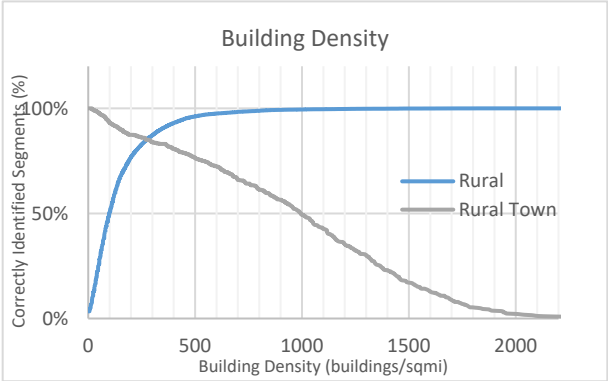


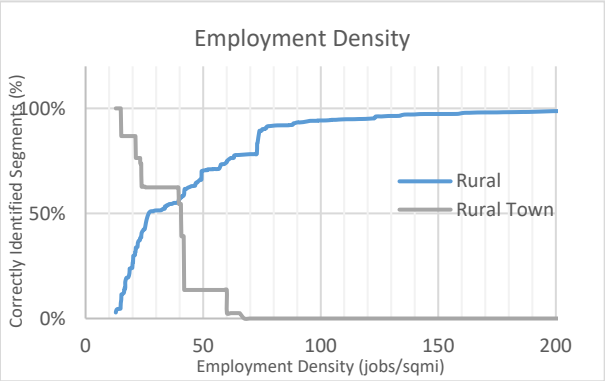


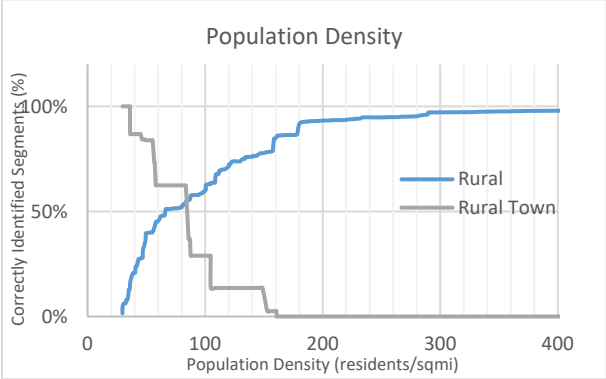
0.50-mile Length x 0.125-mile Buffer

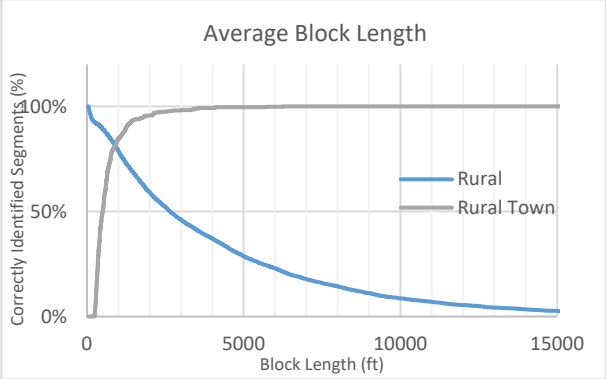


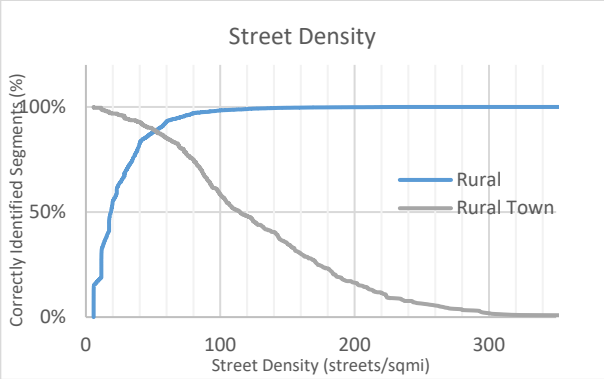


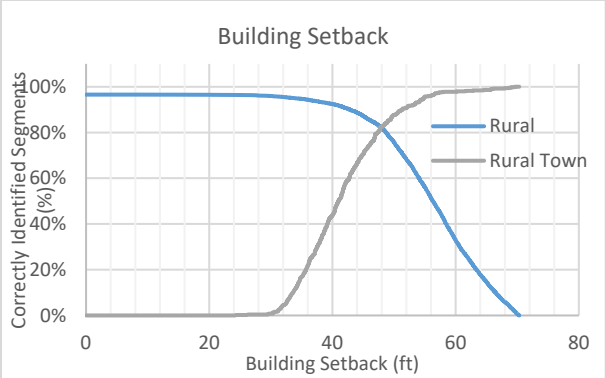

Building Density
Correctly Identified Segments (%)
100%
50%
0%
0
500
1000
1500
2000
Building Density (buildings/sqmi)
Rural
Rural Town


Employment Density
Correctly Identified Segments (%)
100%
50%
0%
0
50
100
150
200
Employment Density (jobs/sqmi)
Rural
Rural Town

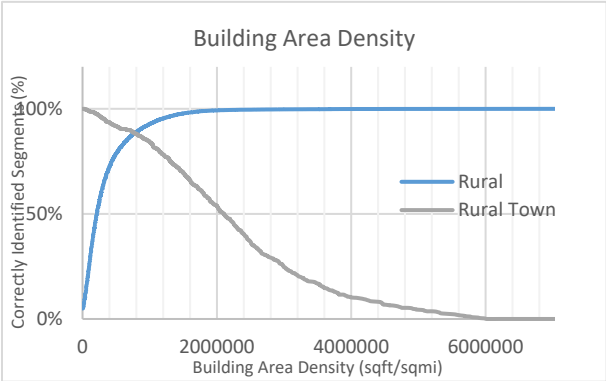

Population Density
Correctly Identified Segments (%)
100%
50%
0%
0
100
200
300
400
Population Density (residents/sqmi)
Rural
Rural Town

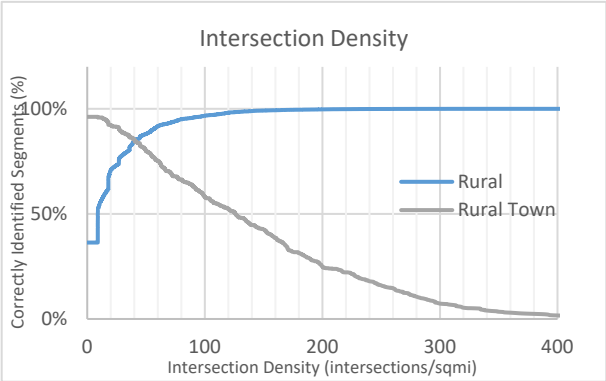

Average Block Length
Correctly Identified Segments (%)
100%
50%
0%
0
5000
10000
15000
Block Length (ft)
Rural
Rural Town

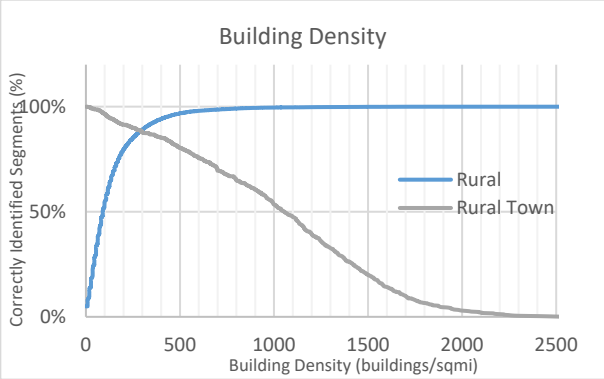

Street Density
Correctly Identified Segments (%)
100%
50%
0%
0
100
200
300
Street Density (streets/sqmi)
Rural
Rural Town

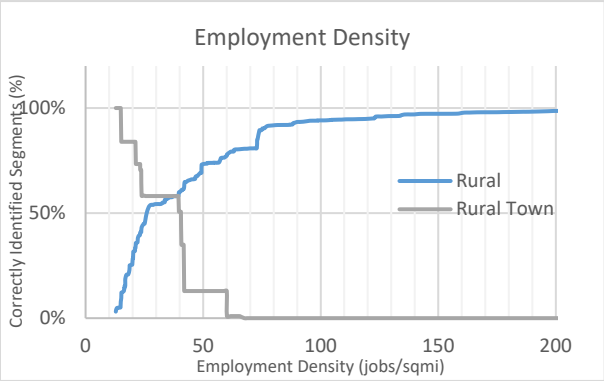

Building Setback
Correctly Identified Segments (%)
100%
80%
60%
40%
20%
0%
0
20
40
60
80
Building Setback (ft)
Rural
Rural Town

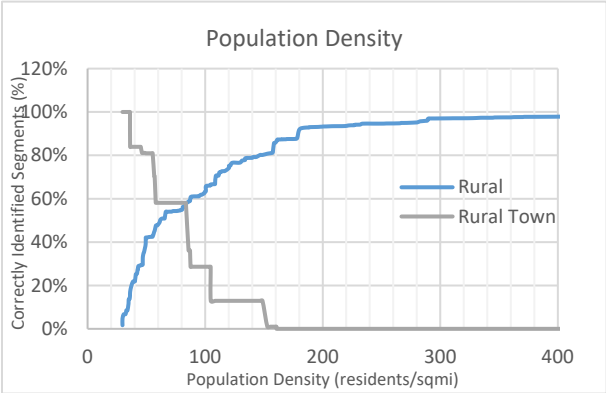
0.25-mile Length x 0.125-mile Buffer

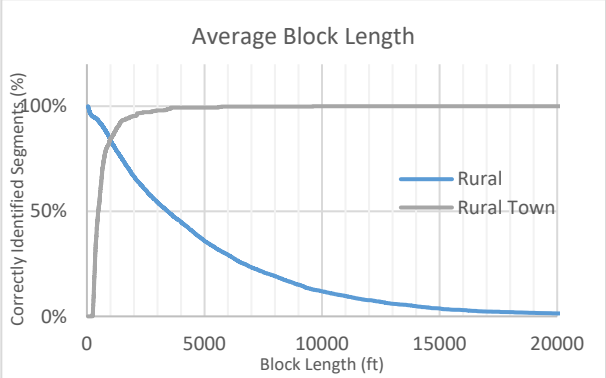


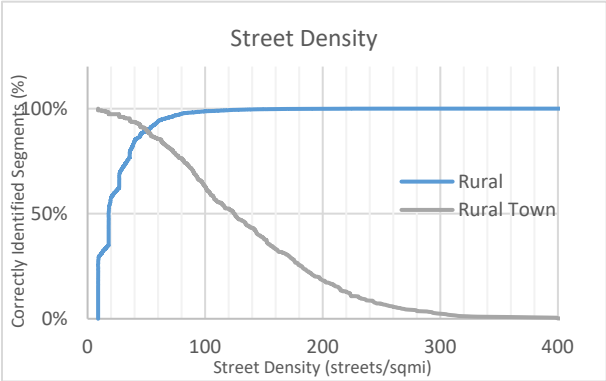


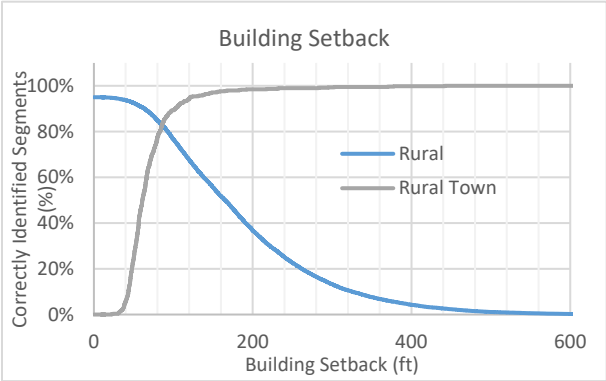












Cluster Analysis Rural/Rural Town Separation

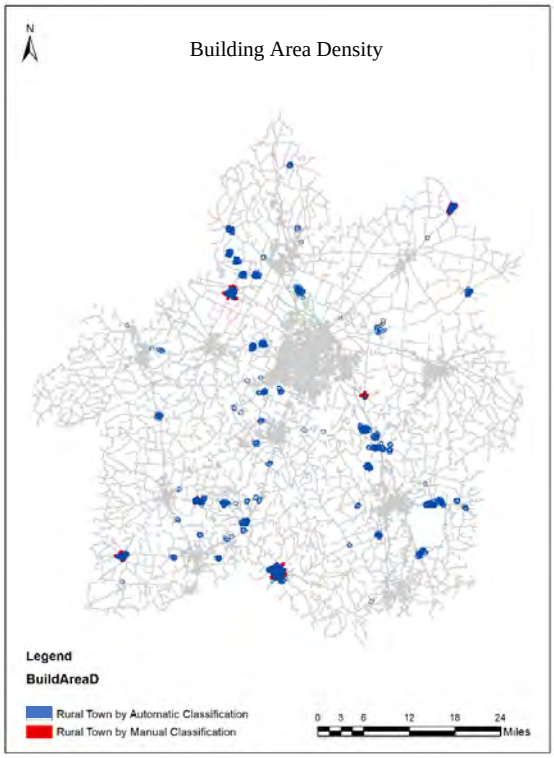
With cluster analysis, threshold levels were increased to minimize the number of Rural roads classified as Rural Town, while still identifying at least one roadway within each Rural Town cluster. Manual review identified the remaining roadways within the Rural Town cluster. To set this threshold, the maximum value was identified for each cluster of Rural Town roadways and the lowest of these maximum values determined. The threshold was then set as the lowest of the maximum values. Setting the threshold at this level allowed for identification of at least one roadway within each of the Rural Town clusters.

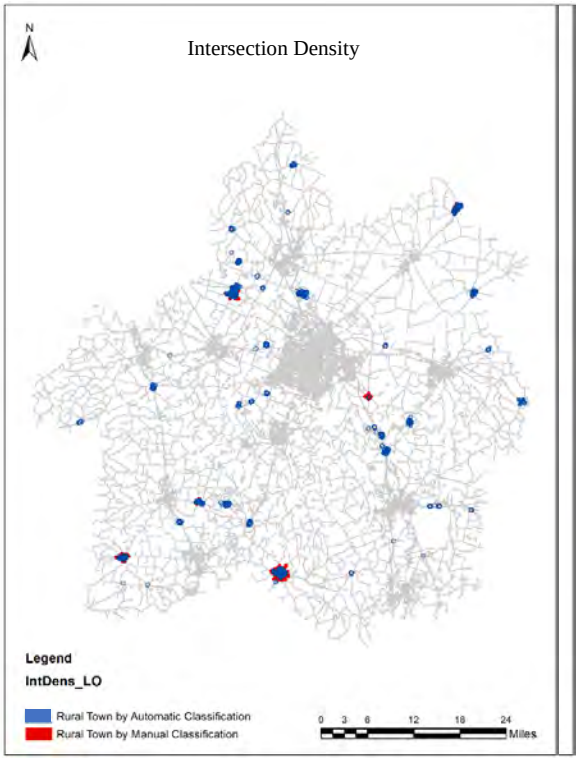
The following plots show analysis for all four scenarios and the summary of the analysis was presented in Table 31. Values in bold denote the highest level of correct classification for each scenario (length x buffer).

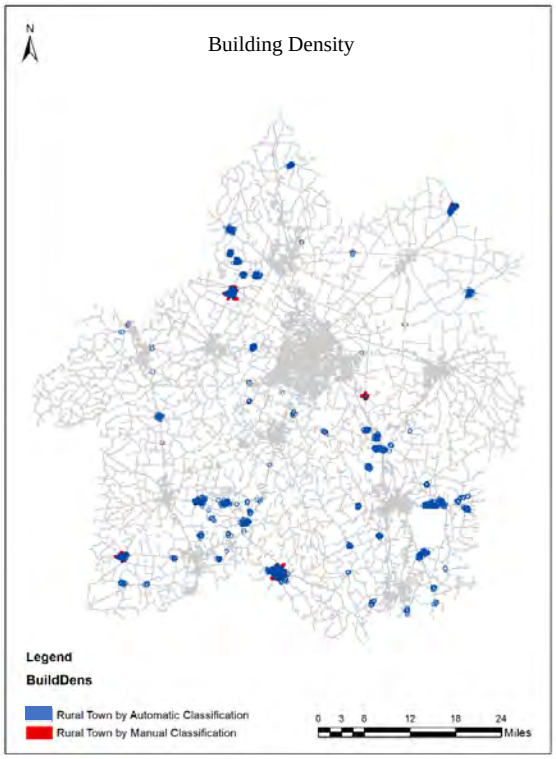
Table 40. Sensitivity cluster analysis for Rural and Rural Town classification

Measure	Length 0.25 mi x Buffer 0.125 mi		Length 0.25 mi x Buffer 0.25 mi		Length 0.50 mi x Buffer 0.125 mi		Length 0.50 mi x Buffer 0.25 mi	
	Thresh.	False +	Thresh.	False +	Thresh.	False +	Thresh.	False +
Population Density	35	Most map	35	Most map	35	Most map	35	Most map
Employment Density	15	Most map	15	Most map	15	Most map	15	Most map
Building Density	710	**25**	290	55	500	65	340	40
Building Area Density (Million)	1.4M	60	0.75M	55	1.1M	80	0.86M	**40**
Street Density	65	120	15	200	80	**50**	20	130
Intersection Density	185	**10**	50	35	135	30	60	25
Block Length	1,150	250	2,090	300	1,030	**150**	2,090	300

0.25-mile Length x 0.25-mile Buffer





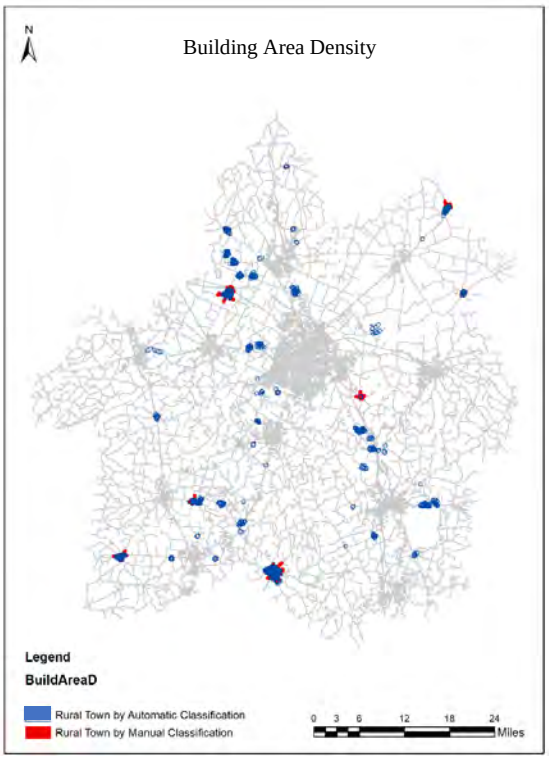


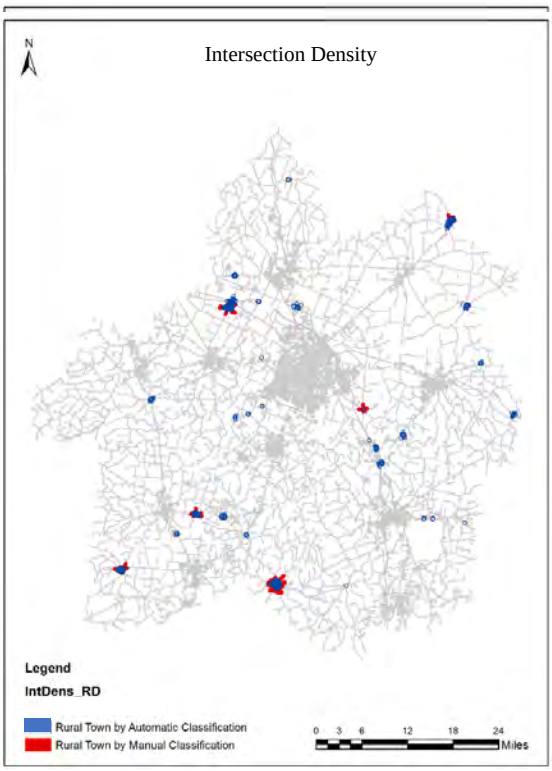

N
Block Length
Legend
Avg_Length
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

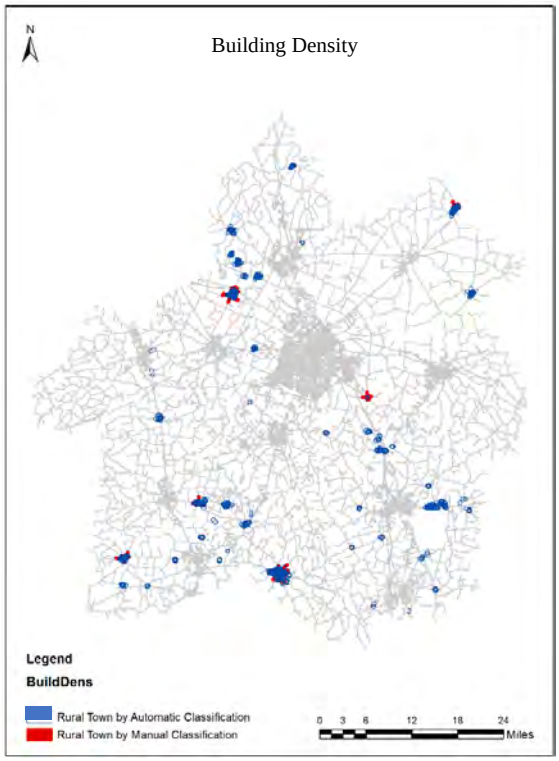

N
Employment Density
Legend
Avg_EmpDen
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles


N
Street Density
Legend
StreetDens
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

0.50-mile Length x 0.25-mile Buffer

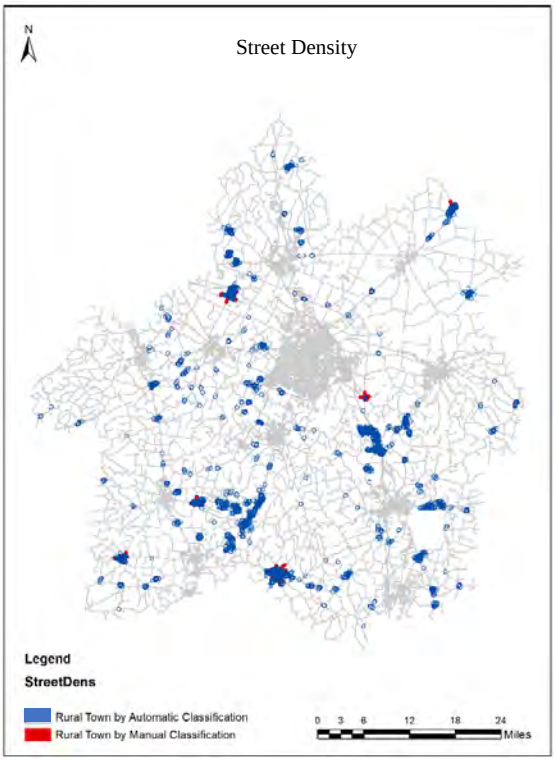




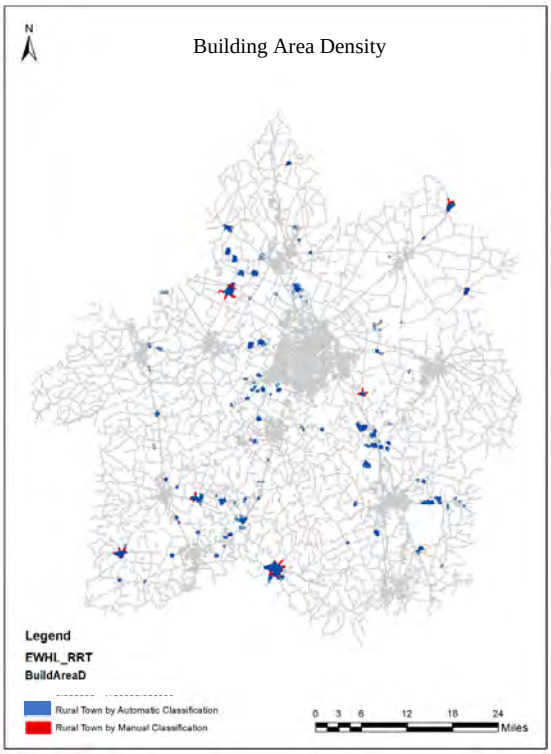


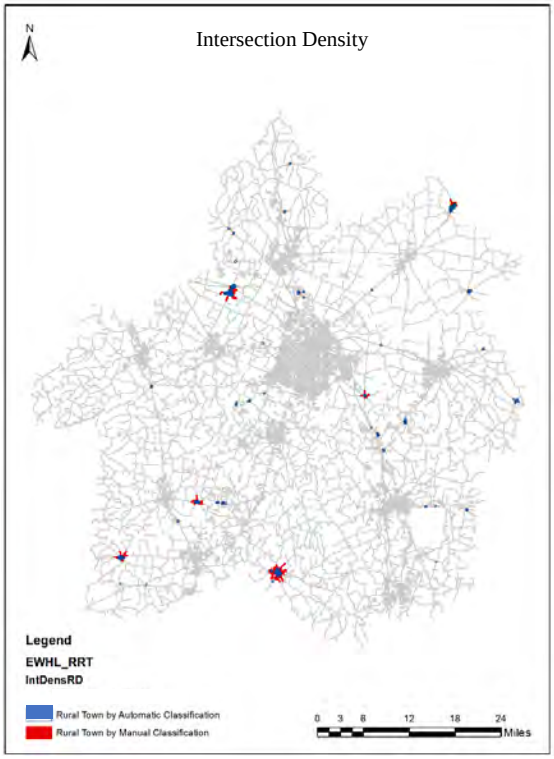

N
Block Length
Legend
Avg_Length
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

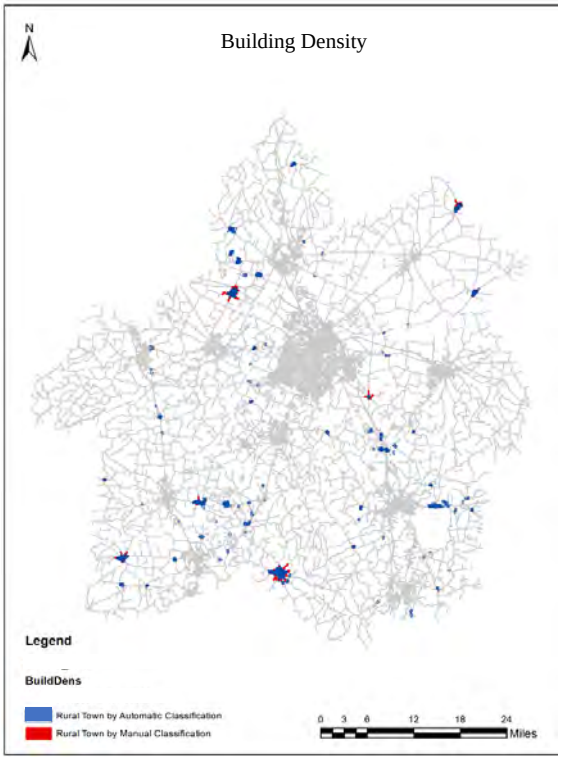

N
Employment Density
Legend
Avg_EmpDen
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

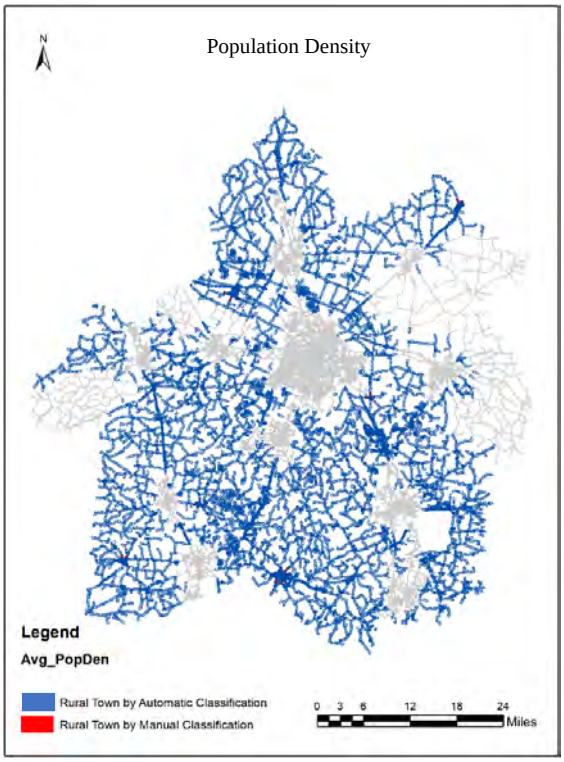

N
Street Density
Legend
StreetDens
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

0.50-mile Length x 0.125 Buffer

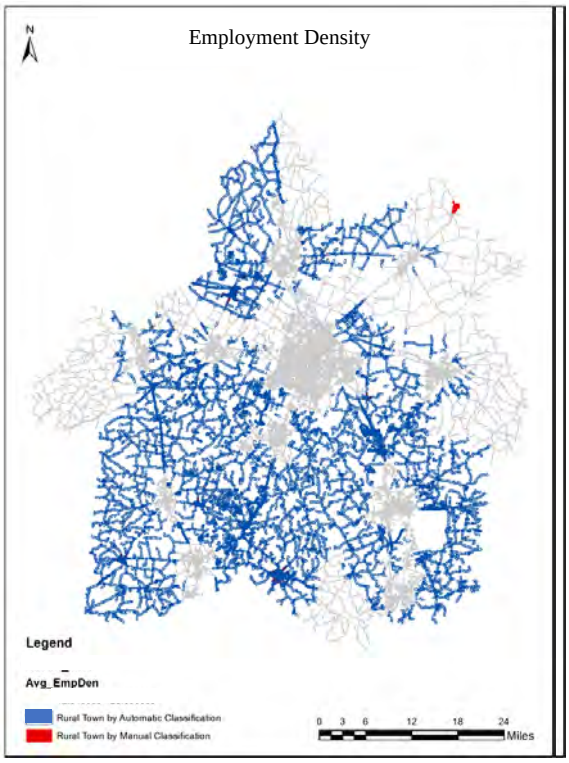


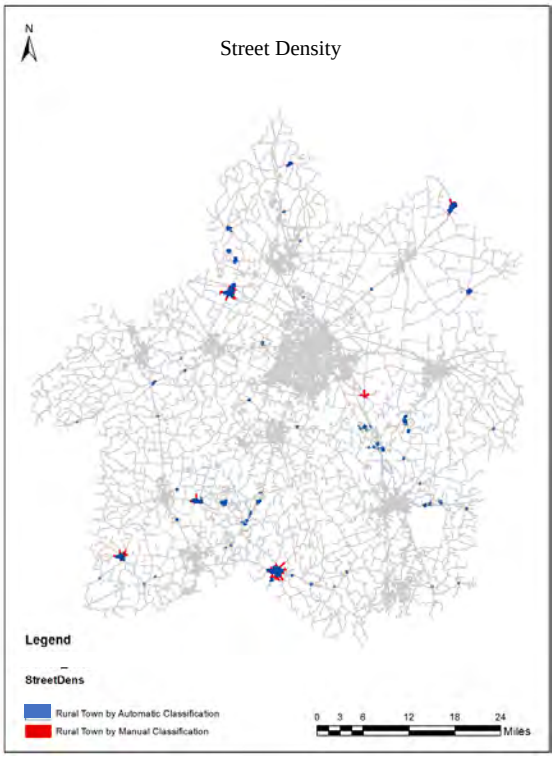




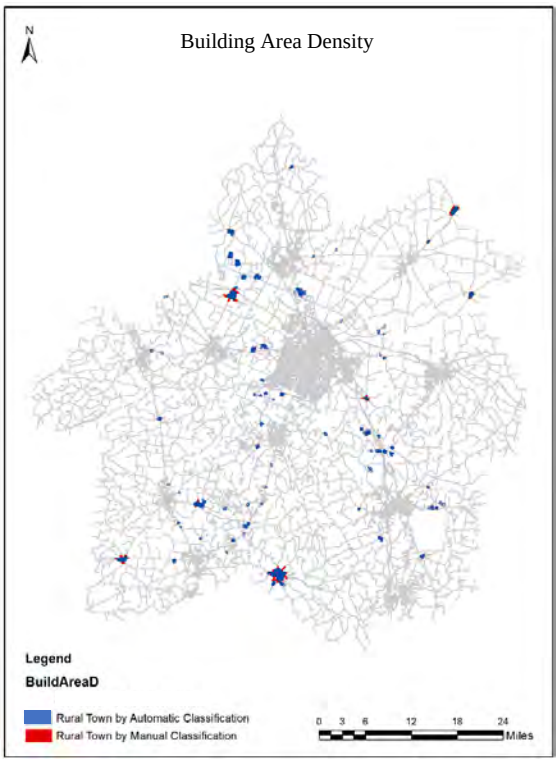


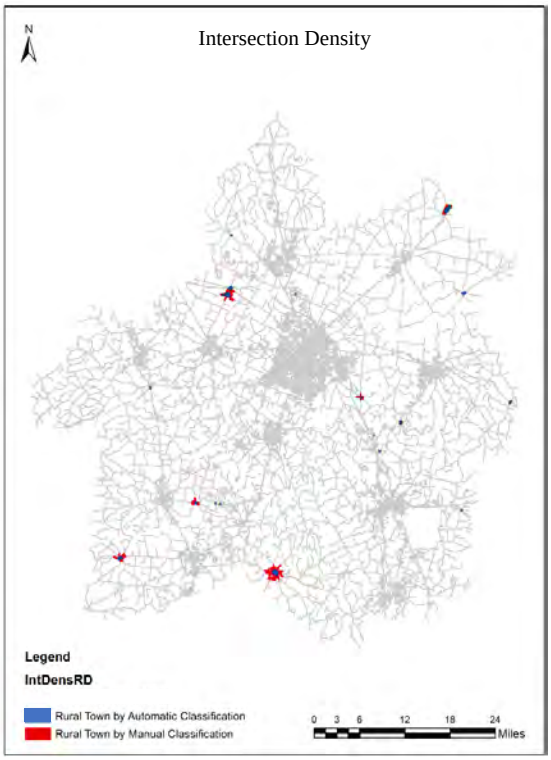

N
Block Length
Legend
Avg_Length
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

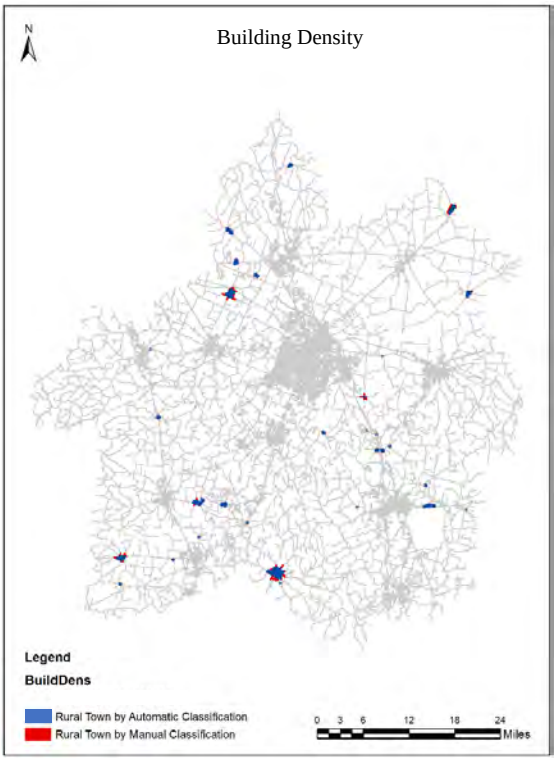

N
Employment Density
Legend
Avg_EmpDen
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

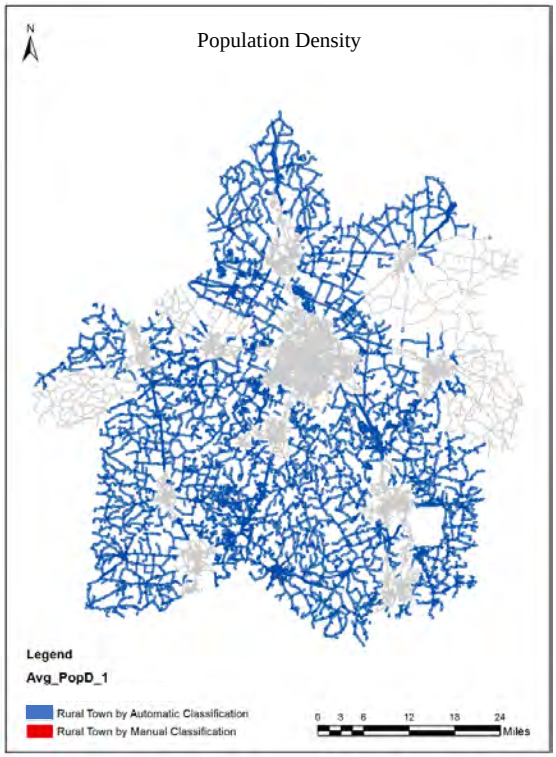

N
Street Density
Legend
StreetDens
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

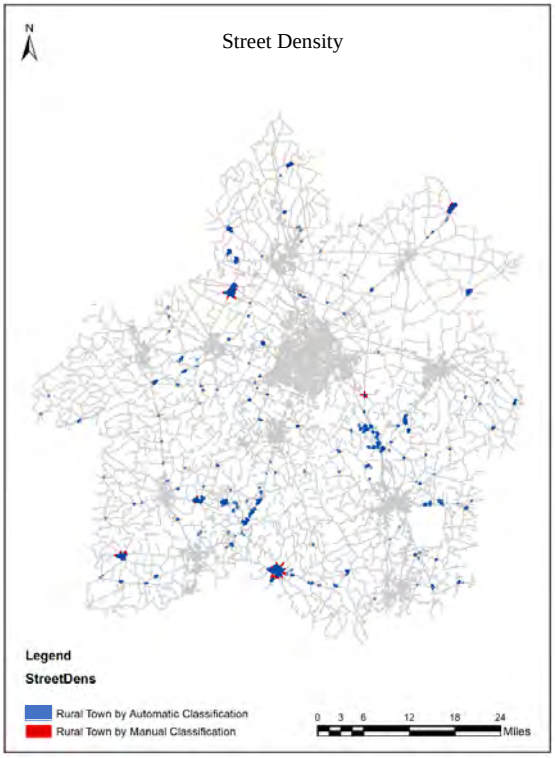
0.25-mile Length x 0.125-mile Buffer










N
Street Density
Legend
StreetDens
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles


N
Employment Density
Legend
Avg_EmpD_1
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles


N
Block Length
Legend
Avg_Length
Rural Town by Automatic Classification
Rural Town by Manual Classification
0 3 6 12 18 24
Miles

0.25-mile Length x 0.125-mile Buffer; Combined Measures