NC 50 CORRIDOR STUDY

PLAYBOOK

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Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina

Capital Area Metropolitan Planning Organization

NC 50 CORRIDOR STUDY

CHAPTER 1

Introduction

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina Capital Area Metropolitan Planning Organization

Introduction

With the support of the NC Capital Area Metropolitan Planning Organization (CAMPO), and NCDOT, a comprehensive study for the NC 50 corridor was prepared. Generally, the study included the identification of short-term needs and the creation of a long-term strategy for the roadway.

Guiding Principles and Vision Statement

One of the most significant products generated during the early phases of the project were the project's Guiding Principles. The Guiding Principles represent a summary of the core philosophy that guided the study process. The *Guiding Principles* were refined and adopted by the Core Technical Team and the Oversight Committee as the following three statements:

- Improve transportation mobility and traffic safety along the corridor
- Preserve the residential and rural nature of the corridor while supporting regional economic development
- Support activities to protect recreation, water quality, and the environment in the Falls Lake watershed

In addition, the project leadership crafted the following vision statement:

It is our responsibility to…

> *"Create a Plan that enhances the safety, mobility, and appearance of the NC 50 corridor, in a manner that promotes quality development, connectivity and economic vitality, while seeking to protect the environment and cultural heritage of the region."*

There were several project deliverables generated during the study process including *three* important documents: the Existing Conditions Report, NC50 Workbook and NC 50 Playbook.

The **Existing Conditions Report** summarizes conditions for transportation, land use, and environment and was made available to participants early in the study process. This investigation revealed the need for an innovative approach that sought to balance the competing interests of land use, the environment, and transportation. As a result, the study embraced the tenants of Context Sensitive Solutions (CSS) - a process that encourages the roadway design to be responsive to the context through which the roadway passes.

The **NC 50 Workbook** was generated near the end of the study after the public outreach and analysis was completed. It addresses general concerns and specific issues identified during the planning process including issues identified during the project symposium and public design charrette. The Workbook catalogs the planning efforts, outlines the issues, and systematically presents recommendations to achieve the community's vision for the greater NC 50 corridor. It also includes a detailed "Action plan" for moving forward with priority projects and planning initiatives.

The **NC 50 Playbook** (this document) is intended to support the other two documents by communicating best practices and serving as a reference guide for the planning and engineering concepts referenced in the other two documents. The Playbook is intended as the primer for citizen planners and local leaders so that they fully understand the intent and motivation associated with the strategy for the NC 50 corridor. In many cases the Playbook directs the reader to where additional information can be found.

The Playbook is not intended to be the vehicle to communicate project specific recommendations (these are clearly expressed in the NC 50 Workbook). The Playbook is a part of a three volume collection of documents that when combined identify the issues and problems, communicates solutions, and provides clear direction for implementing the strategy for the NC 50 corridor. Copies of all three documents are available through CAMPO and online at the following:

www.campo-nc.us

The NC50 Playbook includes chapters on the following:

- Context Sensitive Solutions (CSS)
- Complete Streets
- Connectivity & Collector Streets
- Access Management
- Bicycle, Pedestrian, and Transit Planning
- Smart Growth & Sustainability
- Low Impact Development

While there are many topics and issues that were encountered during the NC50 study process these seven topics represent a core set of philosophies that were embraced during the project or that required some degree of emphasis. The Playbook is not a comprehensive documentation of all planning and engineering elements encountered during the process but rather a primer so that all participants have some understanding of the concepts and best practices both applied during the study as well as those that are recommended as the NC 50 strategy is implemented.

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CHAPTER 2

Context Sensitive Solutions

Prepared By:

Kimley-Horn and Associates, Inc.

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The foundation for successfully linking land use and transportation begins with an understanding of urban form and continues with a commitment to implement context sensitive solutions that preserve the balance between land use and transportation. Along NC 50, urban form generally flows between the natural environment and more suburban and urban scale development.

Context Sensitive Solutions Defined

According to the Federal Highway Administration, "context sensitive solutions (CSS) is a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility. CSS is an approach that considers the total context within which a transportation improvement project will exist."

Context-Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities further explores this definition, identifying CSS as an approach to planning and designing transportation projects that balances the competing interest of diverse stakeholders early in project development and allows flexibility in design to maintain the safety of all users regardless of the travel mode they choose. A common set of tenets for CSS include:

- Balance safety, mobility, community and environmental goals in all projects;
- Involve the public and stakeholders early and continuously;
- Use an interdisciplinary design team tailored to project needs;
- Address all modes of travel;
- Apply flexibility inherent in design standards and guidelines; and
- Incorporate aesthetics as an integral part of good design.

The most detailed guidance for CSS comes from *Context-Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*. This product was a joint effort of the Institute of Transportation Engineers and Congress for the New Urbanism with funding from the USDOT and the U.S. Environmental Protection Agency. Many of the ideas expressed in this chapter of the NC 50 Playbook can be traced to this document.

Elements of CSS

Unsuccessful transportation projects frequently result from not understanding community values and failing to address the concerns of stakeholders. These concerns — whether real or perceived — often include incompatibility with surroundings, impact to the community, placing too much emphasis on mobility, inequitable distribution of benefits or impacts, and lack of public and stakeholder education or involvement.

CSS does not always resolve these issues and concerns. However, a well-conceived approach to transportation planning and design based on the tenets of CSS minimizes the impact of these issues by involving stakeholders early and often in the planning process. Key elements of CSS include:

- A common understanding of the purpose and need of the transportation project;
- Stakeholder involvement at critical points in the project;
- Interdisciplinary team approach to planning and design;
- Attention to community values and qualities including environment, scenic, aesthetic, historic and natural resources, as well as safety and mobility; and
- Objective evaluation of a full range of alternatives.

Principles of CSS

The core CSS principles in regard to transportation processes, outcomes, and decision-making include basing decisions on a shared vision, demonstrating a comprehensive understanding of contexts, maintaining communication and collaboration, and infusing flexibility and creativity in the process and outcome. Collectively, the principles of CSS should be the measuring stick upon which success is judged. Other principles include:

1. The project **satisfies the purpose and needs** as agreed to by a full range of stakeholders. This agreement is forged in the earliest phase of the project and amended as warranted as the project develops.
2. The project is a **safe facility for both the user and the community**.
3. The project is in harmony with the community, and it preserves environmental, scenic, aesthetic, historic and natural resource values of the area, in other words, exhibits **context sensitive design**.
4. The project exceeds the expectations of both designers and stakeholders and achieves a **level of excellence** in people's minds.
5. The project involves **efficient and effective use of the resources** (time, budget and community) of all involved parties.
6. The project is designed and built with **minimal disruption to the community**.
7. The project is seen as having added **lasting value** to the community.

Benefits of CSS

Since the concept was formalized, numerous agencies have turned to CSS due to its numerous benefits. The benefits of CSS, as described by www.contextsensitivesolutions.org, include:

- Solving the right problem by broadening the definition of "the problem" and by reaching consensus before beginning the design process.
- Conserving environmental and community resources.
- Saving time by gaining consensus early.
- Saving money by shortening the project development process and eliminating obstacles.
- Building support from the public and the regulators.
- Helping prioritize and allocate scarce transportation funds in a cost-effective way at a time when needs far exceed resources.
- Group decisions are generally better than individual decisions. Research supports the conclusion that decisions are more accepted and mutually satisfactory when made by all who must live with them.
- Serving the public interest and helping build communities and leaves a better place behind.

Context Sensitive Design

Character Areas

Multiple character areas define the built environment along a given corridor. Each of these areas contains unique design criteria related to scale and enclosure, function, circulation, and furnishings. These typical areas can be described as Natural, Rural, Suburban, and General Urban.

The Natural Character Area includes land with vast greenscapes and very low building density primarily consisting of residential and agricultural land uses. As the landscape moves through Rural and Suburban to the General Urban Character Area, building densities increase, frontages decrease, and a greater mix of land uses appears. Increasingly, land uses include commercial and office designations, and commuters converge onto transportation corridors with added frequency. Each of these four general land categories is accompanied by unique design elements — and while some elements overlap —no one size fits all solution applies.

Design Elements

As auto-dependant development has grown and the consequences of lackluster planning have become apparent, a shift has taken place to realign development to human needs. A return to the concept of general urban, suburban, rural, and natural distinction demands visual cues and supporting features between land types. In transportation corridors, the distinction lies in context-sensitive design through elements such as parking, sidewalks, street trees, and drainage.

Parking

While it may seem contradictory, one of the most important context sensitive design elements is parking. At a time where many developers place parking lots hidden from the public realm behind buildings, it is still important to consider the role of on-street parking in defining space. In a higher-density urban or Traditional Neighborhood Design (TND) area, on-street parking is appropriate and may be used to give definition to a more urban context. On-street parking also may be used in this context to define the boundary between the realms of pedestrian and automotive transportation, and may serve as a physical and visual buffer for pedestrians on the sidewalk. In increasingly rural areas, on-street parking may not be appropriate, as narrower streets are preferred.

Sidewalks

Sidewalks are a necessary element in the urban realm where land use densities are high and many people walk from use to use. In this case, it is appropriate to have sidewalks fronting buildings on both sides of the street. As density increases, the sidewalks become a primary point of activity, and should be accompanied by street furniture such as benches, waste receptacles, media kiosks, and appropriate lighting to serve the needs of the pedestrian and to provide a sense of order. In suburban and rural areas, as building density decreases, pedestrian traffic can be served by a sidewalk on one side of the street, and in some cases, by multi-use paths construction as part of a greenway system. Rural and natural areas are also appropriate locations for trails, which can meander alongside roadways or wind through the landscape. As land use shifts from high-density to lower-density, the appropriate street furnishings will be placed less frequently. However, appropriate lighting is necessary wherever pedestrian traffic is anticipated as a safety provision.

Street Trees

Street trees present an excellent tool in the definition of place and can be used to slow traffic through certain areas. In urban areas, trees may be placed along the street in sidewalk grates, be used to create a sense of enclosure for the street and a buffer to pedestrians. This placement helps distinguish the automotive realm from the pedestrian realm and allows a pleasant break from sunny concrete environments. As land use transitions from urban to suburban areas, planting strips with evenly placed trees are contextually appropriate to cue the gateway from a dense environment to a less urban residential environment. These trees may still serve as a buffer to adjacent sidewalks or multi-use paths, and may be larger in scale than urban street trees. The suburban to rural transition may be supported with serpentine planting, which can provide ample spatial definition while presenting a less ordered appeal. The transition from rural to natural landscape is marked by sporadic planting and primarily natural or agrarian landscapes.

Drainage

An additional element for consideration is drainage. While the curb-and-gutter method is appropriate for urban through suburban contexts, it often is more appropriate to incorporate swale drainage systems into the rural and natural environments. Conversely, it is not appropriate to utilize swale drainage into the more densely populated and paved suburban and urban areas.

Green Streets

The built environment is full of impervious surfaces. Rooftops, roads, sidewalks, and parking lots contribute to stormwater runoff and require various types of mitigation. While roads contribute the most to runoff, they also present the best opportunity to introduce for green infrastructure use.

A key principle of low impact development and context sensitive design involves reducing and treating stormwater close to its source. By integrating stormwater treatment with the natural processes and landscaping, Green Streets address this principle and achieve multiple benefits such as improved water quality and more livable communities. Although the design and appearance of green streets vary, the objective remains the same: *provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, and provide environmentally enhanced roads*.

Benefits of Green Streets

The benefits of Green Streets include cost savings, improved community character, and environmental mitigation. Specifically, these benefits include:

- Clean and cool air and water
- Enhanced neighborhood livability
- Increased community and property values
- Enhanced pedestrian and bicycle access and safety
- Improved pedestrian experience along the street right of way
- Protected surface and groundwater resources
- Additional urban green space and wildlife habitat
- Help with regulatory requirements for pollutant reduction and watershed resource management
- Reduced stormwater in the sewer system
- Cost savings on wastewater pumping and treatment costs
- Enhanced economic development along the corridor

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CHAPTER 3

Complete Streets

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina

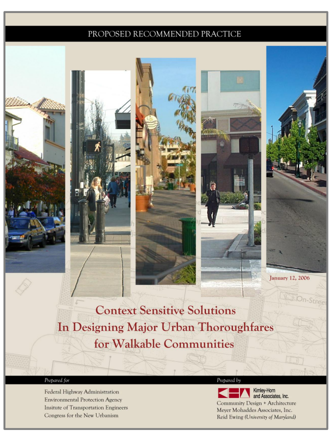
Capital Area Metropolitan Planning Organization

"Complete streets" describes the transformation of vehicle-dominated thoroughfares in urban and suburban areas into community-oriented streets that safely and conveniently accommodate all modes of travel, not just motorists. Inclusion of complete streets in the transportation planning process is a response to public feedback. The general public and stakeholders often express support for these initiative and concern for the inhospitable environment for pedestrians and bicyclists on area roadways. For the NC 50 corridor, complete street initiatives consider the multimodal elements found throughout the plan, including:

- Access management to improve public safety
- Safer and more convenient walkways, sidewalks, and crosswalks
- Safer and more convenient bikeways
- Integration of transit

Implementing Complete Streets

Transforming arterials into complete streets is complicated and requires a diverse range of skill sets and broad support from the community. Fortunately, other metropolitan areas have success stories that have been translated into guiding documents. The most detailed guidance comes from a joint effort of the Institute of Transportation Engineers and Congress for the New Urbanism. With funding from the USDOT and the U.S. Environmental Protection Agency, best practices have been published as *Context-Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*.



Successful complete street transformations require community support and leadership as well as coordination between various disciplines. Common goals for complete streets are economic revitalization, business retention and expansion, and public safety. Typical skill sets needed to retrofit complete streets include urban planning, urban design, landscape architecture, roadway design, utility coordination, traffic engineering, transportation planning, transit planning, architecture, graphic art, and land redevelopment.

Guiding Principles

The most important aspects of a successful complete streets program include:

- Achieving community objectives.
- Blending street design with the character of the area served.
- Capitalizing on a public investment by working diligently with property owners, developers, economic development experts, and others to spur private investment in the area. (A typical return-on-investment of $3 private for every $1 of public investment should be expected. Often, the ratio is 10:1 or more.)
- Designing in balance so traffic demands do not overshadow the need to walk, bicycle, and ride transit safely, efficiently, and comfortably.
- Empowering citizens to create their own sense of ownership in the success of the street and its numerous characters.

Caveats

Street transformations require tremendous effort by numerous stakeholders. Several factors contribute to the success of complete street transformations, including:

- **An interconnected network of major and minor streets with some redundancy in traffic capacity on parallel major streets.** Concern over a loss of traffic capacity can be tempered with surplus capacity elsewhere.
- **A demonstrated and well-defined problem that can be addressed with a complete**

street transformation. The community should agree that the problem demands a solution and enough citizens feel compelled to show up, stand up, and speak up in support. It never will be possible to get everyone to agree with each detail of the new design, but near universal agreement on the problem definition is critical.

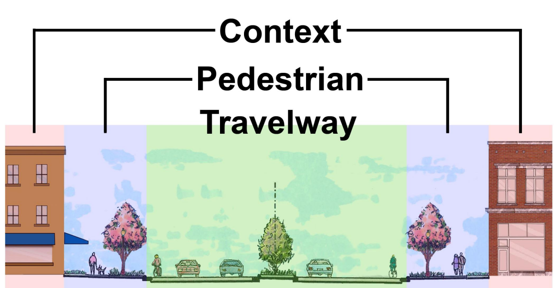
- **A non-profit group to create an agenda for change.** During the early phases of the transformation project, a non-profit group can help facilitate change and participate in design meetings to make sure that designers continue to pursue solutions and decisions that will ultimately achieve the community objective.

Policy Support

Numerous important policy documents should reflect complete street policies or enabling language, including:

- City or county comprehensive plans
- Area plans
- Economic revitalization/ development strategies
- System-level transportation plans
- Corridor-based transportation plans
- Park master plans (if adjacent to corridor)

Street Realms



Four distinct street realms foster interaction between different modes of travel and adjacent land uses. A discussion of this includes how the built environment and ways people travel influence the livability of a corridor. As described on the following pages, complete streets can be viewed in terms of four basic zones or realms: the **context**, **pedestrian**, **travelway**, and **intersection realms**.

Context Realm

The context realm of a complete street is defined by the buildings that frame the major roadway. Identifying distinct qualities of the context realm requires focusing on four areas: building form and massing, architectural elements, transit integration, and site design. Consideration should be given to all of the following, with modifications as appropriate to fit the specific context of the area.

Building Form and Massing

To enhance an already high-quality street design and help create a complete street, new buildings should be located close enough to the street that they frame the public space enjoyed by pedestrians. In more urban areas, these buildings should be located directly behind the sidewalk. Buildings with stairs, stoops, or awnings may even encroach into the pedestrian realm to provide visual interest and access to the public space. Suburban environments that must incorporate setbacks for adjacent buildings should limit this distance to 20 feet or less and avoid off-street parking between buildings and the pedestrian realm.

Larger setbacks in these suburban areas will diminish the sense of enclosure afforded to the pedestrian and move access to the buildings farther away from the street. In both environments, new building heights should measure at least 25% of the corridor width. For example, a 100-foot wide roadway right-of-way should be framed by new buildings that are at least 25 feet high (a typical two-story building) on both sides with facades that are at most 20 feet from the edge of right-of-way.

Architectural Elements

Careful placement and design of new buildings adjacent to the major roadway offer opportunities for meaningful interaction between those traveling along the corridor and those using the corridor for other purposes. These opportunities are greatly enhanced when restaurants, small shops and boutiques, residential units, and offices are located adjacent to the street. Building scale and design details incorporated into individual buildings foster a comfortable, engaging environment focused on the pedestrian. Common building design treatments generally favored in a pedestrian environment include awnings, porches, balconies, stairs, stoops, windows, appropriate lighting, promenades, and opaque windows.

Transit Integration

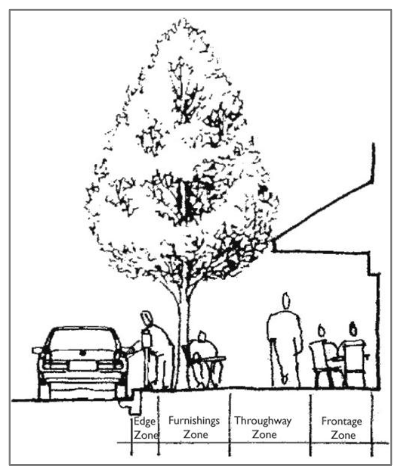
Areas targeted for high-quality transit service must be supported through land use and zoning policies that support transit-oriented development and reflect the benefits of increased access to alternative modes of travel. Policy examples include appropriate densities and intensities for supporting transit use, parking ratios that reflect reduced reliance on the automobile, and setback and design guidelines that result in pedestrian-supportive urban design. In addition, potential transit service identified for transportation corridors within the community should consider the land use, density/intensity, and urban design characteristics of the surrounding environment before selecting proposed technologies or finalizing service plans.

Site Design

The complete street truly is integrated into the surrounding environment when the interface between the site and the street is complementary to the pedestrian environment created along the entire corridor. Access to the site should be controlled through a comprehensive access management program to minimize excessive driveways that create undesirable conflicts for traveling pedestrians. Buildings with entrances facing the street or nearby on the sides of buildings, further defined by interesting landscape and architectural elements incorporated into the entrance area, should reinforce a positive pedestrian experience. Public paths through sites should be provided to shorten blocks longer than 600 feet.

Pedestrian Realm

The pedestrian realm of a complete street extends between the outside edge of sidewalk and the face-of-curb located along the street. Safety and mobility for pedestrians within this realm relies on the presence of continuous sidewalks along both sides of the street built to a sufficient width for accommodating the street's needs as defined by the environment. For example, suburban settings will require different widths than downtown settings. The quality of the pedestrian realm also is greatly enhanced by the presence of high-quality buffers between pedestrians and moving traffic, safe and convenient opportunities to cross the street, and consideration for shade and lighting needs.



The pedestrian realm may consist of up to four distinct functional zones: frontage zone, throughway zone, furnishing zone, and edge zone. The **frontage zone** is located near the back of the sidewalk and varies in width to accommodate potential window shoppers, stairs, stoops, planters, marquees, outdoor displays, awnings, or café tables. The **throughway zone** provides clear space for pedestrians to move between destinations and varies between 6 and 16 feet wide, based on the anticipated demand for unimpeded walking areas. The **furnishing zone** provides a key buffer between pedestrians and moving traffic. It generally measures at least 8 feet wide to accommodate street trees, planting strips, street furniture, utility poles, sign poles, signal and electrical cabinets, phone booths, fire hydrants, bicycle racks, or retail kiosks targeted for the pedestrian realm. The **edge zone** is incorporated into the pedestrian realm concurrent with the presence of on-street parking to allow sufficient room for opening car doors.

Incorporation of one or more of these function zones in the pedestrian realm of a street generally is based on the context of the surrounding built environment. For example, a more urban, downtown environment will include all four zones in the pedestrian realm and could measure up to 24 feet wide. The pedestrian network located in a more suburban setting may omit one or more of the function zones listed above, resulting in an overall minimum width of 11 feet.

Recommended design elements for promoting a healthy pedestrian realm generally focus on one of four areas of concentration: pedestrian mobility, quality buffers, vertical elements, and public open space. Together, these best practices (as described in *Context-Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*) can be implemented in both urban and suburban environments, to varying degrees, for promoting healthy pedestrian environments.

Pedestrian Mobility

The presence of a comprehensive, continuous pedestrian network serves as the foundation for fostering a walkable community that supports active transportation and mode choice. Sidewalks generally provide clear zones of 6 to 8 feet wide to accommodate pedestrian travel. In more urban environments, amenities in the frontage zone and furniture zone will greatly increase the overall width of the corridor when compared with more suburban settings. Mid-block pedestrian crosswalks should be incorporated into the urban fabric as needed to ensure convenient crossing opportunities are provided approximately every 300 feet for maximum efficiency and safety within the pedestrian system. As a general rule, mid-block crossings should be considered on two-lane urban streets when the block length is greater than 500 feet and the posted speed limit for the travel lanes does not exceed 40 miles per hour.

Quality Buffers

Providing separation between pedestrians and moving traffic greatly enhances the character of the pedestrian realm. The amount of separation incorporated into the pedestrian realm may vary based on the building context or on streets with different travel speed and/or traffic volume characteristics. In downtown areas, parallel or angled on-street parking provides sufficient distance (8 to 18 feet) for separating pedestrian and vehicle traffic. Likewise, landscape planting areas (typically 5 feet wide) incorporated into urban or suburban environments provide adequate lateral separation for pedestrians. In urban areas, street trees may be placed in tree wells within an overall hardscaping surface instead of using suburban-style grass areas.

Vertical Elements

Vertical elements traditionally incorporated into the pedestrian realm include street trees, pedestrian-scale street lighting, and utilities. Street trees provide necessary shade to pedestrians and soften the character of the surrounding built environment. Trees should be spaced 15 to 30 feet apart, be adapted to the local environment, and fit the scale and character of the surrounding area. Pedestrian-scale street lighting incorporated into the pedestrian realm should consider metal halide fixtures mounted 12 to 20 feet high. Metal halide produces a truer, white-light compared with bluish light produced by Mercury vapor streetlights or yellow-orange produced by sodium streetlights. Metal halide streetlights produce lighting conditions where faces more easily can be recognized and the perception of public safety and security is enhanced. Utilities should not interfere with pedestrian circulation or block entrances to buildings, curb cuts, or interfere with sight distance triangles. In some cases, burying utilities underground avoids conflicts and clutter caused by utility poles and overhead wires. However, relocation of overhead utilities to tall poles on just one side of the roadway can be a cost-effective aesthetic alternative to burial of utilities in a duct bank under the road.

Public Open Space

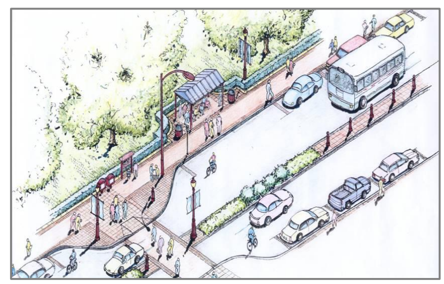
The pedestrian realm serves a dual purpose within the built environment, acting as both a transportation corridor and a public open space accessible to the entire community. As a result, specific design elements incorporated into the pedestrian environment should reinforce this area as a public space. Properly planned, these design elements could provide opportunities for visitors to enjoy the unique character of the corridor in both formal and informal seating areas. Public art and/or specialized surfaces and materials introduced into the pedestrian realm are appreciated by slower moving pedestrians. In more urban areas, street furniture and/or outdoor cafes provide opportunities that foster community ownership in the pedestrian realm, such as people watching. Furthermore, building encroachments in downtown areas, such as stairs and stoops, provide interesting points of access to the pedestrian realm. Lastly, awnings and canopy trees provide shade, which is a welcomed relief during the summer.

Travelway Realm

The travelway realm is defined by the edge of pavement or curb line that traditionally accommodates the travel or parking lanes needed to provide mobility for bicycles, transit, and automobiles sharing the transportation corridor. Recommended design elements incorporated into the travelway realm attempt to achieve greater balance between travel modes sharing the corridor and favor design solutions that promote human scale for the street and minimize pedestrian crossing distance. Recommendations for the travelway realm focus on two areas of consideration: modes of travel and medians.

Multimodal Corridors

Balance between travel modes within the same transportation corridor fosters an environment of choice for mobility that could lead to reduced congestion on major roadways and a healthier citizenry. On a complete street, safe and convenient access to the transportation network for bicycles, transit, and automobiles is afforded within the travelway realm. Travel lanes for automobiles and transit vehicles should measure between 10 and 11 feet wide, depending on the target speed, to manage travel speeds and reinforce the intended character of the street. Parking lanes incorporated into the travelway realm should not exceed 8 feet in width (including the gutter pan) and may be protected by bulb-outs evenly spaced throughout the corridor. Bus stops located along the corridor should be well-designed to include benches and shelters that comfort patrons waiting for the bus. On-street bicycle lanes (typically 4 feet wide) should be considered when vehicle speeds range from 35 to 45 miles per hour. Wide outside lanes may be preferred on other streets. To avoid situations where citizens with only basic bicycle skills may be attracted to a corridor, designated bicycle routes on parallel corridors may be the best option when speeds on the major street exceed 45 mph. According to state law, bicyclists are considered vehicles and are permitted on all corridors except freeways and access-controlled highways.



Median Treatments

Medians often are incorporated into the travelway realm to provide dedicated left-turn lanes, opportunities for landscaping, and pedestrian refuge at crossings. Medians generally vary between 8 and 16 feet wide, depending on their intended application and the limitations of the surrounding built environment. Medians also reinforce other access management solutions provided within the travelway to reduce the number of conflict points and maintain the human scale intended for the complete street.

In addition to center medians, other access management solutions incorporated into the travelway realm should limit the number of individual driveways along the corridor and avoid the use of right-turn deceleration lanes. Together, these improvements will reduce the overall pedestrian crossing distance for the travelway and improve the safety for pedestrians traveling inside the pedestrian realm.

Intersection Realm

Evaluating potential changes for the intersection realm of a street requires careful consideration of the concerns of multiple travel modes that could meet at major intersections within the transportation system. Recommendations for improving the multimodal environment in and around these major intersections focus on two areas of the facility: geometric design and operations.

Geometric Design

Geometric design of an urban intersection should reinforce the operational characteristics of a traffic signal or roundabout. With traffic signals, this includes the introduction of curb extensions, or bulb-outs, to shorten pedestrian crossing distance and protect on-street parking near the intersection. Curb return radii designed for signalized intersections should be 15 to 30 feet to control turning speed around corners. At roundabouts, special consideration should be given to entry and exit speeds, pedestrian refuge in the splitter islands, and assigning predictability to the intersection for pedestrians, bicycles, and vehicles. Both intersection treatments may consider special pavement markings to distinguish pedestrian areas or bicycle lanes, although these surfaces need to be stable, firm, and slip resistant. Additional consideration should be given to maintaining adequate sight triangles in the intersection, addressing the treatment of bicycle lanes through the intersection, and compliance with federal requirements per the American with Disabilities Act for crosswalk and curb ramp design.

Operations and Safety

In terms of operations, traffic signals or roundabouts are the two most appropriate applications for traffic control devices that also could maintain the pedestrian scale of the street reinforced in the context, pedestrian, and travelway realms. The merits of a traffic signal rather than a roundabout for intersection control should be determined on a case-by-case basis after considering key issues such as desired traffic speed, availability of right-of-way, anticipated traffic patterns, and the context of the built environment surrounding the intersection. In general, small signalized intersections may be safer for pedestrians than roundabouts. However, studies of intersection widening always should consider a roundabout. Crash histories support the premise that roundabouts typically have less injury-inducing crashes than large signalized intersections. Furthermore, the slower vehicle speeds associated with most roundabouts result in less injury-inducing crashes when pedestrians are hit by a vehicle.

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CHAPTER 4

Connectivity and Collector Streets

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina
Capital Area Metropolitan Planning Organization

Street connectivity involves establishing a network of streets that forms a grid pattern, providing multiple routes and connections to get to origin and destination points. In well-designed transportation networks, adequate street connectivity results from a mixture of different sized streets such as arterials, collectors, and locals.

General Connectivity

Connectivity refers to the density of connections in path or road network and the directness of links. A well-connected road or path network has many short links, numerous intersections, and minimal dead-ends (cul-de-sacs). As connectivity increases, travel distances decrease and route options increase, allowing more direct travel between destinations, creating a more accessible and resilient system. Connectivity can apply both internally (streets within a given area) and externally (connections with arterials and other neighborhoods).

Experts debate the relative benefits of different street patterns, particularly **grid** (highly connected streets that mostly are long and straight as well as parallel or perpendicular), **modified grid** (highly connected streets that are short and connect at right angles), or a **hierarchical network** (poorly connected streets that are most smaller residential streets with cul-de-sacs or connected to larger, higher-volume arterials).

A well connected area includes parallel routes and cross connections, few dead-end streets, and many points of access. Frequent intersections create block lengths suitable to walking, bicycling, and using transit. This contrasts with the cul-de-sac pattern of streets typical of many developments in recent decades with very long block lengths, numerous cul-de-sacs, and limited connectivity to the rest of the road network. The arterials onto which traffic funnels in these developments typically are designed without accommodations for pedestrians and bicyclists and can encourage higher traffic speeds than a network with more connectivity.

Barriers to Street Connectivity

Natural and manmade barriers — such as rivers, highways and major arterials — create barriers to local motorized and non-motorized travel. Design strategies can help improve connectivity across such barriers, including special bridges, decking over major roadways, and creating Pedways, which are walking networks within major commercial centers that connect buildings and transportation terminals (Savvides, 2005).

Efforts to increase roadway connectivity also must overcome the common consumer preference for residential cul-de-sac streets. The popularity of cul-de-sacs is based in part on such as a street's limited traffic volumes and speeds and its contribution to a sense of community and security. More connected residential streets can have these attributes if designed with short blocks, "T" intersections, narrower widths or if they employ other traffic calming features to control vehicle traffic speeds and volumes and community design features to promote a sense of community and security.

Benefits of Street Connectivity

The benefits of street connectivity extend beyond benefits specifically tied to the transportation network and include public works, economic vitality, and livability. These benefits include:

- A traditional interconnected street network absorbs and diffuses traffic rather than concentrating it in one location
- This network outperforms a conventional disconnected street pattern as all streets are used more efficiently. This system

creates balanced demand, rather than the overuse of some streets and the underuse of others

- Street connectivity reduces emergency response time and aids in evacuation procedures
- Vital public and private services, such as postal, sanitation, and bus service, are delivered more efficiently
- Connected streets facilitate the looping of water lines, which improves water flow and reduces water quality problems
- Variety, choice and convenience to the traveler are provided through the opportunity of using multiple routes
- Street connectivity greatly enhances the mobility of pedestrians and bicyclists
- A connected network of streets increases social capital, a sense of community, and civic awareness by increasing interaction between neighbors
- Air quality is improved through reduced vehicular trip lengths and the reduction in vehicle emissions

Best Practices for Street Connectivity

The importance of street connectivity is well documented and progressive communities across the nation promote its application, even if environmental constraints or land preservation efforts (i.e. cluster design development) preclude certain street connections. The following best development practices enhance the connectivity of the transportation system.

- Requiring all new residential subdivisions in relatively undeveloped areas smaller than 100 dwelling units to include at least one stub-out street to extend and connect with future development.
- Requiring all new residential subdivisions larger than 100 dwelling units to include at least two access points from publicly maintained streets as part of the development review process.
- Requiring all new residential subdivisions in relatively undeveloped areas larger than 100 dwelling units to include at least two stub-out streets to extend and connect with future development.
- Requiring a traffic impact study, prepared by a professional engineer, to accompany all development applications that could generate more than 100 peak hour trips or 1,000 average daily trips, or any other development deemed necessary by the Developmental Services Director for review.

Collector Streets

The role of a collector street in a balanced transportation system is to collect traffic from neighborhoods and distribute it to the network of arterials. As such, these streets provide relatively less mobility but higher overall accessibility compared to higher level streets. The lower design speeds and multimodal amenities also make these streets attractive for bicyclists and pedestrians. The proper design and spacing of collector streets is critical to ensuring a balanced transportation network.

Policy Considerations

The design of the collector street network must respect present and future conditions, the public's vision for the future, and how the network best can balance the natural environment, connectivity, access, mobility, and safety.

Natural Environment

The presence of water features such creeks, rivers, lakes, and wetlands creates significant challenges for local planners. The geography of the land impacts land use and transportation decisions and affects how the community grows (via suitable land and potential for water and sewer connections), where streets can be constructed and maintained, and where connections between streets can be made. Collector streets, as part of the development process, must respect the natural environment.

Street Spacing and Access

Local officials also must consider street spacing guidelines that promote the efficient development of an expanding transportation system. Ultimately, these guidelines could be referenced during the development review process. Different spacing standards are necessary for different development types and intensities. Understanding this principle, a theoretical model largely influenced by land use intensity ranges shows the desired collector street spacing for different intensities (see the table below). In addition to these recommended street spacing standards, individual driveway access to collector streets should be limited to local streets when possible.

Collector Street Spacing Standards

Land Use /Type of Collector Street	Intensity (dwelling units per acre)	Access Function	Approximate Street Spacing
Very Low Intensity Residential	Less than 2	High	3,000 to 6,000 feet
Low Intensity Residential	2 to 4	High	1,500 to 3,000 feet
Medium and High Intensity Residential	More than 4	High	750 to 1,500 feet
Activity Center	Mixed-use	Medium	750 to 1,500 feet

Land Use Intensity	Very Low Intensity	Low Intensity	High Intensity
			
Street Spacing	3,000' to 6,000'	1,500' to 3,000'	750' to 1,500'

Design Elements

As most communities' largest collection of public space, streets need to reflect the values of the community and reinforce a unique "sense of place" to be enjoyed by citizens — whether in urban, suburban, or rural contexts. This is especially true for a collector street system that serves as the backbone for local mobility, property access, and non-vehicular transportation modes.

Recently, municipalities across the country have started implementing complete streets (see Chapter 3 of the Playbook) as one way to transform transportation corridors from vehicle-dominated roadways into community-oriented streets that safely and efficiently accommodate all modes of travel, not just motor vehicles. The complete street movement does not advocate a one size fits all approach — a complete street in an urban area may look quite different from a complete street in a more rural area. However, both facilities are designed to balance mobility, safety, and aesthetics for everyone using the travel corridor. Furthermore, design considerations supportive of complete streets include elements in both the traditional travel corridor (i.e., the public realm) as well as adjacent land uses (i.e., the private realm) for reinforcing the desired sense of place.

Street Design Considerations

As the public realm, streets need to reflect the values of the community and reinforce a unique sense of place to be enjoyed by citizens — whether in urban, suburban, or rural contexts. This is especially true for a collector street system in that it serves as the backbone for local mobility, property access, and non-vehicular transportation modes.

Typical Collector Streets

Several types of collector streets can be incorporated into the development review process. The application of a given type to a specific development scenario largely will depend on the adjacent land use, access control, and the type of facility that it is connecting.

It is important to note that best practices for collector streets must receive design approval prior to their implementation if they will be maintained by the North Carolina Department of Transportation. Three general categories for collector streets within the community include residential, commercial, and industrial.

Residential Collectors

Residential collector streets primarily serve residential land uses and associated traffic. These streets potentially are popular for walking and bicycling and could be incorporated into comprehensive community pedestrian and bicycle plans. Context sensitive street design is essential for residential collectors to prevent excessive travel speeds. Design elements recommended to reinforce the residential character of these streets include:

- Pedestrian facilities both sides of the street (i.e., sidewalk or multiuse path)
- Street trees
- Lighting (i.e., pedestrian scale)
- Left-turn lanes at major intersections
- Traffic calming (as necessary)
- Small curb radii at intersections
- Ten- or eleven-foot travel lanes
- Striped bicycle lanes

Although roadway capacity is not a primary focus for residential collector streets, appropriate intersection treatments are important to the overall functionality of the street. Exclusive left-turn lanes should be considered where residential collector streets intersect arterial roadways. Mini-roundabouts should be considered at collector-to-collector intersections. Intersections with local streets generally would not require exclusive left turn lanes. All decisions for providing left turn lanes should be made on a case-by-case basis by the local Engineer.

Commercial Collectors

Commercial collector streets primarily serve commercial/office land uses, but the recommended street design standards for commercial collector streets may be appropriate for areas transitioning between residential and nonresidential land uses. These streets have the potential to attract moderate traffic volumes and could experience excessive travel speeds. Context sensitive street design is essential for commercial collectors to prevent these streets from becoming popular cut-through traffic routes, resulting in an increase in concerns associated with excessive travel speeds. Design elements recommended to reinforce the commercial character of these streets include:

- Pedestrian facilities (i.e., sidewalk or multiuse path)
- Curb and gutter drainage system
- Street trees
- Street lighting (i.e., vehicle and pedestrian scale)
- On-street parking (where appropriate)
- Left-turn lanes at major intersections
- Traffic calming (as necessary)
- Small curb radii at intersections
- Intersection bulb-outs
- Centerline striping

Industrial Collectors

Industrial collector streets primarily serve light and heavy industrial land uses and uses that have a high potential for attracting high volumes of heavy vehicle traffic. Design elements recommended to reinforce the industrial character of these streets include:

- Pedestrian facilities (case-by-case basis)
- Street trees
- Street lighting (case-by-case basis)
- Left-turn lanes at major intersections
- Large curb radii at intersections
- Intersection bulb-outs
- Centerline striping

In some cases, the application of classification criteria (i.e. residential, commercial, or industrial) will result in a street being included in more than one category. In these situations, consensus building may be necessary to appropriately classify the street. A collector street plan should be based on classification criteria, spacing, and access guidelines; street connectivity guidelines; and quantitative/qualitative characteristics for the existing and proposed transportation system. The new facilities identified in the figure show general alignment and intersections. However, the ultimate placement of new collector streets should be flexible enough to account for unique social, environmental, and constructability issues associated with these corridors.

NC 50 CORRIDOR STUDY

CHAPTER 5

Access Management

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina Capital Area Metropolitan Planning Organization

According to the FHWA, access management "provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed." The Access Management Manual states that access management results from a cooperative effort between state and local agencies and private land owners to systematically control the "location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway."

The ability of motorists to travel through a given roadway segment is essential for both transportation system efficiency and economic development. Access management balances the needs of motorists using a roadway with those of adjacent property owners dependent upon access to the roadway. With poor access management, the function and character of major roadways can deteriorate and adjacent properties can suffer from declining property values and high turnover. This concern is greatest along developed (or developing) corridors such as NC 50. The limited funds available for transportation investments make access management an even more important consideration. Chapter 8 of the NC 50 Project Workbook describes the preferred access plan for the corridor

Access Management Overview

Poor access management directly affects the livability and economic vitality of commercial corridors, ultimately discouraging potential customers from entering the area. A corridor with poor access management lengthens commute times, creates unsafe conditions, lowers fuel efficiency, and increases vehicle emissions. Corridors with poor access management often have increased crashes between motorists, pedestrians, and cyclists; worsening efficiency of the roadway; congestion outpacing growth in traffic; spillover cut-through traffic on adjacent residential streets; and limited sustainability of commercial development. The table below describes a few of the benefits of access management.

Benefits of Corridor Access Management

User	Benefit
Motorists	• Fewer delays and reduced travel times • Safer traveling conditions
Bicyclists	• Safer traveling conditions • More predictable motorist movements • More options in a connected street network
Pedestrians	• Fewer access points and median refuges increase safety • More pleasant walking environment
Transit Users	• Fewer delays and reduced travel times • Safer, more convenient trips to and from transit stops in a connected street and sidewalk network
Freight	• Fewer delays and reduced travel times lower cost of delivering goods and services
Business Owners	• More efficient roadway system serves local and regional customers • More pleasant roadway corridor attracts customers • Improved corridor aesthetics • Stable property values
Government Agencies	• Lower costs to achieve transportation goals and objectives • Protection of long-term investment in transportation infrastructure
Communities	• More attractive, efficient roadways without the need for constant road widening

Access Management Strategies

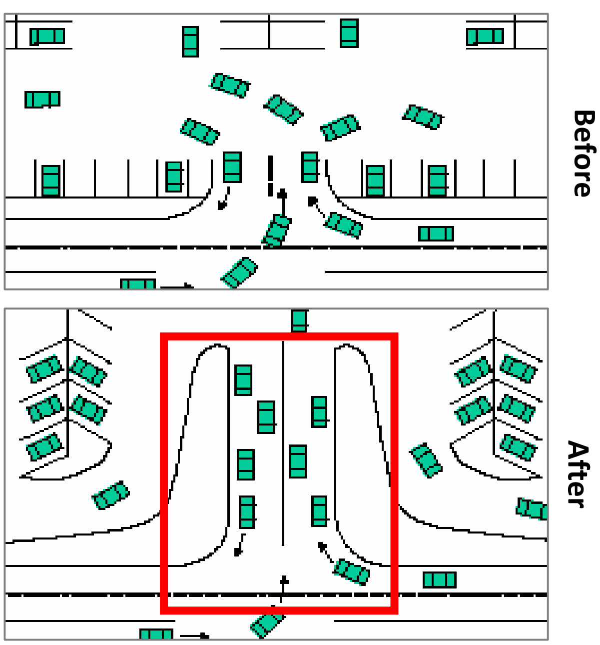
Site Access Treatments

Improvements that reduce the total number of vehicle conflicts should be a key consideration during the approval of redeveloped sites along corridors identified for access management programs. Site Access Treatments include:

- Improved On-Site Traffic Circulation
- Number of Driveways
- Driveway Placement/Relocation
- Cross Access

Improved On-Site Traffic Circulation

One way to reduce traffic congestion is to promote on-site traffic circulation. Pushing back the throat of an entrance (as shown in the figures below) helps to avoid spillback onto the arterial. This action improves both the safety and efficiency of the roadway. A minimum separation of 100 feet should be provided to prevent internal site operations from affecting an adjacent public street, ultimately causing spillback problems. Approximate construction cost varies and usually is the responsibility of private development.



Driveway Throat

Number of Driveways

Only the minimum number of connections necessary to provide reasonable access should be permitted. For those situations where outparcels are under separate ownership, easements for shared access can be used to reduce the number of necessary connections. Reducing the number of access points also decreases the number of conflict points, making the arterial safer and more efficient. Approximate construction cost varies and is usually the responsibility of private development.

Driveway Placement/Relocation

Driveways located close to intersections create and contribute to operational and safety issues. These issues include intersection and driveway blockages, increased points of conflict, frequent/unexpected stops in the through travel lanes, and driver confusion as to where vehicles are turning. Driveways close to intersections should be relocated or closed, as appropriate. As a best planning practice, no driveway should be allowed within 100 feet of the nearest intersection.

Cross Access

Cross access is a service drive or secondary roadway that provides vehicular access between two or more continuous properties. Such access prevents the driver from having to enter the public street system to travel between adjacent uses. Cross access can be a function of good internal traffic circulation at large developments with substantial frontage along a major roadway. Similarly, backdoor access occurs when a parcel has access to a parallel street behind buildings and away from the main line. When combined with a median treatment, cross access and backdoor access ensure that all parcels have access to a median opening or traffic signal for left-turn movements.

Median Treatments

Segments of a corridor with sufficient cross access, backdoor access, and on-site circulation may be candidates for median treatments. A median-divided roadway improves traffic flow, reduces congestion, and increases traffic safety — all important goals of access management. While medians restrict some left-turn movements, overall traffic delays are reduced by removing conflicting vehicles from the mainline. Landscaping and gateway features incorporated into median treatments improve the aesthetics of the corridor, in turn encouraging investment in the area. Median treatments include:

- Non-Traversable Median
- Median U-Turn Treatment
- Directional Cross (Left-Over Crossing)
- Left-Turn Storage Bays
- Offset Left-Turn Treatment

Non-Traversable Median

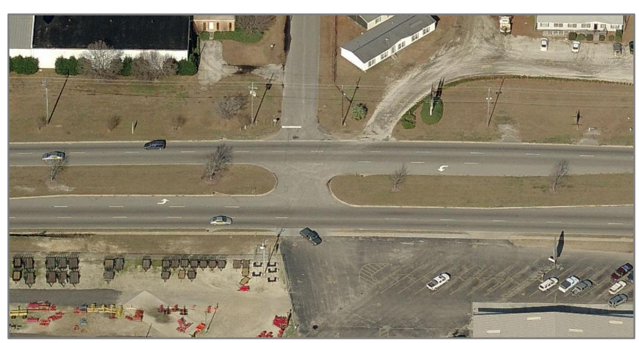
These features are raised or depressed barriers that physically separate opposing traffic flows. Inclusion in a new cross-section or retrofit of an existing cross-section should be considered for multi-lane roadways with high pedestrian volumes or collision rates as well as in locations where aesthetics are a priority. A non-traversable median requires sufficient cross and backdoor access.

The advantage of non-traversable medians include increased safety and capacity by separating opposing vehicle flows, providing space for pedestrians to find refuge, and restricting turning movements to locations with appropriate turn lanes. Disadvantages include increased emergency vehicle response time (indirect routes to some destinations), inconvenience, increased travel distance for some movements, and potential opposition from the general public and affected property owners. To overcome some of these disadvantages, sufficient spacing and location of u- and left-turn bays must be identified. Approximate construction cost varies.

Median U-Turn Treatment

These treatments involve prohibiting or preventing minor street or driveway left turns between signalized intersections. Instead, these turns are made by first making a right turn and then making a u-turn at a nearby median opening or intersection. These treatments can increase safety and efficiency of roadway corridors with high volumes of through traffic, but should not be used where there is not sufficient space available for the provision of u-turn movements. The location of u-turn bays must consider weaving distance, but also not contribute to excessive travel distance.

Advantages of median u-turn treatments include reduced delay for major intersection movements, potential for better two-way traffic progression (major and minor streets), fewer stops for through traffic, and fewer points of conflict for pedestrians



and vehicles at intersections. Disadvantages include increased delay for some turning movements, increased travel distance, increased travel time for minor street left turns, and increased driver confusion.

Directional Crossover (Left-Over Crossing)

When a median exists on a corridor, special attention must be given to locations where left turns are necessary. A left-over is a type of directional crossover that prohibits drivers on the cross road (side street) from proceeding straight through the intersection with the main road, but allows vehicles on the mainline to turn left onto the cross road. Such designs are appropriate in areas with high traffic volumes on the major road and lower volumes of through traffic on the cross road, particularly where traffic needs to make left turns from the main line onto the minor street. A properly implemented left-over crossing reduces delay for through-traffic and diverts some left-turn maneuvers from intersections. By reducing the number of conflict points for vehicles along the corridor, these treatments improve safety.

Left-Turn Storage Bays

Where necessary, exclusive left-turn lanes/bays should be constructed to provide adequate storage space exclusive of through traffic for turning vehicles. The provision of these bays reduces vehicle delay related to waiting for vehicles to turn and also may decrease the frequency of collisions attributable to lane blockages. In some cases, turn lanes/bays can be constructed within an existing median. Where additional right-of-way is required, construction may be more costly.

Offset Left-Turn Treatment

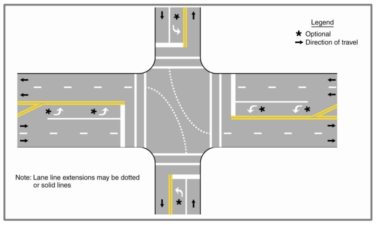
Exclusive left-turn lanes at intersections generally are configured to the right of one another, which causes opposing left-turning vehicles to block one another's forward visibility. An offset left-turn treatment shifts the left-turn lanes to the left, adjacent to the innermost lane of oncoming through traffic. In cases where permissive left-turn phasing is used, this treatment can improve efficiency by reducing crossing and exposure time and distance for left-turning vehicles. In addition, the positive offset improves sight distance and may improve gap recognition. In locations with sufficient median width, this treatment can be easily retrofitted. Where insufficient right-of-way width exists, the construction of this treatment can be difficult and costly. As a result, approximate construction costs vary.

Intersection and Minor Street Treatments

The operation of signalized intersections can be improved by reducing driver confusion, establishing proper curb radii, and ensuring adequate laneage of minor street approaches. Intersection and Minor Street Treatments include:

- Skip Marks (Dotted Line Markings)
- Minor Street Approach Improvements
- Intersection and Driveway Curb Radii

Skip Marks (Dotted Line Markings)



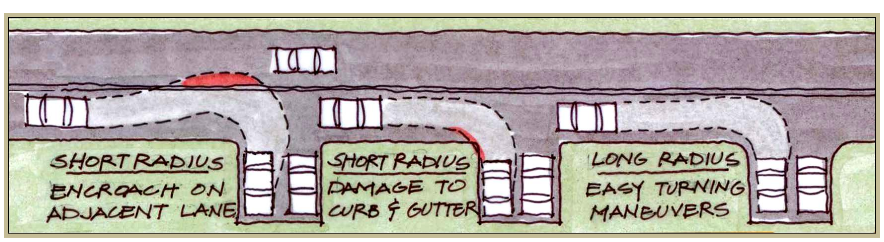
These pavement markings reduce driver confusion and increase safety by guiding drivers through complex intersections. Intersections that benefit from these lane markings include offset, skewed, or multi-legged intersections. Skip marks are also useful at intersections with multiple turn lanes. The dotted line markings extend the line markings of approaching roadways through the intersection. The markings should be designed to avoid confusing drivers in adjacent or opposing lanes.

Minor Street Approach Improvements

At signalized intersections, minor street vehicular volumes and associated delays may require that a disproportionate amount of green time be allocated to the minor street, contributing to higher-than-desired main street delay. With laneage improvements to the minor street approaches, such as an additional left-turn lane or right-turn lane, signal timing often can be re-allocated and optimized.

Intersection and Driveway Curb Radii

Locations with inadequate curb radii may cause turning vehicles to use opposing travel lanes to complete their turning movement. Inadequate curb radii may cause vehicles to "mount the curb" as they turn a corner and cause damage to the curb and gutter, sidewalk, and any fixed objects located on the corner. This maneuver also can endanger pedestrians standing on the corner. Curb radii should be adequately sized for area context and likely vehicular usage.



Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) provide numerous benefits when implemented as part of an overall transportation management strategy. ITS solutions use communications and computer technology to manage traffic flow in an effort to reduce crashes, mitigate environmental impacts such as fuel consumption and emissions, and reduce congestion from normal and unexpected delays. Successful systems include a variety of solutions that provide surveillance capabilities, remote control of signal systems components, seamless sharing of traveler information with the public, and even allow emergency vehicles to have priority to proceed safely through signalized intersections. Intelligent Transportation Systems include:

- Signalization
- Progressive-Controlled Signal System
- Dynamic Message Signs (DMS)
- Closed Circuit Television Traffic Monitoring
- Emergency Vehicle Preemption

Signalization

The volume of traffic attracted to some side streets or site driveways is more than can be accommodated acceptably under an unsignalized condition. Delays for minor street movements as well as left-turn movements on the main street may create or contribute to undue delays on the major roadway and numerous safety issues. The installation of a traffic signal at appropriate locations can mitigate these types of issues without adversely affecting the operation of the major roadway provided they are spaced appropriately. Approximate construction cost is $60,000 per signal.

Progressive-Controlled Signal System

A progressive-controlled signal system coordinates the traffic signals along a corridor to allow vehicles to move through multiple signals without stopping. Traffic signals are spaced appropriately and synchronized so when a vehicle is released from one intersection the signal at the next intersection will be green by the time the vehicle reaches it.

Adaptive signal control involves continuously collecting automated intersection traffic volumes and using the volumes to alter signal timing and phasing to best accommodate actual — real-time — traffic volumes. Adaptive signal control can increase isolated intersection capacity as well as improve overall corridor mobility by up to 20% during off-peak periods and 10% during peak periods. Approximate construction cost is $250,000 per system and $10,000 per intersection in addition to 25% of capital costs in training, etc.

Dynamic Message Signs (DMS)

Dynamic Message Signs alert vehicles of congestion or incidents. DMS units give general alerts, such as “congestion ahead” or specific details on the location of the incident or predicted travel times so motorists can mentally prepare. Often, drivers are more patient if they can anticipate how long the delay will be or how far the congestion spreads. Perhaps most importantly, DMS informs drivers who can choose alternate travel routes during heavy congestion, thereby reducing the volume on the freeway, the likelihood of additional incidents, and the average travel time for the system as a whole.

Closed Circuit Television Traffic Monitoring

Closed Circuit Television (CCTV) cameras primarily are used on interstate facilities and major arterials to provide visual traffic volume and flow information to traffic management or monitoring centers. These centers use this information to deploy incident response patrols/equipment and to provide roadway travel delay information to motorists. By having visual roadway information, traffic management centers are able to identify incidents quickly and respond appropriately and efficiently, helping to reduce the effect of incidents on a single location or on multiple roadways. Approximate construction cost is $20,000 per location.

Emergency Vehicle Preemption

This strategy involves an oncoming emergency or other suitably equipped vehicle changing the indication of a traffic signal to green to favor the direction of desired travel. Preemption improves emergency vehicle response time, reduces vehicular lane and roadway blockages, and improves the safety of the responders by stopping conflicting movements. Approximate construction cost is $5,000 to $7,000 per intersection plus $2,000 per equipped vehicle.

NC 50 CORRIDOR STUDY

CHAPTER 6

Bicycle, Pedestrian, and Transit

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina Capital Area Metropolitan Planning Organization

Transportation plans once focused solely on roadway solutions, with planners and local officials concentrating on commuter traffic and travel patterns. Livable communities balance travel between modes by accommodating pedestrians, cyclists, and transit users for recreational and utilitarian trips. The increasing demand for bicycle and pedestrian facilities and transit enhancements has culminated in an enhanced focus on these modes during the transportation planning process. This chapter of the Playbook includes the background information for the multi-modal recommendations in the Project Workbook.

Bicycle and Pedestrian Planning

Throughout the nation, populated areas are turning to cycling and walking as a viable means of transportation. Sometimes commuters find cycling more efficient, affordable, and convenient than traveling by automobile on congested urban streets. Although most people in the United States choose to travel by automobile, cycling and walking remains the only option for some people. Bicycling and walking can be an appealing alternative to traveling by car when considering it:

- **Is environmentally-friendly** — A shift from automobile travel to cycling or walking conserves fuel, improves air quality, and reduces noise.
- **Promotes good health practices** — Bicycling and walking is a low-impact way to exercise and can improve a person's health by lowering blood pressure, strengthening muscles, lowering stress levels, burning fat, increasing metabolism, and increasing the size, strength, and efficiency of the heart and cardiovascular system.
- **Saves money** — Choosing to ride a bicycle rather than to use a personal automobile could save one person thousands of dollars in a single year.
- **Eases congestion** — Since a bicyclist takes up about a quarter of the physical space of the average car and a pedestrian even less, both can maneuver more easily through traffic in urban areas. Often, cyclists and pedestrians can use dedicated bicycle lanes, greenways or sidewalks, allowing for an even more efficient trip.
- **Represents the livability of a place** — A bikeable and walkable place protects the environment, encourages a healthy, active community, saves money, and increases the mobility of all users. This adds up to a livable community with strong social interaction.
- **Can be viable** — In a 1995 National Personal Transportation Survey, analysts found approximately 40% of all trips are less than 2 miles from origin to destination. The average person can make this trip by bicycle in about 10 minutes.

Despite these benefits, transitioning to a balanced transportation network is not easy. The toolbox that follows presents an overview of users and facilities as well as program and policies available to local officials. The bicycle and pedestrian recommendations presented in the Project Workbook build on these tools.

Users and Facilities

To develop and integrate a recommended bicycle and pedestrian network into the transportation system, the types of users, facilities, and programs must be understood. For bicycling, the most effective set of recommendations addresses the needs and expectations of all advanced, basic adult, and child bicyclists.

Types of Users by Trip Purpose

Bicycling and walking often falls into two distinct types of travel:

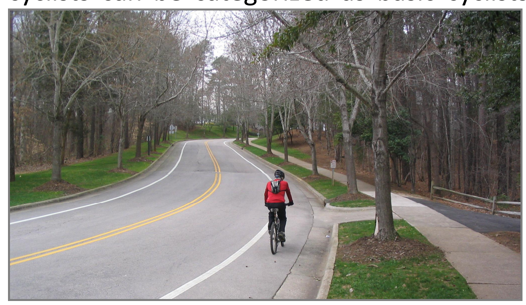
1. **Utilitarian, non-discretionary travel.** Often, children, persons with disabilities, and many elderly are not able to drive. In addition, some households simply cannot afford an automobile. According to the 2000 Census, approximately 11% of all households in the region do not have a vehicle available. This percentage is higher than both the state and national averages. For those unable to drive and persons living in households with no vehicles, the only option for daily necessary trips may be transit, bicycling, and walking.
2. **Recreational, discretionary travel**. As mentioned above, walking and bicycling are excellent methods of exercise, helping residents to establish a healthy lifestyle while enjoying the livability of their communities. Walking and bicycling for fun is increasing in popularity as Americans realize the benefits of these activities.

Both types require a complete network of bicycle and pedestrian facilities as well as programs that educate and encourage current and future users.

Types of Users by Riding Skill

Bicyclists can be placed in one of three categories based on their skill level.

- **Advanced Cyclists** are usually the most experienced on the road and can safely ride in typical arterial conditions of higher traffic volume and speeds. Most advanced cyclists prefer shared roadways in lieu of striped bike lanes and paths but may be more willing to accept striped bike lanes when the street gutter is cleaned regularly. Although this group represents approximately 20% of all cyclists, they account for nearly 80% of annual bicycle miles traveled.
- **Basic Cyclists** are less secure in their ability to ride in traffic without special accommodations. They usually are casual or new adult/teenage riders who typically prefer multi-use paths or bike lanes on collector or arterial streets. Such facilities reduce basic cyclists' exposure to fast-moving and heavy traffic. Surveys of the cycling public indicate that about 80% of cyclists can be categorized as basic cyclists.



- **Child Cyclists** have a limited field of vision while riding and generally keep to the neighborhood streets, sidewalks, and greenways. On busier streets, this group likely stays on sidewalks or off-street facilities that protect them from traffic. While riding on sidewalks should be discouraged, the comfort level of child cyclists' warrant riding on sidewalks provided they yield to pedestrians.

Like drivers, cyclists gain experience over time. As cyclists ride and gain more experience, they progress from basic to advanced cyclists. This transition requires the needs of all three types of cyclists constantly be evaluated and accommodated. Roadways need to be designed with an eye toward the intended use by cyclists and pedestrians and how the facility fits into a system-wide network. The table on the following page summarizes the major bicycle and pedestrian facilities.

Bicycle and Pedestrian Facility Overview

Striped Bike Lanes

Description

- Exclusive-use area adjacent to the outer most travel lane
- Typical width: 4’ to 5’

Target User

- Basic and Intermediate Cyclists

Estimated Cost

- $18,000 per mile (striping only)

Wide Outside Lane

Description

- Extra width in outermost travel lane
- Best on roadways with speed limits of 35 mph or higher and moderate to high daily traffic volumes
- Typical width: 14’ outside lane preferred

Target User

- Advanced Cyclists

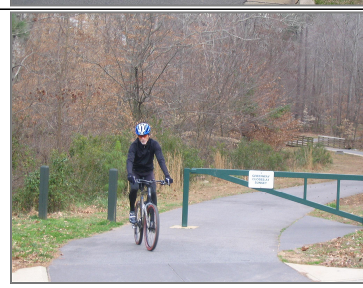
Estimated Cost

- $18,000 per mile (striping only)

Multi-Use Path

Description

- Separated from traffic and located in open space (greenway) or adjacent to road with more setback and width than sidewalks (sidepath)
- Typical width: 10’ preferred; 8’ in constrained areas



Target User

- All Cyclists; Pedestrians

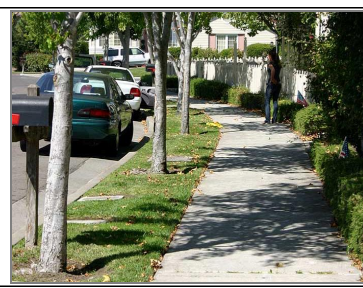
Estimated Cost

- $600,000 per mile (includes clearing, grubbing, grading, and construction)

Sidewalk

Description

- Dedicated space within right-of-way for pedestrians
- Should include a landscaped buffer from roadway
- Typical width: 5’ preferred



Target User

- Pedestrians

Estimated Cost

- $150,000 per mile

Unpaved Trail

Description

- Formal/informal hiking trail made of dirt, mulch, or pea gravel
- Typically connects recreational and environmental features of a community
- Typical width: 5-8’ footpath; 8-10’ bike trail

Target User

- Off-Road Cyclists; Pedestrians; Hikers

Estimated Cost

- $10,000 to $20,000 per mile

Design considerations also should be given to ancillary bicycle facilities and amenities such as bike racks, bikes on buses and bike amenities at transit stops, and bike-friendly drainage inlets. For pedestrians, attention must be given to curb ramps as well as marked crosswalks and enhancements such as raised crosswalks, pedestrian refuge island, and curb extensions.

Programs and Policies

Coordinated programs and policies that instruct and encourage bicyclists and pedestrians in the full and proper use of the non-motorized transportation network must supplement recommended facilities. Many of these programs and policies are characterized by one or more the Five E's.

Engineering

Engineering refers to the network of planned, designed, and constructed pathways. A well-planned bicycle and pedestrian system can enhance user safety and enjoyment and may increase the attraction of each mode. Bicycle and pedestrian facility projects can be divided into two types: independent and incidental projects. Independent projects are separate from scheduled highway projects while incidental projects are constructed as a part of a highway project.

Education

Once the pathways are in place, new and experienced cyclists and pedestrians must be made aware of their locations and the destinations that can be reached by using them. Bicyclists, pedestrians, and motorists must be educated on the "rules of the road" to ensure everyone's safety while operating on and adjacent to the bicycle and pedestrian facilities. Education programs can be initiated from a variety of sources. Local governments can host workshops and bike rodeos, law enforcement officers can launch school-based education programs, and local advocacy groups can distribute educational materials.

Encouragement

People need to be encouraged to bicycle and walk. Encouragement should become easier as the network of pathways makes the region more bicycle- and pedestrian-friendly. Encouragement becomes more critical as these facilities are constructed to justify the investment. Popular encouragement programs include Safe Routes to School, Walk/Bike to School Days, Bicycle to Work Week, Bicycle Rodeos, and Bicycle Mentor Programs.

Enforcement

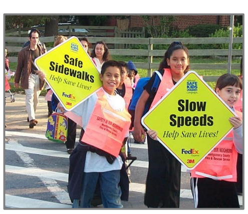
To ensure the safety of all users and the long-term sustainability of the bicycle and pedestrian system, the formal and informal "rules of the road" must be heeded by all. Effective enforcement programs ensure consistent enforcement of traffic laws affecting motorists and bicyclists. These programs include bicycle licensing/registration efforts and positive reinforcement programs implemented by local law enforcement.

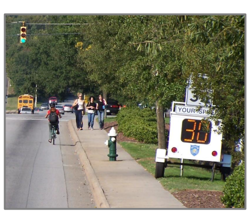
Evaluation

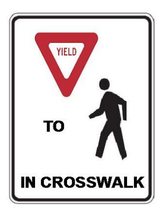
Though often overlooked, evaluation is a critical component of bicycle and pedestrian planning. The friendliest communities for cyclists and pedestrians have a system in place to assess existing programs and outline steps for future expansion.

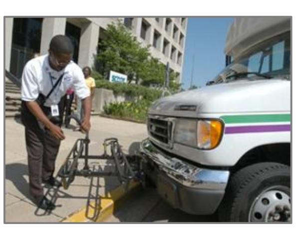
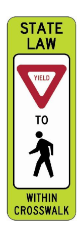
Cycling, Walking, and NC 50

The bicycle and pedestrian considerations for the NC 50 corridor are presented in Chapter 7 of the Project Workbook.







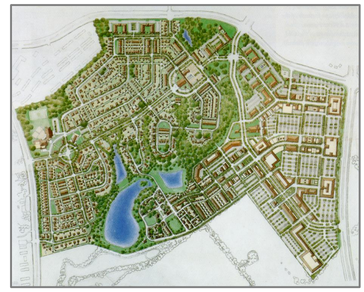

Transit Planning

For many residents, taking transit is not a choice — it's a necessity. These residents without access to private automobiles depend on transit to access jobs, medical care, professional services, and many other aspects of daily life. Some residents choose to ride transit instead of driving. These residents board buses, vans, and shuttles to take advantage of the convenience and cost savings afforded to transit users. As growth occurs and development patterns shift, convenient and reliable transit service becomes more important, and in some ways, more difficult.

Within the context of the transportation system, transit has two overarching objectives. First, transit expands the reach of those without access to other means of travel. Second, transit provides viable transportation alternatives to decrease dependence on the automobile and in turn lessen the demand on the existing transportation system. The notion is to create a transportation system whose primary motive is to move people rather than cars. One way to encourage transit use on existing routes and services is to develop around each stop a safe, comfortable customer delivery system complete with attractive and convenient amenities. And because most regular transit users walk or bike to and from the stop, a network of sidewalks, safe street crossings, bike facilities, multi-use paths, and pedestrian-level lighting should complement the amenities provided at the stop. The efficiency of transit also depends on an interconnected system of roads and highways that provide access to transit stops.

Transit and Urban Form

Many people agree that they would use transit if service was fast, frequent, dependable, and easy to use. While such criteria is required of a complete system of roads, sidewalks, and bikeways, transit also must provide connections to the places people need or want to go at a time when they need to get there. As a result, transit enhancements must occur within a framework of transit-supportive urban form. Two development types that maximize potential transit ridership include transit-oriented development and transit-ready development.



Transit-oriented developments (TODs) provide a mixture of residential and commercial uses focused around transit stations or bus stops. The transit stop is surrounded by relatively high density development that spreads out as you move away from the center. The scale of a TOD generally is limited to an area ¼- to ½-mile in diameter to establish the walkability of the neighborhood. The design of such places maximizes access to transit and supports walking and biking between destinations.

In locations that lack existing transit facilities or demand to support a TOD, regulations and guidelines supporting transit-ready development should be enforced. Transit-ready development describes the coordinated design of new neighborhoods and activity centers that supports future transit expansion. Like TODs, transit-ready developments include a mixture of land uses, pedestrian-friendly design, appropriate locations and/or routes for transit, an interconnected network of internal streets, and appropriate densities supportive of future transit use.

While transit-oriented and transit-ready developments represent ideal urban form for transit destinations, many existing single-use locations can be viable long-term facilities for transit service. Malls, grocery stores, and business parks are just a few examples of vital destinations for many residents. Likewise, visitors may use transit to frequent local parks and historic sites. While the urban design of such places may not be ideal for transit, these locations are places where access to public transportation continues to be an important priority.

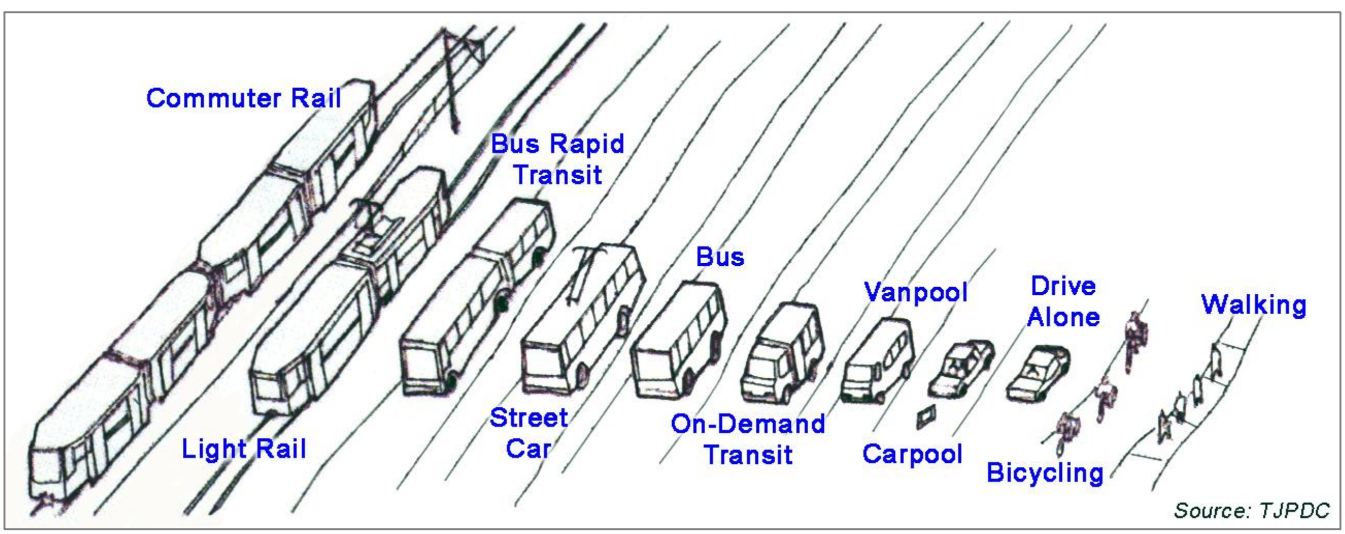
Transit Technologies

Transit planners have a variety of technologies from which to choose when selecting the most appropriate form for an area. A sustainable transit system results from a plan that identifies strategic corridors for transit as well as the proper technology as determined by land use conditions and ridership trends. Often, successful plans allow the system to mature by laying the groundwork with simpler, more cost-effective technology such as shuttles or buses and as demand increases implementing more extensive technology. Transit technologies include:

- **Paratransit and Other Services** — Paratransit systems provide critical dial-a-ride (on-demand) services to persons with disabilities, the elderly, and others who do not live near a fixed bus route. Other services include neighborhood shuttles, employment center shuttles, and vanpool and carpool services.
- **Buses** — Local fixed route bus networks are the workhorses of many transit systems. Buses operating on local streets with curbside bus stops provide a flexible transit technology capable of responding to the evolution of land use types and intensities.
- **Trolleys** — These modern interpretations of the 20th century streetcar are smaller and lighter than LRT vehicles. Trolleys operate similar to buses (in terms of frequent stops along the street) but can hold more passengers than the typical bus.
- **Light Rail Transit (LRT)** — These overhead electric powered light-weight trains typically operate in exclusive rights-of-way but also can mix with traffic. Transit stations can be spaced as close as one mile apart.
- **Bus Rapid Transit (BRT)** — Like LRT, bus rapid transit vehicles can operate on exclusive rights-of-way (busways) or travel through neighborhoods to service passengers at local stops. On-line stations and off-vehicle ticketing combined with the busways help create fast, convenient service.
- **Commuter Rail** — This service provides scheduled service along railroad tracks, typically between a city center and its suburbs. Service often is limited to peak hour and shares the rail with other passenger or freight rail providers.

Transit Element

Transit considerations for the NC 50 corridor are presented in Chapter 7 of the Project Workbook.



NC 50 CORRIDOR STUDY

CHAPTER 7

Planning for Livable Communities

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina

Capital Area Metropolitan Planning Organization

Planning for Livable Communities

The Post-WWII growth of communities across the U.S. created millions of acres of new residential and commercial development located outside of traditional city centers. These suburban growth patterns were fueled by several different socioeconomic and demographic trends, but one of the major influences on this new pattern of growth was transportation – notably the ability of people to access their daily needs by car. Prior to the car serving as the main form of transportation, development patterns in America naturally reflected more compact, mixed use patterns because people relied on walking, riding or being pulled by a horse, bicycles or electric streetcars to move around. With the proliferation of car ownership, inexpensive fuel, available land and major expansions of the highway and roadway systems across America, development patterns took on a very different form in the latter half of the 20th century.

These changes in development forms were directly related to changes in transportation. For example, the distance a person can walk in 10-15 minutes is about a quarter mile. Therefore cities and towns developed when walking was a primary mode of transportation reflect more compact, mixed use development patterns – be it the traditional city center or the small town main streets. Conversely, the distance a person can drive in 15 minutes could be 5, 10 or 15 miles. This dramatic change in accessibility allowed patterns of development to become more spread out and single use without really impacting the amount of time a person would devote to travel.

While advances in transportation technology have had a significant positive impact on people's daily lives, the reliance on the automobile as the sole form of transportation and poor city planning over the last 50 years has created several unintended consequences – notably the negative environmental, economic and societal impacts associated with suburban sprawl.

Charleston, South Carolina developed pre-automobile. The aerial above demonstrates the compact, mixed use nature of the development form. Most of the built space is taken up by buildings, with some formal, public open space. The area is connected by a dense network of two-lane roadways creating significant choice in pathways to access destinations.

Lake Mary, Florida developed as a suburb of Orlando in the post-automobile era. The aerial above illustrates a more spread out pattern with a separation of uses. The built space is not only dominated by buildings and private open space, but there is considerable devoted to roadways and parking lots. The area is connected by two major six-lane arterial roadways, creating very limited options for accessing destinations.

What is Sprawl?

Suburban sprawl is a catch all phrase for poorly planned, inefficient low density land use patterns and failing transportation systems. The causes of sprawl are vast and complex, and some (but not all) of the negative impacts include:

- Higher levels of congestion and air pollution created from vehicle emissions
- Loss of open space, farmland, and natural water recharge areas
- Lack of transportation choices
- Lack of housing diversity to accommodate all stages of life and incomes
- Mismatch between the location of workers and jobs

Given the negative impacts of sprawl, and the maturing of the suburbs over the last 50 years, there is a renewed focus in city planning that aims to better coordinate land use and transportation to create more livable communities. Instead of simply growing further out and "paving our way out of congestion," progressive planning today provides a new roadmap to help communities grow better. Some examples include:

Retrofitting existing suburban corridors – the suburban commercial strip-style development is the most commonly referenced 'type' of sprawl. Over the last decade, several communities have attempted to makeover their aging strip-style commercial corridors and retrofit these for new forms of transit and mixed use.

Infill and redeveloping existing centers – one of the key ways to reduce the pressure to grow out into Greenfield areas is to encourage infill and redevelopment of the existing community centers. When done simultaneously with investments in multi-modal transportation systems, infill and redevelopment can become a very efficient way to accommodate new growth.

Traditional Neighborhood Design (TND) and New Centers – when communities to expand to Greenfield sites, new patterns of development known at TND's or New Urbanists communities provide a more compact, walkable, mixed use model of development for the suburbs. An important issue with TND development is to make sure it is integrated with the larger regional transportation system and provides connectivity to surrounding uses.

Exploring the Effects of Compact Development

Approximately 80 percent of the U.S. population lives in metropolitan areas, but population and employment continue to decentralize within regions, and population density continues to decline at the urban fringe.

The adverse effects of suburbanization and automobile dependence have long been evident but now are particular concerns for several reasons. First, after decades of low energy prices, the cost of oil rose to record highs in 2008, reflecting the growth of China and India and the instability of many key suppliers in the Middle East and other oil-producing areas, and underscoring U.S. dependence on imported fuels. The transportation sector accounts for more than 28 percent of annual U.S. energy consumption; cars and light trucks, mostly used for personal transportation, represent approximately 17 percent of annual U.S. energy consumption, and the share is rising.

Second, concern about climate change has grown domestically and internationally, and transportation is a major contributor to the problem. Gasoline consumption, largely by personal vehicles, accounts for about 20 percent of annual U.S. CO_2 emissions.

At the same time, changing demographics—an aging population and continued immigration—and the possibility of sustained higher energy prices could lead to more opportunities for the kinds of development patterns that could reduce vehicular travel, saving energy and reducing CO_2 emissions.

A key question is to what extent developing more compactly would reduce vehicle miles traveled and make alternative modes of travel—such as transit and walking—more feasible. Special Report 298, *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions*, focuses on metropolitan areas and on personal travel, the primary vectors through which policy changes encouraging more compact development should have the greatest effect.

Excerpt from the Transportation Research Board's Special Report: Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions, June 2010.

Smart Growth and Livable Communities

When the anti-sprawl movement erupted almost 30 years ago, the term "Smart Growth" was coined as the answer to sprawl. Smart Growth provided new guidance to help communities better manage growth and grow in more sustainable ways. Many of the tenants of smart growth have become standard practice in comprehensive planning and public policy.

Smart Growth Principles

Create Range of Housing Opportunities and Choices. Providing quality housing for people of all income levels is an integral component in any smart growth strategy.

Create Walkable Neighborhoods. Walkable communities are desirable places to live, work, learn, worship and play, and therefore a key component of smart growth.

Encourage Community and Stakeholder Collaboration. Growth can create great places to live, work and play -- if it responds to a community's own sense of how and where it wants to grow.

Foster Distinctive, Attractive Communities with a Strong Sense of Place. Smart growth encourages communities to craft a vision and set standards for development and construction which respond to community values of architectural beauty and distinctiveness, as well as expanded choices in housing and transportation.

Make Development Decisions Predictable, Fair and Cost Effective. For a community to be successful in implementing smart growth, it must be embraced by the private sector.

Mix Land Uses. Smart growth supports the integration of mixed land uses into communities as a critical component of achieving better places to live.

Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas. Open space preservation supports smart growth goals by bolstering local economies, preserving critical environmental areas, improving our communities quality of life, and guiding new growth into existing communities.

Provide a Variety of Transportation Choices. Providing people with more choices in housing, shopping, communities, and transportation is a key aim of smart growth.

Strengthen and Direct Development Towards Existing Communities. Smart growth directs development towards existing communities already served by infrastructure, seeking to utilize the resources that existing neighborhoods offer, and conserve open space and irreplaceable natural resources on the urban fringe.

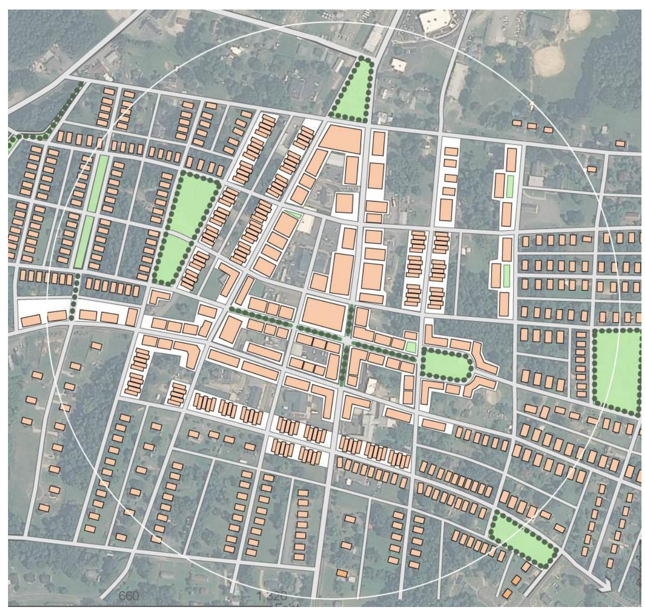
Take Advantage of Compact Building Design. Smart growth provides a means for communities to incorporate more compact building design as an alternative to conventional, land consumptive development.

The concepts of smart growth, sustainability and livability were incorporated into the NC 50 Scenario Planning process. The NC 50 corridor is dominated by existing rural and suburban places. The focus of the scenario planning effort was to look at different future scenarios to illustrate the differences for the community if it followed a 'trend' scenario, which resulted in patterns more similar to sprawl, or if it moved towards more smart growth oriented scenarios. To accomplish this, several prototypical development patterns were designed specific to the study area to reflect a new or enhanced built forms that supported key community goals and smart growth principles. The specific smart growth goals of importance for the study area focused on:

- Creating a better jobs to housing balance
- Creating more transportation choice
- Increasing housing diversity
- Increasing economic competitiveness
- Protecting the Falls Lake watershed
- Preserving the rural veiwsheds

The scenarios tested demonstrated how different patterns of land use (as noted to the right) and transportation configurations could help achieve the community goals stated above. Ultimately the more 'smart growth' oriented scenario performed better than the business as usual trend with regards to key community goals.

The aerial above shows the existing pattern of development in downtown Creedmoor. The orange arrow represents the one-quarter mile radius, or the downtown walking shed. Downtown Creedmoor has an existing historic main street, which is currently the focus of citywide revitalization efforts.



This illustration demonstrates the potential for infill and redevelopment of the existing town of Creedmoor. Of note is the increased number of destinations (both housing and commercial) located within the original quarter-mile walking shed. This infill concept assumes 3-6 dwelling units per acre and 32 employees per acres as measures of density. The infill concept not only achieves compact development goals, but it also helps to create a more balanced jobs to housing ratio.

In recent years, the term "livable communities" has emerged as a way to describe one of the desired outcomes of smart growth and other public policy initiatives. Focused more heavily on transportation and housing, livability describes ways to create more balanced communities to help improve people's individual quality of life. One of the core transportation tenants is to create more transportation choices. Essentially, livable communities focus equally on making walking, biking and riding transit viable modes of transportation in addition to the automobile. Doing so not only involves creating strong multimodal infrastructure improvements and creating a quality walking environment, but it also requires the creation of more compact, mixed use forms of development. If walking, biking and transit are to be viable within a given community, there needs to be a variety of destinations they can get to within the 15 minute walk.

Livability Principles

In June, 2009 the U.S. Department of Housing and Urban Development (HUD), U.S. Department of Transportation (DOT), and U.S. Environmental Protection Agency (EPA) formed a new partnership to help American families in all communities—rural, suburban and urban—gain better access to affordable housing, more transportation options, and lower transportation costs. DOT, HUD and EPA have created a high-level interagency partnership to better coordinate federal transportation, environmental protection, and housing investments and to identify strategies that:

Provide more transportation choices. Develop safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health.

Promote equitable, affordable housing. Expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.

Enhance economic competitiveness. Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well as expanded business access to markets.

Support existing communities. Target federal funding toward existing communities—through strategies like transit oriented, mixed-use development, and land recycling—to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes.

Coordinate and leverage federal policies and investment. Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy

Value communities and neighborhoods. Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods—rural, urban, or suburban.

Resources

There are several resources available to communities attempting to develop growth management, smart growth or livable community policies. The following provides a handful of online resources:

Smart Growth Online

This is an online website containing best practices and resources for smart growth. It is sponsored by the Smart Growth network which is funded in part by the Environment Protection Agency (EPA). *www.smartgrowth.org*

Congress for New Urbanism (CNU)

The CNU website provides information and resources on policy development and design for Traditional Neighborhood Development (TND).

www.cnu.org

National Homebuilders Association

Section describing key talking points for homebuilders relative to smart growth and compact development.

www.nahb.org

Center for Neighborhood Technology

Focused on urban sustainability issues.

www.cnt.org

NC 50 CORRIDOR STUDY

CHAPTER 8

Low Impact Development

Prepared By:

Kimley-Horn and Associates, Inc.

Prepared For:

North Carolina Capital Area Metropolitan Planning Organization

Low Impact Development

Low Impact Development (LID) is a land planning and engineering design approach to manage stormwater runoff. LID emphasizes conservation and use of on-site natural features to protect water quality. The purpose of LID is to maintain and restore a developing watershed's hydrologic regime by creating a landscape that mimics the natural hydrologic functions of infiltration, runoff, and evapotranspiration. The goal of LID in North Carolina is to use a wide array of site-level planning, design, and control techniques to restore and optimize the land's ability to soak up water and capture and process pollutants in the landscape. This is accomplished through an array of LID site planning practices and stormwater treatment techniques that manage runoff volume and water quality. The more effectively LID is integrated into the landscape, the greater the ability of the site to replicate the natural storage capacity of the land to capture water and capture and cycle pollutants. The decentralized and disconnected distribution (as opposed to the centralized end-of-pipe treatment) of small-scale LID stormwater practices throughout a site slows runoff, allowing for infiltration and reducing site discharge flow. LID includes the following five basic strategies, with multiple techniques for each strategy:

- Conserve resources. At the watershed level, the development tract level, and individual lot levels, try to conserve natural resources (trees, water, wetlands and special areas), drainage patterns, topography, and soils whenever possible.
- Minimize impact. At all levels, attempt to minimize the impact of construction and development on natural hydrologic cycles and ecological systems by saving existing vegetation and reducing grading, clearing, impervious surfaces, and pipes.
- Optimize water infiltration. To the maximum extent practicable, slow down runoff and encourage more infiltration and contact time with the landscape by saving natural drainage patterns and by maintaining sheet flow using vegetative swales, lengthened flow paths, and flattened slopes.
- Create areas for local storage and treatment. Rather than centralizing stormwater storage, distribute storage across the landscape, adjacent to areas of flow. Use small-scale practices that allow for collection, retention, storage, infiltration, and filtering on site.
- Build capacity for maintenance. Develop reliable, long-term maintenance programs with clear and enforceable guidelines. Educate homeowners, management companies, and local government staff on the operation and maintenance of all practices, and about protecting water quality.

Are conservation developments LID?

A conservation development sets aside land in permanent easement that will not be developed. The remaining land is usually developed at higher densities, possibly allowing the same or more lots on less area. LID may include conservation development and vice versa, but neither completely incorporates the goals of the other. For example, LID may be used within a more developed urban or suburban areas. It is also possible for conservation developments to protect land while at the same time using conventional stormwater management practices that may not optimize water infiltration and treatment. Defining the terms and goals of various types of development will help a local community to clarify whether they are meeting these goals. *(Adapted from WECO "LID – an economic factsheet")*

Environmental Site Design Approach and Principles

The LID Guidebook illustrates a design approach to LID to help balance both stormwater and water quality goals alongside other community livability goals that might also be desirable. A LID-oriented site design program starts with goals that consider

Incorporate LID into Local Policies

Land use planning should consider environmental impacts at multiple scales, including the site level, subdivision level, watershed level, and regional level. Local governments can achieve multiple benefits by developing land use, open space, and watershed protection plans to identify both areas for growth and areas for conservation and protection. A LID policy is one tool that should be considered within an overall plan for development, conservation, and restoration of natural areas. **Brunswick** and **New Hanover Counties** (North Carolina) serve as examples of local governments incorporating LID as one of many tools within their comprehensive plans. (NCSU "LID Guidebook")

the hydrologic cycle and the LID practices that best suit the site's natural features while also meeting the client's needs. The goals set for site design must be specific to the project, client, context, and site. Sample goals might include:

- Maximize the number of units per acre while addressing social and environmental concerns;
- Preserve a minimum of 20 percent of wooded areas for stormwater management, air quality, carbon sequestration, and wildlife habitat;
- Create a mixed-use development that balances economic and environmental considerations by incorporating a variety of housing styles and types, commercial development, and recreational amenities such that all are mutually beneficial; or,
- Incorporate open space within a half mile of all residents that also serves for stormwater management, alternative transportation modes, and other uses.

It is necessary to examine the full range of goals and values in order to balance the goals of LID with other community and livability goals. Sustainable community design principles can and should be considered alongside the LID focus on hydrology. This necessitates a consideration of social design issues and human values along with a focus on the natural hydrologic cycle. Although maintaining or improving the hydrologic function of a site is the fundamental theme of LID, other factors are also important to designing a sustainable community.

Integrated goal setting will require consideration of various trade-offs or consequences and the development of innovative solutions. For example, while LID seeks to reduce impervious surfaces as much as possible, eliminating sidewalks negatively affects the livability and social vitality of a neighborhood. Another way of reducing impervious cover is to implement cul-de-sac street configurations, but this design could cut off bicycle routes and isolate neighbors. A balance between LID and other design goals is essential for the creation of livable and sustainable neighborhoods.

The LID design process includes the following approach steps:

1. Set project goals and objectives and identify the program.
2. Inventory, assess, and analyze the site.
3. Review and revise the program based on site constraints.
4. Develop proposals and evaluate.
5. Revise and model.

Every site will present a unique set of design challenges for LID depending on the specific characteristics of topography, soil, sensitive areas or existing developed or disturbed areas. The process of setting goals, inventorying, drafting, evaluating and refining a proposal will help achieve the LID and livability goals desired by the program. The LID Guidebook suggests a series of LID design principles which around which it orders a checklist for designers. The table below contains this checklist of principles along with a brief description on how each one works.

LID Design Principle	How it Works
Design impervious areas for the minimum length and width needed to support their intended uses.	• Match road width to traffic volumes. • Reduce parking standards and minimize parking areas. • Emergency and service vehicle access designed to avoid duplication. • Alternative street layout to reduce road length. • Maximize number of housing units per paved area. • Use alternative (permeable) materials.
Incorporate filter strips, vegetated areas, channels, and curb inlets in roadway rights-of-way, landscaped areas, traffic islands, and islands/roundabouts.	• Bioretention areas are located in public rights-of-way or immediately adjacent to roadways. • Bike lanes are made of permeable pavement. • Vegetated swales replace curb and gutter.
Modify traditional lot layouts to reduce road frontages and driveway lengths.	• Use conservation design approach to cluster houses on non-sensitive areas.
Carefully locate and design sidewalks to maximize community benefits from impervious surfaces.	• Sidewalks are located to address primary destinations. • Opportunities for single-sided sidewalk provision are identified, supportable, and implemented. • Permeable pavement is considered.
Substitute pervious for impervious materials where possible.	• Pervious materials for parking, patios, bike lanes, and paths is substituted for less pervious. • Minimize managed lawn areas.
Limit site disturbance, clearing, and grading to the smallest areas necessary for that particular phase of development.	• Development is planned to use roadways, future impervious areas, and building footprints for construction access and parking. • Best soils and most densely vegetated areas are preserved for infiltration. • Roads and driveways are sited so they follow the natural contours of the land, reducing the amount of cut and fill required.
Take advantage of existing waterways, vegetated areas, and amenable soil conditions to direct, absorb, clean, recharge, or store water; reduce air pollution; provide wildlife habitat; and add natural amenity value to a development.	• Existing waterways, vegetated areas, and amenable soils are used to direct, absorb, clean, recharge, or store water. • Opportunities to reduce air pollution, provide wildlife habitat, and add natural amenity value to a development have been recognized and adopted. • Low areas are used to provide retention. • Cut and fill is minimized and opportunities provided by existing topography are maximized. • Relatively high areas on the site (areas of higher topography such as hills or ridges) are identified. Use them as the starting point for infiltration by locating features relatively high and allowing space for infiltration (both structural and non-structural BMPs) at lower elevations. These areas of higher elevation will promote infiltration and begin the treatment train process. • Areas of established high-quality vegetation are preserved.
Use preservation techniques to gain more benefits (both environmental and economic) than are possible from creation or mitigation techniques.	• Natural resources such as vegetated areas, waterways, topography, and cultural resources are preserved. • Opportunities to create areas for recreation and alternative forms of locomotion (such as walking and cycling) are recognized.

Design for ease of maintenance and to minimize maintenance complexity, frequency, and cost.	• Information on future maintenance responsibilities is provided. • Information on appropriate maintenance protocols and intervals is provided. • The level of maintenance and equipment that will be available is accommodated. • Potential maintenance complications such as invasive or fruiting species are recognized and solutions are provided. • Plants require minimal pruning, but provide sufficient coverage to reduce weeding needs. • Native and well-adapted vegetation are used when appropriate. • Maintenance matches landscape needs.
Design for hydrology by preserving sensitive areas, preserving natural features and flows, and dispersing rather than concentrating.	• Sensitive areas that contribute to effective hydrological cycling (such as areas of quality soils or mature vegetation) are identified and preserved. • Existing areas of hydrologic function such as local streams, creeks, and wetlands are maintained. • Paths of flow, such as natural draws, swales, or ditches, which direct water to outflows are preserved. • Water is dispersed rather than concentrated to promote infiltration. • The use of water as a desirable landscape component is recognized. • Impervious surfaces are disconnected by directing runoff to vegetated areas or cisterns.
Design for multiple functions.	• Areas with primary cultural function are maximized for environmental benefit. • Areas with primary environmental function are maximized for cultural and economic benefits. • All areas are maximized for recreational benefits, to enhance walkability, and for aesthetic character. • Vegetated areas address wildlife habitat, infiltration, pollution removal, and stormwater storage. • Stormwater capture and treatment areas provide sources of water for other purposes when possible.
Manage development impacts at the source (or as close to it as possible).	• The use of engineered conveyance systems is limited. • Discrete, very large, or underground systems are avoided to the greatest extent possible. • Cut and fill is limited. • The site is revegetated to replicate pre-development vegetation levels.
Disconnect impervious areas.	• Rainwater is directed from impervious areas to pervious areas. • Avoid linking multiple impervious areas together. • Direct rooftop runoff onto pervious surface areas, such as turf or vegetated areas, or into cistern systems.
Work with the site's soil conditions strategically.	• Clearing and grading and impervious areas are located in areas of less permeable soils. • Areas of permeable soils are preserved from construction and development.
Consolidate natural open space areas whenever possible.	• Plan for primary and secondary conservation areas, as well as development areas using conservation design principles.
Consider alternative architectural designs to reduce building footprints and to adapt layout to site conditions such as topography.	• Follow conservation design process at the site level to minimize sensitive areas and overall site disturbance.

Conservation Development

Conservation design, sometimes known as cluster subdivision/zoning, is a residential subdivision designed so that the dwelling units are clustered together on smaller than average lots on only a portion of the tract, leaving the remainder available for open space or similar uses. It is a design approach that allows for controlled-growth and development in rural areas that protect an area's natural environment, farmland, rural character, landscapes and vistas. This approach may be used in either urban or rural areas, however, the practice is usually associated with rural land development. A key advantage to this approach to rural development, especially for the NC50 area, is to help preserve rural land resources while still meeting the desires of rural landowners to obtain a relatively high development value for their property. It can help achieve both higher development potential and economic return, while preserving open space, ensuring watershed protection standards for the Falls Lake watershed and maintaining the rural character. Though it may not work in all areas of, it an approach tested in the NC 50 scenario planning efforts and was shown to have positive results. This section outlines different aspects and issues to consider in creating, approaching and implementing rural conservation subdivisions.

Separate Density and Minimum Lot Size

To make conservation subdivisions possible the first rule is to not confuse density with minimum lot size. Optimal site configurations are best achieved with no minimum lot size designation. The premise here is to set gross density targets and then allow for a detailed site plan that best adapts to the geography and achieves the key conservation or rural development characteristics desired. Rural conservation subdivisions generally work best when the subdivision begins with a large parcel of land with reasonable acreage (30+ acres).

A locality should identify those features of conservation design most important to community. If the priority is water protection then subdivisions which maximize undisturbed area and minimize impervious surface should be a priority. If protecting viewshed, or historic or cultural resources are a priority then the policies should identify these for protection. The intent of a conservation design subdivision is to allow for flexibility for optimal arrangement of development on a parcel. The intent, or specific priorities, of a conservation design ordinance or policy should be clear so designers, engineers and developers will know what to strive for.

Types of Conservation Subdivisions

There are variations of rural conservation, or cluster, subdivisions (VAPA, 2010).

- **Percent of Land Developed**. One variation is to specify a maximum percentage of the parent parcel or tract that can be converted to non-agricultural or non-open space uses. Such a provision can be relatively simple and may permit a great deal of flexibility to the developer in terms of lot size and unit type on that portion of the land that is permitted to be converted.
- **Lot Size Averaging**. Another variation on rural subdivisions is to specify the average minimum lot size for a rural subdivision, but permit the developer to achieve that average by creating some lots that are larger and some smaller. Again, the advantage of this variant is to provide more design flexibility in order to respond to unique site conditions and to the local market demand.
- **Maximum Size of Building Lots**. Another variation is to set a maximum rather than minimum lot size for rural subdivisions, thereby forcing a clustered layout. The percentage of open space remaining will be determined by the actual maximum lot size required in relation to the maximum overall site density required.

Depending on the provisions of the specific conservation design ordinance, the remaining open space may be held in common and/or be strictly an agricultural or environmental area with no —development rights remaining on it; or, the open space parcel(s) may be allowed to have a dwelling unit with a permanent easement that prohibits further subdivision or additional dwellings.

In urban areas, cluster provisions are typically used for preserving sensitive environmental features and/or for encouraging a compact development pattern that makes efficient use of infrastructure. In rural areas, cluster provisions are typically aimed at agricultural and forest conservation.

Site Assessment - Start Early

It is more efficient, and cost effective, to get it right the first time rather than to retrofit or redo later on. Early site assessment, with conservation design objectives in mind, will help achieve desired outcomes from the start. There are some easy and cost effective steps that can be taken before any more detailed site plans are undertaken. The goal of early site assessment is to save both developers and staff/officials time and money by avoiding expensive preliminary plans to be developed and presented. After agreement is reached on a preliminary sketch plan, the developer can proceed to a more detailed application having had the benefit of this early site analysis, visit and concept development.

- Conduct a detailed existing resource and site analysis map of a property and a context map of the immediate area.
- Conduct a site walk with officials, staff and neighbors from the outset.
- Conduct an inexpensive conceptual sketch plan as the fist layout document.
- Involve landscape architects, physical planners early on in process, not just site engineering.

Conservation Site Design Approach – Four Step Process

Conservation site design builds on a long legacy of design with natural systems, made prominent by renown landscape architect, Ian McHarg. The four step process outlined below is adapted from an approach outlined by landscape architect Randall Arendt, who was building on this fundamental design with natural systems' approach (Arendt, 2010, 1996).

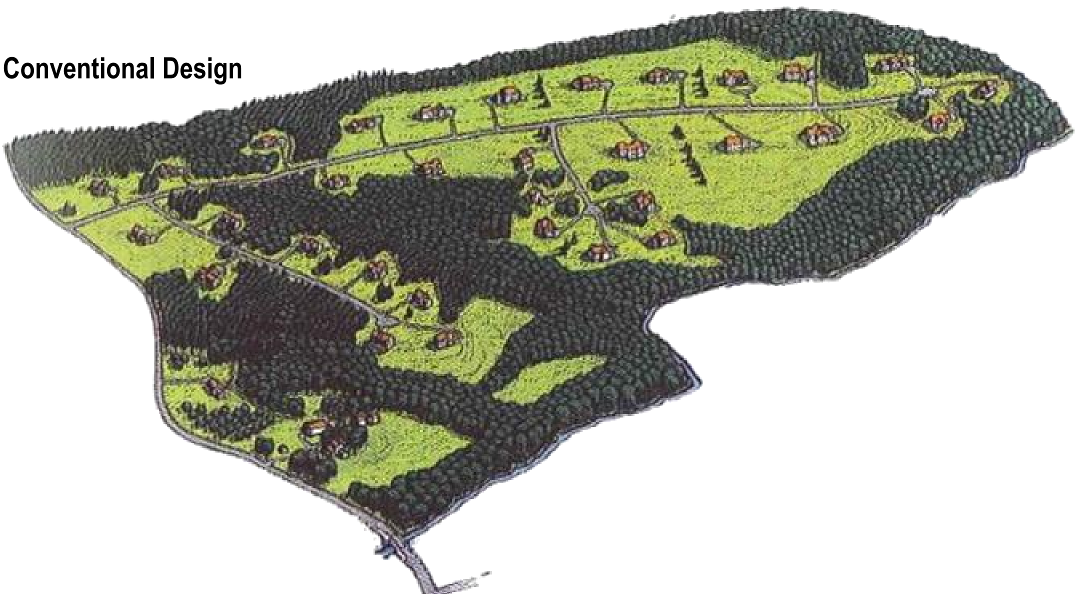
1. **Identify primary and secondary conservation areas**. The open space of a site is determined first and grouped into a hierarchy of primary or secondary conservation. Primary are place that shall remain completely natural or untouched. Secondary conservation areas are still not developed on but can be based on prime soils for pasture or well-drained soils for septic, or have good viewshed values. Development can be near secondary areas but should avoid both tiers of conservation area/open space.
2. **Identify development areas.** The next phase is to identify areas where the development program, the housing units or other community amenities such as recreation facilities or community buildings, should be located. These areas should have access to, but not necessarily on top of soils suitable for septic drainage. Share septic fields are encouraged. The location of houses should maximize the potential of the protected lands especially shared space such as commons, neighborhood greens, trails and greenways, forest preserves, or farmland.
3. **Identify access and connectivity.** The third step is to sketch in the access and connectivity both into the site and within the site. This steps connects-the-dots through weaving in streets and trails.
4. **Site housing and lots based on conservation framework**. The last step is to identify locations and individual lots for the allowable development potential. This yield is determine by calculating what the property would be allowed to develop under conventional zoning code which tends to be 2 acre minimum lots in non-sewered areas of rural Wake and Granville

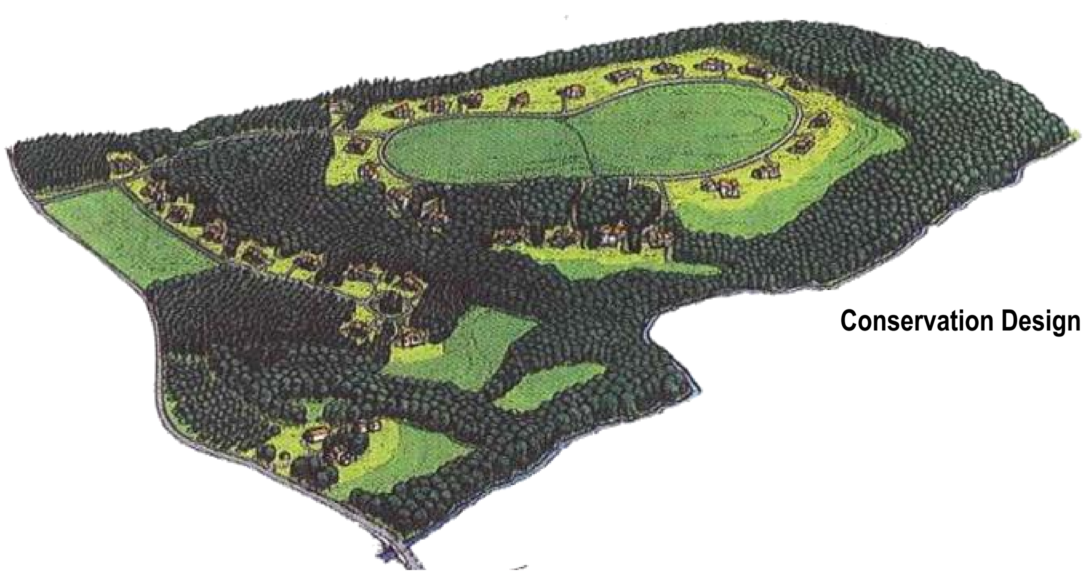
Counties. Then apply any density bonus that may be permissible because of incentives in a conservation design ordinance, for example a 50% increase of allowable units provided these could be added without compromising the conservation design objectives.

The images on this page (Arendt, 2010) illustrate the contrast between a conventional site design and a conservation site design alternative produced using the four-step design approach listed above.

Site Before Development

Conventional Design





Conservation Design

Maintain Property Values

Density bonuses will allow developers to build more units on the property than the traditional yield would allow. If conservation performance measures are met and demonstrated through the preliminary conceptual sketch, then the traditional development yield can be increased by a percentage, say 50%. For example, a 100 acre lot at typical 2 acre/unit zoning would yield 50 units, which could be increased by 50% to 75 units. This density bonus would be permitted by-right if the conceptual plan demonstrated that the performance measures were not compromised by the addition of these units.

If implemented correctly both LID and conservation design approaches have the potential to save costs in a number of ways. The following benefits-to-developers was excerpted from the WECO LID – an economic fact sheet (WECO, 2009):

- Reduces land clearing and grading costs
- Reduces infrastructure costs (streets, curbs, gutters, sidewalks)
- Reduces stormwater management costs
- Increases lot yields and reduces impact fees
- Increases lot and community marketability

Concluding Arguments for Conservation Design

Rural conservation design alone will not solve the problem of preserving agriculture or rural character, but it is one tool that localities can adopt to help address the conflicting pressures for development and preservation. Development in rural areas is still largely auto-dependent and potentially makes for longer travel times to places of work, shopping and recreation. However, it presents an approach that seeks to balance the demand for rural growth patterns but allows them to develop in more sustainable patterns thereby helping to protect watersheds and rural viewsheds while preserving land values and development rights.

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