Integrating Transportation and Land Use:
Land Development Plan Standards and Evaluation Tools

by

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INTRODUCTION

The purpose of this document is to provide guidance to the North Carolina Department of Transportation (NCDOT) and local governments in North Carolina on how to structure local Land Development Plans so that they can be used in long range transportation planning. The impetus for this guidebook is the 2001 amendment to the General Statutes requiring towns that request NCDOT involvement in transportation projects to have a qualifying Land Development Plan.

The amendment has not yet been fully implemented, due in part to the lack of guidance to local governments and NCDOT regarding the necessary plan contents. Additionally, NCDOT has not received sufficient guidance on methods of evaluation for the Land Development Plans, in order to assess whether they comply with the plan requirements. The lack of guidance has caused problems in some areas around the state, delaying transportation planning efforts. In order to bridge these gaps, this document provides the following:

- Detailed discussion of the necessary land development plan components and the rationale for requiring them;
- Plan evaluation questionnaire;
- Detailed discussion of appropriate preparation methods of plan components, with increased guidance to NCDOT regarding how to assess whether the plan preparation is adequate; and
- Suggestions for how to explicitly address transportation issues within the Land Development Plan.

It is not the purpose of this document to provide detailed planning support to local governments. The North Carolina Division of Community Assistance (DCA) is the appropriate state agency for local planning assistance; there are also other agencies and organizations that can provide planning assistance. A list of planning-related resources is provided in Appendix 1. This guidebook also will not address macro-level policies, as they are assumed to come from federal or state mandates beyond the control of local governments.

Figure 1 provides an illustration of the land development planning process and how it feeds transportation planning. To determine the necessary contents of the Land Development Plan, this document starts with the land use forecast that must feed the transportation planning process. Baseline (current year) land use data feeds the forecast, and also provides the basis for any future growth pattern scenarios. Local development management policies, determined in part through the public involvement process, inform the future growth pattern scenarios and the forecast. Finally, the future growth scenarios, informed by macro-level policies, public involvement, baseline conditions, and development management policies, provide the land use forecast map and data that feed into transportation planning.
The following chapters focus primarily on the creation of the land use forecast and the elements of the Land Development Plan that feed it: local development management policies, future growth pattern scenarios, the public involvement process, and environmental analysis.

Part One provides the background and context for the project. Part Two explores the land development-related data required for transportation planning – both data for transportation models as well as relevant policy information. This section ends with a list of necessary data elements and policies, and the corresponding Land Development Plan components that produce them. Part Three provides greater detail on the Land Development Plan components, and potential methods for their creation. Part Four discusses explicit ways to connect the Land Development Plan to transportation issues, primarily by addressing projects in the Transportation Improvement Program (TIP) and access management. Because public involvement is a critical piece of the planning process, Part Five is dedicated to discussing the importance of and best practices in public involvement. A questionnaire for local planners about public involvement techniques will eventually be created out of this section. Finally, Part Six discusses overall plan evaluation in the context of transportation planning, and provides an evaluation questionnaire for CTP Team members and/or NCDOT planners to use to evaluate local Land Development Plans.
1. BACKGROUND AND CONTEXT

1.1 Land Development Plans in North Carolina
In 2001, the North Carolina General Statutes were amended to state that, “The Department of Transportation may participate in the development and adoption of a transportation plan or updated transportation plan when all local governments within the area covered by the transportation plan have adopted land development plans within the previous five years. ... A qualifying land development plan may be a comprehensive plan, land use plan, master plan, strategic plan, or any type of plan or policy document that expresses a jurisdiction’s goals and objectives for the development of land within that jurisdiction.”¹

This amendment acknowledged the interconnectedness of land and transportation system development, but has not yet been clearly implemented. NCDOT has not provided guidance to local governments or to plan evaluators as to what information and features a qualifying land development plan must contain. The purpose of this document is to provide the necessary information to NCDOT to be able to comply with the General Statutes.

1.2 The Land Use – Transportation Connection
The need for a Land Development Plan to feed transportation planning is based on the land use – transportation connection. The concept of accessibility is primary to understanding the relationship between transportation and land use. According to the classic urban economic model developed by Von Thunen (1826), accessibility affects the desirability and consequently the price of land. Under the model of a city with a central core, lower travel costs associated with land closer to the center raises the value of the land. Potential residents and firms will choose to locate near the center in order to take advantage of the convenience of proximity. Similarly, land further away from the center is less expensive, due to greater travel cost. Despite the inconvenience of increased travel, residents or firms may decide to locate further away in order to take advantage of less expensive land. All else being equal, as one moves out from the center, the change in land value is directly related to the cost of travel.

The ability to move farther away, however, depends on the transportation infrastructure. A transportation system that makes commuting inexpensive leads to a decentralized population and an expansion of the boundaries of the city. (For this discussion, the “expense of travel” refers to both economic and personal costs, such as time, convenience, out of pocket cost, etc.) If transport cost is increased, however, the opposite will occur: households and firms will locate closer to the center in order to save on travel (Giuliano, 2004). Figure 2 illustrates the relationship between transportation, land use, accessibility, and travel behavior.

¹ G.S. 136-66.2 (b1)
Starting with transportation, the cycle is described accordingly:

- The characteristics of the transportation system determine the accessibility of locations (the ease of reaching them through the system);
- The accessibility of locations then affects the decisions about where to place various activities and land uses;
- The location of activities, along with the transportation resources connecting them, affects daily activity patterns, which relate to travel patterns and decisions;
- The travel patterns affect the transportation network and its needs, starting the cycle over again.

The reciprocal relationship between transportation and land use development has gained increasing attention in recent years, with research aimed at identifying the impacts they have on one another and how to integrate the two planning processes. There is some debate, however, about the strength of these relationships, and which has a greater effect on the other – transportation or land use. This paper does not attempt to enter the debate, but takes as given that they are related and a change in one will result in a change in the other. What is important is that ultimately, the transportation system (including commute time, transit availability, parking, etc.) influences individuals’ decisions about where to live and work, and developers’ decisions to develop or redevelop an area are based in part on the accessibility of the transportation system (Rodríguez, et. al, 2003).

The transportation and land use systems are both components of the broader urban system, which includes people, institutions, and other infrastructure (Giuliano, 2004). The various components in the urban system change at different rates, and also respond to changes in other components at different rates. The components discussed in this paper change at a relatively slow pace, but they affect and are affected by other components that can change much more quickly. Wegener (2004) breaks down the changes accordingly:

- Very slow change: land use, transportation facilities, infrastructure networks
- Slow change: workplaces and housing
- Fast change: employment and population
- Immediate change: goods transport and travel – very flexible
One limitation of the economic model is the assumption that land cost and transportation cost are the only two factors determining individual location decisions. Tiebout (1956) considered location decisions to be determined more by factors such as taxes, schools, other infrastructure, community services, than by regional accessibility. Because of this, it is difficult to estimate the degree to which the urban spatial structure can influence location and travel behavior. The purpose of this project is not to try to use spatial structure to change travel behavior, but rather to include it in anticipating travel behavior.

This project approaches the issue from the second half of the cycle – the way in which land use changes affect travel behavior and therefore the needs of the transportation network. The hope is that by requiring land development plans, the land use information in the travel demand models will be improved, thereby leading to improved estimates of the future transportation system needs. This does not take the cycle back around to discuss new development resulting from increased accessibility from new roads, but it is hoped that the policy information in the land development plans will add some of that information – where is new growth allowed or encouraged and the types of development. This should help to develop the transportation models and plans in such a way as to be more comprehensive and anticipate needs better. This project assumes the need for communication between the two processes. This is not a normative declaration of support for a certain pattern of development, rather that the two are related, and in order for either process to work well, there must be shared dialogue.

1.3 Planning Responsibility
In the United States, land use planning authority lies with local governments, while transportation planning takes place on a regional scale. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 was the first federal transportation act in the United States to make the connection between transportation, land use and air pollution. In urbanized areas, ISTEA required Metropolitan Planning Organizations (MPOs) to conduct long-range (25-30 year) transportation plans. Outside of urbanized areas, transportation planning is typically conducted by states’ Departments of Transportation (DOTs). After the long-range transportation plan is approved, the state DOT is called upon to implement projects from the plans as part of the Transportation Improvement Program (TIP). The DOTs perform the work necessary to take projects from plans to construction, including engineering design, NEPA environmental analysis, fulfillment of federal funding requirements, and federal natural resource agency consultation and permitting requirements (ICF, 2005). While the NEPA review process requires an assessment of potential secondary and cumulative land development impacts of transportation improvements, the interdependent relationship should not begin there. Ideally, this analysis would build on the locality’s land use plan (Rodríguez, et al, 2004).

There are no federal requirements for local land use planning, although some states have mandates for all communities, or communities in environmentally sensitive areas. While there is no blanket requirement for local land use planning, when courts must determine the validity of local regulatory actions, they typically review whether the action is consistent with and based on a local comprehensive plan. Regulatory programs are more likely to be found reasonable if they are based on a comprehensive plan that has been officially adopted in accordance with due process requirements (TRB, 2003). In North Carolina, planning is required in coastal communities to prevent flooding, through the Coastal Area Management Act (CAMA), but there is no statewide mandate. The General Statutes requiring Land Development Plans for transportation purposes is the closest thing to a general mandate in North Carolina.
2. LAND DEVELOPMENT-RELATED DATA FOR TRANSPORTATION PLANNING

The necessary land development-related data for transportation planning are divided into two categories: data needed for transportation modeling and “other necessary data”. The other necessary data is mostly related to policy decisions, including information that NCDOT needs in order to comply with its federal requirements to protect sensitive populations and sites such as wetlands and wildlife habitat, historic sites, and environmental justice communities. This section also discusses the data needed for the Land Use sub-process of the new statewide Comprehensive Transportation Planning Process (CTP). After discussing each of these categories and the rationale behind the requirements, the section ends with a table detailing the actual data elements and the component of the Land Development Plan that contains each element. Part 3 provides more detail on the Plan components.

2.1 Land Forecasting Modeling

Planners rely on models to help understand land use-transport interactions and relationships. A model can be considered a simplified representation of a part of the real world (Ortúzar, et al, 2001). Long-range plans are guided by the results of transportation modeling, which typically follows a 4-step modeling process: trip generation, trip distribution, modal split, and assignment. These models are used to plan at the regional level, and they rely on a variety of data sources, including local land use information.

Land use forecasts are used to predict future land conditions, which are then used as an input for the four-step model. These relationships highlight the relationship between transportation and land use, which is necessary in order to predict traveler behavior and conditions. Ideally, the process should include a feedback loop to address land development activity resulting from transportation investment. Models have not traditionally included this step, but some newer ones are beginning to account for the feedback.

Land forecasting typically refers to population and employment projections for small geographical areas, such as a Traffic Analysis Zone (TAZ). There are three primary approaches for producing allocations by zone; each varies in the demand for raw data and computing power. The three approaches are briefly described:

- **Negotiated Estimates** use local plans and projections to allocate by zone. These estimates may allocate according to ratios or growth trends, and often require some compromises about where to distribute growth. This method typically uses expert judgment, in processes based on the Delphi Method. The use of expert opinion is discussed below in greater detail. Estimates require a strong data background, with information such as: employment, population, land availability and price, land use occupancy and rent data, zoning, other land use regulations, economic development plans, market assessments, building permits and construction starts, local policies and desires for growth.

- **Scenario Approaches** rely on constructing multiple land use and development alternatives. Scenarios are based on plans that define how the region should look in the future, and allow analysts to test a variety of policy options. Because the scenarios are usually based on information gathered from either expert methods or mathematical models, scenarios are not discussed here in further detail.

- **Formal Mathematical Models** allocate jobs and housing to smaller zones within a region as a function of accessibility, land availability, population and employment by category, household income, etc. While models are not able to predict future conditions with complete accuracy, their advantage is that they account for transportation/land use interactions. Models usually rely on extrapolating past trends subject to constraints, rather than representing location decision-making behavior (Keller, 2004). While the information outputs from the land forecasting is vital to travel demand modeling efforts, there is no clear responsibility for conducting a land forecast. In some situations, municipalities or regional Councils of Government (COGs) perform the forecast and provide the results to the MPO or state DOT conducting the modeling and planning. In other situations, the MPO will take responsibility for the land forecast in addition to the travel model. It is common that a detailed land use forecast is not conducted. Further, if a land forecast conducted, there are no standards regarding the sources of data for the land
forecast. This paper assumes that in order to improve the relationship between transportation and land use planning, the transportation planning authority should be using the same data to create the land forecast that the local government uses. One way to accomplish this is to have the local land development plan provide some of the data that feeds the forecast.

2.1.1 Negotiated Estimate / Expert Opinion Methods

Expert panels are able to provide rigorous analysis in forecasting future land use patterns, without the technical and financial challenges of quantitative models. Expert panels combine understanding of the theory of urban development, empirical knowledge of transportation/land use relationships, and detailed understanding of local conditions. While they are not a replacement for quantitative data, they can integrate data with the perceptions and judgment of people familiar with the study area (Seskin, et al, 2002). In this context, an expert is not necessarily an academic. It should, however, be a relatively objective professional who is familiar with the area and with land use and transportation relationships.

Many types of group processes could be considered “expert panels.” Advisory committees, review committees, stakeholder review boards, and facilitated group processes, for instance, all have similarities to expert panels. This document recommends that if an area decides to use an expert panel, that it be based on the Delphi Method. The Delphi Method is a highly structured technique in which selected experts provide their assessment of likely future outcomes by responding to several rounds of questions. The following are other characteristics of this approach:

- The panel consists of a diverse group of individuals;
- Each panel member has equal access to high quality information;
- Each panelist carries out his or her own analysis;
- Each analysis is shared with the rest of the panel (usually anonymously); and,
- Panelists have an opportunity to revise their initial analysis after reviewing other panelist’s findings. (Seskin, et al, 2002).

It is important to note that a lack of consensus from a panel does not signify a “failure” of the panel, but rather may accurately reflect a situation in which only a wide range of possible impacts can be foreseen. Decision makers are likely to benefit from having this information (Seskin, et al, 2002).

Given the data and calibration requirements associated with computer models, the use of expert panels may be appropriate in smaller, less complicated settings. The use of a panel instead of relying only on the planner or the consultant is recommended in situations not using computer models, in order to ensure that a broad range of issues is considered in detail.

2.1.2 Mathematical Models

Land use-transportation interaction models have the ability to address the reciprocal relationship between land use and transportation in a more comprehensive way. The purpose of these models is to predict the behavior of urban systems by responding to ‘design’ inputs (Keller, 2004). These predictive models can be either “static” or “dynamic”, which assume either equilibrium or disequilibrium conditions, respectively.

Equilibrium models generally assume that independent variables (e.g. price, supply, demand) adjust to eventually reach equilibrium within the model cycle. Conversely, dynamic models assume that some changes occur faster than others, and that urban systems are usually in disequilibrium (Wegener, 2004). As previously discussed, changes within urban systems take place at different time scales. A change in the land development pattern or transportation infrastructure is relatively slow, while a more flexible component, such as travel or goods movement, can change much more rapidly. The static model would assume that these factors will change at the same pace within the model time period, while the dynamic model would not. Current practice is moving in the direction of dynamic models that can continually account for the relationships between transportation and land use forces. The advantage of these models is that they can more holistically consider the urban system and also be more sensitive to policy decisions. The disadvantage is that they are more computationally intensive, and also require very significant data inputs.
The three most relevant categories of models discussed in this section: spatial interaction, input-output, and discrete choice. An example of each type of model is also discussed briefly.

A. Spatial Interaction Models
This class of models primarily focuses on allocating workers to a predefined set of land use zones on the basis of basic employment levels. The necessary data for these models is relatively easy to obtain, and they consider the processes affecting the location of activities over time.

The most common spatial interaction model is the DRAM/EMPAL model developed in the 1970s. It is the only land use forecasting model currently in wide use in the United States. DRAM/EMPAL is derived from the Lowry Gravity model and is able to allow interaction with travel models (Waddell, 2002). DRAM/EMPAL consists of two models – EMPAL allocates employment to zones using forecasts of total employment by types; DRAM forecasts the future location of households given the distribution of employment and the attractiveness of zones (Keller, 2004).

There are several limitations to using DRAM/EMPAL, primarily the insensitivity to behavior and potential policy decisions and the highly aggregate scale of analysis. Population and employment are aggregated to zones, which may be too large to be useful for transportation planning. Also, it is not possible to model the impacts of planning policies or the land market. The only type of land policy that the model can accommodate is zoning or some other land use category. This does not include other policies that may be used, timing of development, or the associated land market and prices (Waddell, 2002; Keller, 2004).

Data inputs include:
- Vacant developable land
- Percent of land already developed
- Total land area
- Land allocation by activity
- Transportation descriptors (links, speeds, capacities)
- Employment by type
- Household by income quartile
(Waddell, 2002; Keller, 2004)

B. Input-Output Models:
This class of models uses the quantity and location of activities as well as the use and rent of land, both of which are subject to planning constraints. There is capacity to model commodity flows and also to include markets for land, labor, and floorspace. The greatest strength of this model is its ability to analyze different types of policies – investment, regulation, pricing, etc. – in both land use and transportation. Of all commercial land use model packages, these come closest to modeling interrelated variables in cities (Waddell, 2002; Keller, 2004).

The two most common input-output models are MEPLAN and TRANUS, which are very similar. They are both widely used outside the United States – MEPLAN in Europe and TRANUS in Central and South America – and are only now beginning to be tested for use in the United States.

In this class of model, land and transportation are treated as two parallel and interacting markets. Land use is influenced by the patterns in the prior period and by previous period transport accessibilities. Transport is influenced by previous infrastructure and present activity patterns arising from land use. The demands for transport are calculated directly from the interactions predicted by the spatial system defined within the land use model (Keller, 2004).

The primary limitations of this type of model are the data needs and difficulty in calibrating the model. While these models require a lot of data, it is possible to simplify the data needs at the expense of model detail. There is enough aggregation within the models that they may be better suited to statewide rather than intra-urban modeling. Also, the calibration process is very difficult and time consuming. Neither the process nor the software encourage testing alternative scenarios (Waddell, 2002; Keller, 2004)
Data inputs include:
- Land use by category
- Floorspace by category
- Land prices by use category and density
- Land use designation in local plans
- Policies such as pricing, zoning, and taxes
- Travel networks
- Population by category
- Employment by category
- Average income per capita by income class
- Household expenditures for land, travel, retail, and other.

(Waddell, 2002; Keller, 2004)

C. Disequilibrium Models:
This class of models attempts to simulate location decision-making behavior on a very disaggregate scale, usually of individual households or firms, by relying on discrete choice models. There is great potential for these models to improve the forecasting process, but they are mostly still under construction and have not yet been widely implemented.

The emerging discrete choice model is UrbanSim, under construction since 1996. UrbanSim uses six interacting models to test the impacts of future policy and infrastructure changes on land use-transportation systems. The six interacting models are: accessibility, economic and demographic transition, household and employment mobility, household and employment location choice, real estate development, and land price. By separating the entire system into the different models, each component can be manipulated independently. The system is also able incorporate policy decisions and assumptions, which are not currently included in most land forecasting models.

UrbanSim is provided online as Open Source software, allowing virtually anyone to download and use it. This allows users to make changes or improvements to the model, and share their changes with others.

The biggest limitation of UrbanSim is the need for very extensive data and computing power. For example, there are 57 different input tables, which can be classified into three categories – households, grid cells, and jobs, and many supporting tables. Data for the tables must be collected from multiple sources and can pose challenges to implementing the model. The system also needs a more extensive interface for coupling with travel models (Waddell, 2002).

Data inputs include:
- Regional control tables
- Parcel data
- Business establishments
- Household data (census, travel survey)
- Land use plan
- Environmental constraints

(Waddell, 2002).

2.2 North Carolina Department of Transportation Modeling Practices
The North Carolina Department of Transportation (NCDOT) is involved in much of the travel modeling in the state, both providing assistance to MPOs and taking responsibility for non-MPO areas. NCDOT does most of the modeling for many of the smaller areas; the places where it is much less involved are the Triangle, Triad, and Charlotte regions.

In general, compared with other states, this state dedicates relatively little resources to travel modeling. NCDOT and the MPOs in North Carolina mostly do not use formal models for land forecasting; rather they rely primarily on the negotiated estimates or expert opinion method and scenario testing. In the future, it
may be worthwhile to adopt a more formal modeling practice, in order to address the feedback between land use and transportation in a more comprehensive approach.

Given that areas in North Carolina primarily use the negotiated estimate approach, it is of utmost importance that there be a quality Land Development Plan from which to make assumptions and decisions.

2.2.1 Land Use Forecasting in North Carolina

The current land use forecasting practice in North Carolina roughly follows the methods described in this section. “Best-guess” estimates of future land uses are created by the NCDOT modeling team, and then given to the local governments to adjust according to local priorities or other policy information. The estimates are based on predictions of growth (population and economic activity), and vacant land parcels that can be developed. The NCDOT estimates are rough, and sometimes allocate too much development to certain areas. They are also limited in their ability to capture infill development or other changes in land use of a particular area (Fussell and Bryson, 2006).

The distribution of growth throughout the region is another difficult issue for transportation modelers to address. As previously discussed, the transportation planning process takes place on a regional scale, while land use planning is the responsibility of local governments. The NCDOT modelers have found that when presenting their land use forecasts to multiple jurisdictions, many towns will “accept” the growth that they want, and attempt to push the less desirable growth to other municipalities within the region. The need for more regional coordination of land use planning is noted, but not the focus of this document.

The forecasts are typically for a 30-year time period. The first 10 years can usually be modeled using current conditions and short-term trends, but the interim time periods, from approximately 10 to 20 years is much more difficult for NCDOT to forecast. Land Development Plans can provide some of the necessary interim information (Fussell and Bryson, 2006).

2.3 Land Use Forecasting Data Needs

There are several data inputs that the Land Development Plans can create for the land forecasting process. The most important data and policy information include:

- Phasing and timing of growth
- Vacant and developable areas
- Broad classification of use (industrial, commercial, residential), including holding capacity
- Detailed description of employment or the types of retail development that is allowed in certain areas, with some estimate of numbers of employees
- Plans to extend water and sewer facilities, as well as other public infrastructure
- Desired roadway projects
- Areas that can support public transit or pedestrian and bicycle travel
- Environmental suitability of development or transportation projects

The biggest question for the NCDOT modeling team appears to be related to modeling employment and travel resulting from various business sectors and areas. They need data on numbers of employees, as well as the type of establishment in order to estimate trips generated by that land use. Because of proprietary matters and collection methods, employment data is much more difficult to obtain than other population and demographic information. The desired level of detail will likely be beyond the scope of the Land Development Plan. However, policy decisions regarding the priority areas for employment growth, the types of development, and policies for interim years will help in creating employment forecasts. This type of policy information should be included in the Land Development Plans.

The NCDOT analysts generally do not require further information for the travel demand modeling beyond what goes into the land forecast.

2.4 North Carolina Comprehensive Transportation Planning Process

In the past several years, NCDOT has begun to redesign the traditional “thoroughfare plan process” to create a new “comprehensive transportation plan” (CTP) process. In 2004, representatives from NCDOT,
the Federal Highway Administration, metropolitan planning organizations (MPOs), and rural planning organizations (RPOs) met for a weeklong process-redesign workshop. The goal of this workshop was “to design a process that supports the development of a new long-range comprehensive (multi-modal) transportation plan.” The Team created a conceptual design for the new CTP process.

The CTP process has the following five high-level steps:
- Develop CTP vision
- Conduct needs assessment
- Analyze alternatives
- Develop final plan
- Adopt plan

The Team also identified additional sub-processes that needed to be detailed:
- Land-use integration
- Stakeholder involvement
- Multi-modal integration
- Modeling
- Environmental considerations
- Documentation
- Air quality
- Fiscal constraint (D’Ignazio and Hunkins, 2004)

The CTP process provides an explicit link to land use planning, and requires land use inputs at multiple points throughout. This section describes the relationship between the Land Development Plan and the CTP process, and how to create the necessary inputs for the CTP process.

The Land Use Subprocess is designed to bring together officials from local governments, MPOs/RPOs, and/or NCDOT. One hope is that bringing together representatives of each of the municipalities within the region will help to address some of the questions about allocation of development throughout the region. A priori, the subprocess requires that the jurisdictions have adopted a land use plan within the past 5 years. The plan is evaluated as part of the subprocess, particularly in terms of the environmental “friendliness” of the plan and the quality of public involvement in creating the plan.

2.4.1 Land Use Data for the CTP Process
The subprocess requires current land use data, both quantitative and qualitative. Important data attributes include existing land uses by parcel, housing and employment, and vacant land overlaid on environmental constraints (TAZ structure). The subprocess analysis should also be able to identify priority land development projects and land uses that must be accommodated by transportation improvements.

2.4.2 Policy Options and Public Involvement
It is necessary for NCDOT to be certain that the Land Development Plans submitted by local governments reflect the goals and visions of the citizens of the jurisdiction. Because these plans will be used as the starting point for the transportation planning process, they must be the product of a robust public involvement process. It should be noted that this is not intended in any way to curtail legitimate debate regarding the actions of NCDOT, rather it is meant to prevent unnecessary controversy and public confusion about the multiple planning processes.

Measures to ensure that the plan reflects community views and objectives may include interviews with planning staff, elected officials, and other identified stakeholders. Another measure may be to review the minutes from relevant meetings, such as those of the planning, zoning, and/or policy boards. The necessary plan components (or accompanying documentation) and methods to assess them will be discussed in Part 3.

Another reason for the emphasis on public involvement is that as part of the Land Use subprocess, the CTP Team must identify land use scenarios to be tested in the transportation plans and assess the
possibility of changing some land use outcomes that potentially constrain transportation solutions. Detailed knowledge of citizen goals and priorities will provide the CTP Team with more information regarding the aspects of the Land Development Plan that may be open to some revision, and the aspects for which there would not be community support for changes.

The following are examples of “Quality Standards” defined in the Land Use subprocess:
- Land use plan includes the data that is useful in the transportation planning process (environmental constraints, demographics, sociological and economic data)
- Realistic land pattern (environmentally)
- Public involvement in Land Development planning
- Policies, goals and vision

The Plan Quality Evaluation section in Part 6 builds upon these ideas in the evaluation scan.

The table on the following pages presents land use data inputs to the land forecast that may be able to come directly or indirectly from the land development plan. Ideally, these data elements should be provided at the most disaggregate level possible. This may mean parcel, census block, block group, tract, or traffic analysis zone. More aggregate level data will be less useful for transportation modeling. While most land forecasting models are not yet very sensitive to local policy, the policies should be clear and easy to understand, in order that those conducting the modeling can include them in the data and use them in creating scenario alternatives.

The use of policies to achieve planning goals and objectives is discussed in greater detail in Part 3. Listed below are some categories of policies that the Land Development Plan should include, in order to better account for the needs of the transportation planning process. More detail on some of these topics is provided in Part 4. These policy categories include:
- Timing of development and priority areas – to help schedule which areas will need transportation improvements first
- Priority land use outcomes and “second-choice” outcomes if transportation plans cannot adapt to the land use. This can be used to model scenarios
- Transportation improvements in the TIP planned for the town and policies for managing land development along the new or improved roadways
- Access management strategies along state highways
- Environmental policies
- Policies for hazard mitigation, as applicable to the area – hurricane, flood, landslides, drought, ice storms. These hazards affect the transportation system, both in terms of flooding across roads, etc, or roads and evacuation plans.
- Particular areas of concern that need to be served (i.e., EJ populations, etc.)
- The legality of any local planning activities – Dillon’s Rule
- Inventory and assessment of local, state, and federal policies, ordinances, and programs that affect development and redevelopment
- Long term growth in areas that use septic systems – need to keep them very low density if not going to extend water and sewer. Would extension promote more growth?
Table 2-1: Land Development-Related Data Needed for Transportation Planning

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Land Development Plan Component</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developable Land</strong></td>
<td></td>
</tr>
<tr>
<td>Vacant lands and their designations</td>
<td>Land Supply and Capacity</td>
</tr>
<tr>
<td>Areas for infill, redevelopment, or adding greater intensity</td>
<td>Land Supply and Capacity</td>
</tr>
<tr>
<td>Roofed space available (possibly by industrial, commercial, other services)</td>
<td>Land Supply and Capacity</td>
</tr>
<tr>
<td><strong>Land Classification (resulting from Suitability Analysis)</strong></td>
<td></td>
</tr>
<tr>
<td>Areas designated for residential development, explanations of “high” or “low” density</td>
<td>Land Classification Districts</td>
</tr>
<tr>
<td>Industrial areas</td>
<td>Land Classification Districts</td>
</tr>
<tr>
<td>Commercial areas (greater detail about different kinds of retail/commercial areas and #s of employees)</td>
<td>Land Classification Districts (detail will come from standards and policies in Land Vision and Principles)</td>
</tr>
<tr>
<td>Land use mix</td>
<td>Land Classification Districts</td>
</tr>
<tr>
<td><strong>Facilities that may attract or stimulate additional development</strong></td>
<td></td>
</tr>
<tr>
<td>(location, number, timing, and capacity)</td>
<td></td>
</tr>
<tr>
<td>Water and sewer</td>
<td>Land Classification Districts, Needs Assessment</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Land Classification Districts, Needs Assessment</td>
</tr>
<tr>
<td>Schools</td>
<td>Land Classification Districts, Needs Assessment</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td></td>
</tr>
<tr>
<td>Persons per acre or square mile</td>
<td>Standards, Districts, Capacity</td>
</tr>
<tr>
<td>Households per acre or square mile</td>
<td>Standards, Districts, Capacity</td>
</tr>
<tr>
<td>Employment, employees, or jobs per acre or square mile</td>
<td>Standards, Districts, Capacity</td>
</tr>
<tr>
<td><strong>Current transportation facilities</strong></td>
<td></td>
</tr>
<tr>
<td>Sidewalks</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Bicycle and pedestrian paths</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Parking lots</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Transit stops</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Local streets, collectors, arterials, thoroughfares, and highways</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Airports</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Goals for promoting bike/ped/transit modes, areas that may facilitate use of other modes</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Clear maps with transportation information</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td><strong>Demographics by zone</strong></td>
<td></td>
</tr>
<tr>
<td>Number of residents</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Age distributions</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Income ranges</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>“Environmental justice” communities</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Other sensitive populations</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Labor participation</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Neighborhood stability and cohesion</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td><strong>Environmental Attributes and Considerations</strong></td>
<td></td>
</tr>
<tr>
<td>Open space, buffers</td>
<td>Suitability Analysis</td>
</tr>
</tbody>
</table>
### Data Element

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Land Development Plan Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impervious surfaces: consider both water contamination and stormwater control</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Critical habitat, endangered species</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Wetlands</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Floodplains</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Land suitability analysis for development classifications</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Landscape-scale map with notable features and impacts</td>
<td>Suitability Analysis</td>
</tr>
<tr>
<td>Land use related minimization and mitigation strategies for use in the land development process</td>
<td>Suitability Analysis</td>
</tr>
</tbody>
</table>

### Explanation of Public Involvement Process

<table>
<thead>
<tr>
<th>Stakeholder groups involved</th>
<th>Public Involvement Section / Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach methods</td>
<td>Public Involvement Section / Questionnaire</td>
</tr>
<tr>
<td>Visioning techniques</td>
<td>Public Involvement Section / Questionnaire</td>
</tr>
</tbody>
</table>

### Maps

| Land use inventory – shows allocation for residential, commercial, industrial, public, parks and open space, institutional, and mixed uses |  |
| Water – lakes, wetlands, rivers, streams, drainage courses. Should also show lands that affect these water sources |  |
| Floodplains, steep slopes, and other conditions not suitable for development |  |
| Water supply network, sewer system, etc. |  |
| Existing transportation facilities, capacity and conditions |  |
3. PLAN COMPONENTS

The purpose of this section is to discuss the components of the Land Development Plan that provide the data elements discussed in Part 2 and examples of appropriate methods for creating these components. This is an exhaustive analysis of planning methodologies or to provide extensive directions for how to create the plan components. Rather, this section is intended to introduce the components and methods that are most relevant to the data needs for transportation planning.

In simple terms, the Land Development Plan is a combination of policies and maps, with text explaining how they were created and why. The text should describe the public process for creating development goals and policies to achieve those goals, as well as the technical analyses and policies for creating the development decisions shown on the maps.

The general land development planning process:

- **Introduction to Plan** – introduction, table of contents, summary of key features, explanation of how to use the plan, etc.
- **Discussion of Current Conditions / State of the Community Report**
- **Explanation of the Public Involvement Process (discussed in greater detail in Part 5)**
- **Land Use Vision and Principles** – includes goals, objectives, and policies, and the values upon which they are based
- **Land Analysis**
  - Land Needs Assessment – land needed to accommodate future development needs, taking into account future infrastructure and improvements to transportation capacity in the near future
  - Suitability Analysis – determine the areas that can accommodate uses, the size of the areas
  - Supply and Capacity – identify all developable land, determine how much development can be accommodated, and where (refer to standards, policies, goals, etc.)
  - Land Classification Districts – classify and explain what they mean, what uses they can contain. Map them and show the size.
- **Monitoring and Implementation** – what steps will be taken to implement and monitor the plan? The plan must be updated or at least verified at regular intervals. How will the plan be monitored in order to properly update it?

3.1 Introduction to Plan

This section provides an introduction to the plan and explanation of how to use it. Ideally, the introduction should contain a table of contents and a summary of the key features of the plan.

3.2 Discussion of Current Conditions / State of the Community

The Land Development Plan must begin with an assessment of current conditions, upon which all programs and policies for future development are based. This discussion should include details of land uses and facilities, as well as citizen perceptions of the current conditions and visions for the future.

Figure 3 below is a reproduction of the diagram of the Land Development Process from the introduction, which provides emphasis on the parts of the Land Development Planning process that are related to this plan component.
Figure 3: Role of State of the Community Report in Land Development Planning Process

Data Provided to Transportation Planning
The data elements provided to the transportation planning process from the Discussion of Current Conditions/State of the Community Report are listed below for quick reference. The actual data should be included in an appendix to the Land Development Plan. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements where relevant.

<table>
<thead>
<tr>
<th>Data Elements Provided by the Current Conditions / State of the Community Component</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics by Zone</strong></td>
</tr>
<tr>
<td>Number of residents</td>
</tr>
<tr>
<td>Age distributions</td>
</tr>
<tr>
<td>Income ranges</td>
</tr>
<tr>
<td>&quot;Environmental justice&quot; communities</td>
</tr>
<tr>
<td>Other sensitive populations</td>
</tr>
<tr>
<td>Labor participation</td>
</tr>
<tr>
<td>Sites of historic significance</td>
</tr>
<tr>
<td>Neighborhood stability and cohesion</td>
</tr>
<tr>
<td><strong>Current Transportation Facilities</strong></td>
</tr>
<tr>
<td>Sidewalks</td>
</tr>
<tr>
<td>Bicycle and pedestrian paths</td>
</tr>
<tr>
<td>Parking lots</td>
</tr>
<tr>
<td>Transit stops</td>
</tr>
<tr>
<td>Local streets, collectors, arterials, thoroughfares, and highways</td>
</tr>
<tr>
<td>Airports</td>
</tr>
<tr>
<td>Goals for promoting bike/ped/transit modes, areas that may facilitate use of other modes</td>
</tr>
<tr>
<td>Clear maps with transportation information</td>
</tr>
</tbody>
</table>
Description and Methods
This section should be based on and include the following types of data:

- Town boundaries and areas in Extra-Territorial Jurisdiction that could be annexed during the lifetime of the plan;
- Demographic characteristics;
- Types of residential and employment development;
- Current population and economic trends;
- Environmentally sensitive areas;
- Assessment of existing facilities and infrastructure;
- Review current local development-management regulations; and
- Unique issues or concerns within the community.

The Plan should include a map of existing conditions; this is a useful way to frame the plan and begin the planning process, and it is generally not very controversial (Kelly and Becker, 2000).

The State of the Community report includes technical data collection and analysis, as well as community-driven data that must come from a public participation process. The technical data analysis can identify many of the issues currently facing the town, but it will not capture all of the nuances, or the local knowledge that can be contributed only by residents. The public process helps to identify key issues facing the town, as well as a vision for the desired future based on community values (Berke, et al, 2006).

For purposes of transportation planning, it is most useful for the Land Development Plan to identify the existing and planned transportation systems in the planning jurisdiction. These include thoroughfares, greenways, bikeways, transit routes and stations. This element should also assess the problems in the existing system and whether the future system will serve future land use patterns (Kaiser and Moreau, 1999). In later sections, the Plan should address any roadway projects that the town knows it wants or needs, as well as areas that will support transit, pedestrian and bicycle modes.

3.3 Explanation of the Public Involvement Process
In the context of moving forward with the Comprehensive Transportation Planning (CTP) process, NCDOT must be confident that the local Land Development Plans upon which transportation decisions will be based have community support and “buy-in”. The Land Development Plan should reflect in some way the process by which it was created and gained such support.

Figure 4 below is a reproduction of the diagram of the Land Development Process from the introduction, which provides emphasis on the parts of the Land Development Planning process that are related to this plan component.
Data Provided to Transportation Planning
The data elements provided to the transportation planning process from the Explanation of the Public Involvement Process are listed below for quick reference. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements, where relevant.

<table>
<thead>
<tr>
<th>Data Elements Provided by the Explanation of the Public Involvement Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Public Process</strong></td>
</tr>
<tr>
<td>Stakeholder groups involved</td>
</tr>
<tr>
<td>Outreach methods</td>
</tr>
<tr>
<td>Visioning Techniques</td>
</tr>
</tbody>
</table>

Another possible connection between the Land Development Plan and future transportation planning efforts is to have community groups draw neighborhood boundaries used in planning. This could feed the Community Impacts Assessment conducted in transportation planning and project development.

Description and Methods
The Land Development Plan should ideally at least list the participants and partnering agencies involved in the preparation of the plan. The public participation process should shape the community vision, which defines in words the overall image of what the community wants to be and how it wants to look in the future. Because this issue is so important, it is discussed very briefly here, and Part 5 of this document is dedicated to addressing public participation.

3.4 Land Use Vision and Principles
The analyses and decisions made in the Land Development Plan are informed by the visions, values, and principles described in this section. The public process should generate some of this information — at least the overarching goals and some indication of what the citizens are willing to do to achieve those goals. There is discretion for the professional planners to create the actual policies to achieve the goals, once they have the necessary information from the citizens.
Figure 5 below is a reproduction of the diagram of the Land Development Process from the introduction, which provides emphasis on the parts of the Land Development Planning process that are related to this plan component.

Figure 5: Role of Land Use Vision and Principles in the Land Development Planning Process

Data Provided to Transportation Planning
While this section does not directly provide data elements for the transportation planning process, it contains the underlying principles upon which analyses and decisions are based. These principles guide decisions regarding the types, size, location, and timing of future development, all of which are necessary for effective transportation planning. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements where relevant.

Description and Methods
Goals, objectives, and policies that result from the public involvement process inform the rest of the planning process. There are some semantic variations in describing plan elements such as goals, objectives, and policies. This document provides one set of definitions widely used in the practice. All plans should have elements that follow these guidelines, although they may be called by different names.

3.4.1 Goals
A goal is an ideal future condition to which the community aspires. Goals are general aims, and are not instruments to achieve something else. Goals are usually expressed as nouns or adjectives and are not quantified. An example of a goal could be an aesthetically pleasing downtown, high environmental quality, or an adequate supply of affordable housing (Berke, et al, 2006; Kelly and Becker, 2000).

Planners deal with five types of goals:
1. Legacy goals come from previously adopted and currently followed policy of the local government; they are a good starting point for the goal-setting process.
2. Mandate goals, “musts,” come from state and federal policy and from the judicial system’s interpretation of statutory authority and constitutional rights.
3. Generic goals, “oughts,” come from political philosophy and the planning literature on good urban form, good land use management, and good governmental process.
4. Needs are goals for accommodating change and are derived from forecasts of population and economic change that must be accommodated.
5. The community’s concerns and aspirations, “wants,” are derived from a participatory goal-setting process. These represent what the community uniquely values about itself, what should be preserved, what problems are of greatest concern, and what the ideal community of the future should represent (Kaiser, et. al, 1995).

3.4.2 Objectives
An objective is a measurable, mid-range strategy used to benchmark achievement in reaching the goals. Objectives do not necessary need to be quantitative, but there should be some way to track them over time (Berke, et al, 2006; Kelly and Becker, 2000). An example of an objective could be to increase downtown development by 15%, or to preserve and restore as many historic buildings as possible.

3.4.3 Policies
A policy is an operational action, with a relatively short-term implementation, that is used to guide further planning and day-to-day development decisions (Kelly and Becker, 2000; Berke, et al, 2006). Policies are typically expressed as verbs, such as: prevent, encourage, study, create, etc. Policies need a good fact base for their selection, as they attempt to address the root issues identified in the goals and objectives. An example of a policy could be to provide tax burden relief to projects making use of already existing infrastructure and utility connections, or to require all historic buildings to be brought up to current fire code standards.

Policies can be worded with either suggestive or imperative language, making use of statements such as “should”, or “shall”. If the policies are imperative, then there should be discussion of ensuring that they are followed.

As policies are often closely related to local regulations and ordinances, it may be appropriate for this section to address specific regulations and ordinances or their relation to the Plan. Examples of relevant regulations and ordinances include zoning, subdivision ordinances, and plans to phase growth. The Plan does not need to provide detail about these regulations, but should include a reference to documents with more information so that the reader can find them if necessary.

The following are categories of policies that relate specifically to the information required for transportation planning:
- Extension of public services;
- Annexations to the planning area or extensions of Extra-Territorial Jurisdiction;
- Land management plans for areas served by TIP projects;
- Stormwater control;
- Open space preservation;
- Recreational facilities.

It is important that goals and policies relate to specific areas within the jurisdiction, as there may be areas that require special attention or consideration beyond the broader development goals (Kaiser and Moreau, 1999). Furthermore, there should be some sort of feedback to see if policies are achieving the objectives and goals, and if anything has been implemented (Kelly and Becker, 2000). This is particularly important for future plan updates and verifications. Some sort of monitoring is necessary to determine if changes need to be made to the Plan based on updated data and projections.

3.5 Land Analysis
The land analysis provides the physical component for the Land Development Plan. This section describes the processes for creating the physical plan. The decisions are based on environmental analysis, population and employment projections and trends, planned or anticipated infrastructure investments, and policies and values. This section is organized according to one example of a logical progression for land analysis. Some of the steps can be conducted in a different order, but should eventually create similar outputs. The process is illustrated below:
The four steps of the land analysis are described in more detail below. The description includes the data provided to transportation planning and the methods for conducting the analysis.

**Figure 6** below is a reproduction of the diagram of the Land Development Process from the introduction, which provides emphasis on the parts of the Land Development Planning process that are related to this plan component.

**Figure 6: Role of Land Analysis in the Land Development Planning Process**

![](image)

**3.5.1 Land Needs Assessment**
This section discusses the methods for determining the amount of land needed to fulfill future land use demands. This will be analyzed by land use type, i.e., the amount of land needed for residential, employment, industrial, commercial, etc. uses. The data inputs are derived from the population and employment forecasts, details of current and future development, and policies and expectations about the future character of development. The determination of needs may be both forecast driven and policy or value driven.

**Data Provided to Transportation Planning**
While this section does not provide explicit data elements for the transportation planning process, it directly guides the rest of the land analysis. It is not possible to adequately plan for future land needs if there is no analysis first of the actual needs. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements where relevant.

**Description and Methods**
The Land Needs Assessment begins with rough approximations of the number of acres needed for each general land use category. In the later stages, estimates are refined to reflect the specific character of desired development, consumer preferences, and the suitability of locations for various densities or mixes of uses. The following describes a four-step procedure commonly used to determine land needs. Not
every assessment needs to exactly follow this process, but they should all include similar steps. The process includes both forecast data and value driven policies:

1. Review characteristics of each existing land use type and the range of densities.  
   (Data source: existing conditions)
2. Review characteristics and capacity of existing infrastructure and anticipated future or planned infrastructure investments.  
   (Data source: existing conditions, policies, NCDOT plans)
3. Decide future level of population and employment to be accommodated in the residential and employment areas of the land use design.  
   (Data source: projections of employment and population)
4. Derive future space standards – consider existing densities, goals and policies, and trends in development practices. Standards can be expressed as ratios, such as acres of land per employee, square feet of retail space per consumer, etc. Standards can also be expressed as minimum lot sizes for large facilities such as schools, shopping centers, or industrial parks.  
   (Data source: existing conditions, goals and policies)
5. Multiply the space standards by the future population and employment to create estimates of needed space. Make sure to use a safety factor to ensure that there is adequate supply of land in case growth is greater than expected, or at a lower density.  
   (Data source: calculation)  
   (Berke, et al, 2006)

### 3.5.2 Land Suitability Analysis

A land suitability analysis determines the ability of a unit of land to support various types of development. This is one of the most important components of the Land Development Plan for transportation purposes and is described in this document in considerable detail.

The criteria for the suitability analysis are primarily environmental and ecological, but can also include other social and policy related criteria. A land suitability analysis requires multiple sources of data, including environmental/ecological features (hydrologic, geologic, biologic), as well as existing land uses and infrastructure. The analysis is typically conducted separately for each land use type (residential, retail, office, etc.). A score is given to each land use type for the land unit based on the environmental features and the accessibility to existing infrastructure. GIS can be used to overlay the maps for each land use type, and to calculate the final scores (Berke, et al, 2006).

The land suitability analysis is important to the transportation planning process for two primary reasons: to ensure environmental friendliness of the Land Development Plan and resulting transportation plans, and to better understand the values that dictate land decision-making at the local level. The land suitability analysis can also help to identify areas that are particularly well or poorly suited for building transportation or other infrastructure.

**Environmental Analysis**

The land suitability analysis is based primarily on environmental and ecological data and the ability of the human and natural environment to accommodate certain types of development. This is important for the transportation planning process, because the transportation planning and project development staff cannot plan to build transportation projects through environmentally sensitive areas.

**Decision-Making and Values**

To varying degrees, the land suitability analysis is based on values held by citizens and local leaders. It should address the importance of various environmental and infrastructure related issues when determining the suitability of land for development. Transportation planners need to understand the values behind decision-making and which issues are more negotiable than others. This can help with the creation of scenarios, any revisions that must be made as part of the CTP process, and determining priority areas for development.
Data Provided to Transportation Planning
The data elements provided to the transportation planning process from the Land Suitability Analysis are listed below for quick reference. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements, where relevant.

<table>
<thead>
<tr>
<th>Data Elements Provided by the Land Suitability Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Attributes and Considerations</strong></td>
</tr>
<tr>
<td>Open space, buffers</td>
</tr>
<tr>
<td>Impervious surfaces: consider both water contamination and stormwater control</td>
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<td>Landscape-scale map with notable features and impacts</td>
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<td>Land use related minimization and mitigation strategies for use in the land development process</td>
</tr>
</tbody>
</table>

Description and Methods
There are several methods for conducting a land suitability analysis. These methods vary in the degree of detail, computational sophistication, sensitivity to goals and policies, and ability to construct unique scenarios. Four methods for land suitability analysis are discussed below in more detail.

For all methods, it is essential that the analysis be accompanied by text explaining the assumptions embedded in the process (Berke, et al, 2006). For example, there must be explanation of the threshold for passing or failing, or which features and attributes receive higher scores or higher weighting than others. The assumptions must be transparent for several reasons: in order for the public to understand the planning process, in case additional scenario analysis is necessary, and for transportation planners to better understand local values and intentions for land development.

A land suitability analysis should be based on and include the following types of data:
- Soils (including areas of high erosion or soil conditions that are unsuitable for septic tanks);
- Slopes (including steep slopes on which development would be problematic);
- Floodplains (including areas prone to flooding);
- Wetlands
- Waterbodies (including lakes, streams, reservoirs).

Other considerations include proximity to existing infrastructure (roads, water and sewer, etc.); brownfield sites; and sites with special architectural, cultural, historic, archeological, or aesthetic value (Kaiser and Moreau, 1999).

Pass/fail Screening
This method depends on minimum standards for each land use type within the planning boundaries. The standards set a threshold that delineates whether or not development is appropriate. For example, a minimum standard for residential development may be for slopes less than or equal to 5 percent. For this one feature, any area with slope less than 5 percent is suitable, and any area with slope greater than 5 percent is not suitable. The screen would be conducted for each feature, for each land use category.

The benefit of the pass/fail method is that it is relatively quick, easy to conduct, and easy to understand (particularly for the public or other consumers of the information). However, the simplicity of the analysis does not allow it to consider for preferences, goals, or tradeoffs to advance other policy objectives (Berke, et al, 2006). This method is most appropriate in smaller, less complicated development situations.
**Equivalent Rating**

This method assigns a suitability score for each feature on a given unit of land, and then calculates a final score for each land use category on that unit of land. If scores for features are provided on a graduated scale, then the scale should be the same for every feature. For example, a scoring scale could follow this system: a score of 5 for slope 0-5 percent, a score of 3 for slope 5-15 percent, a score of 1 for a slope 15-30 percent, and a score of 0 for slope >30 percent. The final score for each land use category within a land unit is the sum of the scores for all features. The score follows this equation:

\[
\text{Score} = R_a + R_b + R_c + \ldots + R_n;
\]

where \( R \) is the score, and \( a, b, c, \ldots, n \) is the feature

The equivalent rating method is more refined than the pass/fail in that it allows for a range in desirability of different attributes. It allows the analyst to prioritize development in certain areas, while still allowing development in less desirable areas if other conditions are met. This method also allows the analyst to consider tradeoffs between different features if there is a very high score for one but a much lower score for another. The primary weakness of this method is that it assumes that every feature is equally important in determining the suitability of a unit of land for a particular use. Depending on the features in the area and the values upon which plans are based, this may not be an appropriate assumption (Berke, et al, 2006).

**Weighted Rating**

This method is similar to the equivalent rating system, with the additions of a weighting factor for each feature. For example, in a given land unit with poorly draining soil, the soil score could be counted as twice as important as the slope. The weighted score can reflect either local priorities or the relative importance of environmental features in the area. The score for each land unit can be calculated by adding together the weighted score for each feature, following the equation below:

\[
\text{Score} = (W_a*R_a) + (W_b*R_b) + (W_c*R_c) + \ldots + (W_n*R_n);
\]

where \( R \) is the score, \( W \) is the weight, and \( a, b, c, \ldots, n \) is the feature

By allowing for relative weights of the various features, the weighted rating method can include more policy or value judgment than the previous methods. Another benefit is that the weights can be a percentage, thus normalizing the final scores around one, which is easier to understand and compare. The primary weakness of this method is that it cannot account for unique combinations of landscape features (Berke, et al, 2006). The need for unique combinations is more relevant in more complicated, highly specialized planning situations.

**Direct Assignment Rating**

This method assigns a suitability score to each land unit by considering all features in combination. Unique combinations of features receive a rating. For example, there could be ratings for the following combinations of features: areas with slope less than 5 percent and close to road have high suitability; areas with slope 5-15 percent and close to road have moderate suitability; areas with very high slope are not suitable, but could be moderate if they are very close to the road or have some other positive attribute; etc.

The benefit of the direct assignment rating method is that it provides a greater level of detail and addresses values and planning tradeoffs. However, this method is complicated to perform, explain, and understand. It can be difficult to convey the assumptions and information to the public or others reading the plan. Also, the analyst must have a strong understanding of the relationships between the various features being considered and the implications of the scenarios that are scored as highly desirable (Berke, et al, 2006)

Table 3-1 summarizes the strengths and weaknesses of the four land suitability analysis methods.
The suitability analysis creates maps showing how the implications of the community’s land features and values affect land use design possibilities. While the maps show options for future land development, they do not reflect actual plans for future development. For example, a map might indicate multiple possible sites for a given type of development that requires only one site. Also, a suitability map might indicate that a site is suitable for multiple types of development, while only one will be chosen. The Land Development Plan should use the results of the suitability analysis and the goals, objectives, and policies to determine the supply and capacity of land, and allocate development to specific districts.

3.5.3 Land Supply and Capacity Analysis

This section describes the methods for determining the supply and capacity of land available for development within the planning area. It begins with a distinction between “supply” and “capacity”, and how they are defined in this document.

“Supply” describes the entire land base within a jurisdiction or region. Total land supply is broken into three categories: (1) fully developed parcels, (2) committed lands in the development “pipeline”, and (3) three types of buildable land – vacant, infill, and development. Vacant land can support new development; “developed” land also evolves, and can accommodate some amount of redevelopment as it adapts to new uses and users.

“Capacity” refers to the types and amount of people or development that the land is capable of supporting. The capacity can vary widely, depending on how the land is regulated, how desirable it is for specific uses, and how much competition exists for the use of the land (Moudon and Hubner, 2000).

Data Provided to Transportation Planning

The data elements provided to the transportation planning process from the Land Supply and Capacity Analysis are listed below for quick reference. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements where relevant.

**Data Elements Provided by the Land Supply and Capacity Analysis**

<table>
<thead>
<tr>
<th>Developable Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacant lands and their designations</td>
</tr>
<tr>
<td>Areas for infill, redevelopment, or adding greater intensity</td>
</tr>
<tr>
<td>Roofed space available (possibly by industrial, commercial, other services)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons per acre or square mile</td>
</tr>
<tr>
<td>Households per acre or square mile</td>
</tr>
<tr>
<td>Employment, employees, or jobs per acre or square mile</td>
</tr>
</tbody>
</table>

Description and Methods

There are several methods for determining the land supply and capacity. A common approach for the entire process is described briefly below, followed by greater detail on some of the analysis methods. Two definitions are provided before describing the process:
“Buildable” land supply is land on which additional or new development can occur within regulatory, physical, and market imposed limits. This is expressed as an amount of land.

“Development capacity” is the amount of additional and new development that can occur on land identified as “buildable”. Development capacity is expressed as a quantity of built space, such as dwelling units or building square footage, or may refer to households or employees. (Moudon and Hubner, 2000).

The approach for the land supply and capacity analysis should follow an approach similar to the one described here:

1. Develop a comprehensive land supply database. This includes existing and planned land uses, regulations, demographics, land ownership, environmental conditions, and existing and planned infrastructure.
   (Data sources: existing conditions, regulations)

2. Conduct an inventory of buildable land supply, including vacant, partially utilized land (with infill potential), and underutilized land (with redevelopment potential). Take out lands constrained by environmental or physical factors, public ownership, or other uses likely to preclude private development (churches, schools, cemeteries, etc.). Also take out any land that cannot be developed due to local, state, or federal regulations.
   (Data sources: existing conditions, regulations)

3. Estimate development capacity. This can be done at various levels of disaggregation to determine potential for land within parcels, watersheds, neighborhoods, zoning districts, etc. Account for site-level restrictions that do not prohibit development, but may limit it. Think about mixed uses, and industrial and commercial lands that are more complicated. Be prepared for “under-build” – vacant land is usually developed at densities lower than what is allowed.
   (Data sources: land supply, development standards derived in Land Needs Assessment)

4. Apply land supply and capacity information to plan making and plan implementation processes.
   (Data sources: existing conditions, products of earlier stages of the planning process).
   (Moudon and Hubner, 2000).

The development and redevelopment capacity of the land within the planning area depends on the results of the land suitability analysis and space standards. The suitability analysis provides the amount of land (e.g., number of acres) available for each activity. Using the demand for various land uses and the standards for space consumption discussed above in the Land Needs Assessment section, the “suitable” acres can be converted to an equivalent number of dwellings, population, or employees that can be accommodated for each land unit. The outputs of this step are maps and tables indicating the holding capacity of each planning area for the different uses potentially located there (Berke, et al, 2006; Landis, 2001).

3.5.4 Land Classification Districts
This section describes the final step of the land analysis portion of the plan – the creation of land classification districts. The creation of land classification districts build upon the needs assessment, suitability, and supply and capacity analyses to delineate land districts and the related allowed uses.

Data Provided to Transportation Planning
The data elements provided to the transportation planning process from the Land Classification Districts are listed below for quick reference. The plan component is described in greater detail in the next section, including discussion of methods for creating the data elements, where relevant.

<table>
<thead>
<tr>
<th>Data Elements Provided by the Land Classification Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Classification</td>
</tr>
<tr>
<td>Areas designated for residential development, explanations of “high” or “low” density</td>
</tr>
<tr>
<td>Industrial areas</td>
</tr>
<tr>
<td>Commercial areas (greater detail about different kinds of retail/commercial areas and #s of employees)</td>
</tr>
</tbody>
</table>
### Data Elements Provided by the Land Classification Districts

<table>
<thead>
<tr>
<th>Land use mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities that may attract or stimulate additional development (location, number, timing, and capacity)</td>
</tr>
<tr>
<td>Water and sewer</td>
</tr>
<tr>
<td>Hospitals</td>
</tr>
<tr>
<td>Schools</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Persons per acre or square mile</td>
</tr>
<tr>
<td>Households per acre or square mile</td>
</tr>
<tr>
<td>Employment, employees, or jobs per acre or square mile</td>
</tr>
</tbody>
</table>

**Description and Methods**

After determining development values, space needs, land suitability, and holding capacity, the final step is to decide the land classification system and draw it onto a map. The classification system must provide enough land for development in efficiently served locations while protecting vulnerable natural resources.

There are three primary types of districts, with multiple sub-districts:

- **Conservation Districts** (natural resources protected, development constrained)
  - Areas of critical environmental concern
    - Particular types of districts include wetlands, water, floodplain, water supply watershed, beach erosion area, other unique environmental resource, etc.
  - Other conservation priority areas
  - Agricultural reserve (maybe)

- **Rural Use** (agricultural and forestry production)
  - Rural holding district (possible long-term development)
  - Community centers (low density)
  - Agricultural reserve, forestry, resource districts. Examples include vineyards, orchards, etc.

- **Urban/Settlement/Development** (urban development and redevelopment)
  - Developing/Growth districts (for rural-urban transition)
    **these areas should be coordinated with infrastructure planning, especially sewer planning**
    - Satellite growth centers (new towns, etc.)
    - Urban-transition districts
      - 0-5 years
      - 5-10 years
      - 10-20 years
      - Long range future development
  - Developed districts
    - Redevelopment districts
    - Stable districts
    - Infill areas
    - Historical preservation areas

(Berke, et al, 2006)

It is recommended for the Plan to include a table describing the land classification system. The table should contain a short description of the purpose, characteristics, population/employment density, and any policies for each classification district. This provides an easy reference for readers of the plan to understand the different districts. Providing this information gives an indication of the types of uses and intensities that are described in greater detail in land regulations and ordinances.
After conceptually creating the classification districts, these districts are drawn on a map and given land areas. As possible design scenarios are created, the planner must be careful to properly account for the land demand and supply that is fulfilled by the scenario. The limits of the planning study area should be drawn sufficiently large so that there is a surplus rather than a shortage of suitable land. For growing municipalities, the planning boundary area should extend beyond the present municipal boundaries and into the ETJ areas. It should include all areas likely to undergo development pressure over the next 20-30 years as a consequence of the plan and market forces. If there is a shortage of developable land, the planner may need to relax standards, raise densities, increase the size of the planning area, or reduce the population or employment levels expected to be accommodated (Berke, et al, 2006; Kaiser and Moreau, 1999).

The boundaries of the land classification districts should be consistent with planned water and sewer service districts, transportation system improvements, and other plans for major capital improvements such as flood-control projects, water supply expansions, and airports. Community facilities should be supported by proposed land use patterns and have the appropriate development nearby so that they can effectively serve their community purpose. The proposed locations should be delineated and protected, particularly in case additional right-of-way must be acquired to serve them with the transportation system. Whenever possible, infrastructure plans should be coordinated with proposed land uses and activity centers. Sources of water supply and site for future solid waste management facilities should also be delineated and protected (Berke, et al, 2006).

3.6 Monitoring and Implementation
The Land Development Plan should include some discussion of how it will be implemented and monitored to ensure that it is working toward its goals. The plan is meant to be a living document, so there should be flexibility regarding its implementation as conditions and trends can change within the lifespan of the plan.

The legislation that requires Land Development Plans in North Carolina does not require their implementation. Therefore, this assessment also cannot require that they be implemented. However, the plans must be regularly updated or verified to coincide with transportation planning. At the time of the update, local planners must determine whether the same issues apply to the jurisdiction, whether the goals and policies should remain the same, and whether the plan should proceed in the same manner. The update process will run much more smoothly if there has been systematic monitoring of the plan in the time between adoption and the update. The plan itself should address these issues and provide some guidance for how it can be monitored. It may be necessary to revisit the objectives written in the Land Use Vision and Principles section to ensure that they are measurable.
4. CONNECTIONS TO TRANSPORTATION WITHIN THE LAND DEVELOPMENT PLAN

Through certain basic plan elements (previously discussed) a high quality Land Development Plan can address the land use-transportation connection. Again, it should be noted that this document does not advocate particular policies or measures. The Land Development Plan should discuss the land use-transportation connection in a comprehensive and fact-based way, but the content is for local governments to decide.

The degree to which a Land Development Plan can make this connection varies according to local characteristics, but as the CTP process moves forward, the connection should continue to strengthen. This section discusses some of the most important connections between land use and transportation in order to: 1) consider whether there is adequate transportation system to support current and programmed land development, and 2) to manage land development along planned roadways. To address these issues in the Land Development Plans, local governments may need additional information or technical assistance from NCDOT or the MPOs regarding planned roadways or capacity of current roadways.

4.1 Incorporating Transportation Improvement Program Projects into Land Development Plans

One of the most important ways to account for the connection between land use and transportation is to consider the projects programmed in the Transportation Improvement Plan (TIP). The Land Development Plan should account for programmed TIP road investments and the related impacts on land development. This accounting also provides a linkage to the assessment of indirect and cumulative impacts during the NEPA process (Rodríguez, et al, 2004).

4.1.1 Adequate Infrastructure

In order to encourage coordination and consistency, the Land Development Plan should jointly present the timing of the implementation of the land use plan and the timing of the planned transportation improvements in the TIP (Rodríguez, et al, 2004). Some towns and cities adopt policies requiring areas planned for significant additional land development not to receive the bulk of the new development (or extension of urban services) until appropriate transportation improvements have been made. This ensures that roadway safety and level of service does not decline to unacceptable levels due to land development. For example, the plan for the City of Gastonia provides a policy stating that,

“Approval of major traffic-generating developments through re-zoning or conditional use should be granted only if the road capacity is in place or improvements are scheduled within the scope of the seven-year TIP.” (referenced in Rodríguez, et al, 2004)

Goals and policies in the Land Use Vision and Principles section can establish and describe the intention of the town or city to coordinate timing of development and maintain transportation facilities. Some towns use Land Development Plan policies to create Adequate Public Facilities Ordinances (APFOs) or concurrency requirements to require that development cannot move forward without the necessary infrastructure to support it. In order to ensure the legal credibility for such actions, they should be referenced and included as part of the overall vision and values in the Land Development Plan. As previously noted, courts are more likely to find regulatory programs to be reasonable if they are based on a comprehensive plan that has been officially adopted in accordance with due process requirements (TRB, 2003).

Ultimately, coordinating the timing of land development and transportation improvements is important because it can help preserve capacity and level of service on existing road facilities.

4.1.2 Land Management

Several studies have concluded that, while new roads have little to do with the rate of growth in a region, they do shape our cities and towns by attracting new development and redevelopment (NCDOT, 2006). As a result of the newfound accessibility that they provide, highway interchanges and newly expanded roadway facilities are often a catalyst for new development (OR DOT, 2005). Therefore, when the local
planners know of programmed road improvements, the Land Development Plan should consider the land opened up to development and account for it in suitability analyses and consequent land classification of the area. Plans should also specifically account for the types of uses and intensities that will be allowed immediately along new roadways and their off-shoots (Vanka, et al, 2005). This is important for two primary reasons: 1) it can be difficult to maintain capacity and safety on a road if land development is not controlled along it, and 2) a new roadway can provide new access to land that was previously less likely to be developed, so growth management is needed to ensure that new development is consistent with community goals and desires. Including these areas will help to ensure that their future development is consistent with the goals and values of the community, and that development proceeds only after rigorous environmental analysis. The following section addresses ways to incorporate access management into Land Development Plans in order to maintain roadway safety and capacity.

4.2 Incorporating Access Management into Land Development Plans
Access management can be defined as “the process that provides (or manages) access to land development, while simultaneously preserving the flow of traffic on the surrounding road system in terms of safety, capacity, and speed”. Access management helps preserve the efficiency of roads and highways, thereby protecting public investment in transportation. Access requirements can also encourage a more orderly use of land and promote development that is consistent with local values and goals (Williams and Forester, 1996).

4.2.1 The Need for Access Management
When access to major roadways is poorly coordinated, local trips increasingly use arterials roads, and congestion and accident rates increase. The roadway level of service also declines, which eventually requires improvements to maintain capacity (Williams and Forester, 1996). If access continues to be poorly coordinated, then the cycle continues.

A major problem from the transportation standpoint is the “up zoning” of agricultural, residential, or multi-family land to allow large commercial development near an interchange (OR DOT, 2005). The commercial development benefits from the highway access, but the new driveway access points and new travelers along the roadway can diminish safety or level of service. While economists will point out that some amount of congestion is good for business, planners know—and economists agree—that too much congestion will have negative impacts that will outweigh the good (NCDOT, 2006).

4.2.2 Land Development Plans and Access Management
Land management plays an important role in coordinating the types of uses that can be placed along roads. Access management strategies often focus very locally on site design and subdivision regulations and miss the more comprehensive view of land development and transportation within the planning jurisdiction. Some localities use a zoning classification, such as, “interchange activity center”, to limit land uses and consolidate access points. They often encourage clustered development or Planned Unit Developments (PUDs) and nodal development (Vanka, et al, 2005). There are important linkages to access management through zoning and subdivision regulations, but they are not the focus of this document. The Appendix includes resources that address access management at the site or development level. This document focuses more broadly on addressing access management through the Land Development Plan.

Assessing the potential effects of land use on transportation facilities requires determining what kind of development will occur, where it will occur, and what form it will take. These determinations (and the land use policies that arise from them) are related to the Land Development Plans created by local governments. The policies and analysis provided in the plan should address the direction, pace, and timing of development, as well as the nature of development—its density/intensity, mixture of uses, and access/connectivity (NCDOT, 2006).
The Transportation Research Board (2003) suggests several techniques for addressing access management in the comprehensive plan:

- Include a section that describes the general principles and benefits of access management in the transportation element of the comprehensive plan to establish how the program relates to the public health, safety, and welfare.
- Include specific goals, objectives, and policies related to access management that will be carried out through the local planning and regulatory program.
- Establish a system of planned roadways that are classified according to function and the general design and access guidelines for these roadways.
- Include a map of roadways that have been assigned an access category or identify any roadway corridors that are designated for special treatment in relation to right-of-way preservation and access management.
- Set forth land use, community design, and activity center concepts that support access management and promote the development of unified access and circulation systems. Address the need for a supporting street system, such as new collector roadways, in all developing commercial and residential areas.

In conducting the Land Analysis, local planners should carefully consider the amount of land that is necessary to accommodate reasonable future land use needs. Designating a certain amount of surplus land is necessary to allow market flexibility, but some communities designate far more land than could reasonably be sustained in commercial use and frequently rezone additional highway frontage to commercial use. This increases the number of driveways and traffic conflicts, which damages the safety and efficiency of the roadway. It also encourages strip development, inefficient use of land, increased vacancies, blighted areas, and sprawl (TRB, 2003).

4.2.3 Growth Patterns and Policies to Support Access Management

The context for development is very important when considering effects on roadway systems – a given project may not adversely affect mobility on roadways, but multiple projects in a relatively small area could have significant impacts. For this reason, it is important to consider the system as a whole, and not just on a project-by-project basis.

The primary goal of access management is to limit the number of local trips to and from commercial centers or residential subdivisions using major arterial roads. Transportation officials recommend discouraging strip commercial development and promoting redevelopment of sites located along existing infrastructure. With both commercial and residential development, access management strategies include promoting clustering of land uses into unified centers and creating a supporting internal street system. In order to ensure the legal credibility for such actions, they should be referenced and included as part of the overall vision and values in the Land Development Plan. As previously noted, courts are more likely to find regulatory programs to be reasonable if they are based on a comprehensive plan that has been officially adopted in accordance with due process requirements (TRB, 2003). Strategies and policies for access management include:

- Policies for capacity of streets and highways to ensure that road capacity can accommodate travel demands.
- Policies to encourage location of large-scale, auto-oriented development near regional arterials to reduce traffic impacts on residential and neighborhood commercial districts and more efficiently serve regional trips. Access to these uses is encouraged from minor arterial roadways, rather than by direct access from the regional arterial system.
- Discourage strip development and promote clustering of land uses into activity centers with unified access and circulation systems – this also supports walking, bicycling, and transit use and reduces the number of short local trips on arterial roadways.
- As communities grow and land is subdivided for development, policies should seek to promote continuation and extension of the existing local street system. Dead-end streets, cul-de-sacs, and gated communities force more traffic to use major roadways even for short local trips. Fragmented street systems also impede emergency access and increase the length of automobile trips. The Plan
could make a goal for a safe and well-connected transportation system, which will also discourage through-traffic in residential areas.

- Multiple points of ingress and egress serving large developments provide access to more than one local road off site, allowing traffic entering and exiting the development to be more evenly distributed throughout the local street network.

(Williams and Forester, 1996; TRB, 2003; NCDOT, 2006)

Additional policies and an evaluation checklist for local access management programs are provided in Appendix 2.

4.3 Summary
This section has provided guidance on two important ways to explicitly make the connection between land use and transportation in the Land Development Plans – 1) coordinating the TIP with the Land Development Plan, and 2) incorporating access management into the Land Development Plan. These measures are not required for transportation planners to be able to effectively use the Land Development Plan, but their inclusion improves the overall quality of the planning process and public investments.
5. PUBLIC INVOLVEMENT

This section discusses the need for public involvement in the Land Development planning process, various techniques, and provides recommendations for how such involvement can be structured. It should be noted that most Land Development Plans provide very little information regarding the structure and techniques of the public involvement process. At best, many provide only a list of the stakeholders who were involved in the final plan creation. This section provides information to get the plan evaluator thinking about the types of public involvement that would be most appropriate for the locality, and the things to look for when reading the plan. If there is not enough information contained in the plan regarding the public involvement process, it may be appropriate to provide a questionnaire to the planning team to obtain more information. Such a questionnaire form will be created in future work for NCDOT.

5.1 Why Public Involvement?

Public involvement is essential to the planning process in order to ensure that decisions are sensitive to and serve the needs of community members. In the context of moving forward with the Comprehensive Transportation Planning (CTP) process, NCDOT must be confident that the local Land Development Plans upon which transportation decisions will be based enjoy community support and “buy-in”. Every person in the community does not need to completely agree with the entire plan, but there must be overall support and agreement that the Land Development Plan represents both the direction in which the community wants to develop (or not develop) and the appropriate path to reach those goals. The push for community buy-in to the Land Development Plan is not intended to stifle debate in the transportation planning process. Rather, it is meant to ensure that the decisions in the Land Development Plan are not so contentious or unacceptable that they will stop the transportation planning process.

Over the past several years, NCDOT has been increasingly proactive about achieving community support. One NCDOT initiative to improve the interaction between the agency and the public has been the Context Sensitive Solutions (CSS) training program. More than 1,500 NCDOT employees, from all departments and from all over the state, have been trained in this program. The three principles of CSS are:

- Address the transportation need (with solutions that are safe, functional, affordable, and “doable”);
- Be an asset to the community (with solutions that match community values); and
- Be compatible with the human and natural environment (with solutions that are low impact and aesthetically pleasing).

While this document does not specifically pertain to the CSS program, the ideals are the same. It should be the intention of any Land Development Planning process that the final plan address community land development goals and needs, match community values, and be compatible with the human and natural environment.

The best way to work toward the three principles listed above is through communication with local stakeholders. Public involvement in the planning process is necessary to determine the values, goals, and needs of members of the community. Public involvement is more than just one public meeting at the end of the process to present the plan to the community. Relying on only one meeting does not guarantee that the public is well informed about the plan or its consequences, nor can it make certain that the plan reflects the goals and ideals of those whom the plan will affect.

The exact form of the public involvement process will vary by situation and community, but certain characteristics should be common for any setting. The community involvement process should have two primary objectives: 1) to provide information to the public about the state of the community and options for future development, and 2) to elicit feedback from the community on their goals and desires. Both of these components are necessary to be sure that a well-informed public supports the direction of the planning process. The dual approach requires the planner to play provide information to the constituents as well as listen to the needs and concerns of the participants.

By including community members in the planning process, there can ultimately be greater information, understanding, and agreement on problems and ways of solving them. Also, the opportunity for
involvement can give stakeholders a sense of ownership of planning proposals and facilitate the formation of coalitions who will work to realize the plans (Burby, 2003). Results can be more equitable and enduring solutions, which help to ensure that the interests of stakeholders are protected over the long term (Brody, et al, 2003).

5.2 The Need for Community Support
In addition to the positive results of community involvement discussed above, there are many negative consequences associated with lack of community support for a plan or planning process. These include:
- Suspicions about planning efforts and NCDOT (or local government) in general;
- Project delay (time and cost);
- Litigation (time and cost);
- Sabotage of future planning efforts;
- Political and personal conflicts;
- Uncertainty about future planning efforts; and
- End solutions that are less than desirable for all involved.

The emphasis on community support and “buy-in” for a Land Development Plan is intended to prevent these negative consequences at later stages in the planning process. By promoting the CSS program, NCDOT has recognized the value of early and ongoing community involvement. While participation can add time and cost at the initial stages of a planning process, the up-front investment can pay off when it comes to agreement on policy and implementation (Brody, et al, 2003).

5.3 Approaches to Community Involvement
This section discusses various approaches to community involvement. It addresses the types of decisions that planners must make about the structure of a participation process, as well as some of the techniques that can be used. While this section does not provide detailed information about how to conduct the process, it discusses the range of possibilities. This section discusses some of the decisions that must be made, and the next section discusses some recommendations and best practices with creating public involvement processes.

The decisions planners make about participation can either promote or stifle it (Burby, 2003). It is therefore important to keep in mind how the design of a participation program dictates the results. On the positive side, the planner could structure the program to produce results that easily feed the creation of the plan itself. On the negative side, the planner could intentionally exclude some stakeholder groups in order to have a smoother or more convenient process. In designing a participation program, planners make six critical choices:

1. Administration – whether to prepare a participation plan and how to staff citizen involvement efforts. The big issue here is the level of resources devoted to the participation effort. Is there a staff member or a consultant assigned to oversee the participation process? Is there anyone with special training on public involvement processes? How much time is allotted to the involvement process?

2. Objectives – whether to share power by educating citizens, seeking their preferences, or granting them influence. The objectives will vary according to the characteristics of the community and the process. Possible objectives include:
   - Learning about citizen preferences and values,
   - Tapping citizen knowledge and experience,
   - Educating citizens about policy issues,
   - Fostering citizen involvement in decision-making, and
   - Mobilizing an active constituency of citizens who would support proposed plans and policies.

3. Stage – when to start encouraging citizen involvement in the planning process. Many believe that in order to ensure meaningful stakeholder involvement, it must be “early, often, and ongoing”. It should be noted that in the early stages of a planning process, the issues raised by participants
are usually relatively general abstract, and may not be specific enough to elicit responses from potentially affected parties. On the other hand, participation that begins at a later stage, while capable of eliciting clear and focused responses from participants, may come too late to impact on the final plan. Both of these concerns should be considered when deciding when to begin the process.

4. Targeting – the types of stakeholder groups and how many to include in participation efforts. A stakeholder is essentially any member or group in the community who could affect or be affected by the plan. In a land development planning context, there are many stakeholder groups. One challenge for planners is to determine how to involve all interested or relevant parties in the process, knowing that if everyone is involved, it may become too big and unwieldy. It might make sense to begin with a broad invitation to participate, and then more strategically focus outreach efforts to key groups later in the process. It is also important to note that there may be important stakeholder groups who will not or cannot volunteer as easily as others. Planners less frequently target less mainstream stakeholders, such as groups representing disadvantaged people, various types of professionals, or older persons. While such groups may not volunteer as readily as others, their needs cannot be ignored.

For transportation planning purposes, the involvement of key stakeholders in the land development planning process is of great importance. Knowing that key stakeholders have had a role in shaping the adopted plan indicates that they will be more likely to support transportation planning efforts to serve both new and existing development. Involvement of other stakeholder groups, which goes beyond the minimum standards required for application to transportation planning, is encouraged and desirable as a way to create a higher quality Land Development Plan. The key stakeholder groups needed to support transportation planning will vary somewhat by situation, but they generally include:

- Businesses or business groups (Chamber of Commerce, etc.)
- Local government elected officials and departments
- Development groups (homebuilders association, downtown business association, etc.)
- Neighborhood groups (homeowners or neighborhood associations, etc.)
- Environmental groups (land trust, Sierra Club, Nature Conservancy, etc.)
- Special district representatives (school districts, public utilities, etc.)

Other stakeholder groups who should ideally be involved in the process include:

- Affordable housing groups
- Disadvantaged groups exposed to hazards
- Older people’s groups
- Youth groups
- Professional groups
- Property owners groups
- Media (newspapers, radio, television, etc.)
- Port, fishing, or marine industry trade groups
- Agriculture or forest industry trade groups

5. Techniques – the types of participation approaches to employ. There is a wide range of methods for exchanging information with the public. Depending on the characteristics of the public and the stage of the process, different techniques will be most appropriate. Examples of public outreach techniques include:

- Formal public hearings
- Open meetings where people talk to planning staff
- Facilitated workshops/meetings
- Visioning, charettes, or workshops for goal setting, strategies, or designs
- Community forums
- Citizen advisory committee
Subcommittee or workgroups
Interviews with key stakeholders
Household surveys
Telephone hotline

6. Information – the types of information and dissemination processes to incorporate in participation activities. Information should be widely accessible and highly integrated into all stages of the process of developing a plan. Examples of information to provide to citizens include:
- Maps of environmentally sensitive/hazardous areas
- Growth projections/build out forecasts
- Summaries of plan elements or issue areas
- Vision statements
- Summaries of citizen input obtained through meetings, surveys, and other means
- Alternative planning design concepts or strategies


All of these issues must be considered when designing a public participation program. The description of the public involvement process provided by the local government should address these issues, with some explanation of why the eventual path was chosen. The most appropriate path will vary depending on the size and characteristics of the town, the current state of planning, and the resources available for a public involvement process. Recommendations and best practices follow.

5.4 Recommendations
This section provides recommendations for how to most effectively structure a public involvement process. These recommendations represent results of studies of various processes and expert experience in public involvement and consensus building.

Planners generally believe that public participation during the early stages of the process is the most effective way to incorporate community knowledge, interests, and expertise into the final plan. Citizens must be provided with information about any meetings, as well as detail about the plans (Brody, et al, 2003). Information concerning the community’s economy and population, environment, land use, transportation and infrastructure systems should be widely disseminated through a variety of channels, ranging from face-to-face workshops to websites and reports (Berke, et al, 2006).

The following are recommendations for the creation of an effective public involvement process:
- The objectives of the participation program should be clearly stated and approved by the local government. An effective public participation process will include objectives for the functioning of the process itself, as well as for the outcomes of the process – the creation of the Land Development Plan.
- Participation should be included from early stages through major decisions. There should be some contact at the following stages:
  - Preplanning/visioning stage,
  - Selection of goals and objectives,
  - Choice of alternatives, and
  - Review and approval of the final package.
- Relevant stakeholders should be targeted. This may require specific invitations and targeted outreach.
- The process should use a range of involvement techniques and media.


Studies have found that the types of meetings and techniques used to obtain information from citizens significantly impact the amount of participation. Visioning workshops and community forums are very positive; informal settings seem to encourage participation. Formal public meetings, which are used most often, generally encourage less participation than other methods (Brody, et al, 2003). Public meetings do a good job of meeting legal requirements, but a poor job of bringing people together to solve difficult problems (Godschalk, et al, 1994).
Computer simulation techniques using pictures of current conditions and a variety of possible future scenarios provide an effective means for community members to visualize the future. These could include maps and pictures showing current or projected future images, as well as visual preference surveys to guide the desired character of development (Moore, 1997). Visual techniques may be particularly effective in more rural areas experiencing development pressures, where community members may find it more difficult to either see all of the development currently taking place or to visualize what the future might look like.

This document recommends that the public involvement process for creating the Land Development Plan include multiple techniques and approaches in order to reach a broader audience. Efforts should include both formal and informal settings, and use visualization techniques to illustrate the development implications of various planning decisions actions within the community. The public involvement process is an opportunity for better planning as well as more desirable outcomes.
6. PLAN EVALUATION

This section provides guidance for evaluating whether local Land Development Plans are acceptable for transportation planning purposes. The guidelines address both general plan quality as well as connection to transportation planning. This section describes the attributes of high quality plans, to which all plans should aspire, as well as minimum standards for acceptable Land Development Plans in North Carolina.

6.1 Land Development Plan Quality

The planning profession has generally avoided normative definitions of what constitutes a good plan and focused instead on methods and processes of plan-making (Berke and French, 1994). The evaluation provided here is designed for a plan that has been adopted, but which has not necessarily yet been implemented. Therefore, this evaluation focuses on planning methods and process and rather than plan outcomes.

Planning is an ongoing process, which consists of more than just making particular plans. Therefore, plan evaluation is important not only to ensure the quality of the plan itself, but also to hold planners accountable for their recommendations, and politicians for their decisions (Baer, 1997).

There are two key conceptual dimensions of plan evaluation: 1) internal plan quality involves the content and format of key components of the plan; and 2) external plan quality deals with the relevance of the scope and coverage of the plan in fitting the local situation (Berke, et al, 2006). The characteristics of each dimension are discussed briefly below.

6.1.1 Internal Plan Quality

Criteria for internal plan quality apply to all basic plan components, including: issues and vision statement; fact base; goal and policy framework; and plan proposals, including spatial designs, implementation, and performance monitoring (Berke, et al, 2006). This “procedural” aspect of plan evaluation measures the extent to which the plan reflects a comprehensive and rigorous analytical and policymaking process (Rodríguez, et al, 2004). The key recommendations for internal plan quality include:

- The introduction to the plan should explain the process by which the plan was created, and the relationships between planners, citizens, and elected officials.
- The issues and vision statement should identify the key issues facing the town, and provide a vision statement that identifies in words an overall image of what the community wants to be and look like.
- The fact base of the plan should describe and analyze social, economic, and environmental conditions and trends related to the growth and development of the community.
- The goals should identify general aspirations of the population, problems needing alleviation, and needs that are premised on shared values of community members.
- Policies and recommended timing of public and private development to insure that progress is made toward achieving the goals specified in the plan.
- There should be consistency between the plan’s various elements and between its articulation of facts, goals, and policies. For example, the classification of development areas should reference the environmental suitability analysis and the community goals. This is referred to as “internal consistency”.

(Burby and May, 1997; Berke, et al, 2006; Norton, 2005).

Another component of plan quality, which is more difficult to achieve, is called “horizontal consistency”. This refers to the consistency of a local Land Development Plan with the plans of neighboring towns and cities. This may be particularly difficult to assess, because while many planners recognize the value of a more regionally focused land development planning approach, very few areas actually coordinate...
between jurisdictions. This is one area in which MPOs and RPOs can be effective, and the CTP process can foster discussion among the jurisdictions within a regional transportation planning area. It should be noted that consistency among local plans may not always be required or even desirable. As Hopkins (2001) points out, in some regions, a plan from one jurisdiction may be of considerably higher quality than a plan from another jurisdiction. It would not be desirable for the higher quality plan to lower its standards to meet the other plan. Further, when considering transportation needs, a “consistent” regional growth pattern may not be necessary, as long as it allows for a coherent transportation network. For this reason, it may be more appropriate to frame this discussion in terms of “horizontal compatibility” rather than “consistency”. A full discussion of methods for evaluating horizontal compatibility is beyond the scope of this document, but may be included in future work for NCDOT.

6.1.2 External Plan Quality
External plan quality criteria refer to how the plan fits the local situation for which it was created. The key characteristics that maximize use and influence of the plan include: encouragement to use the plan, clarity and ease of understanding, interdependency of actions in the plan scope, and transparency of the key participating actors (Berke, et al, 2006).

The planning process must be structured in such a way that the plans can provide meaningful guidance to local decision-makers, and actually be used by the local officials (Norton, 2005). The strength of the public involvement process supports external plan quality, both in identifying the local context in which the plan fits, as well as transparency of the planning process. It is not enough that the plan have goals and policies, if they do not effectively address the local and regional growth concerns that are facing the area. This can be an issue when local governments hire consultants to write Land Development Plan, as they may not have enough local knowledge to effectively apply the planning concepts to the specific area.

6.2 Connection to Transportation Planning
Through the basic elements of the plan that have been discussed in previous sections, a high quality Land Development Plan can address the land use-transportation connection. It should be noted again that this document does not advocate particular policies or measures. The Land Development Plan should discuss the land use-transportation connection in a comprehensive and fact-based way, but the content is for local governments to decide.

In addressing the relation to transportation planning, both “substantive” and “procedural” plan elements are relevant. As mentioned above, “procedural” elements determine the extent to which the plan reflects a comprehensive and rigorous analytical and policymaking process. “Substantive” elements determine whether a plan clearly articulates goals and policies that directly address the relationship between transportation and land use (Rodríguez, et al, 2004).

Procedural connections between land use and transportation include the presence of transportation elements in the plans’ presentation, fact-base, reciprocity between land use and transportation goals and policies, and content. After conducting a survey and analysis of land use plans of 30 local towns and cities in North Carolina, Rodríguez, et al (2004) recommend the following procedural improvements:

a) Broaden the focus of plans to include accessibility, thereby bridging land use and transportation;

b) Improve plan implementation by providing transportation-related indicators to quantify land use goals, and providing measurable objectives including the timing and implementation of the land use plan.

On the substantive side, perhaps the most important connections between land use and transportation are the Transportation Improvement Plan (TIP) projects programmed for the town or nearby area. The plan should account for both the TIP road investments and the related land development impacts.

When planning for new road investments, it is important to consider the land opened up to development and account for that land in the suitability analysis and land classification. It is also important to consider land use controls along new roadways. Plans should account for the types of uses and intensities that will be allowed immediately along new roadways and their off-shoots (Vanka, et al, 2005). This is important for two primary reasons: 1) it can be difficult to maintain capacity and safety on a road if land
development is not controlled along it, and 2) a new roadway can provide new access to land that was previously less likely to be developed, so growth management is needed to ensure that new development is consistent with community goals and desires.

A more detailed discussion of connections to the TIP and access management is provided in Part 4.

6.3 Minimum Plan Quality Standards
So far, this section has discussed ideal plan quality standards towards which the Land Development Plans should work over time. While it may not be feasible for all towns to accomplish all of them right away, it is valuable for the evaluator to understand the basis for these criteria. The following are examples of “Quality Standards” defined in the Land Use subprocess of the Comprehensive Transportation Planning (CTP) process:

- Land use plan includes the data that is useful in the transportation planning process (environmental constraints, demographics, sociological and economic data)
- Realistic land pattern (environmentally)
- Public involvement in Land Development planning
- Policies, goals and vision

These CTP standards, with the addition of provisions for internal consistency and accounting for transportation infrastructure investments, comprise the minimum standards for the Land Development Plans. The questionnaire provided is broken into “minimum standards” and “desirable” plan components.
6.4 Plan Evaluation Questionnaire
The following questionnaire provides a means for assessing whether or not the Land Development Plan contains the necessary components. For each category, the criteria are divided into “minimum standards” and “recommended quality plan components.” Some questions are relevant to multiple categories, and are repeated for each relevant section. Many of these questions are based on the following sources: Berke, et al, 2006 and Rodríguez, et al, 2004.

1. Overall Plan Presentation
   Minimum Standards:
   a) Is a glossary of terms and definitions included?
   b) Is plain English used?
   c) Are clear diagrams and pictures used?
   d) Are maps included?
   e) Is the information on maps clear, relevant, and comprehensible?
   f) Is spatial information clearly illustrated on maps?
   g) Are there transportation maps?
   Recommended Quality Plan Components:
   h) Are supporting documents included with the plan (videos, CD, GIS, Website)?
   i) Is there a transportation section in the plan?

2. Plan Components

2.1 Introduction
   Minimum Standards:
   a) Is the process by which the plan was adopted explained?
   b) Is there an explanation of how plan can affect outcomes (i.e., is there a connection between public interests and actions, and of methods of implementation)?
   Recommended Quality Plan Components:
   c) Is a table of contents included (not just list of chapters)?
   d) Is there an explanation of state and federal legislation enabling or requiring the plan?
   e) Is there an explanation of the commitment of elected officials to using the plan?

2.2 State of the Community Report
   Minimum Standards:
   a) Are key issues, trends, and impacts identified?
   b) Are data tables included?
   c) Is the information in the data tables relevant and comprehensible?
   d) Are facts used to explain key issues?²
   e) Are development trends discussed?
   f) Are sources of information and data referenced?

² Facts can be based on ordinary knowledge of lay people or scientific knowledge
g) Is road supply or demand discussed?

*Recommended Quality Plan Components:*

h) Are the sources of transportation information provided?

i) Are existing undeveloped land and waterbodies discussed?

j) Is other infrastructure capacity (schools, police, water and sewer, etc.) discussed?

### 2.3 Public Involvement Process

*Minimum Standards:*

a) Are organizations and individuals that were involved in plan preparation identified?

b) Are the stakeholders who were involved representative of all groups that are affected by policies and implementation actions proposed?

c) Is there an explanation of participation techniques that were used?

d) Were multiple techniques used?

*Recommended Quality Plan Components:*

e) Is there an explanation of why the organizations and individuals identified in the plan were involved?

f) Is there clear explanation of how stakeholder involvement is related to prior planning activities?

g) Is there any explanation of how disputes or disagreements are resolved?

### 2.4 Land Use Vision and Principles

*Minimum Standards:*

a) Is there a vision statement or mission statement that identifies in words an over-all image of what the community wants to be and look like?

b) Is a clear statement of goals and objectives provided?

c) Are goals clearly prioritized?

d) Can a clear emphasis in the goals/objectives be identified?

e) Are goals based on measurable objectives?

f) Are indicators of each objective included?

g) Are policies linked to achieving goals?

h) Are facts used to explain policy directions?

i) Are policies tied to specific actions?

j) Do policies refer to specific locations within the planning area?

k) Is there cross-referencing of issues, goals, objectives and policies? (Internal consistency)

*Recommended Quality Plan Components:*

l) Do goals, objectives, and policies follow the definitions provided in this document?

m) Do policies use either incentives (“carrots”) or regulations (“sticks”) to accomplish planning goals?

n) Are there any transportation-related goals?

o) Do any transportation-related goals have land use-related objectives and/or policies?

p) Do any land use-related goals have transportation-related objectives and/or policies?
q) Are there policies regarding other infrastructure investments (water, sewer, roads, etc.)?
r) Are transportation-related indicators used? (LOS, volume to capacity ratio, etc.)

2.5 Land Analysis

Minimum Standards:

a) Does the plan include environmental analysis based on existing and projected conditions?
b) Are the criteria upon which the suitability analysis is based clearly explained?
c) Do the classification districts relate to the results of the suitability analysis and goals and policies?

Recommended Quality Plan Components:

d) Are any tradeoffs between planning goals discussed in the final classifications?
e) Does the land suitability analysis take into account transportation facilities?
f) Is road supply or demand discussed?
g) Are existing undeveloped land and waterbodies discussed?
h) Is other infrastructure capacity (schools, police, water and sewer, etc.) discussed?

2.6 Monitoring and Implementation

Minimum Standards:

a) Does the plan contain criteria by which it can be evaluated?
b) Is there a timetable for updating the plan?
c) Are goals based on measurable objectives?
d) Are indicators of each objective included?

Recommended Quality Plan Components:

e) Are organizations identified that are responsible for monitoring and/or providing data for indicators?
f) Are timelines for implementation identified?
g) Are organizations with responsibility to implement policies clearly identified?
h) Are sources of funding identified to implement the plan?

3. Recommended Link to Transportation Planning

a) Is there a transportation section in the plan?
b) Are the sources of transportation information provided?
c) Is induced development from previous transportation expansion discussed?
d) Is induced development from previous expansion of other infrastructure discussed?
e) Are there any transportation-related goals?
f) Is there any discussion of access management?
g) Do any transportation-related goals have land use-related objectives and/or policies?
h) Do any land use-related goals have transportation-related objectives and/or policies?
i) Are transportation-related indicators used? (LOS, volume to capacity ratio, etc.)
APPENDIX 1. PLANNING RESOURCES

This section contains planning-related resources that may help local land planners as well as regional and statewide transportation planners to perform analyses and planning activities discussed in this guidebook. The resources, which are grouped by topic, are designed to aid practitioners.

General Land Use/Land Development Planning


Public Involvement


Land Use Forecasting


Use of Expert Panels


Land Use – Transportation Connection

Access Management


- “Land Use Policy Guidelines for Mobility Protection.” North Carolina Department of Transportation, 2006. Contact: David Wasserman, Transportation Planning Branch. dswasserman@dot.state.nc.us
APPENDIX 2. CHECKLIST AND POLICIES FOR LOCAL ACCESS MANAGEMENT PROGRAMS

A2.1 Evaluation Checklist for Local Access Management Programs

1. Does your local comprehensive plan include goals, objectives, and policies that support access management?

2. Does your comprehensive plan or major thoroughfare plan classify roadways according to function and level of access control?

3. Does your local land development code include a statement of purpose and intent that supports access management?

4. Do your plan and land development code discourage commercial strip development on major thoroughfares?

5. Do your plan and code promote activity centers with unified access?

6. Does your land development code include regulations for driveway spacing, sight distance, and corner clearance?

7. Do you restrict the number of driveways per lot or parcel on arterials?

8. Are minimum lot frontage requirements higher along thoroughfares?

9. Are new developments encouraged or required to provide inter-parcel connections and joint access?

10. Do you treat properties under the same ownership or those consolidated for development as one property for the purposes of access control?

11. Does your land development code include a review process for minor subdivisions or lot splits?

12. Does your land development code include restrictions on flag lots?

13. Does your land development code include standards for lot width-to-depth?

14. Do you regulate design, construction, and maintenance of private roads?

15. Do your local subdivision regulations include reverse frontage requirements for residential lots along arterials and collectors?

16. Do you encourage shared residential access drives for small subdivisions?

17. Do you encourage new development to continue or interconnect with the surrounding street system?

18. Do your driveway design standards address the following:
   a. Driveway throat length?
   b. Driveway flare or radius?
   c. Driveway width?

19. Do you have a procedure for coordinating with the state transportation agency on access permitting?
A2.2 Sample Policies and Objectives that support Access Management

1. Public roadways will be classified according to function and planned, designed, and managed to preserve their functional integrity.

2. Allowable levels of access are assigned to functionally classified roadways to preserve the safety and efficiency of these important transportation facilities.

3. Direct access to major roadways shall be limited to preserve the safety, efficiency, and character of regionally important transportation routes. Individual property access shall not be provided to arterial roadways where alternative access is available.

4. Access to land development along major arterial roadways shall be preserved through the use of parallel roads, side streets, and cross access easements connecting adjacent developments.

5. Commercial activity centers with unified access and circulation systems shall be strongly encouraged on major roadways as an alternative to strip development with individual driveways. Retail streets shall be encouraged on minor arterial or major collector roadways, with shared parking and access.

6. Raised medians shall be incorporated into the design of new and reconstructed multilane arterial roadways with design volumes greater than 24,000 vpd.

7. Driveway connections shall not be permitted in the functional area of the intersections of arterial or major collector roadways.

8. Signalized access points on arterial and major collector roadways shall not be approved where they substantially disrupt the ability to coordinate signals and maintain effective traffic progression.

9. Properties under the same ownership, consolidated for development, or part of phased development plans shall be considered one property for the purposes of access management. Access points to such developments shall be the minimum necessary to provide reasonable access, and not the maximum available, for that property frontage.

10. New residential subdivisions shall include an internal street layout that connects to the streets of surrounding developments to accommodate travel demand between adjacent neighborhoods, without the need to use the major thoroughfare system.

11. Residential subdivisions on arterial roadways shall be designed so that street connections conform with access spacing standards for those roadways. Streets between those points shall be cul-de-sacs with pedestrian and bicycle connections to the arterial wherever feasible to preserve bicycle and pedestrian mobility.
**SOURCES:**


North Carolina Department of Transportation (NCDOT) (2006). Land Use Policy Guidelines for Mobility Protection. North Carolina Department of Transportation, Transportation Planning Branch. Contact: David Wasserman, dswasserman@dot.state.nc.us


Rodríguez, D., Godschalk, D., and Norton, R. (2004). The Connection between Land Use and Transportation in Land Use Plans. The Department of City and Regional Planning, University of North Carolina, for North Carolina Department of Transportation.


