Modeling the Transportation Impacts of Smart Growth Development in Maine

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Transportation Impacts of Smart Growth Development in Maine

Town of Lisbon & Town of Sanford

Final Report

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Disclaimer

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Executive Summary

This study evaluates the reductions in average trip lengths, daily vehicle miles traveled (VMT), and daily greenhouse gas (GHG) emissions from on-road automobiles due to smart growth development strategies in two Maine towns, Lisbon in Androscoggin County and Sanford in York County. The future analysis year is 2030 and considers levels of household and employment growth expected in the two towns.

Three growth scenarios are analyzed. The Status Quo Growth scenario considers future growth following historical land use patterns in Lisbon and Sanford, based on linear growth assumptions. The first smart growth scenario, Targeted Smart Growth, redirects a portion of household and employment growth into one dense, mixed-use infill development, within an assumed growth boundary in each town. The second smart growth scenario, Multiple Smart Growth, is a more rigorous version of Targeted Smart Growth by redirecting a greater amount of growth into two smart growth developments in Lisbon and three smart growth developments in Sanford. In Lisbon, 100 households and 101 jobs are redirected for Targeted Smart Growth, and a total of 239 households and 139 jobs are redirected for Multiple Smart Growth. In Sanford, 358 households and 561 jobs are redirected for Targeted Smart Growth, and a total of 859 households and 852 jobs are redirected for Multiple Smart Growth.

Each smart growth scenario is modeled using travel demand forecasting techniques, and the resulting average trip lengths, VMT, and GHG are compared across the three scenarios. Table ES-1 summarizes the VMT and GHG reductions under the smart growth scenarios in Lisbon and Sanford.

TABLE ES-1: SMART GROWTH REDUCTIONS COMPARED TO STATUS QUO GROWTH

Town	Scenario	Daily VMT Reduction	Percent Reduction	Daily GHG Reduction (metric tons CO_2E)	Percent Reduction
Lisbon	Targeted Smart Growth	-656	-0.43%	-0.3	-0.42%
	Multiple Smart Growth	-1,038	-0.68%	-0.4	-0.57%
Sanford	Targeted Smart Growth	-985	-0.24%	-0.5	-0.27%
	Multiple Smart Growth	-1,698	-0.42%	-0.8	-0.43%

In Lisbon, VMT and GHG emissions estimated for the Targeted Smart Growth scenario were 0.43% and 0.42% lower, respectively, than estimates for the Status Quo scenario. The VMT percent reduction corresponds to 656 fewer vehicle miles traveled daily in the Town of Lisbon. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.68% and 0.57%, respectively, compared to Status Quo. The VMT percent reduction corresponds to 1,038 fewer vehicle miles traveled daily.

In Sanford, VMT and GHG emissions estimated for the Targeted Smart Growth scenario dropped by 0.24% and 0.27%, respectively, from the Status Quo scenario. The VMT percent reduction corresponds to 985 fewer vehicle miles traveled daily in the Town of Sanford. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.42% and 0.43%, respectively, compared to Status Quo. The VMT percent reduction corresponds to 1,698 fewer vehicle miles traveled daily.

In summary, analysis results for Lisbon and Sanford indicate that:

- The densification and mixing of residential and employment growth as infill developments has a slight but observable impact on VMT and average trip lengths.
- The scenario with multiple smart growth developments had greater benefit, in the form or VMT and GHG reductions, than the scenario with one smart growth development.
- Intra-zonal trips tend to increase for smart growth zones, while the number of intra-zonal trips for non-smart growth zones decreases, albeit at varying degrees depending on the land use mix of those zones.
- Some roadways in the towns experienced VMT increases, which were offset by greater VMT reductions on other roadways, resulting in net, network-wide VMT reductions.
- The effect of increases in VMT on some roadways to/from the smart growth developments should be considered when performing detailed planning of such developments.
- The smart growth scenarios are limited to the amount of growth expected in Lisbon and Sanford by the year 2030; greater benefits in VMT and GHG reductions may be more apparent at a later forecast year when more growth could be redirected to smart growth developments.
- Indicating potential for further research, a general estimation shows that greater reductions in VMT and GHG emissions could be attained through an increased share of daily transit trips by providing new transit service to/from the smart growth developments along existing transportation corridors.

It should be noted that only the location, density, and mix of growth were modified across the planning scenarios in the study. Household characteristics, such as size and auto availability, were held constant so that each scenario had similar numbers of daily trips. Use of alternative transportation modes was also held constant, so that there was equal automobile use in each scenario.

Importantly, the study results do not include the effect of future transit service coupled with the proposed smart growth developments. Consequently, the results indicate that the efficacy of the smart growth scenarios to reduce VMT in Lisbon and Sanford is greatly limited without transit to complement the proposed dense, mixed-use developments. One premise of the smart growth scenarios is that the proposed infill developments would be "transit-ready" along existing transportation corridors – Route 196 in Lisbon and Route 109 in Sanford. The smart growth scenarios partially prepare future development for more efficient and viable land use interconnectivity with transit, but transit would also be needed to fully realize this benefit and provide further reductions in daily VMT.

1. Introduction

With growing concern in rural communities about the social, economic, and environmental costs of sprawling growth, development of open lands, and the consumption of fuels for increased automobile travel, there is a desire to understand how planning for the management of growth can affect travel activity characteristics, specifically the length of trips and the amount of vehicle-miles traveled on roads. Many rural towns currently exercise some level of growth management and development planning in the form of land use controls and zoning regulations. However, beyond traditional land use planning there is a desire to understand the impacts of smart growth policies, which generally lead to more stringent control of development and typically involve related planning of transportation systems such as transit, neighborhood design, and considerations for non-motorized travel such as pedestrian and bicycle traffic.

This study investigates the relationship between land use development scenarios, which implement smart growth principles, and their impact on transportation by looking at different scenarios for dense infill development in two existing towns, Lisbon and Sanford, based on their expected growth. The primary goal of the study is to ascertain if implementing higher density mixed-use development in towns in a rural area results in shorter average trip lengths and reductions in vehicle-miles traveled (VMT) and, if so, by what amount.

Connecting Maine, the state's long range transportation plan, identifies social, land-use and transportation challenges and opportunities for the state's transportation future. Among the issues identified are land use development patterns and the impacts of dispersed settlement patterns on Maine's transportation system and quality of life.[1] Dispersed settlement patterns can lead to more transportation trips, increased auto emissions and lack of mobility. Concentrating growth in village centers with access to transit service, known as smart growth and transit-oriented design (TOD) strategies, have been found to reduce transportation trips and vehicle miles traveled.[2] A number of states have implemented TOD and are seeing reduced VMT and revived economic development in those areas.[3] Yet the data from rural areas is limited.

For the most part, smart growth and TOD projects have been undertaken in urban areas with mass transit systems. Because growth and development patterns are created over long periods of time, it is important to start now to evaluate how smart growth can be applied in less urban areas. Clearly, there is a need to apply the principles of smart growth and TOD in smaller population centers in order to prepare for future travel needs and avoid

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[1] Maine Department of Transportation. *Connecting Maine Planning, Our Transportation Future*. Final Draft, December 2008.
[2] Cervero, R., et al. *Transit-oriented development in the United States: Experience, challenges, and prospects*, *TCRP Report 102*. Transit Cooperative Research Program, Transportation Research Board. 2004.
[3] Ewing, R., Bartholomew, K., Winkhehelman, S., Walters, J, and Chen, D. *Growing Cooler: The Evidence on Urban Development and Climate Change*. Urban Land Institute. 2007.

perpetuating auto-dependent land use development patterns and their associated environmental impacts. Yet to date, case studies of TOD in non-urban areas are limited.

For Maine specifically, Cambridge Systematics recently published a report entitled "Travel, Smart Growth, and Climate Change: Can Portland, Maine Be Like Portland, Oregon?" for the Center for Clear Air Policy.[4] The study investigated the greenhouse gas emissions (and the associated VMT) benefits of hypothetical smart growth/TOD and travel demand management strategies in a large area of southern Maine, including Portland, Lewiston-Auburn, Brunswick, Bath, and the surrounding towns. For the smart growth analysis, portions of projected population growth were redirected from less-dense areas to more-dense areas. The TOD strategies involved clustering population within close proximity of proposed rail stations. The report indicates reductions in VMT and greenhouse gas emissions due to the evaluated strategies, especially when multiple strategies are employed jointly.

A long term strategy for TOD might consist of selecting the right locations for future TOD and planning for denser land use patterns. This development should be placed along existing or future mass transit corridors even if service is not yet provided. In many cases this future service might consist of bus mass transit instead of the commuter rail systems that TOD is sometimes built around. Ideally, good growth and development planning aimed at limiting VMT can be initiated earlier while setting the stage for cost-effective alternatives for future transit network expansion.

In this project, the impacts of denser, mixed-use growth on vehicle miles traveled and vehicle emissions are modeled for two Maine towns, Lisbon and Sanford. In collaboration with town residents, town officials and state agency representatives, the researchers have created three scenarios for each town. The scenarios consist of a spatial re-arrangement of future projected development for the entire town into appropriate concentrated locations for the purpose of revitalizing existing buildings and infrastructure with infill development. The scenario planning process has allowed the community to not only contribute to the research project but also experience a learning discussion about how land use patterns impact travel. The three growth scenarios are:

- Assume build-out in the town is status quo and based on historic land use patterns
- Assume build-out in the town incorporates one smart growth (dense/mixed-use) development
- Assume build-out in the town incorporates 2-3 smart growth (dense/mixed-use) developments

Smart growth designates spatial boundaries or limits for growth around currently developed/urbanized areas to prohibit or limit sprawl into undeveloped/rural areas. Smart growth can foster dense, mixed use development that can be effectively serviced by transit with strategies that can encourage use of transit by travelers, thus "transit-oriented." The

[4] Cambridge Systematics, Inc. "Travel, Smart Growth, and Climate Change: Can Portland, Maine Be Like Portland, Oregon?" September 2008.

goal in such policies is to reduce dependence on automobiles for travel and create livable communities while preserving undeveloped land and conserving natural resources. Smart growth with increased development density alone does not necessarily equal transit-oriented development. Since this study explores mixed-use density only, the smart growth scenarios do not represent complete TOD strategies. Transit-oriented development requires more:

- mixed-use development, not just dense development
- transit system/infrastructure, and incentives for transit ridership
- pedestrian-friendly and bicycle-friendly environment and amenities
- reduced automobile parking availability
- appropriate building design and layout

As such, the smart growth scenarios in this study represent “transit-ready” infill development that would be spatially compatible with future transit. That is, although the study modeling does not assume an amount of mode shift to transit due to the redirection of growth, the higher population densities and mix of uses in the smart growth developments will presumably lead to increased transit use and viability.

The growth scenarios are investigated by using travel demand models in TransCAD (Caliper, Inc.) transportation planning software.[5] Since Lisbon is part of an MPO region, the Androscoggin Valley Council of Governments (AVCOG)/Androscoggin Transportation Resource Center (ATRC), its regional model was used for the town’s analyses. Sanford, however, is not part of an MPO, so a specific, new TransCAD model of the town was developed, pulling from a number of data sources including U.S. Census information and the Maine Department of Transportation’s state travel demand model.

2. Smart Growth Analysis

2.1 Background

The Transportation Research Center undertook a process jointly with the Maine Department of Transportation to screen and select towns for the study. The town selection process considered expected growth, infill/redevelopment opportunities, current transit activity and the possibilities for new or expanded service, and whether the candidate towns were located in MPOs with regional planning models. The study scope suggested that one of the two towns would be within an MPO and one would not, and that the TRC would coordinate modeling work with the MPO containing one town in the study and independently model the other town currently without an existing model. An abbreviated list of towns considered includes Biddeford, Brunswick, Gorham, Lewiston-Auburn, Lisbon, Saco, and Sanford.

[5] TransCAD, version 5.0. ©1994-2009 Caliper Corporation. (http://www.caliper.com).

Review of comprehensive plans and outreach to the short-listed towns provided more specific information about planning interests and development opportunities in each community. Ultimately, Lisbon and Sanford were selected. Lisbon serves as the study town within the AVCOG/ATRC MPO, which has a functional travel demand model.

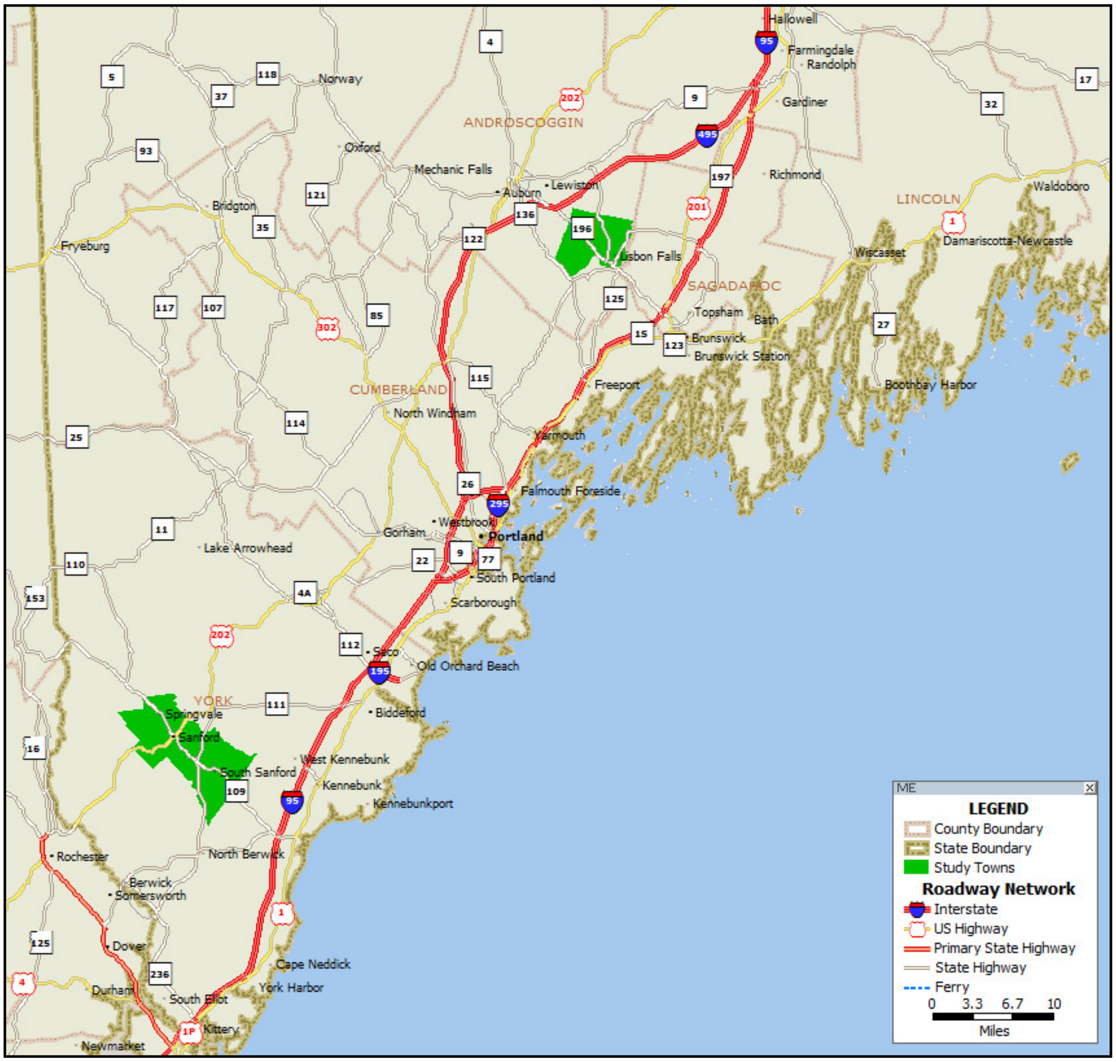

FIGURE 1: SOUTHERN MAINE AND STUDY AREAS

2.2 Study Areas

Town of Lisbon, Androscoggin County

As of the 2000 U.S. Census, the population of Lisbon, including the village of Lisbon Falls, is approximately 9,100. The town's land area is 24.2 square miles. Lisbon is along a major east-west corridor, Route 196, in Androscoggin County connecting Lewiston-Auburn/I-95 (Maine Turnpike) in the west with Brunswick and Bath/I-295 in the east. According to the 2000 U.S. Census Journey-to-Work data (Census Transportation Planning Package), approximately 82% of sampled workers residing in Lisbon, including Lisbon Falls, work outside of the town.

The linear growth estimates in the ATRC MPO model for Lisbon and Lisbon Falls forecast an increase in households by 11%, population by 17%, and total employment by 15% from the model's base year of 2005 to the future year of 2030. Employment includes retail and non-retail (service, manufacturing, and other) jobs. Since population growth is expected to outpace household growth in Lisbon, the average household size (persons per household) would increase from 2005 to 2030. Figure 2 shows the Town of Lisbon as represented in the ATRC MPO model, with the unique identification number for each traffic analysis zone.

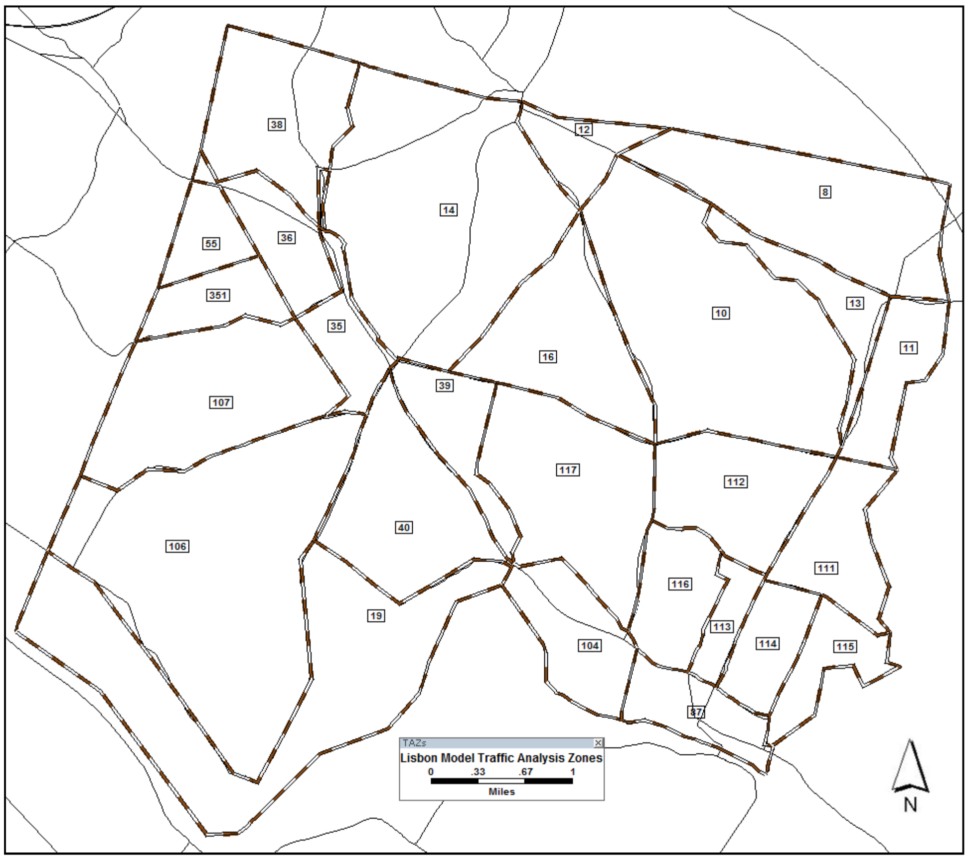

FIGURE 2: LISBON STUDY AREA - MODEL ANALYSIS ZONES

Town of Sanford, York County

As of the 2000 U.S. Census, population of Sanford, including South Sanford and the Village of Springvale, is approximately 20,800. The town's land area is 48.7 square miles. Sanford is at the nexus of Routes 202, 4, and 109 in York County and is approximately 12 miles west of I-95 (Maine Turnpike), which is the nearest interstate. According to the 2000 U.S. Census Journey-to-Work data (Census Transportation Planning Package), approximately 54% of sampled workers residing in Sanford, including South Sanford and Springvale, work outside of the town.

Using projected, average area-wide growth rates from the ATRC MPO model, from the base year of 2000 to the future forecast year of 2030 households would increase by 21%, population by 18%, and total employment by 27%. Since household growth is expected to outpace population growth in Sanford, the average household size (persons per household) would decrease from 2000 to 2030. It should be noted that the base year for the Sanford model is 2000 (unlike 2005 for Lisbon in the ATRC MPO model) because it was developed primarily using data from the 2000 U.S. Census and the Maine Department of Transportation state travel demand model. Figure 3 shows the Town of Sanford as represented in the model developed by the Transportation Research Center, with the unique identification number for each traffic analysis zone.

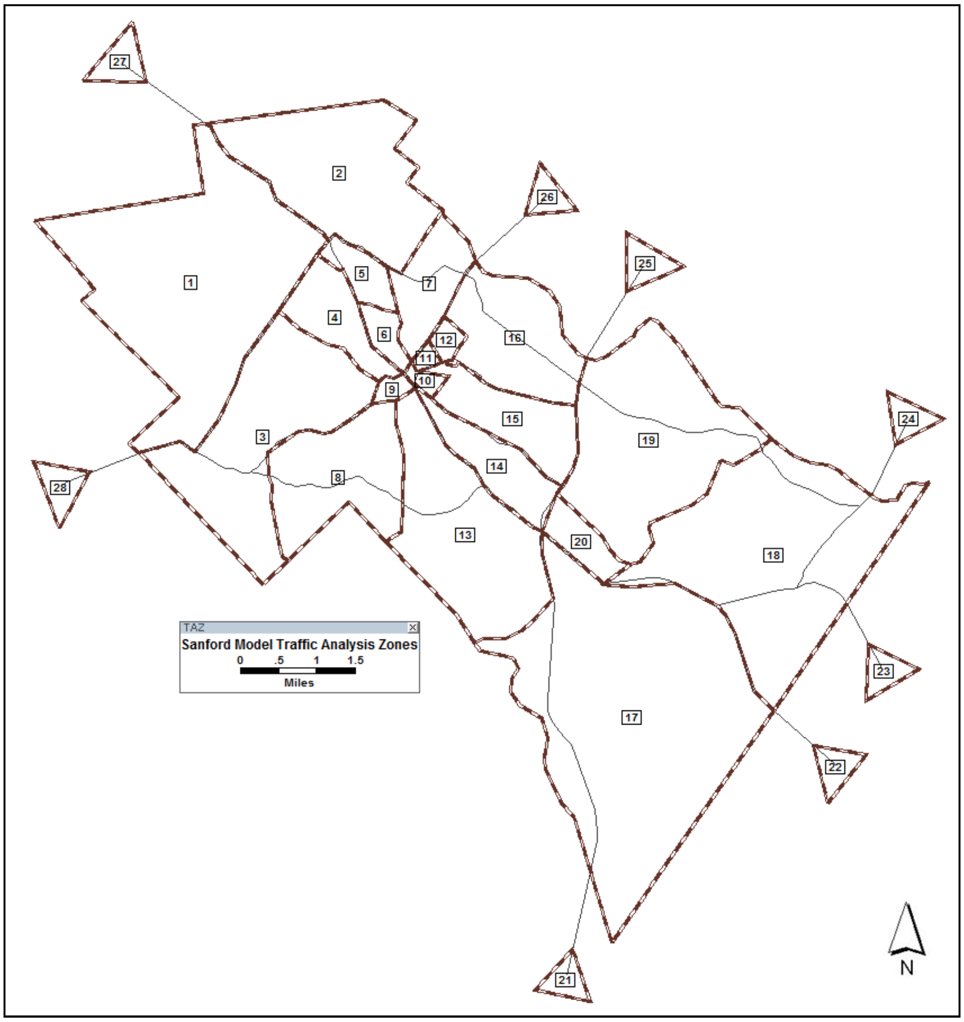

FIGURE 3: SANFORD STUDY AREA - MODEL ANALYSIS ZONES

2.3 Key Assumptions of the Study

Constant trip generation. In order to evaluate the changes in average trip lengths and VMT due only to changes in land use patterns, the numbers of trips produced and attracted within the study area are held constant across the three growth scenarios. Since the two models perform trip generation using cross-classified trip rate tables based on average household size (persons per household) and average auto availability per household, these two parameters were held constant while re-directing growth of new households and employment. However, it is possible that smart growth policies that concentrate growth toward urban centers to increase density and mix of uses could attract households with fewer persons (single people, young couples and families, and seniors/empty-nesters) and households that own fewer automobiles on average. Forecasting that effect was not part of this research.

Constant mode choice shares. The impacts of existing and proposed transit service, or other alternative modes to automobile travel such as non-motorized modes of walking and bicycling, are not analyzed. However, it would be expected that by re-directing new households and employment as described in the smart growth scenarios in this study, there would be improved accessibility between the new development and existing and/or proposed transit service along the primary transportation corridor(s) in the two towns. Furthermore, densification and mixing of land use would improve attractiveness of non-motorized modes for short trips between the smart growth developments and neighboring zones. The smart growth scenarios could be thought of as "transit-ready" development, and a first step in the planning of land use development for transit-oriented development.

With the preceding assumptions, it is expected that trip distribution will capture these effects, in the form of altered trip lengths, and shifts in the numbers of inter-zonal and intra-zonal trips for each traffic analysis zone (TAZ) since the spatial pattern of land use development is the only changing variable for the growth scenarios analyzed. Changes in average trip length and VMT can be solely and directly attributable to the spatial location of land use development.

Future year forecasts. The goal of this study is to evaluate VMT and trip length differences across the future year forecasts for the three growth scenarios rather than focus on the accuracy of the particular future year forecasts. Therefore, the study results and discussion do not focus on the calibration and validation of the base year estimates of the travel demand models, nor the specific methodologies and procedures inherent to each travel demand model.

2.4 Growth Scenarios

The study compares VMT and greenhouse gas (GHG) emission estimates for three growth scenarios. The structure of the study process in given in Figure 4, with Lisbon and Sanford representing Town 1 and Town 2, respectively. Table 1 and Table 2 list the household and employment growth, respectively, for the three growth scenarios and each TAZ in the transportation model used for the Lisbon analysis. Similarly, Table 3 and Table 4 list the household and employment growth, respectively, for the three growth scenarios in Sanford. Appendix A and Appendix B provide growth scenario maps for households and employment in Lisbon and Sanford, respectively.

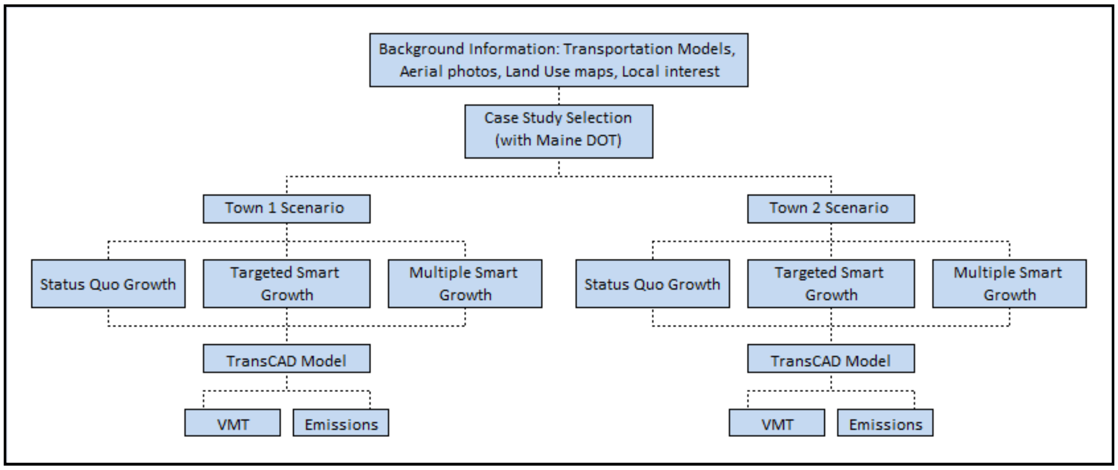

FIGURE 4: STUDY PROCESS

Status Quo Growth. This "business as usual" scenario assumes development in the two towns would follow historic land use patterns. For Lisbon, growth would include approximately 1,500 persons, 400 households, and 340 jobs between 2005 and 2030. For Sanford, growth would be approximately 3,700 persons, 1,800 households, and 2,600 jobs between 2000 and 2030. For both towns, this base scenario is the benchmark for comparison of the two smart growth scenarios.

Targeted Smart Growth. This scenario considers that future household and employment growth in the two towns would incorporate one smart growth – dense, mixed-use – development. For Lisbon, a mixed-use development is assumed in Lisbon Falls based on a growth boundary around the current center of the village. New households and employment projected in Lisbon Falls, only, that would be outside the boundary under the Status Quo scenario are redirected to within the boundary, specifically to one TAZ. The identified potential accommodation for the redirected growth would be the redevelopment and infill at the *Worumbo Mill* site. One hundred (100) households and 101 jobs, which represent 24.9% and 29.8% of expected household and employment growth, respectively, are redirected in this manner to the center of Lisbon Falls village. Growth projected in the rest of the Town of Lisbon is not redirected under this scenario.

For Sanford, a mixed-use development is assumed in downtown Sanford based on a growth boundary around the downtown. A portion of new households and employment projected in Sanford, only, (excluding South Sanford and Springvale) are redirected to within the boundary, specifically to one TAZ. The identified potential accommodation for redirected growth would be the *Sanford Mill Complex/Number 1 Pond Mills* site. Three hundred fifty-eight (358) households and 561 jobs, which represent 20.2% and 21.6% of expected household and employment growth, respectively, are redirected in this manner to downtown Sanford. Growth projected in the rest of the Town of Sanford is not redirected under this scenario.

Multiple Smart Growth. This scenario is an extension of the Targeted Smart Growth scenario. For Lisbon, while Targeted Smart Growth controlled Lisbon development in Lisbon Falls only, the goal of Multiple Smart Growth is to plan two growth clusters along Route 196, one in Lisbon Falls and one in the center of Lisbon, so that development is concentrated so as to conserve hitherto undeveloped land, be better served by existing transportation infrastructure, and potentially support the feasibility of transit services along the Route 196 corridor. Similarly, in Sanford, the goal of this scenario is to plan three dense, mixed-use developments along Main Street (Route 109), one in downtown Sanford, one in South Sanford, and one at the village center of Springvale.

Specifically in Lisbon, household and employment growth are redirected to one development in Lisbon Falls, as described in the Targeted Smart Growth scenario, and to one development at the center of Lisbon. Based on a growth boundary around the center of Lisbon, new households and employment projected outside the boundary (other than those in Lisbon Falls, which are redirected into the first growth boundary) are redirected into the center of Lisbon. One hundred thirty-nine (139) households and 38 jobs are redirected into the center of Lisbon, within the growth boundary. Thus, a total of 239 households and 139 jobs, which represent 59.5% and 41.0% of expected household and employment growth, respectively, are redirected to two smart growth developments under this scenario.

In Sanford, a portion of household and employment growth is redirected to one development in downtown Sanford based on the first growth boundary, as described in the Targeted Smart Growth scenario, and to one development in South Sanford and one development in the village center of Springvale. A second growth boundary is placed around the center of South Sanford (just north of Sanford Regional Airport), and a portion of new households projected outside the boundary (other than those in Sanford and Springvale) are redirected to within it. Two hundred eleven (211) households and 244 jobs are redirected into the South Sanford growth boundary. A third growth boundary is placed around the center of the Village of Springvale, with a redirected portion of new households projected outside the boundary (other than those in Sanford and South Sanford). Two hundred ninety households (290) and 47 jobs are redirected into the center of Springvale, within the growth boundary. Thus, a total of 859 households and 852 jobs, which represent 48.5% and 32.8% of expected household and employment growth, respectively, are redirected to three smart growth developments under this scenario.

TABLE 1: LISBON GROWTH SCENARIOS - HOUSEHOLDS

INCREASE IN NUMBER OF HOUSEHOLDS, 2005 to 2030

Model TAZ ID	US Census Tract	Status Quo Growth	Targeted Smart Growth	Multiple Smart Growth
8	302	3	0	0
10	302	10	0	0
11	302	3	0	0
12	301	2	2	0
13	302	4	0	0
14	301	18	18	0
16	301	7	7	0
19	301	16	16	0
35	301	19	19	158
36	301	3	3	0
38	301	7	7	0
39	301	24	24	12
40	301	56	56	28
55	301	2	2	0
87	302	44	144	144
104	302	19	10	10
106	301	21	21	0
107	301	10	10	0
111	302	10	0	0
112	302	11	0	0
113	302	28	14	14
114	302	22	11	11
115	302	16	8	8
116	302	34	17	17
117	301	10	10	0
351	301	3	3	0
Total		**402**	**402**	**402**
Number of Households Redirected, 2030			**100**	**239**
Percent of Household Growth Redirected			**24.9%**	**59.5%**
Total Number of Households, 2030			**4,148**	**4,148**
Percent of Total Households Redirected			**2.4%**	**5.8%**

TABLE 2: LISBON GROWTH SCENARIOS - EMPLOYMENT
INCREASE IN EMPLOYMENT, 2005 to 2030

Model TAZ ID	US Census Tract	Status Quo Growth	Targeted Smart Growth	Multiple Smart Growth
8	302	0	0	0
10	302	0	0	0
11	302	0	0	0
12	301	0	0	0
13	302	5	0	0
14	301	0	0	0
16	301	0	0	0
19	301	0	0	0
35	301	16	16	54
36	301	0	0	0
38	301	0	0	0
39	301	20	20	10
40	301	56	56	28
55	301	0	0	0
87	302	79	180	180
104	302	31	16	16
106	301	0	0	0
107	301	0	0	0
111	302	12	0	0
112	302	15	0	0
113	302	35	17	17
114	302	29	14	14
115	302	0	0	0
116	302	41	20	20
117	301	0	0	0
351	301	0	0	0
Total		**339**	**339**	**339**
Number of Employment Redirected, 2030			**101**	**139**
Percent of Employment Growth Redirected			**29.8%**	**41.0%**
Total Number of Employment, 2030			**2,593**	**2,593**
Percent of Total Employment Redirected			**3.9%**	**5.4%**

TABLE 3: SANFORD GROWTH SCENARIOS - HOUSEHOLDS
INCREASE IN NUMBER OF HOUSEHOLDS, 2000 to 2030

Model TAZ ID	US Census Tract	Status Quo Growth	Targeted Smart Growth	Multiple Smart Growth
1	301	101	101	25
2	301	167	167	42
3	30201	47	47	0
4	30201	97	97	97
5	301	108	108	398
6	30201	56	56	56
7	30201	84	84	42
8	30203	61	0	0
9	30203	76	76	76
10	30202	54	412	412
11	30202	72	72	72
12	30202	53	53	53
13	30203	206	103	103
14	30202	135	68	68
15	30202	94	47	0
16	30202	80	0	0
17	303	92	92	46
18	303	120	120	60
19	303	58	58	0
20	303	10	10	221
Total		**1,771**	**1,771**	**1,771**
Number of Households Redirected, 2030			**358**	**859**
Percent of Household Growth Redirected			**20.2%**	**48.5%**
Total Number of Households, 2030			**10,041**	**10,041**
Percent of Total Households Redirected			**3.6%**	**8.6%**

TABLE 4: SANFORD GROWTH SCENARIOS - EMPLOYMENT

INCREASE IN EMPLOYMENT, 2000 to 2030

Model TAZ ID	US Census Tract	Status Quo Growth	Targeted Smart Growth	Multiple Smart Growth
1	301	93	93	23
2	301	148	148	37
3	30201	106	106	0
4	30201	142	142	142
5	301	80	80	415
6	30201	52	52	52
7	30201	96	96	48
8	30203	100	0	0
9	30203	312	312	312
10	30202	282	843	843
11	30202	25	25	25
12	30202	17	17	17
13	30203	255	127	127
14	30202	277	138	138
15	30202	154	77	0
16	30202	117	0	0
17	303	125	125	62
18	303	186	186	93
19	303	11	11	0
20	303	16	16	260
Total		**2,594**	**2,594**	**2,594**
Number of Employment Redirected, 2030			**561**	**852**
Percent of Employment Growth Redirected			**21.6%**	**32.8%**
Total Number of Employment, 2030			**12,195**	**12,195**
Percent of Total Employment Redirected			**4.6%**	**7.0%**

2.5 Travel Demand Modeling Process

The Lisbon and Sanford growth scenarios are modeled in TransCAD, which includes the processes of trip generation, determination of mode shares (ATRC MPO model only), trip distribution, and traffic assignment. For the study, the ATRC MPO model is used for travel forecasting in Lisbon, and the study-specific model developed by the TRC is used for travel forecasting in Sanford. Trip generation uses household trip rates based on cross-classification tables of household size (persons per household) and automobile availability (autos per household). Once the numbers of daily person trips produced and attracted are estimated for each zone by trip generation, trip distribution is accomplished using gravity model techniques to distribute those daily persons trips between pairs of zones. Distributed person trips are converted to automobile trips using average automobile occupancy rates for the different trip purposes, and are then assigned to the roadway networks using equilibrium techniques.

The ATRC MPO model used for Lisbon assumes a fixed mode share for trips by transit, that is, trips not by personal automobile, and applies the transit and non-transit shares to number of generated person trips prior to the trip distribution step. This fixed share is insensitive to land use development changes made for this study. The Sanford model does not consider transit, and all inter-zonal trips were assumed to be by personal automobile, so there is no mode split step.

Importantly, for both models only inter-zonal trips (trips between two different zones) are assigned to the roadway networks when performing the traffic assignment step, and such trips are assumed to be by automobile. For intra-zonal person trips, mode of travel (drive, walk, bicycle, etc.) is not necessarily known, and the models do not assign them to the roadway network, even those that would potentially be made by personal automobile. The reason is that the roadway networks for the models are not defined within each analysis zone where intra-zonal trips occur. Instead, centroid connectors defined for each zone represent “local” roadways used for access to the primary roadway network, which is typical of traditional four-step travel demand models. Therefore, VMT estimates presented in this study do not include travel for intra-zonal trips.

Through trips - trips between “external” analysis zones that are not within the two town boundaries – are included in the VMT results, but the portion of VMT attributable to through trips in both towns does not change across the three growth scenarios. This is because those through trips and their route across the towns are not be affected by the land use development modifications considered in the study.

Greenhouse gas emissions were estimated from model-generated VMT totals using a U.S. Environmental Protection Agency formula.[6] The formula uses VMT with assumed values for the amount of metric tons of carbon dioxide (CO_2) emitted per gallon of gasoline consumed

[6] U.S. Environmental Protection Agency. “Calculations and References, Passenger vehicles per year.” http://www.epa.gov/solar/energy-resources/refs.html#vehicles.

and the amount of gallons consumed per mile traveled. Lastly, the formula converts metric tons of CO_2 to carbon dioxide equivalents, which includes methane and nitrous oxide in addition to carbon dioxide. The formula is expressed as:

$$\textbf{GHG emissions (metric tons of } CO_2E) = \frac{VMT * \frac{0.00881\ (\text{metric tons } CO_2 \text{ per gallon gasoline})}{19.7\ (\text{miles per gallon gasoline})}}{0.971\ (CO_2 \text{ per } CO_2E)}.$$

The average vehicle fuel economy assumed in the formula is 19.7 miles per gallon based on the FHWA's *Highway Statistics 2005*.[7] This average value could vary in a rural state such as Maine, either due to driving conditions or vehicle fleet mix, or a combination of both.

2.6 Results and Discussion

Average trip length, daily vehicle miles traveled (VMT), and daily greenhouse gas estimates are reported for each growth scenario. Table 5 and Table 6 present the results for Lisbon and Sanford, respectively.

TABLE 5: LISBON GROWTH SCENARIO RESULTS – ALL DAILY TRIPS, 2030

Scenario	Average Trip Length [1],[2]	Daily Total VMT [3]	VMT Reduction from S.Q.	Percent Reduction from S.Q.	Daily GHG Emissions, CO_2E (metric tons)	Percent Reduction from S.Q.
Status Quo (S.Q.)	8.94	152,955	---	---	70.4	---
Targeted Smart Growth	8.92	152,300	-656	-0.43%	70.1	-0.42%
Multiple Smart Growth	8.91	151,917	-1,038	-0.68%	70.0	-0.57%

[1] Trip length (distance in miles) includes distance traveled for trips from/to Lisbon zones only.
[2] Average trip length of HBW, HBNW, and NHB trip purposes as daily person trips.
[3] VMT for roadway network within Lisbon only; TAZ centroid connectors are omitted from VMT estimates.

In Lisbon, VMT and GHG emissions estimated for the Targeted Smart Growth scenario were 0.43% and 0.42% lower, respectively, than estimates for the Status Quo scenario. The VMT percent reduction corresponds to 656 fewer vehicle miles traveled daily in the Town of Lisbon. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.68% and 0.57%, respectively, compared to Status Quo. The VMT percent reduction corresponds to 1,038 fewer vehicle miles traveled daily.

Under the Targeted Smart Growth scenario, daily intra-zonal trips for zone #87 (refer to Figure 2), where new households and employment were concentrated (refer to maps in Appendix A), increased from approximately 175 person trips under Status Quo to 250 person

[7] *Highway Statistics 2005*. Office of Highway Policy Information, Federal Highway Administration. 2006.

trips. Similarly, for the Multiple Smart Growth scenario, the combined number of intra-zonal trips for zones #35 and #87 increased from approximately 190 persons trips under Status Quo to 290 person trips. Under the smart growth scenarios, the densification of development and mixing of land uses provide more opportunities to satisfy trips within the smart growth zones.

The concentration of smart growth developments at village centers along Route 196 in Lisbon, slightly shorter average trip lengths, and an increase in intra-zonal trips results in a slight drop of daily VMT. However under Targeted Smart Growth, for example, it is apparent that by concentrating the bulk of new households and employment as one infill development situated at the center of Lisbon Falls on Route 196, there would be an increase of VMT on some roadways in the network due to travelers having to drive further to/from that zone. There would be a similar effect for Multiple Smart Growth. Under each of the two smart growth scenarios, daily VMT on Route 196 would increase by about 0.20-0.30% (200-300 daily miles traveled), but VMT on other roadways in Lisbon would decrease by a greater amount, about 1.30-2.10% (850-1,330 daily miles traveled), which would result in a net, network-wide reduction in daily VMT.

TABLE 6: SANFORD GROWTH SCENARIO RESULTS – ALL DAILY TRIPS, 2030

Scenario	Average Trip Length [1],[2]	Daily Total VMT [3]	VMT Reduction from S.Q.	Percent Reduction from S.Q.	Daily GHG Emissions, CO_2E (metric tons)	Percent Reduction from S.Q.
Status Quo (S.Q.)	4.47	406,832	---	---	187.4	---
Targeted Smart Growth	4.42	405,847	-985	-0.24%	186.9	-0.27%
Multiple Smart Growth	4.40	405,134	-1,698	-0.42%	186.6	-0.43%

[1] Trip length (distance in miles) includes distance traveled within the Sanford model study area only; does not include distances traveled outside the Sanford study area for trips from/to external origins/destinations.
[2] Average trip length of HBW, HBNW, and NHB trip purposes as daily person trips.
[3] VMT for roadway network within Sanford only; TAZ centroid connectors are omitted from VMT estimates.

Results for Sanford show similar trends as Lisbon for changes in VMT and trip lengths for the smart growth scenarios. In Sanford, VMT and GHG emissions estimated for the Targeted Smart Growth scenario dropped by 0.24% and 0.27%, respectively, from the Status Quo scenario. The VMT percent reduction corresponds to 985 fewer vehicle miles traveled daily in the Town of Sanford. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.42% and 0.43%, respectively, compared to Status Quo. The VMT percent reduction corresponds to 1,698 fewer vehicle miles traveled daily.

Under the Targeted Smart Growth scenario, daily intra-zonal trips for zone #10 (refer to Figure 3), where new households and employment were concentrated (refer to maps in

Appendix B), increased from approximately 410 person trips under Status Quo to 1,310 person trips. Similarly, for the Multiple Smart Growth scenario, the combined number of intra-zonal trips for zones #5, #10, and #20 increased from approximately 820 person trips to 2,380 person trips. As in Lisbon, under the smart growth scenarios the densification of development and mixing of land uses provide more opportunities to satisfy trips within the smart growth zones. However, as a result of redirecting growth to zones #5, #10, and #20 from other zones, the number of inter-zonal trips between zones experienced a net increase under the two smart growth scenarios. The reason for this behavior is that although the number of intra-zonal trips increase for the smart growth zones, the redirection of development and employment would force some hitherto intra-zonal trips (made by existing households in the study area) to travel outside their zone to the smart growth zones for trip purposes. With a shift from intra-zonal trips to inter-zonal trips, more trips are assigned to the roadway network. However, this is offset by the reduction in trip lengths, thus leading to an overall reduction in daily VMT.

Examining the Targeted Smart Growth scenario further, it is apparent that by concentrating a large portion of new households and employment as one infill development situated at the center of downtown Sanford at zone #10, there would be an increase of VMT on some roadways in the network due to travelers having to drive further to/from that zone. The VMT increases on these roads are low, and combined with VMT decreases on other roadways, there is still a network-wide net decrease in VMT. However, this effect should be considered when planning large, mixed-use developments. It also reinforces the need for improved transit service and limited parking availability (to discourage high automobile ownership rates) to be coupled with smart growth land use policies so that dense, concentrated growth does not have the negative effect of simply concentrating traffic congestion on roadways surrounding the development, which has been identified as a “congestion conundrum” in TOD literature.[8]

In summary, analysis results for Lisbon and Sanford indicate that:

- The densification and mixing of residential and employment growth as infill developments has a slight but observable impact on VMT and average trip lengths.
- The scenario with multiple smart growth developments had greater benefit, in the form of VMT and GHG reductions, than the scenario with one smart growth development.
- Intra-zonal trips tend to increase for smart growth zones, while the number of intra-zonal trips for non-smart growth zones decreases, albeit at varying degrees depending on the land use mix of those zones.

[8] Cervero, R., et al. *Transit-oriented development in the United States: Experience, challenges, and prospects*, *TCRP Report 102*. Transit Cooperative Research Program, Transportation Research Board. 2004.

- Some roadways in the towns experienced VMT increases, which were offset by greater VMT reductions on other roadways, resulting in net, network-wide VMT reductions.
- The effect of increases in VMT on some roadways to/from the smart growth developments should be considered when performing detailed planning of such developments.
- The smart growth scenarios are limited to the amount of growth expected in Lisbon and Sanford by the year 2030; greater benefits in VMT and GHG reductions may be more apparent at a later forecast year when more growth could be redirected to smart growth developments.

The investigated mixed-use developments under both smart growth scenarios in Lisbon and Sanford did not produce moderate to substantial reductions in daily VMT. However, there are important factors to consider when evaluating the implications of the results.

One important consideration is that the amount of growth available for redirection into smart growth developments is expected to be limited (refer to Tables 1–4). Of the total number of households expected in Lisbon in year 2030, 4,148 households, only 2.4% (100 households) would be in a smart growth development under Targeted Smart Growth, and only 5.8% (239 households) would be in a smart growth development under Multiple Smart Growth. Similarly, 3.9% and 5.4% of total jobs would be in a smart growth development under the Targeted and Multiple Smart Growth scenarios, respectively. Of the total number of households expected in Sanford in year 2030, 10,041 households, only 3.6% (358 households) would be in a smart growth development under Targeted Smart Growth, and only 8.6% (859 households) would be in a smart growth development under Multiple Smart Growth. Similarly, 4.6% and 7.0% of total jobs would be in a smart growth development under the Targeted and Multiple Smart Growth scenarios, respectively. These figures mean that in Lisbon and Sanford in year 2030, a vast majority of existing households and jobs, as well as many new households and jobs, and the corresponding daily VMT would be unaffected by the smart growth policies.

Also, the limited amount of growth in individual towns highlights the need for smart growth policies on a more regional level, with potential growth consolidation to existing urban centers and transit connections to village centers on the periphery. This would allow for a redirection of widespread growth and promote the interconnectivity between towns and urban centers. While individual towns could still pursue individual mixed-use infill development to revitalize vacant buildings, such developments could be pieces of a larger, regional smart growth plan.

A second important consideration involves transit. A mode shift to transit was not considered in this study, and the results indicate that the efficacy of the smart growth scenarios to reduce VMT in Lisbon and Sanford is greatly limited without transit to complement the proposed dense, mixed-use developments. One premise of the smart growth scenarios is that the proposed infill developments would be “transit-ready” along existing transportation corridors – Route 196 in Lisbon and Route 109 in Sanford. The smart growth scenarios partially prepare future development for more efficient and viable land use interconnectivity with transit, but transit would also be needed to fully realize this benefit. It is likely that new transit service and increasing ridership between the smart growth developments and to other areas of the towns and neighboring towns/urban centers would lead to further VMT reductions (see Areas of Further Research section and Table 9).

Lastly, it is important to note the other benefits of the smart growth developments that are not measurable or quantified by this modeling analysis. The redevelopment of existing, vacant buildings to facilitate household and employment growth would serve to conserve hitherto undeveloped land in the towns, use existing infrastructure, including utility and transportation systems, and support more livable developed communities. Also, the revitalization of neighboring areas would be aided by the occupancy of currently vacant buildings at the town centers. These considerations go beyond the modeling results and should not be overlooked when evaluating the merits of such developments.

2.7 Key Uncertainties in Implementing Smart Growth Policy

The following discussion highlights some uncertainties that could affect the ability and success of implementing smart growth policies in towns similar to Lisbon and Sanford in Maine.

Overall population, household, and economic growth. The actual type, location, and extent of future growth in Lisbon and Sanford are difficult to project, especially given current housing market and economic conditions. Having enough new development to warrant implementing real smart growth strategies could be increasingly challenging under stagnant growth conditions. Conversely, revitalized growth with foreseeable residential and commercial development over the next decades would provide opportunity for officials and the public to guide that growth. Positive growth was assumed for this study in order to evaluate smart growth strategies, although actual growth could likely vary from those projections.

Measures to implement smart growth policies. Since smart growth strategies like those presented in this study involve densification and mixing of land uses, local zoning regulations could require revision to allow for such development and lay the groundwork for future transit-oriented designs, including building and street design guidelines to create pedestrian/bicycle-friendly communities. Local governments in towns such as Lisbon and Sanford would equally need the support of regional and state planning organizations as well as state agencies, such as the Maine Department of Transportation, to support smart growth policy development. Even though this study explores smart growth on a town level, regional implementation of growth management and supportive transit investments would likely provide greater, widespread benefit. The Maine Department of Transportation report, *Sensible Transportation – A Handbook for Local and Inter-Community Transportation Planning in Maine*[9], provides valuable guidance toward those goals.

Investment for transit infrastructure and service. Growth management through smart growth policies should be coupled with improved travel alternatives to automobile use, namely transit for longer, less walkable/bikeable trips. By concentrating land use development into dense, mixed-use zones near existing transportation corridors, transit would be more accessible by the population and employment centers. As a result, transit could become an increasingly convenient alternative to driving for daily trip-making. Ideally, there would be sufficient investments to fund infrastructure and service to meet increased demand for transit. Transit investments could include fixed-route/schedule bus service, paratransit, and possibly rail, to service travel within and between smart growth clusters in cities and towns in the region. Although the effects of increased transit use for daily trip-making is not explored in this study, a brief scenario of increased transit ridership is discussed in section 3, *Areas for Further Research*.

Population self-selection/desire for smart growth development. Studies identify self-selection by residents choosing to live in smart growth, specifically TOD, communities as a significant factor in reduced automobile use and increased transit ridership.[10,11,12] That is, one reason why transit ridership increases with TOD is because residents initially seek out TOD-type communities for transit availability. Similarly, smart growth in Maine towns like Lisbon and Sanford may only be successful and provide travel benefits if new residents and businesses are attracted to dense, mixed-use developments, and desire to make trips using alternative modes to the automobile. Conversely, if residents solely desire low-density, single-family detached housing set apart from other land uses, viability of dense, infill developments would be limited. Furthermore, gasoline prices and the availability and cost of alternative fuel vehicles – hybrids, plug-in hybrids, and electric vehicles – in the coming years could greatly affect traveler behavior, travel patterns, and choices as to where people live and work.

3. Areas of Further Research

By concentrating growth nearer to more urbanized downtown centers which transit could more readily and efficiently serve, the smart growth developments can be considered as "transit ready." Dispersed growth has the opposite effect, making transit service to scattered

[9] Maine Department of Transportation. *Sensible Transportation – A Handbook for Local and Inter-Community Transportation Planning in Maine*. June 2008.
[10] Cervero, R., et al. *Transit-oriented development in the United States: Experience, challenges, and prospects*, *TCRP Report 102*. Transit Cooperative Research Program, Transportation Research Board. 2004.
[11] Arrington, G.B. and Cervero, R. *Effects of TOD on Housing, Parking, and Travel, TCRP 128*. Transit Cooperative Research Program, Transportation Research Board. 2008.
[12] Smart Growth and Transportation Issues and Lessons Learned – Report on a Conference, September 8-10, 2002, Baltimore, Maryland. Conference Proceedings 32, Transportation Research Board. 2005.

low-density developments difficult to implement and operate. Thus, the smart growth developments can be seen as anchors, or hubs, along existing transportation corridors, such as Route 196 through Lisbon and Route 109 through Sanford. Using Sanford as an example, Table7 and Table 8 show the approximate number and percentage of future year population and employment, respectively, projected to be within one-quarter and one-half mile radii from theoretical future transit stops – one stop at the centers of downtown Sanford, South Sanford, and Springvale. It is reasonable to expect that population and employment growth nearer to transit facilities would result in increased transit ridership demand, specifically to and from the smart growth developments. This, however, is not explored in the current study.

TABLE 7: SANFORD POPULATION PROXIMITY TO FUTURE TRANSIT STOPS

Scenario	2030 Population within ¼ Mile of Transit Stops [1]	Percentage of Total Sanford Population	2030 Population within ½ Mile of Transit Stops [1]	Percentage of Total Sanford Population
Status Quo (S.Q.)	1,430	5.9%	4,510	18.7%
Targeted Smart Growth	2,230	9.2%	5,310	22.0%
Multiple Smart Growth	3,380	14.0%	6,460	26.8%

[1] Potential future transit bus stops considered at the centers of Sanford (downtown), South Sanford, and Springvale.

TABLE 8: SANFORD EMPLOYMENT PROXIMITY TO FUTURE TRANSIT STOPS

Scenario	2030 Employment within ¼ Mile of Transit Stops [1]	Percentage of Total Sanford Employment	2030 Employment within ½ Mile of Transit Stops [1]	Percentage of Total Sanford Employment
Status Quo (S.Q.)	1,690	13.9%	3,700	30.3%
Targeted Smart Growth	2,050	16.8%	4,210	34.5%
Multiple Smart Growth	2,130	17.5%	4,420	36.2%

[1] Potential future transit bus stops considered at the centers of Sanford (downtown), South Sanford, and Springvale.

To estimate the potential benefits of improved transit ridership in conjunction with the study's smart growth scenarios, the research team assumed a 20 percent allocation of daily person trips to transit in Sanford for trips between the TAZs modified under Multiple Smart Growth (TAZs #5, #10, and #20) and the other mostly developed TAZs along Route 109 (Main St). The reduced 20 percent of inter-zonal person trips is then considered transit trips utilizing a possible bus service along Route 109, while the remaining 80 percent of daily inter-zonal person trips are made by automobile. This modified Multiple Smart Growth scenario with 20% trips using transit would result in approximately 398,990 VMT, daily, a reduction of 7,842 miles or 1.93% from Status Quo (see Table 9). Furthermore, while the Multiple Smart

Growth scenario without transit ridership would reduce VMT by 0.42% from Status Quo, attaining the assumed level of transit use would provide an additional 1.51% reduction in daily VMT. Clearly, increased transit ridership coupled with smart growth land use development plans can have a more significant impact on reducing VMT in rural areas – certainly more than growth management alone – and could be further studied in detail using more sophisticated travel demand modeling techniques.

TABLE 9: SANFORD GROWTH SCENARIO RESULTS WITH 20% TRANSIT SHARE

Scenario	Daily Total VMT [1]	VMT Reduction from S.Q.	Percent Reduction from S.Q.	Daily GHG Emissions, CO_2E (metric tons)	Percent Reduction from S.Q.
Status Quo (S.Q.)	406,832	---	---	187.4	---
Multiple Smart Growth *without transit trips*	405,134	-1,698	-0.42%	186.6	-0.43%
Multiple Smart Growth *with assumed transit trips*	398,990	-7,842	-1.93%	183.8	-1.92%

[1] VMT does not include distances traveled outside the Sanford study area for trips from/to external origins/destinations; TAZ centroid connectors are omitted from VMT estimates.

An additional aspect of future research connected to the preceding discussion could include finer levels of analysis zone disaggregation for the particular town(s) being studied. Since the size of the smart growth developments discussed in this report would be on the building/block scale, as infill for revitalization, it would be beneficial to study the impacts of such developments on a neighborhood scale. Furthermore, greater zonal detail, when coupled with a robust mode choice model, could better show the effects of dense, mixed-use developments on walk and bicycle trip behavior, short trips, and interactions with local transit stops.

Lastly, to aid in the forecasting and assessment of smart growth policies, it would be beneficial to have detailed survey data for households in existing smart growth-type developments in rural or small communities. Such data would facilitate more accurate assumptions of household sizes, auto ownership, travel behavior, and residential selection processes of persons living in such developments in those communities.

4. Conclusions

This study explored the effects of smart growth developments on average trip lengths, daily vehicle miles traveled, and the resulting greenhouse gas emissions in the Town of Lisbon and the Town of Sanford in Maine, using traditional travel demand model techniques. The redirection of future growth expected in two towns in Maine into dense, mixed-use infill developments showed a slight impact on travel activity, in the form of shorter average trip lengths and VMT reductions as compared to a status quo scenario of growth.

Three scenarios were tested – Status Quo Growth, Targeted Smart Growth, and Multiple Smart Growth. Status Quo Growth, the benchmark scenario, considered future growth following historical land use patterns in the towns. Targeted Smart Growth and Multiple Smart Growth assumed redirection of expected growth into one or more dense, mixed-used infill developments. Only the location, density, and mix of growth were modified across the planning scenarios in the study. Household characteristics, such as size and auto availability, were held constant so that each scenario had similar numbers of daily trips. Use of alternative transportation modes was also held constant, so that there was equal automobile use in each scenario.

Compared to the Status Quo Growth scenario, the two smart growth scenarios showed slight, but observable, reductions in average trip lengths and daily vehicle miles traveled. Multiple Smart Growth, which had a more rigorous redirection of growth, showed greater reductions than Targeted Smart Growth. Since the degree of growth management in the two smart growth scenarios is limited to the expected amount of household and employment growth assumed in the two towns for future year 2030, a further future year at which point more growth could be redirected to infill development could show greater reductions in average trip lengths and VMT.

Importantly, the study results do not include the effect of future transit service coupled with the proposed smart growth developments. Consequently, the results indicate that the efficacy of the smart growth scenarios to reduce VMT in Lisbon and Sanford is greatly limited without transit to complement the proposed dense, mixed-use developments. One premise of the smart growth scenarios is that the proposed infill developments would be "transit-ready" along existing transportation corridors – Route 196 in Lisbon and Route 109 in Sanford. The smart growth scenarios partially prepare future development for more efficient and viable land use interconnectivity with transit, but transit would also be needed to fully realize this benefit and provide further reductions in daily VMT.

More detailed modeling techniques to capture the impacts of potential transit service, in addition to the smart growth developments explored in this study, could yield further reductions in VMT compared to the growth management strategies alone. A preliminary analysis assuming a fixed percentage of daily person trips as transit (non-automobile) trips would show a greater reduction in VMT than growth management alone; however, it would be important for the model to capture the changes in transit ridership, or mode choice, due to the redirection of growth in mixed-use, infill developments. The findings would aid in the planning of smart growth developments and transit service to and from those development along existing transportation corridors.

Appendix A: Lisbon Growth Scenario Maps

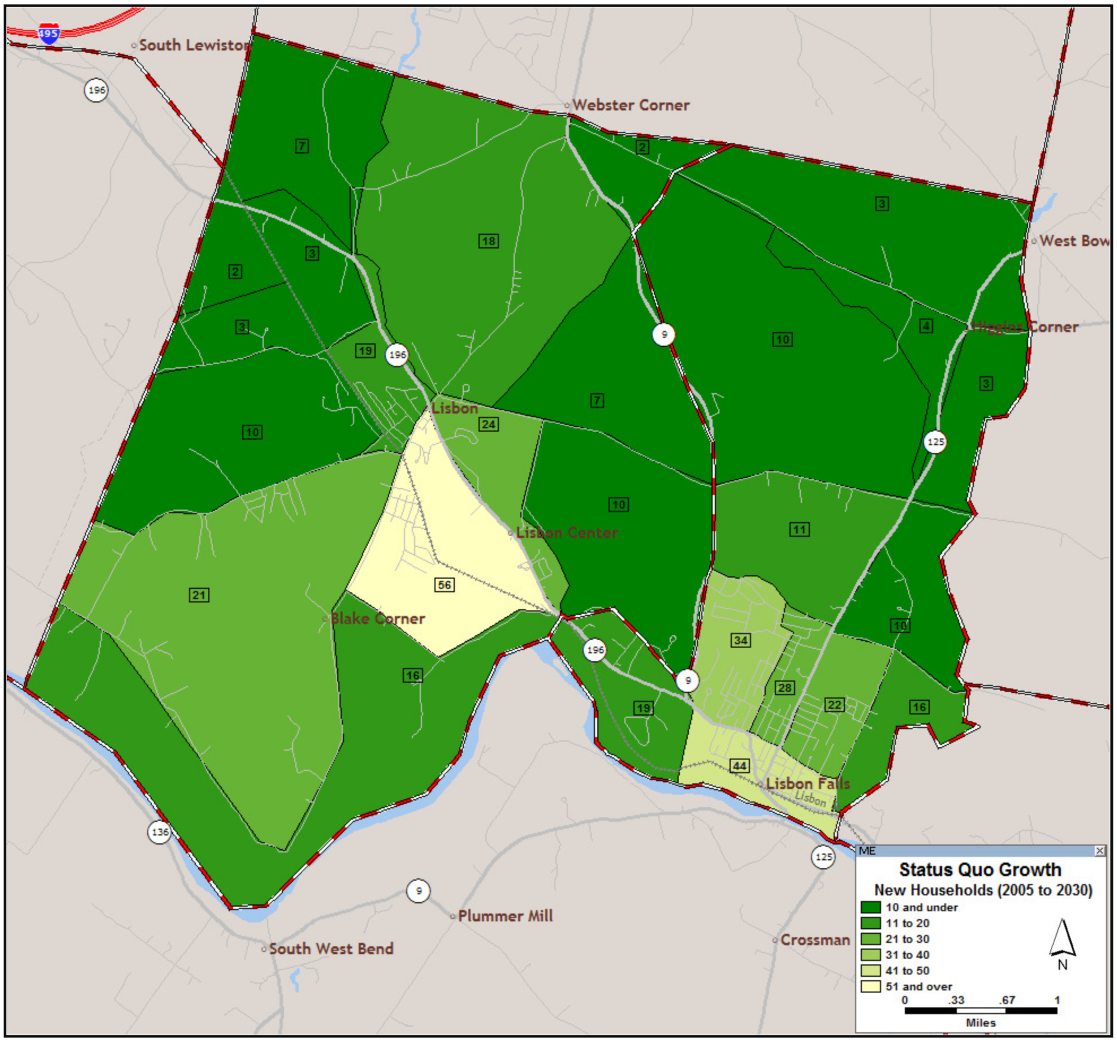

FIGURE A-1: LISBON STATUS QUO GROWTH – HOUSEHOLDS

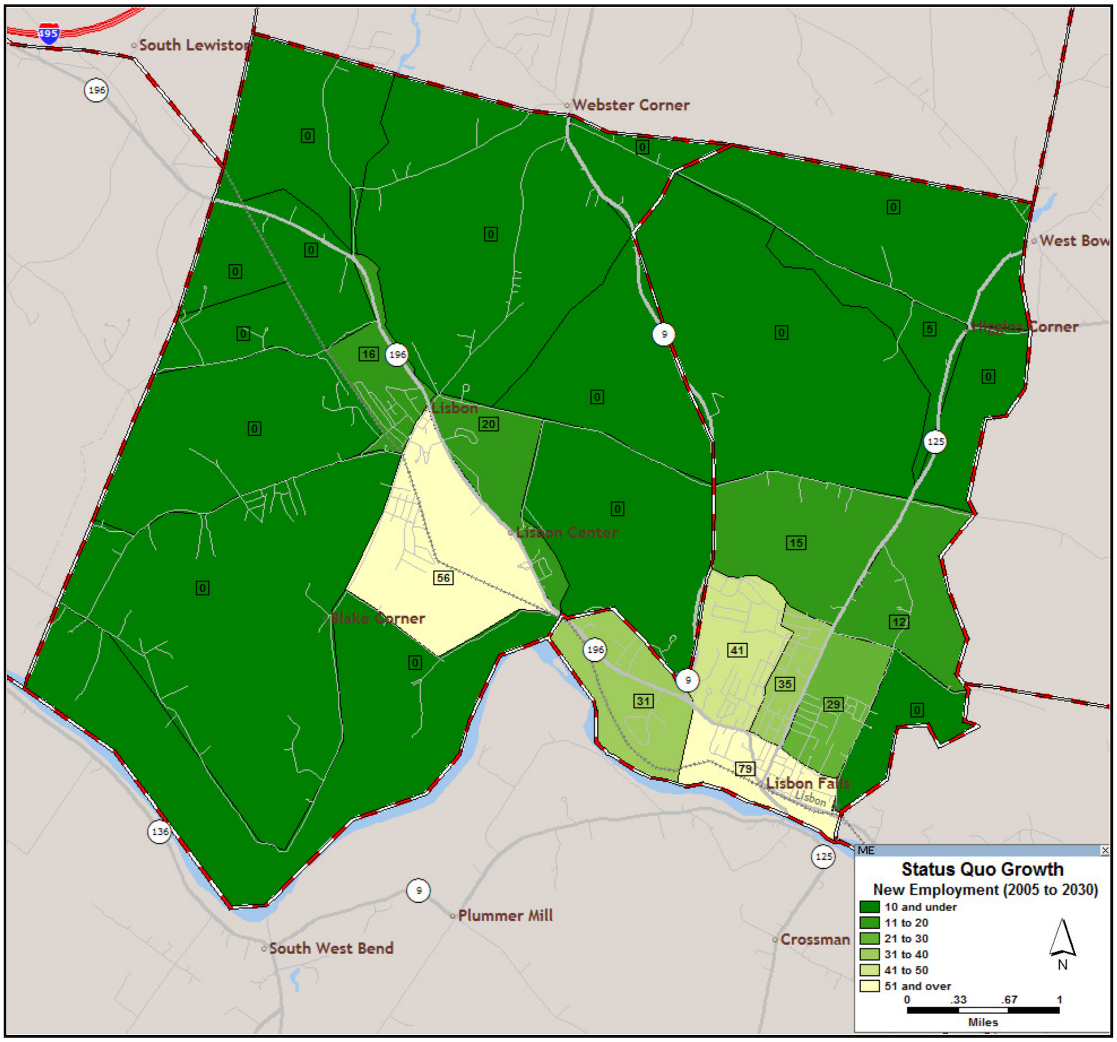

FIGURE A-2: LISBON STATUS QUO GROWTH – EMPLOYMENT

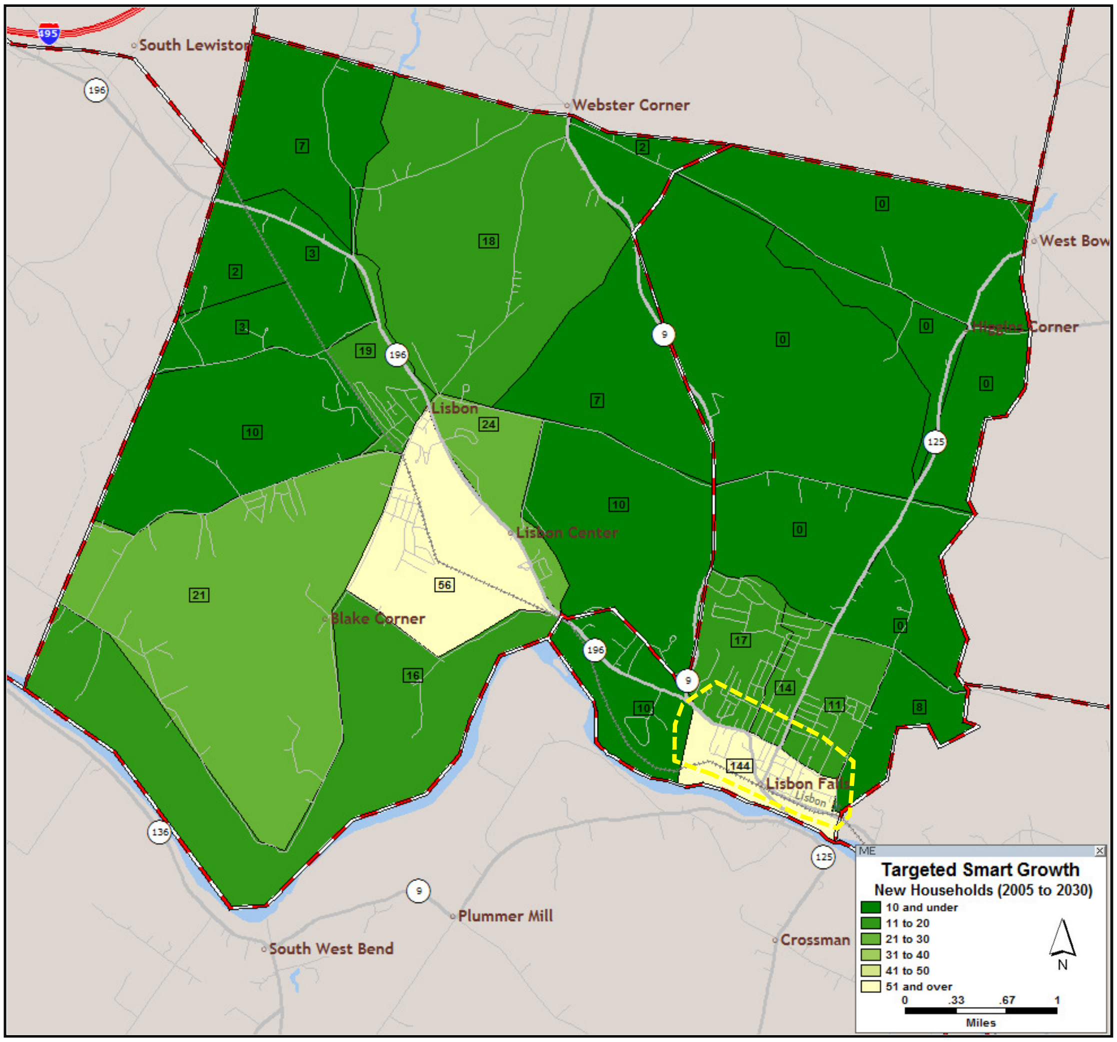

FIGURE A-3: LISBON TARGETED SMART GROWTH – HOUSEHOLDS

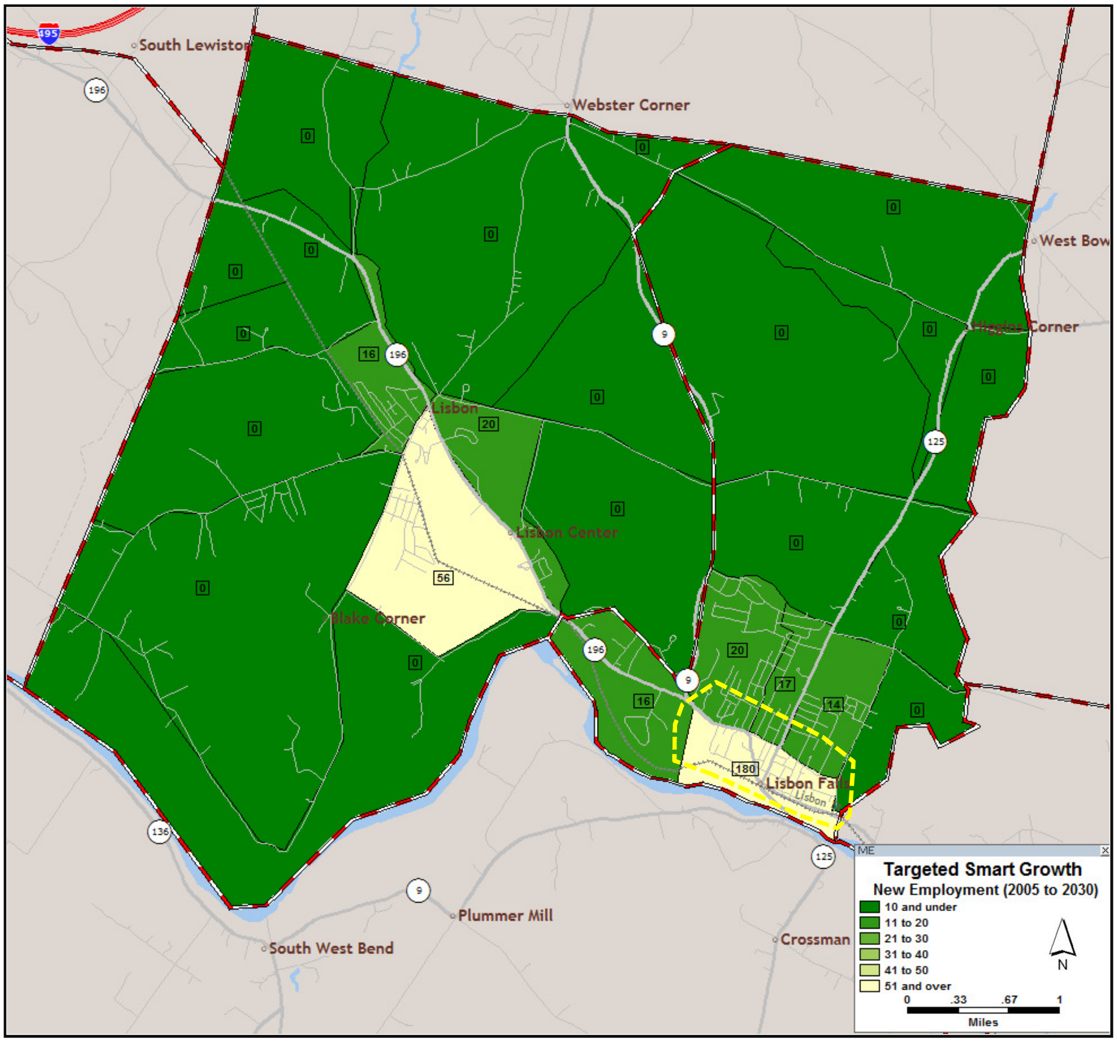

FIGURE A-4: LISBON TARGETED SMART GROWTH – EMPLOYMENT

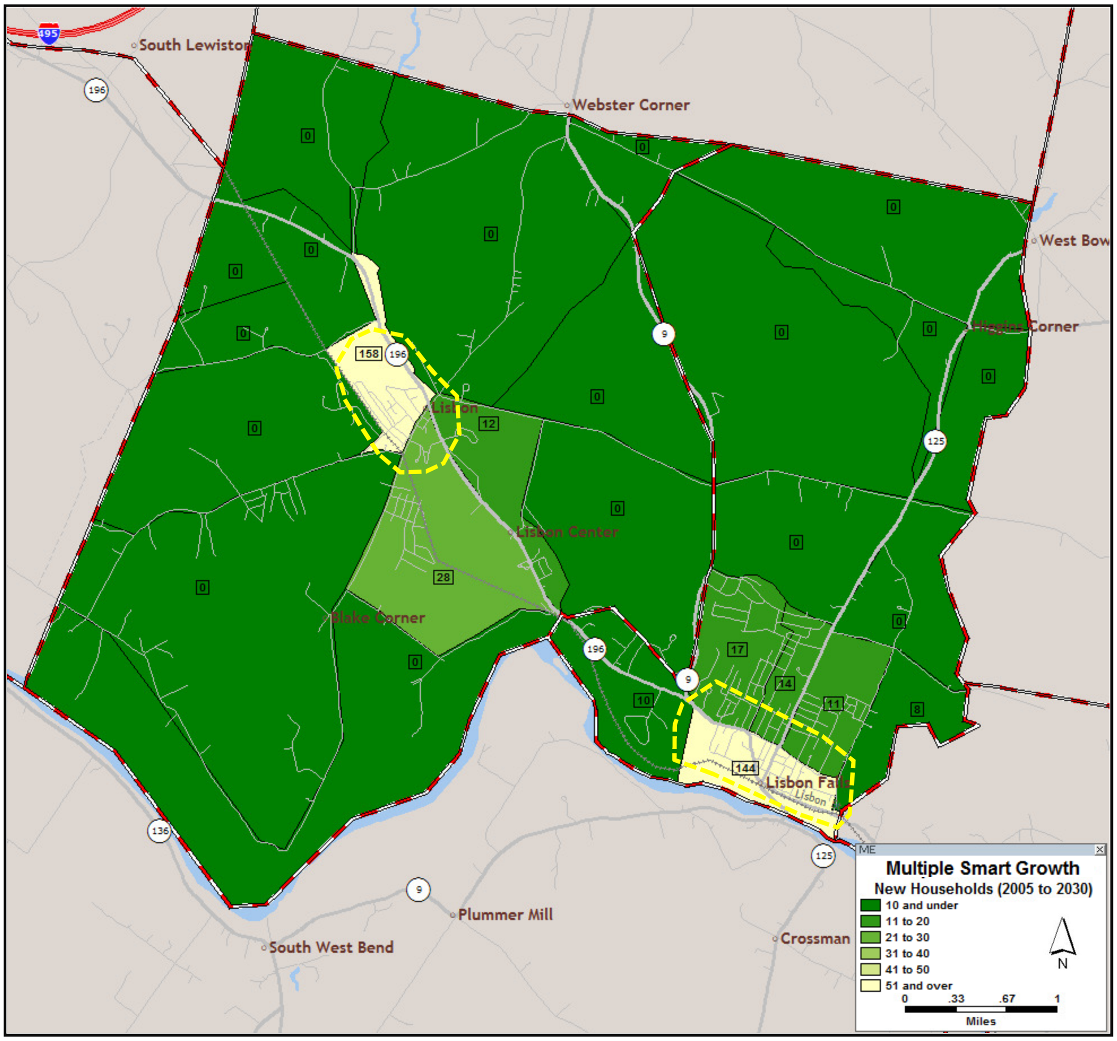

FIGURE A-5: LISBON MULTIPLE SMART GROWTH – HOUSEHOLDS

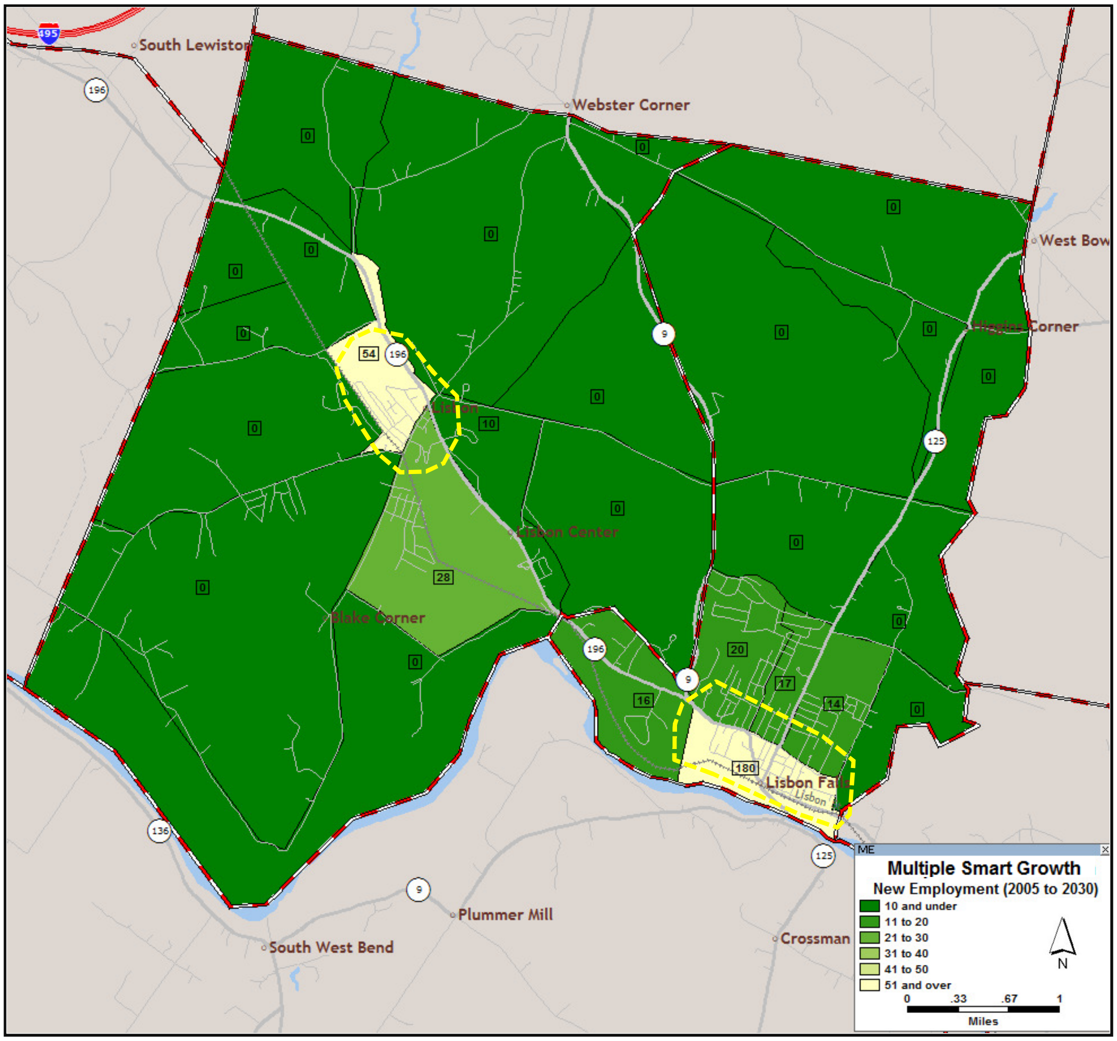

FIGURE A-6: LISBON MULTIPLE SMART GROWTH – EMPLOYMENT

Appendix B: Sanford Growth Scenario Maps

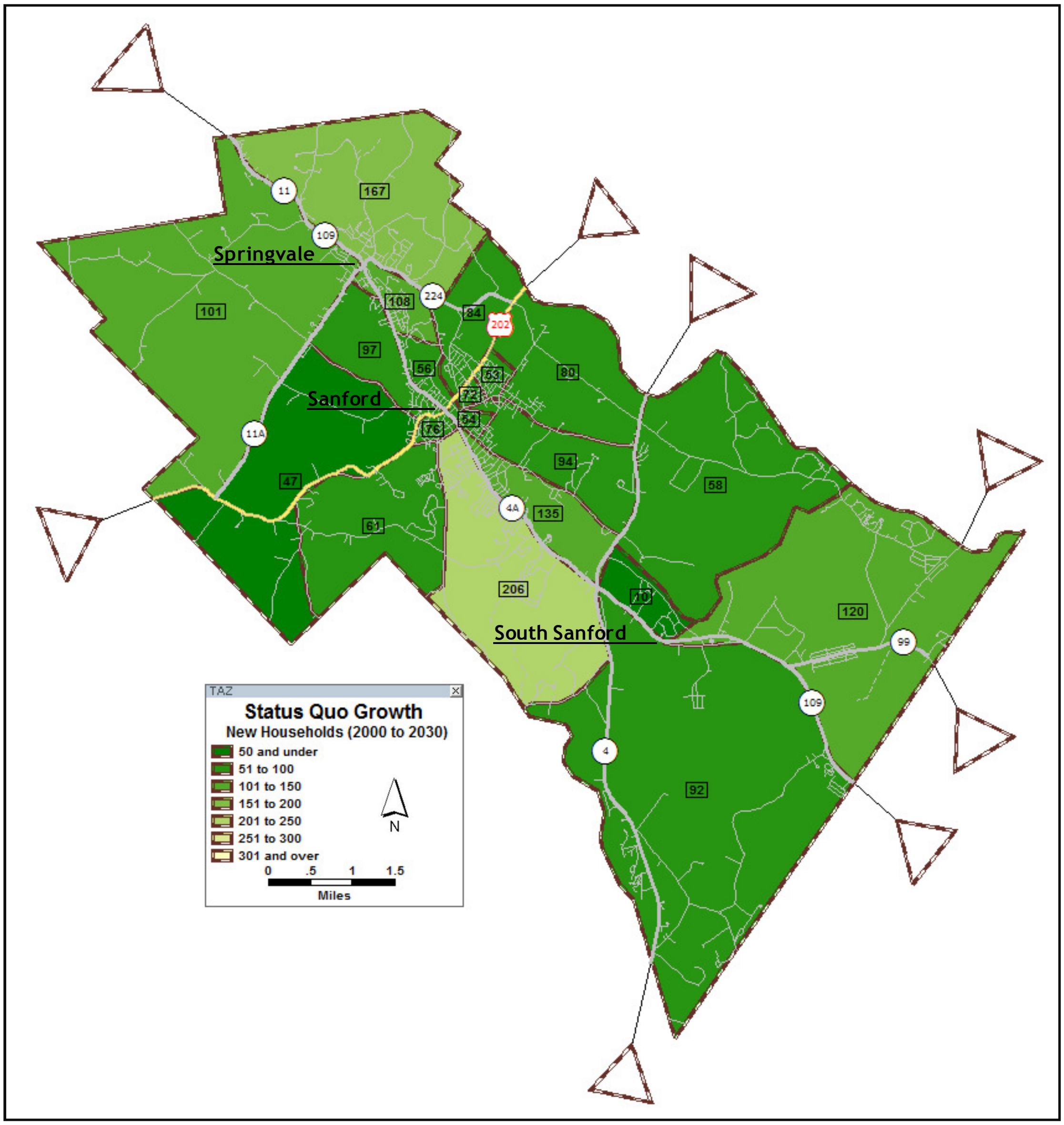

FIGURE B-1: SANFORD STATUS QUO GROWTH – HOUSEHOLDS

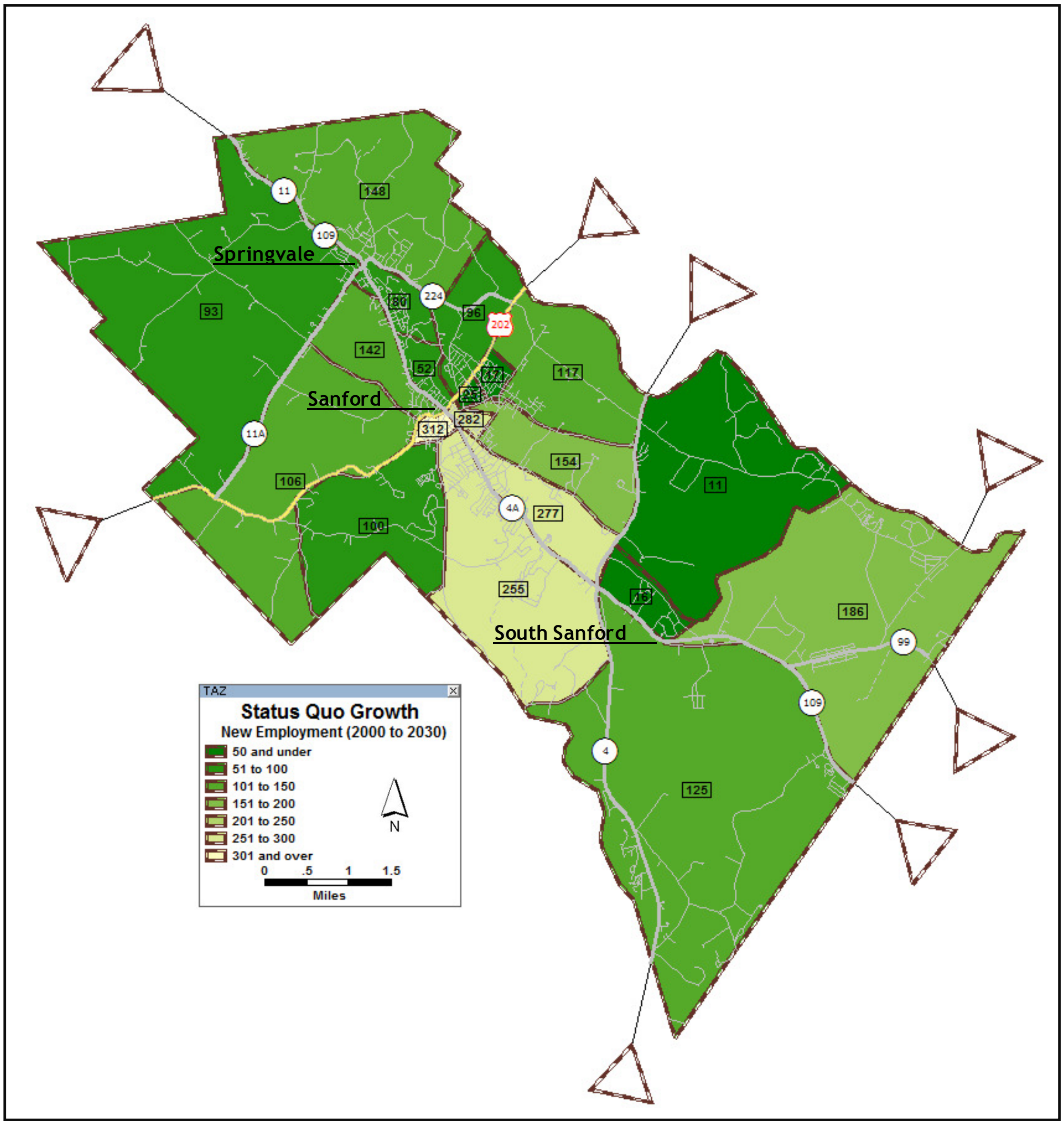

FIGURE B-2: SANFORD STATUS QUO GROWTH – EMPLOYMENT

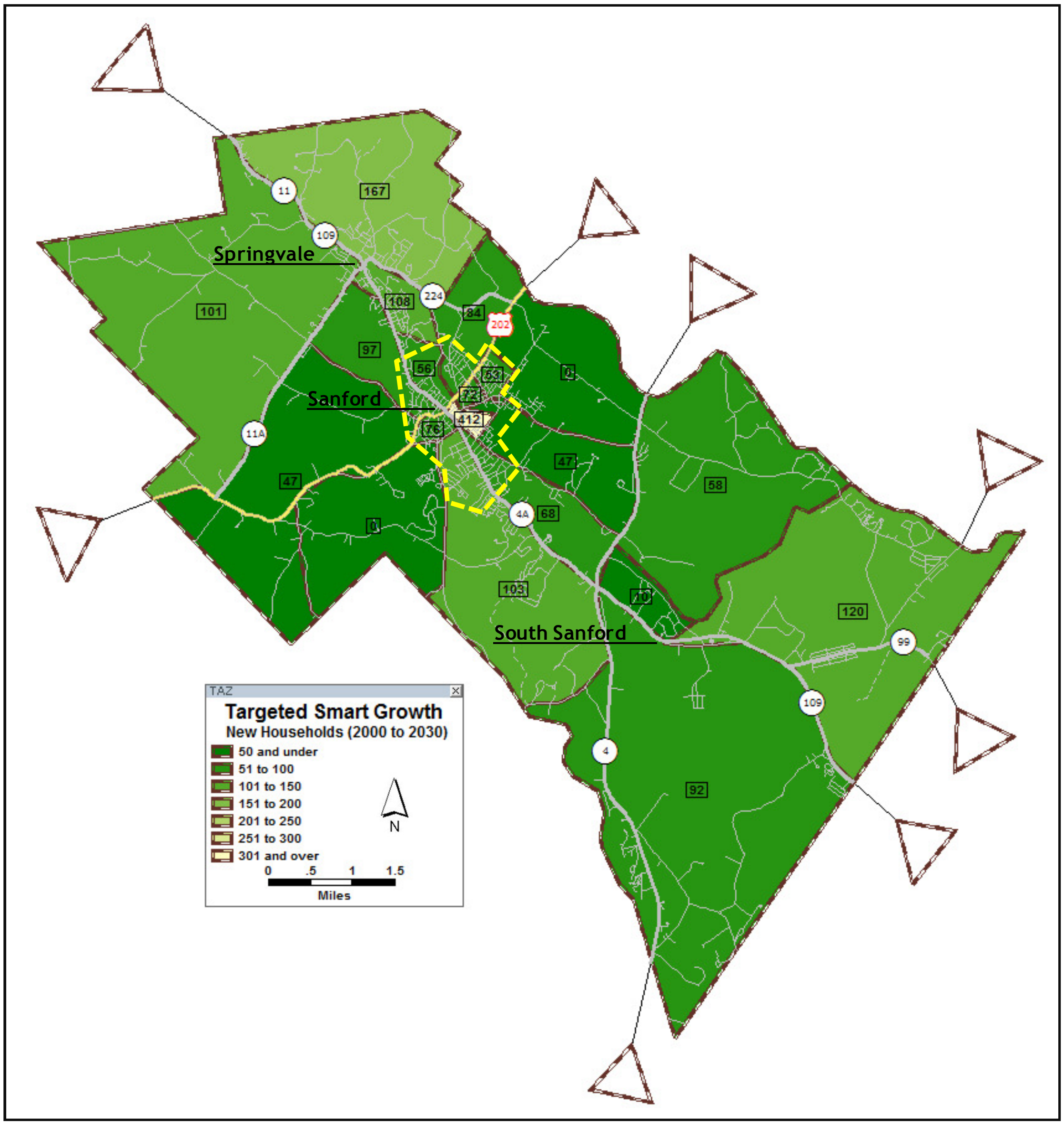

FIGURE B-3: SANFORD TARGETED SMART GROWTH – HOUSEHOLDS

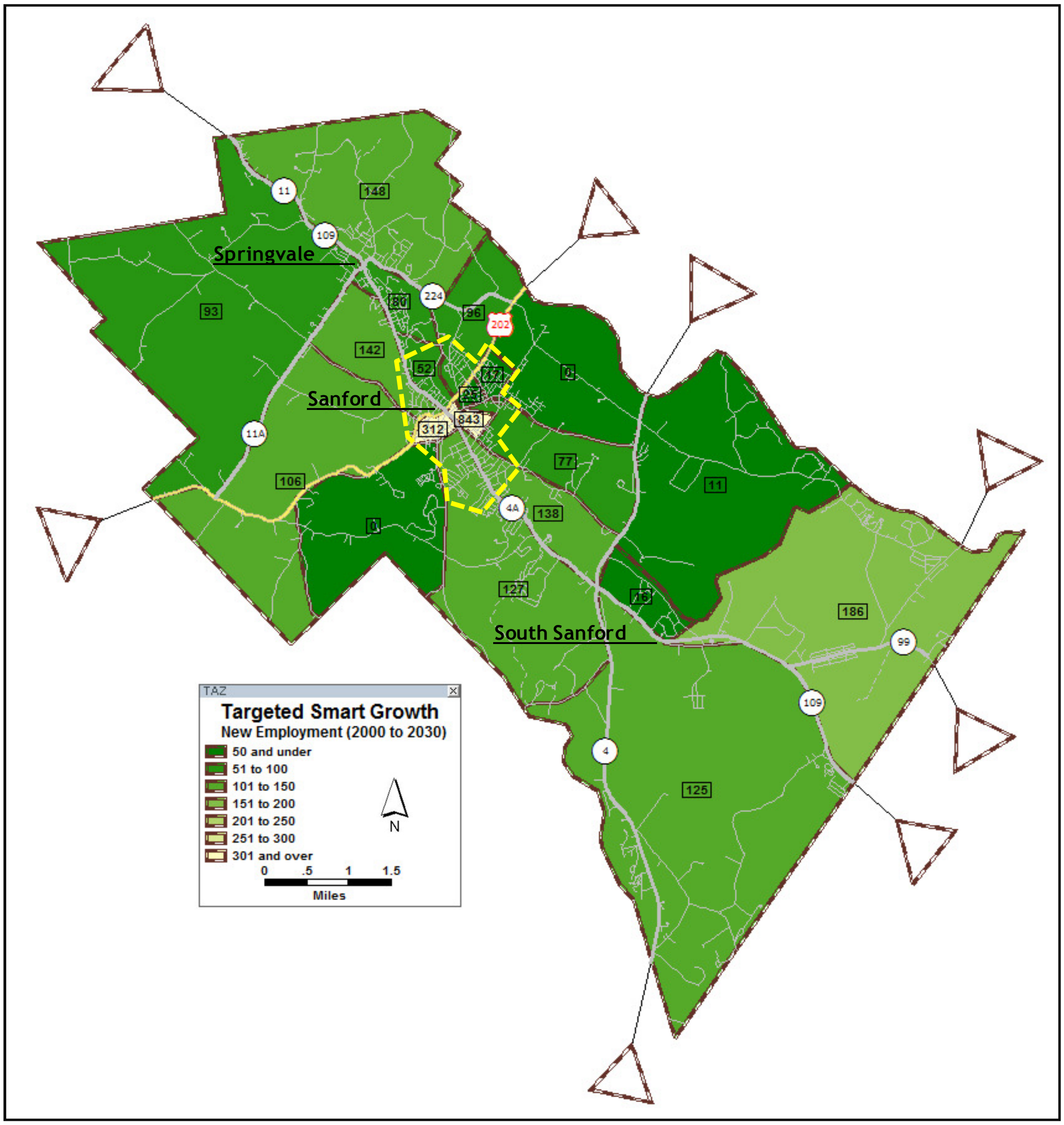

FIGURE B-4: SANFORD TARGETED SMART GROWTH – EMPLOYMENT

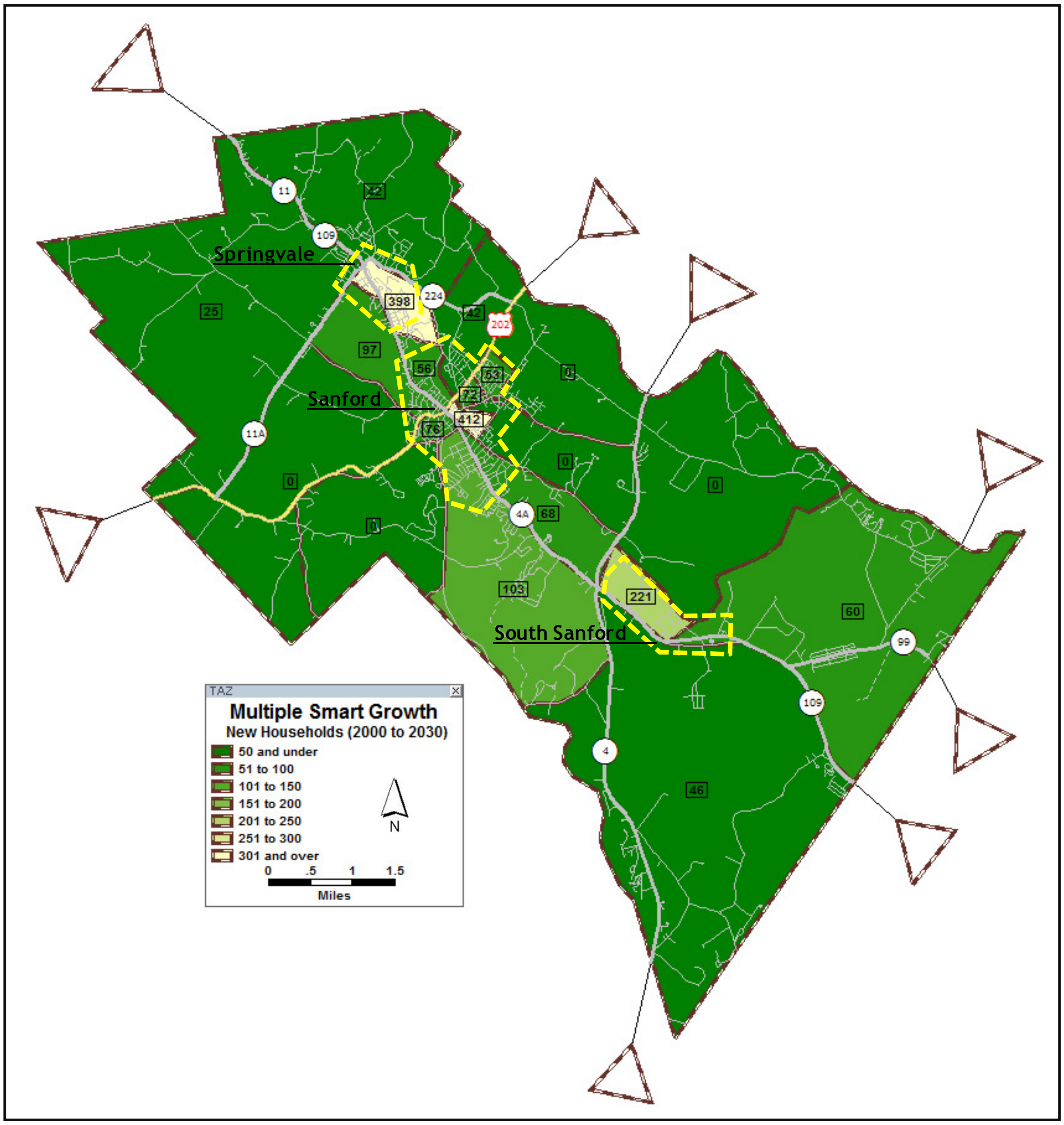

FIGURE B-5: SANFORD MULTIPLE SMART GROWTH – HOUSEHOLDS

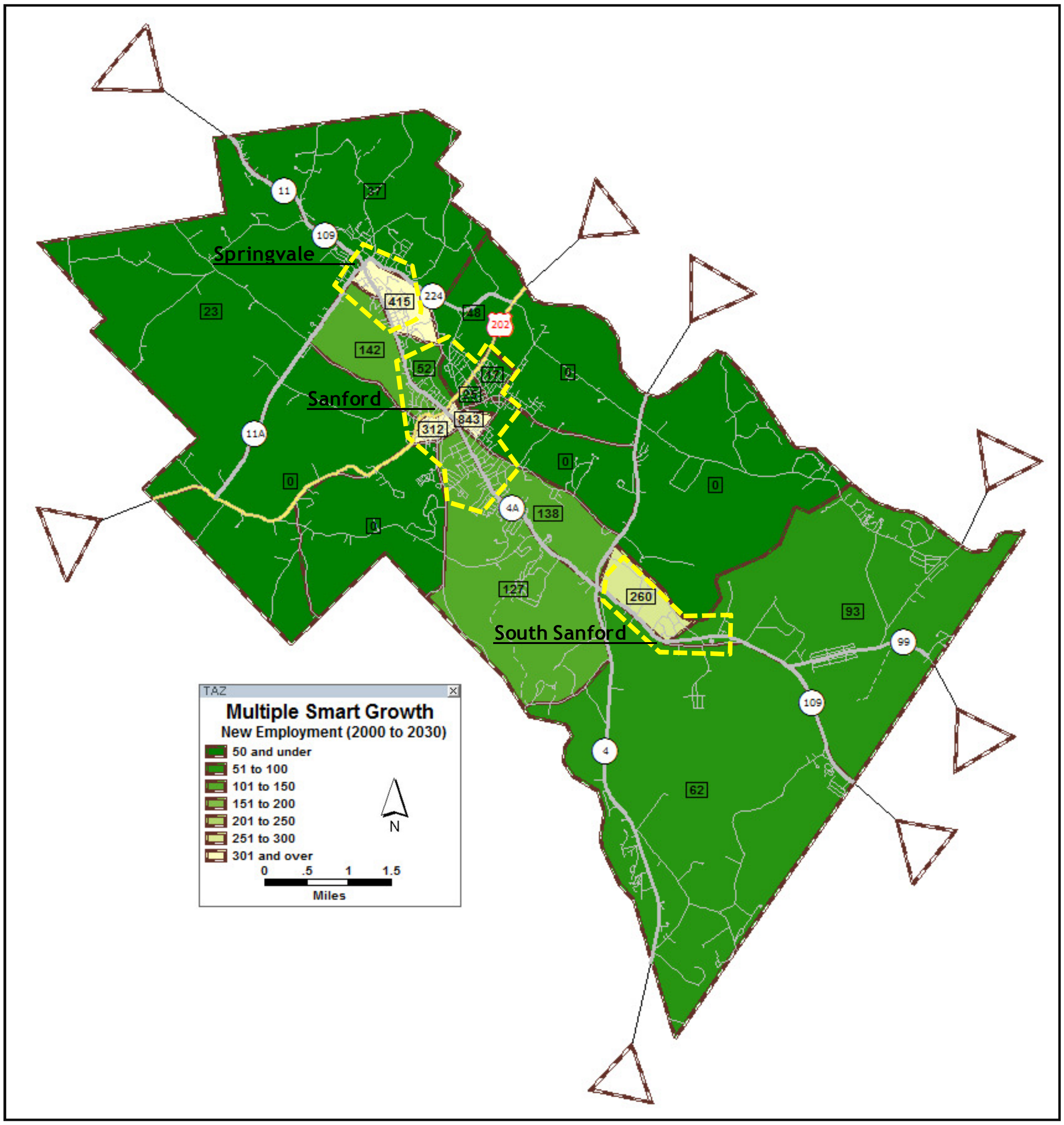

FIGURE B-6: SANFORD MULTIPLE SMART GROWTH – EMPLOYMENT