Smart Growth America
Making Neighborhoods Great Together

NEW JERSEY FUTURE

THE FISCAL IMPLICATIONS OF DEVELOPMENT PATTERNS

Roads in New Jersey

November 2015

Introduction

The State of New Jersey spends millions of dollars each year maintaining its roads. Since 1985, the state has spent more than $15 billion of its Transportation Trust Fund on highways and local aid roads. In 2015 alone, the state plans to spend $754 million on these projects[1]—and that total does not include the additional money municipalities spend to maintain local roads. Despite this spending, however, 35 percent of roads in New Jersey are in "poor condition" and 36 percent of bridges need repair or replacement,[2] meaning New Jersey's real road maintenance needs are actually even higher.

A key reason for this high maintenance bill is the sheer quantity of roads that must be maintained. New Jersey has more than 5.4 billion square feet of road that must be maintained by one level of government or another. These costs include things like resurfacing, pothole repair, vegetation and litter control, and snow removal, among others.

Could New Jersey reduce its maintenance bill without sacrificing road conditions? By directing new development into more compact, dense development patterns, the need for new roads—and therefore maintenance costs—can be reduced over the long-term. This research shows how.

Smart Growth America and New Jersey Future have partnered to analyze the relationship between density and road infrastructure in New Jersey, using two similar but distinct approaches. The aim of this analysis is to make clear the long-term costs and implications of different development options on state and local finances, and to help New Jersey's leaders make informed financial decisions about development.

The Cost of Sprawl, published by the Real Estate Research Corporation in 1974, was the first study to show that providing infrastructure to low-density, sprawling development costs more than for compact, dense developments. Low-density development's greater distances among homes, offices, shops, etc., require more road and pipe infrastructure than would be required to serve the same number of homes and businesses in a more compact development pattern. Looked at another way, one mile of infrastructure costs roughly the same to build no matter where it is, but that mile can serve many times more people in a high-density place than in a low-density place.

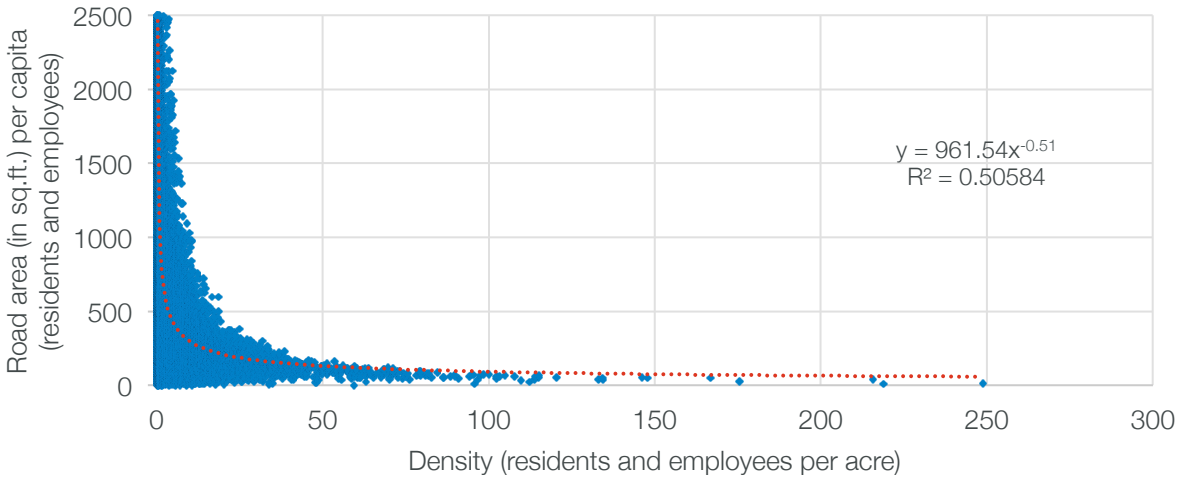
Analysis and methodologies

In early 2015, Smart Growth America created a new fiscal analysis model to compare the costs of different development scenarios.[3] For this project, Smart Growth America researchers conducted a New Jersey-specific application of that model. The application compares population density with pavement area by partitioning the whole state into grid cells of equal size and then compiling data for each cell. Smart Growth America researchers overlaid a grid of 100-acre cells across the entire State of New Jersey. We compiled U.S. Census data regarding population and employment for each cell,[4] and used the New Jersey Department of Transportation's database of road segments, which contains information about both lengths and widths, to compute pavement area for each segment and then aggregate to the municipal level. Using this basis, Smart Growth America researchers constructed a scatterplot showing the relationship between density, as measured by the total number of residents and workers per acre

in the grid cell, and the road area per capita (including residents and employees) in each grid cell (see Figure 1 below). Grid cells covering protected areas such as state parks and wetlands were excluded from the analysis.

FIGURE 1

Road area per capita, by density



As Figure 1 shows, the quantity of road surface per capita declines as density increases. Put another way, infrastructure in dense locations is used more efficiently. More people and employees use each square foot of road built.

Based on the information in Figure 1, a neighborhood with a total density of 50 residents and employees per acre (or 32,000 per square mile, which is typical of the very dense municipalities of Hudson County) would have approximately 130 square feet of road for each resident and employee. If those same residents and employees were spread out in a lower-density pattern, of say, five residents and employees per acre (or 3,200 per square mile, roughly that of subdivision-and-office-park suburbs like East Brunswick, Plainsboro, Scotch Plains, Cinnaminson, or Moorestown), the road area per capita would increase to an estimated 423 square feet—more than three times as much.

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This statewide analysis only provides part of the picture, however. Interstate highways and U.S. and state routes are designed to move traffic from one part of the state to another, and are thus largely beyond the control of any one municipality. Focusing on roads that serve mainly local travel can provide a better understanding of the long-term costs that proceed directly from local land-use decisions.

To shed light on this, New Jersey Future analyzed road area per capita based on municipalities, rather than grid cells. New Jersey Future's approach excluded roads maintained by the state and included only those road segments falling under municipal or county jurisdiction.[5]

New Jersey Future researchers collected 2013 municipal population estimates from the U.S.

Census Bureau, as well as 2013 municipal employment data from the New Jersey Department of Labor. And as with Smart Growth America's approach, New Jersey Future used the New Jersey Department of Transportation's database of road segments to compute pavement area for each segment and then aggregate to the municipal level.

Another distinctive feature of the New Jersey Future analysis was the availability of land-development data at the municipal level. New Jersey Future researchers used this to compute "net activity density" for each municipality, defined as population plus employment divided by developed square miles.[6] Excluding undeveloped land from the denominator gives a clearer picture of what the developed part of a municipality actually looks like and avoids understating the building densities of places like Atlantic City that have a dense, mixed-use downtown core but whose borders also encompass substantial swaths of undevelopable land (like wetlands or permanently preserved open space).

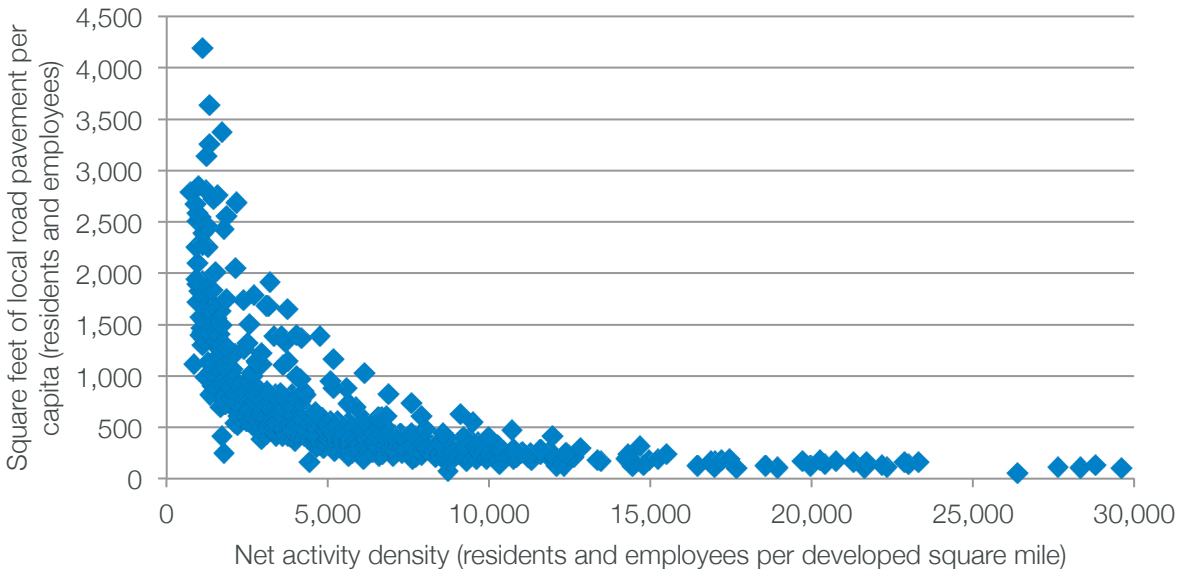
Despite the differences between the two methodologies, New Jersey Future's analysis results in a similar conclusion to Smart Growth America's. Figure 2, below, shows the inverse relationship between net activity density and square feet of local-road pavement per user (including both residents and employees). The higher the activity density in the developed parts of a municipality, the less pavement is needed to serve each resident or job.

FIGURE 2

Local road pavement area per capita, by net activity density

Residents and employees per developed square mile

Data excludes several outlier municipalities with very high net activity densities or with very low population and job totals.



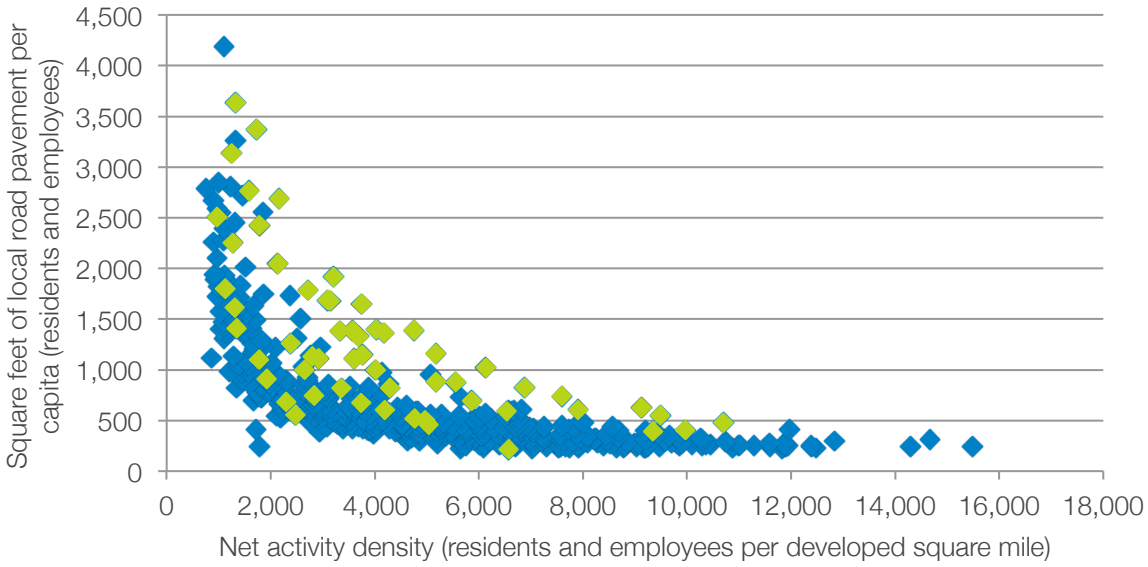
In reality, the relationship is even more pronounced than it appears in Figure 2, because for a subset of municipalities—specifically, Shore towns—the use of year-round population and employment statistics substantially understates the seasonal peak populations for which these places' building inventories and accompanying road networks were truly designed. Using year-

round figures thus overstates the amount of local-road pavement per user, because the denominator of the ratio (the number of users) is artificially small. Figure 3 on page 5 highlights resort towns—the 58 municipalities in which at least 10 percent of housing units were classified in the 2010 U.S. Census as seasonal or recreational. Nearly all of the municipal data points that fall the farthest away from the downward-sloping curve generally describing the relationship between pavement area per user and net activity density are Shore municipalities. Including them in the comparison thus dilutes the true relationship between density and pavement per user, a relationship that becomes even more dramatic once the anomaly of Shore towns has been accounted for.

FIGURE 3

Local road pavement area per capita, by net activity density—resort towns highlighted

Municipalities in which at least 10 percent of housing units are seasonal or recreational units that are vacant for part of the year are highlighted. Several outlier municipalities with very high net activity densities or with very low population and job totals are excluded.



So which municipalities are getting the most out of their road investments? Hudson County dominates the list of places with the fewest square feet of pavement per person and job (see Table 1 on page 6), with Guttenberg, West New York, Jersey City, Hoboken, Union City, and Weehawken all appearing in the top 10. Not coincidentally, these six municipalities all also appear among the top 10 municipalities with the highest net activity densities (see Table 2 on page 6).

The relationship between low square footage of roads and high net activity density remains clear as we move farther down the list. Of the 50 municipalities with the least local-road pavement per user, 41 are also among the 50 with the highest net activity densities.[7] At the other end, of the 50 municipalities having the most pavement per user, 38 are also among the 50 with the lowest activity densities.

TABLE 1

Local-road pavement per person

Square feet per capita (residents and employees)

Rank	County	Municipality	Pavement area/person
1	Hudson	Guttenberg	53.9 sq. ft.
2	Hudson	West New York	56.7 sq. ft.
3	Hudson	Jersey City	59.0 sq. ft.
4	Hudson	Hoboken	67.1 sq. ft.
5	Hudson	Union City	68.8 sq. ft.
6	Bergen	Teterboro	73.3 sq. ft.
7	Bergen	Edgewater	100.6 sq. ft.
8	Hudson	Weehawken	103.5 sq. ft.
9	Middlesex	New Brunswick	108.5 sq. ft.
10	Passaic	Passaic	108.9 sq. ft.
11	Hudson	North Bergen	110.1 sq. ft.
12	Bergen	Fort Lee	111.5 sq. ft.
13	Morris	Morristown	111.8 sq. ft.
14	Bergen	Cliffside Park	114.6 sq. ft.
15	Union	Elizabeth	119.0 sq. ft.
16	Bergen	Fairview	124.1 sq. ft.
17	Hudson	Secaucus	124.2 sq. ft.
18	Hunterdon	Flemington	125.0 sq. ft.
19	Essex	Newark	125.3 sq. ft.
20	Hudson	Harrison	129.4 sq. ft.
21	Bergen	Hackensack	129.6 sq. ft.
22	Hudson	East Newark	130.6 sq. ft.
23	Hudson	Bayonne	130.7 sq. ft.
24	Hudson	Kearny	140.0 sq. ft.
25	Bergen	Palisades Park	140.8 sq. ft.
26	Passaic	Paterson	145.3 sq. ft.
27	Bergen	Rockleigh	155.2 sq. ft.
28	Atlantic	Atlantic City	155.5 sq. ft.
29	Essex	East Orange	156.0 sq. ft.
30	Essex	Irvington	161.9 sq. ft.
31	Mercer	Trenton	161.9 sq. ft.
32	Mercer	Pennington	167.0 sq. ft.
33	Monmouth	Farmingdale	168.3 sq. ft.
34	Bergen	Lodi	168.8 sq. ft.
35	Bergen	Garfield	169.9 sq. ft.
36	Passaic	Prospect Park	171.2 sq. ft.
37	Bergen	East Rutherford	172.2 sq. ft.
38	Monmouth	Red Bank	172.2 sq. ft.
39	Bergen	Wallington	173.5 sq. ft.
40	Monmouth	Shrewsbury Tp.	174.9 sq. ft.
41	Bergen	Lyndhurst	175.0 sq. ft.
42	Essex	Orange	175.9 sq. ft.
43	Monmouth	Englishtown	180.0 sq. ft.
44	Bergen	Little Ferry	183.0 sq. ft.
45	Bergen	Carlstadt	185.7 sq. ft.
46	Gloucester	Swedesboro	186.1 sq. ft.
47	Middlesex	Perth Amboy	187.4 sq. ft.
48	Hunterdon	Lebanon	188.4 sq. ft.
49	Monmouth	Freehold	188.9 sq. ft.
50	Sussex	Newton	190.4 sq. ft.

TABLE 2

Net activity densities per mile

Rank	County	Municipality	Net activity density (2007)
1	Hudson	Guttenberg	62,153.8
2	Hudson	Union City	60,354.1
3	Hudson	West New York	58,380.6
4	Hudson	Hoboken	51,099.2
5	Hudson	Weehawken	29,593.3
6	Hudson	East Newark	28,805.0
7	Passaic	Passaic	28,321.5
8	Bergen	Cliffside Park	27,626.3
9	Hudson	Jersey City	26,385.0
10	Atlantic	Atlantic City	23,298.3
11	Passaic	Paterson	23,003.4
12	Essex	Irvington	22,858.7
13	Bergen	Fort Lee	22,337.8
14	Bergen	Hackensack	22,167.1
15	Mercer	Trenton	21,688.7
16	Middlesex	New Brunswick	21,639.5
17	Essex	East Orange	21,278.3
18	Passaic	Prospect Park	20,745.6
19	Bergen	Palisades Park	20,408.6
20	Monmouth	Shrewsbury Tp.	20,254.1
21	Bergen	Fairview	19,951.6
22	Monmouth	Farmingdale	19,707.2
23	Hudson	North Bergen	18,930.9
24	Essex	Newark	18,561.5
25	Bergen	Edgewater	17,664.2
26	Gloucester	Swedesboro	17,452.1
27	Essex	Orange	17,195.8
28	Bergen	Garfield	16,995.2
29	Morris	Morristown	16,974.4
30	Monmouth	Red Bank	16,869.4
31	Hudson	Harrison	16,465.2
32	Camden	Woodlynne	15,483.6
33	Middlesex	Perth Amboy	15,239.1
34	Monmouth	Englishtown	14,954.9
35	Hudson	Bayonne	14,774.0
36	Monmouth	Asbury Park	14,674.7
37	Union	Elizabeth	14,434.3
38	Bergen	Wallington	14,408.9
39	Camden	Camden	14,304.8
40	Essex	Belleville	14,246.0
41	Bergen	Lodi	13,460.4
42	Bergen	Lyndhurst	13,353.5
43	Somerset	North Plainfield	12,835.6
44	Morris	Dover	12,631.1
45	Union	Roselle Park	12,480.8
46	Bergen	Rutherford	12,394.9
47	Bergen	Bogota	12,374.9
48	Hunterdon	Flemington	12,314.8
49	Monmouth	Freehold	12,286.5
50	Hudson	Secaucus	12,073.0

Table 3, below, shows how much local-road pavement area is typically needed per user (resident or job) as net activity density increases. Places in the lowest category—with fewer than 1,500 residents and jobs per developed square mile—typically need almost 1,700 square feet of pavement per user (person or job) in their local road networks. This is more than *four times* the statewide average of 397 square feet. At the other end, places with very high net activity densities of 20,000 or more (close to four times the statewide average net activity density of 5,240) typically need only 122 square feet of local-road pavement per user—less than one-third the statewide average and only about one-fourteenth of what is needed by the places with the lowest net activity densities.

TABLE 3

Local-road pavement area needed per user, by net activity density

Net activity density range (people and jobs per developed square mile)	Number of municipalities in this range	Median number of square feet of local-road pavement area per person and job among the municipalities in this range	Sample municipalities in this range
Less than 1,500	54	1,689	Most of Salem County, northern Warren County, western Hunterdon County, Colts Neck, Hopewell Twp., Upper Freehold Twp., Bass River Twp.
1,500-2,999	86	792	Vernon Twp., Sparta, Franklin Lakes, Branchburg Twp., Holmdel, Jackson Twp., Tabernacle Twp., Winslow Twp., Egg Harbor Twp., Maurice River Twp.
3,000-5,240	116	490	Mahwah, Tenafly, Denville, Scotch Plains, Bridgewater Twp., Middletown Twp., South Brunswick Twp., West Windsor Twp., Toms River, Delran, Deptford, Hammonton, Vineland
5,240 (state average)	--	397	
5,240-7,499	101	388	Andover borough, Wayne, Ridgewood, Boonton, West Orange, Summit, Linden, Piscataway Twp., Plainsboro, Brick Twp., Evesham Twp., Cherry Hill, Glassboro, Salem
7,500-9,999	69	281	Englewood, Montclair, Cranford, Woodbridge,

			Edison, Long Branch, Lakewood, Lambertville, Bordentown, Collingswood
10,000-19,999	58	217	Clifton, Teaneck, Lodi, Bloomfield, Newark, Bayonne, Morristown, Rahway, Elizabeth, Somerville, Freehold, Red Bank, Camden, Woodbury
20,000 or more	20	122	Hackensack, Paterson, Irvington, Jersey City (and most of the rest of Hudson County), New Brunswick, Trenton, Atlantic City

Although the approaches and data sources differ, both Smart Growth America's and New Jersey Future's analyses generate two important conclusions: first, the quantity of road area per resident and employee increases as density decreases, and second, the relationship is not linear. The effect of moving from two residents and employees per acre (or 1,280 per square mile) to four on road area per capita will be much greater, in absolute terms, than moving from 20 to 40. This means that the efficiency gains from incremental increases in density are much bigger at the lower end of the density scale.

Put another way, the most rural communities—typically the ones with the smallest tax bases—can realize the greatest savings from increasing density. Intentionally increasing density in places with the fewest residents will do little to change the rural character of a place, but it will have a big effect on that place's per-capita road costs.

Cost implications

So how much less would New Jersey and its municipalities have to spend on road maintenance if it had grown in more compact ways?

We estimate that there are about 4,000 square miles in New Jersey where the population and employment per acre within the 100 acre grid cells is less than 10 (6,400 per square mile), excluding protected areas. *Nearly half of the total population and employment in the state is located in these areas.*

If, for the same population and employment levels, New Jersey had directed development into a smaller land area with at minimum 10 people or jobs per acre (still not very dense—single-family homes on quarter-acre lots would meet the criteria), we estimate that the total area of road New

If New Jersey had directed the same population and growth into a smaller, denser land area, the total road area would have been reduced by 36 percent, for **a savings of $470 million statewide every year.**

Jersey and its municipalities need to maintain would have be reduced by 36 percent, or approximately 1.9 billion square feet. And assuming an average cost of $0.25 per square foot[8] to maintain the roads, the result would have been a $470 million savings statewide every year. Admittedly, this is a hypothetical scenario but it provides a useful illustration of the financial consequences of land-use decisions over the long term.

Conclusion

The costs of low-density, sprawling development add up to significant amounts over time. Planners and policymakers in the state should take note before the next 50 years of development makes the problem even worse. Smarter growth, with more compact development patterns, would reduce long-term costs.

In addition to the financial implications, there may also be regional equity implications to these findings. Higher-density places require fewer square feet of pavement per user (residents and employees). In New Jersey and in many other parts of the country, the most densely populated areas tend to be older urban and first-ring suburban areas These are the places that are making the most efficient use of their infrastructure, in the sense that a mile of local road (or water pipe, power line, etc.) serves many more households here than it does in a low-density suburban environment where homes are much farther apart. Yet the costs of constructing and maintaining infrastructure don't necessarily correlate with the actual amount of physical infrastructure that the household regularly uses.

Smarter growth, with more compact development patterns, would reduce long-term costs.

The results of this study suggest the possibility that higher-density places that require far less pavement area per user may be indirectly subsidizing local street networks in lower-density places via transportation funding mechanisms that are collected on a roughly per-capita basis. In other words, are some of the real costs of higher-income households living in spread-out, large-lot developments effectively being underwritten by lower-income urbanites with much smaller infrastructure footprints (and with fewer resources to spare)? Further investigation of road-funding mechanisms is needed, however, before such cross-subsidization—if it is happening—could be authoritatively documented

In any event, the large disparities in population and employment density among New Jersey's 565 municipalities, and the clear advantages of density in lowering the per-capita costs of infrastructure, raises questions about whether the costs of infrastructure in low-density places should perhaps be more proportionally borne by the people who choose to live there.

Endnotes

1 New Jersey Transportation Trust Fund Authority. "NJDOT/NJ Transit Capital Program." Retrieved October 15, 2015 from http://www.state.nj.us/ttfa/capital/.

2 Symons, M. (2015, February 22). "No solution in sight for fixing N.J.'s crumbling roads, bridges." *Asbury Park Press.* Retrieved October 15, 2015 from http://www.courierpostonline.com/story/news/local/south-jersey/2015/02/22/solution-sight-fixing-njs-crumbling-roads-bridges/23864699/.

3 Smart Growth America. (2015, April). *The Fiscal Implications of Development Patterns.* Retrieved October 15, 2015 from http://www.smartgrowthamerica.org/documents/fiscal-implications-of-development-patterns.pdf.

4 The New Jersey Department of Transportation provided a GIS layer with road length and width information. Population data comes from 2010 census block data and employment data is from the 2011 Census Local Employment Dynamics. Because census block boundaries do not match up exactly with the grid cell boundaries, Smart Growth America estimated the population and employment of the cells based on the average population and employment density of the census blocks which intersect each grid cell, weighted by land area.

5 Some segments of roads that are signed as state or national numbered routes do host commercial districts, often functioning as de facto main streets for their host municipalities. In recognition of the fact that they primarily host local traffic, such segments are often delegated to local or county governments to maintain. Because road segments in the NJDOT database were filtered by maintenance jurisdiction rather than by functional system, these segments will still be tallied as local roads and will be retained in our analysis.

6 Net activity density is computed using data from 2007 because this is the most recent year for which the land-development data are available.

7 Excluding the 58 resort municipalities.

8 According to the Reason Foundation, which compiled highway expenditure statistics from the Federal Highway Administration, the State of New Jersey spent $42,317 per lane mile on maintenance in 2012. If we assume that the average lane width is 12 feet, then the result is a per square foot maintenance cost of $0.66. The cost to maintain highways may well be higher than for local roads, however, therefore we have assumed a more conservative estimate of $0.25 per square foot. Actual costs for any given road will vary depending on weather and usage, especially by trucks.

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