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***Response to Special Report 298***  
**Driving and the Built Environment:**  
**The Effects of Compact Development on Motorized Travel,**  
**Energy Use, and CO<sub>2</sub> Emissions**

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The National Research Council recently issued the report *Driving and the Built Environment: The Effect of Compact Development on Motorized Travel, Energy Use, and CO<sub>2</sub> Emissions*. This report is well-researched and well-written. This is not surprising since the NRC committee that produced the report—the Committee for the Study on the Relationships Among Development Patterns, Vehicle Miles Traveled, and Energy Consumption—is made up of well-respected scholars in the subject area.

The report is in response to language included in the Energy Policy Act of 2005. At the time of the Act, there was still a question as to the link between development patterns, the amount people drive, and the associated oil consumption and greenhouse gas emissions. Since 2005, additional research—including the Urban Land Institute's *Growing Cooler: The Evidence on Urban Development and Climate Change*—has solidified the argument that development patterns and VMT are indeed connected and that we must address the amount Americans drive in order to meet national climate and energy goals. The NRC report supports both of these arguments, as does the exhaustive literature review that informed the report.

While *Growing Cooler* and the NRC report agree that development needs to become more compact in order to address climate and energy goals, the estimated VMT and greenhouse gas reductions from such development differ due to different assumptions about the future. The NRC report reflects a conservative bias that is common in much academic work. It assumes that the distant future, even out to 2050, will not be very different from the world today.

Think about how different the U.S. is today than it was in 1970. We, as co-authors of/ contributors to *Growing Cooler*, kept this fact in mind as we made our assumptions about the future. We believe that due to dramatic demographic shifts, the peaking and subsequent decline in conventional oil production, changing life style preferences that are already evident from surveys, climate initiatives that the U.S. is now prepared to lead, and a host of other factors, the world in 2050 will be as different from today's world as today is from 1970. Changing household structure, sharply rising fuel prices, the imperatives of climate change, smart growth initiatives at the federal, state, and local

levels will all pull in the same direction, in an unprecedented manner, toward compact development and reduced VMT. It is significant that *Growing Cooler* is a product of the nation's leading development industry association, leading smart growth advocacy organization, and leading clean air advocacy group. All of these groups understand that dramatic change is necessary and already in motion.

#### *Different Projected VMT, Energy, and CO<sub>2</sub> Outcomes*

In their "moderate" scenario, the NRC committee projects reductions in VMT and associated energy use and CO<sub>2</sub> emissions of about 1 percent below trend by 2030, growing to between 1.3 and 1.7 percent below trend by 2050. Let's be very clear about what this implies. This "moderate" projection represents virtually no change at all from a future of suburban sprawl, cheap gas, and auto-dependence. In this scenario, all of the societal changes listed above have no effect on behavior.

In their "upper-bound" scenario, the NRC committee projects reductions in VMT and associated energy use and CO<sub>2</sub> emissions of 7 to 8 percent below the base case by 2030, growing to between 8 and 11 percent below the base case by 2050.

The NRC committee notes that we in *Growing Cooler* projected a reduction of 7 to 10 percent in future U.S. transportation-related CO<sub>2</sub> emissions resulting from more compact development, which would seem to be in line with their upper-bound projections. However, our projections relate to total CO<sub>2</sub> emissions of the transportation sector, including rural as well as urban travel, including air, rail, and sea travel as well as surface transportation, and factoring in the effects of increased congestion with compact development. The relevant comparison is to our estimate of a 12 to 18 percent reduction in metropolitan VMT with compact development, almost twice their upper-bound estimate.

We now turn to a point-by-point comparison of the two analyses to better understand the different assumptions underlying our very different results. The reader can then judge which set of assumptions is more reasonable.

#### *Different Rates of Development and Redevelopment*

One reason for our differing results is our different assumptions about the amount of development and redevelopment that can be redirected from sprawl into compact patterns. The two analyses assume about the same number of new housing units will be required to accommodate population growth. In fact, our estimate is toward the bottom end of the range assumed by the NRC committee, which means that we have less new development to redirect. However, for two types of development/redevelopment, we are less conservative than the NRC committee.

The first type is commercial and institutional development. The committee states: "While recognizing the importance of commercial space that complements more compact development, the committee was unable to predict how this space would be distributed within metropolitan areas, and thus

focused solely on residential development." We see far more potential for redirecting commercial and institutional development than residential development because the former is replaced at nearly five times the rate of the latter. We project that 190 billion additional square feet of nonresidential space will be built between 2005 and 2050, to replace obsolete stock and accommodate growth. That is more than the total stock of nonresidential buildings in existence in 2005. Just as residential development can be redirected, so can this commercial and institutional development.

The NRC committee appears to misinterpret Nelson's 2004(a) Brookings report estimating commercial and institutional space development needs. The NRC committee observes "(Nelson) projects that about 96.4 billion square feet will be *added* [between 2000 and 2030], nearly as much as existed in 2000 (106.7 billion square feet)" (emphasis added). Nelson's figure actually includes total space to be built to accommodate new jobs *and* replaced for existing jobs, with the net space added being far less than that replaced. The bigger problem, however, is that the NRC committee chose not to address the role of nonresidential development in future land use patterns, despite the fact that it will rival residential space development.

The second type of development/redevelopment with the potential to be redirected is replacement housing. The NRC committee assumed a net replacement rate of 0.2 percent per year based on analysis by Pitkin and Myers, versus Nelson's assumed rate of 0.6 percent per year. Nelson's replacement rate implies the typical home lasts nearly 170 years – a long time by any reckoning. Nelson derived this estimate using decennial census, American Housing Survey, and Residential Energy Consumption Survey data, all provided by federal agencies (Departments of Commerce, Housing and Urban Development, and Energy, respectively) with each using different samples but all resulting in roughly the same rate of residential unit replacement. In contrast, the Pitkin and Myers replacement rate of 0.2 percent, accepted by the NRC committee, is equivalent to a home or its replacement on the same site lasting 500 years.

The NRC committee states that Nelson's analysis would "be a major reversal of current trends, which favor suburban areas, to a move back to urban centers." Nelson wrote differently, however, noting that "outer suburbs ... (will account for) about two-thirds of projected growth" while central cities and first-tier suburbs would account for the rest, or about a third (Nelson 2006, 401). Available data would seem to support Nelson's assessment. American Housing Survey data aggregated over 2001, 2003, 2005 and 2007 of homes built in the preceding four years show that central cities accounted for nearly a third of all homes built within metropolitan statistical areas. In this respect, Nelson's analysis assumes a continuation of current trends, not a reversal of them.

#### *Different Market Acceptance of Compact Development*

Another respect in which the NRC committee's assumptions differ from ours is in the proportion of development between now and 2050 that can be redirected into compact patterns. Their "moderate" scenario assumes that 25 percent of residential development between now and 2050 will be compact, defined as twice the density of trend development. Their "upper-bound" scenario assumes that 75 percent of residential development will be compact. We, on the other hand, assume that between 60 and 90 percent of all new development through 2050 will be compact.

To some the NRC committee's assumptions would seem to be realistic, and ours to be overly optimistic. However, consider that we are talking about the increment of new development on top of a base that is mostly sprawl. Because current development patterns are mostly sprawling, and much of the development that exists today will remain in 2050, our assumptions translate into at least 40 percent of built environment in 2050 continuing to be sprawled.

The NRC committee's "moderate" assumption translates into as much as 80 percent of the built environment continuing to be sprawled, despite the forces described above moving us toward more compact development. For instance, between 2010 and 2050, more single-person households will be added than households with children. Moreover, roughly two-thirds to three-quarters of the net gain in households between 2010 and 2050 will be among households without children. Housing demand functions of households without children and single-person households are different from households with children.

We have previously shown that there is enough large lot single-family development on the ground today to meet the entire demand in 2025 (Nelson 2006). What changing demographics and lifestyle preferences suggest is an unmet demand for small lot single-family and attached-unit development. We believe that the development industry will meet the rising demand for compact development, with a time lag that is the historical norm. Indeed, but for local land use regulations, the development community in many parts of the nation would be well on its way to responding to changing demand. (We applaud the NRC committee for pointing out this barrier to meeting housing needs.)

#### *Different Travel Patterns Association with Compact Development*

A third area where our assumptions differ from the NRC committee's is in the VMT reduction associated with compact development. The NRC committee's "moderate" scenario assumes a 12 percent reduction in driving with compact development relative to sprawl. Their "upper-bound" scenario assumes a 25 percent reduction. Their "lower-bound" scenario assumes a 5 percent reduction. They describe the upper and lower bounds as bracketing values from the literature.

Our range of 20 to 40 percent reduction is based on four different literatures, only one of which, the regional scenario literature, suggests a reduction as low as 20 percent (Bartholomew and Ewing 2009). The other three literatures are:

The aggregate travel literature, which suggests a reduction of 25 to 35 percent (see Ewing, Pendall, and Chen 2002);

The disaggregate travel literature, which suggests a reduction of one-third or more (see Ewing and Cervero 2001); and

The project-level simulation literature, which suggests a reduction ranging upward to 75 percent (see Ewing et al. 2008).

While we don't have a particular problem with the NRC committee's upper-bound estimate, their "moderate" estimate is clearly in error. It is the reduction they would expect from a doubling of density alone. Thus they fall into the common trap of equating compact development with denser development. Denser development is only one of several travel altering characteristics that Ewing, Pendall, and Chen (2002) and Ewing and Cervero (2001) associate with compact development. Compact development mixes land uses, while sprawl segregates them. Compact development has strong population and employment centers, while sprawl has weak ones. Compact development has pedestrian-friendly urban design, while sprawl has auto-scale design. Significantly, from the Ewing and Cervero meta-analysis (2001), density is less important than the kind of destination accessibility one associates with infill development and redevelopment, and only as important as diversity (mixed use) and design (pedestrian-friendly urban design). See Table 1.

**Table 1. Typical Elasticities of Travel with Respect to Four D Variables (Ewing and Cervero 2001)**

D-Feature	Vehicle Trips (VT)	Vehicle Miles Traveled (VMT)
Local density	– .05	– .05
Local diversity (mix)	– .03	– .05
Local design	– .05	– .03
Destination accessibility	.00	– .20

In any event, in an EPA-funded study, the Ewing and Cervero meta-analysis has been updated, and the results are far more definitive than any study to date. The new meta-analysis is based on over 50 empirical studies from 1996 through the present, from which travel elasticities could be derived. This updated meta-analysis suggests that the other D variables—diversity, design, destination accessibility—have more impact on VMT than does density (see Table 2).

**Table 2. VMT Elasticity Values from Recent Meta-Analysis**

population density	-0.041
job density	0.019
land use mix	-0.059
jobs-housing balance	-0.028
intersection density	-0.094
street connectivity	-0.095
job accessibility by auto	-0.196
job accessibility by transit	-0.061
distance to downtown	-0.161
distance to transit	-0.047

Despite its conservative bent, the NRC study will serve as a valuable platform for the argument that regulations and incentives that favor compact development can and should be part of national, state and local efforts to reduce greenhouse gas emissions. As with other energy policy arenas, such as vehicle efficiency and renewable energy standards, it will take time for this argument to attain acceptance as a climate strategy with the public and lawmakers. Compact development is already gaining favor for reasons other than climate goals. Market preferences and economic benefits are already leading developers and local governments to start changing the way communities are planned and built. *Growing Cooler* and the NRC study agree that this is a win-win solution for the economy and the environments that state and federal governments should do more to support.

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