DEMOGRAPHIA

Population Density, Traffic Density and Nitrogen Oxides (NOx) Emission Air Pollution Density in Major Metropolitan Areas of the United States

This report summarizes the latest Environmental Protection Agency (EPA) data on the density of daily traffic densities and road vehicle nitrogen oxides (NOx) emissions densities by counties within the 51 metropolitan areas with more than 1 million population in the United States as of 2010. The measures used are described under "The Measures," below.

The EPA data indicates a strong association both between:

- Higher population densities and higher traffic densities (Figure 1).
- Higher population densities and higher road vehicle nitrogen oxides (NOx) emission intensities (Figure 2)

In both cases, the relationships are statistically significant at the 99 percent level of confidence.

These relationships are summarized by population density category in Table 1, which includes total daily road vehicle travel density (vehicle miles per square mile), annual nitrogen oxides (NOx) emission intensity and a comparison to the average of all of the metropolitan area counties.

Table 1
Nox Emission & Road Travel Intensities by Population Density
Counties in Major Metropolitan Areas (Over 1,000,000 Population)

Population Density	NOx Emissions per Square Mile	Compared to Average	Road Travel per Square Mile	Compared to Average
20,000 & Over	108.1	13.7	304,064	22.1
10,000 - 20,000	79.8	10.1	173,450	12.6
5,000 - 10,000	65.1	8.3	146,149	10.6
2,500 - 5,000	40.3	5.1	84,695	6.1
1,000 - 2,500	23.1	2.9	45,064	3.3
Under 1,000	4.6	0.6	7,057	0.5
Average of Major Metropolitan Counties	7.9		13,779	

Table 3
Nox Emission & Road Travel Intensities by Population Density
Highly Urbanized Counties in Major Metropolitan Areas (Over 1,000,000 Population)

It is important to recognize that air pollution emissions alone are not a fully reliable predictor of air quality, though all things being equal, higher air pollution emissions will lead to less healthful air. This issue is described further under "Caveats." Below.

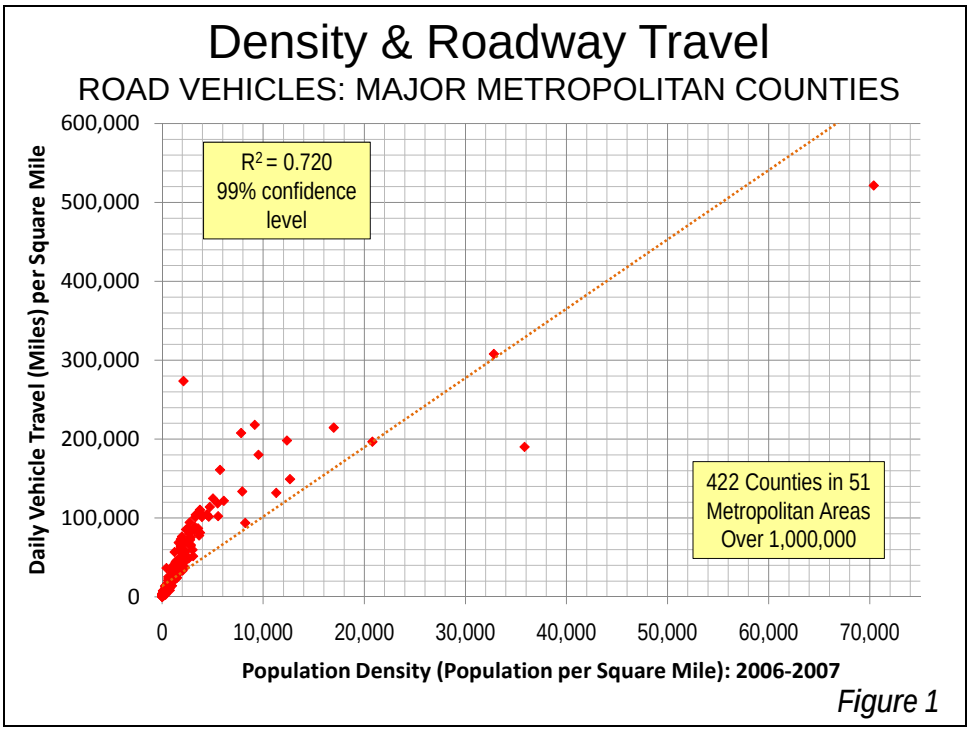

Figure 1

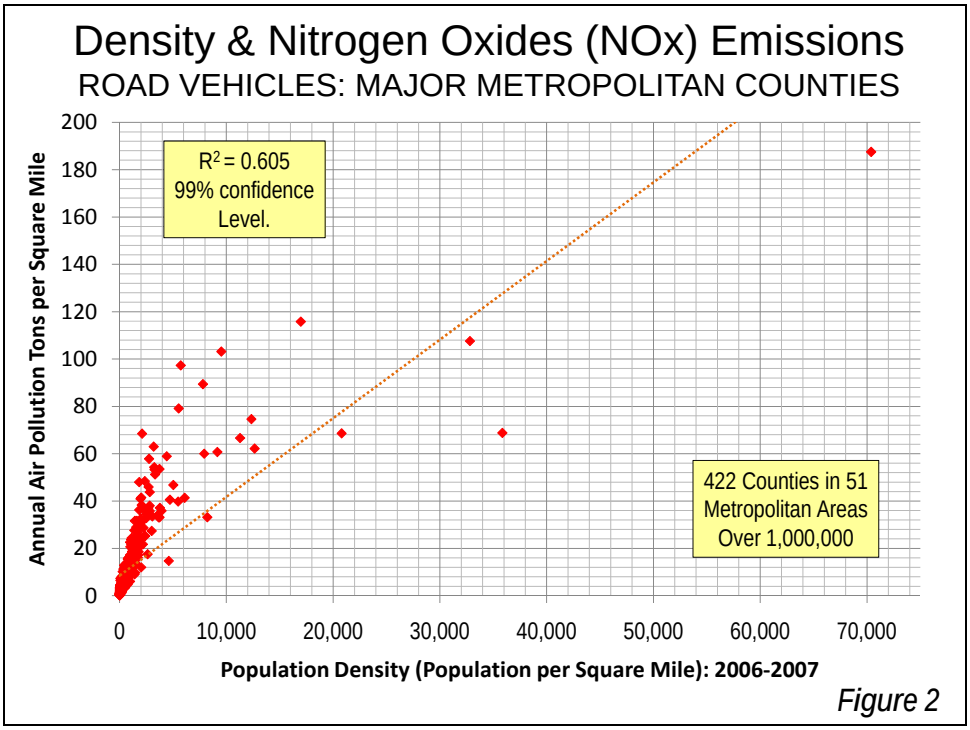

Figure 2

Data by County

Some in the urban planning community have implied that vehicle travel is lowered by higher densities and more intense transit service. It has also been implied that higher population densities are associated with lower air pollution levels.

In fact, New York County (Manhattan), the highest density county in the nation, also has the highest traffic density and the highest total nitrogen oxides (NOx) emission density out of all of the nation's nearly 3,200 counties, metropolitan and non-metropolitan. Moreover, New York County also has the highest concentration of emissions for the other criteria air pollutants, such as carbon monoxides, particulates and volatile organic compounds (2002 data).[1]

The clearest lesson from these data is that *both propositions are patently false.* The county with the highest population density in the nation (New York County) has the both the highest traffic density and nitrogen oxides (NOx) emission density. Generally, increasing population densities leads to increased traffic and air pollution density. The new traffic generated by the new residents substantially offsets any per capita reduction in driving.

Seven of the 10 counties with the highest NOx emissions concentration[2] (annual tons per square mile) in major metropolitan areas (those with more than 1 million population) are also among the top 10 in population density (2008). As noted above, New York County (Manhattan) has by far the most intense NOx emissions and is also by far the most dense. New York City's other three most urban counties (Bronx, Kings and Queens) are more dense than any county in the nation outside Manhattan and all are among the top 10 in NOx emission density (Table 3).

More concentrated traffic leads to greater traffic congestion and more intense air pollution. The data for traffic concentration is similar.[3] Manhattan has by far the greatest miles of road travel per square mile of any county. Again, seven of the 10 counties with the greatest density of traffic are also among the 10 with the highest population densities. As in the case of NOx emissions, the other three highly urbanized New York City counties are also among the top 10 in the density of motor vehicle travel (Table 3).

Table 2
Intensity of Nox Emissions & Motor Vehicle Travel (per Square Mile)

NOx Emissions				Motor Vehicle Travel			
	Density		Compared to		Density		Compared to
Rank	Rank	County	Average	Rank	Rank	County	Average
1	1	New York Co, NY	23.8	1	1	New York Co, NY	37.8
2	5	San Francisco Co, CA	14.7	2	3	Bronx Co, NY	22.3
3	3	Bronx Co, NY	13.7	3	50	Fredericksburg city, VA	19.9
4	9	Washington city, DC	13.1	4	10	Alexandria city, VA	15.8
5	16	St. Louis city, MO	12.4	5	5	San Francisco Co, CA	15.6
6	13	Arlington Co, VA	11.3	6	13	Arlington Co, VA	15.1
7	15	Cook Co, IL	10.0	7	7	Suffolk Co, MA	14.4
8	7	Suffolk Co, MA	9.5	8	4	Queens Co, NY	14.3
9	2	Kings Co, NY	8.7	9	2	Kings Co, NY	13.8
10	4	Queens Co, NY	8.7	10	9	Washington city, DC	13.1
Calculated from 2008 EPA Data				Calculated from 2005 EPA Data			
Ranking out of 422 counties				Ranking out of 422 counties			

Urbanization

Most counties have substantial rural land area, which results in lower factors for both traffic density and air pollution emission density. This is evident in Los Angeles County (California) for example, which contains most of the Los Angeles urban area, which has the highest population density of any urban area in the country. Los Angeles has been renowned for decades as having some of the country's worst air pollution. Yet, this report shows Los Angeles County to have a much lower traffic density than many

[1] Calculated from data downloaded from http://www.epa.gov/oar/data/geosel.html.
[2] http://www.epa.gov/ttn/chief/net/2008inventory.html
[3] http://www.epa.gov/ttnnaaqs/pm/docs/2005_vmt_county_level.xls

other counties. This reflects the fact that approximately one half of the land area of Los Angeles County is very low density rural, which substantially reduces the traffic density. Similarly, the air pollution emission factors in Los Angeles County are lower than would be expected because of the large share of the county that is rural.

Data from the 35 counties in which 90 percent or more of the land is developed indicates virtually the same relationships as were indicated in the overall analysis. Table 3 shows the results, which indicates a substantially the same population density/traffic density and population density/air pollution emission density relationship as in all of the metropolitan area counties.

Table 3
Nox Emission & Road Travel Intensities by Population Density
Highly Urbanized Counties in Major Metropolitan Areas (Over 1,000,000 Population)

Population Density	NOx Emissions per Square Mile	Compared to Average	Road Travel per Square Mile	Compared to Average
20,000 & Over	108.1	0.1	304,064	22.1
10,000 - 20,000	79.8	0.1	173,450	12.6
5,000 - 10,000	65.1	0.1	146,149	10.6
2,500 - 5,000	44.8	0.1	91,701	6.7
1,000 - 2,500	26.3	0.0	51,140	3.7
Under 1,000	-		-	
Average of Major Metropolitan Counties	833.3		13,779	
Counties with 90% or more in urban land (35)				

Cautions:

The air pollution data contained in this report is for emissions, not for air quality. Air quality is related to emissions and if there were no other intervening variables, it could be expected that emissions alone would predict air quality. However there are a number of intervening variables, from climate, wind, topography and other factors. Again, Los Angeles County makes the point. As the highest density large urban area in the nation is to be expected that Los Angeles would have among the highest density of air pollution emissions. However, the situation in Los Angeles is exacerbated by the fact that the urban area is surrounded by mountains which tend to trap the air pollution that is blown eastward by the prevailing westerly winds.

The EPA data for 2002 can be used to create maps indicating criteria pollutant densities within metropolitan areas. Examples of a map of the New York metropolitan area and the Portland (OR-WA) metropolitan area are shown (Figures 3 and 4), with the latter indicating the data illustration feature using Multnomah County (the central county of the metropolitan area).

The Measures:

Road Travel Volumes: Annual traffic volumes in vehicle miles are reported by EPA.[4] The annual vehicle miles for each county is divided by the number of days (365) and then by the county land area in square miles to generate a vehicle miles per square mile (density) figure. The EPA data is for 2005, which is the latest data available on the EPA website.

[4] http://www.epa.gov/ttn/naaqs/pm/docs/2005_vmt_county_level.xls.

Vehicle Air Pollution Emissions: The EPA reports annual air pollution emissions by county, both gross and by density for various pollutants on its website.[5] This analysis is based on the density of nitrogen oxides (NOx).

This report covers local air pollutants only and does not provide information on greenhouse gas emissions (nor does the EPA "Air Data" website).

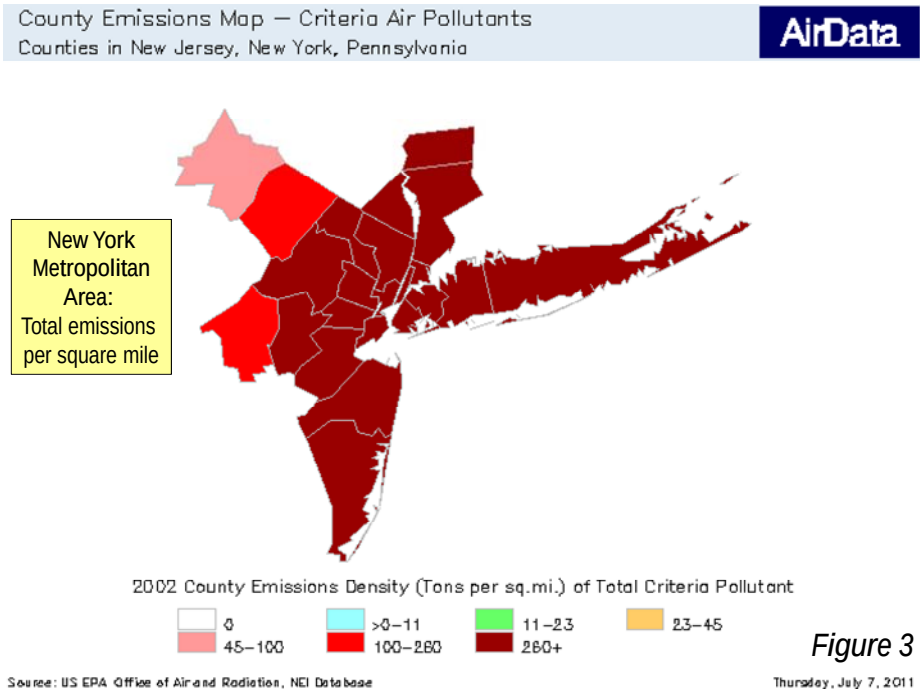

Figure 3

[5] http://www.epa.gov/air/data/geosel.html.

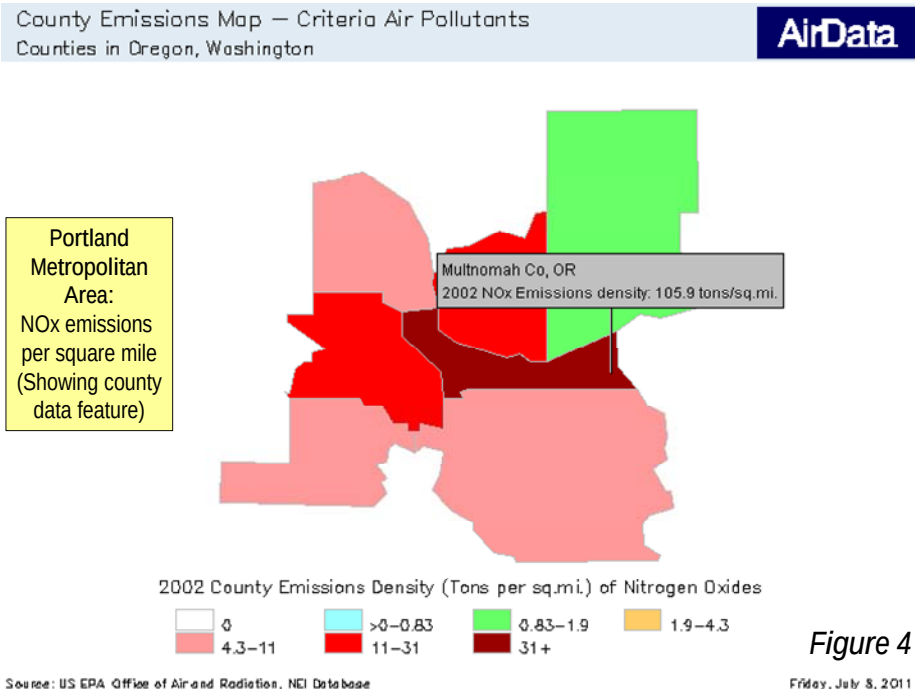

Figure 4

Other Air Pollutants

Similar relationships exist with respect to the other criteria air pollutants. In each case, the relationships between higher population densities and more intense air pollution is statistically significant at the 99 percent level of confidence. The relationships are illustrated in the following figures:

Figure 5: Carbon Monoxide

Figure 6: Volatile Organic Compounds (VOC)

Figure 7: Sulpher Dioxide (SO^2)

Figure 8: Particulate Matter less than 2.5 micrometers in diameter (PM-2.5)

Figure 9: Particulate Matter less than 10 micrometers in diameter (PM-10)

Figure 10: Ammonia ($NH^{3)}$

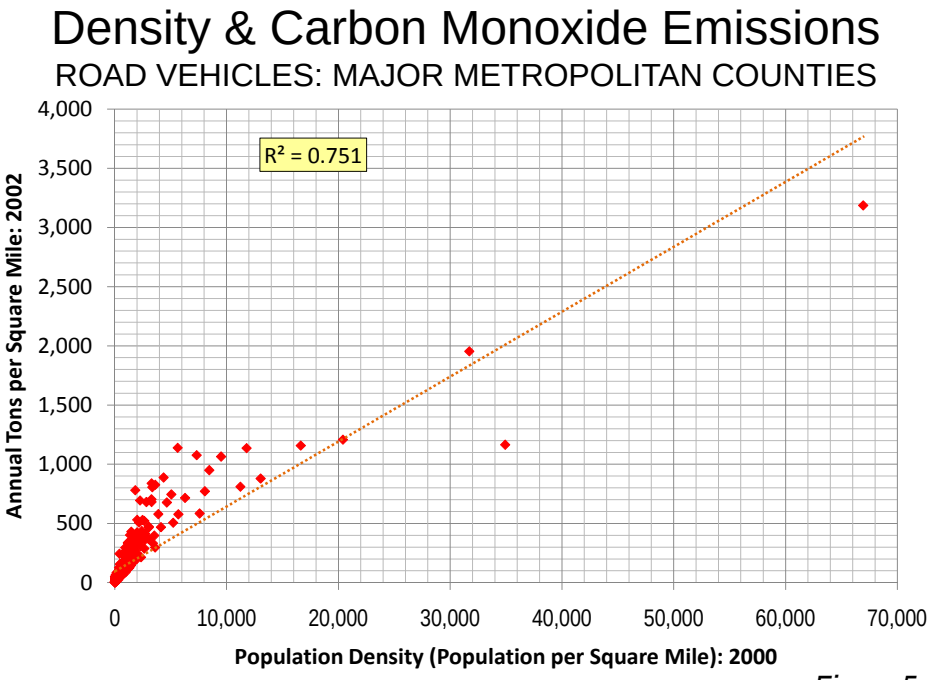

Figure 5

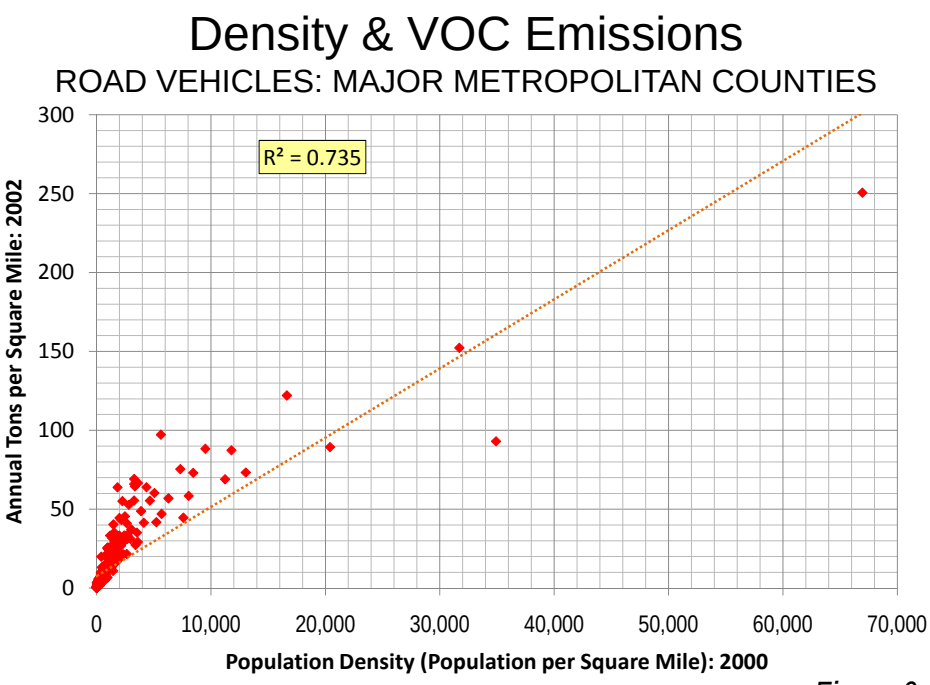

Figure 6

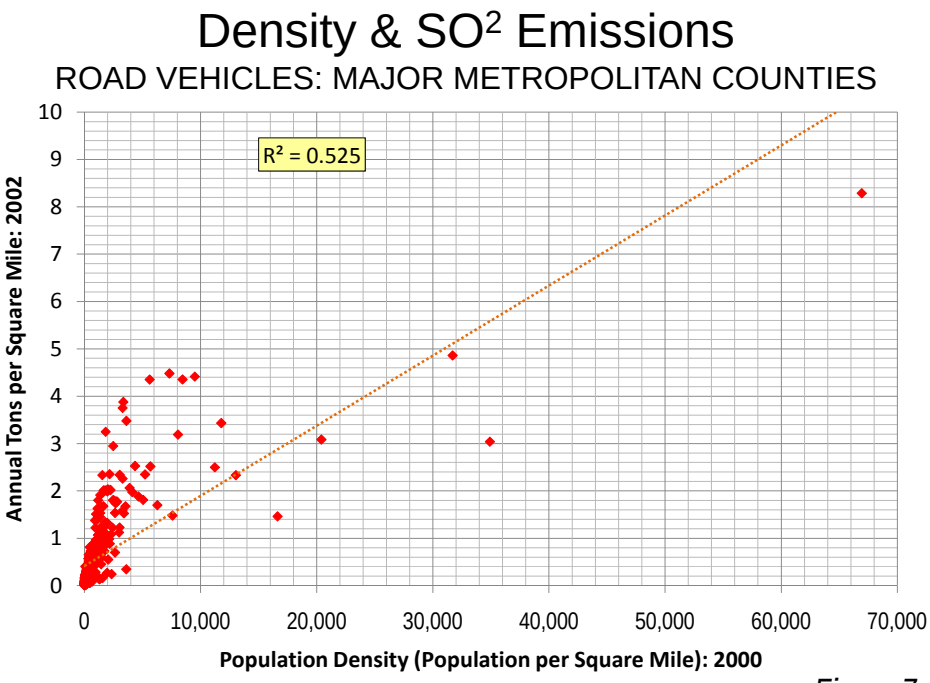

Figure 7

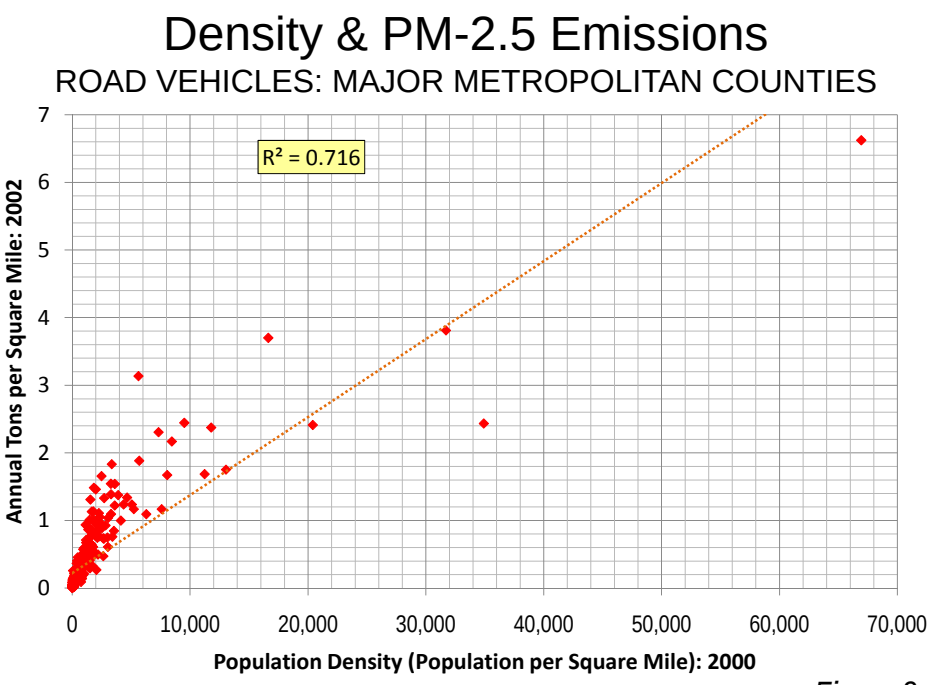

Figure 8

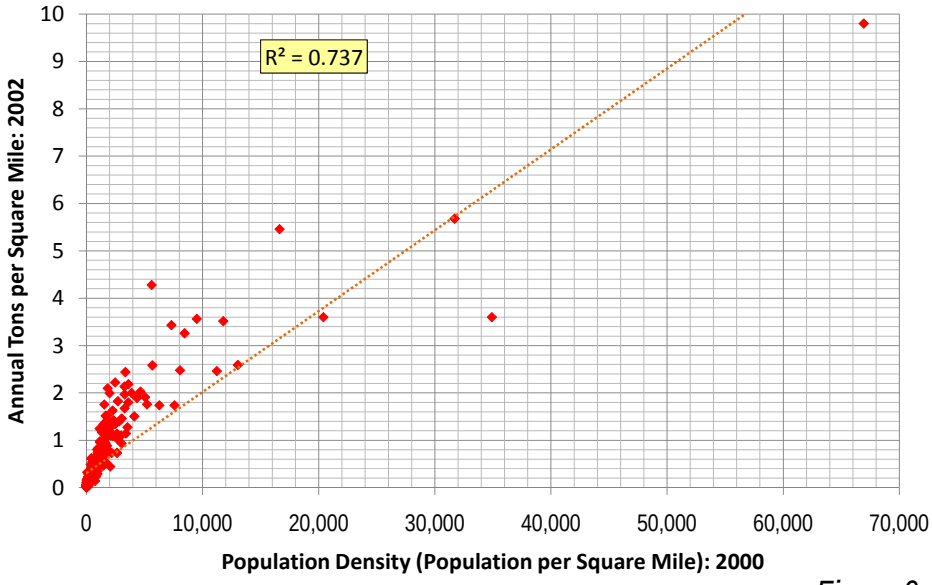

Figure 9

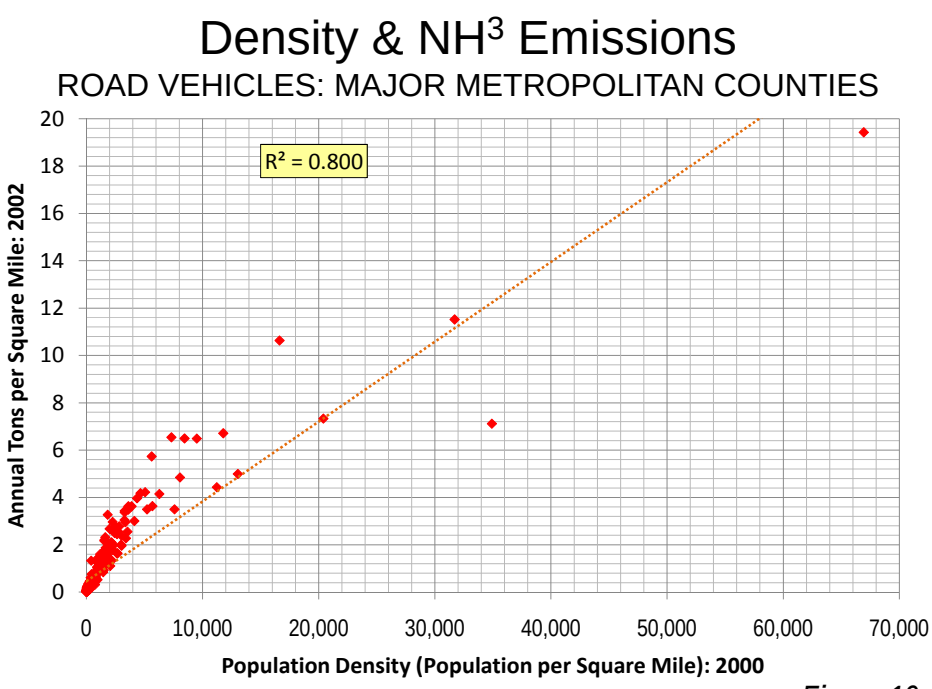

Figure 10