## CHAPTER 4

## DISCUSSION OF RESULTS

This chapter summarizes the results of the analyses conducted to estimate emissions of $NO_x$ and VOCs in the State of Tennessee for a typical high ozone summer day. The MOBILE6 model was used to generate emission factors, in terms of grams/mile of vehicle miles traveled. These emission factors, when multiplied by the daily vehicle miles traveled (DVMT), yield the emissions in units of mass/day. Emission projections were done for the years 1999 through 2030. This is to show the effects of new emission standards that will be implemented within the next ten years. Emissions were also projected out to year 2030 to show the effects if no other future standards were implemented. The projections are based on the continued implementation of I/M programs in those counties that currently have I/M programs as required in their respective Long Range Transportation Plans (Shelby, Davidson, Rutherford, Sumner, Williamson and Wilson County). In this study, emission projections were conducted for all 95 counties in the State of Tennessee. Tables E1 through E3 tabulate the emissions for $NO_x$ and VOCs for all the counties in East, Middle and West Tennessee, respectively.

For the purpose of discussion, graphical results of the emission projections are presented for one county from each of the five area subgroups as explained earlier, most of which correspond to a Metropolitan Statistical Area (MSA), and for the State of Tennessee as a whole. These counties are Shelby, Knox, Davidson, Hamilton and Sullivan Counties. The $NO_x$ and VOC baseline emissions for 1999 and future year projections are shown for the five counties in Figures 4-1 through 4-5. Figure 4-6 shows

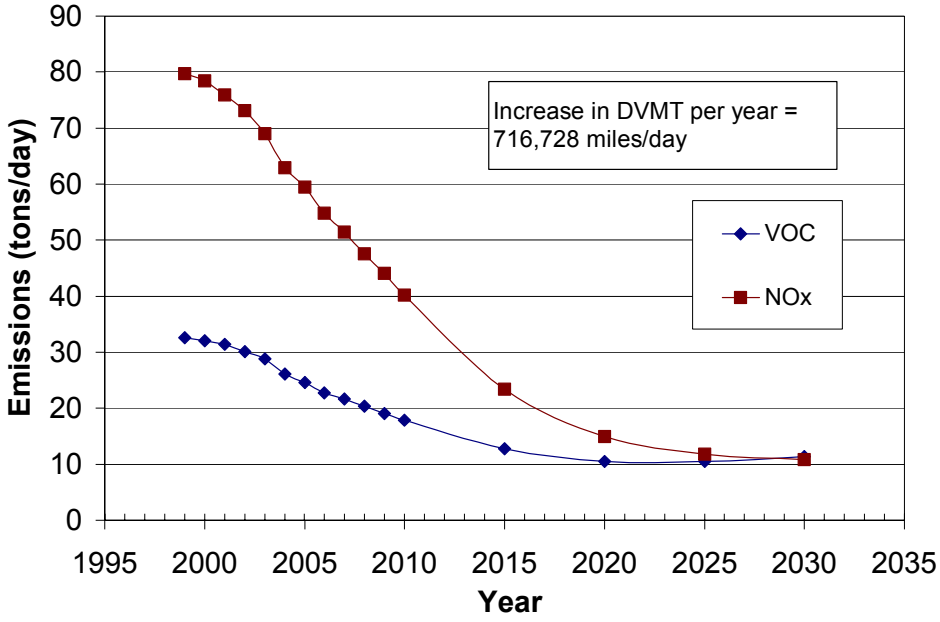


**Figure 4-1. Davidson County - Mobile Source Emissions (MOBILE6)**

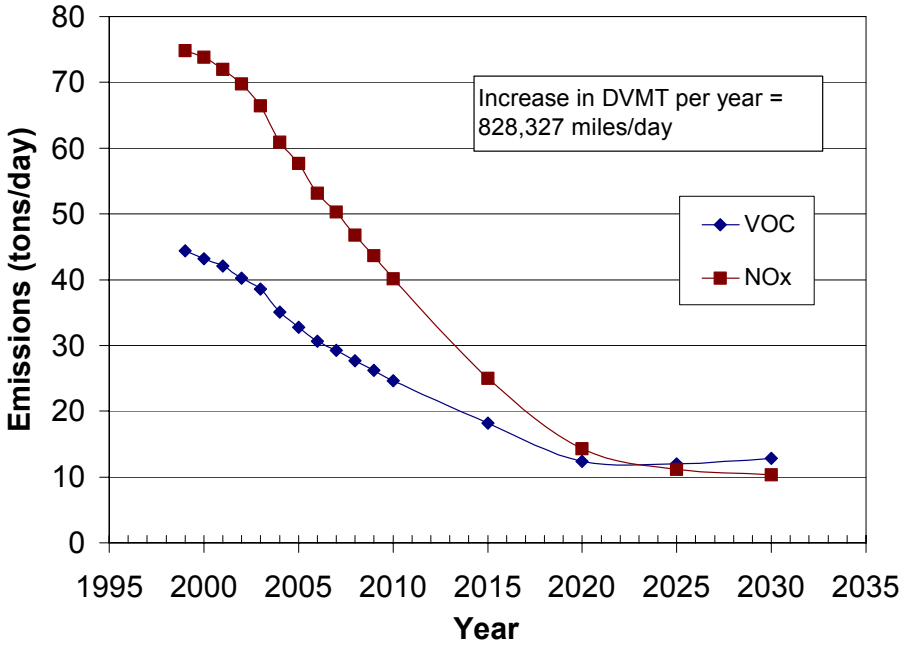


**Figure 4-2. Shelby County - Mobile Source Emissions (MOBILE6)**

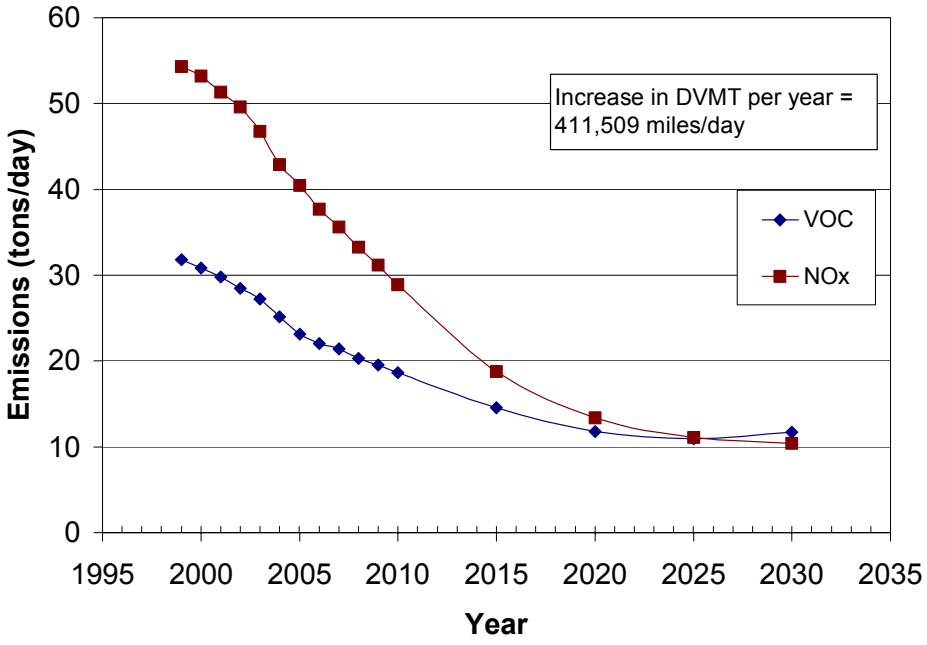


**Figure 4-3. Knox County - Mobile Source Emissions (MOBILE6)**

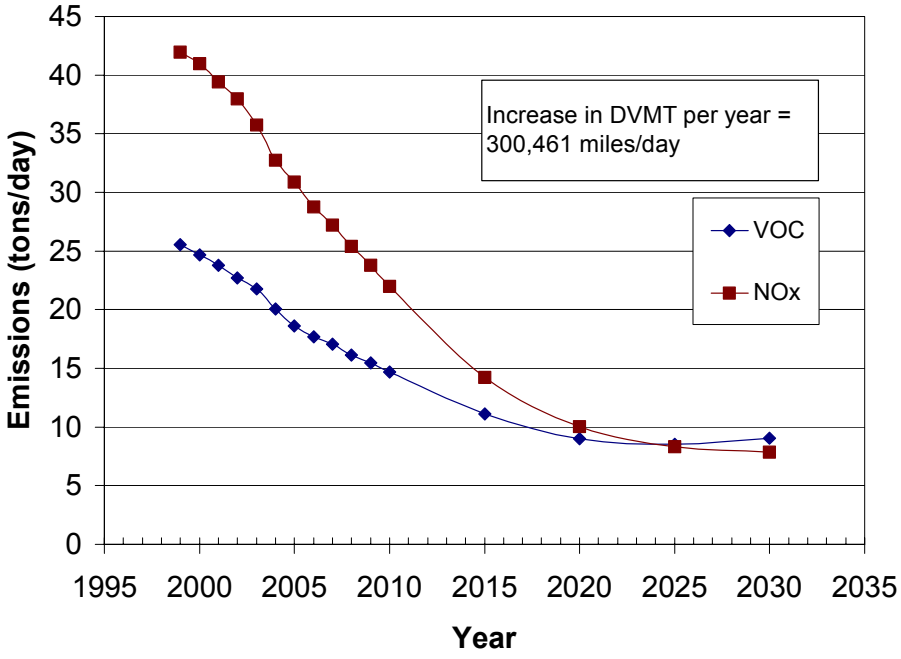


**Figure 4-4. Hamilton County - Mobile Source Emissions (MOBILE6)**

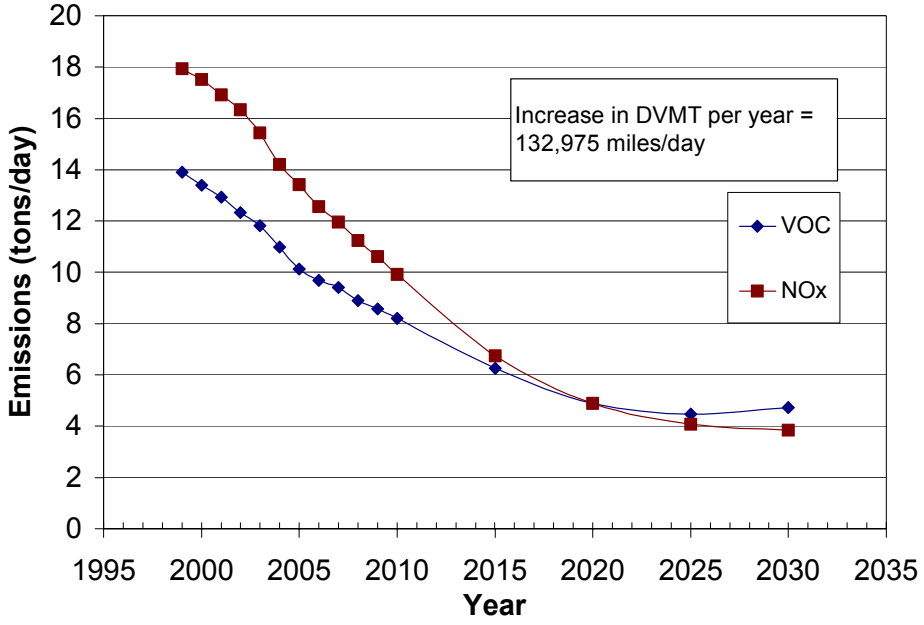


**Figure 4-5. Sullivan County - Mobile Source Emissions (MOBILE6)**

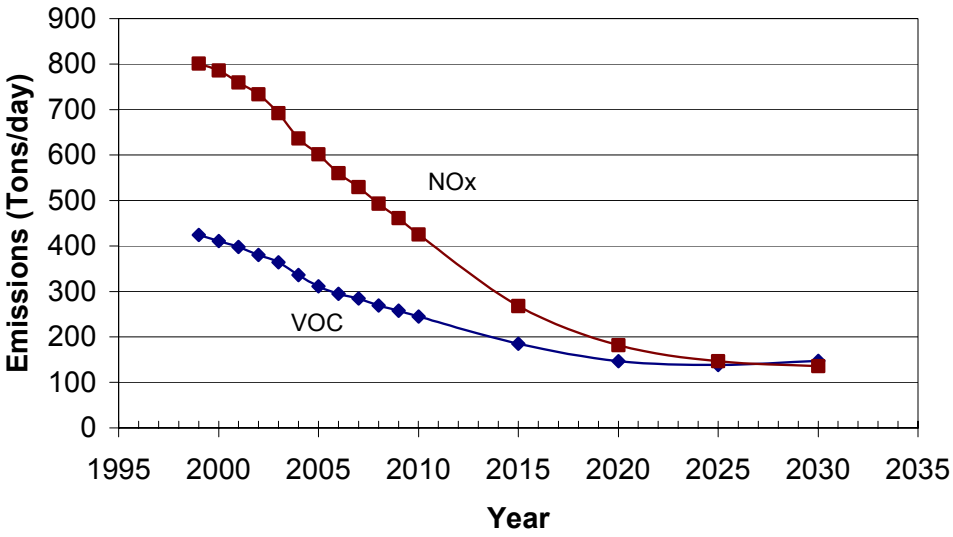


**Figure 4-6. Total Projected Emisions in Tennessee (MOBILE6)**

the statewide baseline and projected emissions. While the magnitude of the emission levels of these five counties varied considerably due to the different levels of DVMT that occurred in each county, the general trends (relative changes in emission levels in future years compared to the baseline year) for both $NO_x$ and VOC emissions were found to be similar. It was also found that the relative trends were very similar to the other 90 counties in Tennessee. The increase in DVMT each year for the five counties varied from 133,000 to 828,000 miles/day as shown in the figures, while the statewide DVMT increase was 5.8 million miles/day. It was assumed in the calculations that the DVMT increase per year for each county would remain constant in the future and equal to the value determined for the period 1990 through 1999 for that county.

As shown in the figures, $NO_x$ emissions are projected to decrease continuously from the baseline year 1999 to year 2030, with a flattening trend towards year 2030. Similarly, VOC emissions are projected to decrease initially, with an increase after approximately 2020. Emissions of $NO_x$ and VOCs are projected to decrease due to the four new emission standards (LEV, HDDV$NO_x$, Tier2/Sulfur and HDDV/Sulfur) being implemented during the next ten years. The negative effect of DVMT growth rate overcomes the positive effect of the standards causing a gradual flattening trend in the emissions of $NO_x$ towards the end of year 2030 and a possible increase beyond that period (not shown in graphs) and a projected increase in VOC emissions after year 2020. It is apparent from the emission projections that implementation of the new regulations has less effect on VOC emissions than $NO_x$ emissions.

Shelby County and Davidson County are two of the counties that are subject to I/M programs, whereas the other 3 counties are not currently required to have I/M

programs. Shelby County with an I/M program has a 73% projected reduction in VOC emissions and a 85% projected reduction in $NO_x$ emissions by year 2025 and Davidson County with an I/M program has a 68% reduction in VOC and 85% reduction in $NO_x$ emissions by year 2025 as shown in Figures 4-1 and 4-2, respectively. The other 3 counties (Knox, Hamilton and Sullivan County) with no I/M program have projected 66%, 67% and 68% reductions in VOC emissions, respectively, and 80%, 80%, and 77% reductions in $NO_x$ emissions by year 2025 as shown in Figures 4-3, 4-4, and 4-5, respectively.

In an effort to provide some insight into the potential for reducing emissions by implementation of I/M programs (as might be required in the future for counties not yet requiring I/M), a series of calculations was conducted using Davidson County. For illustrative purposes, emissions were recalculated for Davidson County assuming that it had no I/M program and an RVP of 9.0 psi, a scenario which is typical of the counties in Tennessee which have no required I/M program. The emissions were also calculated assuming the I/M program option in MOBILE6 with an RVP of 7.8 psi, a scenario characteristic of a county with an I/M program. For purpose of comparison, it was assumed that even those vehicles which drove through the county but were not registered in that county, were subjected to the I/M program. A comparison of these two different scenarios shows the potential benefit of implementing an I/M program. In Figures 4-7 and 4-8, the emission projections for both $NO_x$ and VOC with and without an I/M program in Davidson County are shown, respectively.

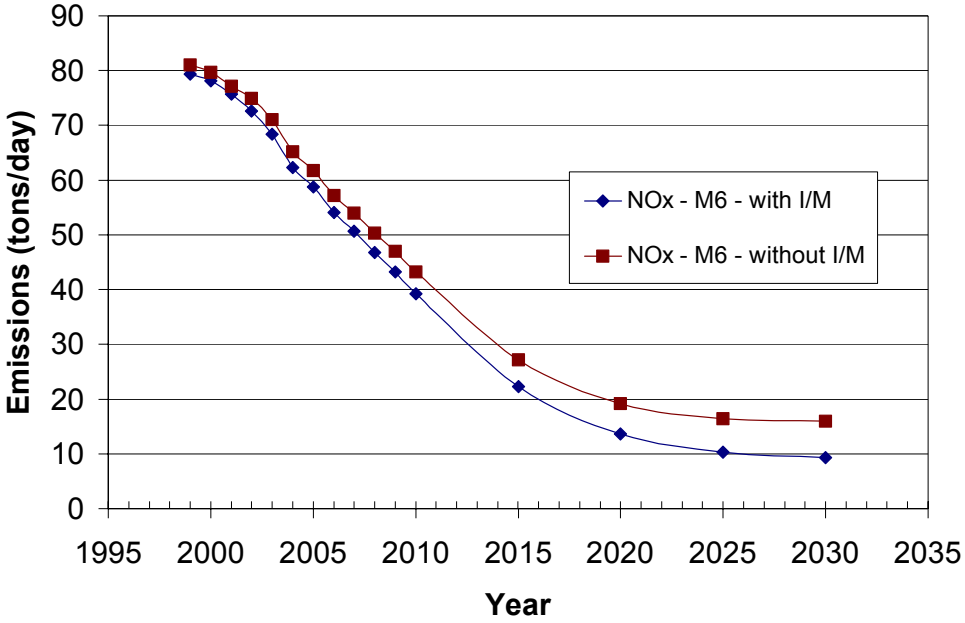


**Figure 4-7. Davidson County - $NO_x$ Emissions with and without I/M Program**

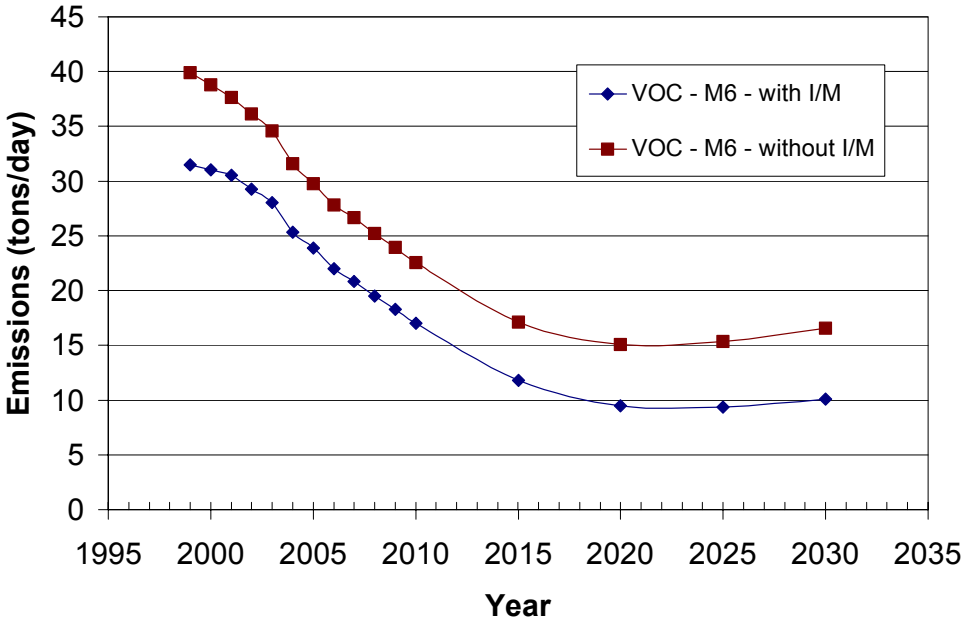


**Figure 4-8. Davidson County - VOC Emissions with and without I/M Program**

There is a 80% projected reduction in $NO_x$ emissions and a 61% projected reduction in VOC emissions without an I/M program compared to a projected reduction of 87% in $NO_x$ emissions and 70% projected reduction in VOC emissions with an I/M program by year 2025. The percent emission reduction per year that is projected to be achieved through the implementation of an I/M program, as compared to no I/M program, varies from about 2% in 1999 to about 42% in 2030 for $NO_x$ emissions. Similarly, for VOC emissions, the projected emission reduction per year resulting from the implementation of an I/M program varies from about 21% in 1999 to about 39% in 2030 as shown in Figures 4-7 and 4-8, respectively.

A key concern which is often raised is with regard to the rate of growth in VMT which could be sustained without a subsequent increase in emissions. In essence emissions for future years remain constant as long as the VMT growth rate does not exceed the rate at which the composite emission factor is decreasing due to emission standards being implemented. Figures 4-9 and 4-10 show the composite emission factor (g/mile) for 1999-2030 for the conditions shown for Davidson County in the case when I/M is fully implemented for all vehicles. The rapid decrease from 1999 to 2010 followed by a flattening of the curve occurs because more and more of the fleet has been replaced by newer, more efficiently controlled vehicles. Since the current MOBILE model only contains those regulations which are already in place or already planned to go into effect, the curves, become very flat (no significant further reduction after 2025). The approximate rate of change in the composite emission factor (and thus grams/mile) for $NO_x$ and VOC emissions between 2020 and 2030 is approximately –4.4% and –1.3% per year, respectively.

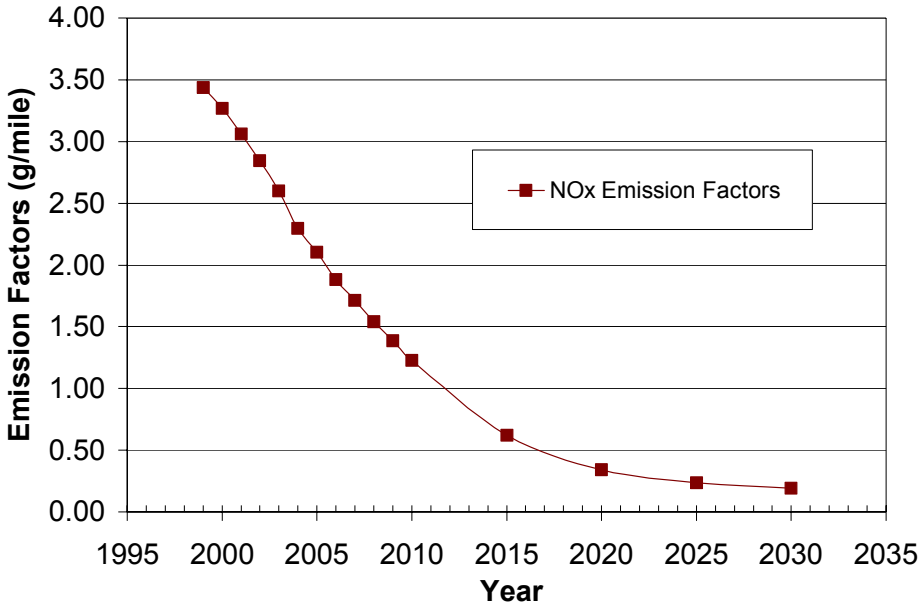


**Figure 4-9. Davidson County (with I/M Program) - $NO_x$ Emission Factors vs. Year**

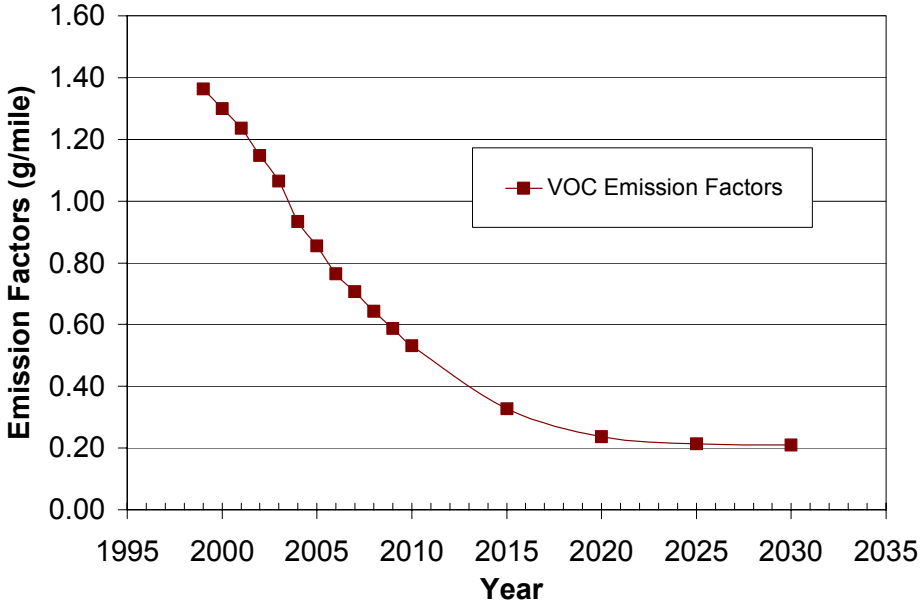


**Figure 4-10. Davidson County (with I/M Program) - VOC Emission Factors vs. Year**

Therefore, if the DVMT growth rate (rate of linear increase based on 2020 DVMT) remains lower than 4.4%, then the $NO_x$ emissions will continue to decrease. Similarly, if the growth rate remains lower than 1.3%, then the VOC emissions will continue to decrease. For the case of Davidson county, for $NO_x$ emissions, a 4.4% growth rate in DVMT is greater than that of the current linear DVMT growth. Therefore there would not be a problem maintaining the low projected emissions. On the other hand, a linear increase in the DVMT at the rate of less than 1.3% per year would be needed to maintain the decreasing emissions of VOCs based on current emission standards. The graphs (Figures 4-7 and 4-8) show a slight increase in the VOC emissions after 2020 because of the fact that the rate of linear increase in DVMT exceeds 1.3% per year. If this lower growth rate cannot be achieved by 2020, then it is apparent that other strategies would need to be implemented to maintain the VOC emissions at the level achieved by 2020. These include, but are not limited to further tightening of the federal emission standards, and the increased use of vehicles with emissions which are less than allowed under the emission standards at that time, such as hybrid electric and/or zero emission (electric and fuel cell-powered) vehicles. The emission projections in this report do not reflect any benefit from these technologies, since these newer technologies are not required by any federal, State of Tennessee or local regulations.