



CENTRAL TEXAS  
Regional Mobility Authority

***183A Toll Road  
2009 Vehicle Emissions Study***

October 16, 2009

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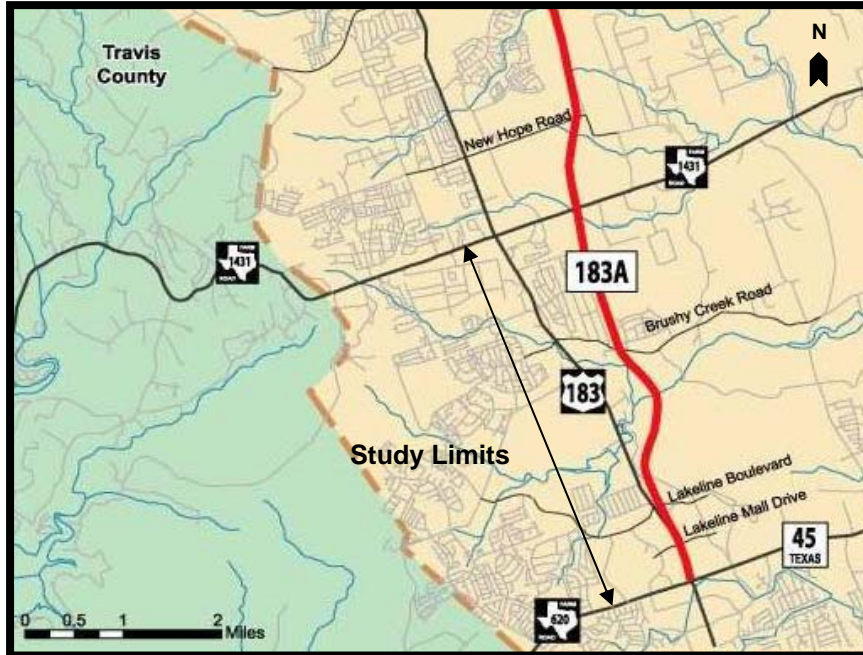
## 1. Executive Summary

In June, 2009, a vehicle emissions study was conducted and constrained to only evaluate the differences in fuel usage, emissions and travel time between the parallel facilities of US 183 and the 183A Toll Road. The study area was bounded to the south by RM 620 and FM 1431 to the north. The vehicle emission study process consisted of a series of trial runs using two test vehicles under actual traffic conditions; including both AM and PM peak periods. The test vehicles consisted of a standard sedan and an SUV. Each vehicle was equipped with special emissions testing equipment.

Based on data obtained from the vehicle emissions study, current traffic counts and previous time travel analysis, the following observations are noted and conclusions can be made for motorists traveling the 183A Toll Road as compared to traveling on US 183:

- Average travel time was reduced by approximately 6-7 minutes
- Compared to US 183 prior to construction of 183A Toll Road, average time travel was reduced by approximately 15 minutes; a time reduction of over 75%
- All emissions were reduced for both peak and off-peak hours
- Fuel consumption was reduced for both peak and off-peak hours
- Estimated annual fuel savings per vehicle of 108 gallons with an annual cost savings of \$281
- Total estimated annual fuel savings of 664,723 gallons with cost savings of \$1,728,280
- Data indicates that for every vehicle that uses the 183A Toll Road, there is significant reduction in overall emissions within the study area when compared to all vehicles using US 183 only
- Although the total life cycle analysis of the carbon footprint was not evaluated as part of this study, the study demonstrates a reduction of vehicle carbon footprint for the 183A Toll Road through a reduction of vehicle emissions as seen in the CO<sub>2</sub> and CO calculated annual reductions
- Annual reduction in emissions and fuel consumption was calculated to be:
  - Carbon Dioxide (CO<sub>2</sub>) emissions reduced by 28% (7,231.9 Tons/Yr)
  - Carbon Monoxide (CO) emissions reduced by 47% (21.8 Tons/Yr)
  - Nitrogen Oxides (NO<sub>x</sub>) reduced by 56%
  - Total Hydrocarbon (THC) emissions reduced by 37%
  - Fuel consumption reduced by 26%

## Location Map



## 2. Background

In June, 2009, a vehicle emissions study was conducted and constrained to only evaluate the differences in fuel usage, emissions and travel time between the parallel facilities of US 183 and the 183A Toll Road. US 183 is a four-lane undivided highway with signalized at-grade intersections and many driveway accesses. The 183A Toll Road is a limited access highway class road. Two different vehicles, a small sedan and a large SUV, were used for the study to capture data from vehicles generally representative of size class vehicles that utilize the two roads. Both vehicles made several laps on US 183 and 183A Toll Road, between RM 620 and FM 1431, during peak and off-peak hours. Traffic counts were taken at US 183 and 183A Toll Road during the study to ensure average traffic conditions were being represented and to discount any anomalies such as a traffic accident on the road.

## 3. Analysis Process and Assumptions

Two vehicles, a sedan and an SUV, were analyzed as part of the Emissions Study. Each vehicle made passes along both corridors, US 183 and 183A Toll Road, during peak and off-peak times. During each pass, vehicle emissions, travel times, and fuel efficiencies were recorded. The emissions testing equipment consisted of SEMTECH-DS and EFM 2 Units to measure the emissions via a sampler manifold connected to the exhaust pipe. Field data from the emissions study and the following basic assumptions and approach that was utilized in developing the analysis for the study were as follows:

- Two different types of representative test vehicles, traveling both US 183 and 183A Toll Road within the limits of RM 620 and FM 1431, were utilized
- Traffic was assumed to consist of 57% sedans and 43% SUVs based on the 2002 Texas Transportation Profile produced by U.S. Department of Transportation
- Daily traffic counts over a period from January 2009 to June 2009 from the Park Street Mainlane toll gantry on 183A Toll Road were used to estimate the peak, off-peak, and yearly traffic volumes on the 183A Toll Road
- Annual per vehicle emissions and fuel efficiencies are based on commuter traffic (5 weekday roundtrips during peak hours)
- Per vehicle emissions and fuel efficiencies were calculated using an average 183A Toll Road traffic count and measurement data from both the sedan and SUV study vehicles
- The measured emissions rates and fuel efficiencies for US 183 were compared to the 183A Toll Road emissions rates and fuel efficiencies
- Total life cycle emissions analysis comparison of the two facilities was beyond the scope of this study. The study was constrained to the contrast of vehicle emissions between free flow 183A Toll Road and obstructed flow US 183 facilities

## 4. Discussion

During the study period, vehicles traveling the 183A Toll Road experienced lower levels of gas emissions and greater fuel efficiency when compared to those traveling on US 183. The reductions in emissions by vehicles traveling on the 183A Toll Road as compared to those traveling US 183 were greatest during peak hour traffic. The following tables compare the emissions and fuel efficiencies of actual traffic on the 183A Toll Road to emissions levels that those same vehicles would have experienced traveling on US 183.

Southbound vehicles traveling between FM 1431 and RM 620 during the morning peak hour (7am-8am) experienced the following reductions:

**Table 1. Measured Time/Fuel/Emissions Comparison Southbound AM Peak Hours (per vehicle)**

|                       | Units       | US 183       | 183A Toll Road | Reduction |
|-----------------------|-------------|--------------|----------------|-----------|
| <b>Time</b>           | <b>Min.</b> | 9.84         | 4.07           | 5.77      |
| <b>*Fuel</b>          | <b>Gal.</b> | 0.2285       | 0.1734         | 24%       |
| <b>CO<sub>2</sub></b> | <b>Lbs.</b> | 4.6691       | 3.4810         | 25%       |
| <b>CO</b>             | <b>Lbs.</b> | 8.229197E-03 | 5.123952E-03   | 38%       |
| <b>NOX</b>            | <b>Lbs.</b> | 3.273296E-04 | 1.893608E-04   | 42%       |
| <b>kNOX</b>           | <b>Lbs.</b> | 3.398273E-04 | 1.971510E-04   | 42%       |
| <b>THC</b>            | <b>Lbs.</b> | 5.734488E-05 | 3.961251E-05   | 31%       |

In 2004, prior to the construction and operation of 183A Toll Road, the CTRMA General Engineering Consultant conducted a limited southbound travel time analysis on US 183 during morning peak hours between FM 1431 and RM 620. This analysis indicated a travel time of approximately 19 minutes. Compared to the travel times recorded during the study of US 183, the travel time savings on 183A Toll Road is approximately 15 minutes; a time reduction of over 75%.

**Table 2. Calculated Time/Fuel/Emissions Comparison Southbound AM Peak Hours (All Traffic )**

|                       | Units       | US 183 | 183A Toll Road | Reduction |
|-----------------------|-------------|--------|----------------|-----------|
| <b>Time</b>           | <b>Hrs.</b> | 3,483  | 1,440          | 2,043     |
| <b>*Fuel</b>          | <b>Gal.</b> | 485    | 368            | 24%       |
| <b>CO<sub>2</sub></b> | <b>Lbs.</b> | 9,912  | 7,390          | 25%       |
| <b>CO</b>             | <b>Lbs.</b> | 17.47  | 10.88          | 38%       |
| <b>NOX</b>            | <b>Lbs.</b> | 0.69   | 0.40           | 42%       |
| <b>kNOX</b>           | <b>Lbs.</b> | 0.72   | 0.42           | 42%       |
| <b>THC</b>            | <b>Lbs.</b> | 0.12   | 0.08           | 31%       |

Northbound vehicles traveling between RM 620 and FM 1431 during the afternoon peak hour (5pm-6pm) experienced the following reductions:

**Table 3. Measured Time/Fuel/Emissions Comparisons Northbound PM Peak Hours (per vehicle)**

|                 | Units | US 183       | 183A Toll Road | Reduction |
|-----------------|-------|--------------|----------------|-----------|
| Time            | Min.  | 10.87        | 3.86           | 7.01      |
| *Fuel           | Gal.  | 0.3001       | 0.1924         | 36%       |
| CO <sub>2</sub> | Lbs.  | 6.0441       | 2.3797         | 61%       |
| CO              | Lbs.  | 1.615052E-02 | 6.231098E-03   | 61%       |
| NOX             | Lbs.  | 4.176683E-04 | 8.978536E-05   | 79%       |
| kNOX            | Lbs.  | 4.152233E-04 | 2.179590E-04   | 48%       |
| THC             | Lbs.  | 5.610619E-05 | 4.051608E-05   | 28%       |

**Table 4. Calculated Time/Fuel/Emissions Comparisons Northbound PM Peak Hours (All Traffic)**

|                 | Units | US 183 | 183A Toll Road | Reduction |
|-----------------|-------|--------|----------------|-----------|
| Time            | Hrs.  | 3,984  | 1,414          | 2,570     |
| *Fuel           | Gal.  | 660    | 423            | 36%       |
| CO <sub>2</sub> | Lbs.  | 13,297 | 5,235          | 61%       |
| CO              | Lbs.  | 35.53  | 13.71          | 61%       |
| NOX             | Lbs.  | 0.92   | 0.20           | 79%       |
| kNOX            | Lbs.  | 0.91   | 0.48           | 48%       |
| THC             | Lbs.  | 0.12   | 0.09           | 28%       |

Based on the results of the emissions study data obtained, it is estimated that drivers traveling between RM 620 and FM 1431 could experience the following annual reductions in emissions and fuel consumption by using the 183A Toll Road instead of US 183:

**Table 5. Average Annual Emissions and Fuels Consumption (per vehicle)**

|                 | Units | US 183       | 183A Toll Road | Reduction |
|-----------------|-------|--------------|----------------|-----------|
| *Fuel           | Gal.  | 367.08       | 258.92         | 29%       |
| CO <sub>2</sub> | Lbs.  | 7,426.60     | 4,438.28       | 40%       |
| CO              | Lbs.  | 1.588782E+01 | 7.656118E+00   | 52%       |
| NOX             | Lbs.  | 5.949743E-01 | 2.386315E-01   | 60%       |
| kNOX            | Lbs.  | 6.086185E-01 | 3.136078E-01   | 48%       |
| THC             | Lbs.  | 8.533804E-02 | 5.784640E-02   | 32%       |

**Table 5. Average Annual Emissions and Fuels Consumption (per vehicle)**

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| <b>*Fuel</b>          | Gal.  | 367.08       | 258.92         | 29%       |
| <b>CO<sub>2</sub></b> | Lbs.  | 7,426.60     | 4,438.28       | 40%       |
| <b>CO</b>             | Lbs.  | 1.588782E+01 | 7.656118E+00   | 52%       |
| <b>NOX</b>            | Lbs.  | 5.949743E-01 | 2.386315E-01   | 60%       |
| <b>kNOX</b>           | Lbs.  | 6.086185E-01 | 3.136078E-01   | 48%       |
| <b>THC</b>            | Lbs.  | 8.533804E-02 | 5.784640E-02   | 32%       |

**Table 6. Total Annual Emissions and Fuel Consumption (All Traffic - peak and off-peak)**

|                       | Units | US 183     | 183A Toll Road | Reduction |                 |
|-----------------------|-------|------------|----------------|-----------|-----------------|
| <b>*Fuel</b>          | Gal.  | 2,519,161  | 1,854,438      | 26%       | 664,723 Gal./Yr |
| <b>CO<sub>2</sub></b> | Lbs.  | 50,753,389 | 36,289,591     | 28%       | 7,231.9 Tons/Yr |
| <b>CO</b>             | Lbs.  | 92,488     | 48,846         | 47%       | 21.8 Tons/Yr    |
| <b>NOX</b>            | Lbs.  | 5,328      | 2,351          | 56%       | 1.5 Tons/Yr     |
| <b>kNOX</b>           | Lbs.  | 5,528      | 2,557          | 54%       | 1.5 Tons/Yr     |
| <b>THC</b>            | Lbs.  | 690        | 432            | 37%       | 0.1 Tons/Yr     |

Based on the fuel calculations, it is estimated that drivers traveling between RM 620 and FM 1431 could experience the following annual fuel and cost savings by using the 183A Toll Road instead of US 183.

**Table 7. Estimated Fuel and Cost Savings Per Year Comparisons**

|                       | Units | US 183    | 183A Toll Road | 183A Toll Road Fuel Savings | 183A Toll Road Cost Savings at \$2.60/gal. |
|-----------------------|-------|-----------|----------------|-----------------------------|--|
| <b>Per Vehicle</b>    | Gal.  | 367.08    | 258.92         | 108.16                      | \$281.22                                   |
| <b>**Total Annual</b> | Gal.  | 2,519,161 | 1,854,438      | 664,723                     | \$1,728,279.80                             |

\* Fuel consumption calculations are determined from the exhaust mass flow rate and the calculated air/fuel mass fraction. Fuel economy is computed for a test period by summing the fuel consumed and dividing by the distance traveled.

\*\*Based on an annual average traffic count of 9,865,830 vehicles; from CTRMA Toll Data.

## 5. Study Observations / Conclusions

Based on data obtained from the emissions study, current traffic counts, and previous time travel analysis, the following observations are noted and conclusions can be made for motorists traveling the 183A Toll Road as compared to traveling on US 183 (refer to the Appendices A and B for additional supportive detail):

- Average travel time was reduced by approximately 6-7 minutes
- Compared to US 183 prior to construction of 183A Toll Road, average time travel was reduced by approximately 15 minutes; a time reduction of over 75%
- All emissions were reduced for both peak and off-peak hours
- Fuel consumption was reduced for both peak and off-peak hours
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  - Total Hydrocarbon (THC) emissions reduced by 37%
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# Appendix A

## Supporting Calculations



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# **Appendix B**

## **Vehicle Emissions Study Field Report**