



Evaluation of Dust Control Suppressants on Unpaved Roads Using Mobile Sampling

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Presentation Outline

- **Background**
- **SCAMPER Approach**
- **Results from Treated Public Unpaved Roads**
- **Results from Treated Mine Haul Road**
- **Conclusions**



BACKGROUND

- **PM Emission Rates for Unpaved Roads have been Determined from Upwind-Downwind Sampling**
- **Based on the Studies an Equation was Derived to Estimate Emission Rates (USEPA AP42 Equation):**

$$E = k * (s/12)^{0.9} * (W/3)^{0.45} * 281.9 \text{ g/VKT}$$

where:

E = PM emission factor in the units shown

k = A constant dependent on the aerodynamic size range of PM (0.23 for PM_{2.5}; 1.5 for PM₁₀)

s = surface material silt content

W = mean vehicle weight in tons

VKT = vehicle kilometer traveled

- **Upwind-Downwind Measurement are Labor-Intensive and the Equation above May or May Not Apply to Treated Unpaved Roads**



A New Measurement Approach

- **Method to rapidly evaluate the PM emission rates from roads using real-time sensors in front and behind a test vehicle**
 - Measure PM directly in front of and behind a test vehicle with an isokinetic sampling probe
 - Use real-time sensors to quickly accumulate large amounts of PM data
 - Determine emission factors based on the concentration within the vehicle's wake
 - Determine location by GPS
 - PC to log all data at 1-second intervals
- **SCAMPER**
 - **S**ystem for **C**ontinuous **A**erosol **M**easurement of **P**articulate **E**missions from **R**oadways



Inspiration





SCAMPER in Action





SCAMPER Emission Factor Calculation

$$ER \text{ (mg/m)} = (PM10_r - PM10_f) * c * A_f$$

where:

ER = PM₁₀ Emission Rate

PM10_r = PM₁₀ concentration, **rear DustTrak**

PM10_f = PM₁₀ concentration, **front DustTrak**

c = **Calibration factor** to relate DustTrak response to filter-based PM₁₀ mass measurement

A_f = **Frontal area** of the test vehicle (based on wake homogeneity testing)



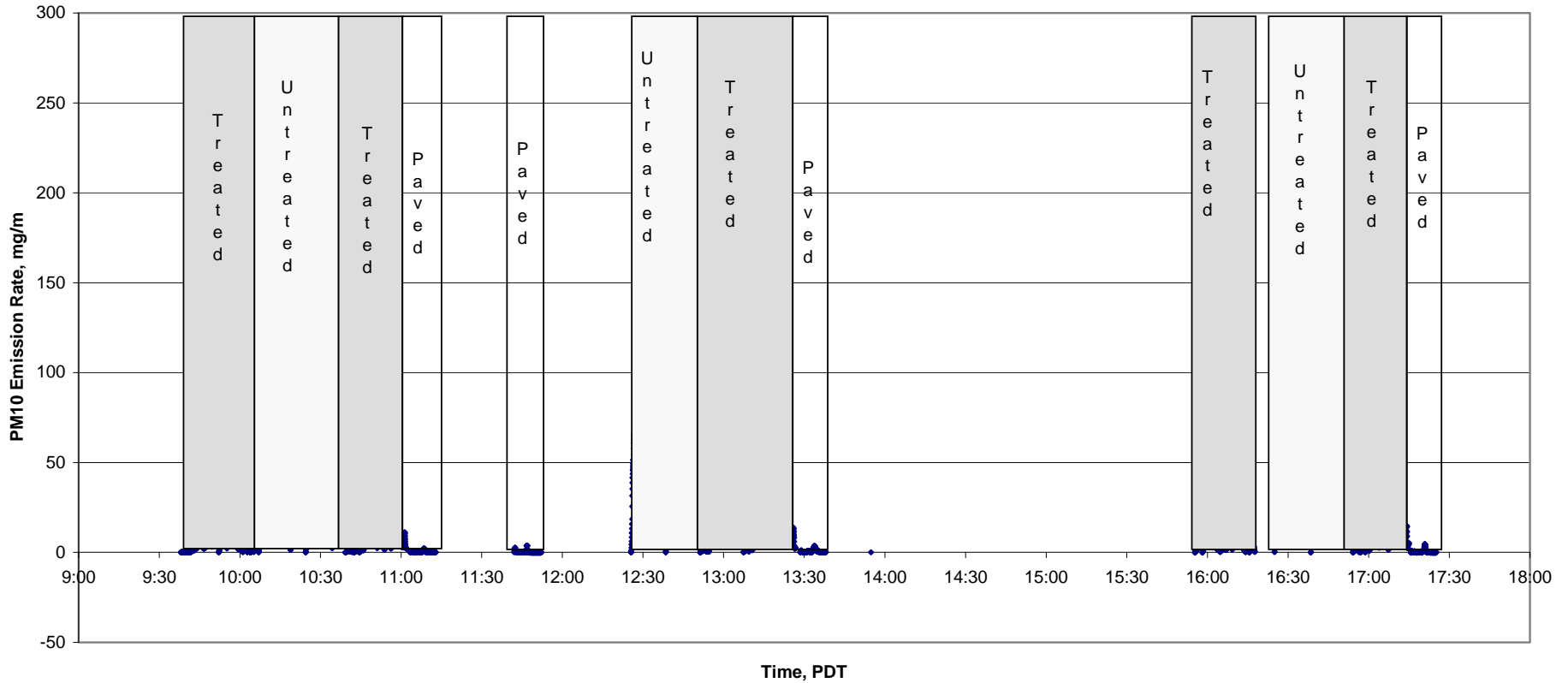
Unpaved Public Road I

- **State Route 88 in Arizona**
 - Envirotac II Acrylic copolymer at a rate of 0.03 gallon per square foot
 - First six miles treated in May 2005
 - Last mile treated in October 2003
- **SCAMPER was used to make repeated test runs**
 - Test runs included paved road, treated unpaved section, untreated unpaved section
 - Tests performed in October 2005
 - Mean speed 18 mph unpaved, 32 mph paved



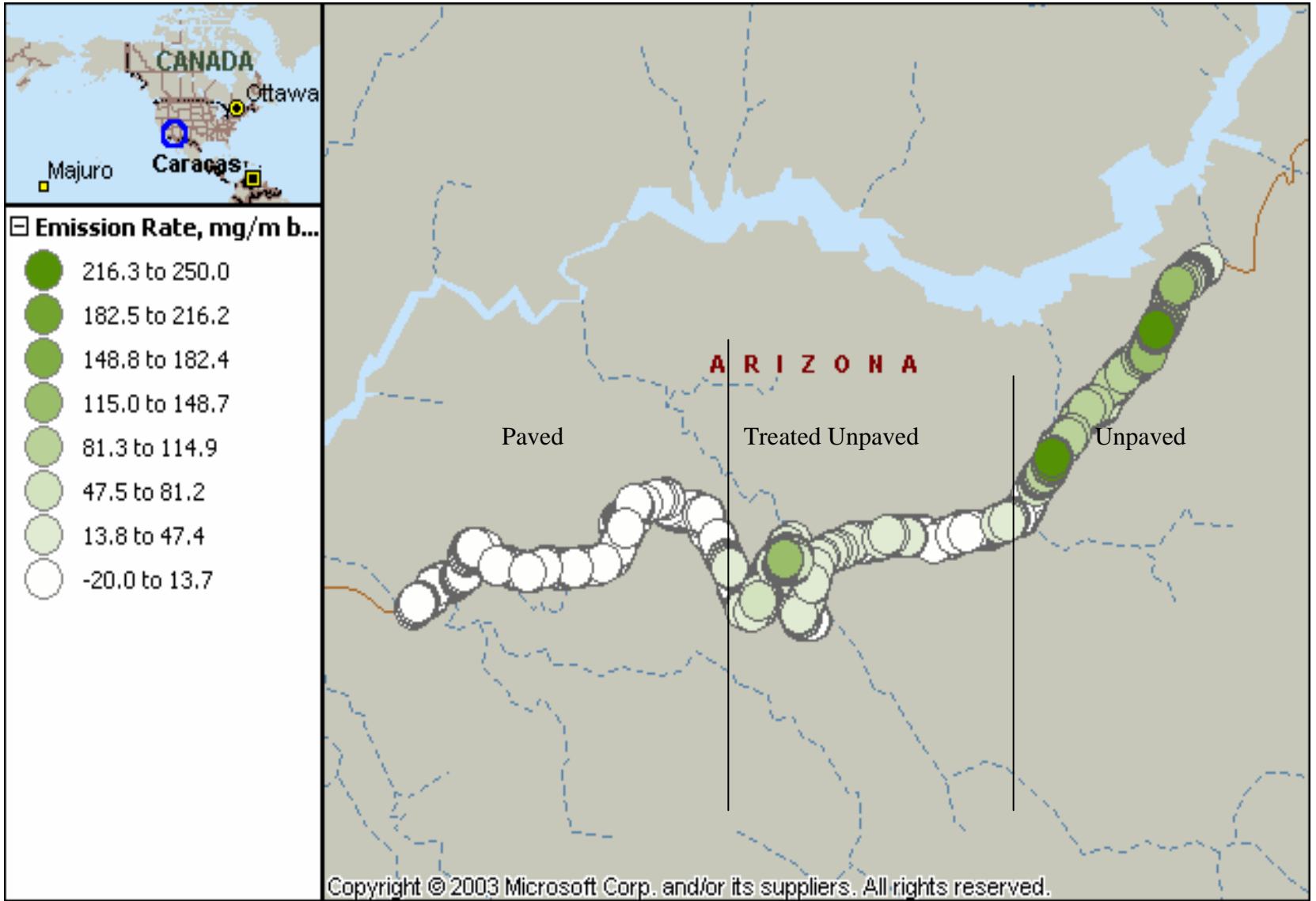
SCAMPER Results Public Road I

Time Series of PM10 Emission Rates SR88 October 10, 2005





SCAMPER Results Public Road I





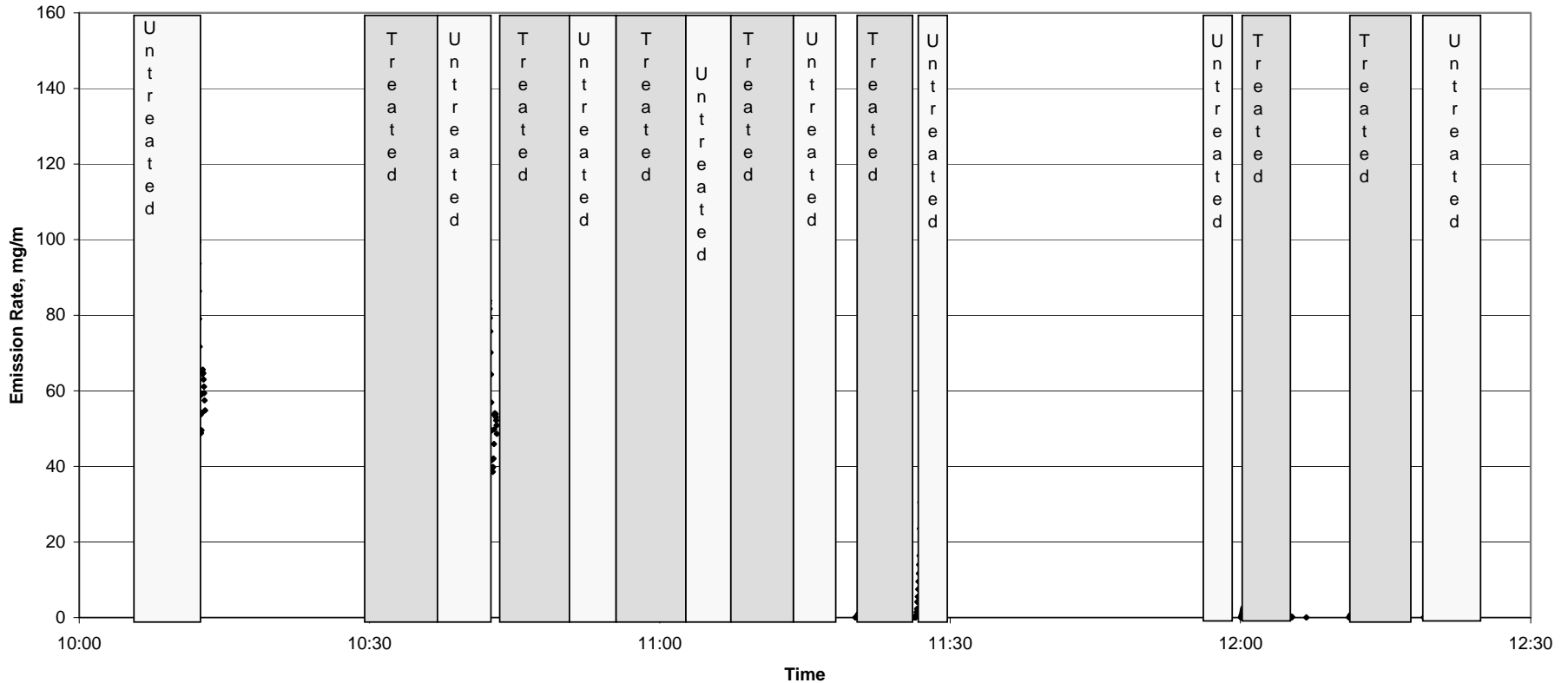
Unpaved Public Road II

- **State Route 188 in Arizona**
 - **Six miles treated in 2004**
 - **Treated by:**
 - Application of 1:1 mixture of SS1
 - Milled top six inches
 - Applied CRS II Emulsified liquid at a rate of 0.5 gallons/sq yd
 - Applied 28 pounds/ sq yd 3/8 inch chips
- **SCAMPER was used to make repeated test runs**
 - **Test runs included unpaved sections on each end of the treated section**
 - **Tests performed in October 2005**
 - **Mean speed 16 mph**



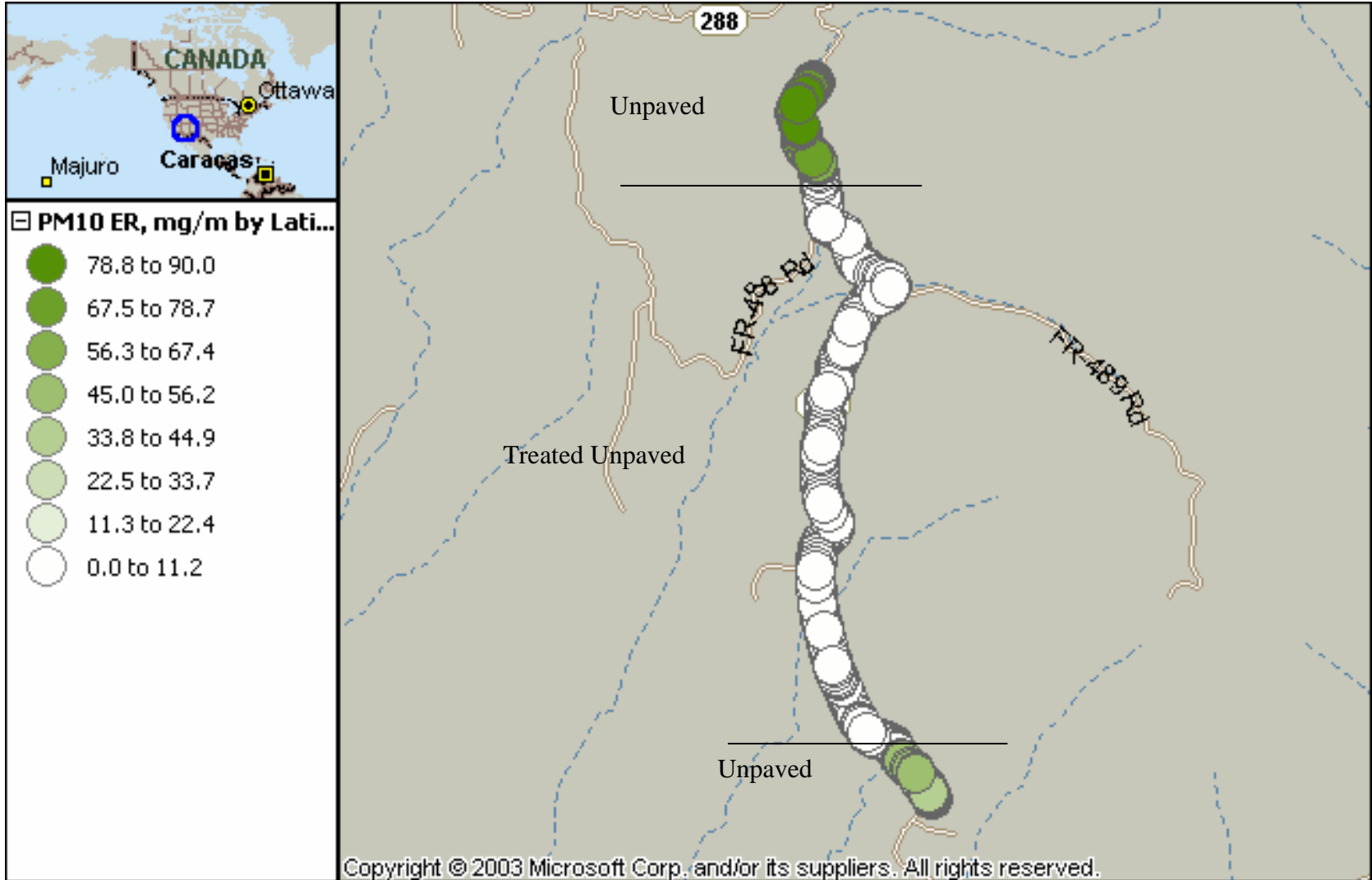
SCAMPER Results Public Road II

Time Series of PM10 Emission Rates SR188 October 11,2005





SCAMPER Results Public Road II





Mine Haul Road

- **Treated native Material**
- **Five Miles Long**
- **Speed Regulated by Permit**
- **Haul Truck 50 tons Empty (NW); 150 Tons Loaded (SE)**
- **Two SCAMPER Modes Used**
 - **Normal Ford Expedition Tow Vehicle**
 - **Haul Truck Tow Vehicle Empty and Full**



SCAMPER On Haul Truck





SCAMPER Haul Road Results

- **Expedition Tow Vehicle**
 - NW Direction: 0.51 mg/m
 - SE Direction: 0.52 mg/m
- **Haul Truck Tow Vehicle**
 - NW Direction (50 tons): 4.2 mg/m
 - SE Direction (150 tons): 7.0 mg/m
- **PM10 Emission Rates Tended to be Inverse of Relative Humidity (lower in morning and evening, higher mid-day)**



Relationship to the AP42 Equation?

- $E = k * (s/12)^{0.9} * (W/3)^{0.45} * 281.9 \text{ g/VKT}$
 - $k = 1.5$
 - Assume $s = 12\%$
- Expedition PM10 Emission Rate
 - Calculated: 389
 - Measured: 0.52 g/VKT
- Unloaded Haul Truck PM10 Emission Rate
 - Calculated: 1,500 g/VKT
 - Measured: 4.2
- Loaded Haul Truck PM10 Emission Rate
 - Calculated: 2,460 g/VKT
 - Measured: 7.0



Can the AP42 Equation be Adjusted?

- Normalized the AP42 to the Ford Expedition, 281.9 becomes 0.318
- Calculated Unloaded Haul Truck PM10 Emission Rate Normalized:
 - Calculated: 1.7 g/VKT
 - Measured: 4.2 g/VKT
- Calculated Loaded Haul Truck PM10 Emission Rate Normalized:
 - Calculated: 2.8 g/VKT
 - Measured: 7.0 g/VKT
- Normalized Result is Within a Factor of 3; Not Bad for a HUGE Extrapolation
- Power Function of $W^{0.45}$ Correctly Predicts the Relationship Between Unloaded and Loaded Haul Trucks:
 - $1.7/4.2 = 0.4$
 - $2.8/7.0 = 0.4$



CONCLUSIONS

- The suppressant applied to SR88 five months to two years ago reduced PM_{10} emissions by a factor of five.
- The suppressant applied to SR188 a year ago reduced PM_{10} emissions by a factor of sixty.
- SCAMPER measurement precision was 20% on unpaved public roads
- SCAMPER was shown to be an effective method to quantify performance of dust suppressants on unpaved roads



CONCLUSIONS

- The AP42 equation grossly over-predicted PM10 emissions from the haul road
- The weight power function of 0.45 of AP42 correctly predicted the PM10 emission rates between the unloaded and loaded haul trucks on the treated haul road
- SCAMPER was shown to be an effective method to quantify performance of dust suppressants on haul roads
- Treated haul roads should be permitted by performance and not AP42 estimates
- A normalized AP42 equation could be used to evaluate permit compliance over a range of vehicles