Wind Erosion Dynamics after Surface Disturbance

ADMIN RECORD

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SW-A-006043

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Sources of Erodible Dust

- Bare soil
  - Consolidated/crusted
  - Freshly disturbed
- Surface deposits on bare soil (from previous wind events)
- Deposits on vegetation
- Decayed vegetation

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High Wind Event

- Releases dust during event
- Rearranges coarse dust particles on surface
- Deposits dust at end of event

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Complicating Factors

- Limited availability of erodible material
- Dominance of short-term wind gusts
- Non-uniformity of surface exposure to wind

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Dry Particle Deposition Mechanisms

- Gravitational Settling
- Attraction of Small Particles to Larger Particles, for Enhanced Gravitational Settling
- Capture on Other Oppositely Charged Surfaces (Electrophoresis)
- Capture on Cooler Surfaces, such as Vegetation (Thermophoresis)

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Surface Disturbance

- Causes erosion potential to increase sharply above "equilibrium" value
- Emission rate exceeds particle replenishment rate during subsequent wind events while surface is returning to equilibrium

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Equilibrium Surface Condition

- No net loss of fine particles
- Rate of erosion equals rate of surface production plus rate of deposition
- Stable condition implies crust or vegetative cover

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Soil Moisture

- Decreases erosion potential below value for dry consolidated surface
- Sources of Moisture
  - Precipitation
  - Condensation
  - Upward migration of subsurface moisture

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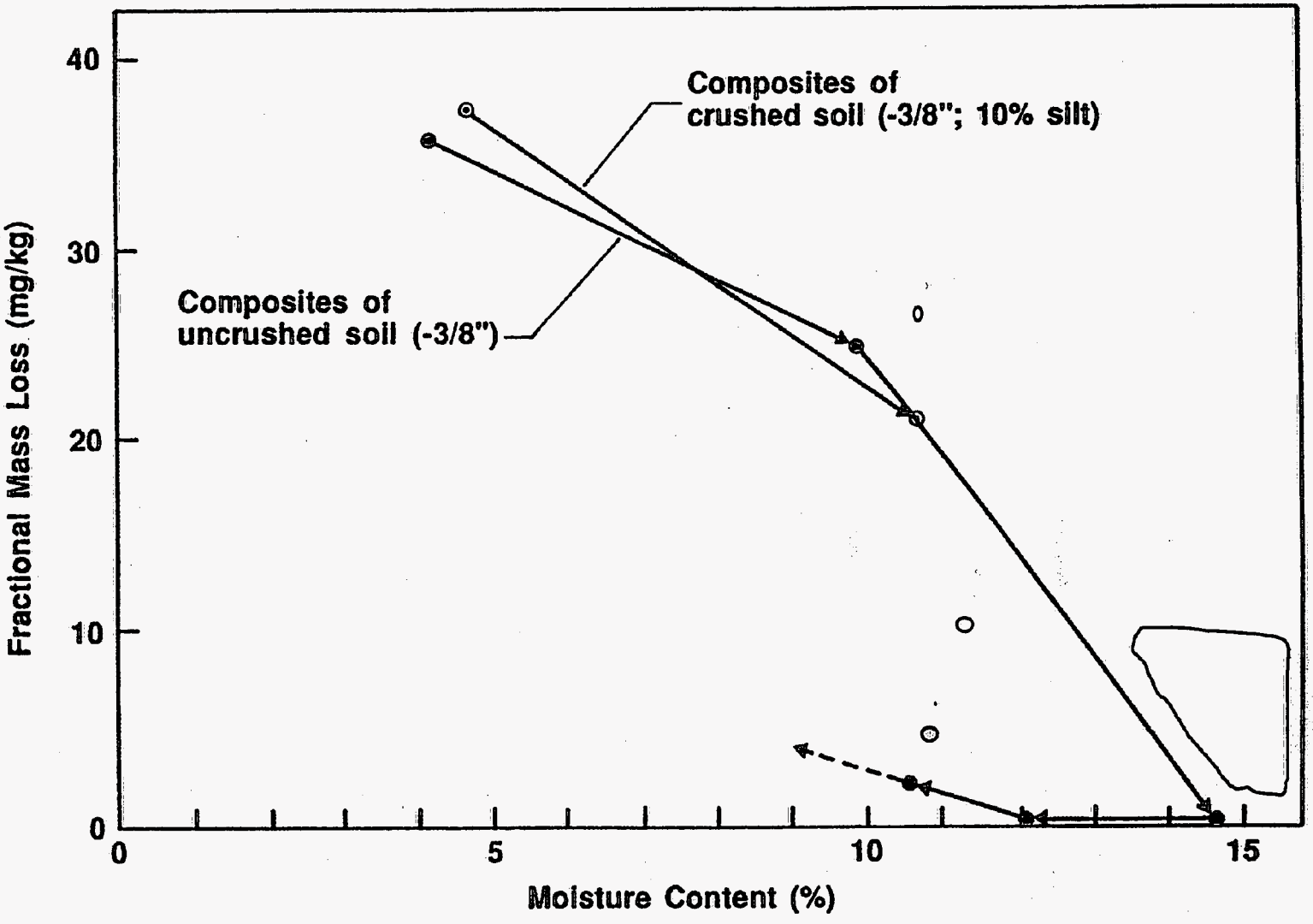
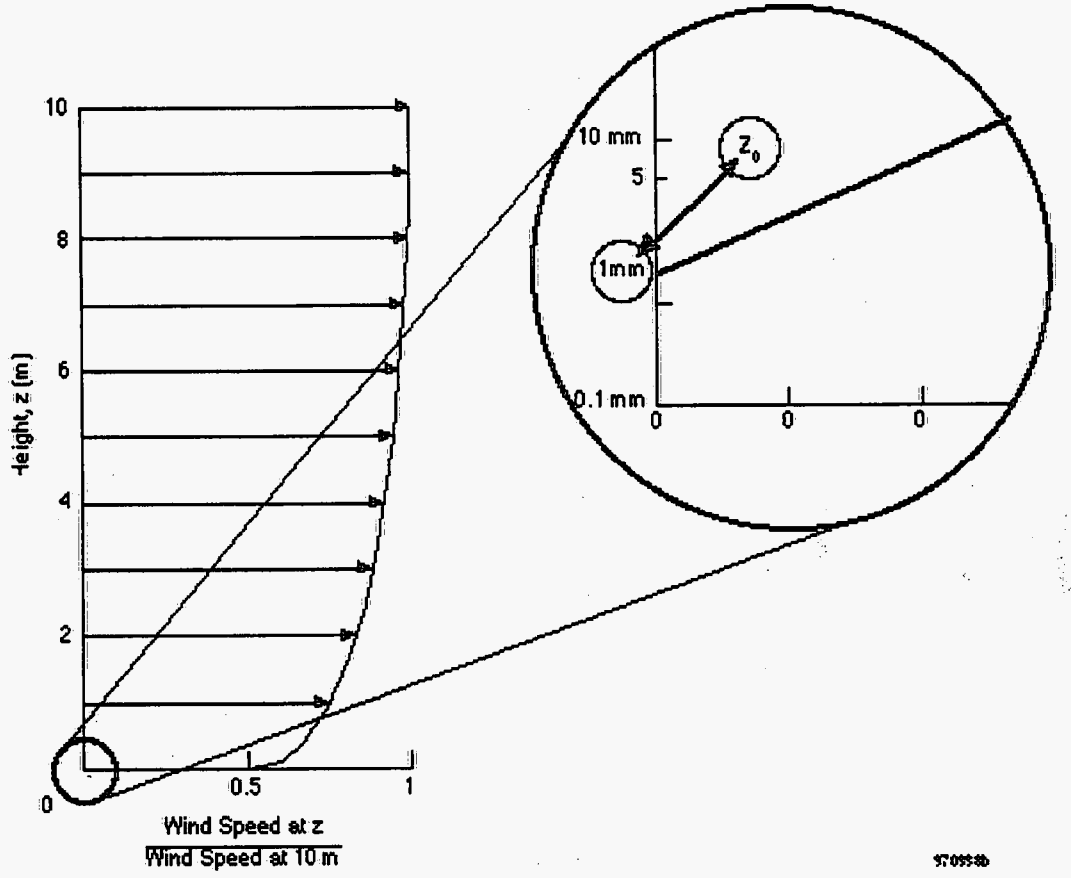
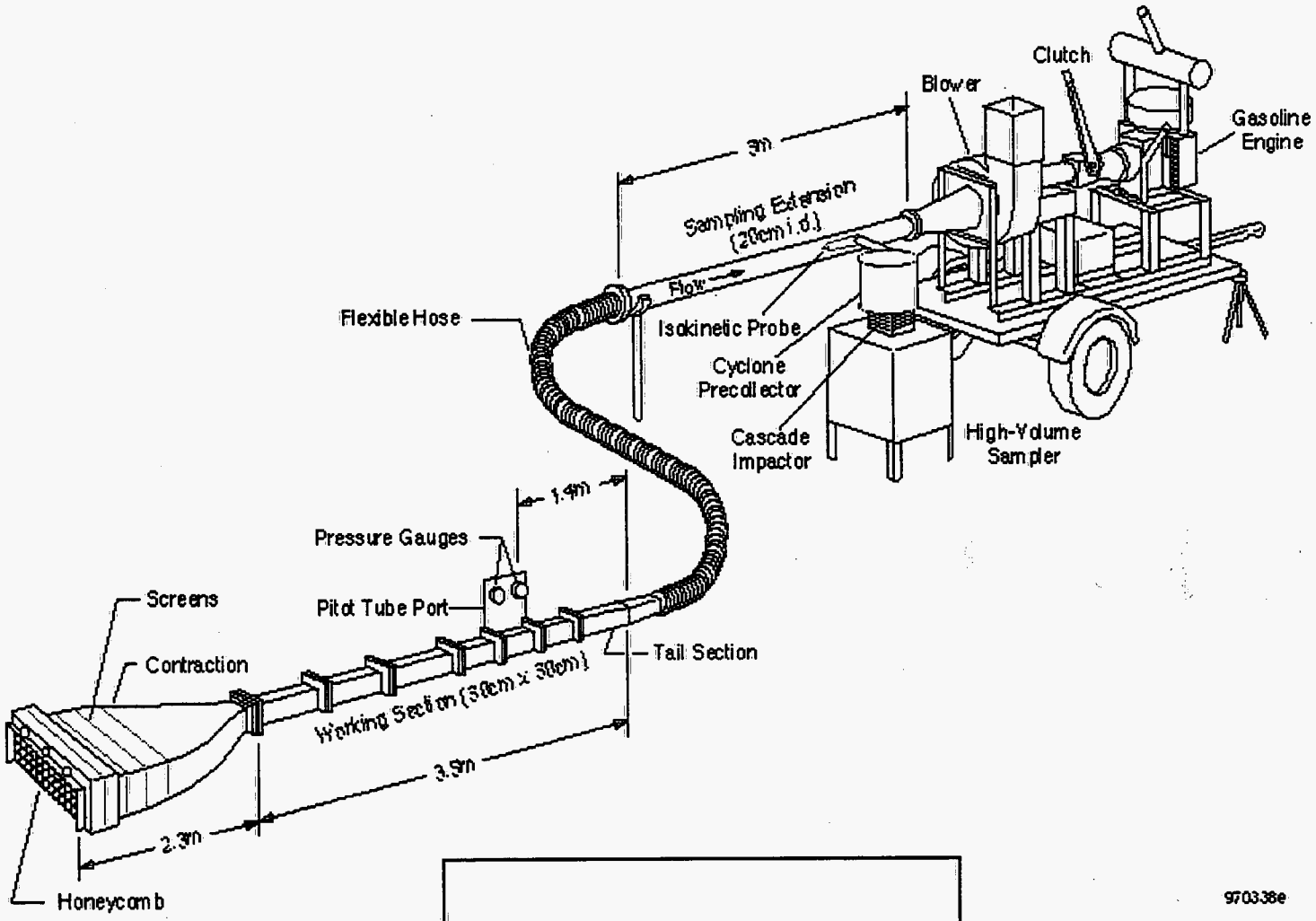
Hysteresis Effect of Moisture Content on Dustiness



Logarithmic Wind Speed Profile



MRI Portable Wind Tunnel



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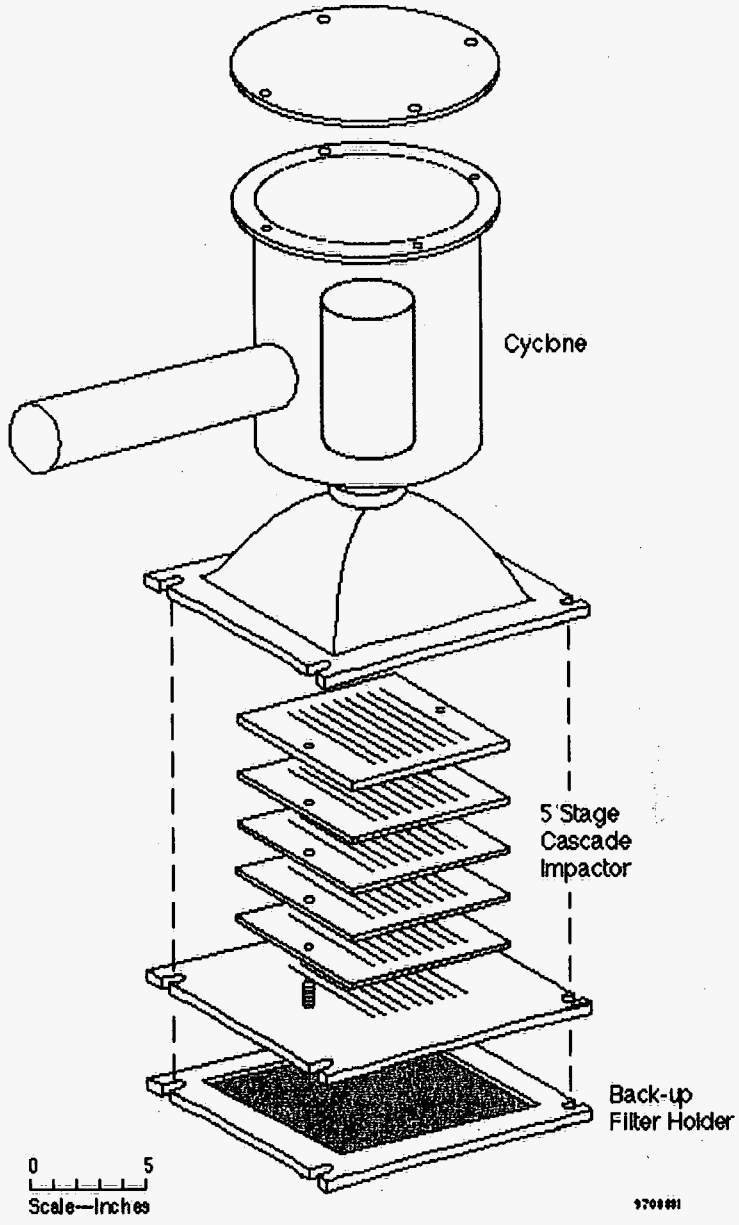
MRI Cyclone with inertial impactors and backup filter



Reference Wind Tunnel Test Method

- Place open-floored wind tunnel on test surface
- Determine wind erosion threshold velocity
  - Increase airflow gradually up to threshold velocity, as determined by observable sustained particle migration

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Reference Wind Tunnel Test Method (cont)

- Conduct emission tests at tunnel airflows between threshold velocity and capacity of wind tunnel
  - Perform back-to-back emission tests at first test airflow, changing sample collection media between tests
  - Repeat above at second test airflow

Reduced Scale Wind Tunnel

- Approximately 1/4 scale version of reference wind tunnel
- Utilizes same sampling module as reference scale wind tunnel

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Controls that Bind Particles

- Usually work on basis of particle surface area
- Tend to bind fine particles more effectively
- Tend to fail first for coarse particle components

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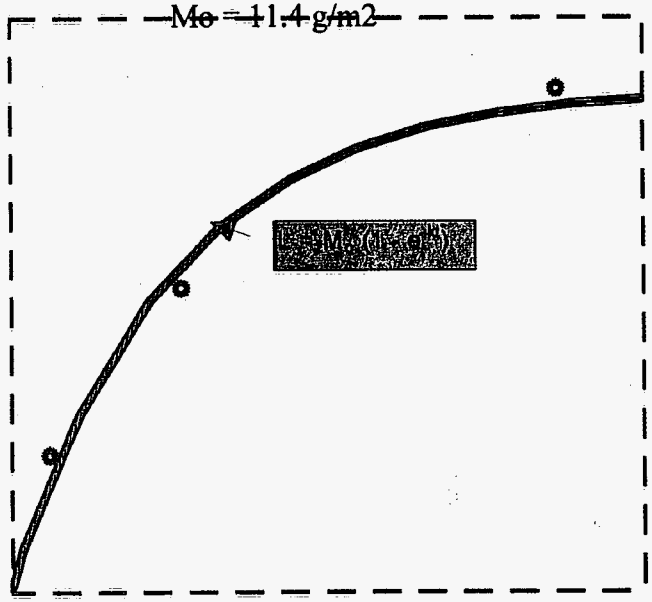
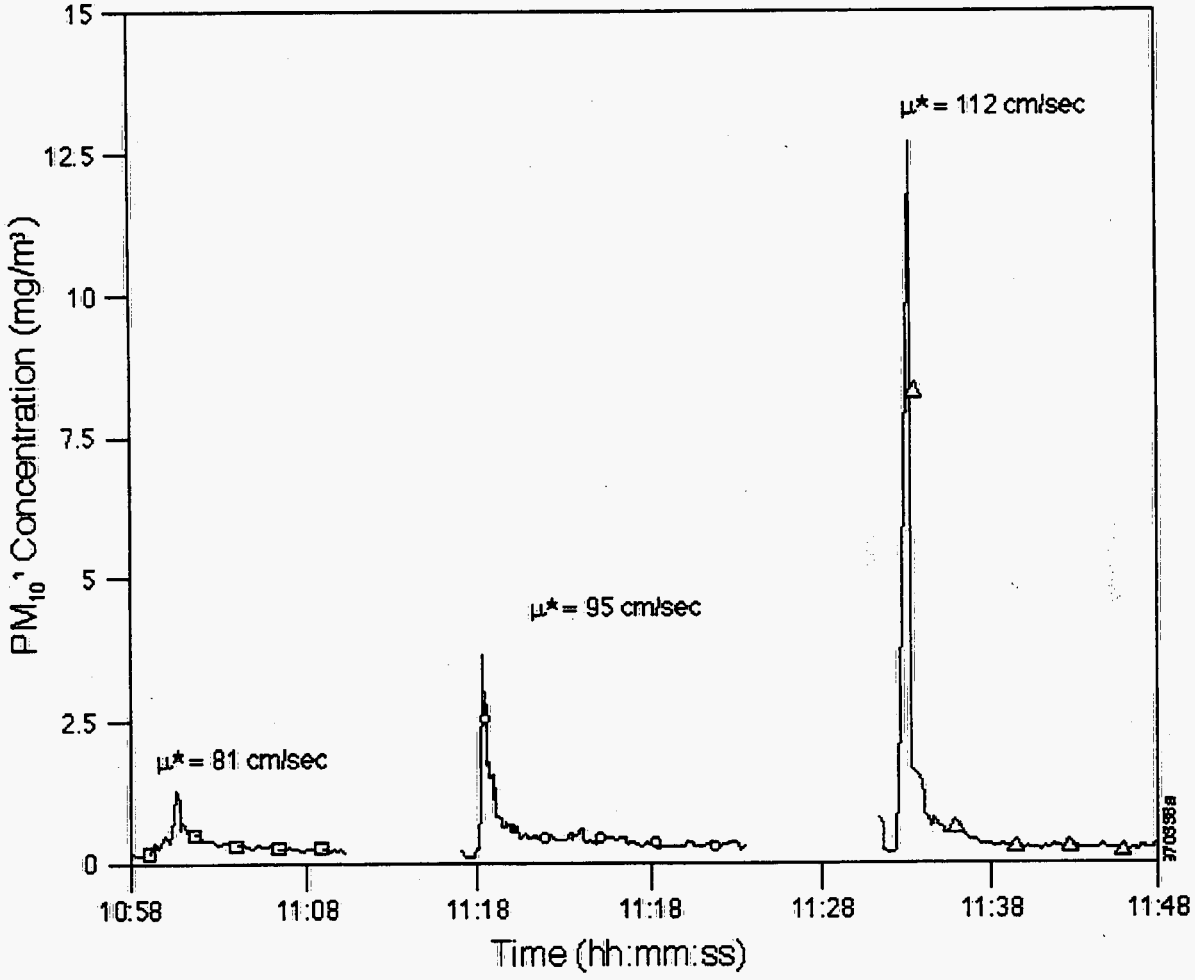
CUMULATIVE EROSION LOSS



Example Wind Erosion Emission Dynamics

Disturbed Soil at Fontana Landfill
Tests BF-19, 20, 21



Advantages of Wind Tunnel Method

- Tunnel wind conditions well characterized
- Ease to isolate sources - best to sample under light ambient winds
- Provides more explicit data on effects of surface conditions

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Enhanced Wind Tunnel Test Method

- Simultaneous Tracking of Wind Speed and PM-10
  - Wind speed (differential pressure transducer output to computer)
  - PM-10 concentrations (TSI DustTrak monitor output to computer)
- Increasing Wind Speed Plateaus
  - Increase in ~5 mph increments
  - Maintain wind speed at each plateau until significant decay in PM-10 emissions

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Enhanced Wind Tunnel Test Results

- Wind Erosion Potentials
  - By wind speed
  - By date following disturbance
  - By particle size fraction

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Rocky Flats Studies

- 1995 Study
  - Characterization of Soil Erodibility
    - Grassland at 3 disturbance levels
    - Lake shore, crusted and disturbed
- 2001 Study
  - Wind tunnel tests over 3-month time period following prescribed burn
  - Wind tunnel tests following wildfire

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Rocky Flats Findings

- Prescribed Burn Tests
  - TP and PM-10 erosion potentials decreased with time after burn
  - Dampness in soil reduced the erosion potential below dry soil value
  - Revegetation contributed to reduction in erosion potential
  - Carbon particle (OC/EC) fraction was greatest immediately after burn

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Rocky Flats Findings (cont)

- Wildfire Tests
  - Erosion potentials developed
    - PM-10 and TSP
    - Different wind speeds
  - Three soil fractions partitioned for actinide activity

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Actinide Activity vs. Particle Size

- Surface Soil Average Pu239 Concentration
  - Coarse (> 600 μm): 1.27 pCi/g
  - Midsize (75 to 600 μm): 2.09 pCi/g
  - Fine (< 75 μm): 1.77 pCi/g
- Filter PM-10 Average Pu239 Concentration
  - Disturbed soil test: 3.156 mg/m^3
  - Undisturbed soil test: 0.502 mg/m^3

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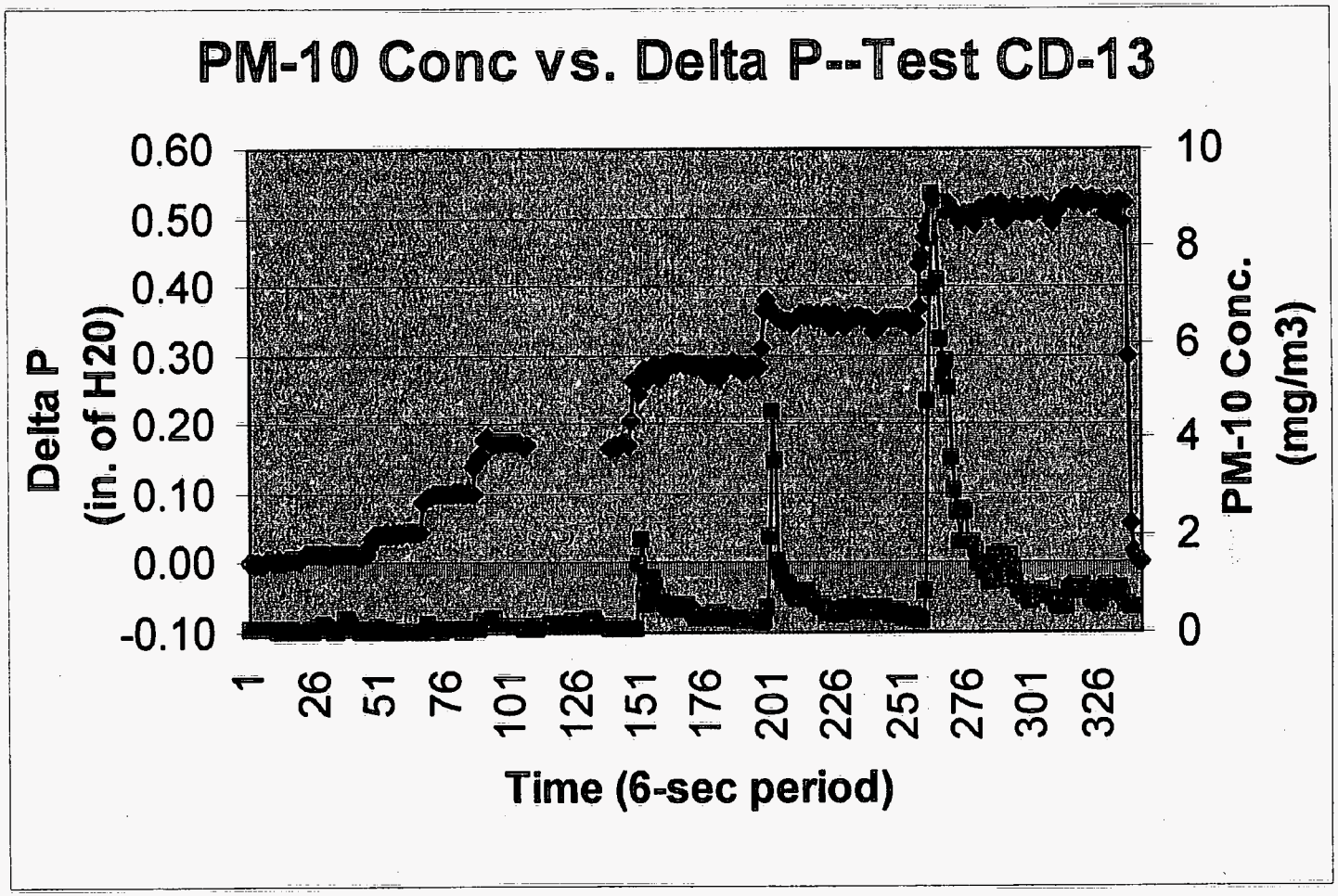
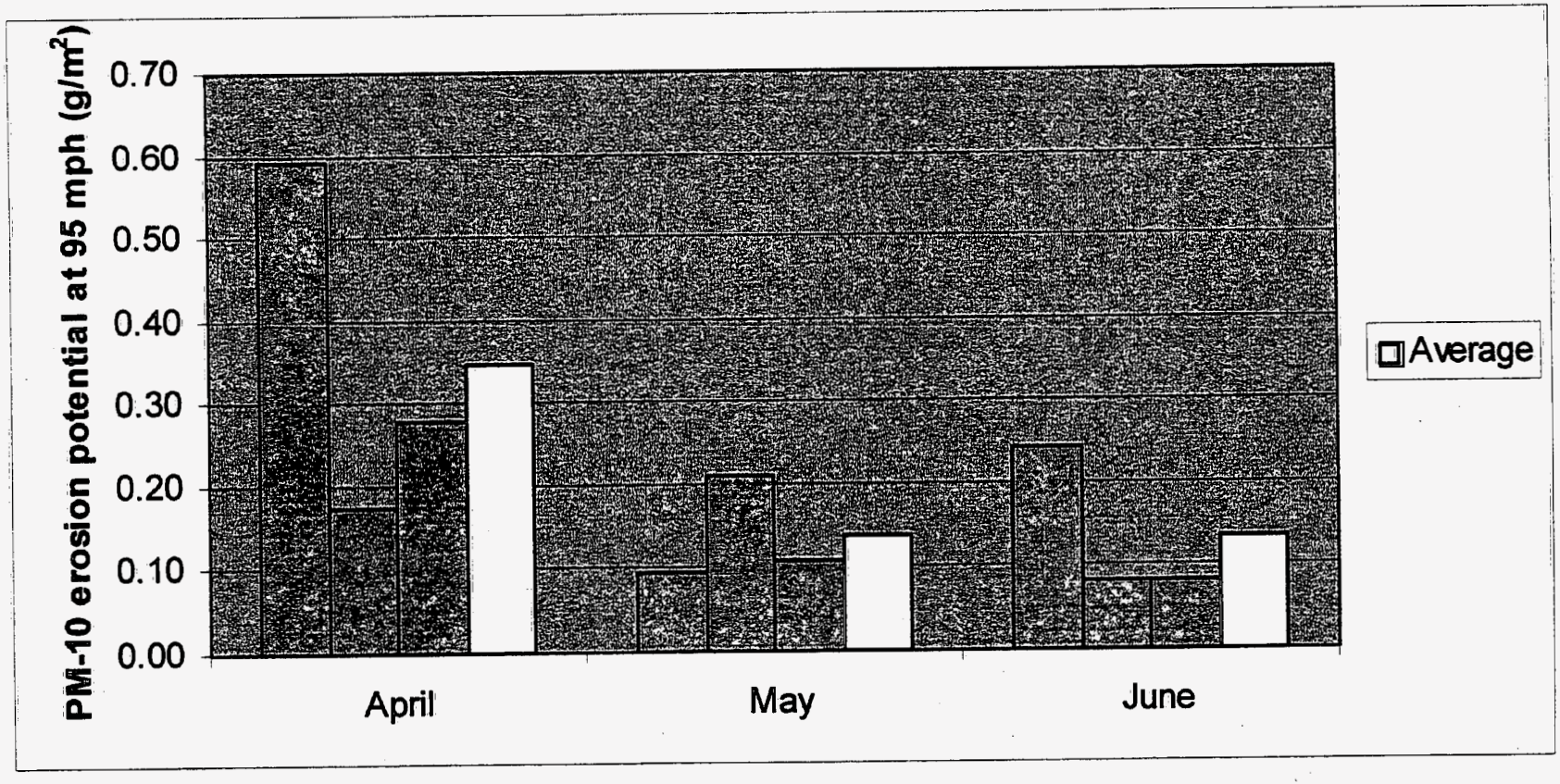
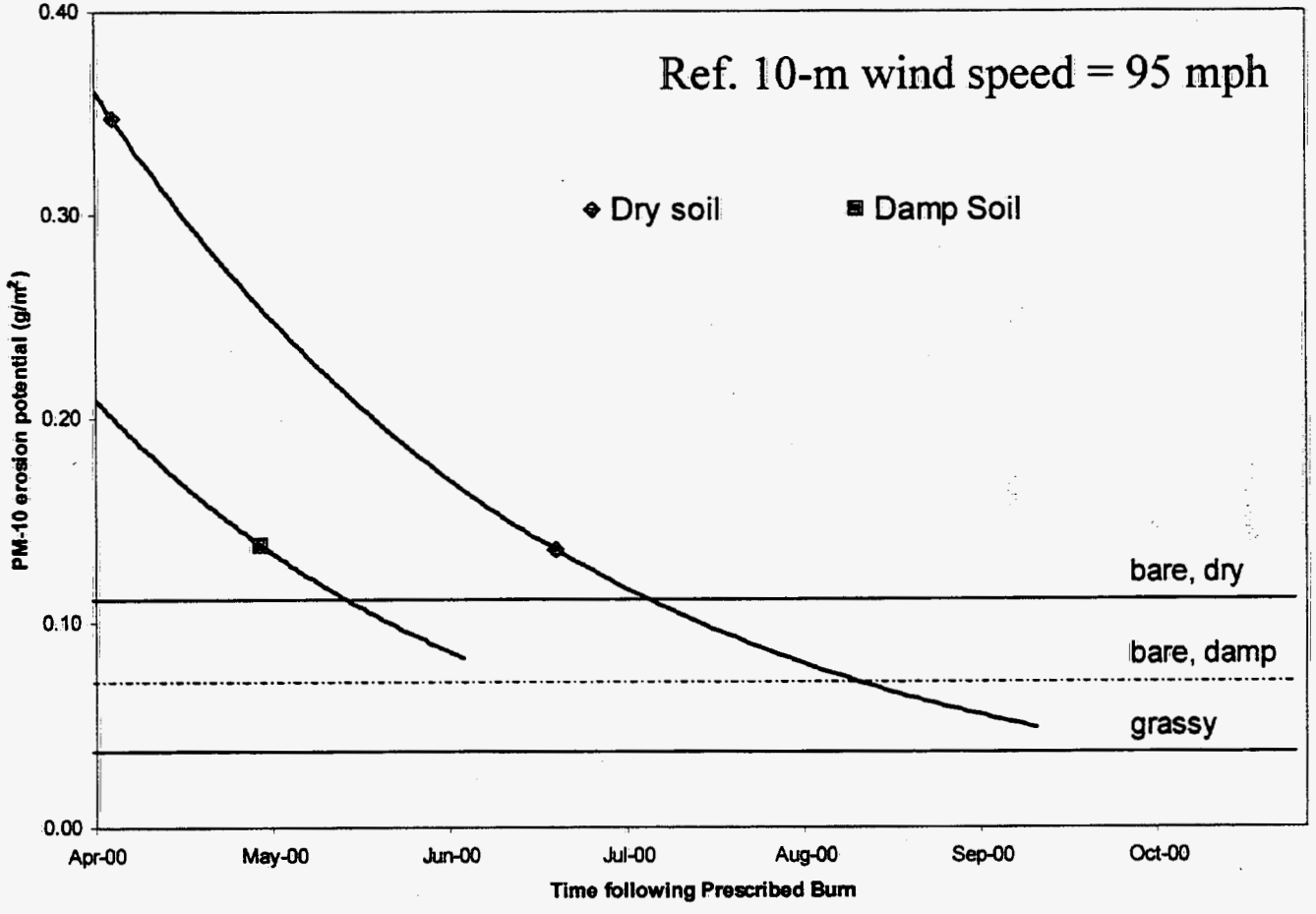
Tracking of Erosion Process



PM-10 Erosion Potentials for Prescribed Burn Area



Decay of PM-10 Erosion Potential after Prescribed Burn



Air Dispersion Modeling Approach

- Generate Erosion Potential Decay Curves for Each Tested Wind Speed
  - Dry soil
  - Damp soil
- Track Ambient Mean 15-min Wind Speed
- Project Daily Particle Deposition Based on Mean PM-10 Concentration

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Air Dispersion Modeling Approach

- Eliminate Periods During and Immediately After Precipitation Events
- Use Damp/Dry Soil Curves as Appropriate for each 15-min Period
- Model 1-yr Period until Full Revegetation
- Take into Account Erosion Losses from Previous Wind Events

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