

# Changes in MSATs at Near-Roadway Schools After the Expansion of US 95 in Las Vegas, Nevada

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# US 95 Settlement Agreement

- A Court Settlement Agreement was reached between the Sierra Club and NDOT/FHWA regarding urban freeway expansion where three schools are adjacent to the roadway.
- Both mitigation and monitoring were required to reduce and assess student exposure.
  - MSAT monitoring study at schools (this study)
  - Filtration added to HVAC systems at schools
  - Bus retrofit program
  - Bus idling education
  - FHWA gradient study (with EPA)

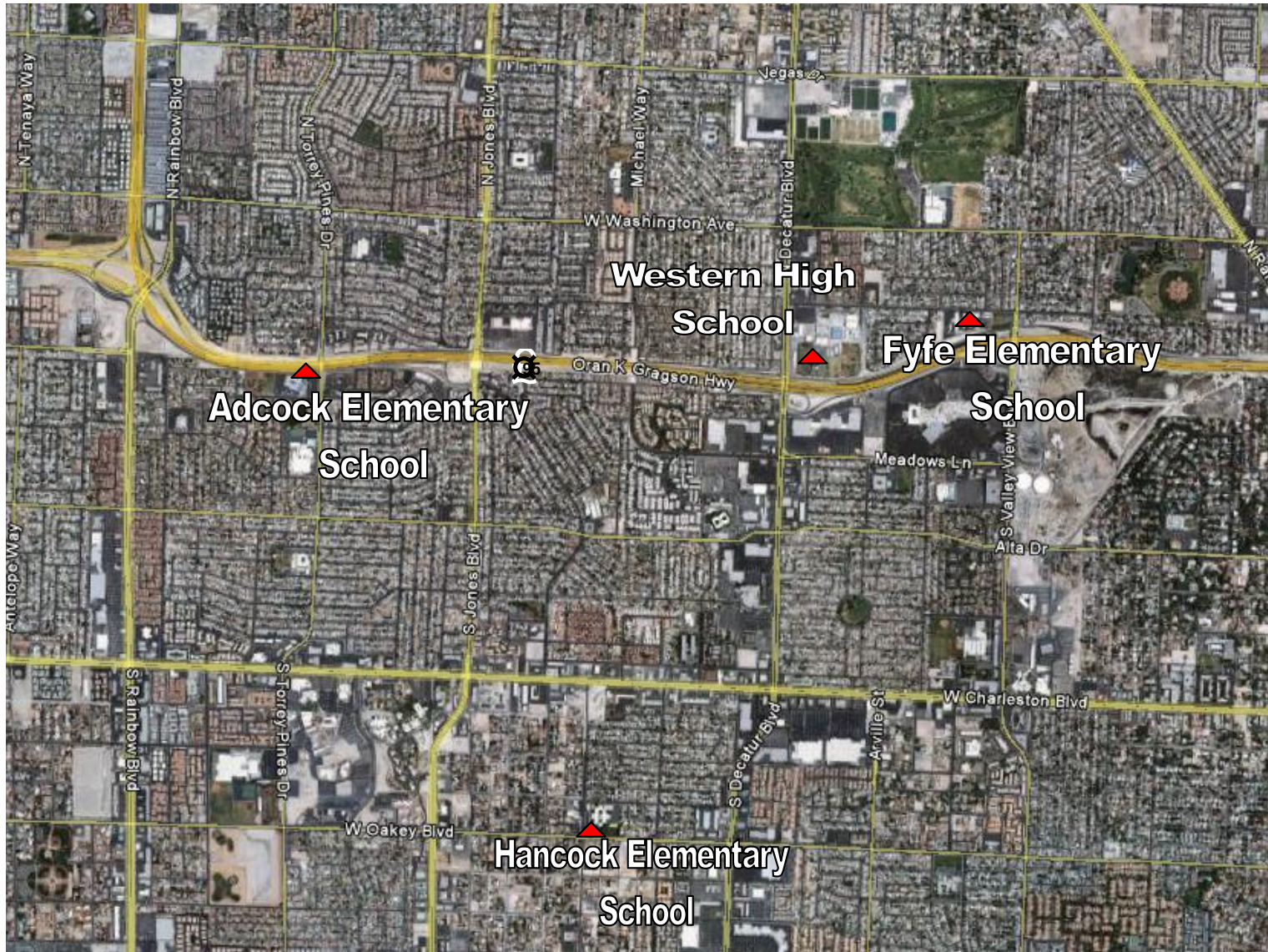
# Introduction to US 95 MSAT Study

## MSAT study objectives

- Characterize outdoor and indoor concentrations at schools (student exposure)
- Determine US 95 vehicle contributions (before and after new lanes opened)
- Determine MSAT removal efficiencies of new filtration systems

Focus on priority MSATs: diesel particulate matter, benzene, 1,3-butadiene, acrolein, formaldehyde, and acetaldehyde

# Monitoring Sites at Schools



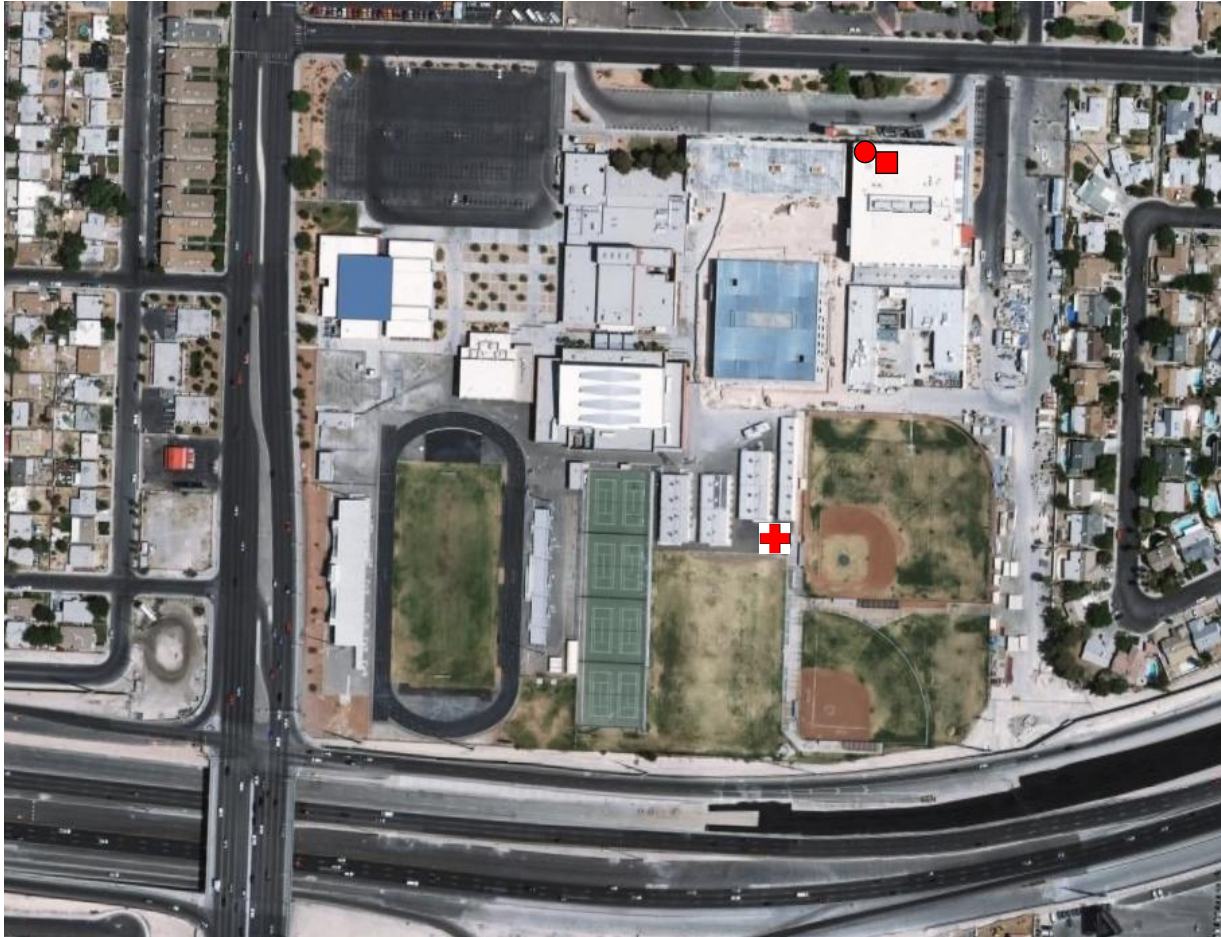
# Fyfe Elementary School Monitoring Sites



**Legend:** ● Air Inlet ■ Classroom + Ambient

Ambient monitor is 20 meters from sound wall (SW); air inlet is 76 meters from SW.

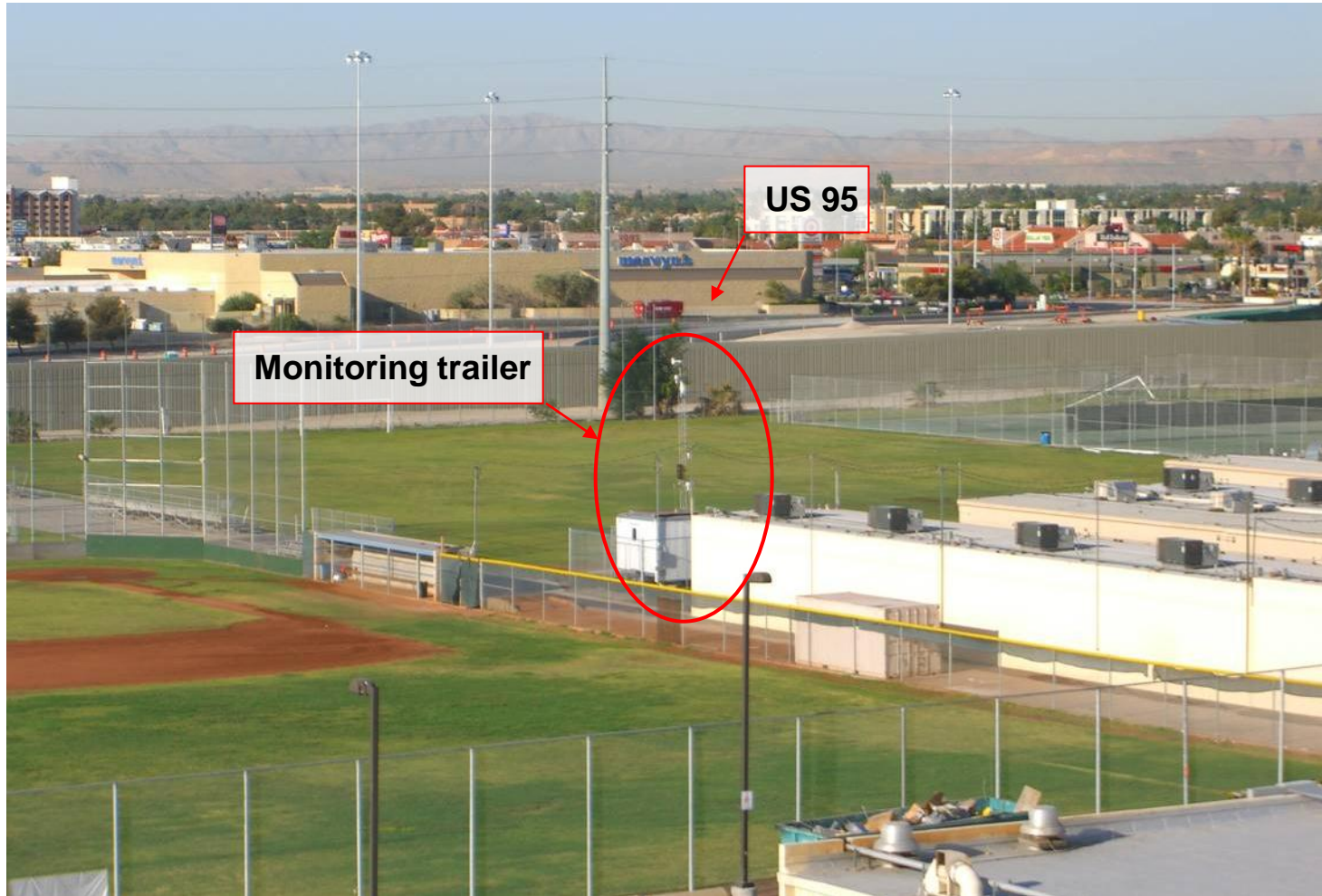
# Western HS Monitoring Sites



**Legend:** ● Air Inlet ■ Classroom + Ambient

Ambient monitor is 136 meters from sound wall (SW); air inlet is 317 meters from SW.

# View from Science Roof at Western H.S. Toward Monitoring Trailer and US 95



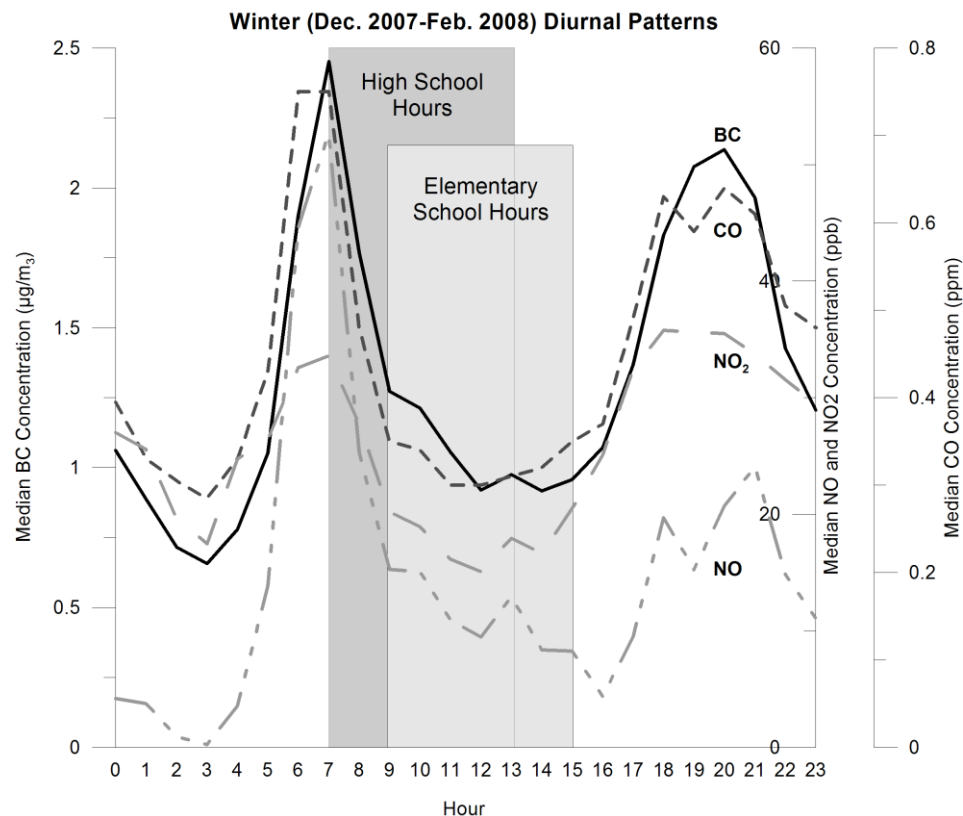
# Adcock Elementary Monitoring Sites



**Legend:** ● Air Inlet ■ Classroom + Ambient

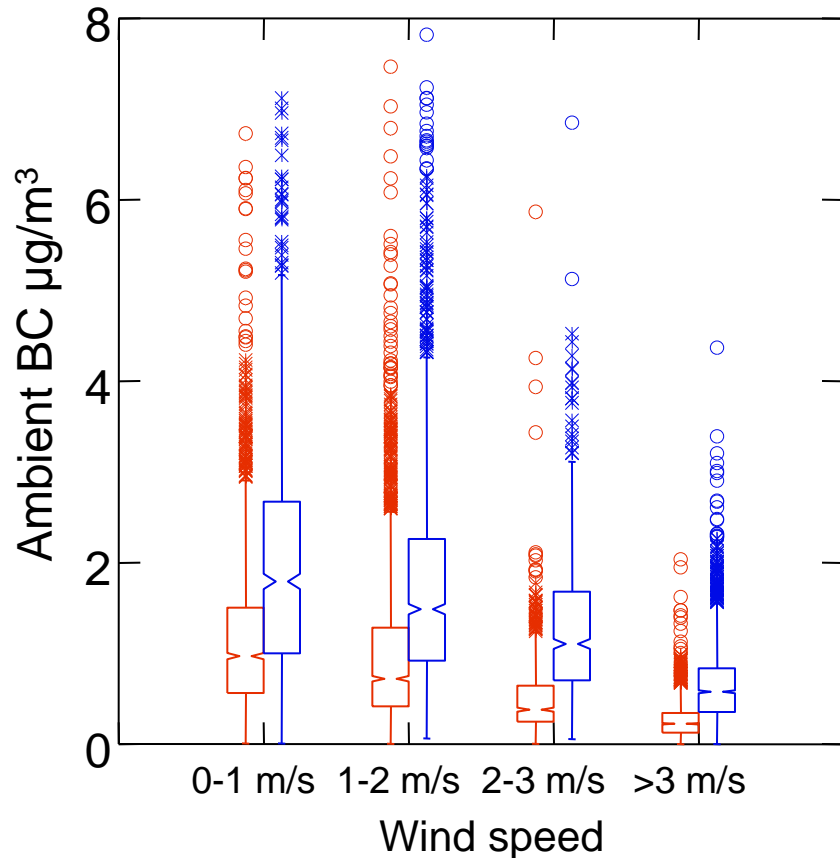
Ambient monitor is 17 meters from sound wall (SW); air inlet was 39 meters from SW; air inlet for new system is 33 meters from SW (not shown).

# Diurnal Pattern of Pollution Is an Important Consideration for Exposure and Mitigation



Median concentrations by hour of BC ( $\mu\text{g}/\text{m}^3$ ), CO (ppm), NO (ppb), and NO<sub>2</sub> (ppb) at Fyfe on weekdays in winter (December 2007 to February 2008)

# BC Concentrations Upwind and Downwind: Influence of Wind Speed



Adcock upwind

Fyfe downwind

When winds blow from south to north, observations show a significant difference across the freeway, suggesting freeway influence on BC could be at least 50% of the observed concentrations at these sites.

Notch: median, 95% CI

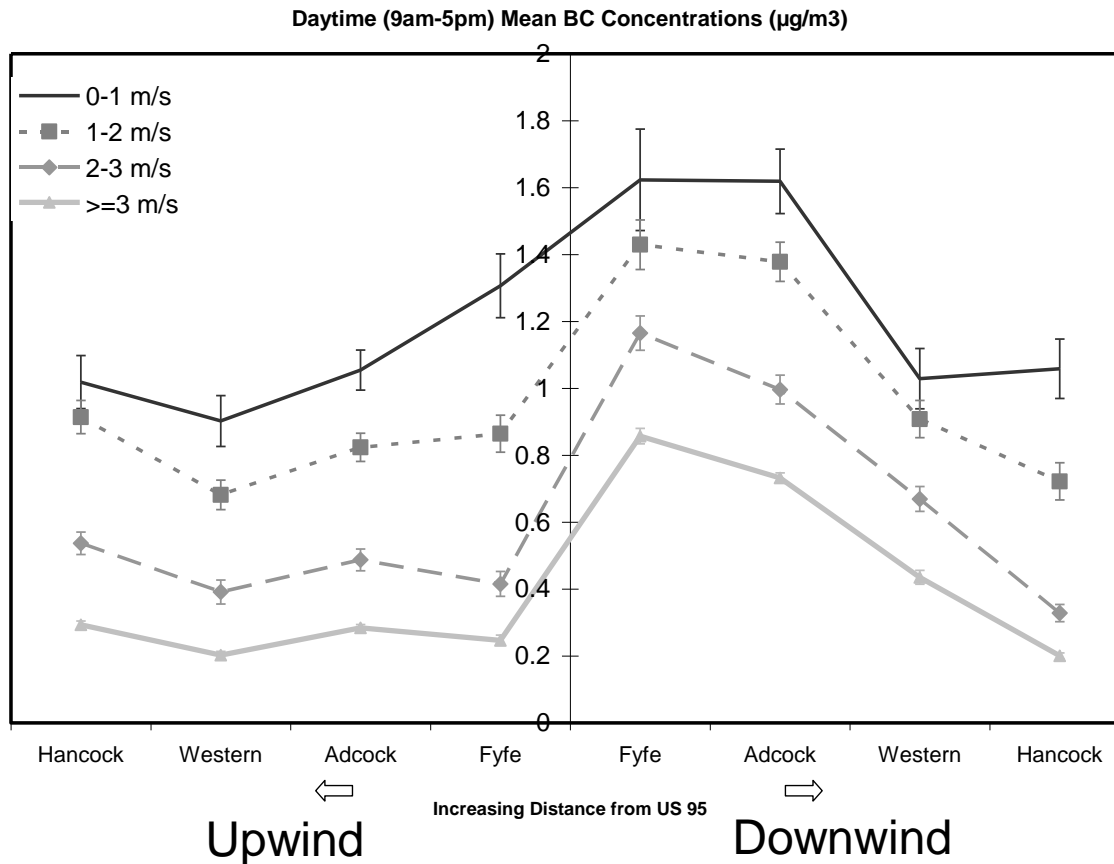
Box: interquartile range

Whisker:  $1.5 \cdot \text{IQR}$

Points: beyond  $1.5 \cdot \text{IQR}$

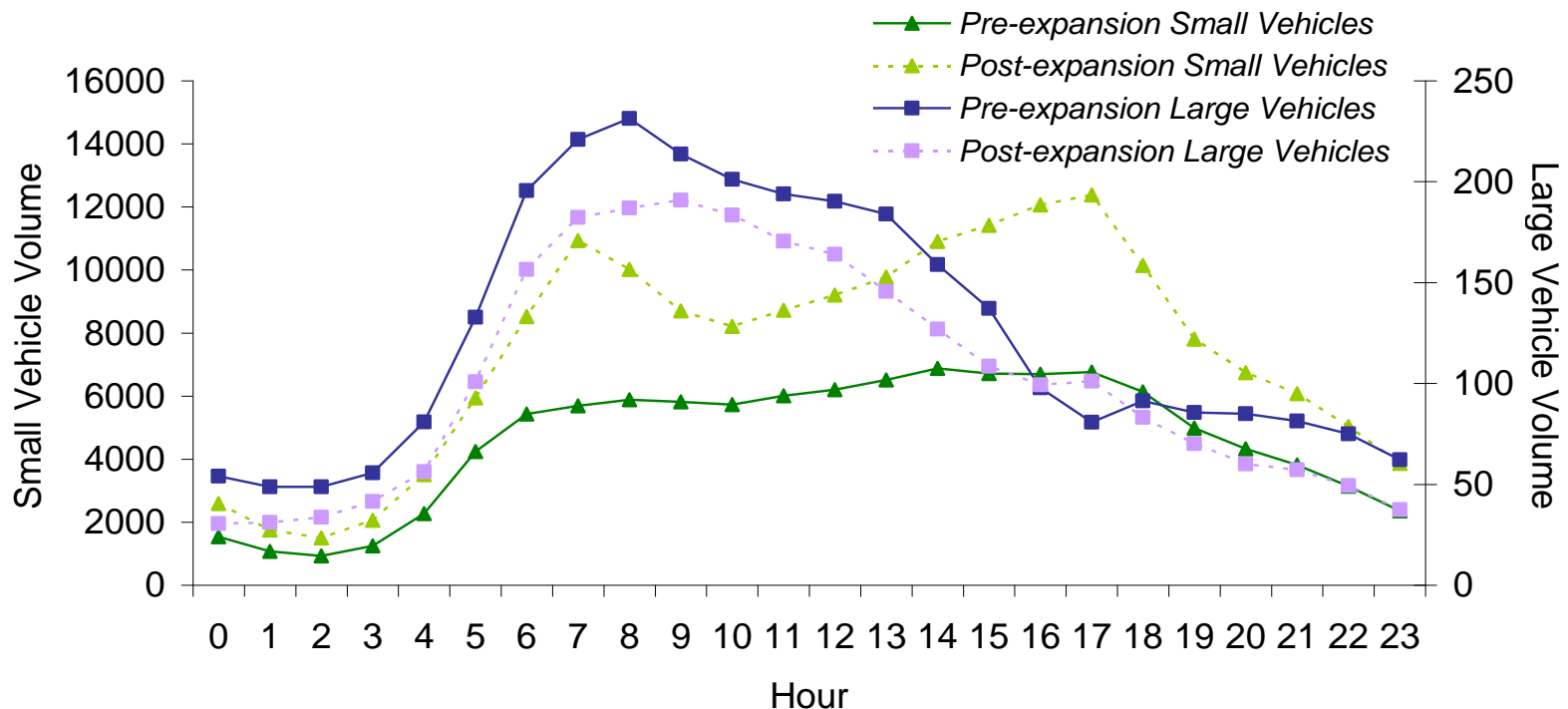
A significant difference is present if notches do not overlap.

# Downwind BC Gradients Are Influenced by Wind Speed



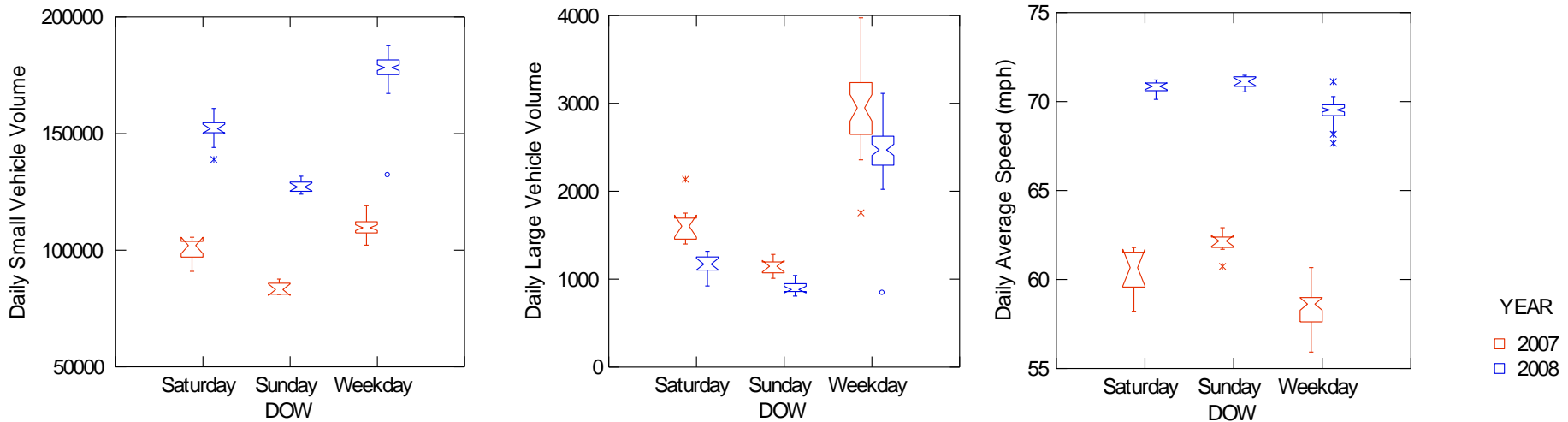
Concentration gradient in near-roadway concentrations of BC ( $\mu\text{g}/\text{m}^3$ ) as a function of wind speed

# Small-Vehicle Traffic Increased About 62% and Large-Vehicle Traffic Decreased About 17% After US 95 Expansion (and Economic Downturn)



Average hourly small-vehicle (< 21 feet in length, typically gas-powered) and large-vehicle (> 40 feet in length, typically diesel-powered) volume pre-expansion (June-August 2007) and post-expansion (June-August 2008) on weekdays

# Traffic Volume Before and After US 95 Expansion: Daily Averages



Daily average traffic volume at Torrey Pines overcrossing of US 95

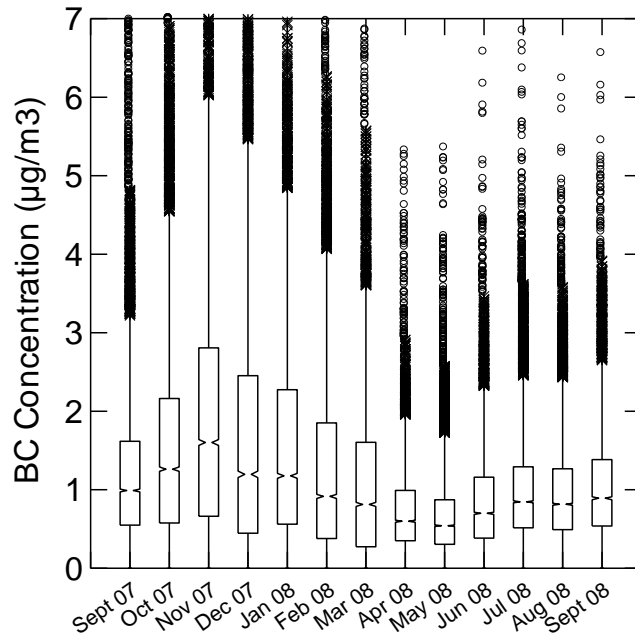
- Small vehicles (< 21 ft., typically gas-powered, left)
- Large vehicles (> 40 ft., typically diesel-powered, center)
- Speed (mph, right)

Pre-expansion: June-August 2007 (red symbols, left of each pair)

Post-expansion: June-August 2008 (blue symbols, right of each pair)

Average daily traffic was 150,000 vehicles in 2007 and 203,000 vehicles in 2008

# Comparison Issues Before and After US 95 Expansion



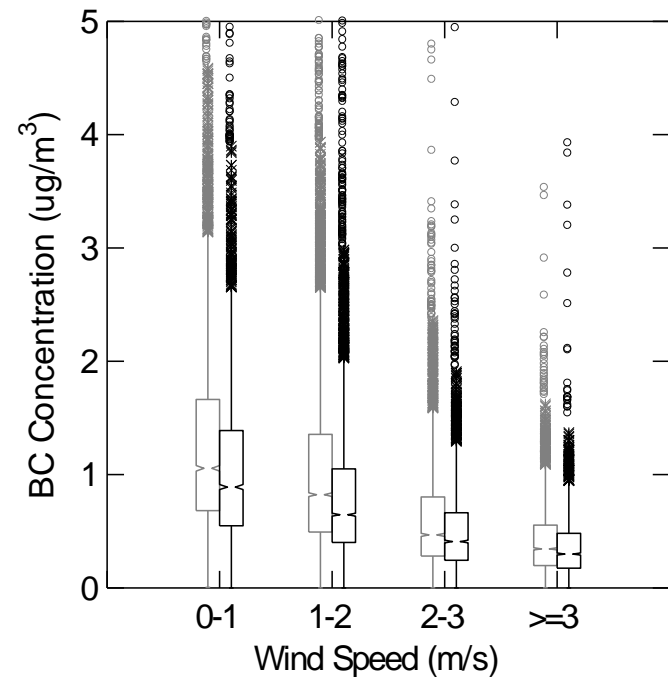
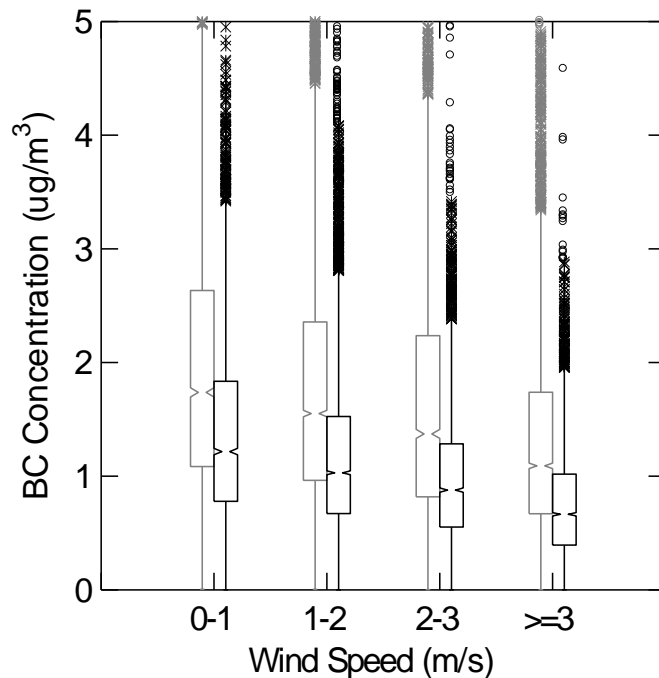
Near-road (BC) influenced by

- Diurnal traffic changes
- Seasonal traffic changes
- Expansion traffic changes
- Congestion
- Changes in the economy
- Meteorology (mixing, wind speed, wind direction)
- Reactions and photochemistry

Approaches: Compare

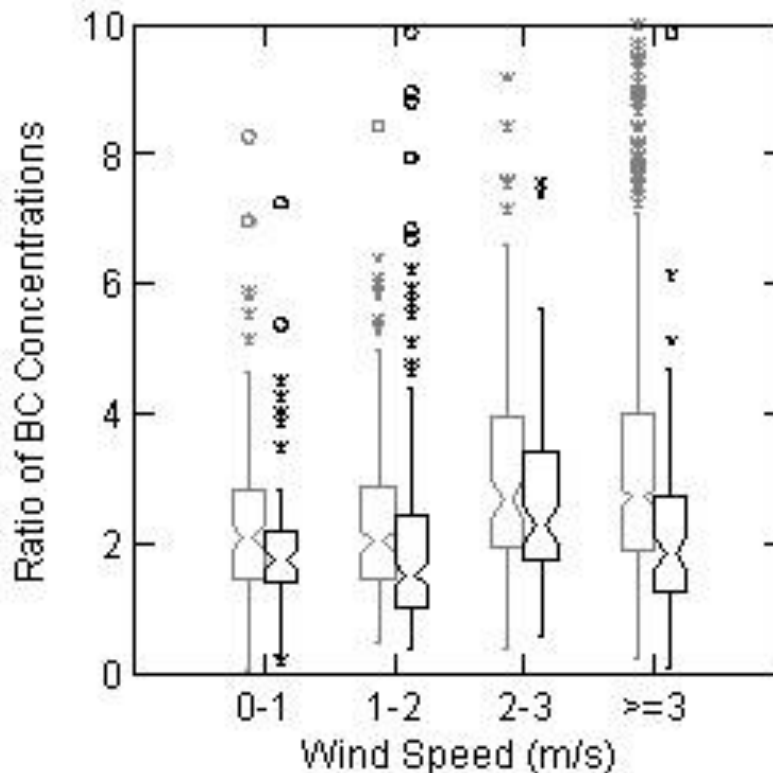
- Ratio of downwind concentration to upwind concentration
- Concentration during same season
- Concentration under similar conditions (wind speed)

# BC Concentrations Are Down About 15-30% After US 95 Expansion (and Economic Downturn) (1 of 2)



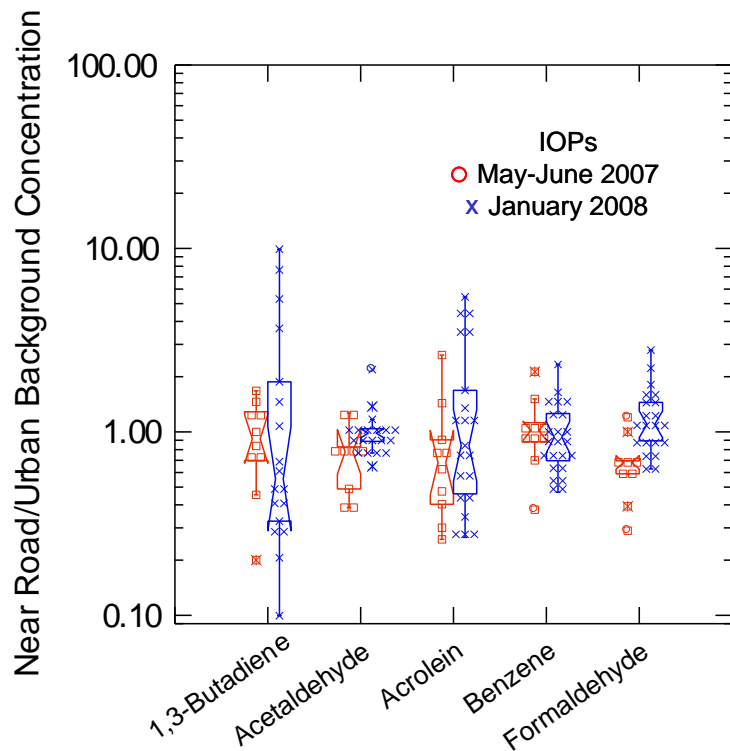
Pre-expansion (Summer 2007, gray) and post-expansion (Summer 2008, black) concentrations for Fyfe (left) and Hancock (right), weekdays

# BC Concentrations Are Down About 15-30% After US 95 Expansion (and Economic Downturn) (2 of 2)



Pre-expansion (October 2007, gray) and post-expansion (February 2008, black) concentration ratios for Fyfe (downwind) compared to Adcock (upwind), weekdays

# Gaseous MSAT Concentrations Before and After US 95 Expansion (and Economic Downturn)



2-hr integrated samples at 9-11 a.m.  
and 1-3 p.m. on 14 days in 2007  
and 14 days in 2008

Pre-expansion (May-June 2007, red) and post-expansion (January 2008, blue) concentration ratios for Fyfe/Hancock

## Near-Road MSATs After US 95 Expansion in November 2007 (and Economic Downturn)

- Black carbon concentrations decreased about 15-30% at near-road and urban background locations
- Small-vehicle traffic on US 95 increased 62%, but large-vehicle traffic decreased about 17%
- Ratio of near-road to background concentrations decreased (BC), increased (formaldehyde, acetaldehyde), or showed no change (acrolein, 1,3-butadiene, benzene)

# Acknowledgments

- This work was funded by the Nevada Department of Transportation (NDOT)
- John Terry was the NDOT Project Manager
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