



**ENVIRONMENT
NORTHEAST**

Particulate Matter in New Haven:

Local Diesel Sources and Solutions

A Project of Environment Northeast's
New England Diesel Initiative

26 October, 2004

Conclusions

- New Haven is home to significant heavy duty diesel traffic
- Diesel traffic in New Haven generates fine particulate matter (PM_{2.5}) and ultrafine particulate matter pollution which:
 - contributes to elevated levels of air pollution
 - is known to harm human health
- Solutions – cleaner fuels, retrofit emission controls, and reduced idling –
 - are readily available and affordable
 - will significantly cut local diesel particulate matter pollution, and
 - will improve local air quality and human health

Why Here, Why Now, Why Diesel?

- Public health and environmental objectives
 - New Haven is experiencing high levels of fine particulate air pollution and high rates of respiratory illness
 - EPA preliminary designation of “non-attainment” for PM_{2.5}
 - City of New Haven and the State of Connecticut are pursuing climate change goals

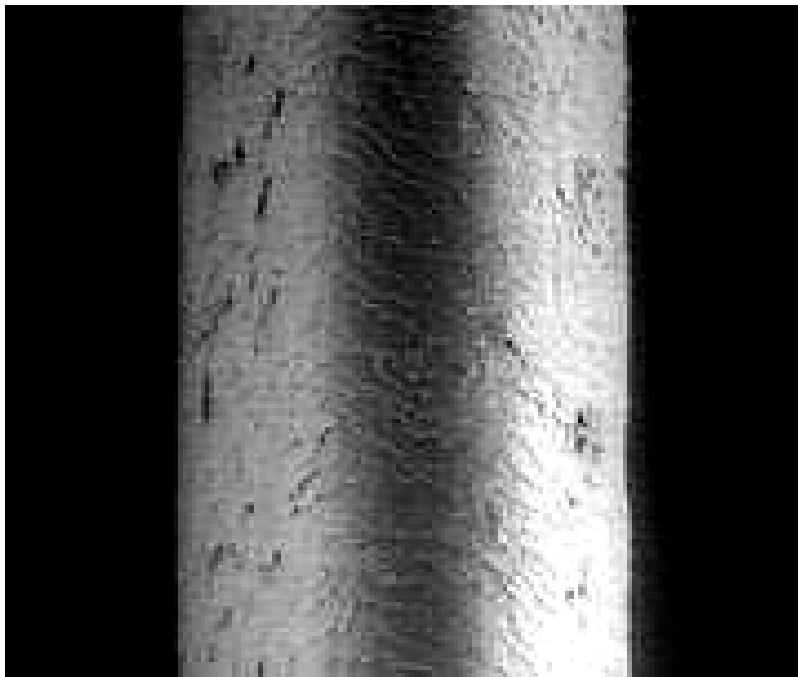
- Diesels emit high levels of fine particulates
 - Linked to respiratory illness
 - Linked to cancer and heart attacks
 - Linked to global warming

- Federal (EPA) rules do **not** adequately reduce pollution from currently “in-use” heavy duty diesel engines, which last decades
 - EPA rules only apply to “new” engine sales
 - New heavy duty diesels sold later the decade will be 90% cleaner than “in-use” diesels

- New fuels and technologies make diesel solutions achievable

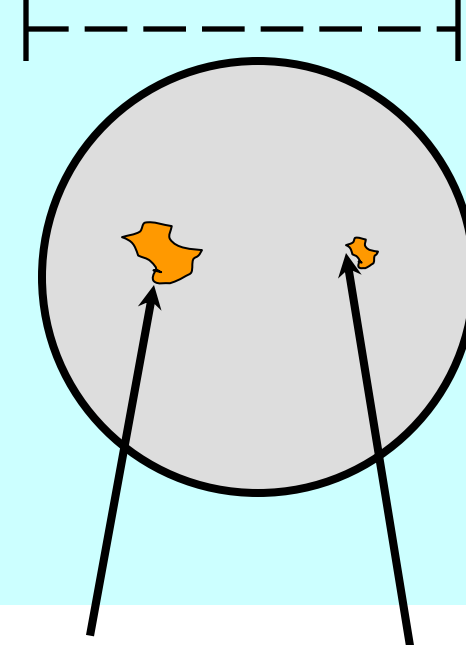
PM_{2.5} = Fine particulate matter

Microscopic particles penetrate deep into lung tissue



Human Hair
(60 μm diameter)

Hair cross section (60 μm)



PM₁₀
(10 μm)

PM_{2.5}
(2.5 μm)

Diesels contribute to local health risk

■ New Haven

- 18% of school aged children have asthma
- Highest asthma hospitalization rate in the state

■ Connecticut

- 202,000 adults and 75,000 children with asthma
- Elevated levels of PM_{2.5} along highway corridors

PM2.5 air pollution is linked to:

- **Premature death from heart and lung disease**
- **Aggravation of heart and lung diseases**
 - Hospital admissions
 - Doctor and ER visits
 - Medication use
 - School and work absences
- **And possibly to**
 - Lung cancer deaths
 - Infant mortality
 - Developmental problems, such as low birth weight in children



Source: US EPA

Diesel PM contributes to local haze

Hartford

Oct. 8, 2002
4 p.m. EDT



Hourly
conc. of
fine
particles –
4 $\mu\text{g}/\text{m}^3$

Hartford

Oct. 2, 2002
4 p.m. EDT

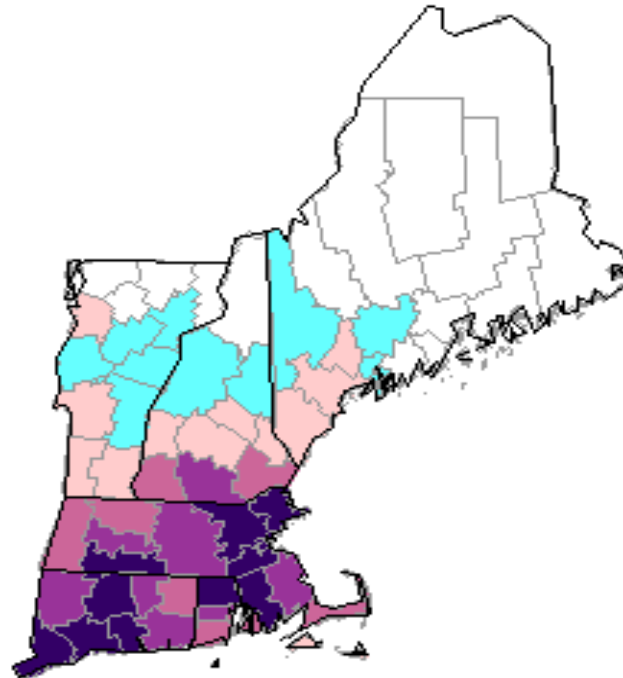


Hourly
conc. of
fine
particles –
24 $\mu\text{g}/\text{m}^3$

Source: CT DEP

CT among highest exposures to Diesel PM

1996 Estimated County Median Ambient Concentrations
 Diesel Particulate Matter – EPA Region 1 Counties



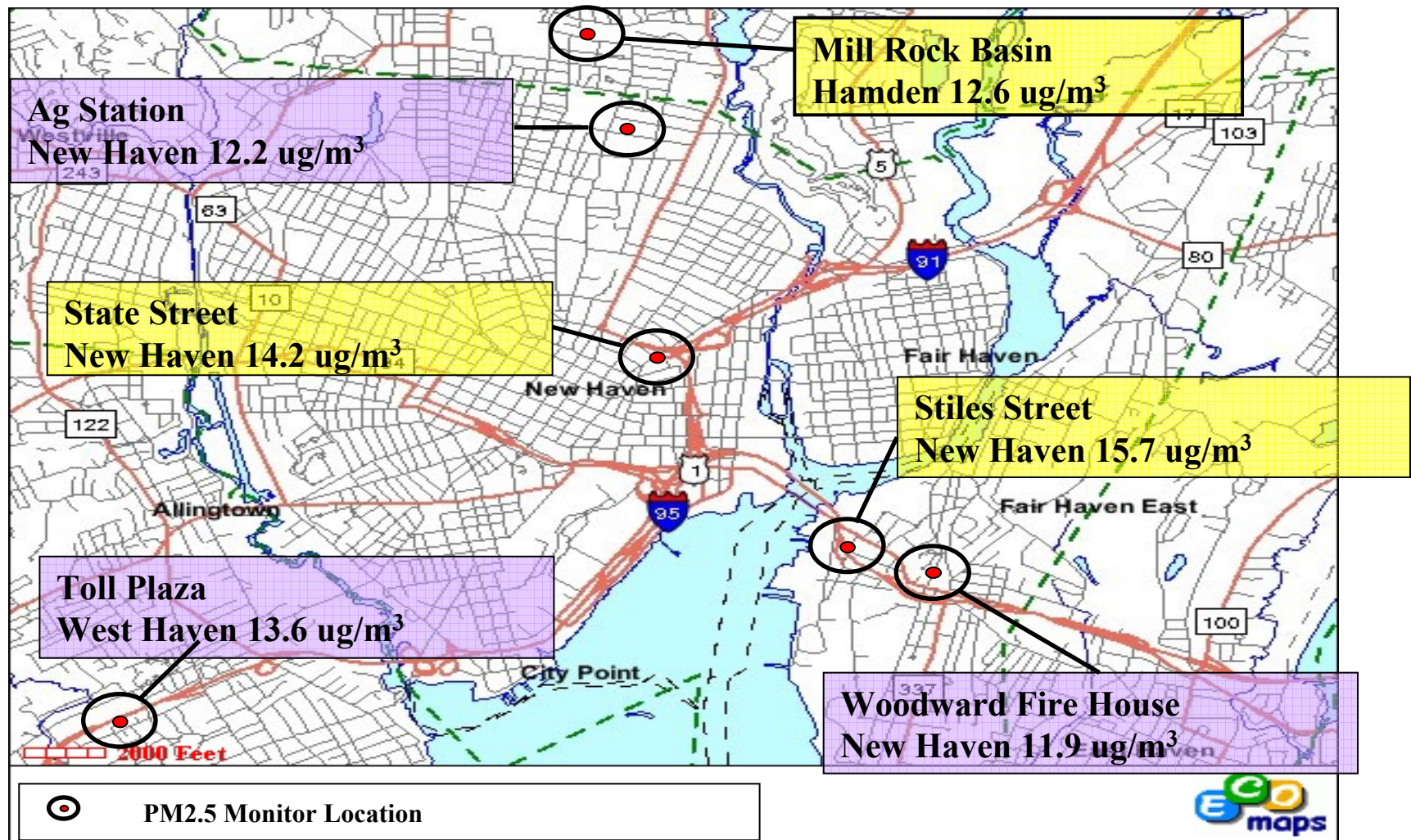
Distribution of U.S. Ambient Concentrations

Highest In U.S.	15
95	1.90
90	1.47
75	0.98
50	0.64
25	0.38
Lowest In U.S.	0.014

County Median Ambient Pollutant Concentration
 (micrograms / cubic meter)

Source: U.S. EPA / QAQPS
 NATA National-Scale Air Toxics Assessment

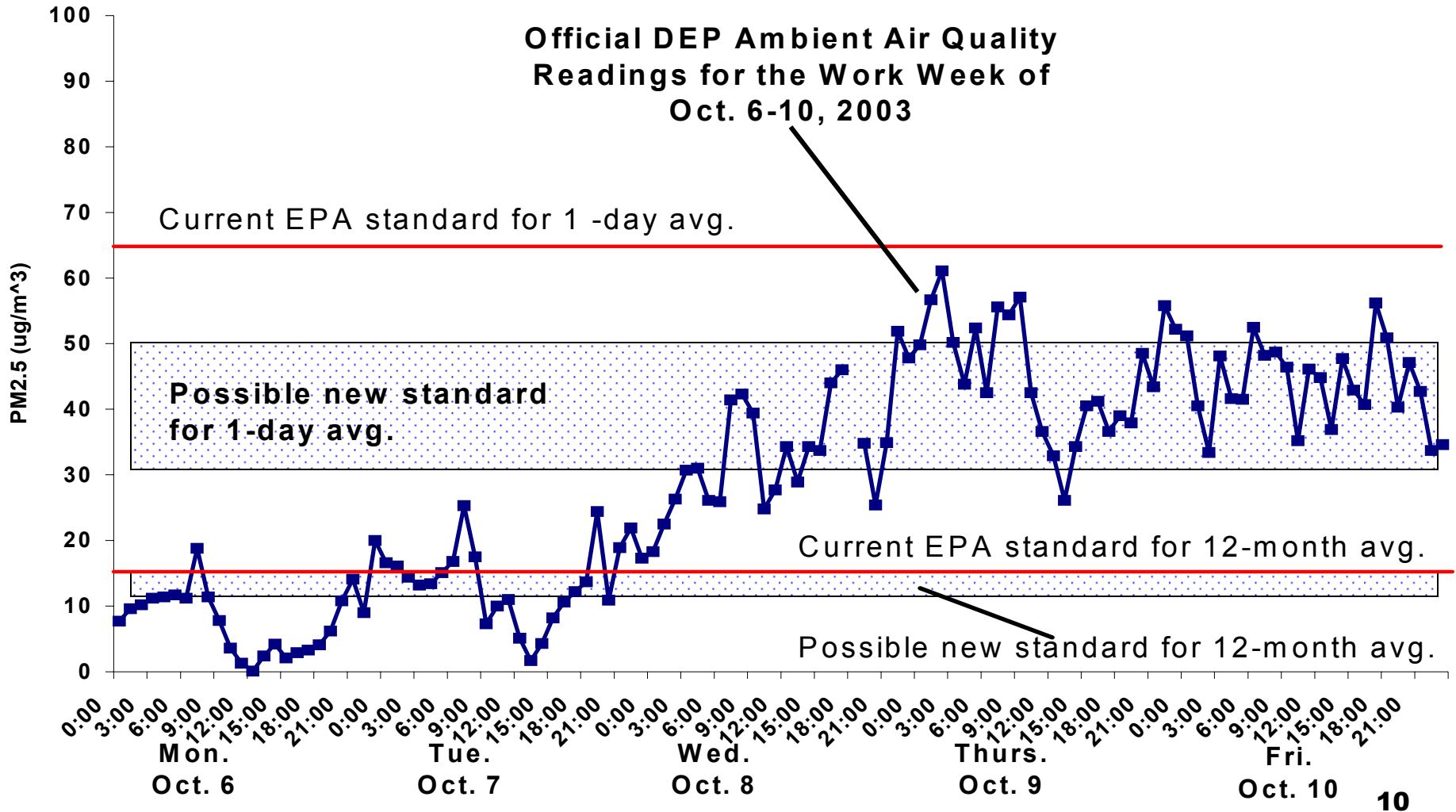
New Haven Area PM_{2.5}



Apr-Sept 2003 avg. from DEP air quality monitors located in New Haven. The annual federal standard is 15 ug (micrograms). EPA may lower standard in future. Map Source: CT DEP.

PM2.5 levels in New Haven

A Bad Week in 2003 (State St. Monitor)



Repercussions

of air pollution problem in CT

- EPA preliminary designation of “non-attainment” for PM_{2.5} in New Haven and Fairfield Counties
 - Final determination in November '04

- EPA designated all of CT in “non-attainment” for ozone

- American Lung Association report card
 - CT received an “F” for air quality

Citizen Monitoring Project

May 4-6, 2004

October 26, 2003

Monitoring Local Sources

Environment Northeast is implementing a project to identify and report local sources of particulate pollution in New Haven while involving local constituencies.

- Raise awareness about the problem and solution
- Build local constituencies
- Identify priority local opportunities to cut pollution
 - study target areas of town
 - study different vehicle types
- Report findings to City's Clean Air Initiative - Diesel Reduction Strategy, and state policymakers

Gathering Data

Volunteers helped experts monitor particulate matter (PM) levels in the air near where diesel vehicles operate

- Volunteers from:
 - New Haven Environmental Justice Network
 - Common Ground High School
 - Conn. Fund for the Environment
 - Archdiocese of Hartford Office of Urban Affairs
 - Cold Spring School 4th and 5th Graders
 - Sierra Club
- Technical Experts
 - Clean Air Task Force
 - Environment and Human Health, Inc.
- Project Organizer
 - Environment Northeast
- Dates
 - October 26, 2003
 - May 4, 5, and 6, 2004



Findings: Graphs and Images

PM2.5 and Ultrafine Particle Measurements, May 4-6, 2004

Inquiry 1 – Construction

Inquiry 2 – Other Industrial Diesels

Inquiry 3 – Public Transportation

Inquiry 4 – School Buses

Summary Findings

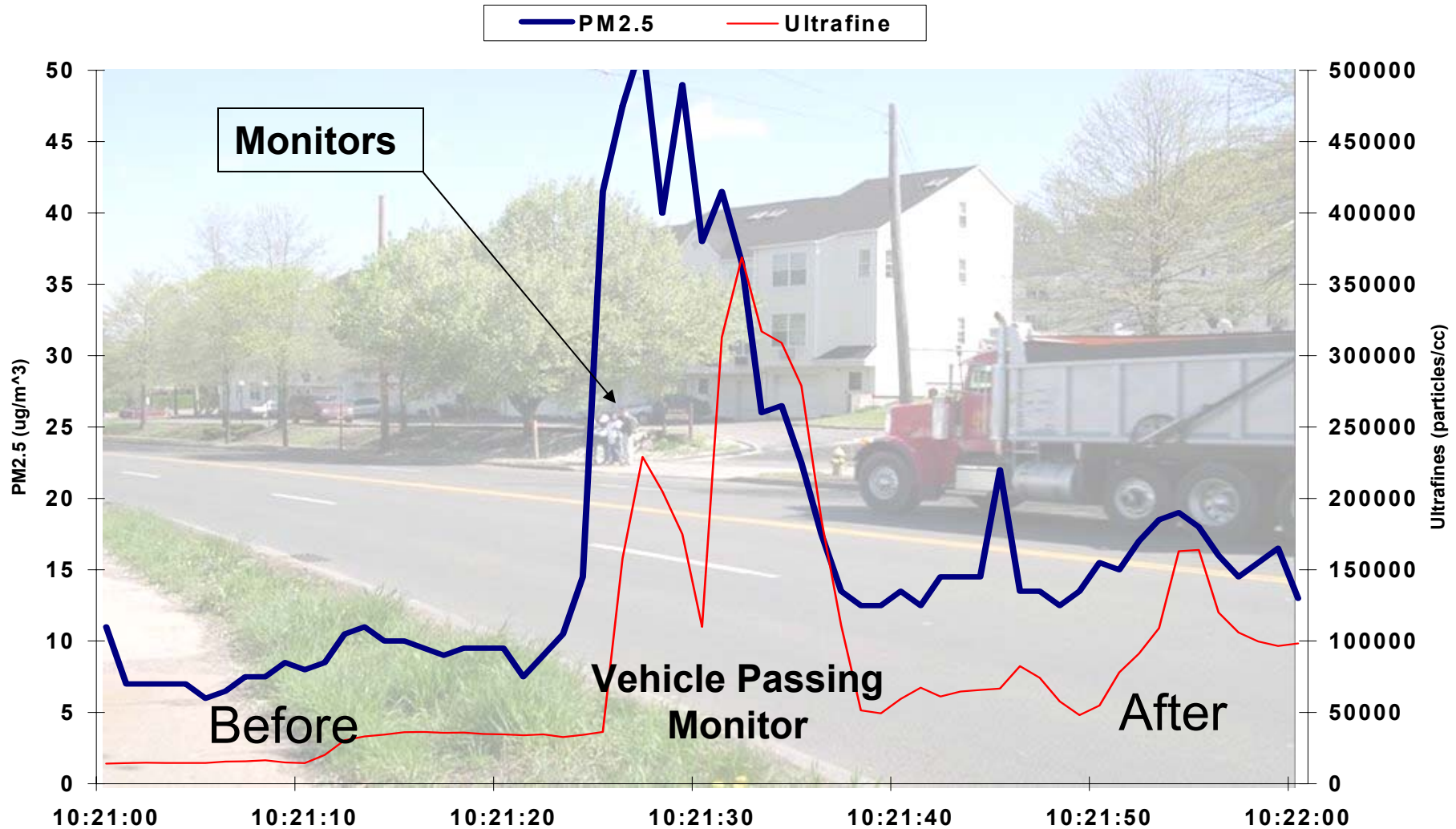
- **Construction and Other Industrial Diesels**
 - The concentration of construction work and local industrial diesel traffic in New Haven contributes to high PM2.5 levels in residential neighborhoods
 - Super-emitting diesels cause very high PM2.5 readings, and are avoiding detection/enforcement
- **Public Transportation**
 - Diesel trains idling at Union Station are causing high PM2.5 levels near apartments across the street
 - Older CT Transit and other buses cause high curbside PM2.5 readings
- **School Buses**
 - Cause high curbside PM2.5 readings at morning drop-off and afternoon-pickup, but problem should be addressed with planned retrofits
- For more info, see “Detailed Findings,” below.

Inquiry 1 -- Construction

- Non-Road Equipment
- Dump Trucks

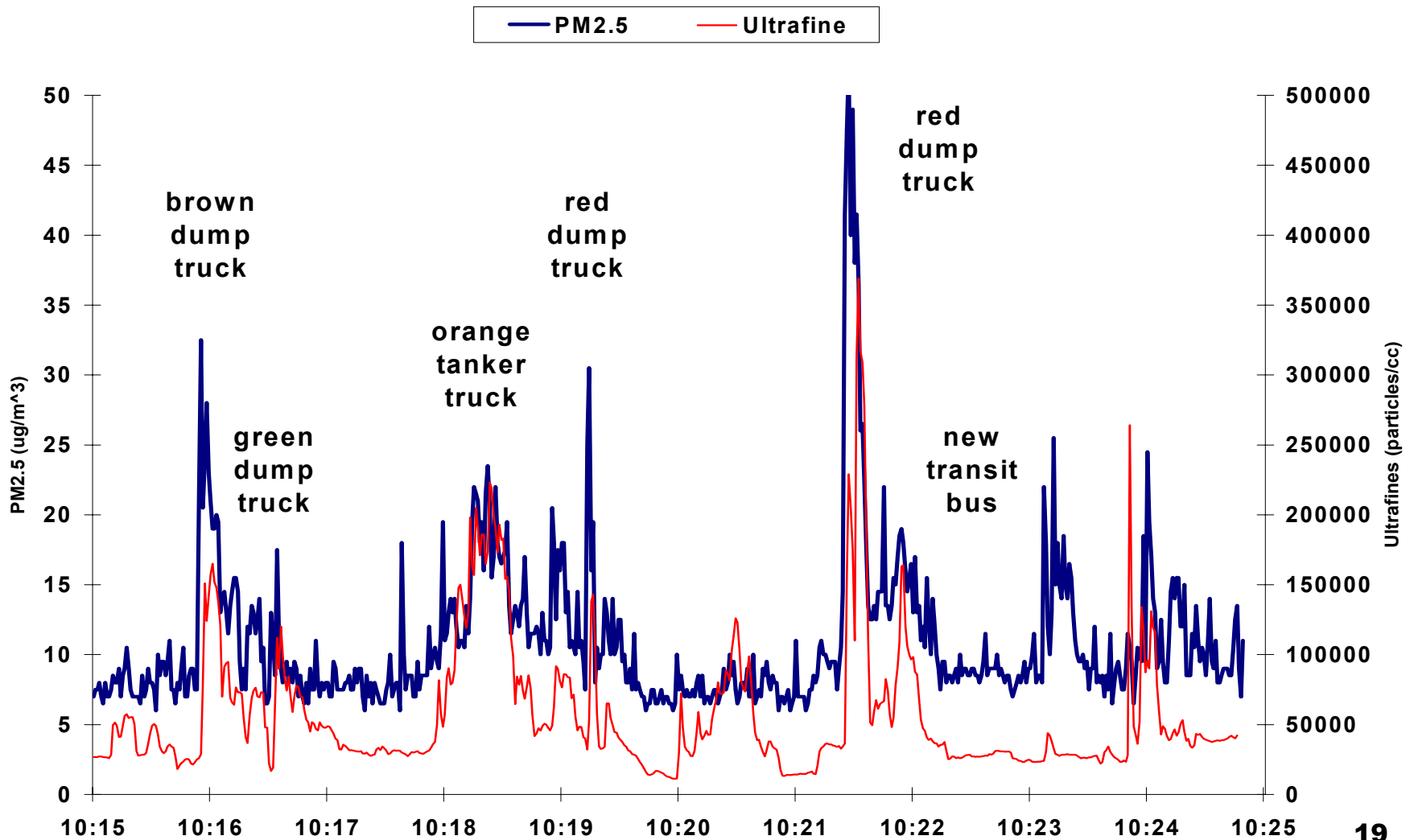
Profile: Dump Truck

Forbes Commons Apartments



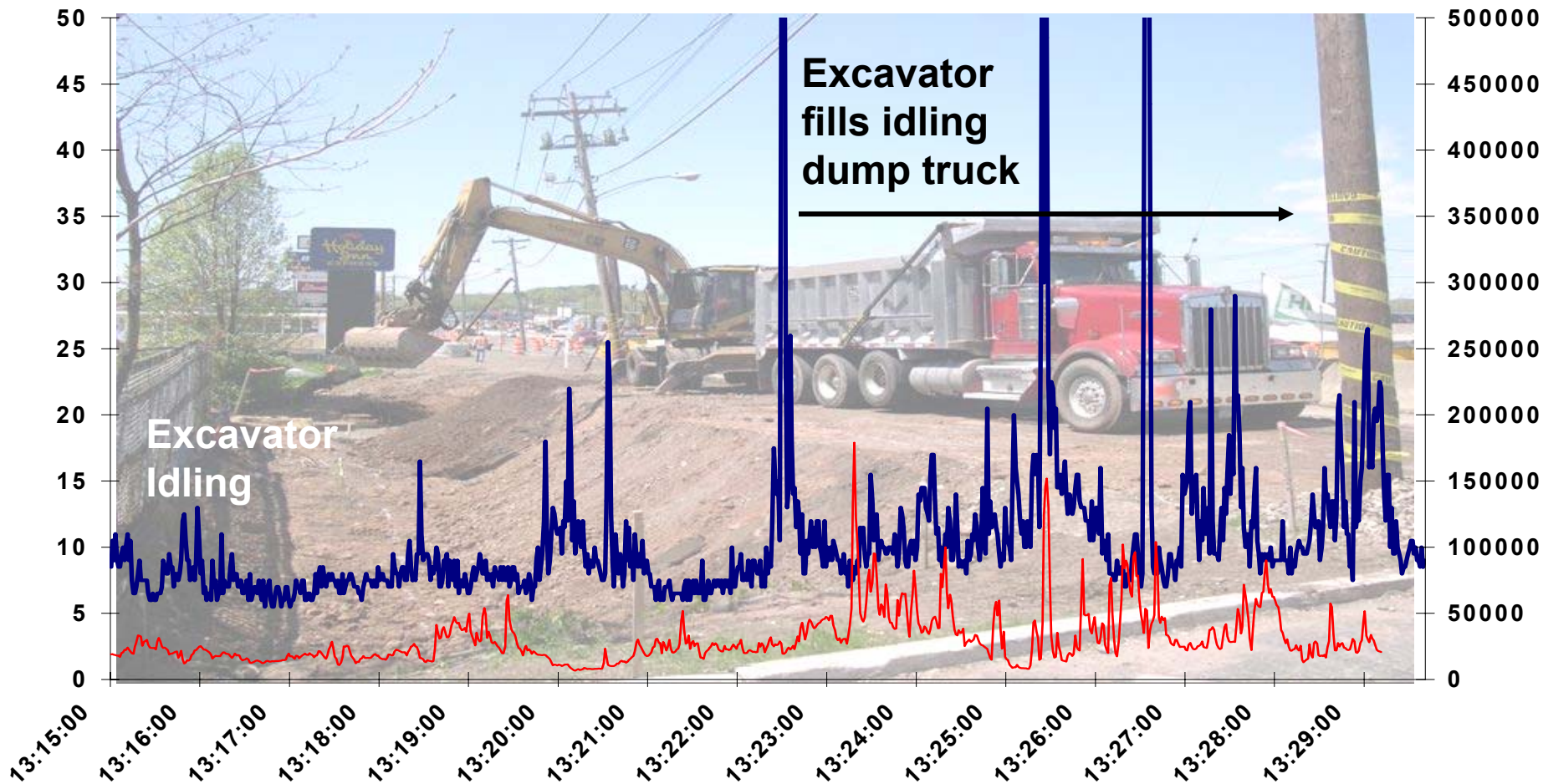
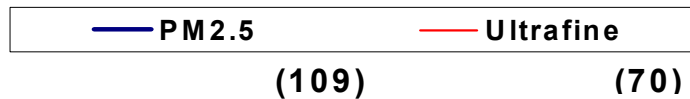
Episode: Construction Traffic

Forbes Commons Apartments



Episode: Construction

Frontage Ave, Q Bridge Work



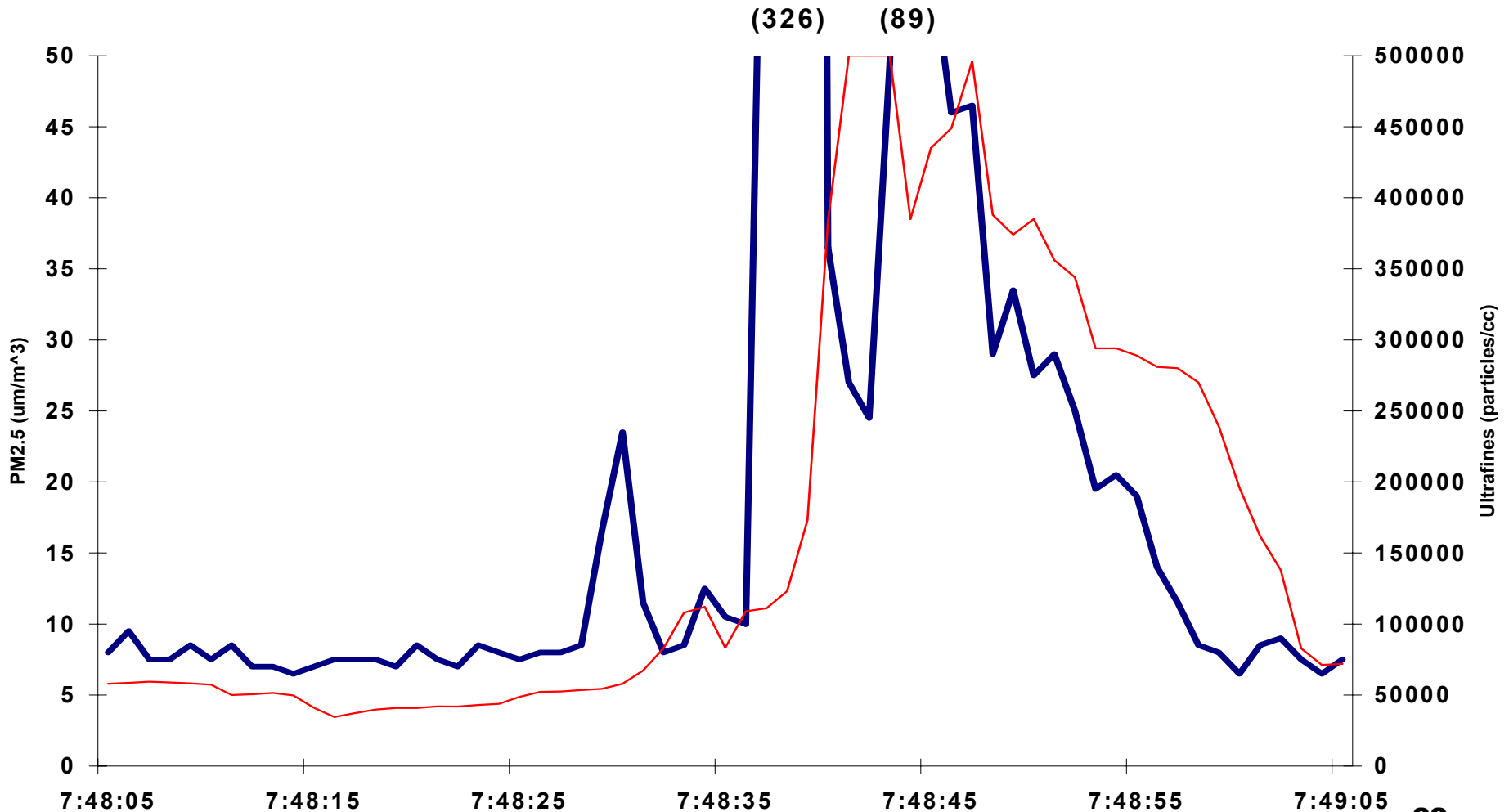
Inquiry 2 -- Other Industrial Diesels

- Solid Waste Haulers
- Fuel Tankers
- Cement Mixers

Solid Waste Hauler

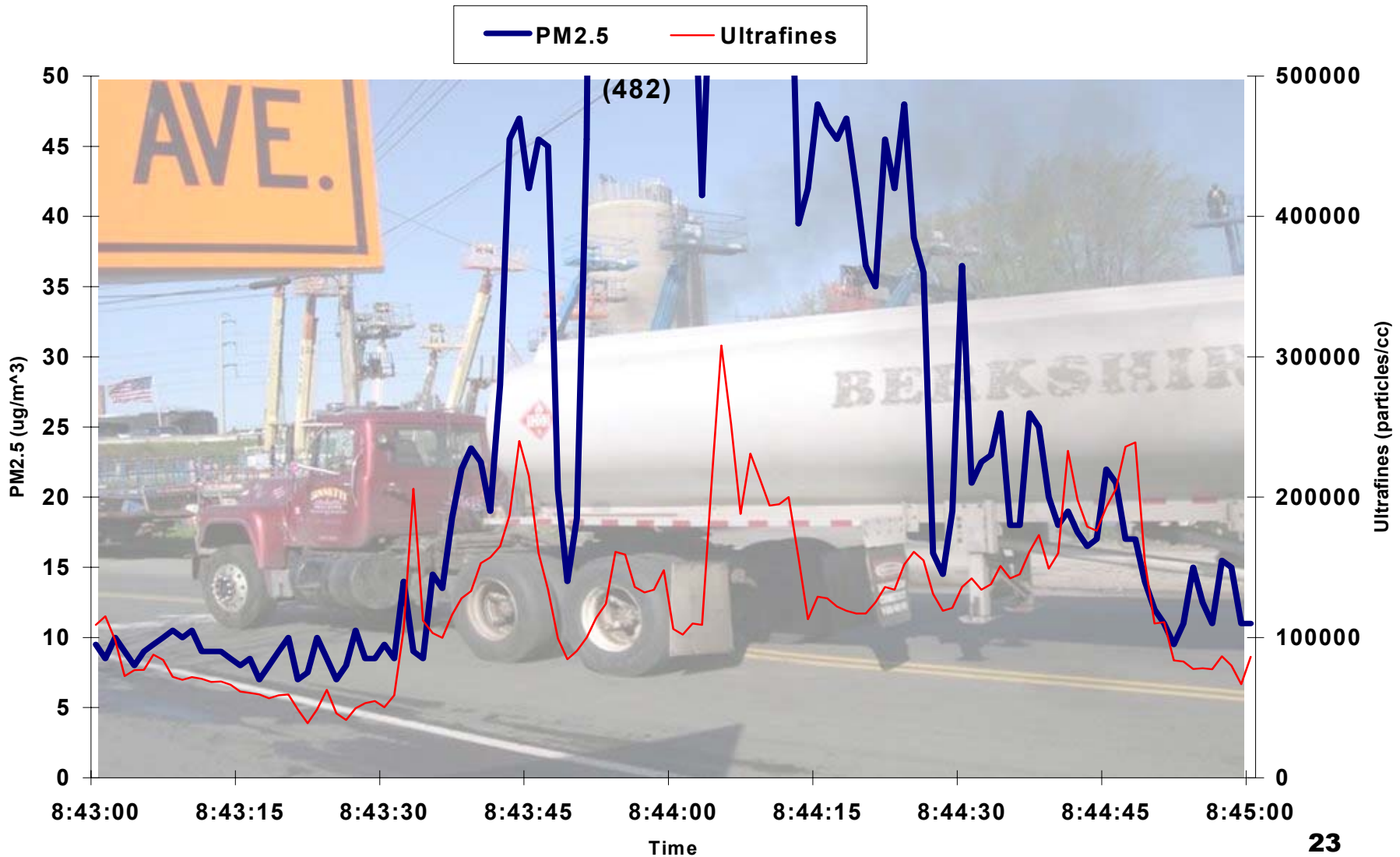
Intersection of Forbes Ave. and Stiles St.

— PM2.5 — Ultrafines



Fuel Tanker

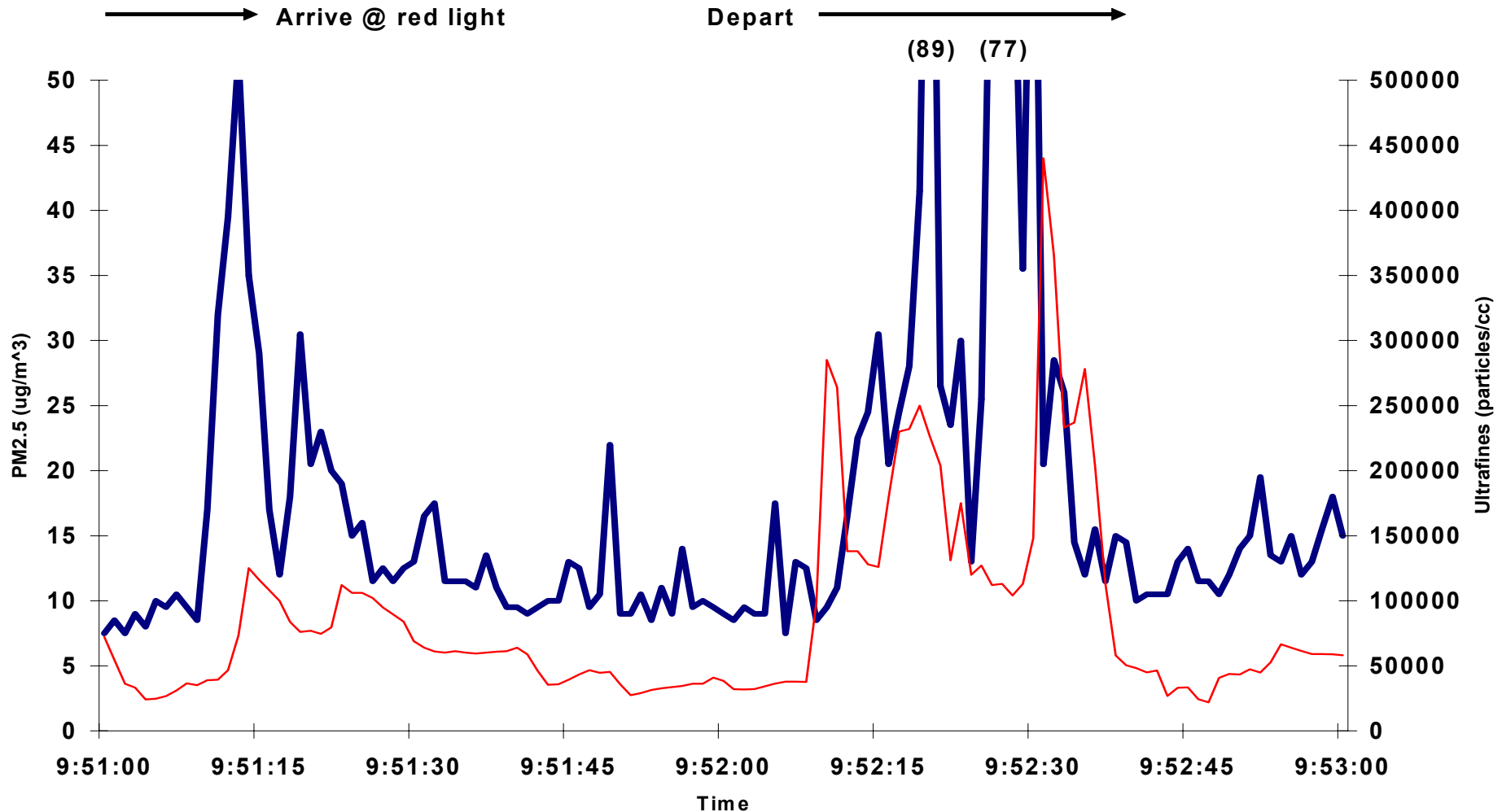
Stiles St. On-ramp



Profile: Cement Mixer

Intersection of Forbes Ave and Stiles St.

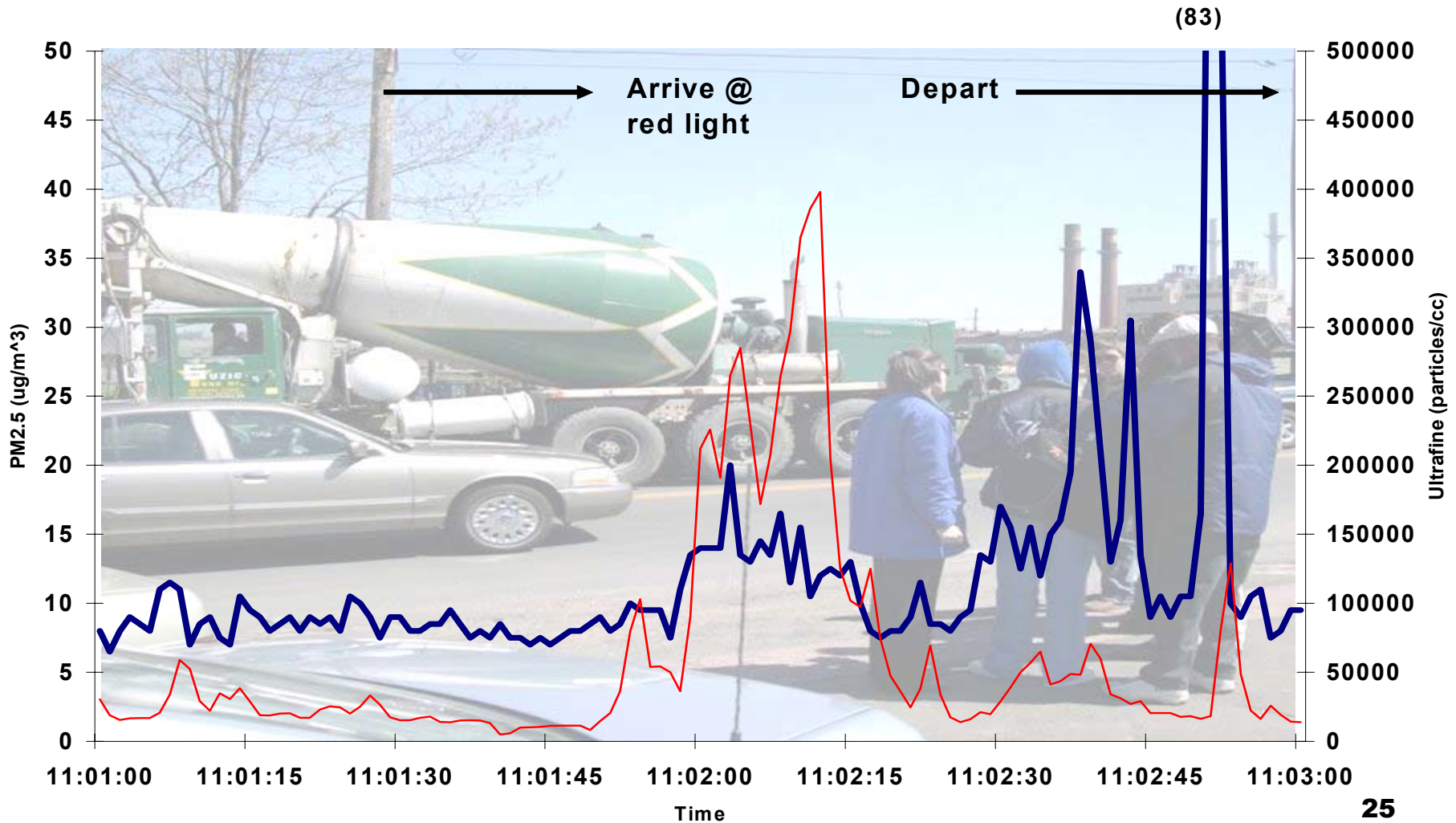
— PM2.5 — Ultrafines



Profile: Cement Mixer (2)

Corner of East St. and Chapel St.

— PM2.5 — Ultrafine



Episode: Industrial Trucks

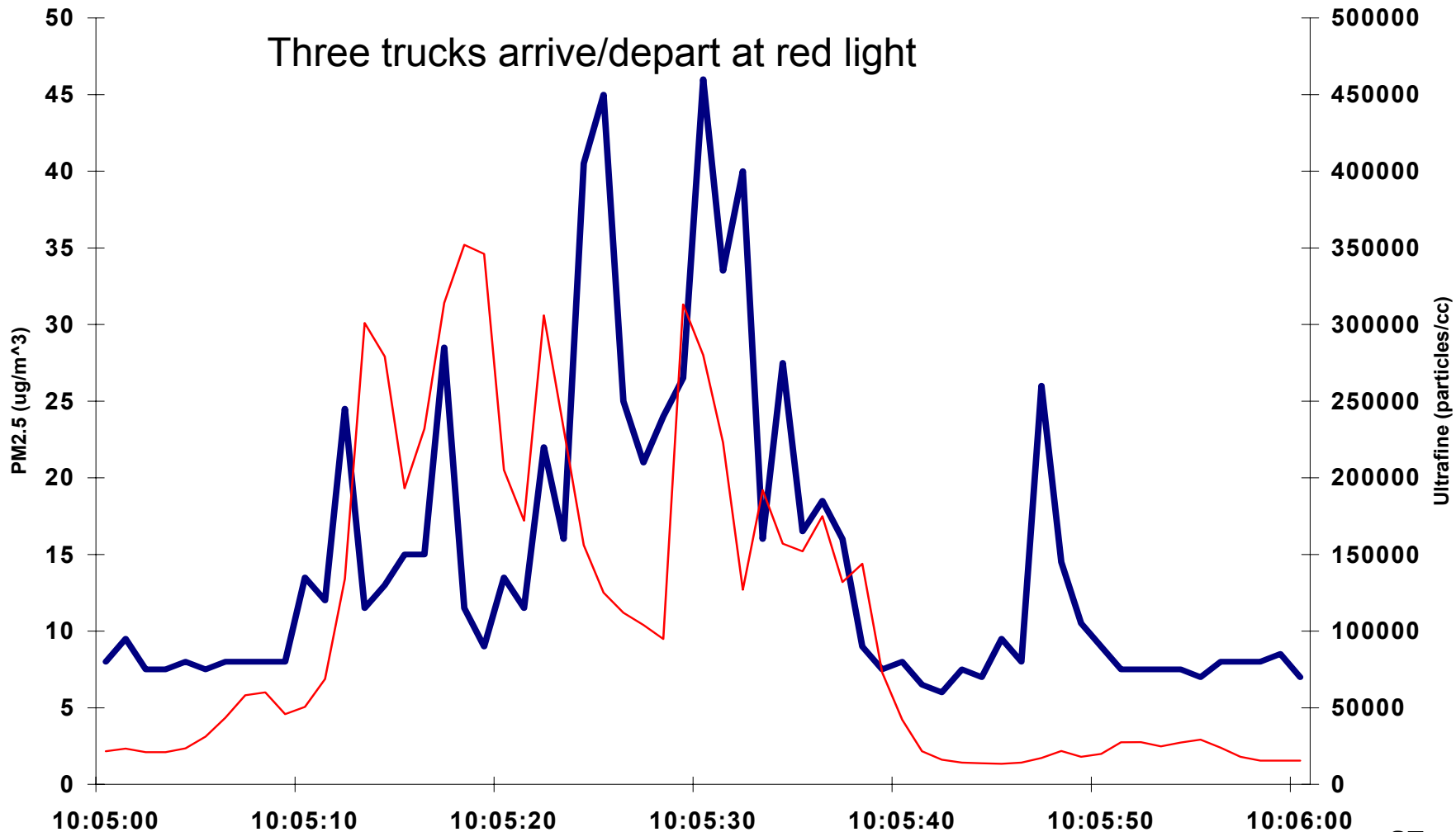
Woodward School on Forbes Ave.



Episode: Three Trucks

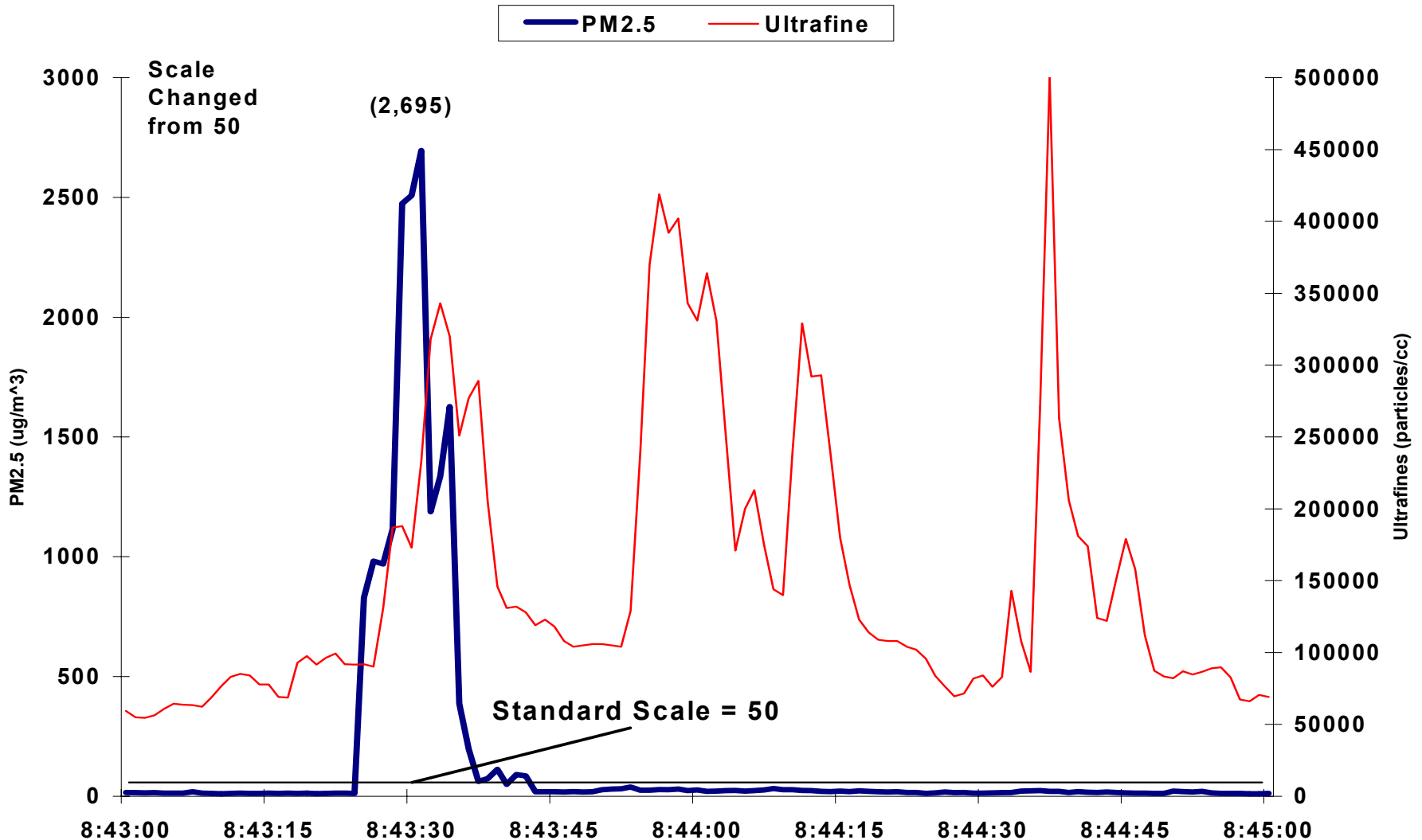
Woodward School on Forbes Ave.

— PM2.5 — Ultras



Episode: Waste Hauler + Delivery Truck

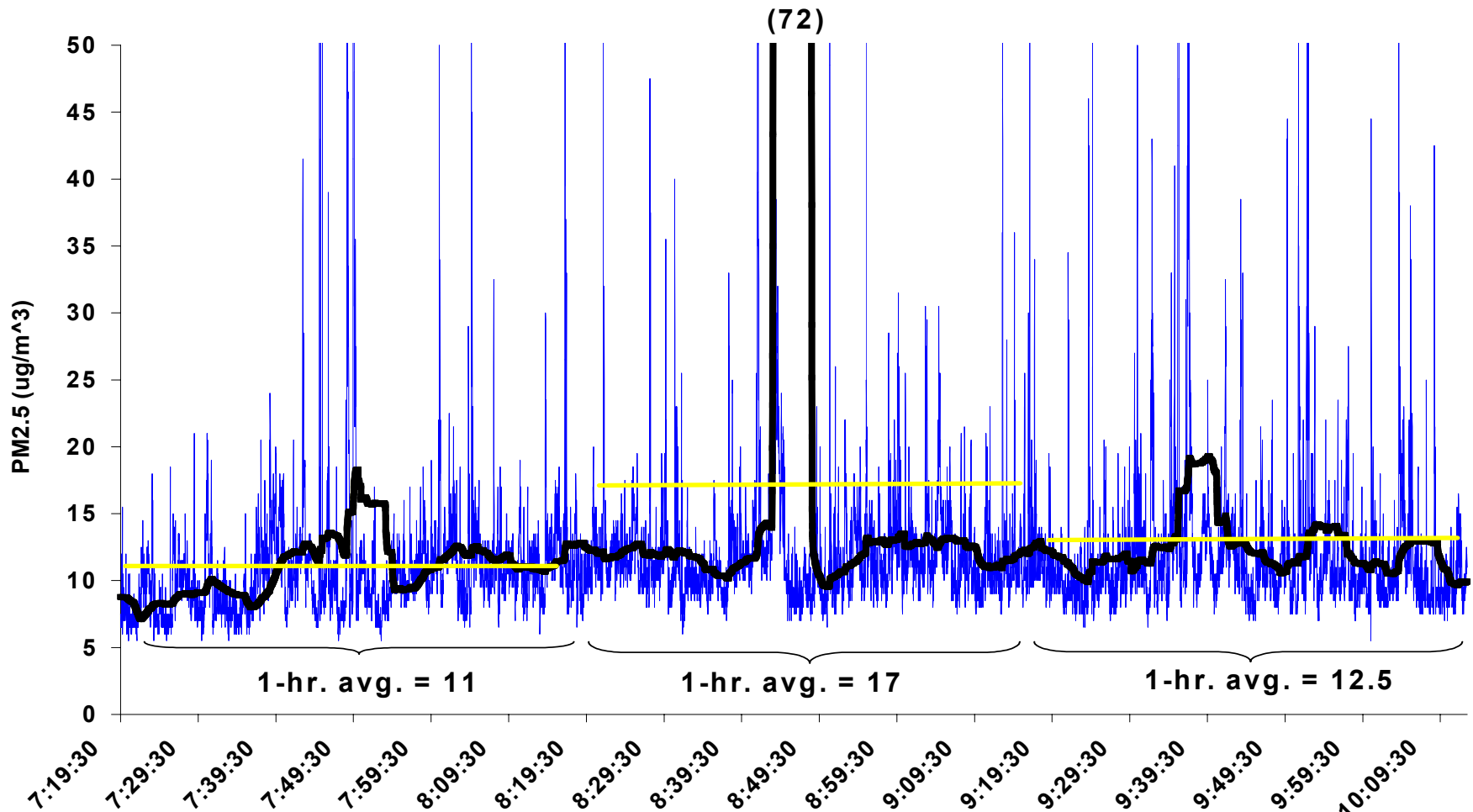
Arrive/depart intersection of Forbes Ave. and Stiles St.



Cumulative Effect - PM2.5

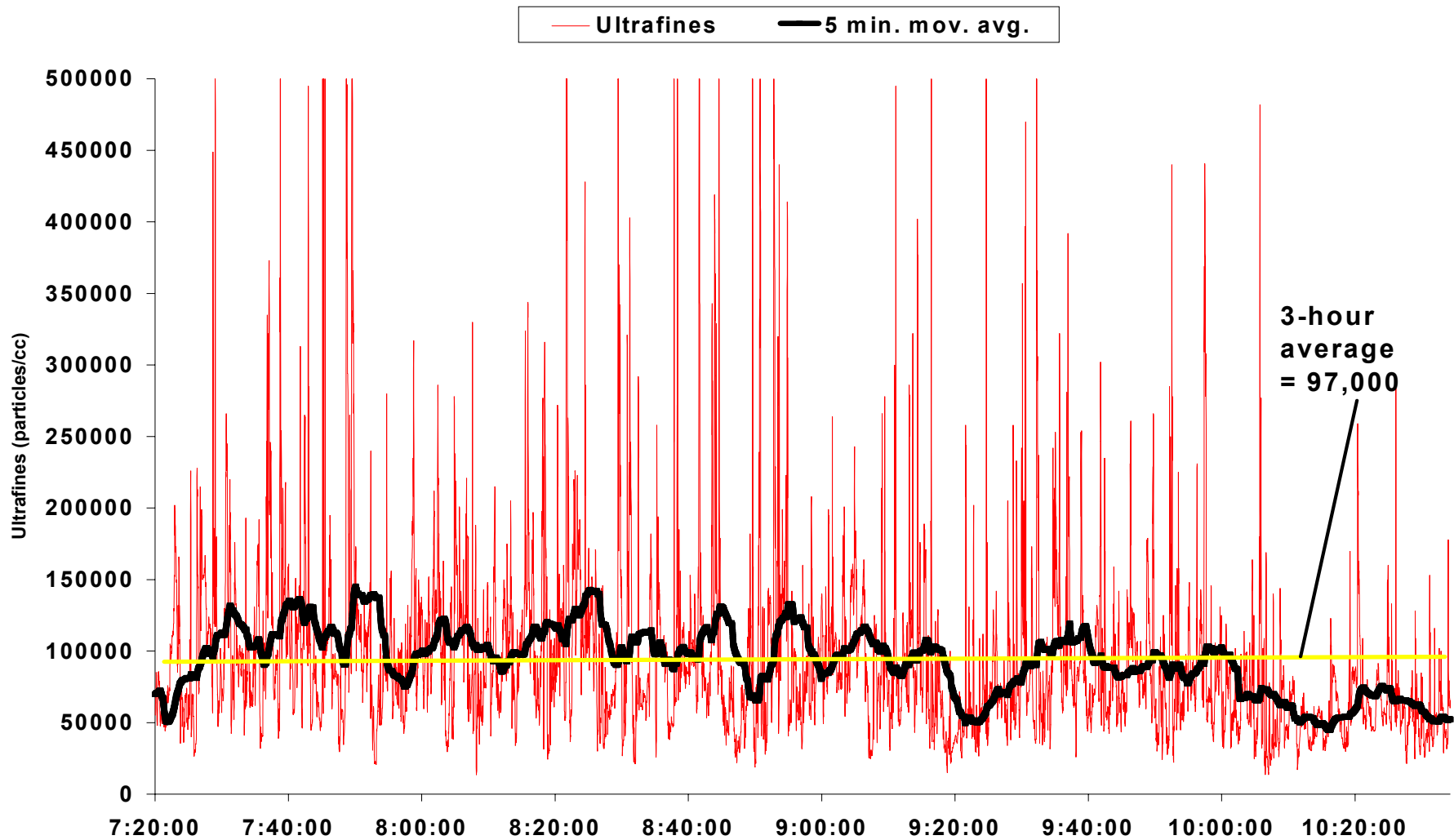
Intersection of Forbes Ave. and Stiles St.

— PM2.5 — 5 min. mov. avg.



Cumulative Effect - Ultrafines

Intersection of Forbes Ave. and Stiles St.



Industrial Traffic @ Forbes Commons Apts.



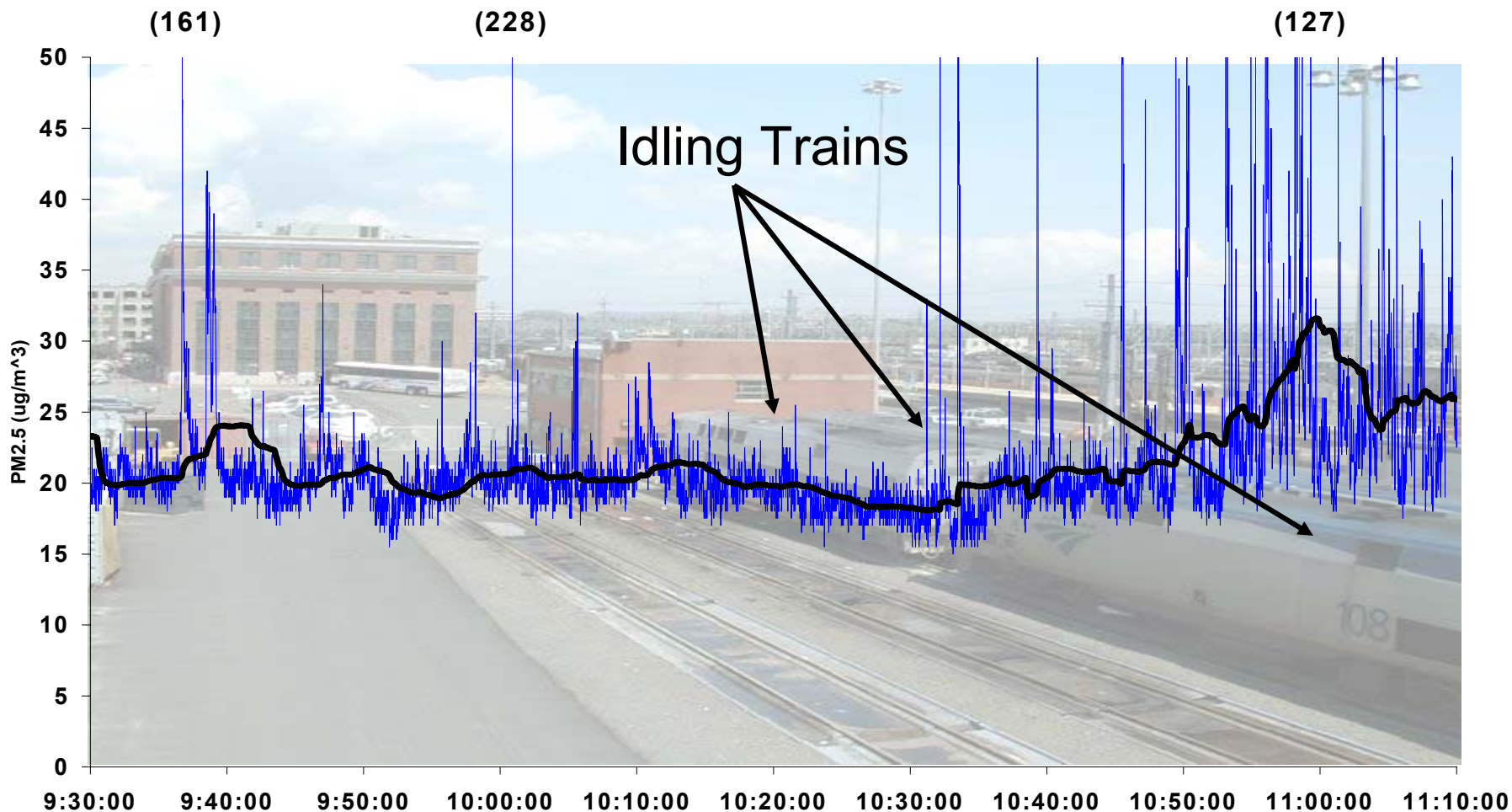
Inquiry 3 -- Public Transportation

- Trains
- Transit Buses

Cumulative Effect -- PM2.5

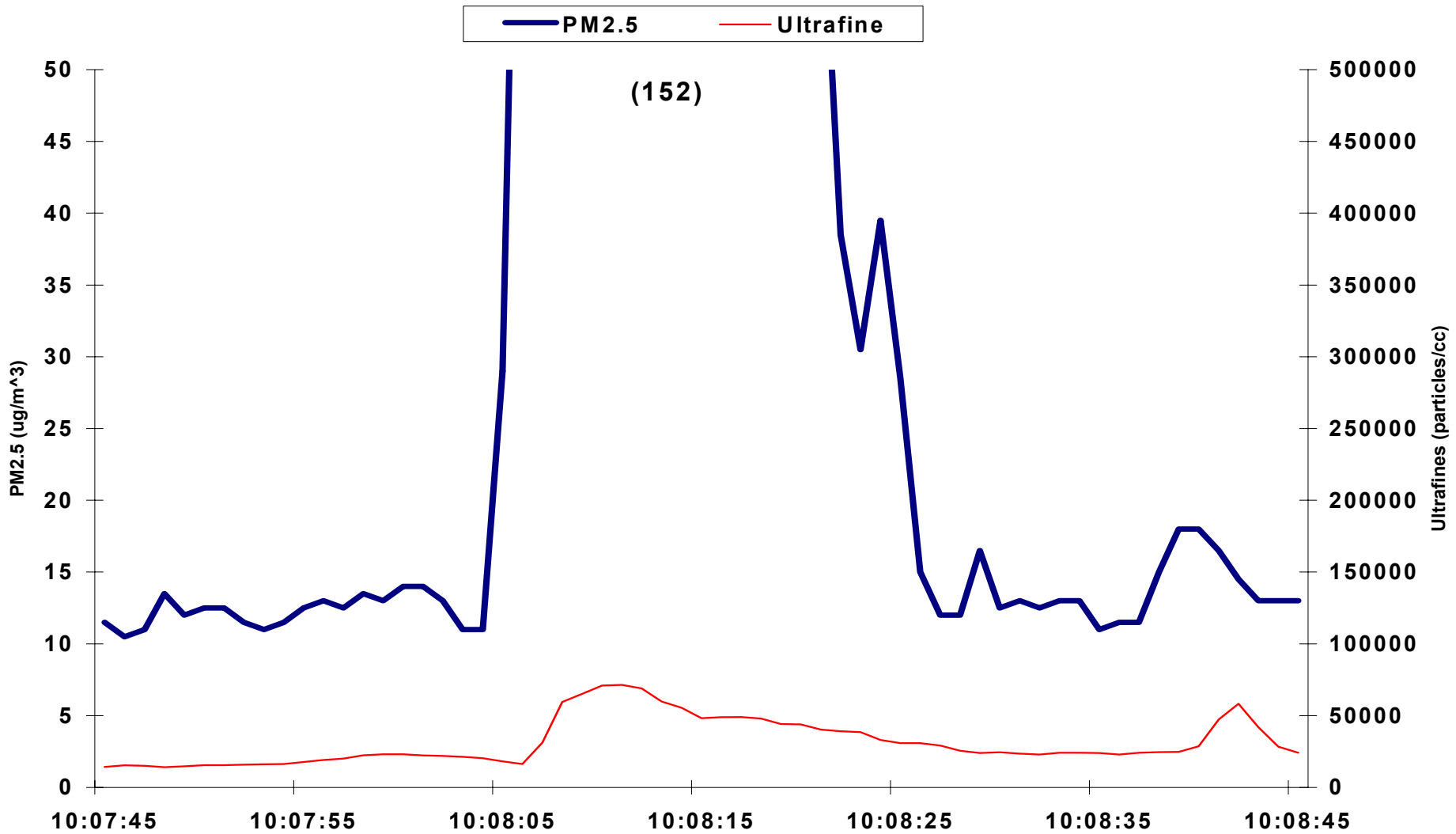
Passenger Trains @ Union Station

— PM2.5 — 5 min. mov. avg.



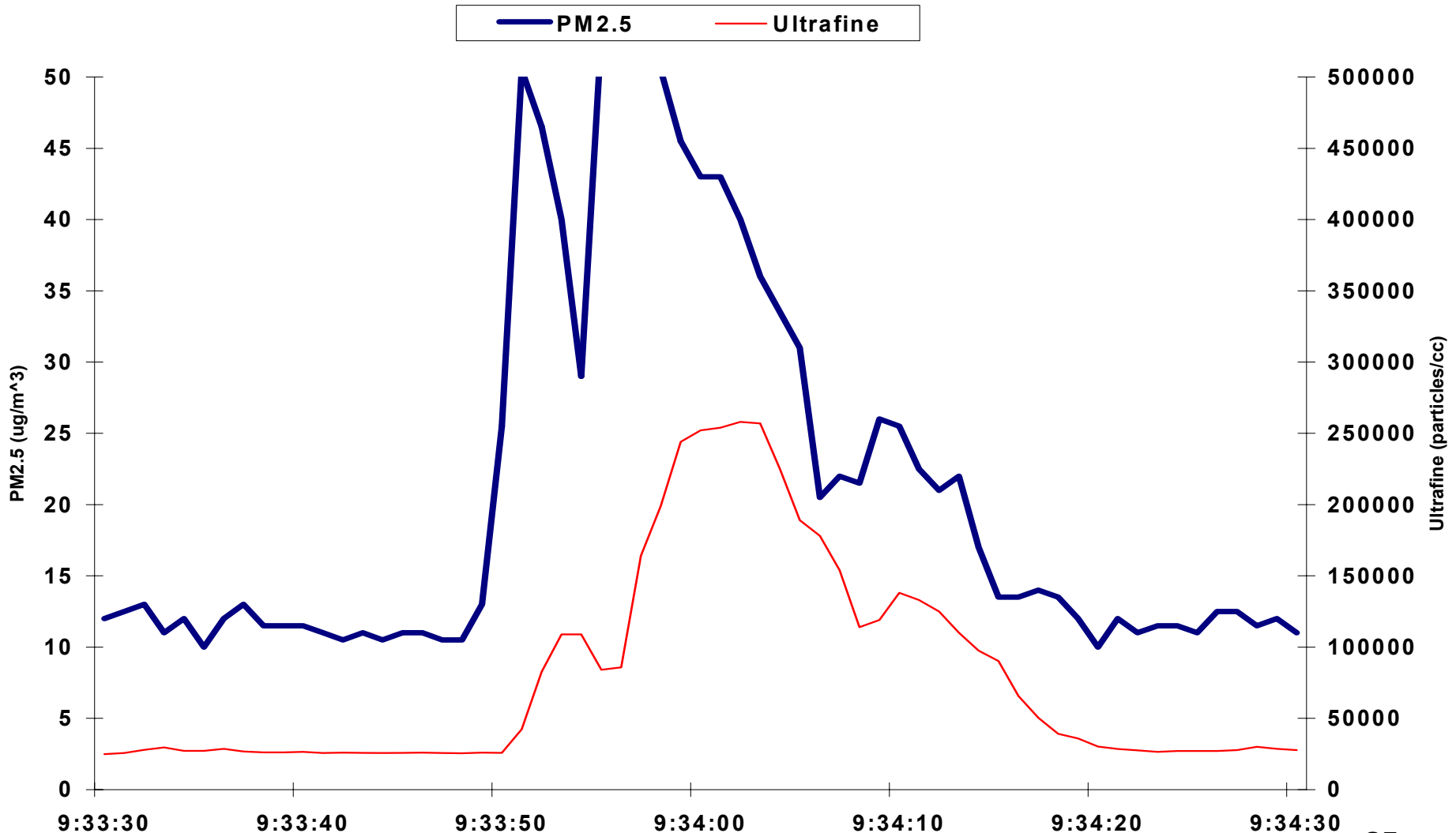
Profile: Older CT Transit Bus

Bus Stop on The Green



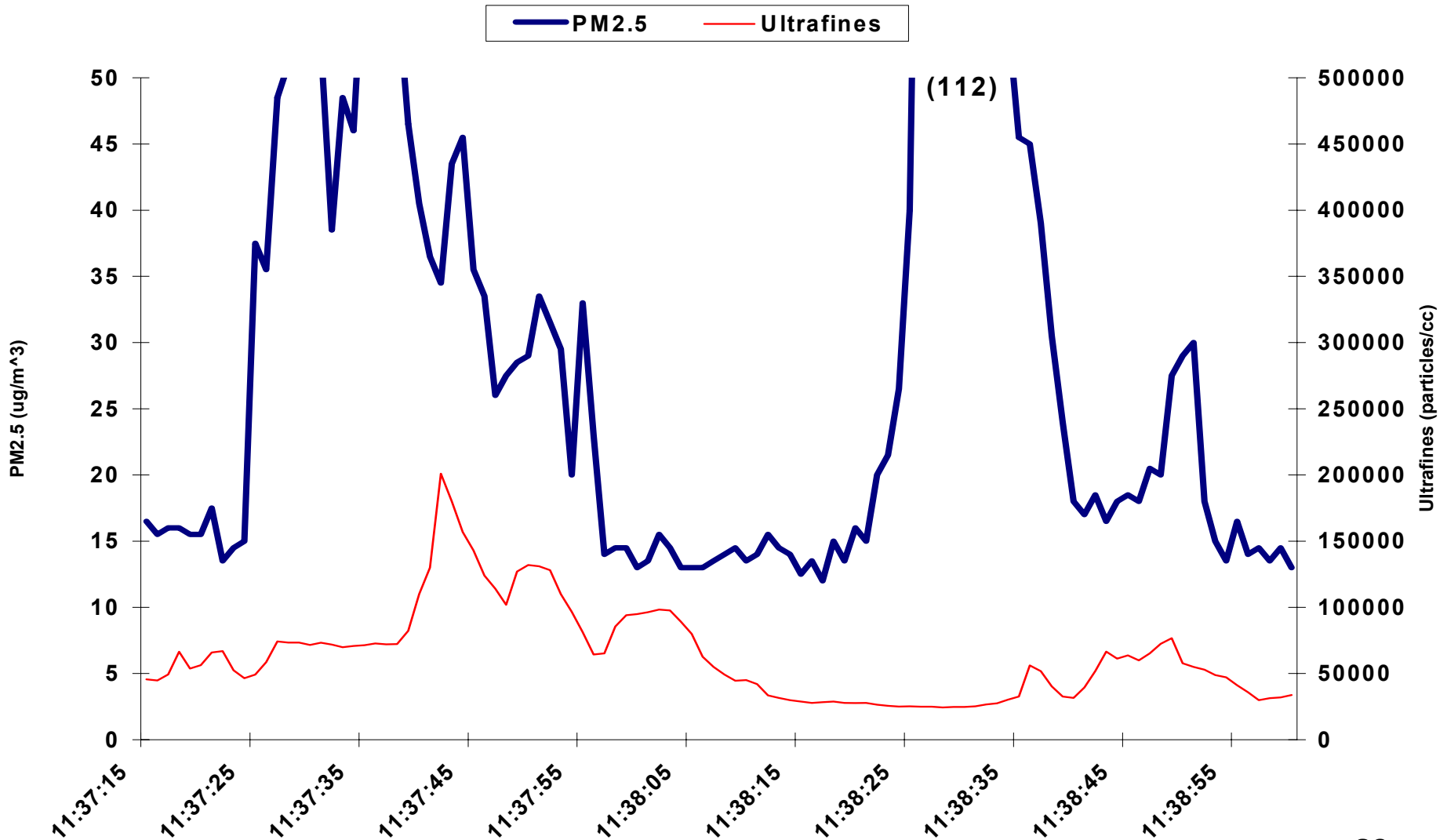
Profile: Transit Bus (#471)

Bus Stop on The Green



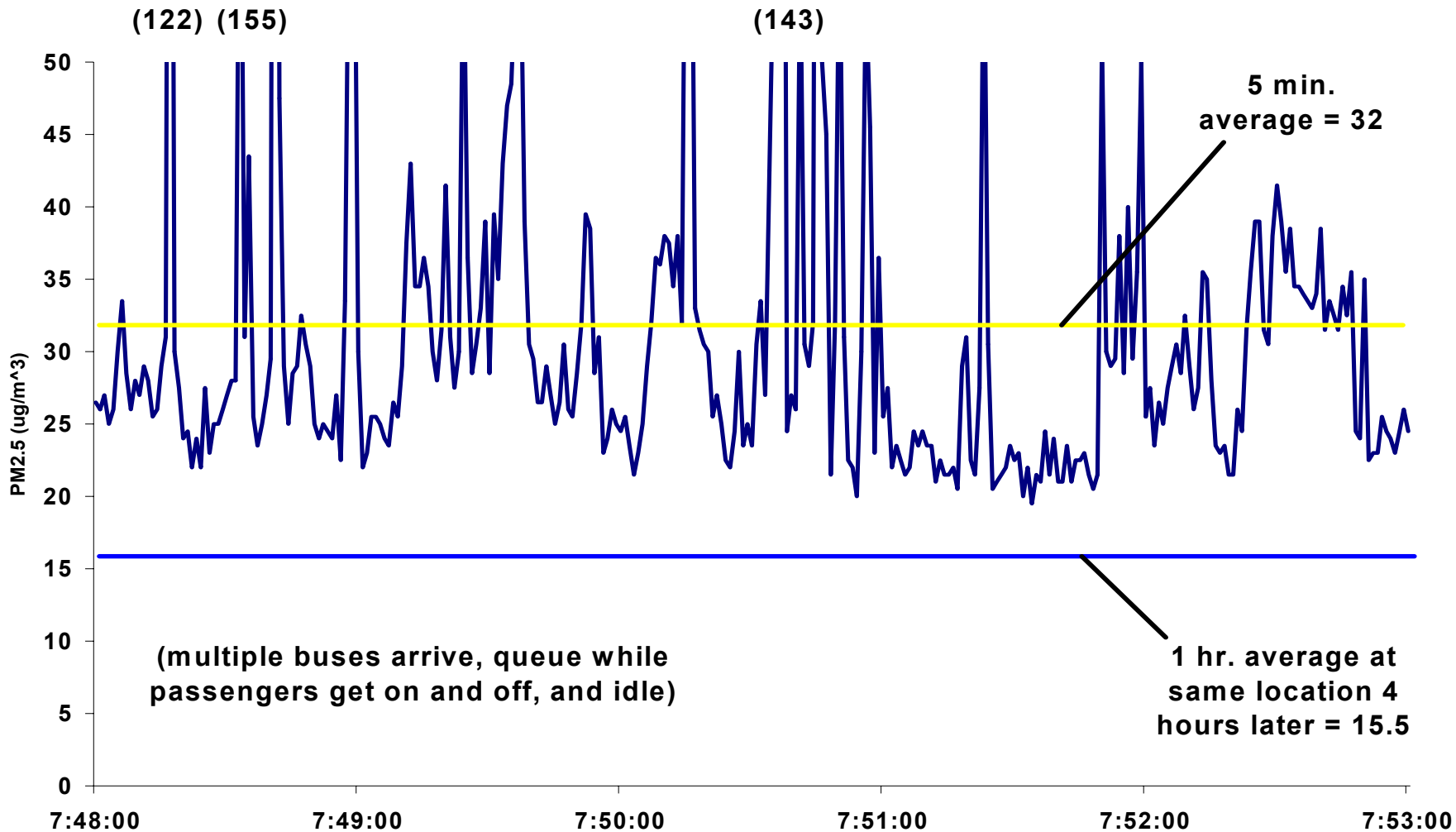
Profile: New Haven Bus Service

Chapel Street, Downtown



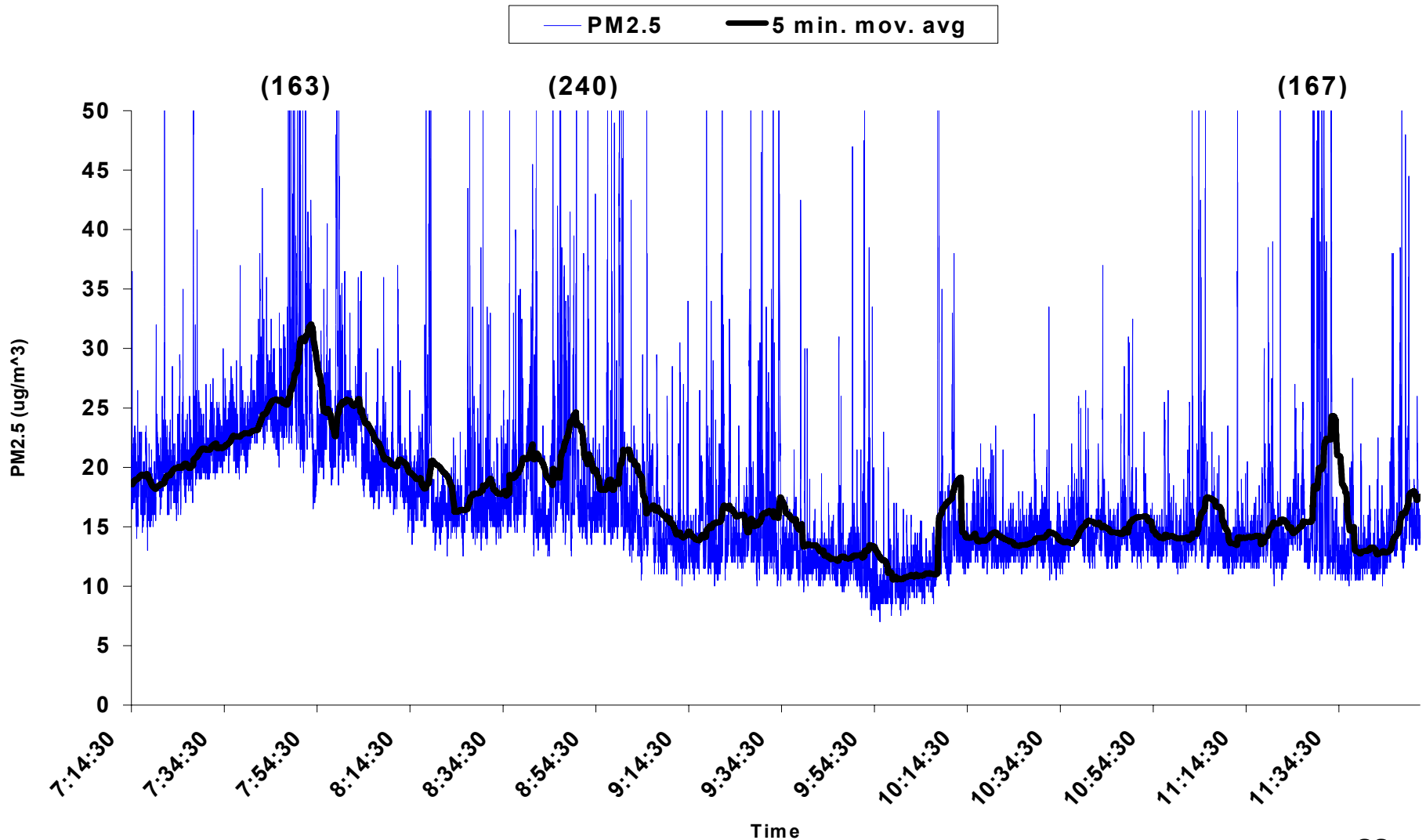
Episode: Transit Bus Queue

Temple St. Bus Stop on The Green



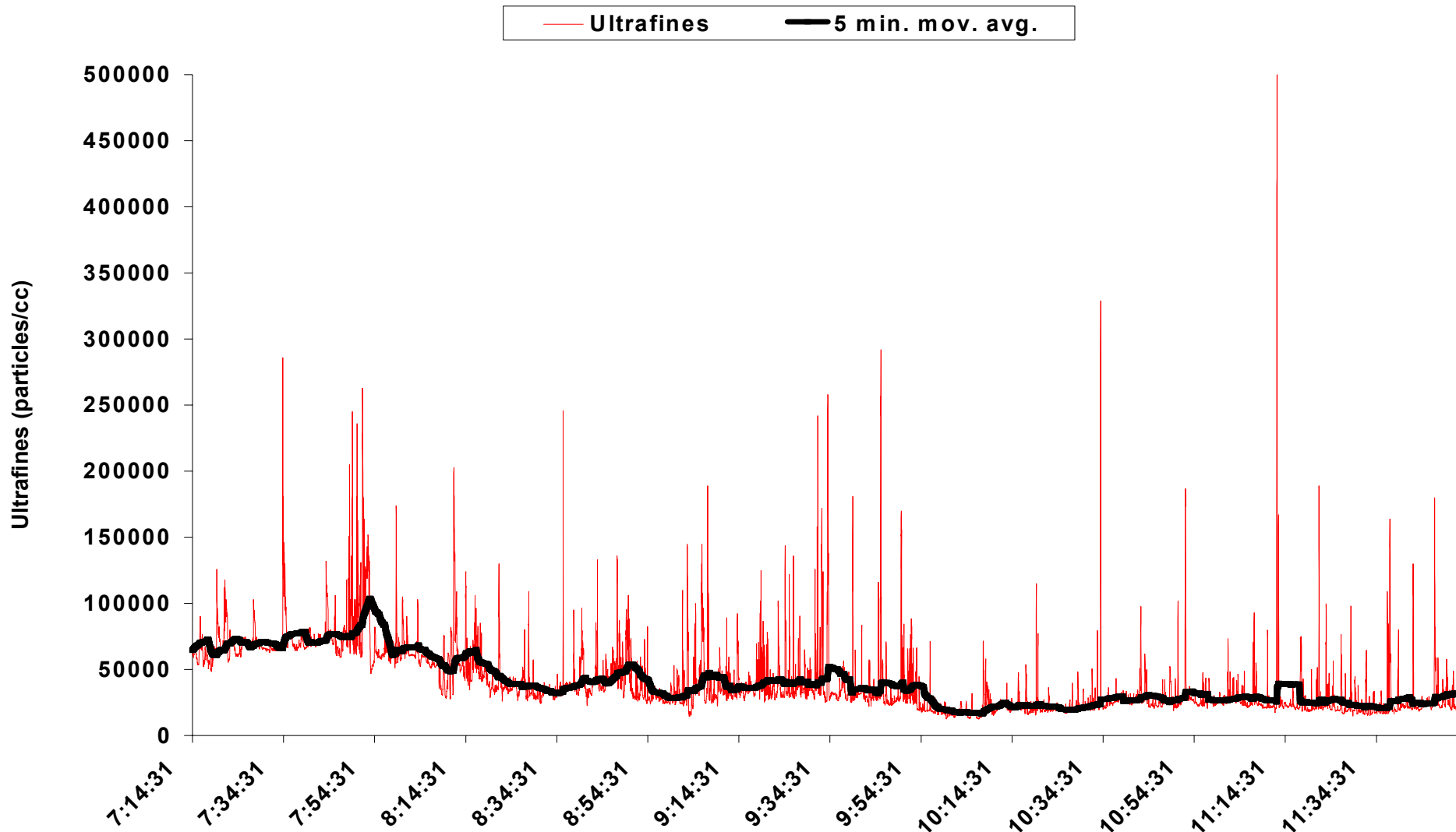
Cumulative Effect – PM2.5

Rush Hour @ Bus Stop on The Green



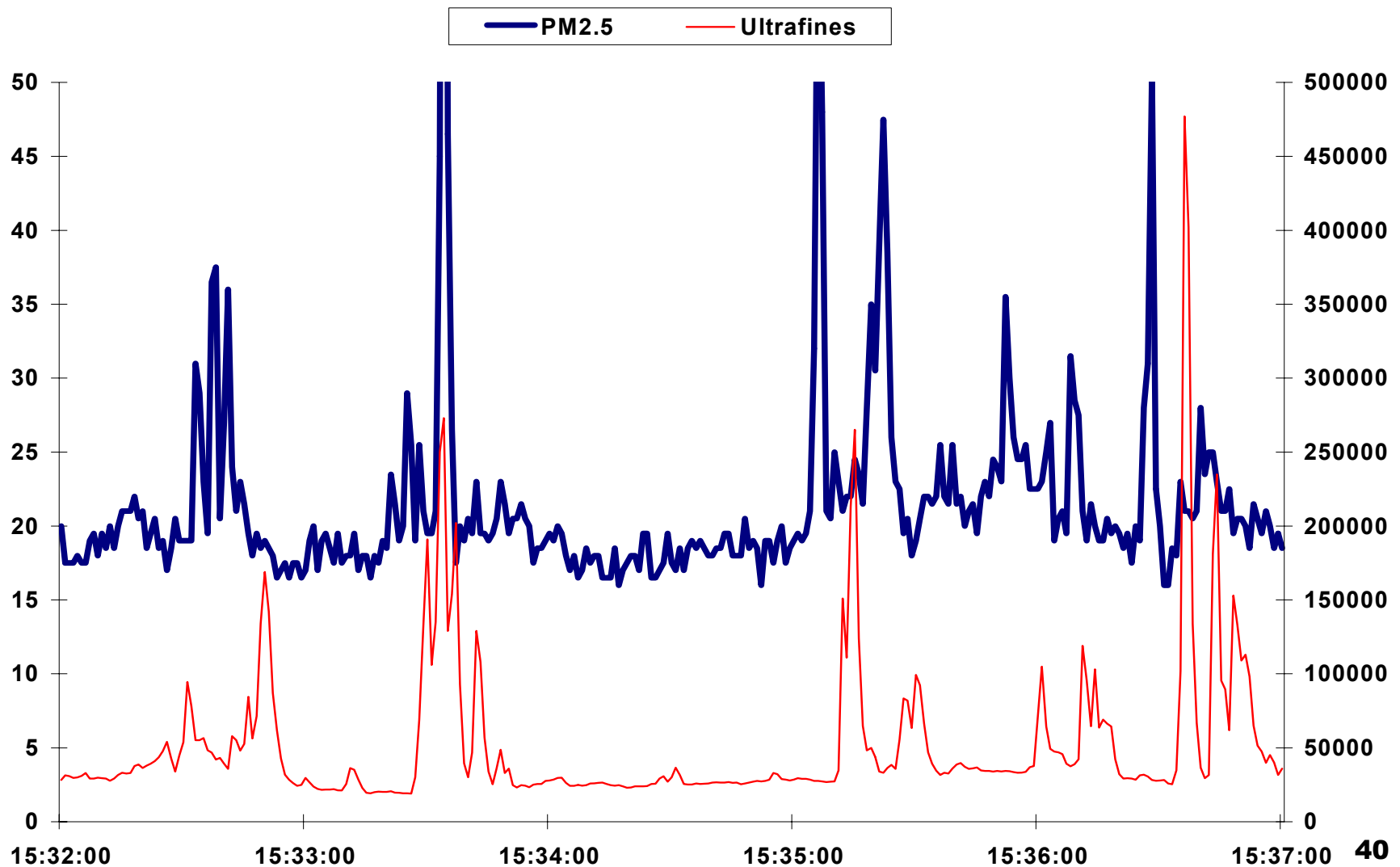
Cumulative Effect – Ultrafines

Rush Hour @ Bus Stop on The Green



Trailing a Transit Bus in Traffic

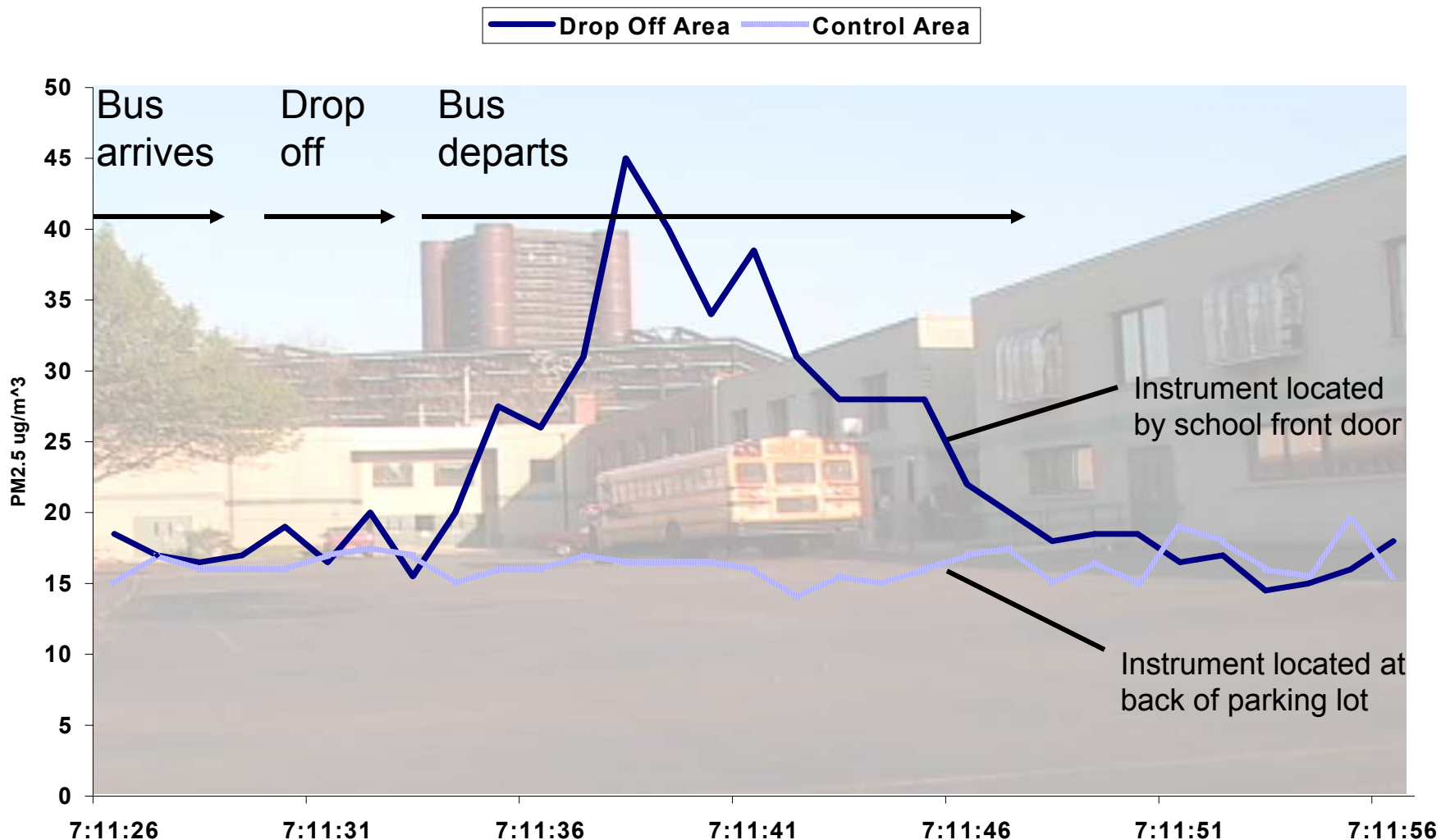
through downtown New Haven



Inquiry 4 -- School Buses

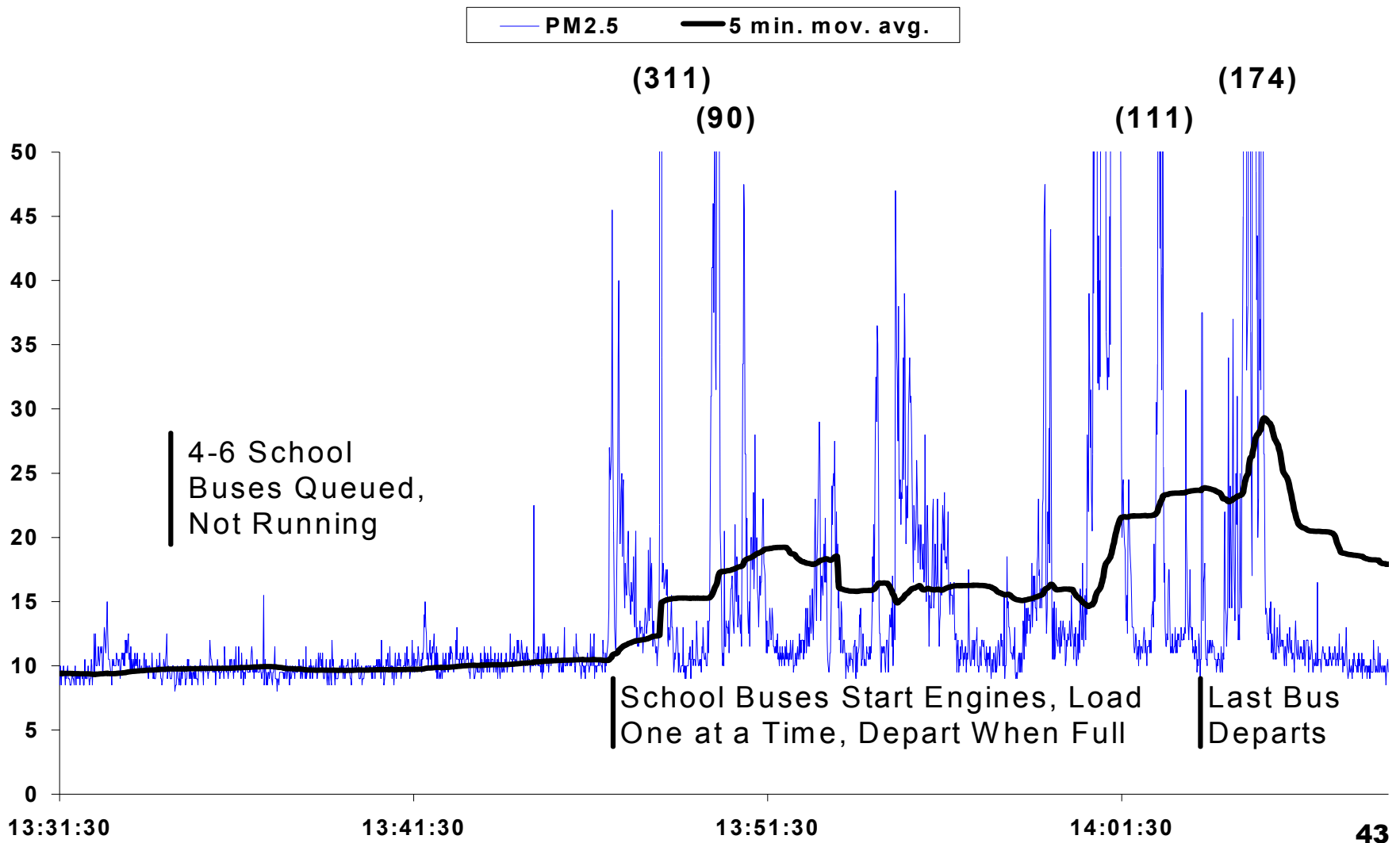
Profile: School Bus

High School in the Community



Episode: School Bus Pickup

East Rock Magnet School (Oct. 2003)



Detailed Findings

Findings – Construction Diesels

- Excavators, bulldozers, and dump trucks on the job site of the Q Bridge project are active in East Haven, Fair Haven, and moving toward downtown New Haven
- Dump trucks travel from the job site through neighborhood streets
- Curbside PM_{2.5} readings doubled
 - when an excavator filled an idling dump truck (this compared 1-minute averages before, during and after excavator was in operation)
- Notable “sensitive receptors” include Forbes Commons Apartments, Forbes Diner, workers at New Haven Terminal
 - At least 4 secondary schools are located within ¼ mile of upcoming Q Bridge construction
- The steady traffic and emissions of local heavy duty diesels around the New Haven Terminal and Forbes Avenue are compounded by
 - diesel emissions from advancing construction on the Q Bridge project and
 - interstate highway trucks

Findings – Other Industrial Diesels

- Solid waste haulers, fuel tankers and cement mixers concentrate around the New Haven Terminal and Forbes Ave.
 - Traffic – 168.2 industrial trucks/hour crossed the intersection of Forbes Ave. and Stiles St.
 - Curbside PM_{2.5} measurements @ Corner of Forbes and Stiles
 - Highest sustained 5-minute moving avg. PM_{2.5} = 72 ug/m³
 - Average from 7:20 am – 8:20 am = 11 ug/m³
 - Average from 8:20 am – 9:20 am = 17 ug/m³
 - Average over 3.5 hours = 13.4 ug/m³
 - Curbside ultrafine particle measurements
 - counter maxed out the monitoring instruments at 500,000 particles/cc on 18 separate occasions from 7 – 10:30 a.m.
 - Average over 3.5 hours = 97,000 particles/cc
- Numerous super-emitter (aka “smoker”) trucks passed from industrial zone through residential neighborhood
 - Highest measured curbside PM_{2.5} level -- 3000 ug/m³
 - These trucks would NOT pass DMV emission (“opacity”) test but are not being caught on local streets

Findings – Public Transportation

■ Trains at Union Station

- Amtrak and other trains idle in the yard for extended periods
- Large residential apartments are located within ¼ mile
- Curbside PM_{2.5} measurements @ Union Ave.
 - 2 hour average = 21.5 ug/m³
- Curbside Ultrafine measurements @ Union Ave.
 - 2 hour average = 22,000 particles/cc
- Cabin air quality on diesel commuter trains has not been measured

Findings – Public Transportation (2)

■ CT Transit Buses on The Green

- There is a temporary cumulative effect around bus stops, which is worse when buses queue at rush hour
 - Roughly 20 buses/hr stop at Elm and Temple Street during this period
- PM2.5 measurements at @ Elm and Temple Streets
 - 7:30-8:30 a.m. avg. = 22.5 ug/m³
 - 11-noon avg. = 15.5 ug/m³
 - 5-minute moving avg. PM2.5 rose 50% (to 32 ug/m³) as transit buses queued to drop off and pick up commuters
 - Older CT Transit buses temporarily caused curbside PM2.5 levels to spike from 13.5 ug/m³ to over 150 ug/m³.
- The oldest CT Transit buses are recently retired, replaced with 2003-2004 buses. 20+ buses are from Model Year 1996-2000, some of which are being replaced
- Trailing a transit bus in traffic causes extended exposure to higher PM2.5 levels

■ New Haven Bus Service and Yale buses

- Tend to be older and more polluting

Findings – Public School Buses

- Morning Drop-Off
 - Curbside PM_{2.5} increased about 50% as buses arrived/departed at morning drop-off at H.S. in the Community

- Afternoon pick-up @ East Rock School
 - Buses complied with anti-idling rule. While engines were off, background levels of PM_{2.5} were about 15 ug/m³.

 - During 5-minute interval after buses started engines (but before they departed), PM_{2.5} levels exceeded 50 ug/m³ more than 60 times

- New Haven Ahead of the Curve
 - All New Haven school buses already use Ultra Low Sulfur Diesel Fuel

 - 183 full size New Haven school buses will be retrofitted with emission controls this year; smaller buses are already using oxidation catalysts



Recommendations and Next Steps

Recommendations

1. Construction and Highway Maintenance

- On state owned, leased or contracted construction diesels and dump trucks ...
- require each engine to emit the lowest achievable particulate matter levels using ...
 - ultra-low sulfur diesel fuel (ULSD) and the best available emission control technology
 - filters if technically feasible, or oxidation catalysts if not
 - or any alternative that achieves an equivalent PM reduction
- Allow exceptions, e.g., for small contracts

2. Other Industrial Trucks around New Haven Terminal and Forbes Ave.

- Enhance State inspection and maintenance program to catch and fix “super-emitters”
- Develop incentive program to retire/replace or retrofit of priority fleets

Recommendations in New Haven (2)

3. Public Transportation

Trains

- Evaluate locomotive anti-idling options (APUs, electric, etc.)
- Require the lowest achievable PM levels, using ULSD and retrofit emission controls if technically feasible
- Study cabin air quality on diesel lines

Buses

- Replicate ConnDOT Stamford Program to New Haven Fleet
 - Convert all CT Transit buses to Ultra Low Sulfur Diesel (ULSD) fuel
 - Retire/replace or retrofit filters onto 20+ CTTransit buses MY1996 – 2000
 - Phase in filters onto remainder of new (blue) buses
- Encourage New Haven Bus Service to retrofit or retire dirty buses

4. School Buses

- Complete planned retrofit and use of ULSD fuel
- Consider needs/options for small buses and neighboring school districts
- Encourage Yale to retrofit or retire dirty buses

Next Steps (1)

Outreach

- Share results of this monitoring
 - Constituencies
 - Clean diesel advocates
 - Health care professionals
 - EJ community
 - School system
 - Policymakers
 - Mayor, City staff, Aldermen, State Legislators, Federal Delegation
 - DEP, DOT, Dept. of Health, EPA
 - Opinion-makers and the Media

Next Steps (2)

Policy Advocacy

- State Legislation
 - Construction and Highway Maintenance
 - Set rule for State owned and contracted fleets
 - Public Transportation
 - Trains – reduce idling, use low sulfur fuel, retrofit if feasible
 - Set timetable for CT Transit Buses to reach Best Available Control Technology standard
 - School Buses
 - Set timetable for retrofitting all school buses in CT
 - “Super-emitters”
 - Enhance identification and clean-up
- City Policies
 - Consider procurement rule for construction contracts
 - Retrofit other municipal fleets
 - Consider routing rules for industrial traffic
- Federal
 - Coordinated effort to seek federal help addressing interstate sources (e.g., long-haul trucks, marine vessels) as well as in-state sources
 - Resist any rollback of EPA standards for “new” diesel engines

Next Steps (3)

Research and Analysis

- Solutions:
 - settle definition of Best Available Control Technology
 - establish appropriate timetables for implementation
 - identify financial incentives
 - devise means to enhance inspection/testing
- Commuter train air cabin quality
- Projected local health impacts of diesel
- Other costs-benefits

Reference Info

Equipment

Instrumentation, technical support and video were provided by the Clean Air Task Force

- PM 2.5 Meter - DustTrak
 - measured **PM 2.5** mass
 - units: micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)
 - NOT calibrated to DEP units

- Ultrafine Meter - PTrak
 - measures **ultrafine** particles ($<0.1 \mu\text{m}$ or microns)
 - Units: number of particles each second per cubic centimeter

- Black Carbon Aethelometer
 - marker for diesel PM
 - results not reported here

- Digital video and cameras



Calibration

Divide by 2 – Raw measurements of PM_{2.5} mass from the DustTrak were divided by two as an approximate calibration to DEP hourly monitoring data.

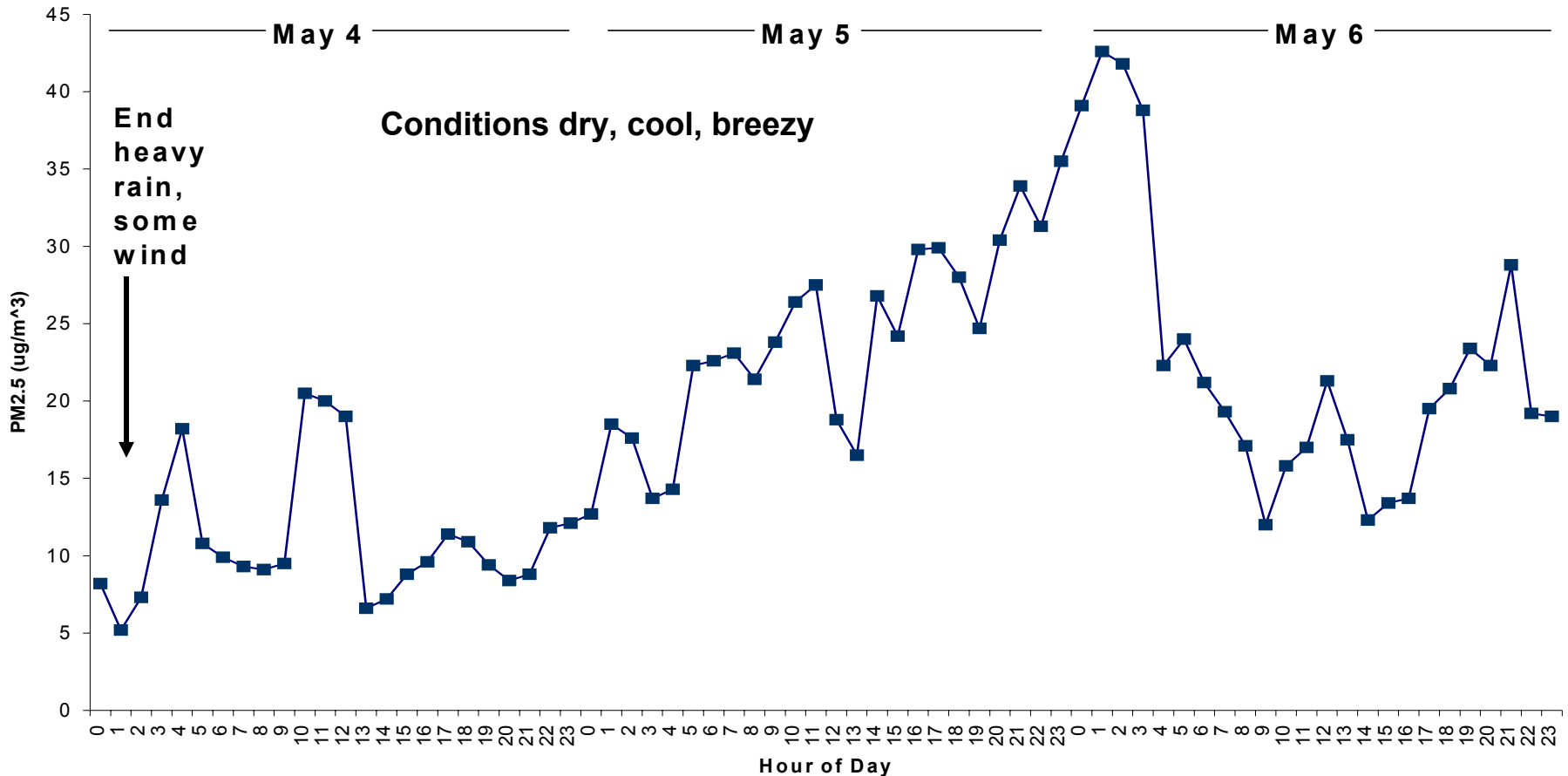
- “DustTrak reported higher PM_{2.5} concentrations than collocated 12-hr PM_{2.5} PEM samples, by approximately a factor of 2.”
 - Li-Te Chang et al, “Laboratory and Field Evaluation of Measurement Methods for One-Hour Exposures to O₃, PM_{2.5}, and CO,” *Journal of the Air & Waste Management Association* Volume 51, October 2001, p. 1414
 - See also, Levy, J., “Fine Particulate Matter and Polycyclic Aromatic Hydrocarbon Concentration Patterns in Roxbury, Massachusetts: A Community-Based GIS Analysis,” *Environmental Health Perspectives* , VOLUME 109, NUMBER 4, April 2001, p. 342
 - DustTrak is calibrated by the manufacturer using emery oil aerosol and nominally adjusted to respirable mass of standard ISO 12103-1, A1 test dust (Arizona test dust).

- All graphs in the Environment Northeast presentations of New Haven monitoring reflect this calculation

Baseline Reference

DEP Downtown PM2.5 Levels during 3 days of ENE project

PM2.5 - May 4-6, 2004



Calibration to ENE results would require simultaneous measurements in identical locations. This was not done. ENE results are best used to show relative changes over time.



**ENVIRONMENT
NORTHEAST**

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