

Appendix E

**SOUTHEASTERN MICHIGAN PM_{2.5} CONTROL PLAN:
MONITORING STRATEGY
SUPPORT DOCUMENTATION
FOR THE
FINE PARTICULATE SIP**

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Southeastern Michigan PM_{2.5} Control Plan: Monitoring Strategy

The purpose of this document is to propose a monitoring strategy as part of the southeastern Michigan PM_{2.5} control plan. The strategy consists of ambient measurements both from the existing monitoring network (with a few changes) and new special purpose monitoring, and associated data analyses. The ability to implement this strategy, especially changing the existing network and conducting new monitoring, is dependent on the availability of additional funding. (Note, the strategy will need to be reviewed and, as necessary, revised based on the final set of emission reduction programs selected for the PM_{2.5} control plan.)

Monitoring Objectives

The objectives of the monitoring strategy include:

- assess attainment of National Ambient Air Quality Standard,
- provide real-time measurements (to support public outreach),
- improve understanding of the PM_{2.5} nonattainment problem (including to help identify the contribution of source types and source regions to PM_{2.5} levels),
- track progress towards attainment (and assess effectiveness of emission reduction programs).

Measurements

A summary of existing and suggested additional measurements is provided in Table 1. A map of the existing monitoring sites is shown in Figure 1.



Figure 1. PM_{2.5} Monitoring Sites in Southeastern Michigan (Note: although not shown, there are two other sites – Newberry and FIA – located near Dearborn and Fort Street (SWHS))

Two changes to the existing monitoring network (pending the availability of funding) are recommended:

- Establish a TEOM monitor at SWHS¹.
- Establish an STN monitor at SWHS – either by moving the Luna Pier STN monitor or siting an available STN monitor (which would require additional resources for lab support).

It should also be noted that in light of pending budget cuts by USEPA, the State may need to reduce the number of FRM (and, perhaps, STN) sites in the network. Further discussion is needed on any specific proposed reductions.

New special purpose monitoring (pending the availability of funding) is desirable to improve understanding of the PM_{2.5} nonattainment problem, especially for organic carbon. General suggestions for organic carbon-related monitoring and data analyses are discussed in the Appendix. Of these suggestions, serious consideration should be given to the following activities in southeastern Michigan:

- Collect continuous OC/EC data at Dearborn and, if possible, Allen Park. (Note, these data should be reviewed regularly to assess the adequacy of the existing 1-in-6-day STN sampling schedule at Dearborn.)
- Collect speciated OC data at Dearborn. High time resolution data are important. One approach is to analyze existing or new filters for many high OC concentration days, similar to what University of Wisconsin did earlier this year.
- Following analysis of the continuous measurements (see below) and the subsequent identification of important local sources, source sampling should be conducted for the important sources in the vicinity of the Dearborn monitor to develop improved source profiles for source apportionment analyses.

Although lesser priority, additional lab analyses of existing filters would also be desirable to support source apportionment analyses and improve understanding of PM_{2.5} sources:

- ICP/MS to determine metals concentrations - ICP/MS yields lower minimum detection limits (MDLs) than the standard XRF protocol, but also has disadvantages, including poorer resolution for some species and it is a destructive method. While ICP/MS is technically feasible and yields good quality data, it is more expensive than XRF (i.e., about \$28K for 40 elements on 100 FRM Teflon samples, or about \$19K for 20 elements on 100 FRM Teflon samples).
- Scanning electron microscopy to assess sources of certain elements (note: this type of analysis was recently done using filters collected in the vicinity of Granite City Steel near St. Louis)

¹ As noted in Table 1, Dr. Jerry Keeler has operated a TEOM at SW High School, but these data are not currently available.

Data Analysis

Near-term activities include additional analysis of existing measurements, including a review of continuous measurements to assess plume hits, and an examination of burning sources, as discussed in the Appendix. On-going activities include quarterly review of FRM and STN data, and periodic source apportionment studies using the latest measurement (e.g., assess trends in source contributions). These activities can be conducted by in-house personnel (e.g., MDEQ and LADCO).

Table 1. PM_{2.5}-Related Air Quality Measurements in Southeastern Michigan

Monitoring Type		FRM	TEOM	Aethalometer	STN	Other/New Measurements
Pollutant/Species		PM _{2.5} mass	PM _{2.5} mass	Black (elemental) carbon	Sulfates, nitrates, organic carbon, elemental carbon, soil	
Sampling Frequency		1-in-3 day, 1-in-6 day	continuous	continuous	1-in-3 day, 1-in-6 day	
Purpose		Assess attainment of NAAQS	Provide real-time measurements	Provide data for SIP development	Provide data for SIP development (improve understanding of PM _{2.5})	
Allen Park	261630001	x	x	x	x	Continuous OC/EC Measurements (if available)
SW High School	261630015	x	x (Keeler short-term study)			Establish STN monitor (use existing equipment of move Luna Pier STN) Establish TEOM
Linwood	261630016	x				
E. 7 Mile	261630019	x				
Livonia	261630025	x				
Dearborn	261630033	x	x	x	x	Continuous OC/EC Measurements Speciated OC Data (w/ source apportionment analyses)
Wyandotte	261630036	x				
Newberry	261630038	x	x	x	x (Schauer short-term study)	
FIA	261630039	x	x			
New Haven	260990009	x				
Luna Pier	261150005	x			x (move to SWHS?)	
Oak Park	261250001	x				
Port Huron	261470005	x	x			
Ann Arbor	261610005	x				
Ypsilanti	261610008	x	x		x	

APPENDIX

Organic Carbon Monitoring and Data Analysis Activities

Overview: The purpose of this paper is to suggest ambient measurements and data analyses for organic carbon (OC) to address the following objectives:

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|--------------------------------|--|
| Near-Term (by early 2007): | <ol style="list-style-type: none">(1) better define burning source(s)(2) better identify local OC sources(3) justify emissions inventory adjustment factors |
| Longer-Term (2008 and beyond): | <ol style="list-style-type: none">(1) improve understanding of mobile sources(2) improve understanding of OC sources(3) assess effectiveness of control programs in reducing OC concentrations |

These monitoring and data analysis activities are intended to provide a better understanding of organic carbon and support possible regulatory efforts for PM_{2.5} in the Upper Midwest.

Background: In 2004 – 2005, LADCO supported the Urban Organics Study, with contractor assistance study by the University of Wisconsin and Sonoma Technology, Inc. (STI). The purpose of this study was to provide ambient measurement-based information on sources of PM_{2.5} organic carbon concentrations (e.g., anthropogenic v. biogenic, urban v. rural, and primary v. secondary). It was hoped that this information would be sufficient to identify organic carbon sources and to determine possible control programs.

Special OC measurements were made at five urban sites (Chicago, St. Louis, Detroit, Cincinnati, and Indianapolis) and one rural site (Bondville, IL)². Source apportionment analyses were then conducted using these measurements. The study results indicated four major OC source types (mobile, burning, industrial, and secondary), but were unable to provide any further definition. Consequently, the resulting control strategy implications were rather general, and numerous suggestions were made for further work.

Monitoring and Data Analysis Activities: To meet the near-term and longer-term objectives, the following activities should be considered:

- (1) **Maintain STN Network:** Speciated PM_{2.5} measurements need to be continued at a core set of existing sites. (Due to funding cuts and periodic network reviews, it may not be possible or necessary to maintain all original STN sites.) On-going measurements are needed to define trends in PM_{2.5} species and improve understanding of organic carbon sources.
- (2) **Continuous Data Collection:** Continuous EC/OC (Sunset method) and BC (aethelometer) measurements at multiple locations are needed to further explore plumes and diurnal behavior. Such data are desirable in one or more of the expected PM_{2.5} residual nonattainment areas: Detroit, Chicago, Cleveland, Granite City (St. Louis), and Steubenville.

² In the case of Detroit, STI focused on measurements collected at Allen Park, while UW analyzed measurements from both Allen Park and Dearborn.

While we are awaiting these data, follow-up analyses to the Urban Organics Study should be conducted. For example, available continuous air quality and meteorological measurements should be reviewed to look for plume “hits”. This analysis may help identify nearby sources.

- (3) Speciated OC Data Collection: Special measurements, such as hi-vol sampling with analysis of individual organic species to identify specific chemical markers to support source apportionment studies. Such measurements were collected in the Urban Organics Study, and a special study in the Seney National Wildlife Refuge (see “Source Apportionment of Atmospheric Fine Particulate Matter Collected at the Seney National Wildlife Refuge”, May 2004). In the Seney study, chemical markers associated with biogenic emissions were identified.
- (4) Analysis of Burning Source: Levoglucosan analysis is needed to determine biomass burning (independent of OC analysis). The Jeff Collett method (anion-exchange chromatography with pulsed amperometric detection) is very specific for levoglucosan and can be done more cheaply. This is typically done on high-vol filters and has not been attempted on archived STN or FRM filters, but Jeff thinks it is possible and is interested in such a project. (Neil Frank is also interested in a multi-regional program to look at ways to estimate biomass using levoglucosan and, perhaps, potassium and may have money that could be leveraged.)

While we are awaiting these data, follow-up analyses to the Urban Organics Study should be conducted. For example, back trajectories should be prepared for all days identified as having a high burning source impact in the initial source apportionment analyses. This information may help determine source regions and burning activities.

- (5) Examination of Old and New Carbon: C14 analysis could be conducted to determine fossil/modern carbon split. New carbon is mostly associated with biogenic Secondary Organic Aerosol (SOA) and biomass burning, while old carbon is associated with mobile source, stationary fossil fuel combustion, and fossil fuel source SOA. Together with the levoglucosan data above, this would allow us to develop a more certain bound on anthropogenic and biogenic contributions (i.e., biomass burning is a fraction of modern carbon -- whatever is left of modern carbon after biomass burning is subtracted is the biogenic contribution). This is an expensive analysis -- ~\$500/sample.
- (6) Characterize Intra-City Spatial Variability (Jamie Schauer methodology): Routine sampling along a transect in the prevailing wind direction with at least three sites to quantify upwind, center city or industry, and downwind. Detroit would be an ideal location; for example, select Allen Park, Dearborn, and Linwood. Combining this with continuous data (EC/OC) would help discern some source patterns (mobile, industrial plumes) in the much higher resolution data.
- (7) Development of Source Profiles: Source sampling is critical in light of the significant uncertainties we have discovered in numerous source apportionment studies. Most important are steel mills, especially the different processes within the mills, locomotives, and other off-road mobile sources. Data on on-road mobile sources would be helpful as well. (Note, these data may be EPA’s Kansas City study.)

Would also be useful to have resuspended dust (road dust and soil) for various cities -- this would help interpret some profiles that can confuse common crustal signatures with those of industrial processes and develop some knowledge of geological variability in the Midwest. Need to find Gary Casuccio's report on CCSEM at a Pennsylvania steel mill -- supposedly this characterizes various processes.

- (8) Additional Data Analyses (using existing data): Besides the two follow-up data analysis activities noted above (i.e., analysis of available continuous data and trajectory analyses of burning source), additional recommended analyses include: (a) evaluate the emissions inventory in the context of the source apportionment results (note, this analysis is likely to lead to an adjustment factor for primary organic carbon emissions from on-road mobile sources), and (b) assess trends in source contributions (note, this analysis may help determine the effectiveness of certain control programs).

The table below identifies the relevant objectives for these activities:

	Near-Term Objectives			Long-Term Objectives		
	<i>Better Define Burning Source</i>	<i>Better Identify Local Sources</i>	<i>Justify EI Adjustment Factors</i>	<i>Improve Understanding of Mobile Sources</i>	<i>Improve Understanding of OC Sources</i>	<i>Assess Effectiveness of Control Programs</i>
Monitoring Data Analysis Activities						
Maintain STN Network					X	X
Continuous Data Collection		X			X	
Analysis of Burning Source	X					
Source Profile Development		X		X	X	
Speciated OC Data Collection/Analysis					X	
Examination of Old-New Carbon		X			X	
Characterize Intra-City Spatial Variability					X	
Additional Data Analyses						
* Evaluate EI			X			
* Assess trends in source contribution						X

Next Steps: This paper will be shared with federal, state, academic, and stakeholder representatives to ensure that the recommended activities are relevant and appropriate. In addition, available funding options need to be explored (e.g., private foundations, special federal appropriation, and stakeholder contributions). Once we have a good idea of how much new money will be available, then the activities will be prioritized and LADCO will proceed with a competitive contract process.