STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

79 ELM STREET HARTFORD, CT 06106-5127

PHONE: 860-424-3001

Gina McCarthy
Commissioner

August 18, 2005

Michael N. Jones
US EPA (D243-02)
EMAD/AAMG
Research Triangle Park, NC 27711

Dear Mr. Jones:

In response to the United States Environmental Protection Agency's (US EPA) Local-Scale Air Toxics Ambient Monitoring Grant Solicitation Notice, I am pleased to submit the State of Connecticut's proposal. This proposal seeks funding to develop and conduct a study to assess wood smoke contributions to fine particle matter in Connecticut, and also to conduct monitoring and testing to characterize the emissions for an emerging source known as outdoor wood furnaces (OWFs), outdoor wood boilers (OWBs), or hydronic heaters.

There is increasing concern regarding the impact of wood smoke from residential wood combustion sources on air quality. According to the 2002 Mid-Atlantic Regional Air Management Association (MARAMA) emissions inventory, wood smoke contributes 38% of the fine particle emissions in Connecticut. Recent increases in the price of heating fuels have resulted in significant increases in the use of wood for residential and commercial heating. Sales trends indicate that OWFs are gaining greater market share of the wood-burning market with sales increasing 150% annually. The Northeast States for Coordinated Air Use Management (NESCAUM) estimates that by the end of 2005, 125,000 OWFs will be in place nationwide. This emergence of OWFs on the market poses a serious concern for air quality given that they are uncontrolled, unregulated, and largely uncharacterized up to this point.

This proposal seeks to leverage current air monitoring programs in Connecticut to establish a wood smoke monitoring network which will provide valuable information in assessing the impact of wood smoke sources on air quality. The information gathered as a result of executing this proposal will provide valuable direction in policy development and risk characterization for the most highly impacted populations. The Connecticut Department of Environmental Protection (CTDEP) will work closely with NESCAUM on this project. NESCAUM is a key partner in this regional effort based on its role as a leader and coordinator relative to technical and policy issues regarding wood smoke.

Efforts related to this proposal will be coordinated with similar and complementary ongoing efforts. This includes a NESCAUM-led initiative for the US EPA to take immediate action to regulate OWFs, and a recent petition from the New York Office of the Attorney General to the US EPA to list OWFs as a category of stationary sources and to promulgate standards of performance for OWFs. Health and environmental professionals support continued research in this area to further define $PM_{2.5}$ contributions from wood smoke to better ascertain public health implications and links to asthma and other adverse health outcomes.

This effort will provide information needed develop reduction strategies within the State's fine particulate non-attainment area where approximately one half of the state's population (1.73 million people) reside. This study will assess levels of the high priority Hazardous Air Pollutants as defined by the National Air Toxics Assessment (NATA) as they relate to wood burning sources. The results from NATA indicated that Connecticut was in the more at-risk areas of the nation for both cancer and non-cancer risk. This project will also provide results and valuable information that will be transferable both regionally and nationally.

We would welcome the opportunity to partner with EPA on this project. If you have any questions, please contact Anne Gobin of my staff at (860) 424-3026.

Yours truly,

Gina McCarthy
Commissioner

GM/pb
Enclosure

OMB Approval No. 03-4-8-0043

APPLICATION FOR FEDERAL ASSISTANCE

2. DATE SUBMITTED	Applicant Identifier
8/11/05	
3. DATE RECEIVED BY STATE	**State Application Identifier**
4. DATE RECEIVED BY FEDERAL AGENCY	**Federal Identifier**

1. TYPE OF SUBMISSION

Application	*Pre-application*
[ ] Construction	[ ] Construction
[X] Non-Construction	[X] Non-Construction

5. APPLICANT INFORMATION

Legal Name:	Organizational Unit
CT DEPARTMENT OF ENVIRONMENTAL PROTECTION	Bureau of Air Management
Address *(give city, county, state, and zip code)*: 79 Elm Street, Hartford County, Hartford, CT 06106-5127	**Name and telephone number of the person to be contacted on matters involving this application.** (give area code): Anne Gobin, Bureau Chief, (860) 424-3026

6. EMPLOYER IDENTIFICATION NUMBER (EIN): 06-6000798

7. TYPE OF APPLICANT: *(enter appropriate letter in box)* [A]

A.	State	H.	Independent School Dist.
B.	County	I.	State Controller Institution of Higher Learning
C.	Municipal	J.	Private University
D.	Township	K.	Indian Tribe
E.	Interstate	L.	Individual
F.	Intermunicipal	M.	Profit Organization
G.	Special District	N.	Other (Specify) _____

8. TYPE OF APPLICATION:

[X] New [ ] Continuation [ ] Revision

If Revision, enter appropriate letter(s) in box(es): [ ] [ ]

A. Increase Award B. Decrease Award C. Increase Duration

D. Decrease Duration Other *(specify)* _____

9. NAME OF FEDERAL AGENCY:

U.S. ENVIRONMENTAL PROTECTION AGENCY

10. CATALOGUE OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 66-034

TITLE: Surveys, Studies, Demonstrations and Special Purpose Activities Relating to the Clean Air Act (B)

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:

Local-Scale Air Toxics Ambient Monitoring

12. AREAS AFFECTED BY PROJECT *(cities, counties, states, etc.)*

STATE OF CONNECTICUT

13. PROPOSED PROJECT:

Start Date	End Date
10/1/2005	9/30/2007

14. CONGRESSIONAL DISTRICTS OF:

a. Applicant	b. Project
STATE OF CONNECTICUT	STATEWIDE

15. ESTIMATED FUNDING:

a. Federal	$ 500,000 .00
b. Applicant	$ .00
c. State	$ .00
d. Local	$ .00
e. Other	$ .00
f. Program Income	$ .00
g. TOTAL	$ 500,000 .00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE _____

b. NO. [ ] PROGRAM IS NOT COVERED BY E.O. 12372

[x] OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

[ ] Yes If "Yes," attach an explanation. [X] No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED

a. Typed Name of Authorized Representative	b. Title	c. Telephone Number
GINA McCARTHY	COMMISSIONER	(860) 424-3001

d. Signature of Authorized Representative: Gina McCarthy

d. Date Signed: 8/16/05

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Section 2: Narrative Workplan

I. Project Title: Evaluation of Wood Smoke Contribution to Particle Matter in Connecticut

II. Category: Source Identification and Characterization (Bin 1)

III. Applicant Information: Connecticut Department of Environmental Protection, Bureau of Air Management

Contact: Peter Babich, Sc.D., Environmental Analyst
CTDEP, Bureau of Air Management
79 Elm Street
Hartford, CT 06106-5127
Phone: (860) 424-3027
Fax: (860) 424-4063
pete.babich@po.state.ct.us

IV. Funding Requested: $500,000

V. Total Project Cost: $629,866

VI. Project Period: January 1, 2006 to January 1, 2008

VII. Project Narrative and Work Plan:

A. Introduction

The Connecticut Department of Environmental Protection (CTDEP), Bureau of Air Management, is applying for a grant to assess wood smoke contributions to fine particle matter ($PM_{2.5}$) in Connecticut, and also to conduct monitoring and testing to characterize the emissions for an emerging source known as outdoor wood furnaces (OWFs), outdoor wood boilers (OWBs), or hydronic heaters.

The first part of this project would use ambient measurements to evaluate the portion of $PM_{2.5}$ concentrations that can be attributed to wood burning. The second part of this project would characterize the air toxic and $PM_{2.5}$ emissions associated with OWFs, an emerging, uncontrolled and unregulated source that has been largely uncharacterized up to this point.

The information obtained through this project will be valuable in developing control strategies and emission inventories, while gaining a better understanding of the wood smoke contribution to Connecticut's $PM_{2.5}$ levels. The results obtained in this study can be applied to other areas with significant wood smoke sources and provide direction for similar studies. The information obtained in this project regarding OWF testing will be valuable, not only to Connecticut, but also to other state and local agencies, as well as the United States Environmental Protection Agency (US EPA) in assessing the impacts of OWFs to air quality and public health. Currently, Connecticut and several other states are assessing the need to develop regulations that would require emission controls on these units. Gaining a fuller understanding of OWF emissions would direct further action.

This study will assess levels of the high priority Hazardous Air Pollutants (HAPs) as defined by the National Air Toxics Assessment (NATA) as they relate to wood burning sources. The results from NATA indicated that Connecticut was in the more at-risk areas of the nation for both cancer and non-cancer risk. All counties in Connecticut were above the fiftieth percentile nationally with three counties (Fairfield, New Haven and Hartford) at the ninety-fifth percentile nationally. The information gathered as a result of successfully executing this proposal would provide valuable direction in policy development and characterizing risk for the most highly impacted populations. The results of theses efforts will provide a direct linkage to the US EPA Strategic Plan by providing high-quality, high-resolution local-scale ambient monitoring data that ultimately supports progress toward the US EPA Strategic Plan Goal 1 (Clean Air and Global Climate Change), Objective 1.1 (Healthier Outdoor Air) and Sub-Objective 1.1.2 (Reduced Risk from Toxic Air Pollutants). According to David Brown, Sc.D., Director of Public Health Toxicology for Environmental and Human Health, Inc. (EHHI), the proposal put forth here will produce a highly time-resolved toxics dataset "that will provide extremely useful information for exposure and risk assessment purposes." Health and environmental professionals

support continued research in this area to further define $PM_{2.5}$ contributions from wood smoke to better ascertain public health implications and links to asthma and other adverse health outcomes (see attached EHHI endorsement letter).

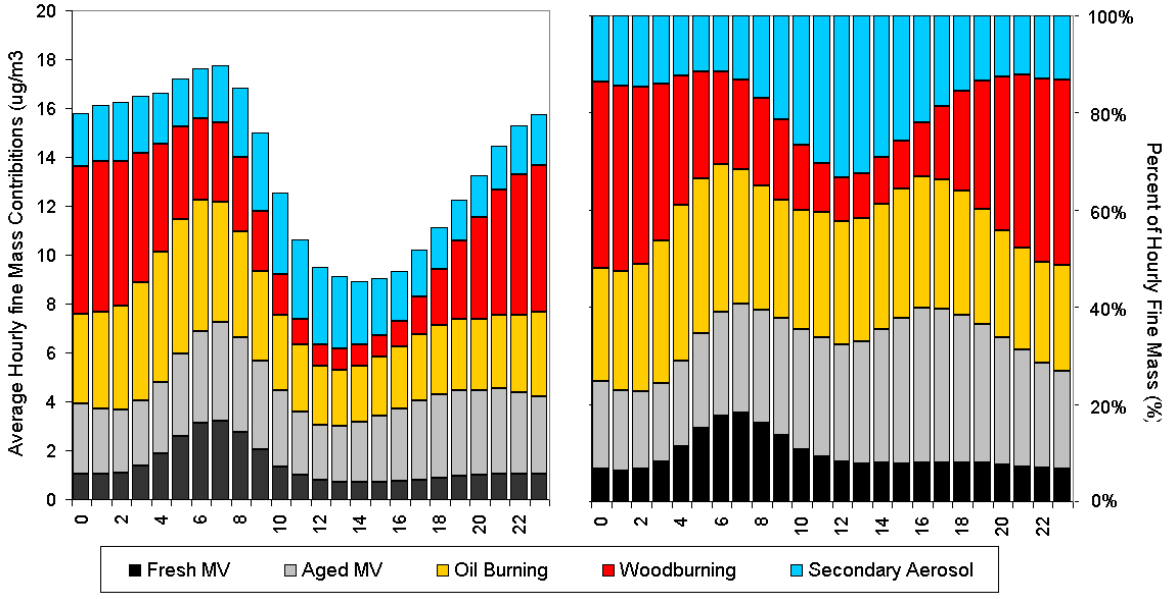
B. Background Information

Ambient Wood Smoke Monitoring:
The severity of potential health effects and magnitude of populations affected by wood smoke have led health scientists to conclude that exposure to it should be minimal. Wood smoke is comprised of numerous constituents including $PM_{2.5}$, carbon monoxide (CO), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Some VOCs and PAHs are respiratory irritants and also have carcinogenic and mutagenic properties, while carbon monoxide exposure has been associated with adverse respiratory and cardiac effects. Exposure to $PM_{2.5}$ may play a large role in observed health effects related to wood smoke. Fine particles are of health concern because of their association with serious cardiopulmonary health outcomes and their impact on a large number of susceptible population subgroups, including young children, asthmatics, persons with respiratory or heart disease, diabetics, and the elderly.

There is increasing concern regarding the impact of wood smoke from residential wood combustion (RWC) sources on air quality. According to the 2002 Mid-Atlantic Regional Air Management Association (MARAMA) emissions inventory, wood smoke contributes 38% of the $PM_{2.5}$ emissions in Connecticut. Woodstoves are now available that are EPA-certified; however, the majority of the woodstoves in operation are older units with no pollution control devices. As fuel prices have risen, so have the sales of woodstoves and OWFs. OWFs are unregulated (i.e., no EPA certification) and are routinely being installed as primary residential heat-sources on a year-round basis. Although there is little conclusive data about OWFs, initial data indicates that these units emit at rates 14 to 57 times higher than EPA certified woodstoves.

A pilot study was conducted in Rutland, VT, by two of the key personnel on this proposal. The study was conducted to evaluate an approach that quantified, in near real-time, the contribution of wood smoke to $PM_{2.5}$ concentrations (WS PM). The pilot project succeeded in apportioning the $PM_{2.5}$ into several source categories. The highly time-resolved data collected in the Rutland study allowed for results shown in Figure 1, where the motor vehicle sources show a distinct morning rush hour maxima and a smaller afternoon increase, the secondary aerosol source peaks at midday, and the wood and oil combustion sources peak at night. The Rutland study also identified ways in which this approach could be improved upon in future studies; these concepts are integrated in this proposal. For the entire Air & Waste Management Association conference proceedings paper, please follow this link: http://bronze.nescaum.org/regionalhaze/2004-10-25--Allen-Realtime_WoodSmoke_Indicator_AWMA.pdf.

Figure 1. Absolute and Percent Source Contributions to Hourly PM2.5 Mass, by hour of day



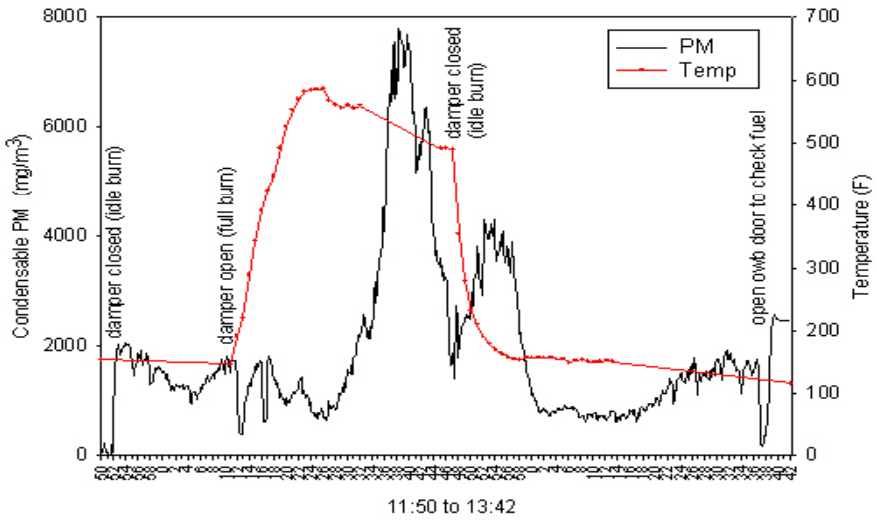
Outdoor Wood Furnace Source Characterization:
Recent increases in the price of heating fuels have resulted in significant increases in the use of wood for residential and commercial heating. Of greatest concern are OWFs, the emissions of which remain relatively uncharacterized. Limited data indicates that they pose a significant public health impact. The limited data available indicates that these units emit approximately 14 to 57 times more $PM_{2.5}$ than EPA certified woodstoves. Using these numbers, an individual OWF emits as much $PM_{2.5}$ as six heavy-duty diesel trucks. Furthermore, these units are designed to replace home furnaces and hot water heaters, which translates into year-round use to provide domestic hot water and heating swimming pools or spas. Given OWFs high emission rates and year-round use, their impact on ambient PM levels could be significant.

In addition to the year round use, these units pose additional problems not usually found with indoor wood stoves, indoor wood furnaces, or fireplaces. OWFs have short stacks (usually eight to ten feet from ground level), which emit smoke near the ground, allowing for little dispersion and creating significant local impacts. Furthermore, the units are designed to provide long burn times with loading once a day, or less. The large fuel capacities and automatic damper controls, typically combined with primitive combustion design, result in poor combustion, heavy smoke, noxious odors, and high concentrations of fine particulate and other air toxic pollutants associated with low temperature combustion of wood fuel.

Recent analysis of sales data indicates that the use of these units is increasing at substantial rates. The Northeast States for Coordinated Air Use Management (NESCAUM) estimates that by the end of 2005, 125,000 OWFs will be in place nationwide. Sales trends indicate that these units are gaining greater market share of the wood-burning market with sales increasing 150% annually. As these units become more popular, the need to understand their emission impact increases. Unfortunately, little data exists regarding the true emissions from these units. To date, the US EPA has conducted one laboratory test in 1996 and NESCAUM recently conducted a preliminary field test. The initial data indicates that OWFs emit large volumes of fine particulate matter.

NESCAUM conducted a pilot field test to obtain measurements on a residential OWF to determine emission rates for different burn scenarios using real-time measurements and integrated samples. The results from these measurements are anecdotal in nature since only a single furnace and wood type were tested and the measurement methods used are somewhat non-traditional. The indications from the in-use field testing are that earlier lab tests significantly underestimate emissions. The knowledge gained by this initial test provided the data needed to plan conclusive field-testing in order to achieve a better understanding of the potential impact of these sources on air quality. The experience gained from these tests in how to better characterize the real-world emissions from OWF units will be used to guide development of improved measurement methods and testing protocols for this project. Figure 2 is an example of the continuous $PM_{2.5}$ data obtained during the pilot study. NESCAUM observed stack concentrations as high as 8,000 mg/m^3.

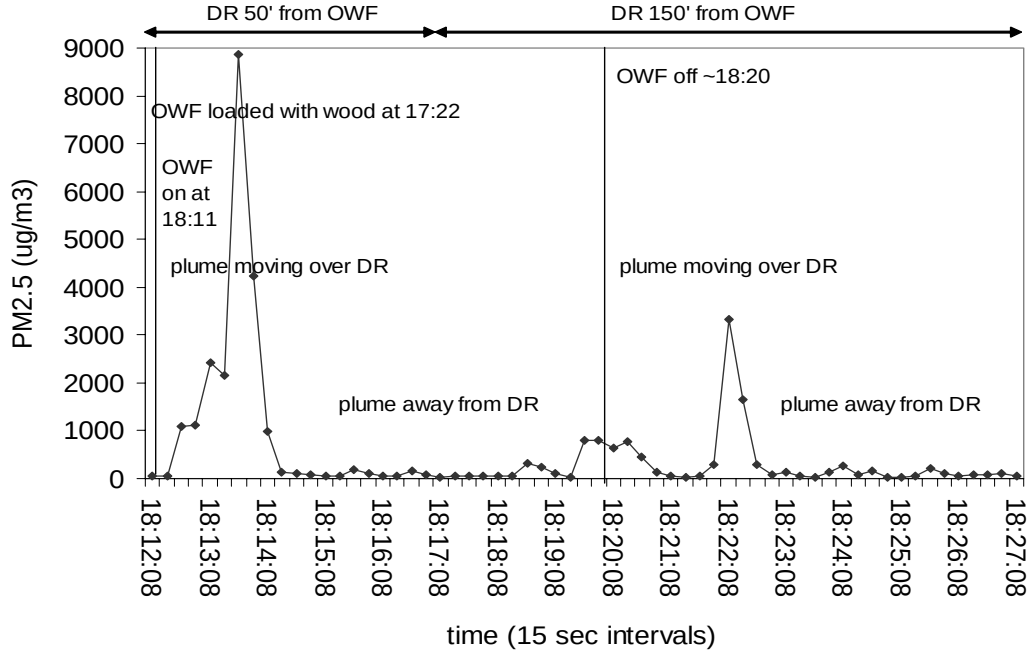
Figure 2: NESCAUM OWF Stack Sampling; Continuous $PM_{2.5}$ (DataRAM) - June 22, 2005



NESCAUM also conducted exploratory field sampling in March 2005 in central New York State on the residential property of an OWF owner. Figure 3 shows extremely high values upwards of 4,000 $\mu g/m^3$ recorded over distances of 50, 100, and 150 ft. A maximum value of 8,880 $\mu g/m^3$ was monitored. These results indicate that residences located in

proximity to OWFs can experience elevated ground-level concentrations of $PM_{2.5}$ dominated by submicron aerosols. This raises public health concerns given the effective infiltration capacity of fine particles and other pollutants into indoor environments where people spend the majority of their time. These concerns are augmented by consideration of design features typical to OWFs, including low stack height, poor combustion operating modes, primitive emissions control, large firebox chamber capacity, potential to burn trash, and four-season utility.

Figure 3: Continuous $PM_{2.5}$ field measurements in proximity to an OWF



C. Objectives

Ambient Wood Smoke Monitoring:
The main objective of the wood smoke monitoring portion of this study is to better characterize the contribution of wood smoke to ambient $PM_{2.5}$ concentrations in Connecticut. This will be accomplished by selecting monitoring sites that are representative of areas that are impacted by wood smoke sources. The ambient wood smoke monitoring effort will: 1) characterize the impact of wood burning on $PM_{2.5}$ concentrations; 2) assess the contribution of wood smoke to $PM_{2.5}$ during wintertime inversion events; 3) assess emission inventory estimates; 4) evaluate modeling results with monitoring data; 5) determine control and reduction strategies to address non-attainment status; and 6) build upon new techniques that quantify $PM_{2.5}$ concentrations from wood smoke on a real-time basis. This study will provide valuable information as the CTDEP looks to identify risk reduction strategies and develop $PM_{2.5}$ and Regional Haze State Implementation Plans (SIPs).

Outdoor Wood Furnace Source Characterization:
The main objective of the outdoor wood furnace characterization portion of this study is to gain a better understanding of the particulate and air toxic emissions from these wood units, as well as to gain a better estimation of the contribution of these units to ambient $PM_{2.5}$ concentrations. This will be accomplished by conducting stack tests at several units that represent typical residential units. The units will be tested under normal operation in the field. Initial tests indicate that in-use emissions are significantly greater than those measured in the US EPA lab test. The OWF effort will: 1) characterize the emissions from OWFs, a metric that we currently do not possess; 2) assess the contribution of OWFs to ambient $PM_{2.5}$ levels; 3) assess local impacts from these units; 4) identify appropriate monitoring/testing techniques for OWFs; 5) develop a testing protocol for field tests of these units; and 6) identify control and reduction strategies. This study will provide valuable information as the CTDEP looks to identify risk reduction strategies.

D. Study Design

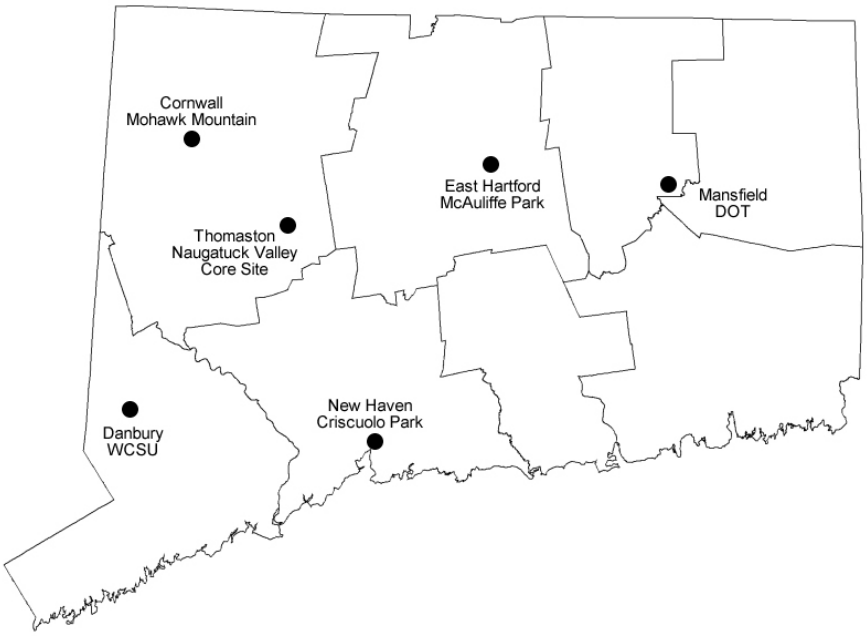
Ambient Wood Smoke Monitoring:
The CTDEP will conduct wood smoke monitoring that will be comprised of one newly established core site and five satellite sites of which four are currently established sites and the fifth is a former site with the air monitoring shed still in place. A full range of parameters will be operated at the core site while the five satellite sites will still collect the

appropriate data to assess WS PM using information obtained and applied from the core site. See Figure 4 for a map of the proposed monitoring sites in Connecticut. The proposed project period for this portion of the study is January 1, 2006 through January 1, 2008. This includes six months of establishing network, one year of data collection (approximately July 1, 2006 through June 30, 2007), and six months of sample and data analysis.

Core site: The core site will be located in the Thomaston area, located in western Connecticut. Thomaston is located in the Naugatuck Valley and is prone to wintertime inversions, which trap pollutants close to the ground. The emphasis will be placed on collecting highly sensitive, highly time-resolved data to best characterize and apportion sources. A comprehensive selection of pollutants will be measured at this site to best assess the $PM_{2.5}$ contributions from wood smoke. Continuous $PM_{2.5}$, along with volatile and non-volatile fractions of $PM_{2.5}$, will be measured in addition to continuous speciation methods to obtain highly time-resolved organic carbon (OC), elemental carbon (EC), sulfate (SO_4), and the optical absorption of PM at two wavelengths (370 and 880 nm). Trace-gas analyzers will be used to obtain carbon monoxide (CO), sulfur dioxide (SO_2), and reactive oxides of nitrogen (NO_y). Highly time-resolved measurements of trace metals and PAHs will be collected, as well. This information will be used to quantify WS PM and to relate the measurements to other wood smoke markers (i.e., potassium) and other pollutants (i.e., PAHs).

Satellite sites: A total of five satellite sites in Connecticut will be included in the wood smoke monitoring network. Three of the sites will be located in Danbury, East Hartford and Mansfield. These sites were selected based on the fact that they are located in valleys that are prone to wintertime inversions and are located in western, central and eastern Connecticut, respectively. A two-wavelength Aethalometer will be deployed to each site to provide semi-quantitative, real-time WS PM estimates. These WS PM measurements will be better quantified using analysis performed on data obtained from the core site. The other two sites will be located on Mohawk Mountain in Cornwall and at Criscuolo Park in New Haven. Both Mohawk Mountain and Criscuolo Park are established sites that are prospective NCORE Level II sites under the National Monitoring Strategy with a comprehensive selection of parameters currently being measured. The Cornwall Mohawk Mountain site is a rural background site located well above inversion boundary layers and is in the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Rural Aerosol Intensive Network (RAIN). The New Haven Criscuolo Park site is a coastal urban site which is prone to inversion conditions, but is presumably more heavily impacted by mobile sources relative to wood smoke sources. A two-wavelength Aethalometer would be deployed to Cornwall while a unit is currently in operation in New Haven.

Figure 4: Proposed Wood Smoke Monitoring Network in Connecticut



Outdoor Wood Furnace Source Characterization:
NESCAUM has identified five potential OWF units for testing. These units represent several manufacturers and outputs with outputs ranging from 180,000 btu/hr (residential unit) up to 3,000,000 btu/hr (commercial unit). The partners anticipate conducting a minimum of four stack tests. The project team will review the units that could be tested

and determine which will yield the most relevant data. Selection of units will be based upon unit size, unit output, unit features, and unit physical condition (e.g. age, rust, upkeep). The proposed project period for this portion of the study in which data will be collected is January 1, 2006 through January 1, 2008. This includes OWF sampling between January 1, 2006 and June 30, 2007 and six months of sample and data analysis.

Source Testing: OWF stack testing will be conducted to provide a source characterization during typical wintertime operating conditions. The testing schedule will consist of four, one-week periods during which three full-cycle runs will be conducted during 2006-07. Two units will be selected for initial testing during the winter season. Given the cyclic operation of these units, the winter operation mode will provide data on emissions when a household is placing a heavy load on the OWF. Testing will be conducted to capture data during high burn periods, low burn periods and transitional periods. In addition, measurements will be taken throughout the entire fuel charge. This will capture emissions data from an entire charge cycle since initial data indicates that OWFs emissions vary significantly not only during low and high burn rates, but also vary depending on the duration into the fuel charge.

Once the initial tests are completed the project team will review the data and determine the path for the final two tests. If similar emission rates are found from both OWFs operating in the winter mode, then the same OWFs will be tested in the summer season to measure emissions when a lower load is placed on the OWF. However, if emission information varies significantly from the two units, the project team will likely test two additional units in the winter mode to identify trends in emissions.

Testing will consist of continuously measuring $PM_{2.5}$ and PAHs, and obtaining integrated VOC and dioxin measurements. A one-week test period will consist of one day of setup, three full-cycle test runs (approximately twelve hours in duration), and one day of take down. Each test will use the same fuel mix consisting of seasoned mixed hardwoods, such as maple, oak, and birch. The mixed hardwood will be purchased at the same time from the same supplier to ensure consistency throughout the testing. Moisture measurements of the wood will be taken during each test to continue to control for variability in the fuel.

Near-Source Monitoring: Near-source monitoring will be conducted to characterize potential exposures to $PM_{2.5}$ from OWFs. Continuous $PM_{2.5}$ will be collected at approximately 200 feet from the OWF unit. Sampling will be conducted near both OWF units that are used to conduct source testing for a period of at least one month. Near-source monitoring may be conducted in proximity to other OWF units, if available.

E. Sampling/Analytical Methodology

Ambient Wood Smoke Monitoring:
Monitoring to be established to assess woodsmoke contributions to $PM_{2.5}$ will emphasize obtaining high-resolution measurements to better evaluate temporal and spatial distributions. Following is a list of the methodologies that will be deployed and the pollutants to be measured in order to meet the study objectives. Table 1 lists the sites along with what instrumentation is currently deployed and what is proposed at each site.

WS PM: A two-wavelength Aethalometer (Magee Scientific Model AE42) will be operated at all six sites. The Aethalometer will be used to measure the optical absorption of PM at 880 nm (BC) and 370 nm (UV-C). The difference between these two channels (Delta-C) has been shown to be a specific, semi-quantitative indicator of wood-smoke related PM. The Rutland study showed that the Delta-C measurement was specific to WS PM even in presence of PM associated with mobile sources. The Aethalometer will be configured to capture one-minute measurements to allow for spatial scale analysis, as well.

Continuous $PM_{2.5}$: An FDMS-B TEOM (Rupprecht & Patashnick Series 8500) will be operated at the core site to obtain hourly $PM_{2.5}$ concentrations, as well as volatile and non-volatile fractions of $PM_{2.5}$, which is valuable in terms of source apportionment. An FDMS-B TEOM is currently in operation at the Criscuolo Park site in New Haven and it is proposed that an additional FDMS-B TEOM be deployed to Danbury, as it is another valley location potentially impacted by wood smoke and there is much value having the continuous $PM_{2.5}$ measurements complement data obtained from the two-wavelength Aethalometer. MetOne BAMs are currently in operation at the New Haven and Cornwall sites to obtain continuous $PM_{2.5}$ measurements.

Continuous Speciation: A continuous OC/EC analyzer (Sunset Laboratory Model 3) will be deployed to the core site to collect two-hour OC and EC measurements. A continuous SO_4 analyzer (Thermo Environmental Model 5020 SPA) will be deployed at the core site to obtain 15-minute sulfate averages. Both of these analyzers are currently in operation, and will remain in operation, at the Cornwall site.

Trace Gases: Trace-gas analyzers will be deployed at the core site for CO (Thermo Environmental Model 48C-TLE), SO_2 (Thermo Environmental Model 43C-TLE), and NO_y (Thermo Environmental Model 42CY). The utilization of trace instrumentation is important in order to increase the sensitivity, which allows increased confidence in assessing source contributions. Trace SO_2 is currently in operation at Cornwall and other trace gas analyzers are planned for deployment to the New Haven and Cornwall sites.

Trace Metals: A slotted 3-Drum Impactor (DELTA Group) will be deployed at the core site to obtain high-resolution trace metal and optical attenuation measurements for three size ranges. Among the target metals to be measured are high priority HAPs that include arsenic, beryllium, cadmium, chromium, manganese and nickel.

PAHs: A continuous PAH analyzer (EcoChem PAS 2000) will be deployed at the core site to obtain real-time particle-bound PAH measurements.

Meteorological Parameters: A meteorological system (Climatronics) will be deployed at the core site to obtain wind speed, wind direction, ambient temperature, barometric pressure and dew point. Similar meteorological systems are currently deployed at four of the satellite sites and will be deployed at the fifth.

Data Acquisition: Two dataloggers (ESC Model 8832) will be operated at the core site to allow for both digital and analog data capture of all parameters. Dataloggers are currently in operation at four of the five satellite sites, and one will be deployed at the fifth and configured to capture data from the Aethalometers; however, for data analysis purposes, the data stored internal to the Aethalometer will be utilized. The central polling computer located at the air-monitoring laboratory in Windsor will poll all sites on an hourly basis.

Table 1: Existing (X) and Proposed (P) Methodology for Core and Satellite sites.

	Core site	**Satellite sites**				
	Thomaston	**Cornwall**	**Danbury**	**East Hartford**	**New Haven**	**Mansfield**
Specific Wood Smoke Indicator Measurements						
Two-wavelength Aethalometer	P	P	P	P	X	P
$PM_{2.5}$ Mass Measurements						
FDMS TEOM	P		P		X	
MetOne BAM		X			X	
$PM_{2.5}$ FRM		1/3	1/3	1/1	1/1	
$PM_{2.5}$ Speciation Measurements						
Sunset OCEC	P	X			*	
Continuous SO_4	P	X			*	
3-slot DRUM	P					
IMPROVE		X				
STN					X	
Trace-Gas Measurements						
Trace CO	P	*			*	
Trace SO_2	P	X			*	
Trace NO_y	P	*			*	
Criteria Gas (non-Trace) Measurements						
CO				X		
SO_2			X		X	
NO_x				X	X	
Ozone		X	X	X	X	
Particle-bound PAHs						
EcoChem PAH	P					
Meteorological Parameters						
Climatronics	P	X	X	X	X	P
Data Acquisition						
ESC Datalogger/Model	P / 8832	X / 8832	X / 8816	X / 8816	X / 8832	P / 8816

* Planned for deployment separate from this proposal.

Outdoor Wood Furnace Source Characterization:
Testing at the stack and near-source ambient monitoring will be conducted to characterize OWFs. Following is a list of the methodologies that will be used to meet the study objectives.

Dilution Probe: A dilution probe (Rupprecht & Patashnick Series 6100 HI-RES Micro Diluter) will be used to conduct stack testing of the OWF units. The dilution manifold will allow for monitoring of multi-pollutants through the various available ports. The utilization of the dilution probe allows for the measurement of the condensables, which is critical to properly assessing total PM emissions.

Continuous $PM_{2.5}$: A continuous $PM_{2.5}$ analyzer (Rupprecht & Patashnick Series 7000 Source Particulate Monitor) will be used to obtain one- to two-minute $PM_{2.5}$ emission measurements from the OWF. This analyzer provides measurements equivalent to US EPA Methods 17 and 5 used for regulatory stack testing and has obtained conditional test method approval.

PAHs: A continuous PAH analyzer (EcoChem PAS 2000) will be used to obtain real-time particle-bound PAH measurements from the OWF units.

VOCs: VOCs will be measured using EPA Method TO-15. Canisters will be used to obtain integrated VOC measurements during the OWF test runs. Among the target compounds to be measured are high priority HAPs that include acrolein, benzene, carbon tetrachloride, chloroform, 1,3-dichloropropene, methylene chloride, perchloroethylene, 1,1,2,2-tetrachloroethane, tricholorethylene and vinyl chloride.

Dioxins: Dioxins will be measured using a General Metals Works PS-1 sampler. The sampling module of this unit contains two chambers: the upper chamber, which supports the particulate filter media, and the second chamber, which accommodates a glass cartridge containing a section of polyurethane foam (PUF). Dioxin analysis will be conducted in accordance with EPA Method TO-9.

F. Leverage of Other Resources

Coordination of Concurrent Efforts, Related Studies and Community Support: Efforts related to this proposal will be coordinated with similar and complementary ongoing efforts. These efforts include a NESCAUM/Air Directors-led initiative for the US EPA to take immediate action to regulate OWFs, and a recent petition from the New York Office of the Attorney General to the US EPA to list OWFs as a category of stationary sources and to promulgate standards of performance for OWFs (http://www.oag.state.ny.us/press/2005/aug/aug11a_05.html). The results of this study will be made available to health and environmental professionals.

Utilization of Existing Sites and Air Monitoring Programs: The CTDEP currently maintains monitoring sites at Cornwall, Danbury, East Hartford and New Haven. This is a valuable asset relative to establishing a wood smoke monitoring network, as resources will *not* have to be allotted to establish additional siting for these satellite locations. Additionally, there is significant value in the existing pollutants currently being measured at the existing sites as part of various established air monitoring programs; this will provide complementary data that will contribute to the assessments and evaluations relative to this proposal. The only sites that are not currently in operation are the proposed core site to be located in Thomaston and a satellite site proposed to be located in Mansfield. The Mansfield location was a former air monitoring site and the necessary equipment, such as a monitoring shelter, phone lines and power, are currently in place.

Utilization of Existing Equipment: The CTDEP and NESCAUM currently possess many of the analyzers that are proposed to be deployed at the core site to be established in Thomaston. These analyzers include the Sunset OCEC analyzer, a Thermo SO_4 analyzer, and a Thermo Trace-SO_2 analyzer. There is significant experience within the CTDEP in running all three of these new methods, as all three analyzers (separate from the three slated for the core site) are currently in operation at the Mohawk Mountain site in Cornwall. Additionally, NESCAUM possesses five of the Aethalometers that will be deployed to all sites. There will also be significant value in the information gathered at the existing sites to complement the data collected from the two-wavelength Aethalometer. Both the Mohawk Mountain site in Cornwall and the Criscuolo Park site in New Haven are prospective NCORE Level II sites and currently host much of the instrumentation that is proposed at the core site in Thomaston. This has inherent value in terms of experience with these new and emerging technologies and provides complementary data to assess the wood smoke impact on air quality. Regarding equipment related to source and near-source monitoring, a DataRAM 4000, provided by NESCAUM, would be utilized to continuously monitor $PM_{2.5}$ concentrations close to the source ($\approx$ 200 ft.).

Staff Expertise: Key personnel from both the CTDEP and NESCAUM included in this proposal possess the experience and expertise to successfully execute what has been put forth in this proposed study. The personnel that will be involved in this effort have significant experience in designing and managing air monitoring studies, project coordination, data management and analysis, and a thorough understanding of the wood smoke and OWF issues on both the regional and national levels.

CTDEP Salary, Fringe and Indirect Costs: The CTDEP has committed to contributing the majority of the salary, fringe and indirect costs associated with the management and execution of this project. The estimated contributed costs total $129,866.

G. Data Analysis and Reporting

Data Management and Analysis: Ambient monitoring data will be managed in the ESC EDAS database located at the Windsor Air Monitoring Laboratory. Data will be polled, stored, validated and then generated into Air Quality System (AQS) files for reporting to the US EPA. The monitoring data will be analyzed to characterize spatial resolution, concentration gradients and source signatures of air pollutants specific to wood smoke sources. The analysis performed on the data obtained in this study will build upon results from the pilot study conducted in Rutland, VT. UNMIX modeling will be applied to apportion measured $PM_{2.5}$ from the core site located in Thomaston into several source categories. The resulting factor to convert the difference of the two channels from the Aethalometer into WS PM will then be applied to the data obtained at the satellite sites. Running the UNMIX model on several of the satellite sites is possible for the sites that have a comprehensive selection of parameters currently in operation. This would be used to compare the results from the core site; however, the core site will provide the most robust analysis, given the time-resolved speciation data and the high sensitivity of the trace gas measurements. Comparisons of these results against more traditional measures of wood smoke indicators (i.e., PAHs, potassium) will also be made.

The Aethalometer will be configured to collect one-minute data. This will allow for spatial scale analysis to be conducted to determine micro-, middle-, neighborhood-, and urban-scale contributions of WS PM. This type of analysis has been conducted previously by the CTDEP in assessing local contributions of PM from diesel trucks, and has proven to be a valuable method in determining contributions from different scales of representativeness using highly time-resolved measurements.

The data obtained during the stack testing of the OWF units will be used to characterize the emissions during various operating modes. The highly time-resolved data will allow for a unique temporal analysis relative to the test runs. The data will also be used to develop emission factors for OWFs and will be put in context with other RWC units, such as woodstoves and fireplaces. The quantification of OWF emissions will also allow comparisons to proposed or future OWF emission criteria. Pollutant measurements made at the stack of the OWFs will be put into context relative to typical levels observed at ambient monitoring stations to assess contributions to air quality.

Data Submission and Reporting: The CTDEP plans to submit the quality assured data to AQS 120 days after the quarter ends, and have a final report to US EPA ninety days after the project period ends.

H. Roles of Applicant and Partners

CTDEP: The CTDEP will take a lead role in all aspects of this proposal. CTDEP will procure, deploy and operate all equipment relative to ambient wood smoke monitoring. Data validation, analysis and reporting related to ambient monitoring conducted in Connecticut will also be conducted by the CTDEP. CTDEP will work closely with NESCAUM to design and coordinate test protocols for OWF source characterization and will participate in data analysis and reporting of results. CTDEP will be responsible for reporting quality assured ambient monitoring data to the US EPA's Air Quality System (AQS) Database. CTDEP will be responsible for all Quality Assurance Project Plans (QAPPs) and quarterly and final report submissions to the US EPA.

NESCAUM: NESCAUM is a key partner in this regional effort based on its role as a leader and coordinator relative to wood smoke issues. The inclusion of NESCAUM's expertise on technical and policy issues are vital to the success of this proposal. NESCAUM will participate in the study design and data analysis, as well as reporting relative to the ambient wood smoke monitoring conducted in Connecticut. NESCAUM will coordinate efforts related to source characterization of OWFs and will be instrumental in the study design, procurement of a contractor to perform stack testing, data analysis and reporting of results. NESCAUM will coordinate efforts related to near-source ambient monitoring to include protocol development and analysis of results. NESCAUM will assist CTDEP in developing QAPPs and quarterly and final reports.

I. Key Personnel

CTDEP

Peter Babich, Environmental Analyst, **Project Manager**
Eleven years of experience in conducting air monitoring studies and directing data management/analysis, including four years with the Vermont Department of Environmental Conservation as a Project Manager for various ambient air monitoring programs, and five years at the Harvard School of Public Health, Department of Environmental Science & Engineering, participating in air monitoring studies and methods development.
Sc.D, Environmental Health, 2000, Harvard School of Public Health
B.S. Chemistry, 1995, University of North Carolina at Chapel Hill

Paul Norton, Supervisor, Air Monitoring Group
Thirty-three years of experience managing and directing air monitoring programs at the CTDEP Bureau of Air Management, including extensive experience in siting, procurement of equipment, network planning and implementation of quality assurance and standard operating procedures. The Air Monitoring Group is responsible for deployment of equipment, data acquisition, special purpose monitoring and maintains over 25 air monitoring stations.
P.E./M.S. Mechanical Engineering, Rensselaer Polytechnic Institute
B.S. Mechanical Engineering, University of Hartford

Ellen M. Pierce, Supervisor, Data Validation & Analysis Group
Twelve years of experience managing air toxics control programs and data handling for ambient air monitoring programs at CTDEP Bureau of Air Management. Two years of experience managing environmental health and occupational medicine programs at a non-profit organization. Ten years as an adjunct professor, teaching pharmacology and environmental toxicology, preparation of risk assessments, and reviewing research proposals. Six years managing laboratory research program on temporal aspects of tumor development following acute and chronic exposure to physical and chemical carcinogens at New York University Medical Center.
Ph.D., Environmental Medicine and Biology, New York University

David Wackter, Supervisor, Attainment Planning & Stationary Sources Group
Thirty years of experience in meteorology and air pollution studies, including eighteen years developing state air pollution program plans at the CTDEP and ten years as an air quality modeling program manager at TRC Environmental Consultants.
M.S. Atmospheric Sciences, 1975, Colorado State University
B.S. Meteorology, 1973, Belknap College

NESCAUM

George Allen, Senior Scientist
Twenty-five years of experience at the Harvard School of Public Health as an Engineering Supervisor and Project Manager for air pollution field studies and method development. Four years of experience at NESCAUM as a Senior Scientist planning and participating in a wide range of ambient and source-related air pollution projects.
B.S. Electrical Engineering, 1974, Tufts University

Lisa Rector, Senior Policy Analyst
Fourteen years of experience in conducting a variety of air pollution and data management studies at both the state and interstate level. This includes seven years of experience at NESCAUM as a Senior Policy Analyst working on a wide range of policy and technology studies. Five years with NEWMOA as a Senior Project Manager and three years with the Vermont Department of Environmental Conservation.
B.A. Political Science/Environmental Studies, 1986, University of Vermont

Phil Johnson, Senior Environmental and Public Health Analyst
Nine years of experience working in the community-scale air pollution monitoring, exposure assessment, and public health areas. During this time, he has studied and researched health effects and exposure concerns relating to residential biomass combustion. He recently conducted near-field ambient $PM_{2.5}$ monitoring of outdoor wood heaters.
M.P.H. Environmental Health Sciences, University of Washington
M.S. Environmental Science and Risk Analysis, University of Washington
Ph.D. (in progress), Air Pollution and Human Health, Yale University

Environment and Human Health, Inc.
1191 Ridge Road
North Haven, Connecticut 06473
Phone: (203) 248-6582 **Fax: (203) 288-7571**

Michael N. Jones
U.S. EPA (D243-02)
EMAD/AAMG
Research Triangle Park, NC 27711

August 11, 2005

Dear Mr. Jones:

Environment and Human Health, Inc. (EHHI) is writing in support of the Connecticut Department of Environmental Protection (CTDEP), Bureau of Air Management's grant request of $500,000 to investigate the contribution of wood smoke to Connecticut's air pollution of fine particulate matter, ($PM_{2.5}$). Wood smoke is a serious hazard to human health and there is a great need to know more about its contribution to the air pollution of Connecticut.

EHHI is a non-profit organization made up of ten people who are doctors, public health professionals, and policy experts. The organization is dedicated to protecting human health from environmental harms through research, education and the promotion of sound public policy.

The contacts of this organization are vast; included are connections with the Yale University School of Medicine, The Yale School of Forestry and Environmental Studies, the local Health Departments, the State Health Department, as well as the medical community as a whole.

Because EHHI conducted a study funded by the Centers for Disease Control (CDC) on *The Prevalence of Asthma Among Elementary School Children*, and because it completed its own study on *Children's Exposures to Diesel Exhaust on School Buses,* EHHI is taken very seriously in the area of air pollution and its effects on human health. We have worked closely with state legislators to create more protective policies that have resulted from our research studies. As well, David Brown, Sc.D., has worked with NESCAUM on a number of air pollution projects.

EHHI knows air pollution well and knows its harmful effects on human health - both as it relates to respiratory and coronary disease. Wood smoke is a serious air pollutant and very little, if anything, has been done in Connecticut to assess its contribution to PM 2.5 in this state. The study proposed by the CTDEP will be a very important contribution to our knowledge of air pollution in Connecticut and thus will be equally important for the introduction of policies that will be more protective of human health.

We hope you will look favorable on this important investigative study.

Sincerely,

Nancy Alderman

Nancy Alderman, President
Environment and Human Health, Inc.

NESCAUM
www.nescaum.org

The Clean Air Association of the Northeast States

101 Merrimac Street, 10th Floor Boston, MA 02114
Phone 617-259-2000 Fax 617-742-9162
Arthur N. Marin, Executive Director

August 16, 2005

Anne Gobin
Bureau Chief
CT Department of Environmental Protection
Bureau of Air Management
79 Elm Street, 5th Floor
Hartford, CT 06106-5127

Re: CT-DEP proposal on wood smoke to the U.S EPA

Dear Ms. Gobin:

NESCAUM commits to work as a subcontractor to the CT Department of Environmental Protection on the " Evaluation of Wood Smoke Contribution to Particle Matter in Connecticut", if your proposal to the U.S. EPA is funded. As agreed to in your agency's discussions with George Allen and Lisa Rector (NESCAUM Senior Staff), the budget for NESCAUM's involvement (including contracts for services) will be $185,000. NESCAUM is uniquely qualified to participate in this project with CT-DEP, and is very hopeful that you will receive a favorable response from EPA. We look forward to the opportunity to work with your agency on this project.

Sincerely,

Arthur N. Marin
Executive Director

Section 3: Detailed Itemized Budget

a. Personnel		$12,466
b. Fringe Benefits		$6,856
c. Contractual		
NESCAUM; to include:	$185,000	
Personnel: $49,136		
Fringe & Indirect: $43,731		
Contractual (stack-test): $80,000		
Travel: $8,000		
Equipment/Supplies: $4,133		
Dioxin analysis	$25,000	
TO-15 analysis	$20,000	
DRUM mass and toxic metals analysis	$20,000	
	Contractual Total	$250,000
d. Travel		$0
e. Equipment		
2 FDMS TEOMs	$50,000	
1 DRUM Sampler	$7,000	
2 Trace-CO Analyzers	$30,000	
2 Trace-NOy Analyzers	$35,000	
2 EcoChem PAH Analyzers	$40,000	
2 Climatronic Meteorological Stations	$22,000	
3 ESC 8832 Dataloggers	$24,000	
3 S-Plus Data Management/Analysis Software	$7,500	
DataRAM (DR4000) Calibration	$1,000	
	Equipment Total	$216,500
f. Supplies		$10,533
g. Other		$0
h. Total Direct Costs		$496,355
i. Total Indirect Costs		$3,645
j. Total Cost		**$500,000**

Section 4: Quality Assurance Narrative

The CTDEP has an approved Quality Management Plan (QMP; August 2002) on file with the US EPA. The CTDEP plans to submit Quality Assurance Project Plans (QAPPs) that are specific to this project to the US EPA before monitoring begins. Upon notification of the grant award, QAPPs will be developed for both the Ambient Wood Smoke Monitoring and the Outdoor Wood Furnace Source Characterization portions of this proposal. Both QAPPs will identify specific Data Quality Objectives (DQOs) associated with the respective activities described in this proposal. The Ambient Wood Smoke Monitoring QAPP to be developed will build upon on the infrastructure and other QAPPs currently in place at CTDEP. Current QAPPs that have been approved or have been submitted to EPA Region I for consideration, and which will be utilized as part of the Ambient Wood Smoke Monitoring effort, are as follows:

- CTDEP Particle Matter (PM) QAPP (August 8, 2005)
- CTDEP O_3, SO_2, CO and NO_2 Air Pollutant QAPP (August 1, 2005)
- CTDEP Black Carbon Sampling and Analysis QAPP (January 21, 2004)
- Regional Aerosol Intensive Network (RAIN) QAPP (April 15, 2005)
- Interagency Monitoring of Protected Visual Environments (IMPROVE) QAPP (March 2002)
- $PM_{2.5}$ Speciation Trends Network (STN) QAPP (August 1999)

These QAPPs will be updated annually, where appropriate, to reflect necessary changes related to the ambient wood smoke monitoring efforts. For example, the Black Carbon Sampling and Analysis QAPP will be updated to address the inclusion of analysis of the 370 nm channel, in addition to the 880 nm channel. The Ambient Wood Smoke Monitoring QAPP will refer to these existing QAPPs and also address new technologies that will be deployed as part of this proposal.

The CTDEP will develop, along with NESCAUM, a QAPP that specifically addresses the Outdoor Wood Furnace Source Characterization portion of this proposal. To be included along with the DQOs, are the study design, test protocols, sampling procedures, analytical methods and data management and analyses processes.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OMB CIRCULAR A-87 COGNIZANT AGENCY
NEGOTIATION AGREEMENT

State of Connecticut
Department of Environmental Protection
Hartford, CT

Date: May 28, 2004
Filing Ref: February 25, 2002

The indirect cost rates contained herein are for use on grants and contracts with the Federal Government to which Office of Management and Budget Circular A-87 applies, subject to the limitations contained in the Circular and in Section II, A below.

SECTION I: RATES

Type	Effective Period			
Fixed:	From	To	Rate	Base
Indirect Costs	7/1/2002	6/30/2003	28.95%	(a)
Indirect Costs	7/1/2003	6/30/2004	31.56%	(a)
Indirect Costs	7/1/2004	6/30/2005	29.24%	(a)

Basis for Application
(a) Direct salaries and wages excluding student labor and sick leave upon retirement.

Treatment of Fringe Benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs.

SECTION II: GENERAL

A. LIMITATIONS: The rates in this Agreement are subject to any statutory and administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the department/agency or allocated to the department/agency by an approved cost allocation plan were included in the indirect cost pool as finally accepted; such costs are legal obligations of the department/agency and are allowable under governing cost principles; (2) The same costs that have been treated as indirect costs have not been claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the department/agency which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. CHANGES. The fixed rate contained in this agreement is based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in the organizational structure or changes in the method of accounting for costs which affect the amount of reimbursement resulting from use of the rate in this agreement, require the prior approval of the authorized representative of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowances.

C. THE FIXED RATE contained in this agreement is based on an estimate of the cost which will be incurred during the period for which the rate applies. When the actual costs for such a period have been determined, an adjustment will be made in the negotiation following such determination to compensate for the difference between the cost used to establish the fixed rate and that which would have been used were the actual costs known at the time.

D. NOTIFICATION TO FEDERAL AGENCIES: Copies of this document may be provided to other Federal agencies as a means of notifying them of the agreement contained herein.

E. SPECIAL REMARKS: None

ACCEPTANCE

By the State Agency:

Peter K. Kukiel
(Signature)

Peter K. Kukiel
(Name)

~~Chief, Fiscal Admin Services~~ 1
(Title)

CT Department of Env Protection
(Agency)

6/16/04
(Date)

By the Federal Agency:

James Pecot
(Signature)

James Pecot, Cost Negotiator
Financial Analysis and Rate
Negotiation Service Center
U.S. Environmental
Protection Agency
May 28, 2004

Negotiated by: James Pecot
Telephone: 202-564-4423