

Airborne Particulate and Silica Health Risks from Sand Mining and Processing

18 January 2013

Land Stewardship Project Citizens' Frac Sand Summit

Tau Center, Winona, MN

Crispin Pierce PhD

University of Wisconsin-Eau Claire



Academic Partners



STOUT
UNIVERSITY OF WISCONSIN

and

Environmental Health Sciences RESEARCH CENTER
A National Institute of Environmental Health Sciences Center of Excellence

[Home](#) [Contact Us](#)

The University of Wisconsin

About the EHSRC

- Director's Welcome
- Strategic Vision
- EHSRC History

Center Members

Pilot Grant Program

Alternative energy sources, such as wind and biofuels are changing the rural landscape and improving environmental health.

SUMMARY

- Frac sand mining, processing, and transportation increase fine dust particle levels (PM_{2.5}, which include crystalline silica) in the air.
- These particles cause cardiovascular disease, lung disease and lung cancer.
- Our measurements have found higher levels around sand plants, compared to regional levels.
- Monitoring of local PM_{2.5} and silica is essential to protect public health.

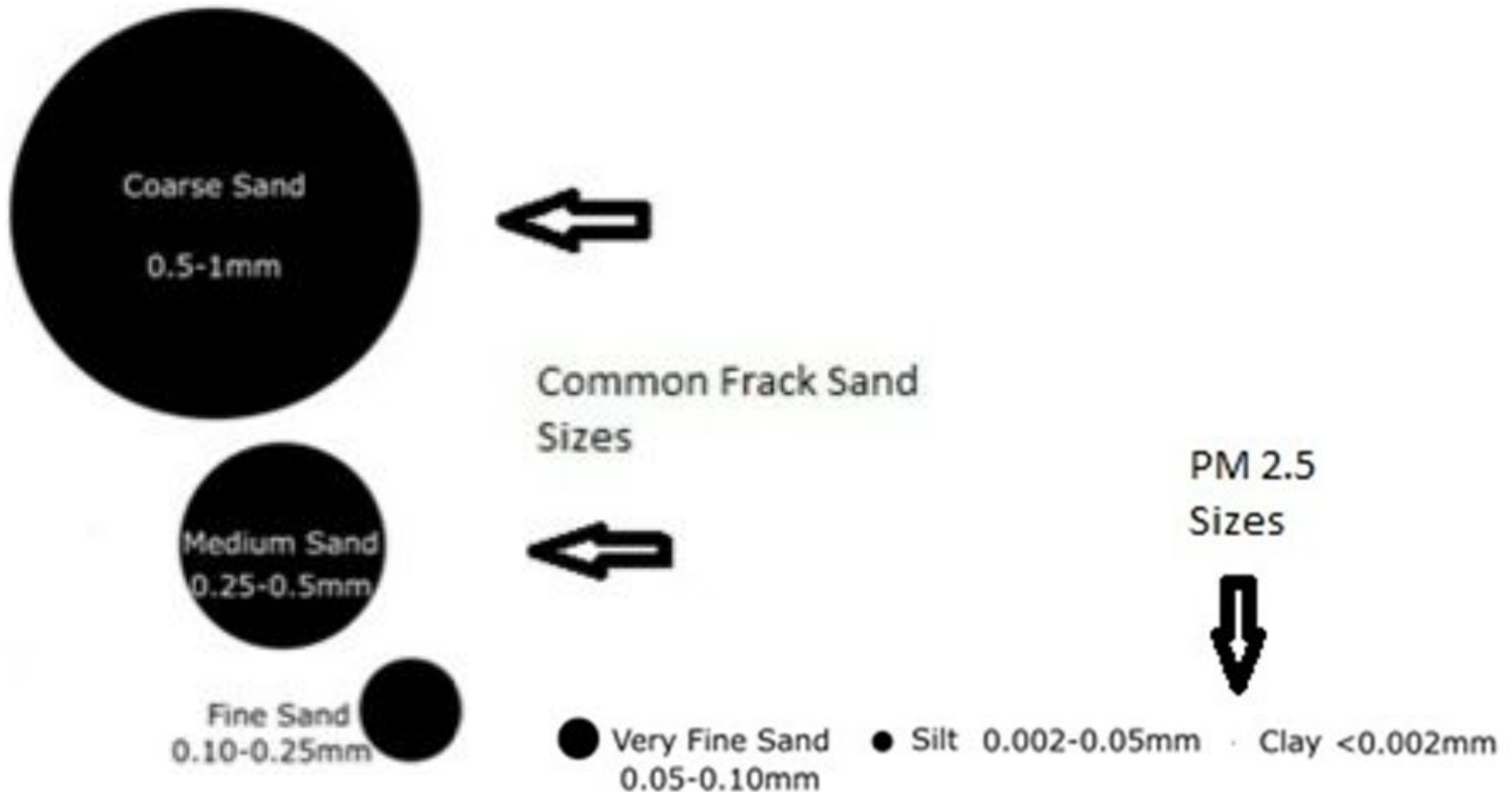
Overview of Health Risks

- **Airborne pollutants**
- Waterborne pollutants
- Noise pollution
- Light pollution
- Wetland loss that affects local water quality.
- Truck traffic that affects road safety.
- Greenhouse gas generation that increases climate change.

Particulate Matter (PM)

- Increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, asthma;
- Development of chronic bronchitis;
- Irregular heartbeat;
- Nonfatal heart attacks; and
- Premature death in people with heart or lung disease.

Particle Size is Important



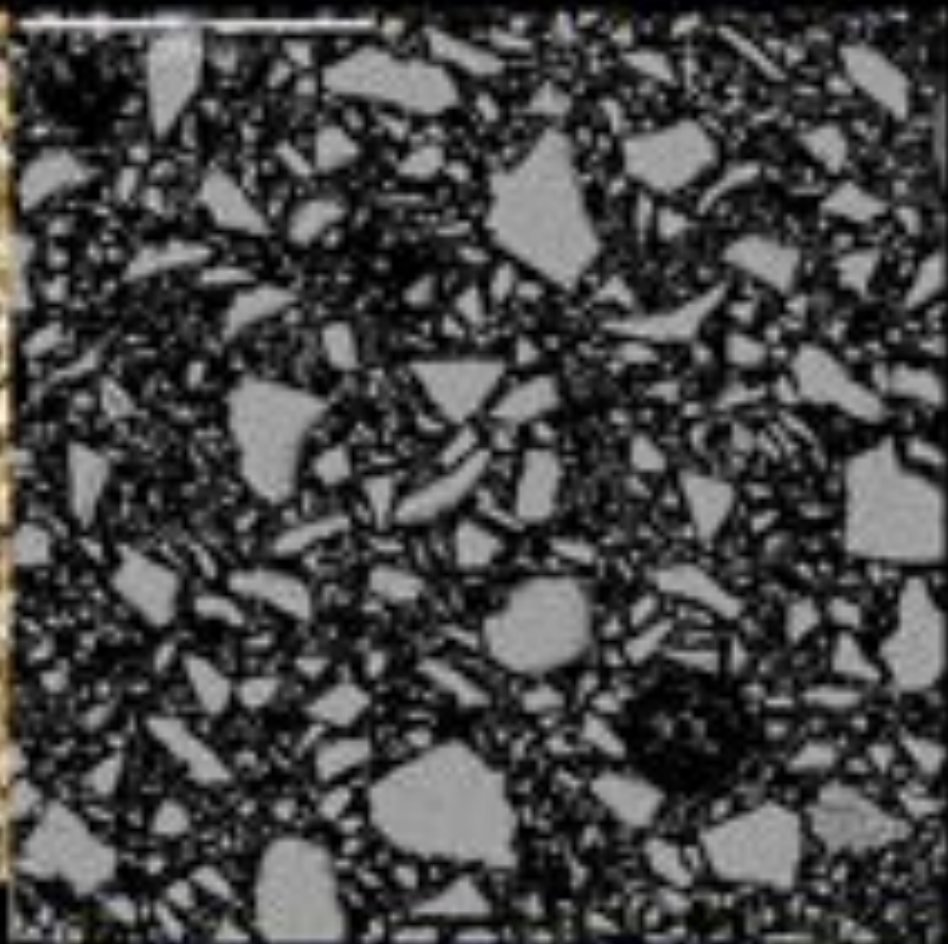
Crystalline Silica (Quartz)



Sand



Respirable Silica (Quartz)



CDC

NIOSH

Health Effects

- Silicosis –a fibrosis (scarring) of the lungs. Silicosis is progressive and leads to disability and death.
- Kidney, autoimmune diseases
- About 200 people in the US will die this year due to workplace exposure to silica (NIOSH 2008).
- Between 8-18 people are expected to die in Wisconsin from workplace silicosis in 2013.

Lung Cancer – Crystalline silica (quartz) is classified as a human carcinogen by the following regulatory agencies:

- International Agency for Research on Cancer (IARC)
- National Toxicology Program
- California Proposition 65
- American Conference of Governmental Industrial Hygienists (ACGIH)
- Occupational Safety and Health Administration (OSHA) - Potential Cancer Hazard
- National Institute for Occupational Safety and Health (NIOSH) – Potential Cancer Hazard

How Are Particulates and Silica
Generated During Sand Operations?



Image:
upstreamonline.com

- Frac sand mining and processing generate PM and silica through blasting, loading, and hauling; processing activities such as crushing; and transporting frac sand and “waste sand.”



Photos taken of the silica sand mine and processing site at CTH DD and STH 64 in the Town of Auburn on October 7, 2011 by James Torseth. Note visible emissions from sand piles.



Photo: Vaughn Nagahashi

Conveyor Belt Sand Leakage



Photo: Vaughn Nagahashi

Blasting



Photo: Vaughn Nagahashi

Frac Sand Trail Derailment



DNR Violations of Truck-to-Train Transfer

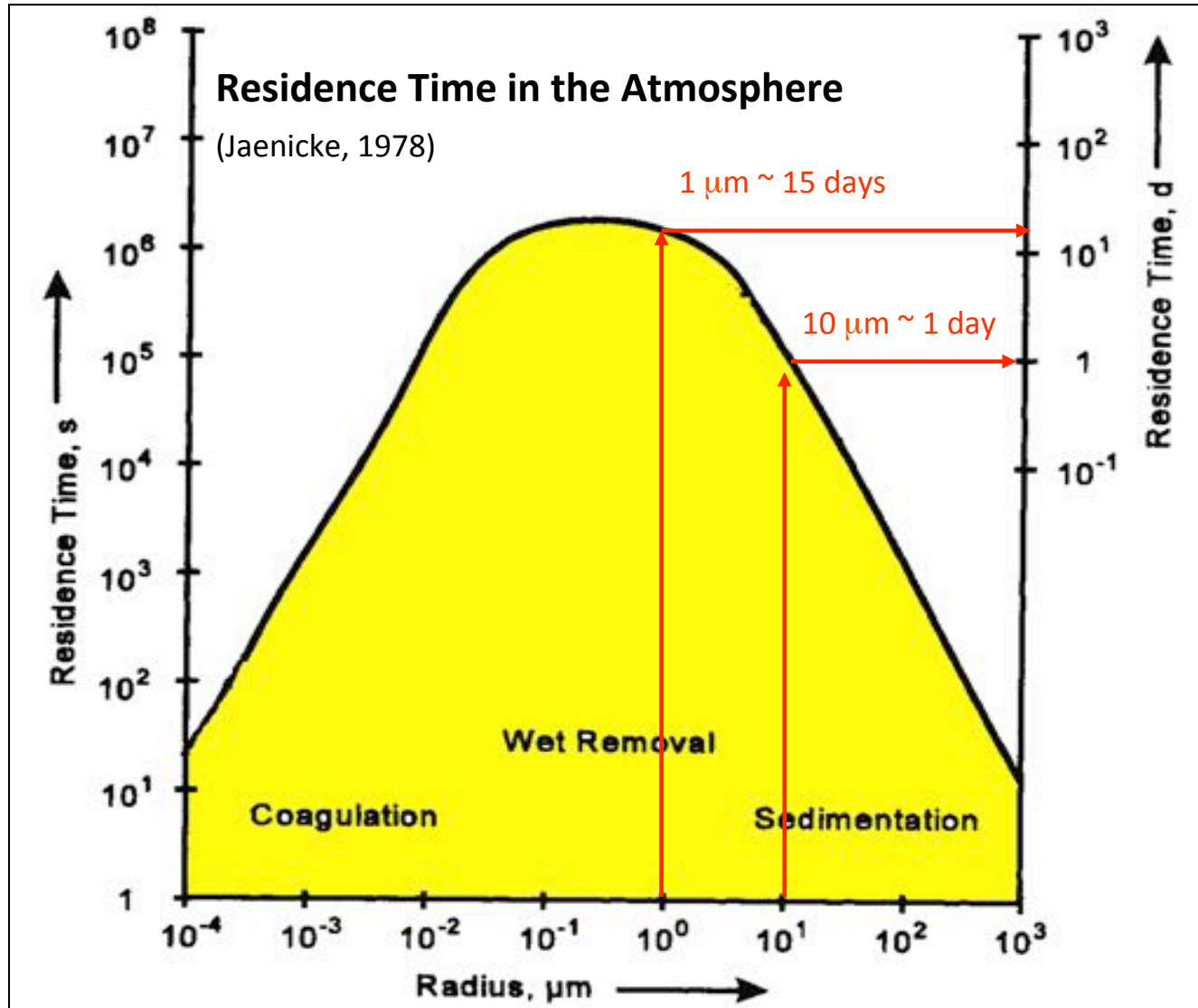


“Pattison Sand South Main Street older conveyor spout not properly sealed to railcar (01/09/2013)”

Sand Plants Add Significant PM_{2.5} Pollution to the Air

NAAQS Analysis	PM ₁₀ 24-hr	PM _{2.5} 24-hr	PM _{2.5} Annual
Facility Impact	17.7	7.1	0.6
Background	29.4	25.6	8.7
Total	47.1	32.7	9.3
NAAQS	150.0	35.0	15.0
% NAAQS	31	93	62

PM2.5 is in the Air for 10-15 Days



Regulation

- Six states (but not Wisconsin) are now regulating crystalline silica exposure: the State of California OEHHS has done a careful job of establishing a non-cancer risk threshold of 3 ug/m³ to protect the public from silicosis (Myers 2010).
 - New Jersey: 3 ug/m³ measured as PM₁₀.
 - New York: 0.06 ug/m³ measured as PM₁₀.
 - Texas: 0.27 ug/m³ measured as PM₄.
 - Vermont: 0.12 ug/m³ measured as PM₁₀.
 - Minnesota: 3 ug/m³ measured as PM₄.

WDNR Believes PM2.5 Standards are Being Exceeded

- Jeffrey Johnson, an environmental engineering supervisor at the DNR ... said there are "a couple of [frac sand plants] that would exceed the [federal] PM 2.5 standards." (Source: [Inside Climate News, 5 Nov. 2013](#))

Industry Studies

Industry Study Found Low Levels of Silica (Richards 2013)

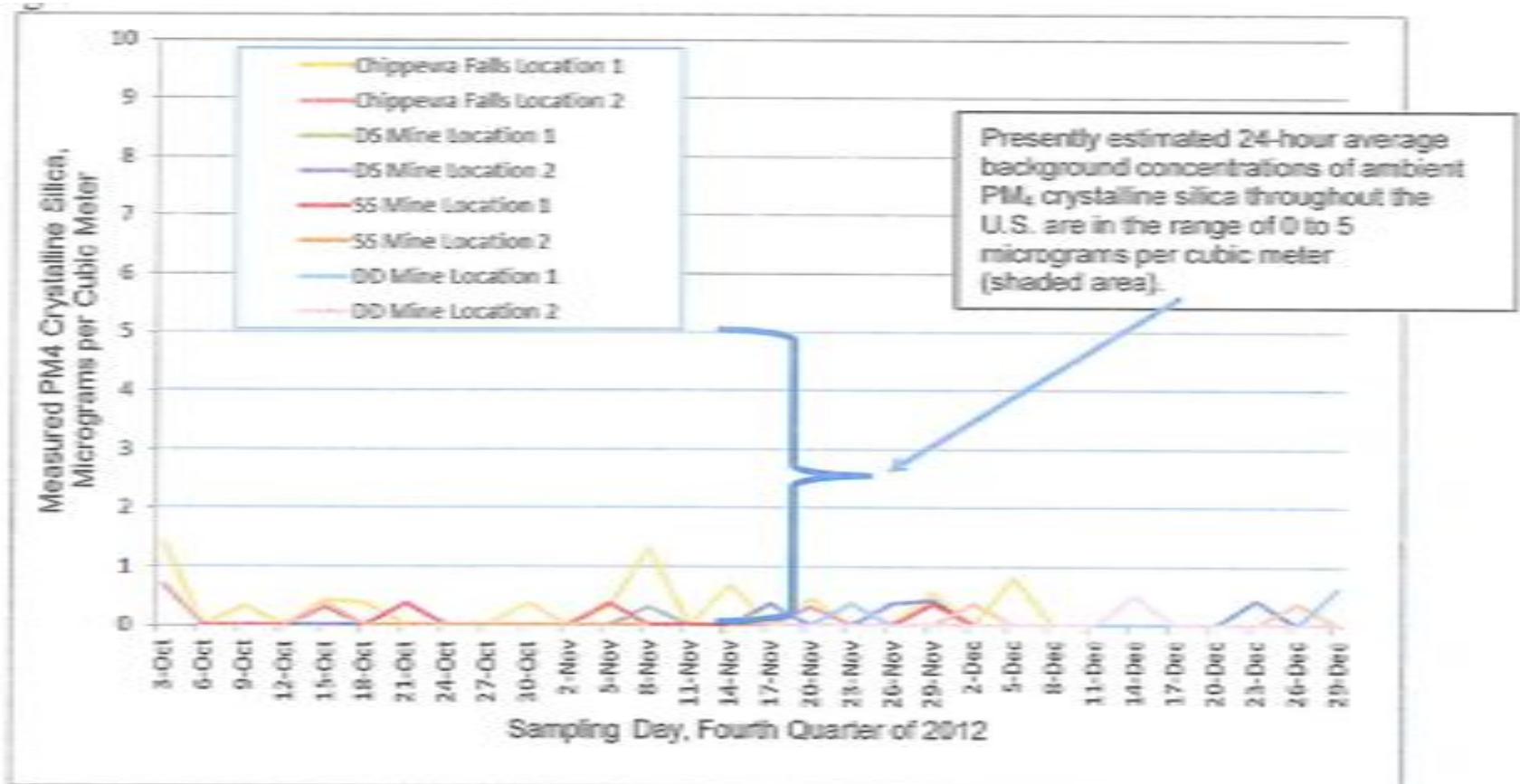


Figure 1-I. PM4 Crystalline Silica Concentrations (Total of 201 Samples)

EPA found levels <3 ug/m3 in major cities (EPA/600/R95/115) .

- Industry values are 10-30 ug/m³ PM₁₀ (Stantec Consulting Services Inc. for Superior Silica Sand).
- Equivalent to 6-19 ug/m³ PM_{2.5} (using 63% of PM₁₀ is PM_{2.5}).

Our Research





- Local sand mining, processing, and transport sites in the Chippewa Valley area
- Proposed site in Winona, MN
- Data collection of PM_{2.5} and PM₁₀ sized particulates concentrations in air around active and inactive sites
 - 1 to 2 minute ‘snapshots’ and 24-hour filter collections
- Also recorded longitude, latitude, relative humidity, wind direction, wind speed, and time (actual/duration)

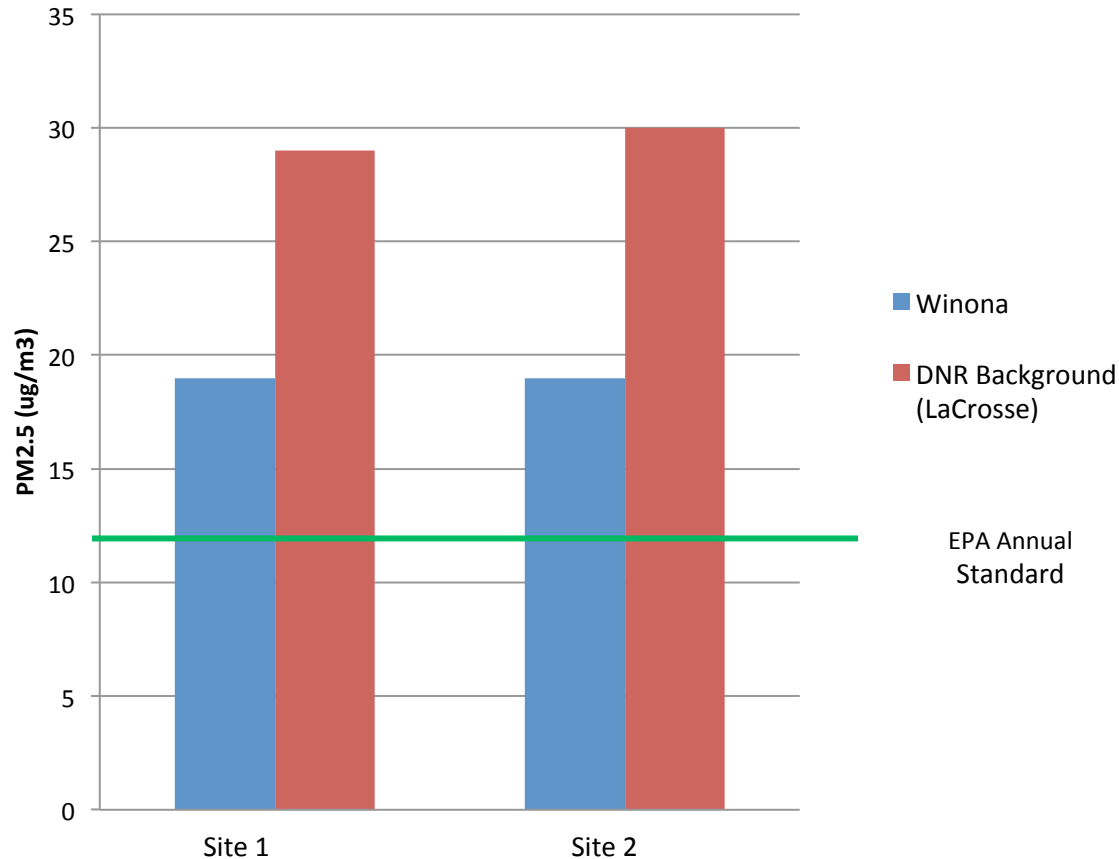
PM2.5 Levels May be the Best Indicator of Public Health Risk

- A 1995 American Cancer Society study, 2002 follow-up, and published 2012 study of six cities found that each 10-microgram per-cubic-meter increase in long-term average PM2.5 concentration was associated with,
 - a 4-14% increased risk of death from all natural causes,
 - a 6-26% increased risk of death from cardiopulmonary/cardiovascular disease (including stroke), and
 - an 8-37% increased risk of death from lung cancer.

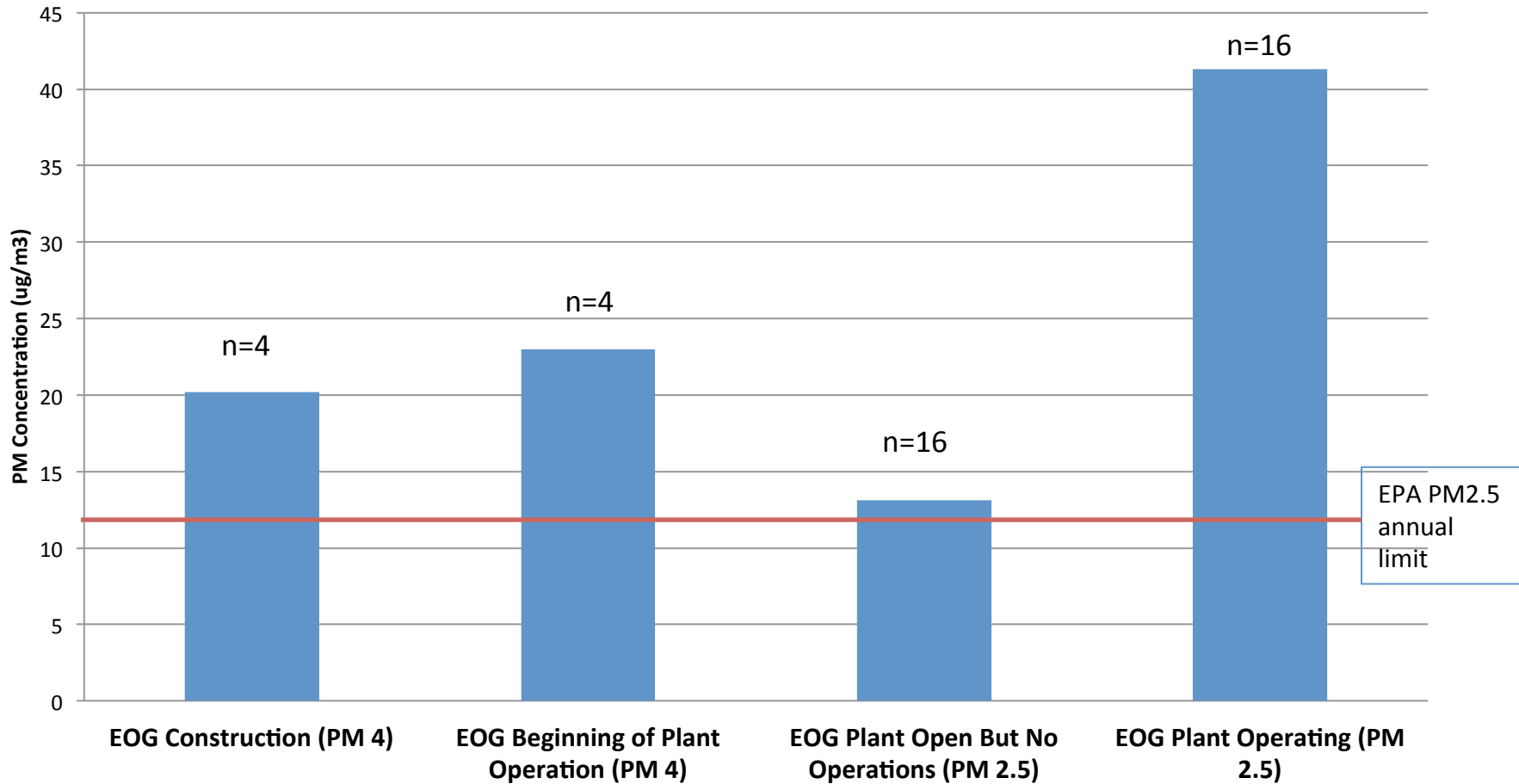
Measurement and Enforcement of the Current EPA 12 ug/m³ PM_{2.5} Standard is Likely to Protect Against Silicosis Risk

- About 15% of PM₄ is silica (MSHA inspections)
- Using the PM_{2.5} standard, 12 ug/m³ x 15% = 1.8 ug/m³.
- This is below the State of California silica standard of 3 ug/m³.

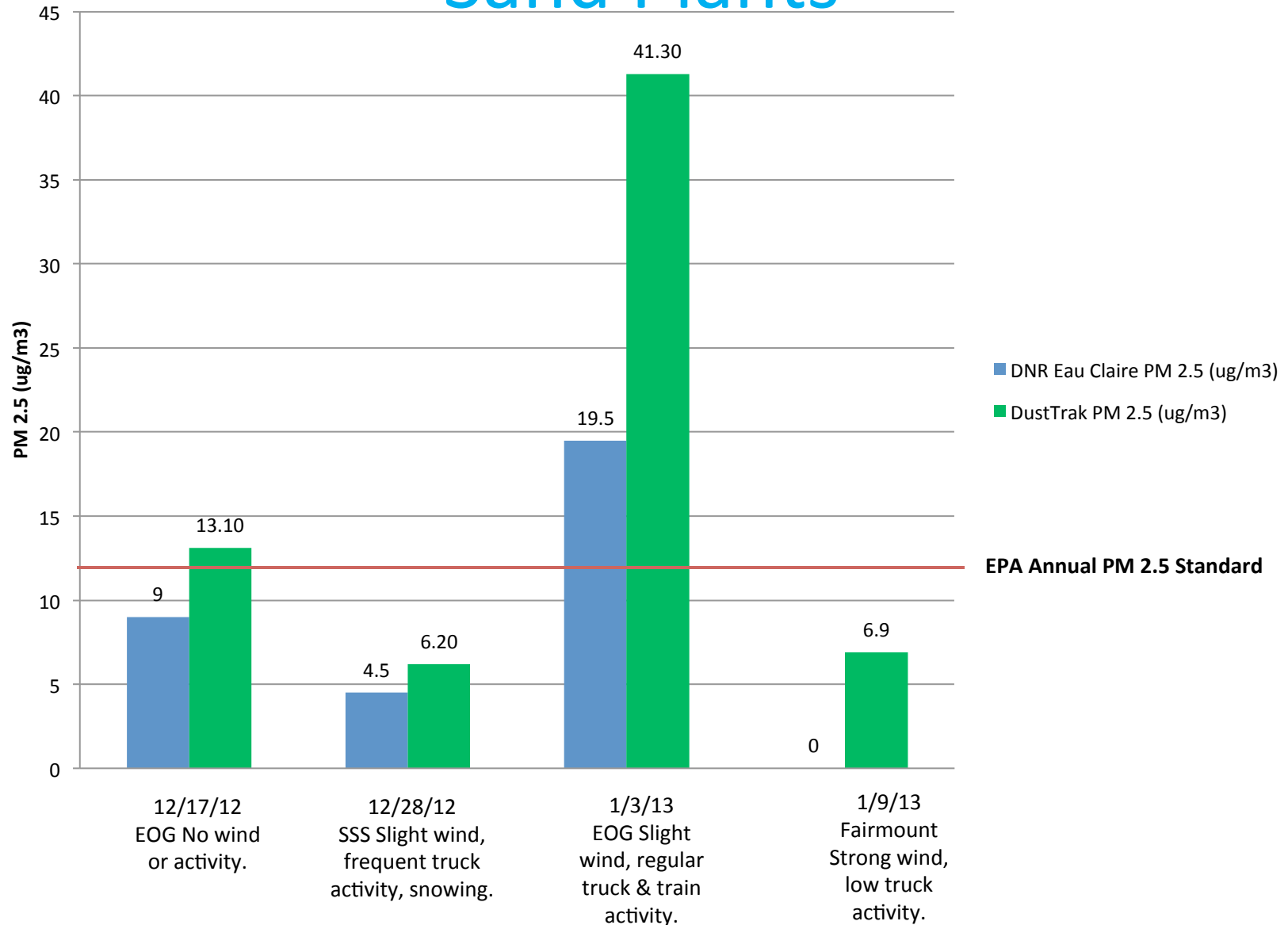
PM2.5 Samples in Winona, MN Prior to Sand Plant Construction Were Lower Than DNR Background Levels



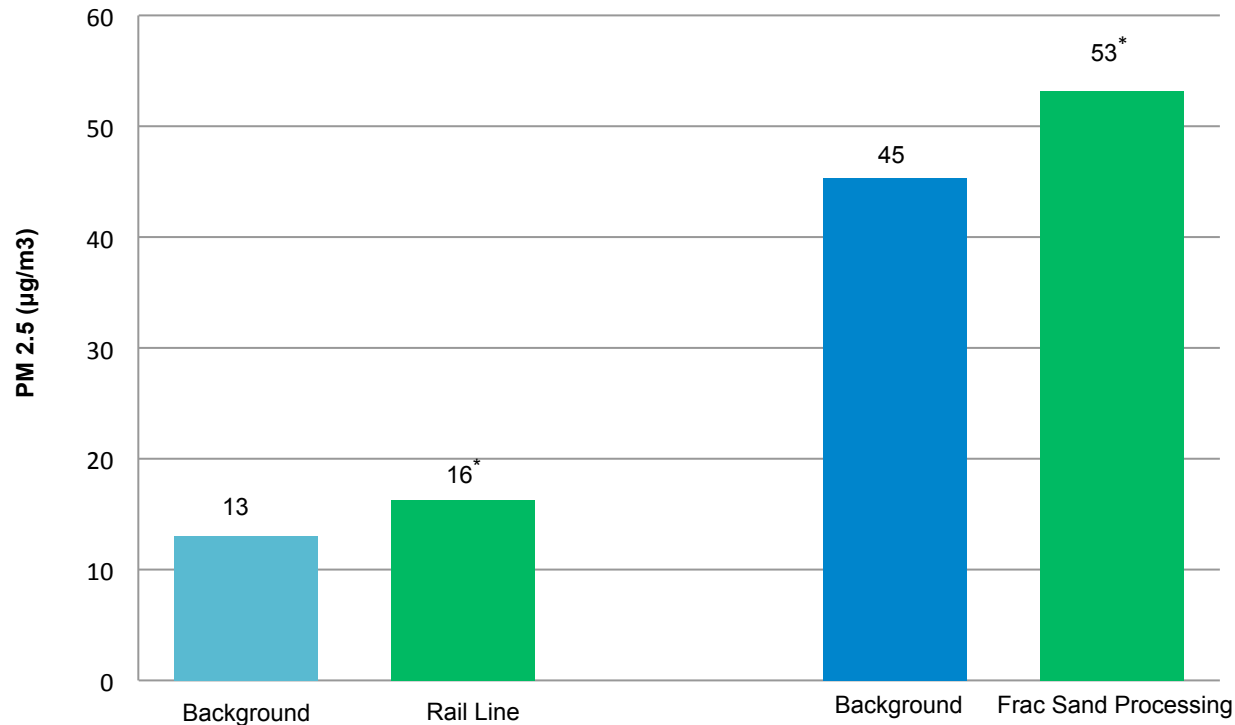
Measured EOG PM2.5/4 Increased During Operation



PM 2.5 Increases Over Background at Sand Plants



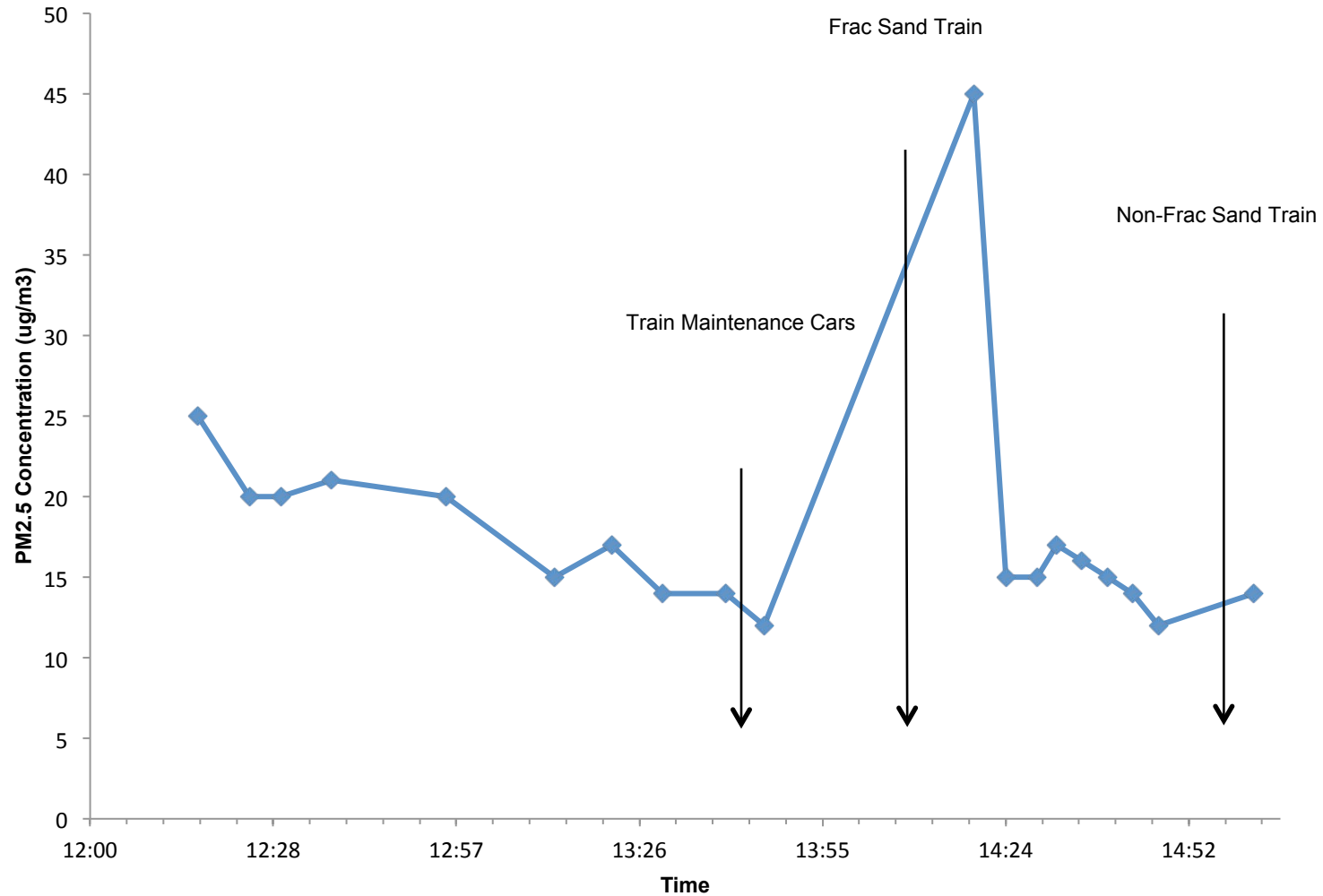
PM 2.5 Increases Over Background with DustTrak



*Significantly higher than background ($p < 0.05$)

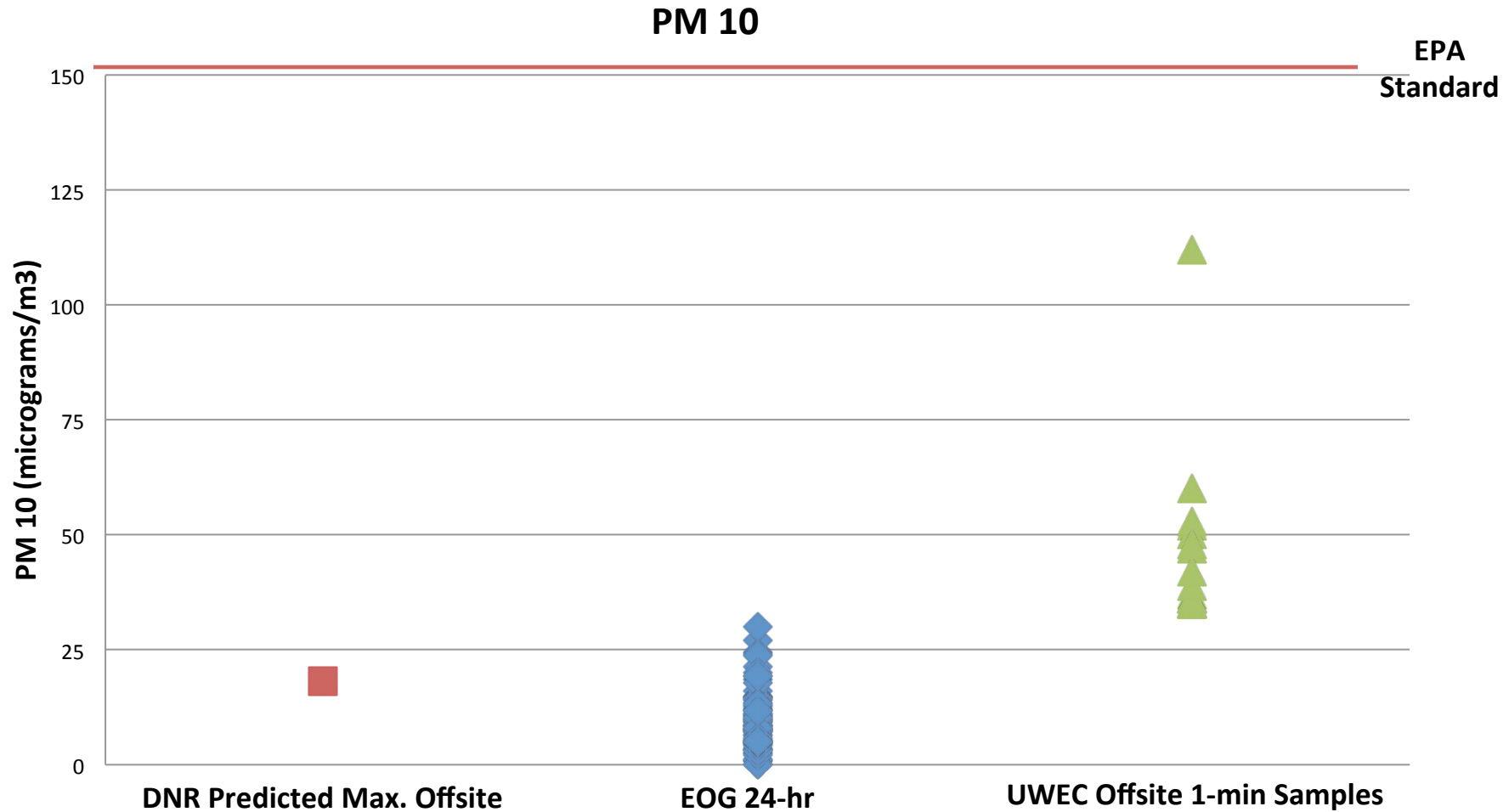
Background and frac sand rail transport and processing site PM_{2.5} concentrations.

PM2.5 Levels Along Rail Line



PM_{2.5} concentrations next to a frac sand rail line with and without train traffic.

PM10 Levels Higher Than DNR Predicted or EOG Measured



Conclusions

- PM2.5 (particles with diameters of 2.5 micrometers and less) are of most concern to public health;
- Measurement and enforcement of the current EPA annual PM2.5 standard of 12 micrograms/m³ is likely to protect against silicosis risk from respirable crystalline silica;

- Our 1- to 5-minute multiple "snapshot" samples found that the measured levels of PM_{2.5/4} increased starting from the Chippewa Falls EOG plant construction through full operation; and
- Measured levels of PM_{2.5} at EOG, Superior Silica Sands (New Auburn, Auburn), Fairmount mine (Menomonie), and Hi-Crush (Bridge Creek) were 1.7-22 micrograms/m³ higher than concurrent DNR regional levels.

- 24-Hour filter samples have also shown elevation of PM_{2.5} around sand plants, compared to DNR regional levels.
- Initial measurements suggest elevation of PM_{2.5} levels along rail lines as loaded frac sand trains pass.

Support for LSP Positions

“Continuous ambient air quality monitoring. ...the installation and maintenance of state-of-the-art continuous air monitoring equipment that is overseen by the MPCA. Facilities must not allow silica dust in the ambient air at their property line to exceed the [level of safe exposure established by the Minnesota Department of Health](#). Computer modeling should not take the place of on-the-ground real time monitoring. **Monitoring data is made public.** Air monitoring results are produced and available to the public in real time via the web.”

Real-Time PM2.5 Data on “Smogwatch”

DATA TABLE

Units: ug/m3

Date: 1/16/2014

District(s): Minneapolis, Minneapolis Area (other nearby AQ stations)

Hour (CST, begin-hour)

SITE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Winona	4	3	3	5	5	5	3	3	6	5	4	5	9	7	8	7	7	7	11	8	6	4	3	-999

<http://www.smogwatch.com/minn/>

Click on “Real-time Data” near the top of the page, scroll to the bottom of the page that comes up, choose a date, for “Parameter” choose “PM 2.5”, and then click on “Select.”

Questions?

- Crispin Pierce, PhD
- Associate Professor, University of Wisconsin-Eau Claire
- 715-836-5589
- piercech@uwec.edu
- <http://www.uwec.edu/Watershed/enph/silica/index.htm>

DNR Regulation

- Uses EPA AERMOD computer model to predict increase in air levels of pollutants.
 - Amount of sand processed per day
 - Unit emission rates for different kinds of stacks
 - Pollution control equipment (e.g., baghouses)
- PM10 monitoring “required” but often waived.
- “Fugitive dust control plan” for emissions not from a stack.

Critique of DNR Approach

- Does not include fugitive dust emissions in prediction of pollutant levels.
- Does not consider cumulative effects from nearby sources of pollutants (e.g., other sand plants).
- Has declined to establish a limit for crystalline silica exposure.
- Does not require monitoring of PM_{2.5} or crystalline silica.

DNR Identifies Crystalline Silica as a Carcinogen



State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew J. Frank, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY Access via relay - 711

Crispin H. Pierce, Ph.D.
1314 S. Farrell St
Eau Claire, WI 54701

FID #609072860

Subject: Your letter to Al Shea regarding Canadian Sands & Proppants

Dear Mr. Pierce:

Thank you for your letter to Al Shea regarding his response to Jamie Saul of Midwest Environmental Advocates. Mr. Shea asked me to respond.

Since there is little in the way of accepted scientific tools or applicable regulatory standards to evaluate the risk or impact of exposure to crystalline silica, the Department took a pragmatic approach. Crystalline silica is a carcinogen. Under our state rules for hazardous air pollutants (ch. NR 445, Wis Adm. Code), carcinogens are regulated by either keeping emissions below a certain level, or by providing a high level of technology control. In this case the standard is to provide a high level of technology control.

Wisconsin Occupational Health Lab Study

- The Wisconsin Occupational Health Lab measured an increase from <1% (June-Dec. 2011) to 5-10% crystalline silica (Dec. 2011-June 2012) in New Auburn School air filters.