Sand Plant Particulate/Silica Research Update

Crispin Pierce PhD
University of Wisconsin-Eau Claire
7 June 2013

Overview of Health Risks

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

Chemicals of Concern: Particulate Matter (PM)

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

Particle Size is Important

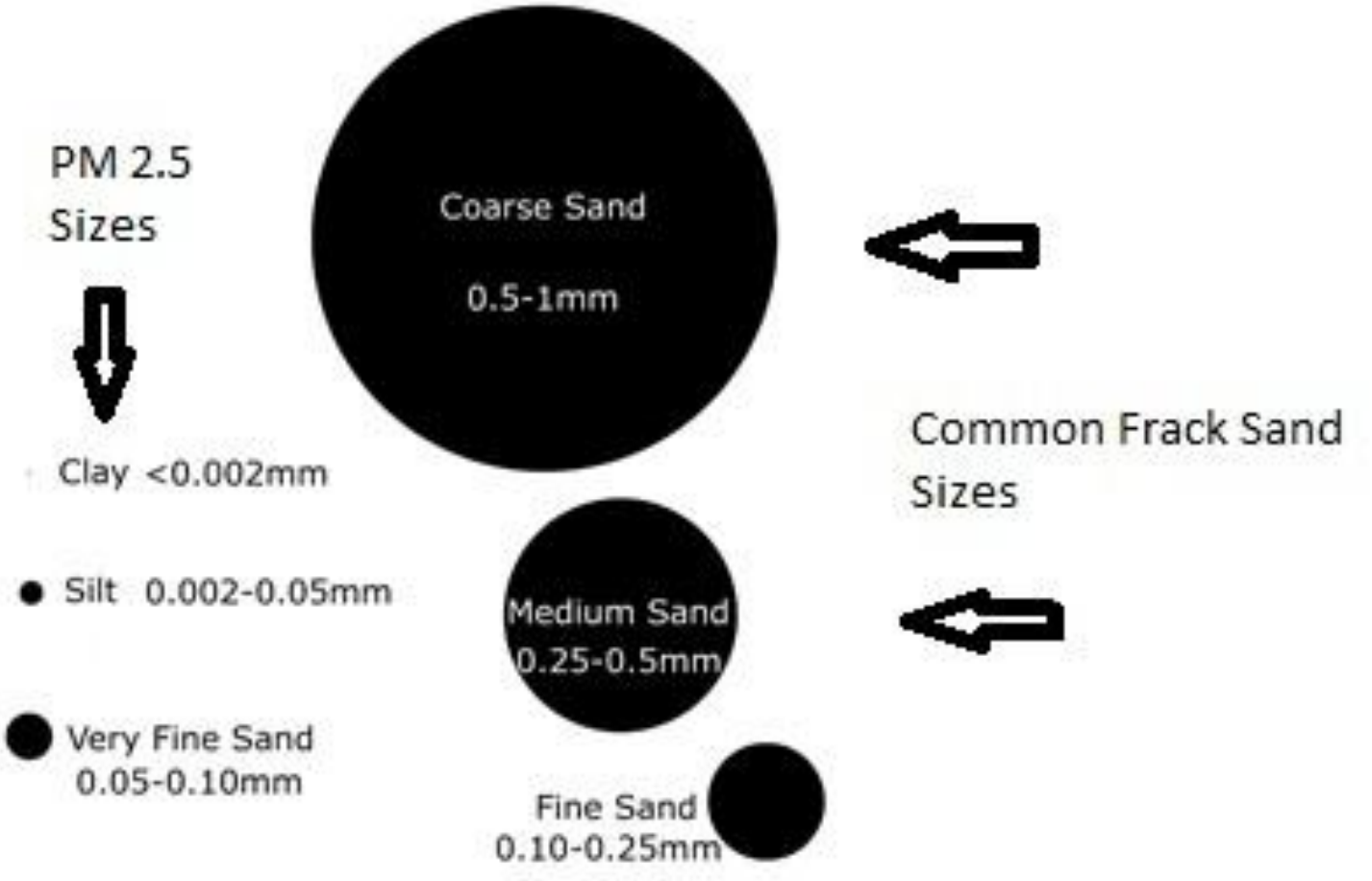


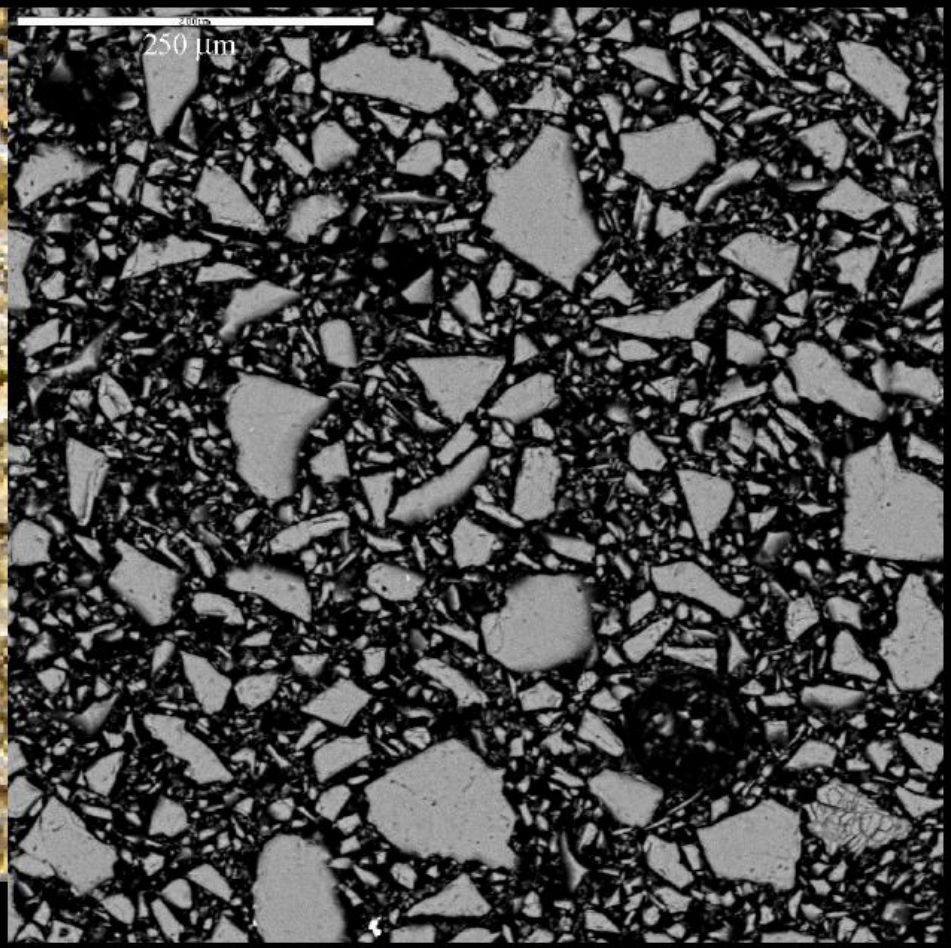
Image: Modified from http://www.riverpartners.org

Chemicals of Concern: Crystalline Silica

NIOSH OIL & GAS EXTRACTION SAFETY & HEALTH RESEARCH

Sand

Respirable Silica (Quartz)



SEM image courtesy: Geoff Plumlee, Ph.D., Heather Lowers, MS, USGS 2011

CDC Workplace Safety and Health NIOSH

Health Effects

- Silicosis –a fibrosis (scarring) of the lungs. Silicosis is progressive and leads to disability and death.
- 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 2012.

SOURCE: National Center for Health Statistics multiple cause of death data. Population estimates from U.S. Bureau of the Census, http://www.cdc.gov/niosh/docs/96-134/pdfs/96-134e.pdf

- 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**
  - **Occupational Safety and Health Administration - Potential Cancer Hazard**
  - **National Institute for Occupational Safety and Health (NIOSH) – Potential Cancer Hazard**

Sand Mining and Processing Generate PM and Silica

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.”

Particulates and Silica From Sand Plants

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. Photographer noted *"Upwind of the site the sky was clear. Downwind of the site there was a whitish gray haze extending for a mile or more."*

Regulation

- Five 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).

Research at UW-Eau Claire

- Review previous research and exposure standards for exposure to particulate matter (PM10, PM4, PM2.5, and “respirable” dust particles), and crystalline silica (quartz).

- Record GPS coordinates, wind speed and direction, particulate matter concentrations and crystalline silica concentrations surrounding sand mining, transporting, and processing plants in Wisconsin.

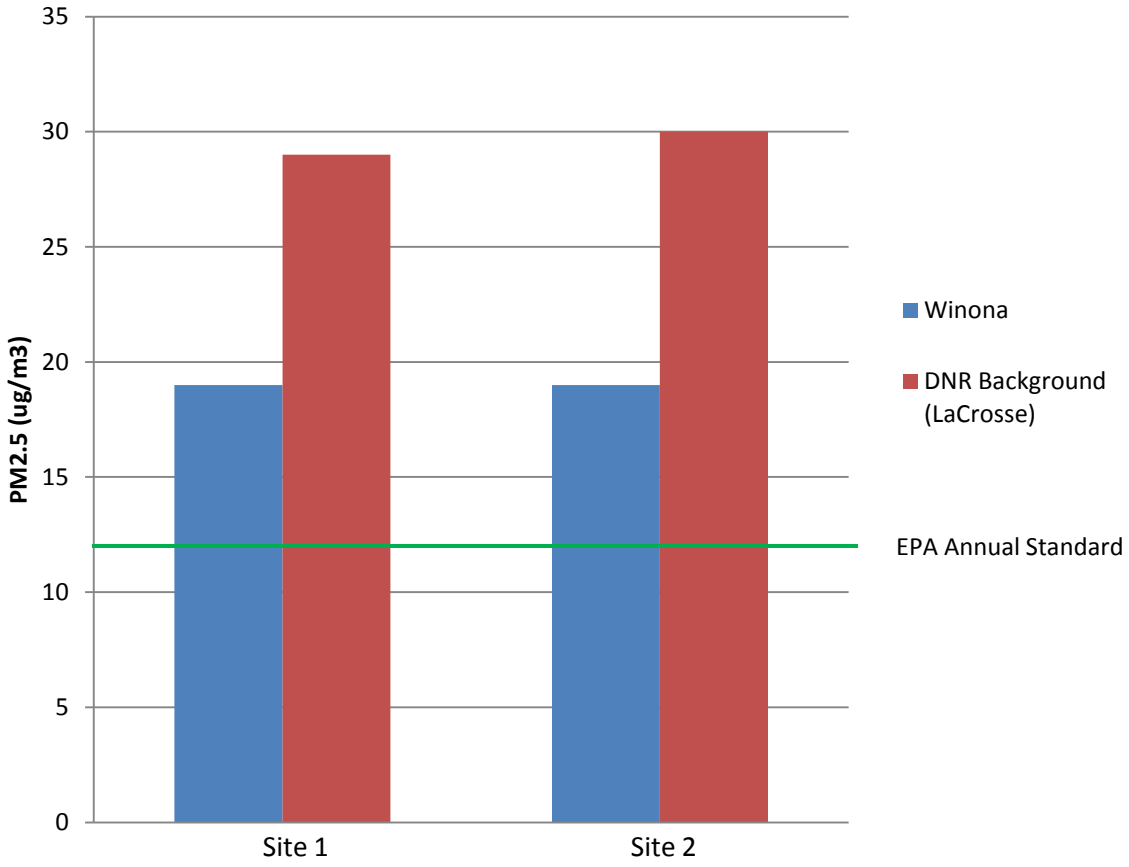
RESULTS

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, and
  - an 8-37% increased risk of death from lung cancer.

References: http://toxicology.usu.edu/endnote/1132.pdf, http://**dx.doi.org/10.1289/ehp.1104660**

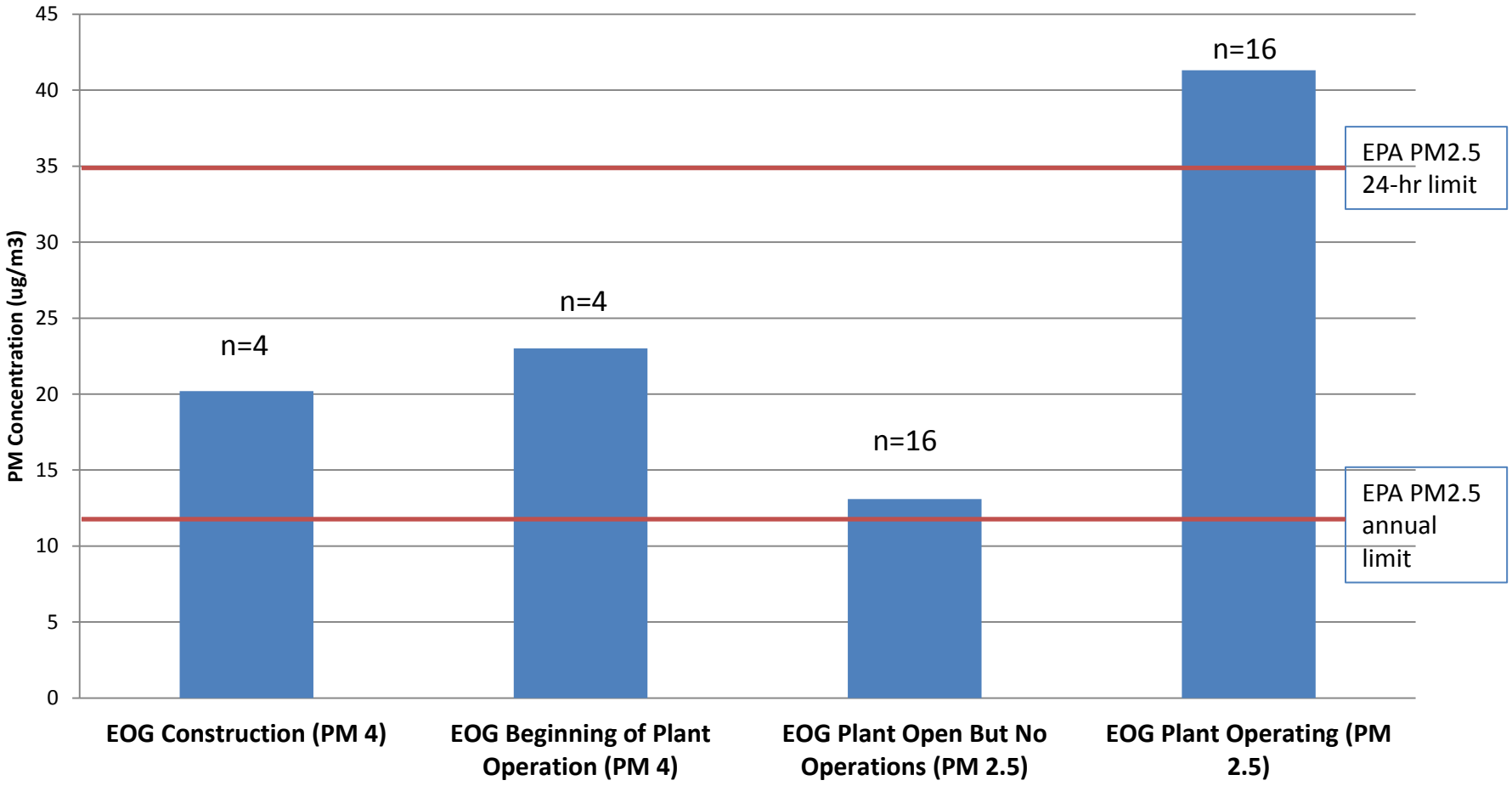
PM2.5 Samples in Winona, MN Prior to Sand Plant Construction Were Lower Than DNR Background Levels



Measured Levels of PM2.5/4 Increased from EOG Plant Construction Through Full Operation

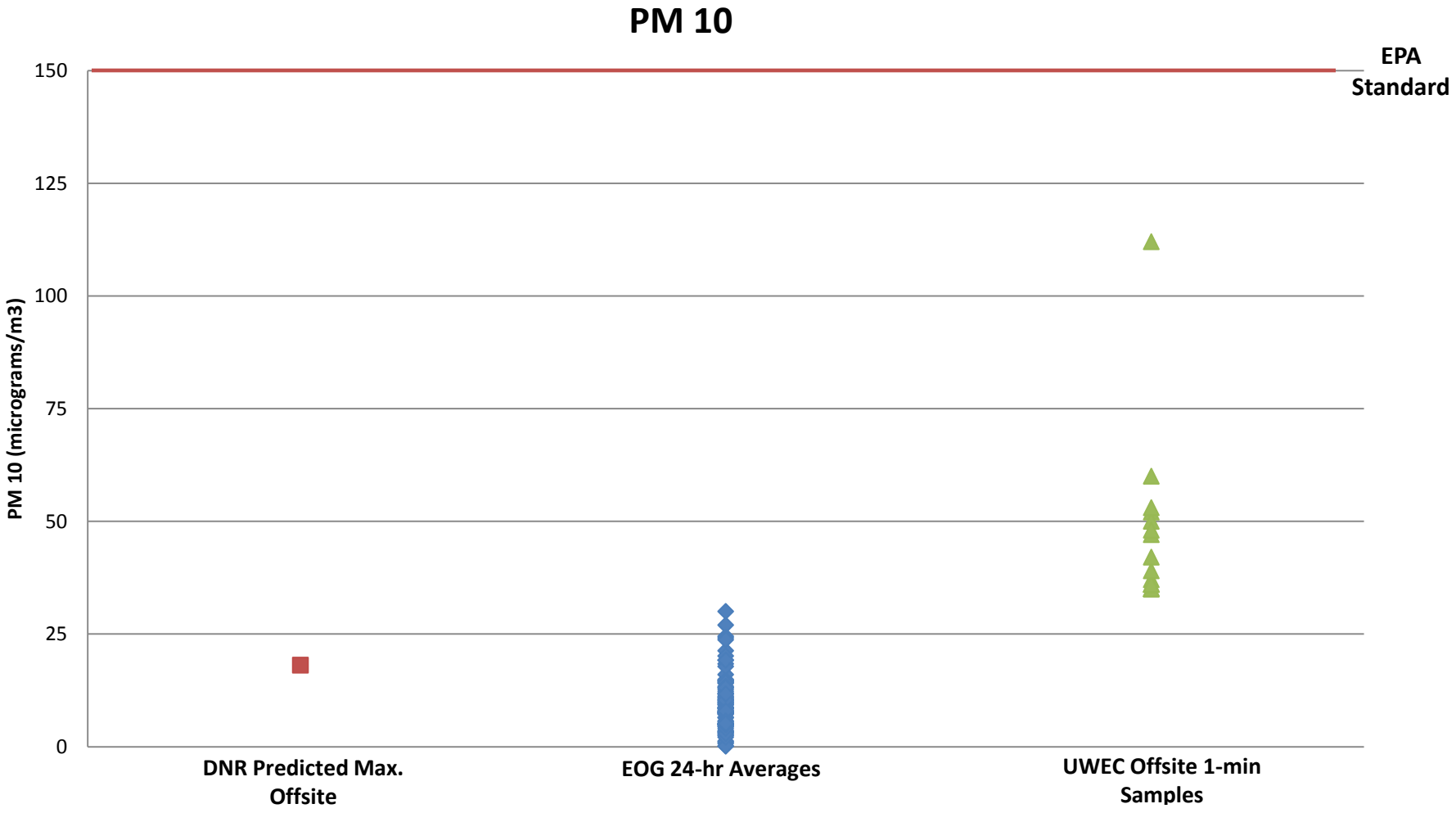
- Our 1- to 5-minute multiple “snapshot” samples found the following:
  - Measured values of PM 2.5 or PM 4 increased across sampling dates between 30-31 July 2011 and 2 January 2013.
  - Measured values during full operation were above the EPA annual and 24-hour PM2.5 standards.

Measured EOG PM2.5/4 Increased During Operation



Measured PM10 Levels During Operation Were Higher than the DNR Model-Predicted Maximum Concentration and the EOG 24-Hour Measured Levels

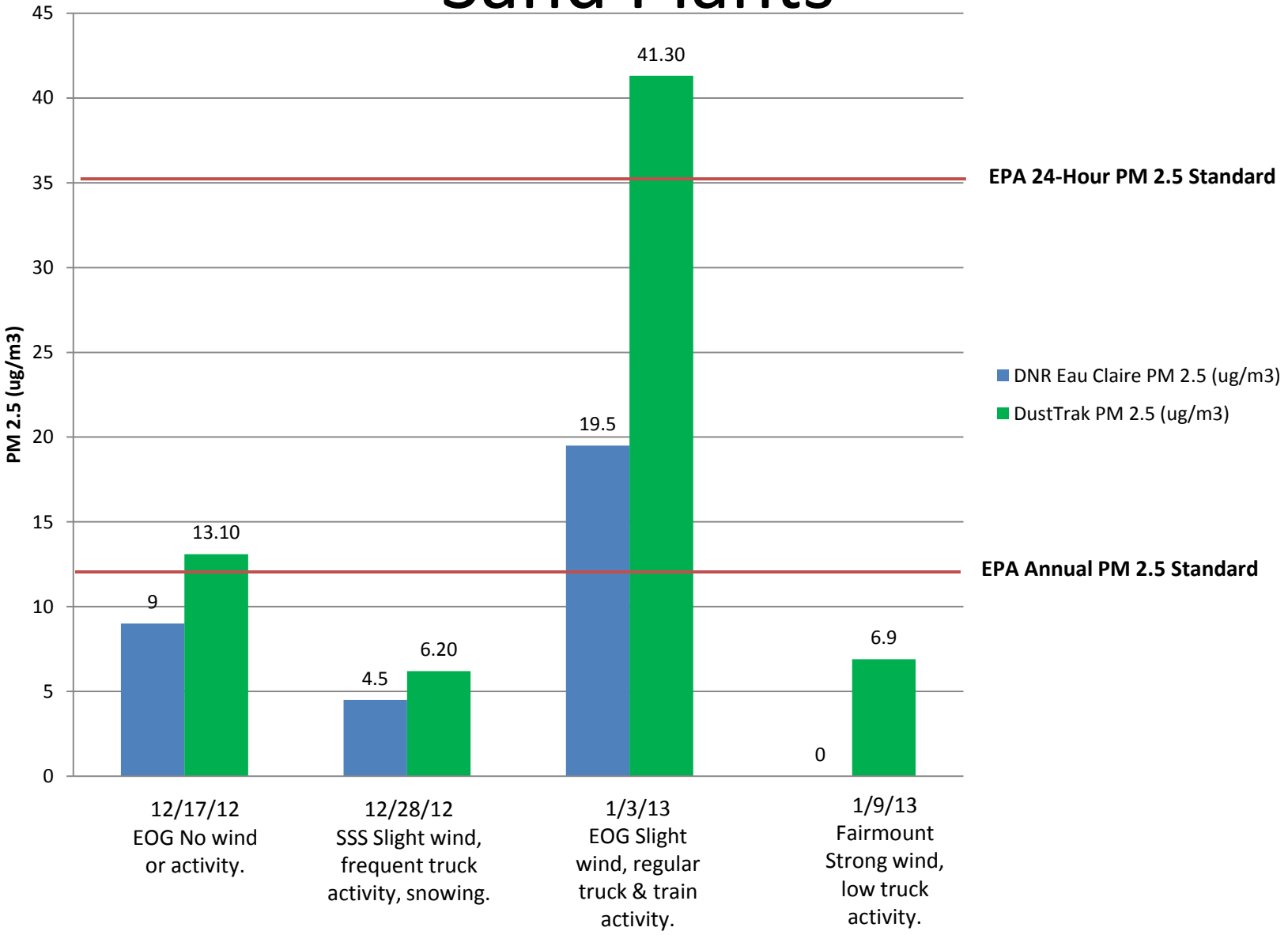
UWEC Measured PM10 Higher Than DNR Predicted or EOG Measured



Measured Levels of PM2.5 at EOG, Superior Silica Sands (Auburn), and Fairmount Mine (Menomonie) Were 1.7-22 micrograms/m3 Higher Than Concurrent DNR Regional Levels

- Average measured PM2.5 levels were compared to listed Eau Claire DNR PM2.5 levels over the same hourly periods.

PM 2.5 Increases Over Background at Sand Plants



Measurement and Enforcement of the Current EPA 12 micrograms/m3 PM2.5 Standard is Likely to Protect Against Silicosis Risk

- Measured 14.5% silica concentration in 41 respirable dust samples collected in Wisconsin by MSHA.
- State of California OEHHA reference concentration of 3 micrograms/m3 respirable crystalline silica.
- 12 micrograms/m3 PM2.5 x 14.5% = 1.74 micrograms/m3.

MSHA Sampling Results

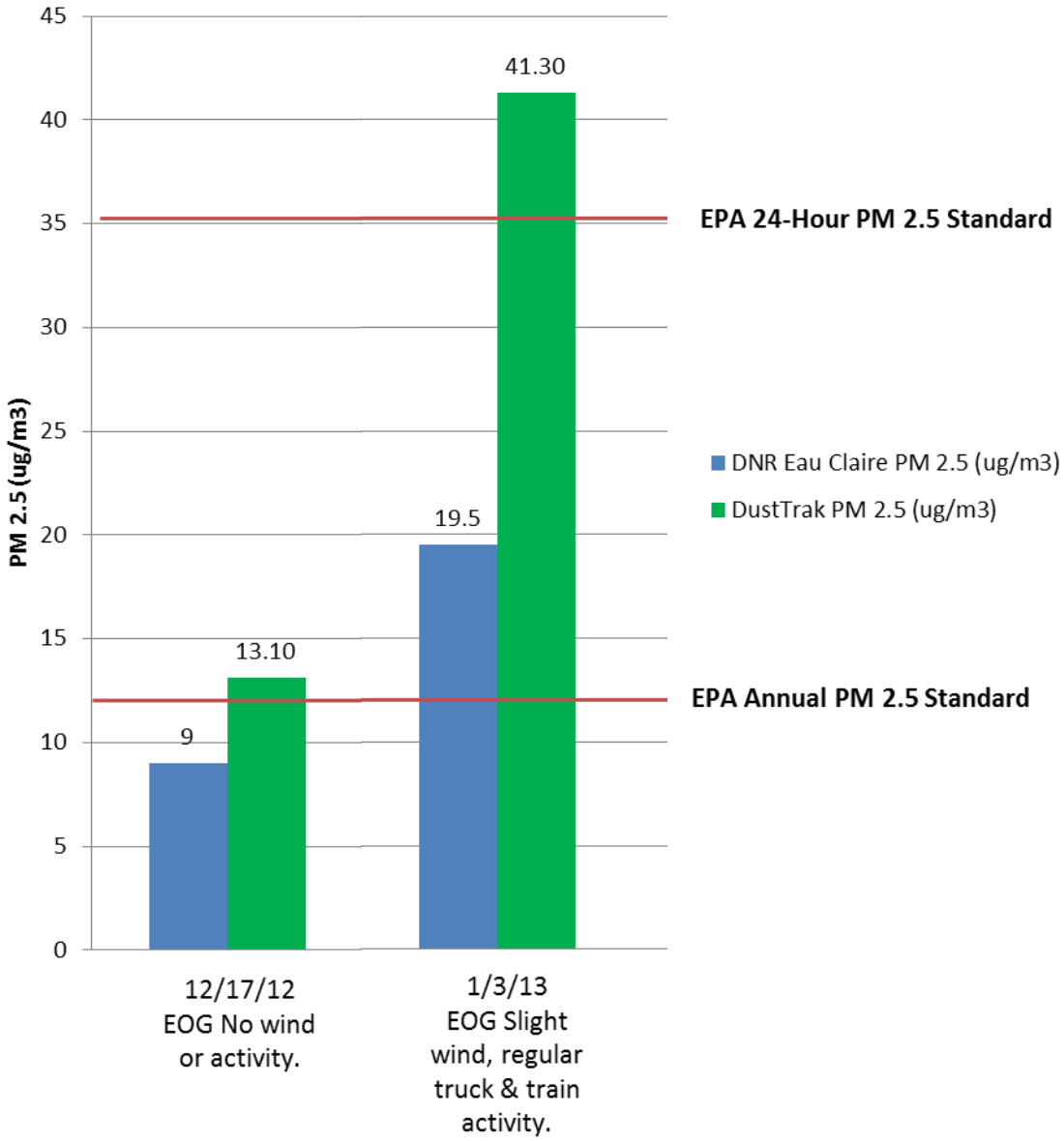
Date	Location	Job	Contaminant	Concentration (mg/m3)	PEL (mg/m3, varies by %SiO2)	%SiO2	SiO2 Concentration (mg/m3)	Sand Mining/Processing Company
2/18/2009	M - Drying & Roasting	Kiln/Dryer Operator	Quartz, respirable, >1% Qtz	0.34	0.28	33.7142857	0.114628571	A F Gelhar Co Inc
2/11/2009	M - Drying & Roasting	Mechanic	Quartz, respirable, >1% Qtz	0.36	2.47	2.048583	0.007374899	Badger Mining Corporation
12/16/2009	M - Dry Screening	Dry Screen Plant Operator	Quartz, respirable, >1% Qtz	0.13	0.64	13.625	0.0177125	Badger Mining Corporation-Fairwater Plant
11/8/2011	S - Active Production	Washer Operator	Quartz, respirable, >1% Qtz	0.32	2.35	2.25531915	0.007217021	Barton Sand & Gravel Co
6/6/2012	S - General	Electrician	Quartz, respirable, >1% Qtz	0.13	0.56	15.8571429	0.020614286	EOG Resources, Inc
3/27/2012	Laboratory	Lab Technician	Quartz, respirable, >1% Qtz	0.23	0.4	23	0.0529	"
3/27/2012	M - Washing & Screening	Washer Operator	Quartz, respirable, >1% Qtz	0.6	0.53	16.8679245	0.101207547	"
3/27/2012	S - General	Electrician	Quartz, respirable, >1% Qtz	0.82	0.57	15.5438596	0.127459649	"

≈ ≈

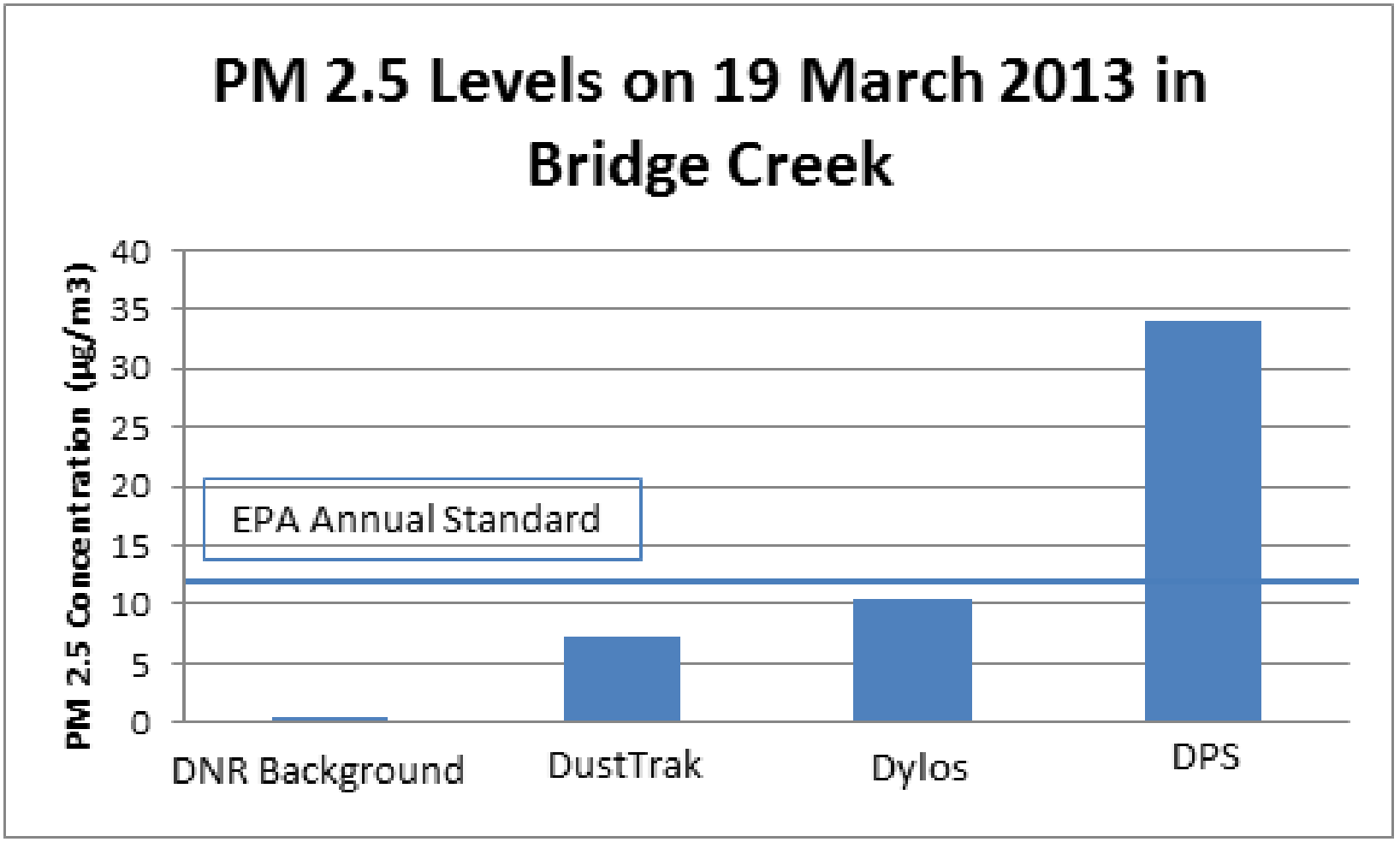
MIN	1.24675325
MAX	39.6666667
AVERAGE	14.517322
s.d.	10.434715

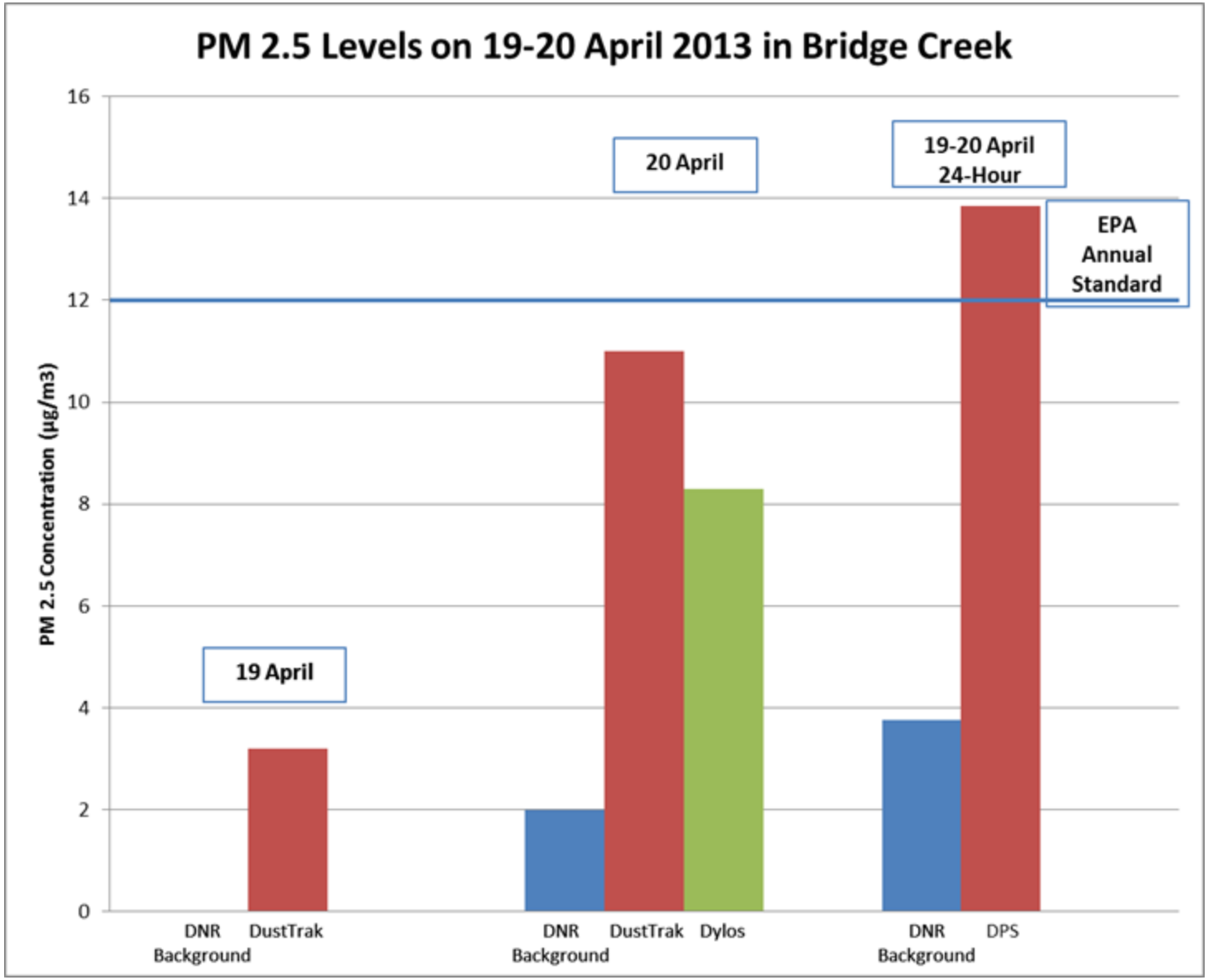
Snow, Wind and Degree of Plant Activity Appear to Influence Measured PM2.5 Levels

No Activity vs. Regular Activity



Bridge Creek Samples Were Higher than DNR Background Levels




PM 2.5 Levels on 19-20 April 2013 in Bridge Creek
PM 2.5 Concentration (µg/m3)
16
14
12
10
8
6
4
2
0
19 April
20 April
19-20 April 24-Hour
EPA Annual Standard
DNR Background
DustTrak
DNR Background
DustTrak
Dylos
DNR Background
DPS

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 PM2.5/4 increased starting from the Chippewa Falls EOG plant construction through full operation;
- Our measured PM10 levels during operation were higher than the DNR model-predicted maximum concentration and the EOG 24-hour measured levels;
- Measured levels of PM2.5 at EOG, Superior Silica Sands (Auburn), Fairmount mine (Menomonie), and Hi-Crush (Bridge Creek) were 1.7-22 micrograms/m3 higher than concurrent DNR regional levels; and
- Snow, wind and degree of plant activity appear to influence measured PM2.5 levels.

Next Steps

1. Awaiting DNR response to our request to co-locate our instruments with theirs in Eau Claire to assess any bias.
2. Sampling along train route corridors.
3. Revisit sites measured in winter to assess differences in PM10 and PM2.5 during summer months.

DNR Violations of Truck-to-Train Transfer

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

Questions?

- Crispin Pierce, PhD
- Associate Professor, University of Wisconsin-Eau Claire
- 715-836-5589
- piercech@uwec.edu
- http://www.uwec.edu/CONHS/programs/enph/silica/silicaresearch1.htm