Dust In The Wind –How Does Sand Mining Affect Air Quality?

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Environmental Resources Management

What's The Problem?

- Community concerns lead to permitting delays, moratoriums, onerous operating constraints.
- Responsible developers/operators need ways to assess impacts.

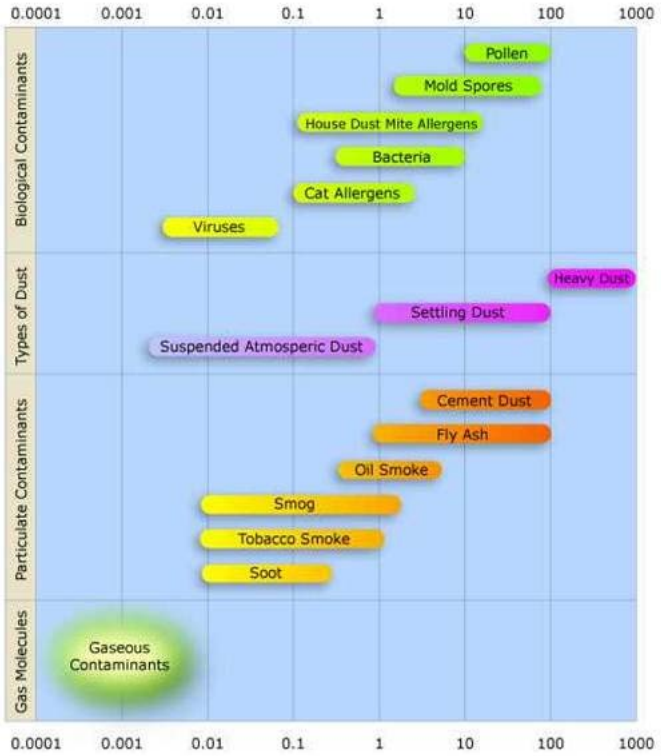
Concerns include:

- Truck traffic
- Noise
- Environmental
  - water quality
  - air quality
    - crystalline silica

What We'll Cover...

- Particulate Matter (PM) Characterization
- Sand Mine/Processing PM Emissions Sources
- Air Quality Particulate Matter Criteria
- Ambient Monitoring Methods & Programs
- Monitoring Data & What It Means

Characterizing PM (Size Matters)



Particle side determines how it disperses and settles...

...and how far it can penetrate into the respiratory system.

Mesh	Microns	Comment
16	1,190	Eye of a Needle = 1,230 microns
40	420	
50	297	
60	250	Fine Sand
100	149	Sand (100 - 2,000 micron)
140	105	
200	74	Portland Cement
	70	Average Human Hair (70 - 100 micron)

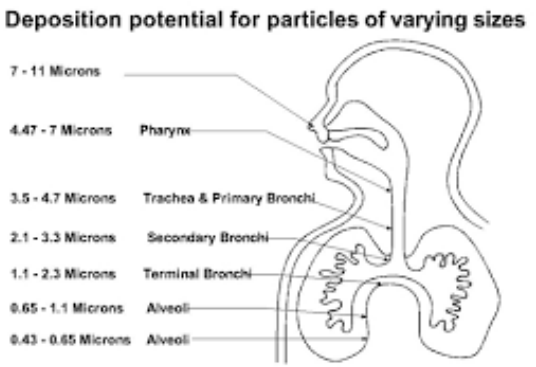
Potential Health Impact Factors

To have the potential to affect health, a particle must:

1. Remain suspended until it reaches a person, and
2. Penetrate deep into the respiratory system.

If particles reach sensitive tissues in the lungs, potential health consequences depend upon:

1. Particle chemistry,
2. Morphology, and
3. Concentration.



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Sand Mine/Processing PM Emissions Sources

Mine

- Working face (surface); Mine mouth/vents (underground)
- Drilling/blasting
  - Process
  - Drill rig engine
- Conveying
- Wet Processing Plant
- Outdoor storage
- Mobile equipment
  - Engine
  - Road dust

Sand Mine/Processing PM Emissions Sources

Dry Processing Plant/Storage/Shipping

- Dryer
  - Combustion
  - Process
- Conveying
- Storage bins
- Truck receiving
- Outdoor storage
- Mobile equipment
  - Engine
  - Road dust
- Rail Loadout

Sand Mining PM Emission Characteristics

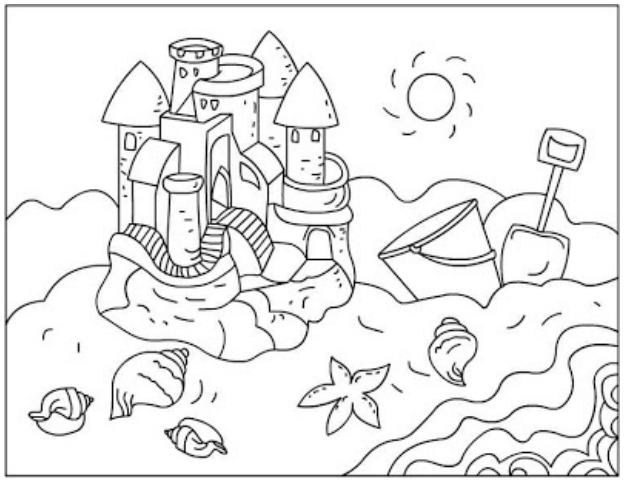
Combustion Sources

- Internal combustion engines (diesel, gas)
  - Drill rig, mobile equipment, generators, pumps
- Dryer (typically, natural gas or propane)

Particulate Matter Characteristics

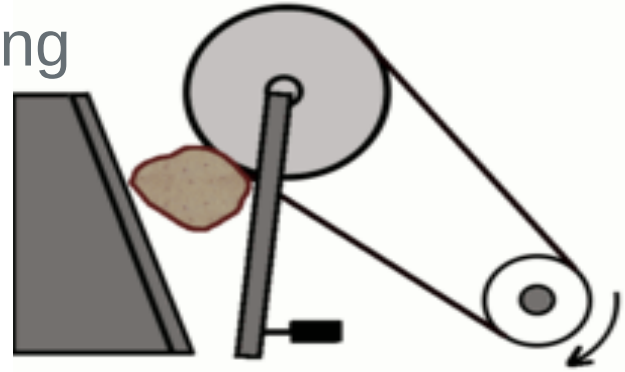
- Emission rate – relatively low for well-controlled devices
- Size: < 1.0 micron
- Chemical bioactivity: varies
  - Propane and natural gas combustion products – relatively benign
  - Diesel soot is a potential human carcinogen.

Sand Mining PM Emission Characteristics



Process Sources

- Material conveyance, processing, loading



Particulate Matter Characteristics

- Emission rate – varies by source, emission control methods
- Size: large (> 100 micron) to very small (< 2.5 micron)
- Chemical bioactivity: largely inert; exception being (very fine) crystalline silica—causative factor (at occupational exposure concentrations) in silicosis

We Must Have Standards

But they are hard to come by...

- Only broadly recognized **crystalline silica** standard is OSHA's occupational exposure standard. Current proposed limit is 50 micrograms of respirable (i.e., PM_4) crystalline silica per cubic meter of air ($\mu g/m^3$), averaged over an 8-hour day.
- U.S. EPA has PM_{10} and $PM_{2.5}$ particulate matter standards. Since crystalline silica is emitted as particles, PM measurements constitute a conservative ceiling on crystalline silica concentrations.

EPA Particulate Matter Standards

- PM_{10}
  - 150 microgram/cubic meter, 24-hour average
- $PM_{2.5}$
  - 35 microgram/cubic meter, 24-hour average
  - 12 microgram/cubic meter, annual average

For comparison—Proposed OSHA PM_4 crystalline silica PEL is 50 microgram/cubic meter, 8-hour average.

OSHA regulations are geared to protect healthy workers exposed for a maximum of 8 hours at a time.

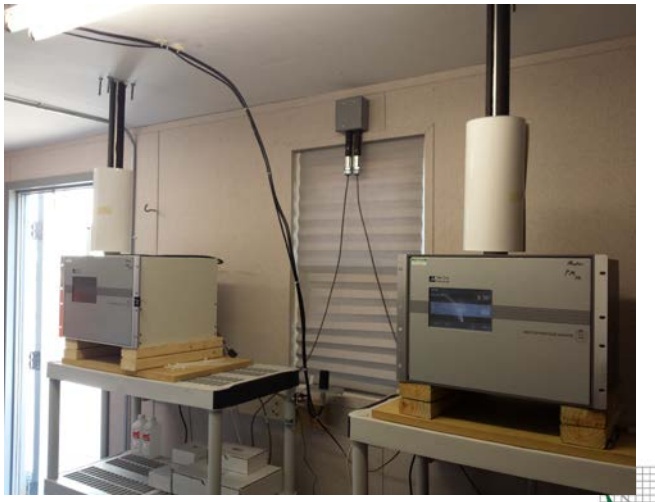
EPA standards, by statute, must protect even the most sensitive populations—with an ample margin of safely.

Measuring the Air

- State and federal environmental agencies have been monitoring PM in outside air for decades.
- Some states require mines to monitor PM—either as a permit or regulatory requirement.
- Monitors have been established near some mines and processing plants.
- We have synthesized the monitoring data collected near industrial sand facilities and compared them with typical ambient levels.
- Analysis was limited to PM_{10} mass measurements—not enough $PM_{2.5}$ data near sand facilities; ambient air PM_4 crystalline silica data too few to allow comparison.

How to...

- PM_{10} and $PM_{2.5}$ can be measured continuously or with 24-hour integrated filter samples—followed by lab analysis.
- Most of the data analyzed for this study were PM_{10}, and were collected using filter samplers.
- Data were drawn from Minnesota and Wisconsin monitoring programs; Illinois was contacted and found to have no relevant data.



Wisconsin and Minnesota PM_{10} Monitoring

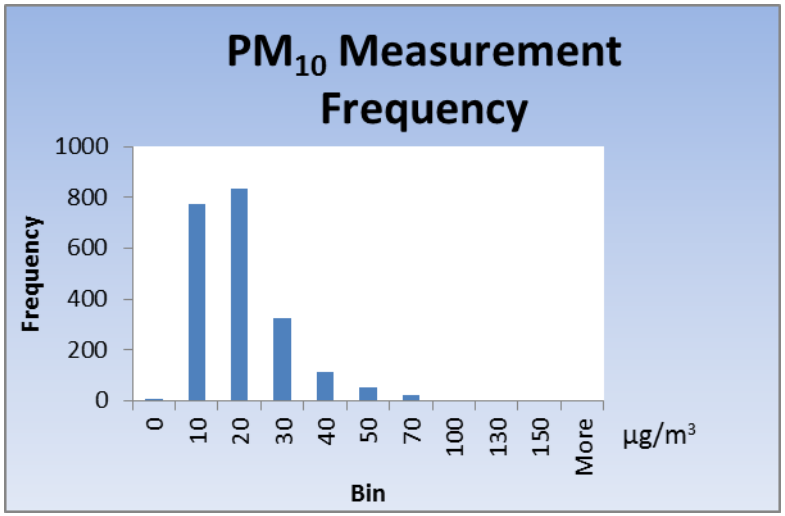
- PM_{10} measured over 24 hours, typically, once every 6 days using filter sampler/laboratory gravimetric analysis
- From one to three monitors per sand facility—total of 18 monitors (14 in WI; 4 in MN) at 14 sand processing plants (12 in WI; 2 in MN)
- Period of record varies by monitor, earliest data from 2011
- Total of 2135 valid measurements

Summary Statistics

- Average: 15 µg/m^3
- # values > 150 µg/m^3: 0
- # values > 50 µg/m^3: 27 (< 2% of values)
- Max. value: 105 µg/m^3, 2/3rds of ambient standard

Detailed PM_{10} Monitoring Results

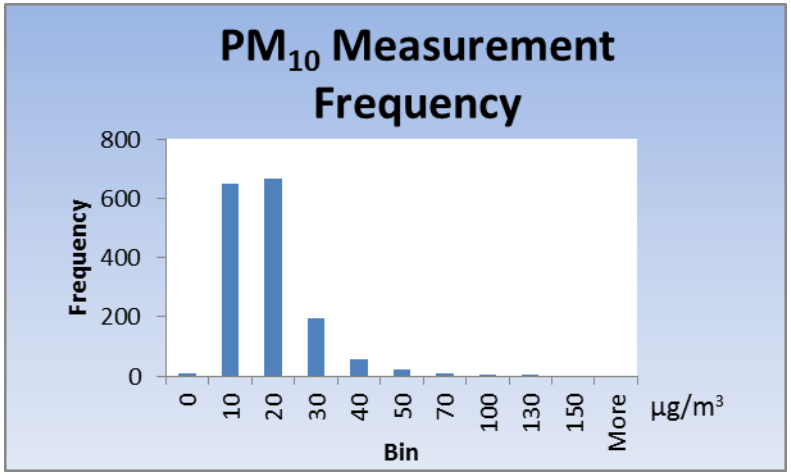
Total combined WI and MN Measurements



Number of Samples =	2135
Bin	*Frequency*
0	8
10	772
20	834
30	324
40	116
50	53
70	21
100	5
130	2
150	0
More	0

All WI Measurements

Number of Samples =	1612
Bin	*Frequency*
0	8
10	650
20	667
30	195
40	58
50	22
70	8
100	2
130	2
150	0
More	0



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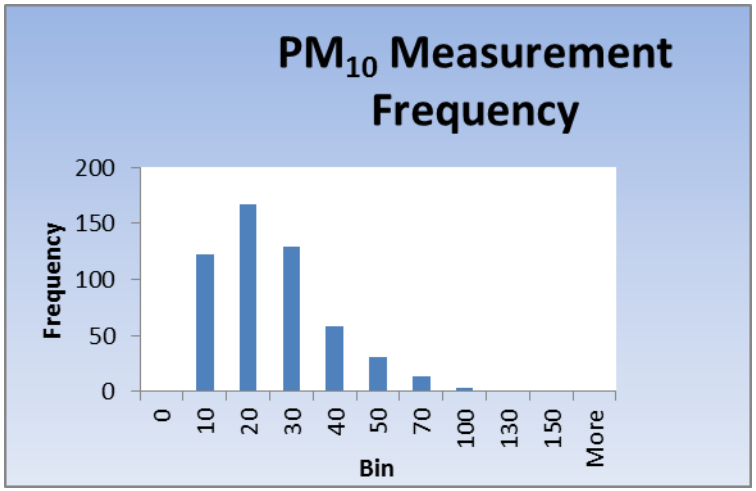
Detailed PM_{10} Monitoring Results

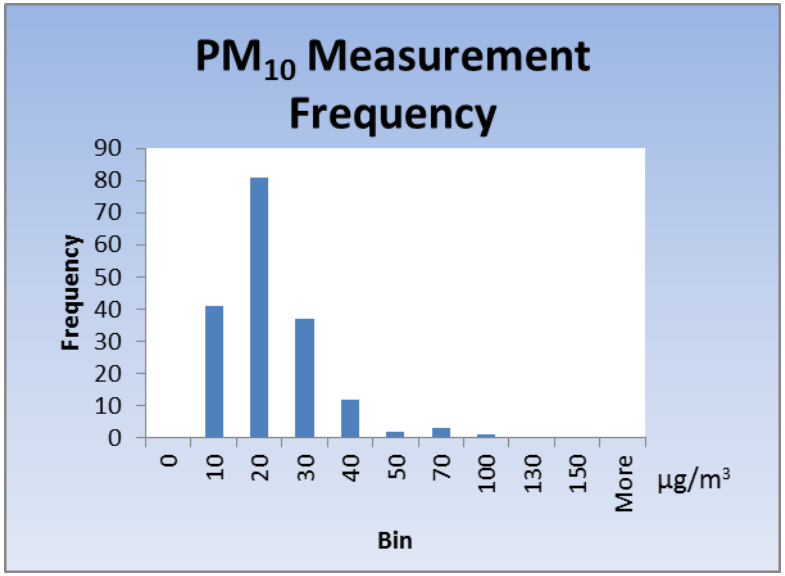
All MN Measurements



Number of Samples =	523
Bin	*Frequency*
0	0
10	122
20	167
30	129
40	58
50	31
70	13
100	3
130	0
150	0
More	0

Example Individual WI Site (ID# 55-005-1001)

Number of Samples =	177
Bin	*Frequency*
0	0
10	41
20	81
30	37
40	12
50	2
70	3
100	1
130	0
150	0
More	0



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Minnesota Respirable Crystalline Silica Monitoring

- The Minnesota Pollution Control Agency has conducted PM at 12 sites, associated with 3 sand processing facilities.
- Monitored species included respirable crystalline silica (PM_4) at several sites
- Period of record varies by monitor, earliest data from mid-2012.
- No high crystalline silica concentrations were found in ambient air

Questions?

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How About Now?