

# Dust Management

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# Road Map

- Dust Fundamentals - demonstration
- Gravel Road Design Basics
- Institutional Methods for Dust Control
- Dust Suppressants - demonstration
- Planning and Funding a Dust Control Project



# Dust 101



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Photo by ADEC

## An Example of the Magnitude of the Problem

Consider: -> 2-mile stretch of unpaved road,

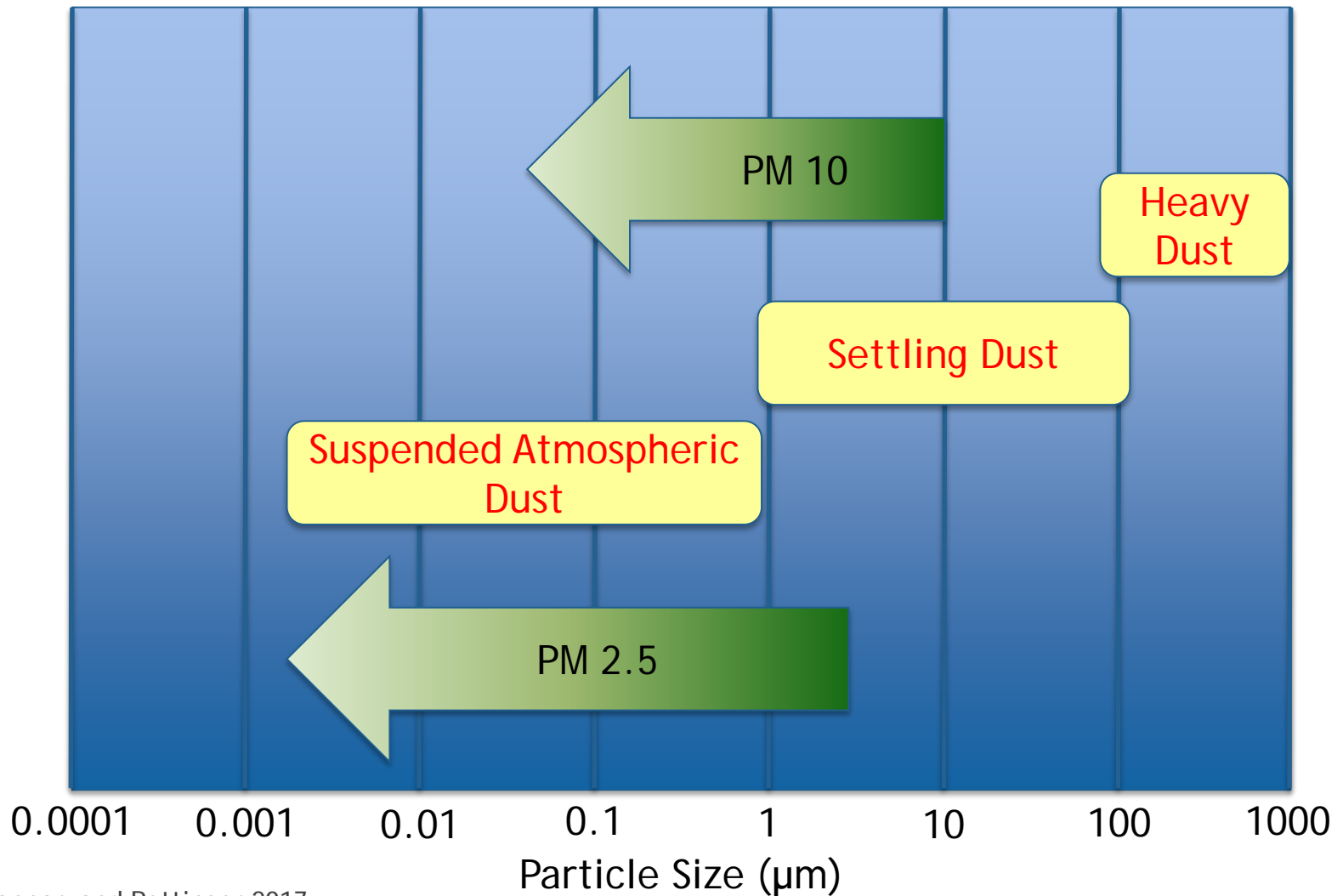
-> 20 vehicles/day,

-> average speed= 30 mph.

Result: 10,920 lbs of dust ( $PM_{10}$ ) per month

(Roberts et al., 1975)

# How Small are These Particles We Are Working With?



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# Really Small!

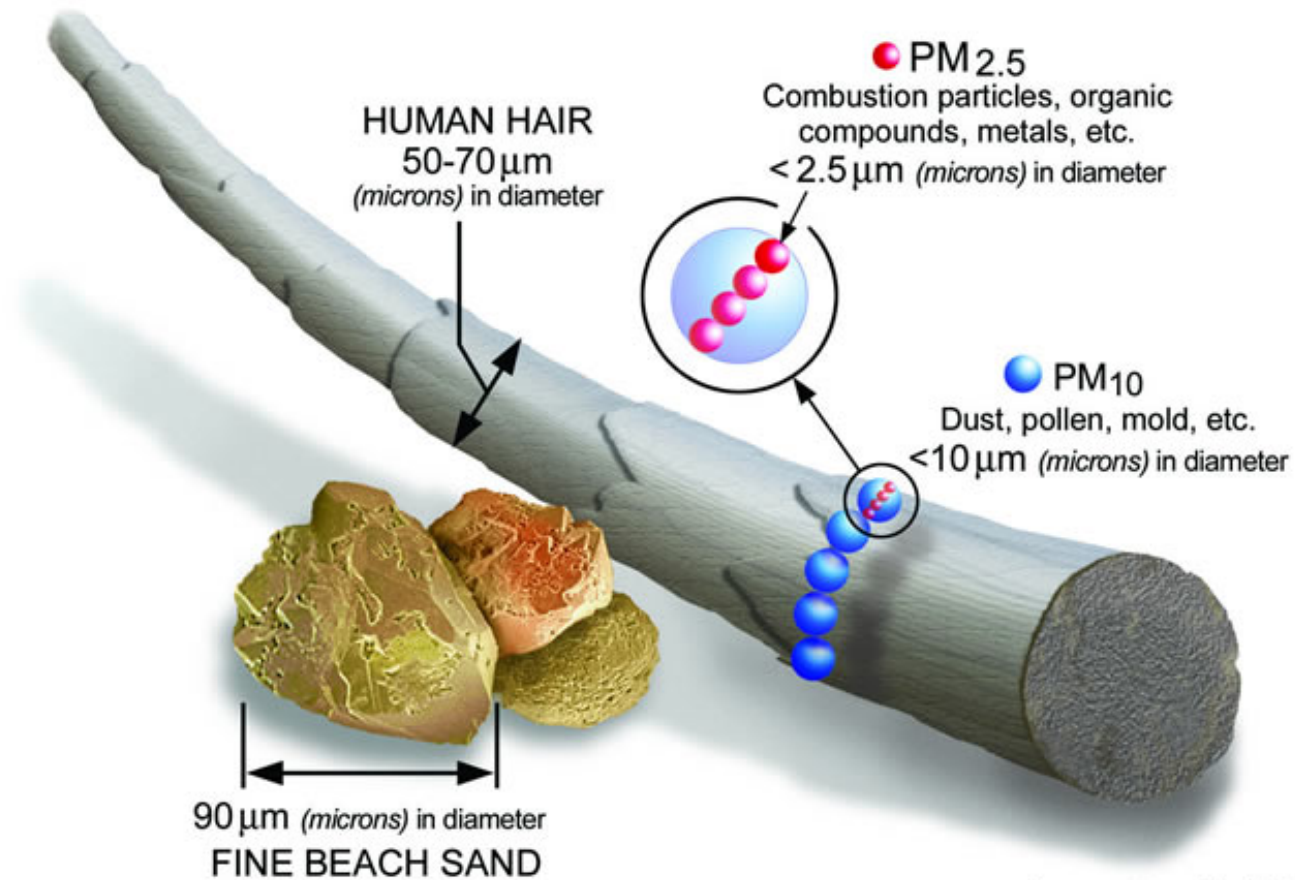


Image courtesy of the U.S. EPA

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# What Causes This?

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# We Need a Source of Dust



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# Next We Need a Mechanical Means of Lofting Particles into The Air



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# Road Dust Generation Mechanisms

Slippage Entrainment

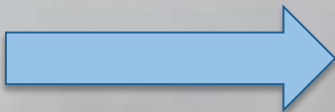
Vortex Entrainment




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# Next we need to Move the Dust

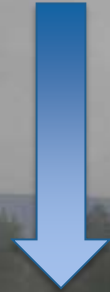


Advective Transport



Turbulent  
Diffusion

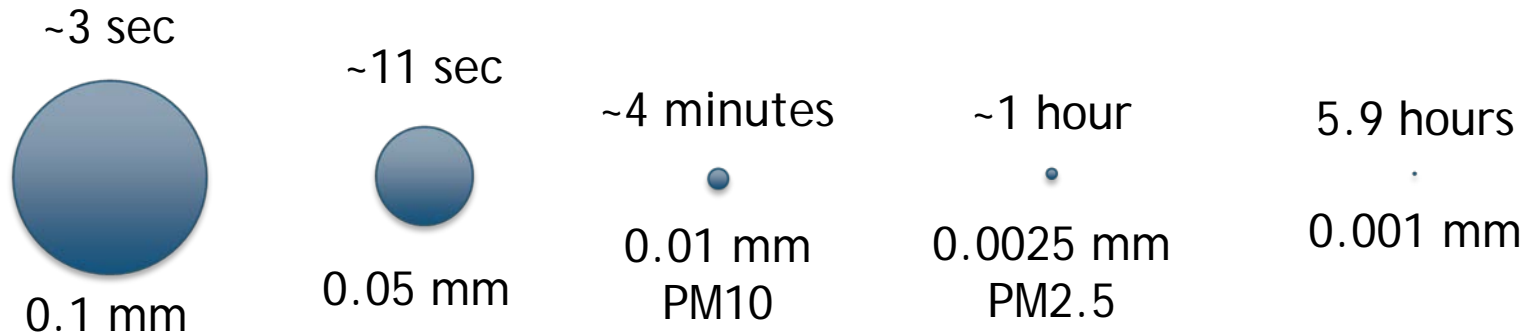
Settling



Mechanical  
and  
Convective  
Lofting

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# Settling time from a 2m loft



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# Dust Fall Demo

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# Impacts

Unpaved roads released 11 million tons of particulate matter less than 10  $\mu\text{m}$  in aerodynamic size ( $\text{PM}_{10}$ ) to the atmosphere in the United States in 2014. These emissions make up 51% of all emissions from stationary sources of  $\text{PM}_{10}$  air pollution in the United States (U.S. EPA, 2017).



# Impacts

- Health
- Economics
- Quality of life
- Safety
- Environment

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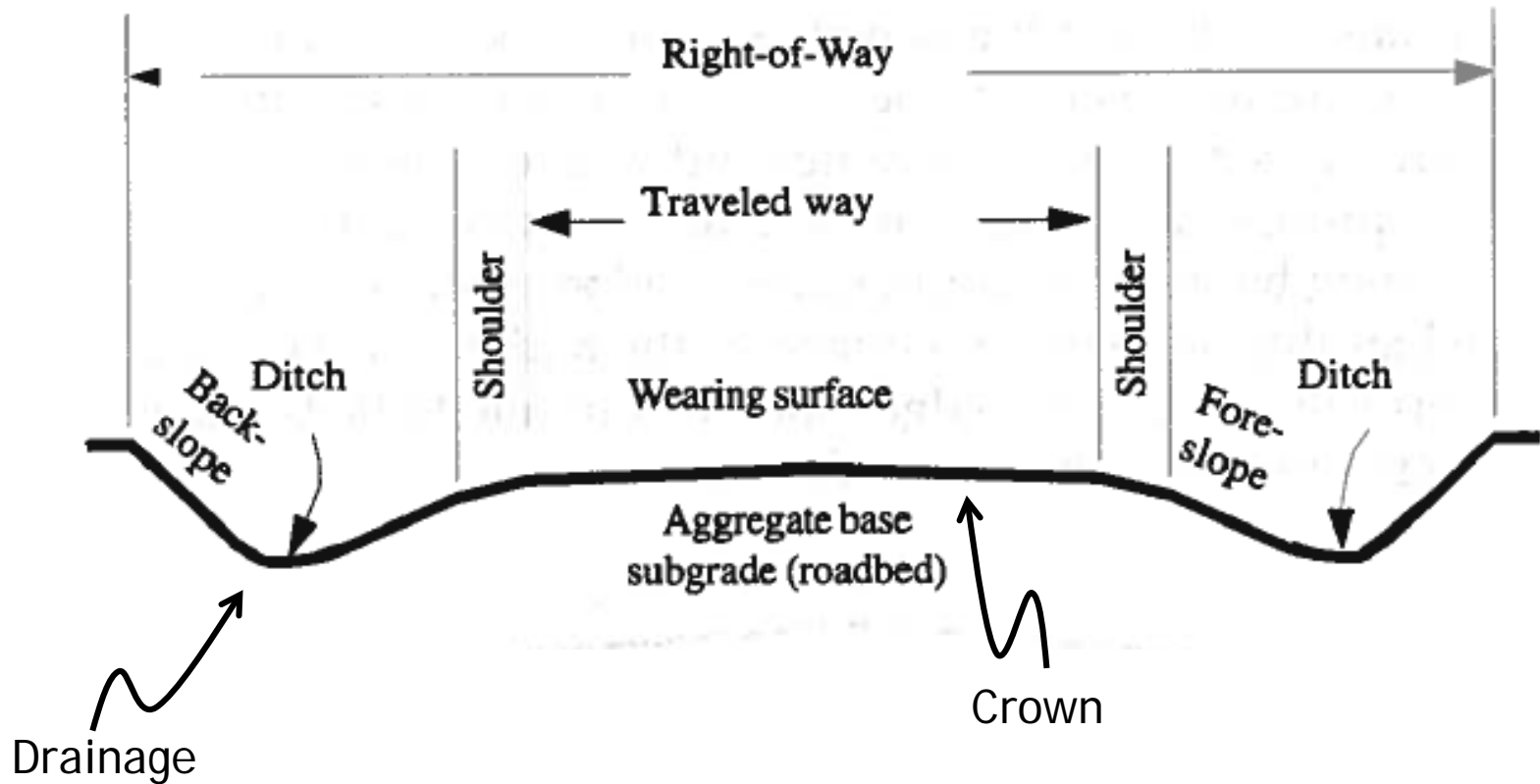
A black pickup truck is driving away from the viewer on a wide, sandy road. The road is flanked by dense green trees and shrubs. The sky is clear and blue. The text "Good Dust Management Starts with a Good Road" is overlaid on the lower half of the image.

# Good Dust Management Starts with a Good Road

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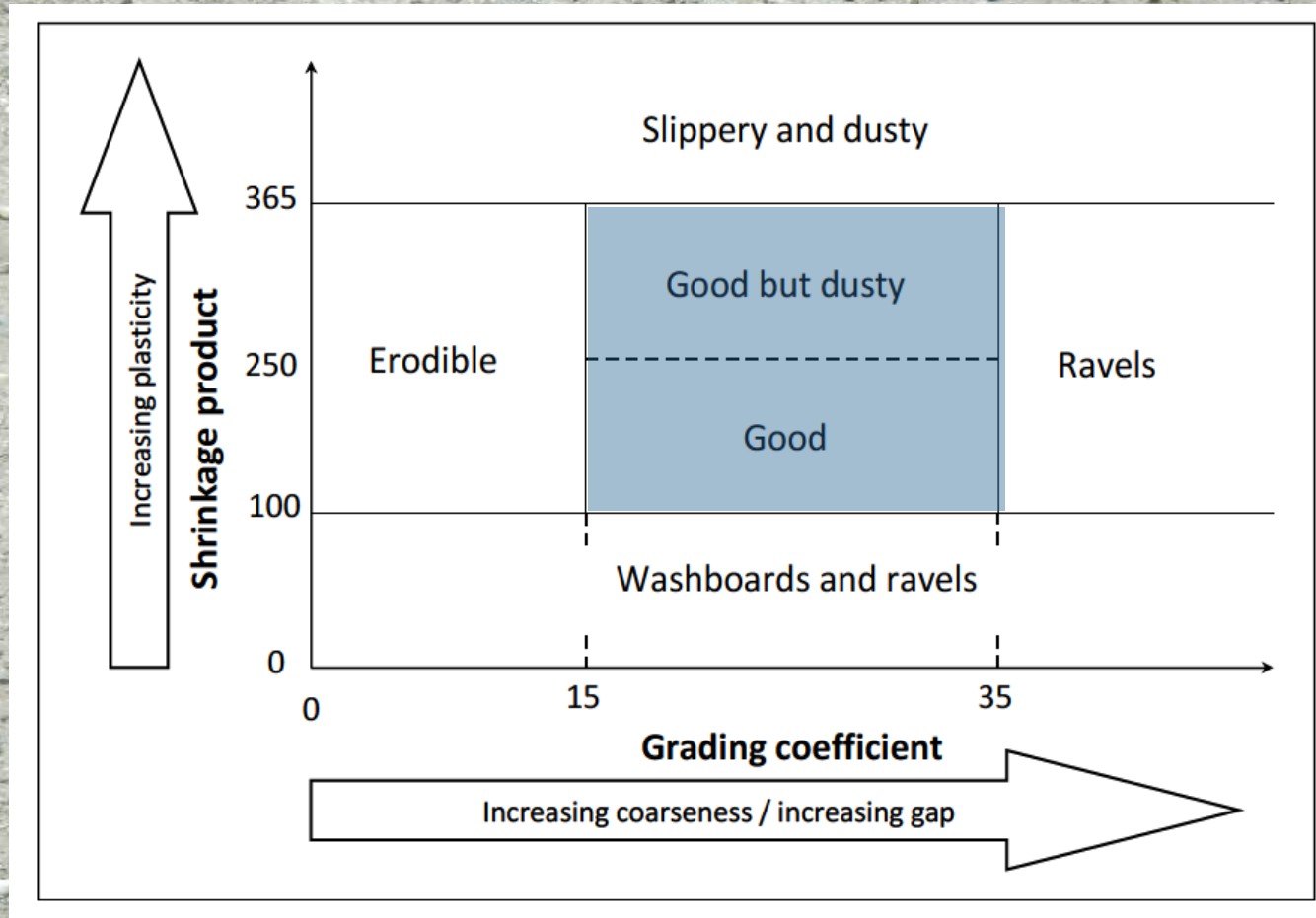


# Control Dust through Proper Design and Construction



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# Using the Right Building Material is Critical



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From Paige-Green, 1989



# Proper Fines is Critical

Too Few Fines Increases  
Dust and Causes  
Wash-boarding and Low  
Strength

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A photograph of a gravel road stretching into the distance, flanked by green grass and trees. A blue float tool is positioned in the center of the road in the foreground. The text "Proper Fines is Critical" is overlaid at the top.

Proper Fines is Critical

Float

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# Proper Fines is Critical

Too many fines causes rutting and muddy roads



From: Roadex Network



From: Roadex Network

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# Proper Fines is Critical

Proper fines content (passing the #200 sieve) is between 8 and 15% for untreated roads.

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# A Good Crown is Critical

Too Flat Causes ponding

09.27.2007

*since 1917*

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# A Good Crown is Critical

Too Steep Causes Erosion

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# A Good Crown is Critical

Should be between 4% and 5%

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# Commercial Slope Meter



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# Examples of Poor Drainage



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# Examples of Proper Drainage



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# Dust Management



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# Institutional Dust Management

- Speed
  - Increase speed from 10 to 20mph  $\cong$  double the amount of dust
  - Increase speed from 20 to 30 mph  $\cong$  triple the amount of dust
- Limit Driving on the dustiest days
- Control aggressive driving



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# Institutional Dust Management



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# Dust Suppressants

- Water
- Salts and Brines - calcium chloride and magnesium chloride
- Non-petroleum based organics - lignin sulfonates, vegetable oils
- Synthetic fluids
- Petroleum-based organics
- Electrochemical products
- Clay additives
- Mulch and fiber mixtures
- Polymers

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# Application Methods

## ❖ Calcium chloride

- Adsorbs water from atmosphere
- Reduces evaporation rate by a factor of 3.4
- Liquid, flake, and pellet
- Dry application - mixed in the with a grader while adding water
- Flake 1.0 - 1.5 lb/yd<sup>2</sup>, Pellet 0.8 - 1.3 lb/yd<sup>2</sup>
- Liquid 0.2 to 0.3 gal/yd<sup>2</sup>

## ❖ Lignin sulfonate

- Binds particles
- Best performance in soils with a clay content (silt and clay content 4-8%)
- Powder 1.0 to 2.0 lb/yd<sup>2</sup>
- Application method is same as for calcium chloride
- Application may be limited near dwellings, water wells and surface water

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# Application Methods

## ❖ Synthetic fluids

- Increases apparent cohesive forces in aggregate
- Reduces water evaporation rate
- Topical application (no water trucks)
- 9 to 14% fines content
- Typical application rates: 40 to 30 ft<sup>2</sup>/gal
- Multiple application passes
- Re-compact treated roads ever few weeks



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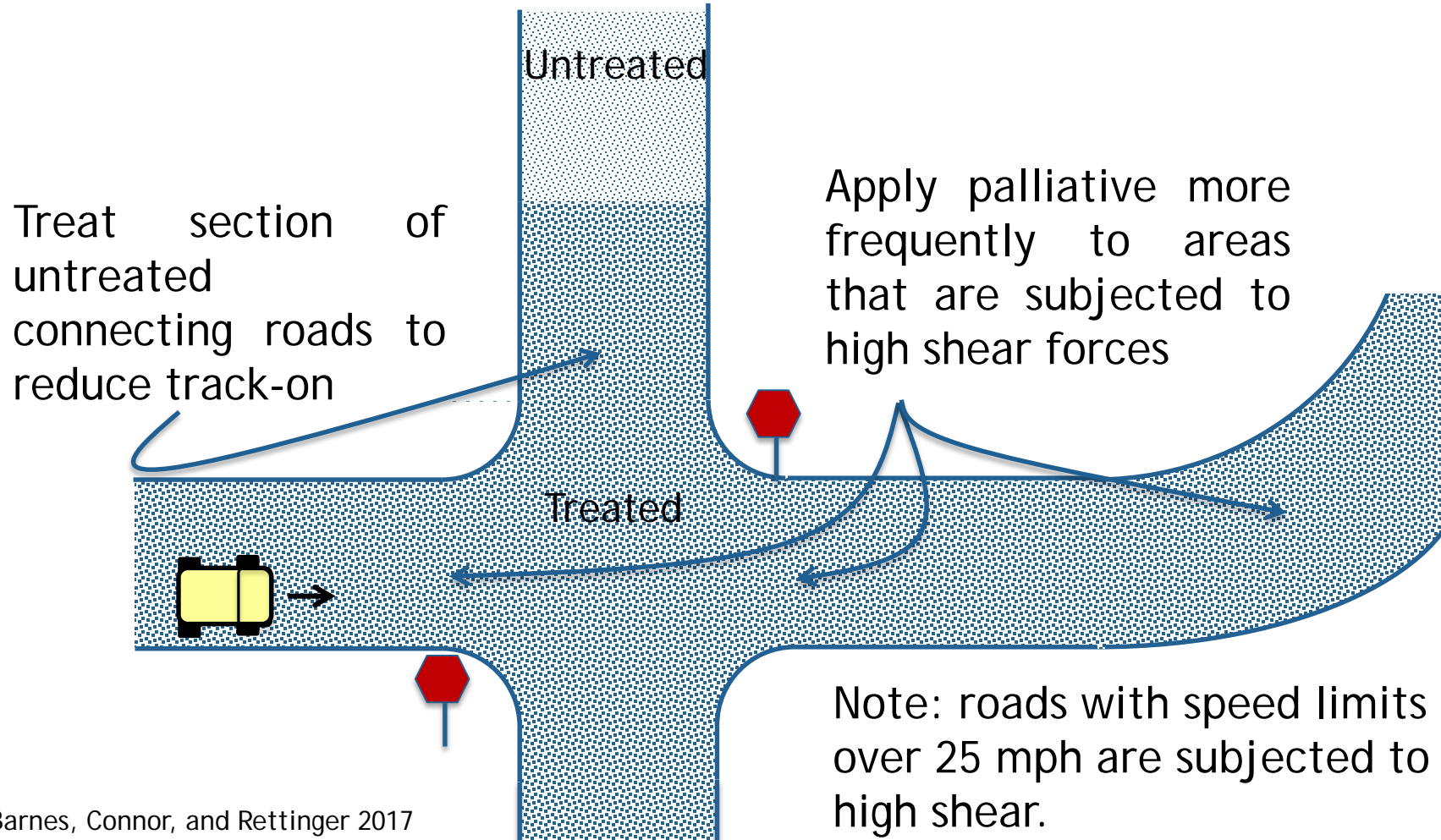


# Palliative Performance Demo

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# Product Application and Maintenance



Note: roads with speed limits over 25 mph are subjected to high shear.



# Re - Application

- Observe and photograph dust production behind vehicles every few weeks
- When noticeably dustier, re-apply palliative to dusty areas at a lower rate



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# Reasons for Poor Performance

- Surface too sandy (low fines)
- Material too dense to allow penetration of the selected product
- Weather
- Too little product applied
- Use wrong equipment for application
- Not applied in multiple passes





# Questions?

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