Best Practices for Dust Control in Minnesota

LRRB
LOCAL ROAD RESEARCH BOARD

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INTRODUCTION

More than 50 percent of the road network in the United States are gravel roads, underscoring their crucial role in the transportation system. However, one of the drawbacks and biggest complaints of gravel roads is the dust they generate when vehicles pass, causing inconvenience for residents from dust that settles on homes, yards, and parked cars. Dust can also reduce the safety for drivers due to impaired vision.

To control the dust on gravel roads, local agencies apply various dust suppressants on their roadways. Over the years the Local Road Research Board (LRRB) has produced a few documents addressing dust control of aggregate roads in Minnesota:

- Aggregate Roads Dust Control: A Brief Synthesis of Current Practices (2013)
- Best Practices for Dust Control on Gravel Roads (2009)
- Evaluation of Gravel Stabilizer Used on Gravel Roads and Gravel Shoulders (active, 2026 completion date)

Recently, counties have received calls from residents inquiring about environmental, health and corrosion concerns with dust and dust control suppressants. This document investigates these additional questions as well as reviews and updates previous LRRB reports on dust control.

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Since 1959, the Minnesota Local Research Board has completed successful research and implementation products supporting local agencies. The secret of this success is the outstanding knowledge within the city and county communities and the willingness to share that expertise to address shared needs.

A special thank you to this outstanding Technical Advisory Panel!

SUMMARY OF STATEWIDE GRAVEL ROAD SURVEY

A statewide survey of Minnesota local agencies was conducted via MnDOT State Aid and received responses from 65 agencies. Full survey questions are located in Appendix A.

Table 1. Do you currently treat gravel roads for dust?

	Total	County	City
Yes	42	35	7
No	23	13	10
Total	65	48	17

Table 2. What dust suppressant materials do you primarily use?

Suppressant	Number of Responses	Key Points
Calcium Chloride ($CaCl_2$)	36	See Table 3
Magnesium Chloride ($MgCl_2$)	13	See Table 3
Water	4	• Serves as the initial preparatory step before applying suppressants, particularly effective during construction projects amidst drier summers, ensuring optimal conditions for suppressant application • Serves as the primary option in small projects • Not a long-term solution; it demands a weekly application • Cheap, readily available, and no environmental impacts
Shingles	2	• Works wonders at intersections and sandy subgrades where chloride disappears • Free and reduces washboards and dust but limited on supply • Can have issues with nails if not crushed properly
Recycled Asphalt	1	• Adds strength to the road but does slightly reduce dust • Needs additional binder
Vegetable Oil	1	• Useful on low traffic volume roads
Base One	1	• Used as a gravel stabilizer but does not by itself suppress dust. So, it is less effective • Aids compaction and stiffness of gravel
Asphalt Emulsion	1	

Total responses: 39, some use more than one suppressant.

The survey asked local agencies a series of questions about common dust suppressants, reasons for application, product limitations, frequency of use, cost, etc. These survey responses are summarized in the appendices.

Table 3. Agency survey responses comparing the two most common dust suppressants used in Minnesota
These are merely summaries of survey responses; NOT recommendations or research conclusions.

Suppressant	Calcium Chloride ($CaCl_2$)	Magnesium Chloride ($MgCl_2$)
# of agencies	36	13
Why they use	• Cost-effective • Readily available • Stabilizes gravel (retains fines) • Historical performance (fairly effective, long lasting, prolongs the life of gravel, reduces maintenance) • The only option/product available • Low bid alternative by contractors • For performance comparison with $MgCl_2$ • Ease to apply • When water doesn't cut it • Works better than other options	• Cost-effective • Readily available • Stabilizes gravel (retains fines) • Historical performance (fairly effective, long lasting, prolongs the life of gravel, reduces maintenance) • The only option/product available • Low bid alternative by contractors • For performance comparison with $CaCl_2$
Attributes	• Cost-effective • Dual purpose: dust control and prolonging the life of aggregates (reduces maintenance) • Application of material requires less blading • Reduces grading and improves the driving surface by reducing rumble strips • Lasts longer (all summer) and has residual effects • Readily available • Easy and quick to apply	• Cost-effective • Dual purpose: dust control and prolonging the life of aggregates (reduces maintenance) • Application of material requires less blading • Reduces grading and improves the driving surface by reducing rumble strips • Good residual (lasts longer) • Available locally • High application rate
Limitations	• Corrosive effects on vehicles and equipment • Environmental effects • Treated roads get sloppy, greasy, slimy, or potholed when wet • Public complaints about increased smooth surface and icing during winter, requiring increased grit • Needs more moisture than $MgCl_2$ • Does not work well in dry seasons • Must be reapplied annually • Difficult to clean blending machine • Prices have gone up in the past years	• Corrosive effects on vehicles and equipment • Environmental effects • Treated roads get sloppy, greasy, slimy, or potholed when wet • Public complaints about increased smooth surface and icing during winter, requiring increased grit • Slightly less effective than $CaCl_2$, so need to increase application rate • Limited availability • Expensive

Suppressant	Calcium Chloride ($CaCl_2$)	Magnesium Chloride ($MgCl_2$)
# of agencies	36	13
Application	• The suppressant is mostly applied in liquid brine at a rate of: » 0.12 – 0.30 gallons/sq yd » Manufacturers' recommendation • 35% and 38% solutions are common • Some agencies sell flakes to residents to apply themselves	• The suppressant is mostly applied in liquid brine at a rate of: » 0.16 – 0.35 gallons/sq yd » 1,800 gal per mile » Manufacturers' recommendation • 30% and 33% solutions are commonly used
Frequency	• Once every two years (02) • Annually (29) • Twice in a year (02) • Monthly to quarterly (01) • As needed/requested (04)	• Annually (10) • Twice in a year (02)
Application tips	• Blade the road right before application and do not pack • Adequate moisture content is needed. Have the road pre-wetted • Twice per year at a lower rate helps with sloppiness and corrosive complaints • No rain for 3 days after application • The best results come after the 2nd or 3rd application • Add gravel if needed before application and blade to ensure a smooth surface. After application no blading or a very minimum amount. • Fan shaped spray	• Blade the road right before application and do not pack • Adequate moisture content is needed. Have the road pre-wetted • Twice per year at a lower rate helps with sloppiness and corrosive complaints • No rain for 3 days after application
Cost	• $1.10 – $1.65 per gallon • $2,175 – $6,000 per mile	• $1.06 – $1.26 per gallon • $2,000 – $2,750 per mile
Maintenance after	• Routine blading • As needed blading/grading	• Routine blading • As needed blading/grading
Environmental concerns	• Increases Chloride concentration of nearby water bodies (10) • Corrosiveness on vehicles and farm equipment (07) • Yes (unspecified)/Minimal (04) • No data to support or reject claims (01) • None (07)	• Increases Chloride concentration of nearby water bodies (03) • Corrosiveness on vehicles and farm equipment (04) • Yes (unspecified)/Minimal (01) • No data to support or reject claims (01) • None (02)

(#) = number of agencies using suppressant

These are merely summaries of survey responses; NOT recommendations or research conclusions.

FREQUENTLY ASKED QUESTIONS

This section answers common questions local agencies have regarding dust control. These questions were gathered as part of the statewide survey conducted via MnDOT State Aid.

1. How do dust suppressants work?

Dust is a mixture of particles from various sources, such as soil, pollen, organic matter, and more. When disturbed, these particles can become airborne. Dust suppressants work in the following manner:

- **Weight Increase:** Water is a basic but essential tool in this type of dust control. By wetting the dust particles, their weight increases, making it harder for them to become airborne. This is the principle behind simple dust suppression techniques like watering. In addition, moisture causes particles to stick together (induces cohesion) further increasing their weight. Deliquescent salts, such as Calcium Chloride or Magnesium Chloride, can be used to attract moisture as they absorb water from the air. Soils treated with these salts have a higher water content than untreated soils.
- **Binding:** Some dust suppressants work by binding the dust particles together, making them too heavy to be carried by the wind. This is how soil stabilizers work - they essentially "glue" the soil particles together. These chemicals fall into several groups, such as petroleum-based (e.g., emulsified asphalts, cutback asphalt, and Bunker C), organic nonpetroleum (e.g., lignosulfonates and resins), electrochemical stabilizers (e.g., sulphonated petroleum, ionic stabilizers, and bentonite), and synthetic polymers (polyvinyl acrylics and acetates).
- **Surface Hardening (Protective Layer):** Some dust suppressants take binding further. They not only bind the dust particles together but also create a protective layer on the surface that helps to prevent the particles from becoming airborne in the first place. This is often achieved through a combination of binding agents and surfactants, which reduces the surface tension of the liquid, allowing it to spread more easily and cover a larger area. For example, the brine solution created by Magnesium Chloride or Calcium Chloride can penetrate into the surface of the road, binding dust particles deeper within the soil or gravel. This helps to stabilize the surface and reduce the amount of loose material that can be kicked up as dust.

Table 5. How Different Suppressants Work

Suppressant	How It Works	Increases Weight of Particles	Binds Particles	Creates Hard Surface
Water	Water is used as a dust suppressant because it increases weight and binds dust particles together, but it does not last long.	X	X	
Calcium Chloride	It is a hygroscopic salt that draws moisture from the air to form a solution in road gravel. The moisture helps to bind particles together to create a hard and compact road surface. Because it penetrates several inches into the road base, it also contributes to overall road surface stability.	X	X	X
Magnesium Chloride	It is hydroscopic that bonds particles together, creating a hard surface that gives the road stability. It is most commonly supplied in liquid form at a concentration of about 30%.	X	X	X
Petroleum-based Binders (Emulsified asphalts, Cutback asphalt, and Bunker C)	These agents coat particles with a thin layer of asphalt, increasing particle weight and decreasing the chance of becoming airborne. Emulsified asphalt is a mix of asphalt and water which penetrates road surface dirt. This works well when the asphalt is mixed into the top inch or two of road surface with a grader.	X	X	X
Organic Nonpetroleum (Lignosulfonates and Resins)	Lignin is a natural polymer and can bind soil particles together. Lignosulfonates are water soluble and can move out of, or deeper into, a roadway surface with rainfall.	X	X	
Electrochemical Stabilizers (Sulphonated petroleum, Ionic stabilizers, and Bentonite)	These products neutralize soils that attract water and allow bonds to form between particles. Electrochemical stabilizers need to be worked into the road surface by an equipment.		X	
Synthetic Polymers (Polyvinyl acrylics and Acetates)	They bind soil particles and form a semi-rigid film on the road. These products are either liquids or powders that are mixed with water. Products are applied in liquid form and require drying.	X	X	X

2. Is there a process, method, or flow chart to evaluate the cost effectiveness of reduced maintenance?

Evaluation of cost-effectiveness resulting from reduced maintenance due to dust control agents involves several steps. Below is an outline of the process:

A. Assess Current Maintenance Practices

- Begin by evaluating the existing maintenance practices without the use of dust control agents.
- Document the frequency and types of maintenance activities performed and their associated costs.

B. Select and Apply Dust Control Agents

- Select the appropriate dust control agents based on effectiveness, environmental impact, cost, and other relevant factors.
- Apply the chosen dust control agents to the appropriate areas according to the manufacturer's recommendations.

C. Monitor Dust Control Effectiveness

- Collect data on dust suppression efficiency and any observed improvements in maintenance requirements.

D. Calculate Reduced Maintenance Costs

- Analyze the data collected to determine the reduction in maintenance activities and associated costs due to the use of dust control agents.

E. Compare Costs

- Compare the total costs of maintenance before and after implementing the dust control agents.
- Consider both the direct savings from reduced maintenance and any additional costs associated with purchasing and applying the dust control agents.
- It is the best practice to normalize the costs to a common scale, such as annual, to ensure easy comparisons.

F. Documentation and Decision-Making

- Document the findings of the evaluation process, including cost savings, return on investment, and any recommendations for future improvements.
- Use the evaluation results and cost-effectiveness analysis to inform decision-making regarding the continued use of dust control agents or potential adjustments to the maintenance strategy.
- Establish a feedback loop to continuously gather input from stakeholders and incorporate lessons learned into future dust control and maintenance practices.

There are examples of evaluating the cost effectiveness of dust control on various websites; two examples identified by this project's Technical Advisory Panel* include:

- FHWA's Unpaved Road Dust Management 2013-05-28, page 12:

The Lakes Highway District in Northern Idaho determines all of its costs, resulting in a clear picture of the true cost of road construction and maintenance.	
Untreated	**Treated**
1. Aggregate a. Crushed to specification b. Reapplication 2. Average price of haul to roadway a. Equipment and supplies (fuel, oil, tires and the truck) b. Operator (loaded rate) 3. Placement (also used for ongoing maintenance) a. Motor grader i. Prorated hourly rate ii. Fuel, tires, oil and cutting edges iii. Operator (loaded rate) b. Roller i. Prorated hourly rate ii. Fuel and oil iii. Operator (loaded rate) c. Water truck i. Prorated hourly rate ii. Fuel, oil and water iii. Operator (loaded rate) 4. Salary a. Supervisor b. Crew c. Office staff	For a newly treated roadway at a $MgCl_2$ shot rate of ½ gallon/square yard of roadway and a cost of $92.20/ ton, the treatment to the roadway was $3,501/mile. For a retreated roadway, ¼ gallon was used, which cut the cost in half to $1,750/mile. Additional costs included preparation/ maintenance of the roadway with a grader, water truck and roller (twice per year at a cost of $480/mile). **First year costs**: Spring maintenance: $480/mile $MgCl_2$: $3,500/mile Fall maintenance: $480/mile Total Cost = $4,460/ year **Second year costs:** Spring grading: $480/year Rejuvenation at ¼ gallon $MgCl_2$: $1,750 Fall grading: $480/year Total cost = $2,710/year
Average cost per untreated mile = $8,980/year* *This roadway required blading 18 times per year to maintain an acceptably safe and comfortable ride. Additional pro-rated costs per year are added for the replacement of gravel (item 1)	Average cost per treated mile**: 1st year = $4,460/year 2nd year = $2,710/year ** Does not factor in replacement gravel, which will be needed, but at much lower frequency than untreated roads

Please note that these costs are from 2013 and should not be used in calculations of current costs.

- Calcium Chloride Dust Control – Treated vs. Untreated Cost/Benefit Analysis
  **Note, this is not meant as an endorsement, just as an example*

RESEARCH ON HEALTH, ENVIRONMENTAL, AND CORROSION CONCERNS OF DUST CONTROL

Minnesota agencies have received calls from residents regarding issues either with gravel roads, dust, and/or dust control maintenance. The first issue focuses on dust from gravel roads; the other two issues center around dust control maintenance:

- Health concerns related to dust from gravel roads
- Environmental concerns of dust control suppressants
- Corrosion concerns of dust control suppressants

Health concerns related to dust from gravel roads

Studies have documented health issues associated with dusty gravel roads. These health concerns primarily stem from exposure to particulate matter (PM) generated by the dust, which can have respiratory and cardiovascular impacts, especially among vulnerable populations such as children, the elderly, and individuals with pre-existing respiratory conditions.[1] Several research papers and reports have investigated the health effects of dusty gravel roads. For instance, a study published in the "National Library of Medicine" in 2018 examined the respiratory health effects of road dust, highlighting increased rates of respiratory symptoms and diseases among residents living near such roads.[2]

Addressing these health concerns is important, prompting the implementation of dust control measures to mitigate the adverse effects of road dust on public health. While dust suppressants may have environmental impacts, particularly if they are improperly used, the benefits of implementing dust control measures for public health outweigh any potential harm caused by these suppressants when applied correctly.[3] The health risks associated with exposure to road dust, including respiratory and cardiovascular issues, particularly among vulnerable populations, are well-documented. Therefore, prioritizing dust control to mitigate these health risks is beneficial.

Environmental concerns of dust control suppressants

Although dust control agents can pose environmental concerns due to their chemical properties, **as noted below, the US Forest Service stated the chloride levels in soils were below thresholds for concern**. Independent research into the environmental, health and safety impact of calcium chloride and magnesium chloride in dust control applications has found that the concerns related to the use of these materials can be effectively managed through proper handling and application procedures and by adhering to recommended application rates. The U.S. Department of Agriculture Forest Service reported that soil samples taken after multiple dust control test projects using calcium chloride and magnesium chloride showed similar effects for both chemicals: increases in chloride levels in soils were below thresholds for concern. Data from tree samples taken as part of the same studies showed increased chloride levels but chloride levels were not deemed a significant long-term threat to vegetation survival.

Which additives or treatments are more environmentally friendly?

Environmentally friendly dust suppressants are products or methods that help control dust without causing harm to the environment. Water is, in fact, environmentally friendly. However, all others pose harm in certain or extreme conditions (See page 3 in Dust Palliative Selection and Application Guide). Some of the most environmentally friendly dust suppressants include:[4]

- **Water:** Water is the most basic and eco-friendly dust suppressant. Regularly spraying water on unpaved roads or construction sites can help to control dust. However, this method requires frequent applications and can consume significant amounts of water, which might not be feasible in areas with water scarcity.

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1 Environmental Protection Agency (EPA). (2021). Stormwater Best Management Practice - Dust Control
2 Khan and Strand (2018). Road Dust and Its Effect on Human Health: A Literature Review
3 Minnesota Pollution Control Agency (2013). Dust Control Treatments for Roads and Surfaces
4 What are the Most Environmentally Friendly Dust Palliatives?

- **Organic binders:** These are made from natural, biodegradable materials like lignin sulfonate (derived from wood processing), vegetable oils, and plant-based polymers. They act as binders, stabilizing soil particles and reducing dust emissions. Organic binders are non-toxic and generally have minimal environmental impact.
- **Synthetic polymers:** These are man-made, water-soluble polymers that can help control dust by binding soil particles together. Some examples include polyvinyl acetate and acrylic copolymers. While not as eco-friendly as organic binders, they can be effective and less harmful than traditional dust suppressants like petroleum-based products.

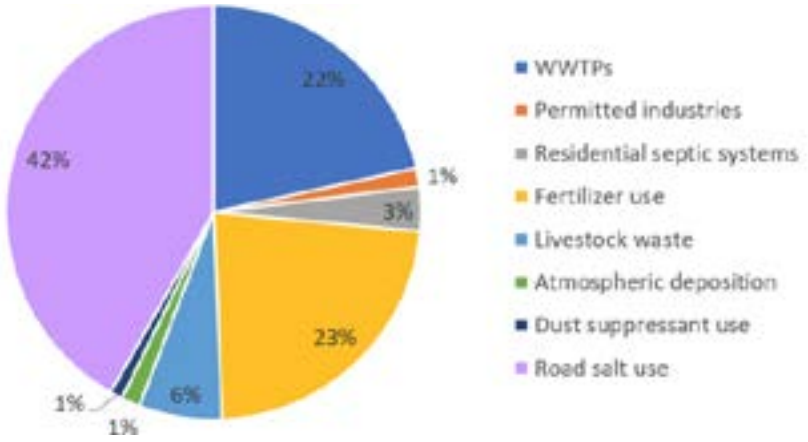
Calcium Chloride: dust suppressant vs other sources (winter maintenance and water softeners)

Calcium chloride produces the same types of environmental concerns when used as a dust suppressant versus as a road deicer. However, when used as a dust suppressant the effect is considerably less due to the smaller amounts used and its low systemic toxicity. Calcium added by way of dust suppressant is insignificant in comparison to the amount already present in the environment. Chloride itself is also present in all natural waters.[5]

According to the Minnesota Pollution Control Agency (MPCA) and U.S. Geological Survey (USGS), the amount of salt added to stormwater from dust control is significantly lower than that from winter maintenance and water softeners.

- **Winter Maintenance**: Road salting during winter maintenance activities introduces substantial amounts of chloride into the environment. In 2019, researchers at the University of Minnesota reported that road salt is the largest contributor to the statewide chloride budget, adding 403,600 tons of chloride to surface waters annually, representing 42% of total chloride contributions.[9]
- **Water Softeners**: Water softeners also release significant amounts of chloride. A 2019 University of Minnesota study estimated that 65% of all chloride passing through wastewater treatment plants (WWTPs), or approximately 136,000 tons annually, originates from residential and commercial water softening processes. Chloride from WWTPs accounts for 22% of the total contribution, or approximately 209,900 tons annually.[9]
- **Dust Control**: The use of salt for dust control on gravel roads can vary widely, but it generally contributes much less salt compared to winter road maintenance. Estimates suggest that dust control adds around 9,400 tons of chloride annually, about 1% of the total contribution, varying with application frequency and area covered.[6]

Researchers at the University of Minnesota further estimated the contributions of chloride from various statewide sources in 2019. From a statewide perspective, de-icing salt, fertilizers, and WWTPs (including residential, commercial, and industrial softening, along with other sources of chloride in the influent make up the predominant sources of chloride, as illustrated in the figure below. This figure is cited in the Minnesota Statewide Chloride Management Plan (p16).



[5] Environmental Protection Agency (EPA). (1992). Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures

[6] Overbo, A. et al. (2019). Chloride Contributions from Water Softeners and Other Domestic, Commercial, Industrial, and Agricultural Sources to Minnesota Waters

Corrosion concerns of dust control suppressants

Chloride-based dust control agents, such as magnesium chloride and calcium chloride, are known for their corrosive properties.[7] These agents work by attracting moisture from the atmosphere, forming a brine solution that helps suppress dust on roads. However, this hygroscopic nature also accelerates corrosion on metal surfaces they come into contact with.[8] Comparatively, salt used for winter maintenance poses similar corrosion risks to vehicles and infrastructure. Sodium chloride, a commonly used deicer, lowers the freezing point of water, preventing ice formation on roads during winter. However, it also promotes corrosion on metal surfaces due to its corrosive properties when dissolved in water.[9] [10] To minimize the corrosive impacts, agencies can consider several strategies.

- **Alternative products:** Organic dust suppressants, lignin-based products, and biodegradable polymers offer dust suppression with reduced corrosive effects compared to chloride-based agents.
- **Application rate:** Applying dust control agents based on the recommended application rate can decrease their corrosiveness while maintaining dust suppression effectiveness. Agencies can adhere to the recommended application rate based on environmental and infrastructure considerations to balance efficacy with corrosion risk.[11]
- **Additives**: Incorporating additives into dust control can provide added protection for metal surfaces. For example, DuraBlend®-CEP) is used as an additive to reduce chlorides leaching into the environment.[12]

If an agency is curious about how their applications of chlorides for dust control compare to winter maintenance, a calculator was developed to provide a very simple comparison. This calculator uses some general assumptions and is intended as a guide versus an exact, technical comparison.

Are there additives that are less corrosive?

The US Army Corp published a report in 2021, Corrosion and Performance of Dust Palliatives: Laboratory and Field Studies, which looked at 15 products. Chapter 4 focused on corrosion. According to the report (p.57):

- *Fourteen different dust palliatives (and water) were evaluated in the laboratory as a way to select the products to be used in the field. All five products used in these field investigations performed well as dust suppressants in the laboratory. The performance of the dust palliatives in the field in order of best performance was BioSoyl Plus followed by EK35, magnesium chloride, X-Hesion Pro™, and SandTec 9006. Of the five tested in the field only SandTec 9006, and X-Hesion Pro™ were USDA BioPreferred® products.*
- *Magnesium chloride was the most corrosive (as expected) followed by Soykill on both aluminum alloys (2024-T3 and 7075-T6).*

There is an ongoing LRRB study, Evaluation of Gravel Stabilizer Used on Gravel Roads and Shoulders, scheduled to be completed in February of 2026. Although this project's focus is on stabilizers, which are different than a dust control suppressant, there is some product overlap and the study is evaluating some of the issues raised about dust control suppressants (corrosiveness, environmental and cost effectiveness). This project constructed 20+ test sites within Cass, Itasca, Mcleod and St. Louis Counties, and is evaluating the Dustex, BaseOne, BaseOne & MgCl2, Perma-zyme & MgCl2, Perma-zyme and MgCl2 stabilizers. The focus of the project is to analyze the benefits of stabilizers in terms of cost savings, long-term service life, and environmental impacts via life-cycle analysis.

[7] US Army Corps of Engineers (2018). Corrosion Inhibitive Hygroscopic Organic Based Dust Palliatives
[8] Wisconsin Transportation Bulletin. Dust Control on Unpaved Roads
[9] Minnesota Stormwater Manual. Other Impacts of Deicer Use
[10] MNDOT. Minnesota Snow and Ice Control - Handbook
[11] US Department of Agriculture (2006). Surface-Aggregate Stabilization with Chloride Materials
[12] Envirotech Services. DuraBlend(R) - CEP

RESOURCES AND TOOLS FOR SELECTING DUST CONTROL SUPPRESSANTS

Technical References

Best Practices for Dust Control on Aggregate Roads (2009)

- Provided Minnesota experience, performance and cost of commonly used dust palliatives ($CaCl_2$, $MgCl_2$, and organic polymer-plus-binder)
- Moisture content is the best predictor of dust control efficiency
- Provided guidance on developing some best practices

Corrosion and Performance of Dust Palliatives: Laboratory and Field Studies (2021)

- Evaluated 15 products; Chapter 4 focused on corrosion
- Magnesium chloride was the most corrosive

Evaluation of Gravel Stabilizer Used on Gravel Roads and Shoulders (active, 2026 completion date)

- Evaluates some of the issues raised about dust control suppressants
- Constructed 20+ test sites in Minnesota evaluating various stabilizers

Unpaved Road Dust Management – A Successful Practitioner's Handbook, FHWA (2013)

- Provides useful and insightful excerpts of real-world examples and includes practical how-to instructions for determining what type of treatment may be needed for different situations
- $CaCl_2$, $MgCl_2$, Lignosulfonate, Petroleum resin, Synthetic polymer, and many others

Unpaved Road Chemical Treatments – State of the Practice Survey FHWA (2013)

- A supplement of the above providing survey results regarding the state of the practice of using chemical treatments on unpaved roads. $CaCl_2$, $MgCl_2$, Lignosulfonate, Petroleum resin, Synthetic polymer, and many others
- Provides lessons learned and best practices

Unpaved Road Chemical Treatment Selection Tool

- Good tool that assists with treatment selection; a great tool for engineers

Vendor Resources

EnviRoad® Products

- Vendor's site on various dust control products (Sulfonate and similar)

Substrata Products

- Vendor's site on various dust control products (Enzymes and similar)

Cypher Environmental Products

- Vendor's site on various dust control products (Non-Chloride (DUST/BLOKR®))
- Addresses questions regarding issues with corrosiveness and environmental issues

Envirotech Services Products

- Vendor's site on various dust control products (Chloride & Non-Chloride)

Peters Chemical Company – Minimizing Corrosion

- Vendor's site with information on corrosion-inhibited calcium chloride

APPENDICES

Appendix A: Survey Questions and Responses

- A.1 General Summary of Survey Responses
- A.2 Summary of $CaCl_2$ Users
- A.3 Summary of $MgCl_2$ Users
- A.4 Summary of Other Suppressants

Appendix B*: Sample Dust Control Specifications

- B.1 Hubbard County Specification
- B.2 Itasca County Chloride Application Specification
- B.3 Polk County Specification

*Appendices B.1 and B.2 are available in this document. To access Appendix B.3, please visit the link.