UNPAVED ROAD CHEMICAL TREATMENTS
State of the Practice Survey

Publication No. FHWA-CFL/TD-13-002 **January 2013**

U.S. Department of Transportation
Federal Highway Administration

CTIP

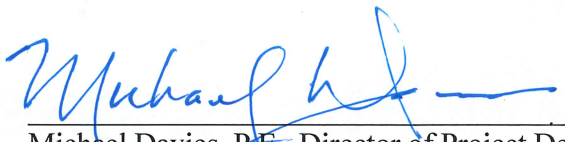
Federal Lands Highway
Commitment to Excellence

Central Federal Lands Highway Division
12300 W. Dakota Ave.
Lakewood, CO 80228

FOREWORD

The Federal Highway Administration (FHWA) encourages programs that protect both the environment and the life of the roadway. Fugitive dust from unpaved roads threatens air, soil and water quality and roadside flora and fauna. This loss of material cause road surface deterioration, increases maintenance cost, and adds to the complexity of managing a network of unpaved roads.

This FHWA report called *Unpaved Road Chemical Treatments, State of the Practice Survey* provides insights into how road managers at various levels of municipal, county, state, federal and tribal government, private industry and academic institutions approach unpaved road management regarding the use of chemical treatments.



Michael Davies, P.E., Director of Project Delivery
Federal Highway Administration
Central Federal Lands Highway Division

Notice

Quality Assurance Statement

The FHWA provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. The FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-CFL/TD-13-002		

4. Title and Subtitle	5. Report Date
Unpaved Road Chemical Treatments *State of the Practice Survey*	January 2013
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Angela Kociolek	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Western Transportation Institute P.O. Box 174250 Bozeman, MT 59717-4250	11. Contract or Grant No. DTFH68-09-E-00099

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Federal Highway Administration Central Federal Lands Highway Division 12300 W. Dakota Ave. Lakewood, CO 80228	Final Report, December 2009 – February 2010
	14. Sponsoring Agency Code HFTS-16.4

15. Supplementary Notes

COTR: Roger Surdahl, FHWA-CFLHD. This project was funded under the FHWA Federal Lands Highway Coordinated Technology Implementation Program (CTIP).

16. Abstract

This report documents survey results regarding the state of the practice of using chemical treatments on unpaved roads. It provides insights into road manager choices and challenges and is useful supplementary reading to the accompanying *Unpaved Road Dust Management, A Successful Practitioner's Handbook* by Jones et al. (2013).

Roughly 80% of the survey respondents used chemical treatments for six or more years. Ninety eight percent (98%) of those indicated it was to control (fugitive road) dust, in part, to comply with federal regulations, for human and livestock health, in response to public complaints, or as a courtesy to the public. Other top reasons were to reduce maintenance costs and extend grader maintenance intervals.

The most common treatment method was spray-on surface application with the top three chemical treatments being magnesium chloride, calcium chloride, and lignin sulfonate, respectively.

17. Key Words	18. Distribution Statement
FUGITIVE ROAD DUST, DUST CONTROL, CHEMICAL TREATMENT(S), UNPAVED, GRAVEL, UNSEALED ROADS, PALLIATIVES, STABILIZATION, UNPAVED ROAD MANAGEMENT	No restriction. This document is available to the public from the sponsoring agency at the website http://www.cflhd.gov.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	58	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	Millimeters	mm
ft	feet	0.305	Meters	m
yd	yards	0.914	Meters	m
mi	miles	1.61	Kilometers	Km
		AREA		
in^2	square inches	645.2	Square millimeters	mm^2
ft^2	square feet	0.093	Square meters	m^2
yd^2	square yard	0.836	Square meters	m^2
ac	acres	0.405	Hectares	ha
mi^2	square miles	2.59	Square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	Milliliters	mL
gal	gallons	3.785	Liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	Grams	g
lb	pounds	0.454	Kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	Lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2	poundforce per square inch	6.89	Kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	Inches	in
m	meters	3.28	Feet	ft
m	meters	1.09	Yards	yd
km	kilometers	0.621	Miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	Hectares	2.47	Acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	Milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	Gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	Ounces	oz
kg	kilograms	2.202	Pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	Poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380 (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

The author wishes to thank Roger Surdahl of the FHWA-CFLHD for the sponsorship and leadership.

For their help in promoting the survey, the author thanks Tina Barbaccia of Better Roads Magazine, Michele Beck of the Montana Local Technical Assistance Program (LTAP), Lorie Cover of the Idaho Technology Transfer (T^2) Center, Mike Fitch of the Ohio Department of Transportation, Anthony Giancola of the National Association of County Engineers, John Kiefer of Michigan LTAP, Terry McNinch of Michigan LTAP, Russell Merle Jr. of the Clark County Department of Air Quality & Environmental Management, David Page of the Florida T^2 Center, Carrie Plasters of EnviroTech Services, Dan Ratermann of the Missouri Association of County Transportation Officials, Bob Raths of the Association of Oregon Counties, Richard Rolland of the Tribal Technical Assistance Program, Mike Long, Chairman of the Transportation Research Board's Low-Volume Roads Committee, and others who may have regretfully been missed. The author is also very grateful to everyone who took the time to participate in the survey.

Finally, thanks to the staff at the Western Transportation Institute for their administrative support.

CHAPTER 1 – BACKGROUND AND METHODS

This state of the practice survey focuses on unpaved road management with an emphasis on chemical treatments as a means to control fugitive road dust. This task was conducted in conjunction with the *2010 National Scan of Best Practices for Chemical Treatments on Unpaved Roads* sponsored by the Federal Highway Administration's Central Federal Lands Highway Division which culminated in the *Unpaved Road Dust Management, A Successful Practitioner's Handbook* (Jones et al. 2013).

While the Steering Committee (see Jones et al. 2013, Appendix A) determined that the scan tour itself should strive to include sites that depict practices worthy of replication, the survey could and should capture a broader state of the practice. The survey language, therefore, was designed to obtain information on whether agencies use or do not use chemical treatments as an unpaved road maintenance strategy. Furthermore, it was deemed important to understand why practitioners do *not* use chemical treatments in order to better address the barriers to treating unpaved roads in the future. In addition, the survey was a tool for identifying potential host sites for the national scan tour.

The survey questions were developed by consensus of the Steering Committee during conference calls and email correspondence. The survey was exempt from the Institutional Review Board for the Protection of Human Subjects at Montana State University.

Questions were loaded into and formatted with an online survey tool which also served as the survey response data collector. The target audience of unpaved road managers, practitioners and researchers were invited to participate in the survey via email invitation (i.e., listserv or direct personalized mail), internet-based promotion on relevant news sites, and hard copy promotional cards displayed at a relevant conference (i.e., Transportation Research Board).

All prospective survey takers were directed to a landing page at www.roaddustinstitute.com which described the intention of the survey and who was conducting it. If, after reading the background information, the prospective survey taker chose to participate, they were directed to the actual survey at www.surveymonkey.com. The survey was available online from December 8, 2009 to February 4, 2010. Survey invitation reminders were sent out periodically to maximize participation.

Screenshots of the survey questions and format follow in Chapter 2, with the Results section in Chapter 3.

(blank page)

CHAPTER 2 – SURVEY QUESTIONS AND FORMAT

National Scan of Best Practices for Chemical Treatments on Unpaved

Part 1 of 4

YOUR AFFILIATION

1. Choose the best option that describes your affiliation or where you work.

- ◯ Municipality
- ◯ County
- ◯ State
- ◯ Federal
- ◯ Tribal
- ◯ Academic/Research
- ◯ Private Industry
- ◯ Other (please specify)

Part 1 of 4 continued

2. Choose the best option that describes your role/job description.

- ◯ Decision maker/manager
- ◯ Project engineer
- ◯ Maintenance superintendent
- ◯ Maintenance worker
- ◯ Researcher
- ◯ Other (please specify)

Although academic/research organizations rarely manage an unpaved road network, we would appreciate your responding to the questions based on your general experience or specific experience with one of your projects/client road agencies. You may skip questions that are not applicable to your experience.

To continue with survey, please hit "next."

PART 2 of 4

GENERAL INFORMATION ON YOUR AGENCY/ORGANIZATION'S USE OF CHEMICAL TREATMENTS ON UNPAVED

Page 1

National Scan of Best Practices for Chemical Treatments on Unpaved ROADS

3. Does your agency/organization use chemical treatments (for dust control, stabilization, reduced maintenance, etc) on unpaved roads?

- ◯ Yes
- ◯ No
- ◯ Don't know

Part 2 of 4 continued

GENERAL INFORMATION ON YOUR AGENCY/ORGANIZATION'S USE OF CHEMICAL TREATMENTS ON UNPAVED ROADS

4. If your agency/organization manages unpaved roads but does not use any form of chemical treatment, please state reasons why. (check all that apply)

- ☐ Environmental concerns
- ☐ Legal concerns
- ☐ No funding
- ☐ Too expensive/not cost-effective
- ☐ Equipment limitations
- ☐ Insufficient information available to make informed decisions
- ☐ Bad experience in the past
- ☐ Procurement problems with purchasing proprietary products
- ☐ Procurement problems with purchasing products with no specification
- ☐ Don't know
- ☐ Other

If you selected "Other," please specify

Part 2 of 4 continued

GENERAL INFORMATION ON YOUR AGENCY/ORGANIZATION'S USE OF CHEMICAL TREATMENTS ON UNPAVED ROADS

Page 2

National Scan of Best Practices for Chemical Treatments on Unpaved

5. Why does your agency/organization use chemical treatments on unpaved roads? (check all that apply)

- [ ] Control dust
- [ ] Control erosion
- [ ] Improve wet weather drivability
- [ ] Improve level of service for road user
- [ ] Reduce road maintenance costs
- [ ] Extend grader maintenance intervals
- [ ] Preserve gravel
- [ ] Aid compaction
- [ ] Improve strength of in situ or imported materials
- [ ] Improve safety by minimizing washboards on grades
- [ ] Other

If you selected "Other," please specify

6. How long has your agency/organization used chemical treatments on unpaved roads?

- ◯ One year or less
- ◯ Between two and five years
- ◯ Six years or more

7. How does your agency/organization apply chemical treatments on unpaved roads? (check all that apply)

- [ ] Spray directly onto the road surface
- [ ] Mix into the wearing course layer
- [ ] Mix into layer(s) beneath the wearing course layer

Page 3

National Scan of Best Practices for Chemical Treatments on Unpaved

8. What types of chemical treatments does your agency/organization use for each of the methods checked in Question 7? (check all that apply)

	Spray directly onto the road surface	Mix into the wearing course layer	Mix into layer(s) beneath the wearing course layer
Magnesium chloride	☐	☐	☐
Calcium chloride	☐	☐	☐
Other brine	☐	☐	☐
Lignin sulfonates	☐	☐	☐
Tree resins, molasses, or other plant residues	☐	☐	☐
Synthetic polymer emulsions (e.g. acrylates, acrylics, vinyl acetates, etc)	☐	☐	☐
Synthetic oils (e.g. mineral oils, iso-alkalines, etc)	☐	☐	☐
Petroleum resins (e.g. blend of lignin sulfonate and petroleum product)	☐	☐	☐
Sulfonated oils (e.g. ionic soil stabilizers)	☐	☐	☐
Enzymes and biological agents	☐	☐	☐
Asphalt (emulsion and/or cutback)	☐	☐	☐
Cement, flyash, and/or lime	☐	☐	☐
Bentonite	☐	☐	☐
Proprietary product(s) with unknown formulation	☐	☐	☐

Other (please specify)

9. The length of my agency/organization's paved road network (in miles) is:

10. The length of my agency/organization's unpaved road network (in miles) is:

Page 4

National Scan of Best Practices for Chemical Treatments on Unpaved

11. What percentage of your agency/organization's unpaved road network is chemically treated? Answer for each of the methods checked in Question 7.

	Spray directly onto the road surface	Mix into the wearing course layer	Mix into layer(s) beneath the wearing course layer
Between 0 and 2 percent	☐	☐	☐
Between 3 and 5 percent	☐	☐	☐
Between 6 and 10 percent	☐	☐	☐
Between 11 and 20 percent	☐	☐	☐
Between 21 and 40 percent	☐	☐	☐
Between 41 and 60 percent	☐	☐	☐
61 percent or more	☐	☐	☐

12. My agency/organization's annual paved road maintenance budget is:

13. My agency/organization's annual unpaved road maintenance budget is:

14. How often does your agency/organization apply chemical treatments? (check all that apply)

- ☐ Periodically when funds are available
- ☐ Periodically when requested by road users/land owners
- ☐ Periodically when paid for by road users/land owners
- ☐ Routinely four or more times per year
- ☐ Routinely two or three times per year
- ☐ Routinely once per year
- ☐ Routinely once every two years
- ☐ Routinely once every three to five years
- ☐ During regravelling / reconstruction
- ☐ Other

If you selected "Other," please specify

Page 5

National Scan of Best Practices for Chemical Treatments on Unpaved

15. What percentage of your agency/organization's road maintenance budget is used for chemical treatments?

- ◯ Less than or equal to 5 percent
- ◯ Between 6 and 10 percent
- ◯ Between 11 and 20 percent
- ◯ Between 21 and 30 percent
- ◯ 31 percent or more

16. My agency/organization will apply chemical treatments if a land owner pays for it.

- ◯ Yes
- ◯ No

17. For your agency/organization's most commonly used treatment, why do you choose this treatment? (check all that apply)

- ☐ Cost-effectiveness
- ☐ Environmental benefits (e.g. reduced dust, reduced gravel loss, improved air quality)
- ☐ Road user/land owner pressure
- ☐ Availability
- ☐ Recommendation by other practitioner(s)
- ☐ Recommendation by sales representative
- ☐ Experience from previous experiments
- ☐ Other

If you selected "Other," please specify

18. For your agency/organization's most commonly used chemical treatment, how long have you been using this treatment?

- ◯ One year or less
- ◯ Between two and five years
- ◯ Six or more years

Page 6

National Scan of Best Practices for Chemical Treatments on Unpaved

19. For your agency/organization's most commonly used treatment, how would you rate your satisfaction with performance?

- ◯ Very satisfied
- ◯ Generally satisfied
- ◯ Generally unsatisfied
- ◯ Very unsatisfied

Provide most important reason for your answer

20. How does your agency/organization assess performance of chemical treatments on unpaved roads? (check all that apply)

- ☐ Visual assessment/drive-by evaluations
- ☐ Dust level / PM10 measurement
- ☐ Ride quality measurements
- ☐ Documenting grader maintenance intervals compared to untreated roads
- ☐ Documenting gravel replacement intervals compared to untreated roads
- ☐ Road user/land owner feedback
- ☐ Assessment of dust impacts on nearby biota or water bodies
- ☐ Other

If you selected "Other," please specify

PART 3 of 4

DESIGN, CONSTRUCTION AND MAINTENANCE METHODS FOR UNPAVED ROADS

Page 7

National Scan of Best Practices for Chemical Treatments on Unpaved

21. How does your agency/organization design unpaved roads (gravel specifications, layer thickness, compaction and strength requirements, etc)? (check all that apply)

- ☐ In-house written guidelines*
- ☐ Other agency written guidelines*
- ☐ Historical experience
- ☐ On-the-job training from experienced practitioners
- ☐ Other (please specify)*

*Please provide document name(s) or other comment

22. What equipment does your agency/organization use for applying chemical treatments for each of the methods checked in Question 7? (check all that apply)

	Spray directly onto the road surface	Mix into the wearing course layer	Mix into layer(s) beneath the wearing course layer
Water tanker with spray-bar	☐	☐	☐
Mechanical spreader	☐	☐	☐
Motor grader	☐	☐	☐
Reclaimer / other in-place mixer	☐	☐	☐
Rotivator, disc plough or other mixing equipment	☐	☐	☐
Roller – pad / sheepsfoot	☐	☐	☐
Roller – steel drum	☐	☐	☐
Roller – pneumatic	☐	☐	☐
Dump truck	☐	☐	☐

Other (please specify)

PART 4 of 4

CLOSING THOUGHTS

Page 8

National Scan of Best Practices for Chemical Treatments on Unpaved

23. Please select a choice for each of the following statements about your agency/organization's experience with product manufacturers/suppliers. (please answer all)

	Strongly agree	Agree	Disagree	Strongly disagree
I have generally had good experiences	◯	◯	◯	◯
The representative has training and experience in unpaved road engineering	◯	◯	◯	◯
The product chemistry and how the product works was clearly explained	◯	◯	◯	◯
Potential environmental impacts were clearly explained	◯	◯	◯	◯
The technical documentation provided was sufficiently comprehensive	◯	◯	◯	◯
The MSDS form provided was sufficiently comprehensive	◯	◯	◯	◯
Justification for the products cost-effectiveness claim was clearly explained	◯	◯	◯	◯
On-site assistance with design and application / construction was satisfactory	◯	◯	◯	◯
I would prefer to use a product with an ASTM, AASHTO or other specification	◯	◯	◯	◯

24. Please select a choice for each of the following general statements related to unpaved road management. (please answer all)

	Strongly agree	Agree	Disagree	Strongly disagree
Chemical treatments can be considered as an unpaved road best management practice	◯	◯	◯	◯
More research is needed on chemical treatments for unpaved roads	◯	◯	◯	◯
More comprehensive guideline documentation for chemical treatments on unpaved roads is needed	◯	◯	◯	◯
The chemical treatment manufactures/suppliers should form an industry association	◯	◯	◯	◯

Page 9

National Scan of Best Practices for Chemical Treatments on Unpaved

25. Please select a choice for each of the following agency/organization-specific statements related to unpaved road management. (please answer all)

	Strongly agree	Agree	Disagree	Strongly disagree
My agency/organization has evaluated chemical treatment experiments in the past	○	○	○	○
My agency/organization plans to evaluate chemical treatment experiments in the future	○	○	○	○
My agency/organization's unpaved road chemical treatment program is a good example of an unpaved road best management practice	○	○	○	○

26. I would like to see the following output(s) from a national program of managed research on unpaved road management practices

- ☐ "How to" manual for best practices in application of chemical dust suppressants
- ☐ Database of summary reports from road managers about performance of dust suppressant practices
- ☐ Web-based clearinghouse of information resources about chemical dust suppressants
- ☐ Other

If you selected "Other," please specify

27. The number of participants on FHWA's proposed scan tour in spring/summer 2010 will be 10 or less. If you think your agency/organization would be willing to host a national scan tour visit in order to show your unpaved road chemical treatment program, please provide contact information.

28. If you know of other agencies/organizations that believe their unpaved road chemical treatment programs include best management practices, please provide contact information.

Page 10

National Scan of Best Practices for Chemical Treatments on Unpaved

THE SURVEY IS COMPLETE. PLEASE SUBMIT BY CLICKING ON THE "DONE" BUTTON BELOW. THANK YOU FOR YOUR TIME.

Page 11

(blank page)

CHAPTER 3 – RESULTS

At least 2,000 practitioners received the survey invitation via direct email and at least another 500 practitioners saw the invitation in the form of electronic or hard copy promotion. This promotion strategy maximized participation and offered a good chance of understanding the breadth of unpaved road management practices currently employed across the nation.

A total of 288 respondents started the survey and 199 completed it (69.1% completion rate). One respondent entered "test" for open-ended questions and was removed from the analysis. Therefore, the actual total number of respondents was 287. Not all respondents answered every question. Responses to each survey question were downloaded from www.surveymonkey.com and analyzed in Excel.

AGENCY AFFILLIATION AND ROLE

Slightly more than half of the survey respondents (51%; n = 285) were affiliated with county level government. Others represented private industry, municipalities, federal or state agencies, academic institutions, tribal organizations, or considered themselves to not be easily classified (i.e., "other") (Figure 1; APPENDIX A-I).

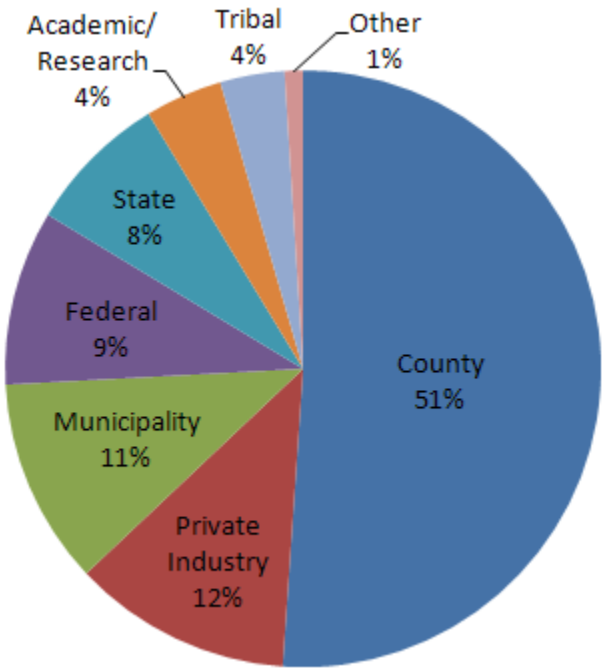


Figure 1. Graph. Affiliations of survey respondents. (rounded up to nearest percent; n = 285)

The majority of respondents (59%; n = 268) indicated their role as being a decision maker or manager within their agency. The remainder represented a variety of respondent-described roles entered as "other," or maintenance superintendents, project engineers, and to a negligible degree, researchers and maintenance workers (Figure 2). "Other" roles included engineer (other than "project engineer"), business administrator, sales representative, planner, consultant, educator, technical support, and regulator (APPENDIX A-II).

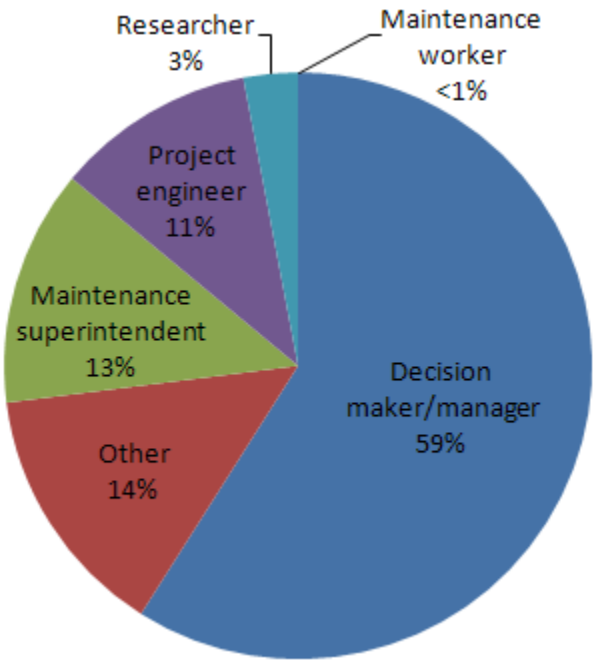


Figure 2. Graph. Roles of survey respondents. (rounded up to nearest percent; n = 268)

AGENCY USE OF CHEMICAL TREATMENTS

Most respondents (73%; n = 274) indicated their agency uses chemical treatments on unpaved roads for dust control, soil stabilization, reduced maintenance, etc. Twenty five percent (25%) indicated their agency *does not* use chemical treatments and 2% did not know whether or not their agency uses chemical treatments on unpaved roads.

Respondents who indicated that their agency *does not* use chemical treatments were directed to a more specific question, "If your agency manages unpaved roads but does not use any form of chemical treatment, please state reasons why (check all that apply)." Fifty three respondents answered the question with seven simply stating that their agency does not manage any unpaved roads. The remaining forty six respondents provided the rationale for why their agency does not employ chemical treatments as part of their unpaved road maintenance strategy (Figure 3). The top five most common reasons for not employing chemical treatments were 1.) lack of funding, 2.) cost ineffectiveness, 3.) environmental/health concerns, 4.) equipment limitations, and 5.) insufficient information to make informed decisions. Respondents also provided a variety of other reasons (APPENDIX A-III). This question signified the end of the survey for the set of respondents who indicated their agency *does not* use chemical treatments on their unpaved road network.

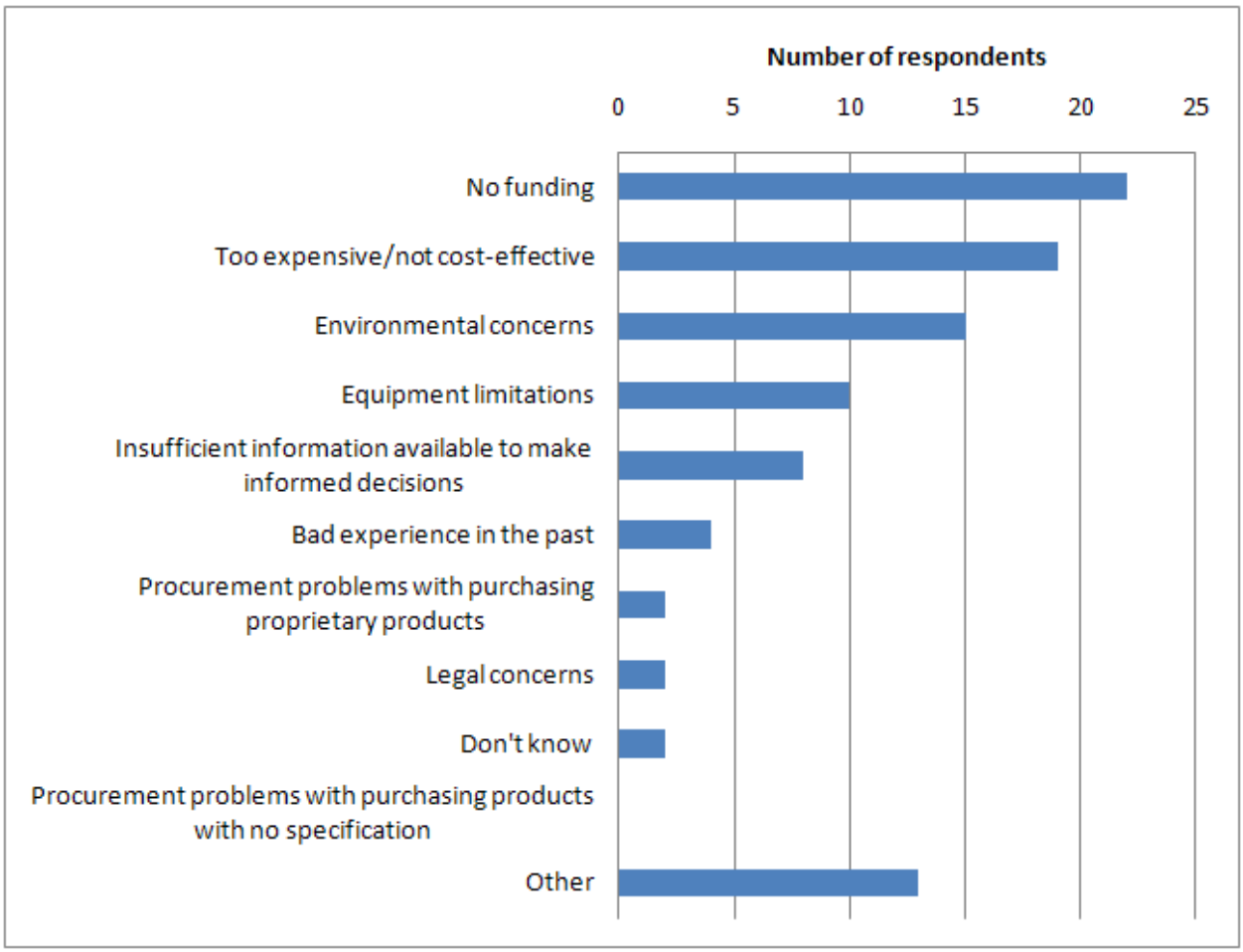


Figure 3. Graph. Rationale for *not* using chemical treatments on unpaved roads. Respondents were asked to check all that apply. (n = 46)

SIZE OF ROAD NETWORK AND CORRESPONDING BUDGET

The remainder of the survey pertained to respondents who indicated their agencies *do* employ chemical treatments on their unpaved roads. The Steering Committee deemed it important to gain an understanding about the relative composition of road networks referenced in this survey. Therefore, the survey included several questions about the length of the road network for which the respondent was affiliated and corresponding budgets (both paved and unpaved).

Seventy five percent of respondents (75%; n = 135) represented agencies responsible for 3 to 500 miles (4.8 to 805 km) of *paved* roads. Only 4% of respondents represented agencies responsible for tens of thousands of paved road miles (Figure 4). The average paved road network length for respondents of this survey was 1,235 miles (1,986 km). Inapplicable responses, zero values, and question marks were not included in the analysis.

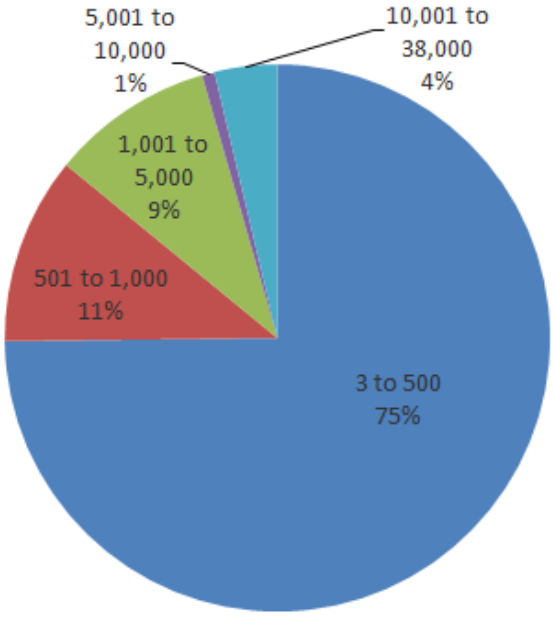


Figure 4. Graph. Relative percent of survey respondents by length of their respective *paved* road network (assuming center lane miles). (n = 135)

Fifty six percent of respondents (56%; n = 143) represented agencies responsible for 2 to 500 miles (3.2 to 805 km) of *unpaved* roads. Only 4% of respondents represented agencies responsible for tens of thousands of unpaved road miles (Figure 5). The average unpaved road network length for respondents of this survey was 2,001 miles (3,220 km). Inapplicable responses, zero values, and question marks were not included in the analysis.

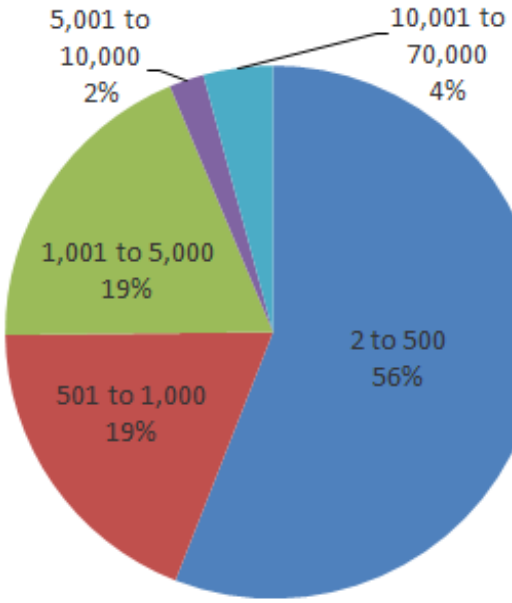


Figure 5. Graph. Relative percent of survey respondents by length of their respective *unpaved* road network (assuming center lane miles). (n = 143)

The amounts of annual road maintenance budgets varied widely. The most common amount for *either* paved or unpaved was between $100,001 to $1,000,000 US. Twenty nine percent (29%; n = 109) of respondents are affiliated with an agency that has a *paved* budget in that range (Figure 6) and 30% (n = 108), an *unpaved* budget in that range (Figure 7).

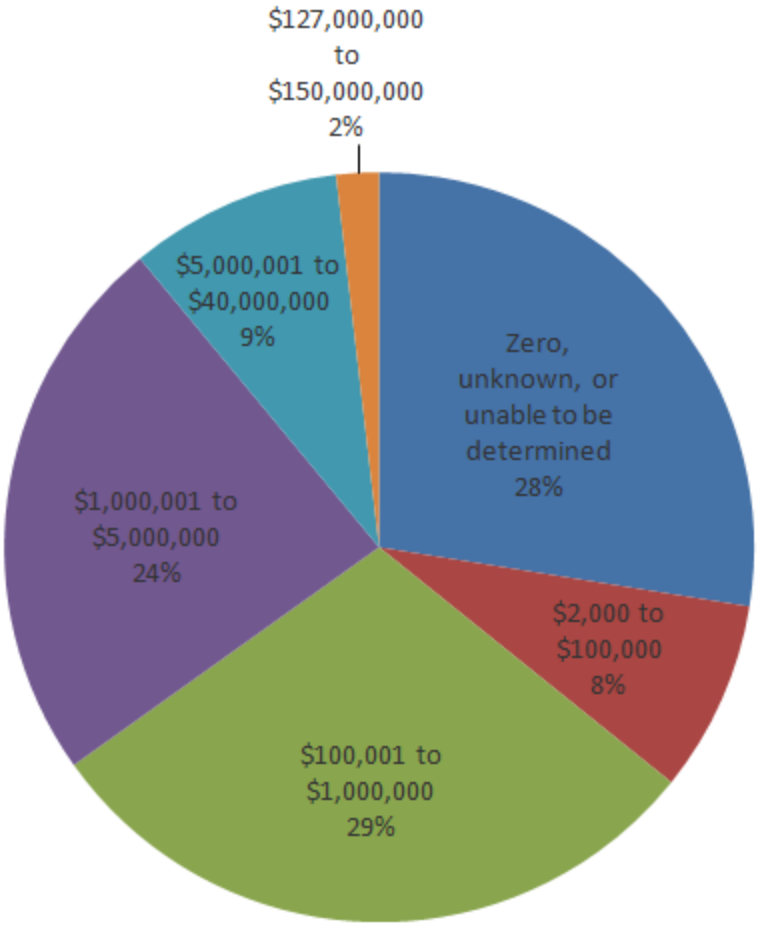


Figure 6. Graph. Relative percent of survey respondents by amount of respective annual paved road maintenance budget (in US$). (n = 109)

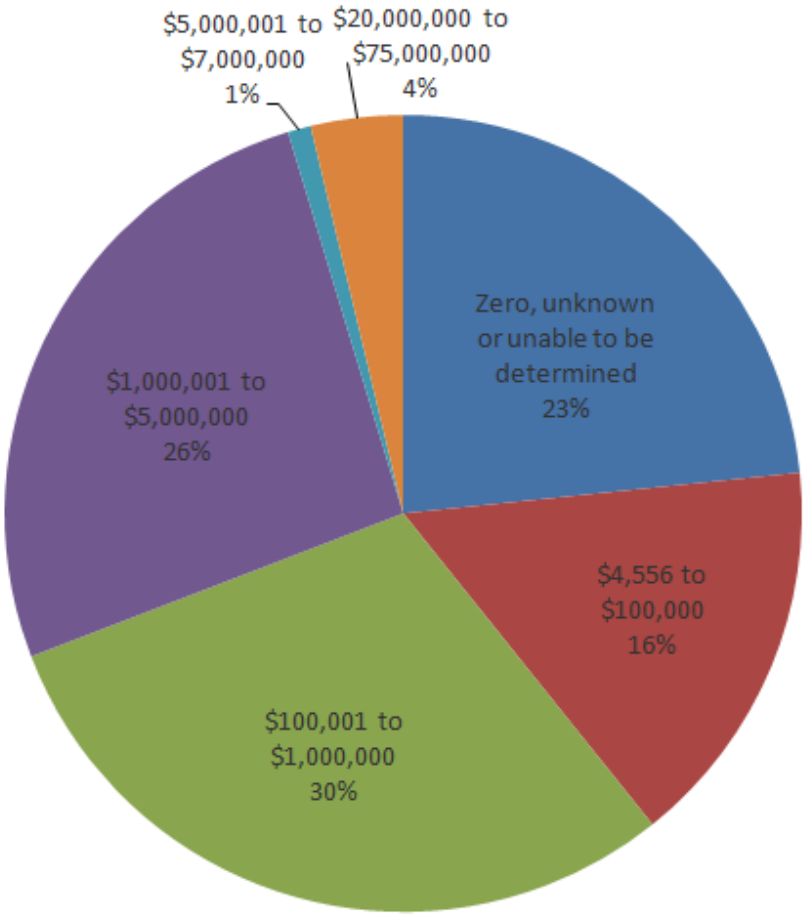


Figure 7. Graph. Relative percent of survey respondents by amount of respective annual *unpaved* road maintenance budget (in US$). (n = 108)

Ninety (90) respondents provided relatively comprehensive information for the length of their agency's road network *and* corresponding annual budget amounts (paved and unpaved). Nine (9) of these respondents indicated, however, that their agency's annual road maintenance budget does not differentiate between paved and unpaved.

Of the remaining 81 respondents who provided enough detailed information on this topic, 39 respondents (48%) were affiliated with an agency whose *paved* road network is bigger than its unpaved network. Similarly, 40 respondents (49%) were affiliated with an agency whose *unpaved* road network is bigger than its paved network. The remaining two respondents who provided enough detailed information were affiliated with an agency whose paved and unpaved networks are the same length.

In 67 of the cases (83%; n = 81), the bigger portion of the total agency road network also had the larger corresponding annual budget amount, regardless of whether the bigger portion was paved or unpaved. For respondents who provided enough detailed information on this topic, agencies allocate annually an average of $4,989 per paved road mile (n = 77) and an average of $3,909 per unpaved road mile (n = 81). Table 1 illustrates the lowest, highest and average budgets reported. For comparison, one respondent indicated that the national average for Bureau of Indian Affairs/Tribal Roads is about $2,100 per mile, paved or unpaved.

Table 1. Range and average of road maintenance budgets reported ($ US)

Lowest annual budget reported (corresponding network length[s]); resulting average budget per mile	Highest annual budget reported (corresponding network length); resulting average budget per mile	Overall average "per mile" budget
Paved (n = 77)		
$0 (3 to 5,000 miles); $0	$875,000,000 (38,000 miles); $23,026	$4,989
Unpaved ($ US) (n = 81)		
$0 (13 to 1,740 miles); $0	$75,000,000 (2,400 miles); $31,250	$3,909

The majority of respondents (83%; n = 144) indicated that 5% or less of their agency's unpaved road maintenance budget is used for chemical treatments (Figure 8).

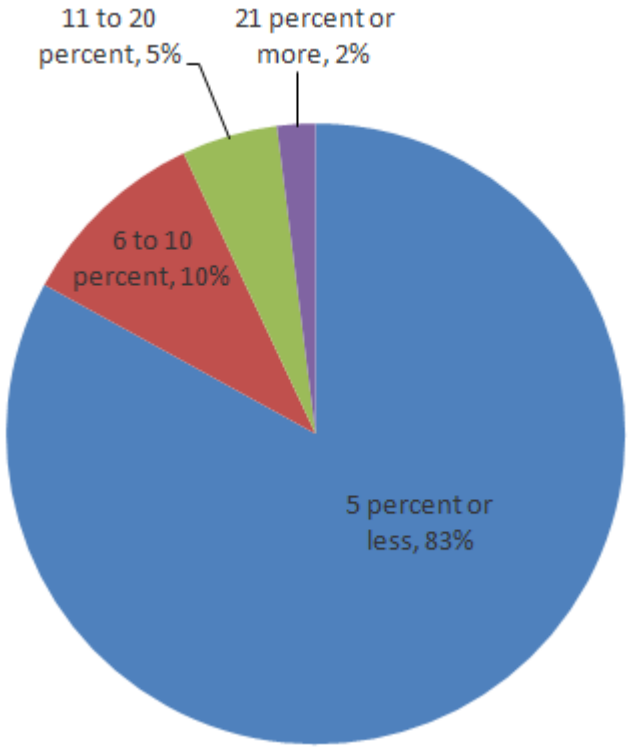


Figure 8. Graph. Relative percent of survey respondents by percentage of agency's unpaved road maintenance budget used for chemical treatments. (n = 144)

Notably, 61% (n = 146) indicated that their agency will apply chemical treatments if a land owner pays for it.

CHOICE OF CHEMICAL TREATMENTS

Roughly 80% of respondents (n=164) indicated that their agency has been employing chemical treatments for six or more years. Less than 4% have been using chemical treatments for a year or less.

One hundred sixty nine respondents replied with a rationale for using chemical treatments. However, five (5) "other" responses were not applicable (e.g., "do not have paved roads," "do not use chemical treatment") and, therefore, were not included in the analysis. One of these respondents indicated that his/her agency uses "certified proven environmentally friendly products" in lieu of the chemical treatments described in the survey but, unfortunately, provided little specific information as to what those alternatives might be.

Of those that use or promote the use of chemical treatments, 98% of the respondents (n = 164) indicated it was to control (fugitive road) dust. Some respondents further explained their motivation to control dust (i.e., to comply with federal regulations, for human and livestock health, in response to public complaints, or as a courtesy to the public). Fifty two percent (52%; n = 164) or more of respondents indicated that reducing maintenance costs and extending grader maintenance intervals is part of their agency's rationale for using chemical treatments. Additional reasons (all from options provided in the survey text) are shown in Figure 9 and "other" responses are listed in APPENDIX A-IV.

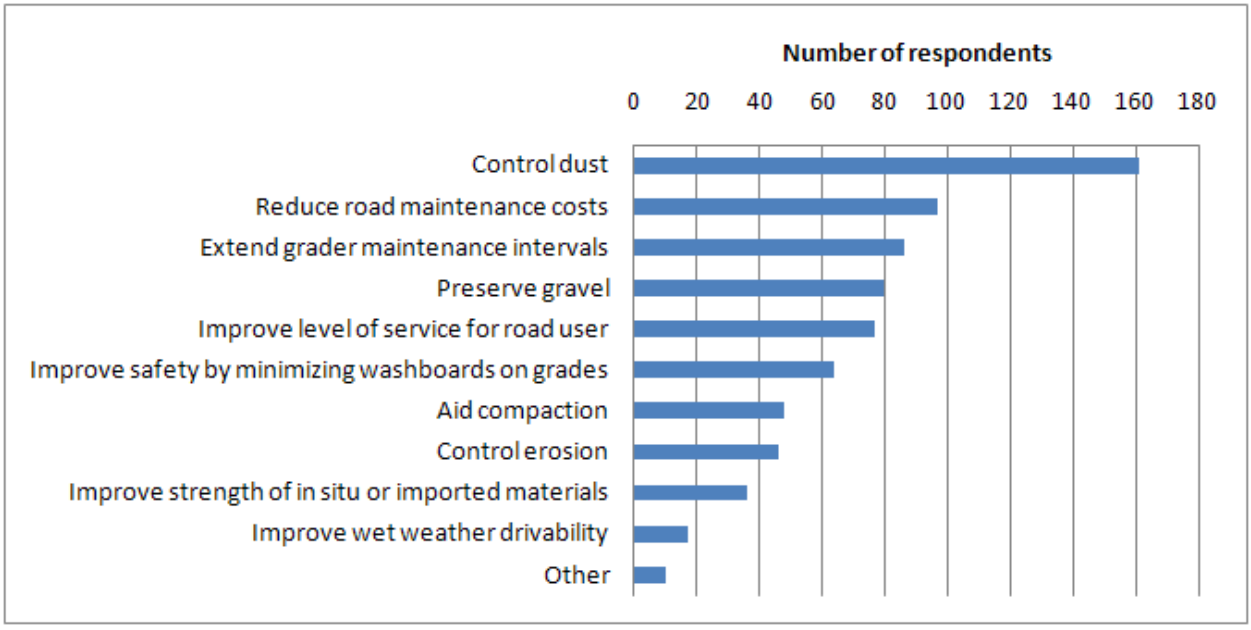


Figure 9. Graph. Rationale for using chemical treatments on unpaved roads. Respondents were asked to check all that apply. (n = 164)

By far, the most common method of chemical application is by spraying directly onto the road surface rather than mixing into road surface layers (Figure 10).

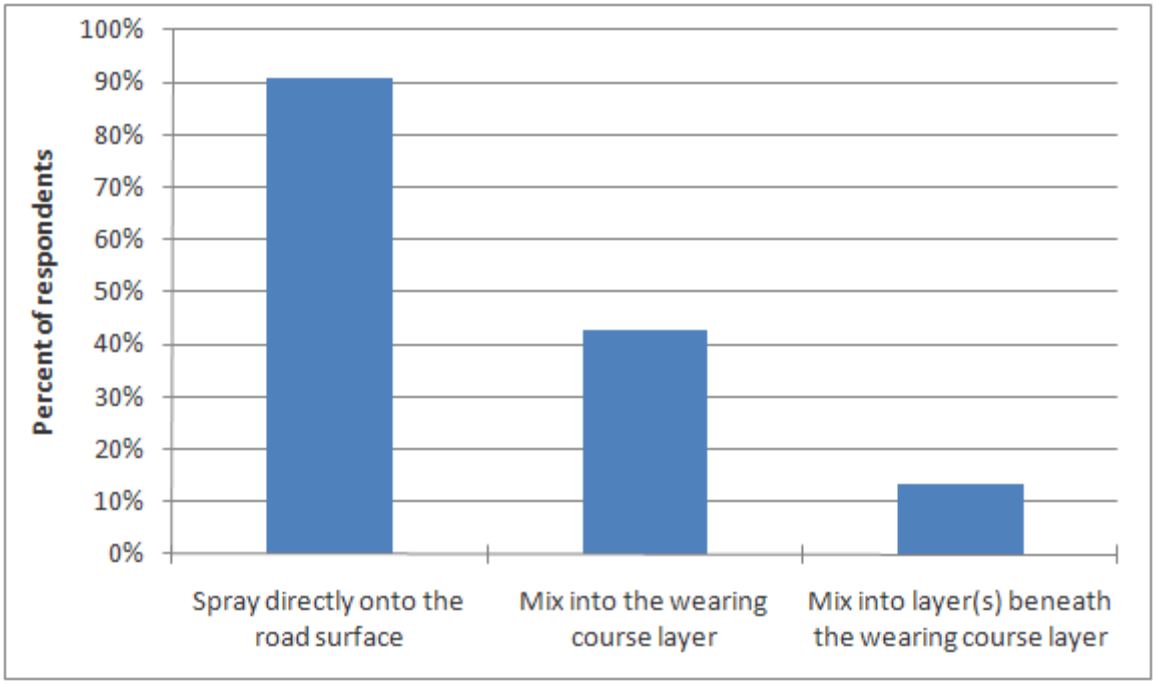


Figure 10. Graph. Methods by which agencies apply chemicals. Respondents were asked to check all that apply. (n = 164)

One hundred sixty-three (163) respondents answered the question, "What types of chemical treatments does your agency/organization use for each of the methods checked (previously)? (check all that apply)." Two "other" responses were not applicable and, therefore, not included in the analysis. The chemicals mostly commonly used by respondent agencies are magnesium chloride (MgCl) (57%; n = 161) and calcium chloride (CaCl) (52%), with lignin sulfonates a distant third (26%). Less than 17% of respondents to this question indicated that their agency uses any of the other chemical treatment options listed in the survey text (Figure 11). Nine respondents offered "other" chemical treatment information (APPENDIX A-V).

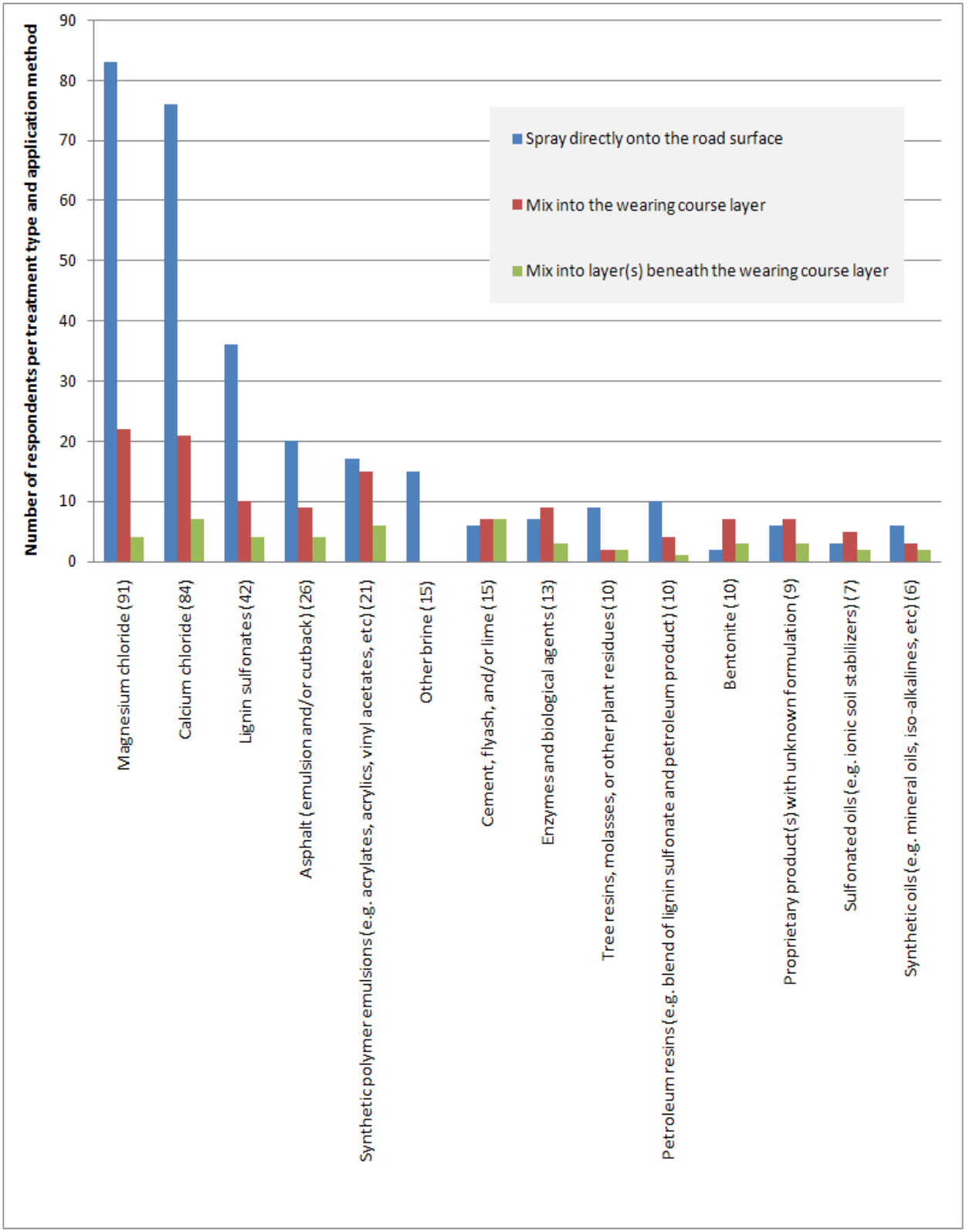


Figure 11. Graph. Use of chemical treatment by application method. Parenthesized number refers to the total number of respondents per treatment type regardless of application method. Respondents were asked to check all that apply. (n = 161)

One hundred forty-nine (149) respondents answered the question, “What equipment does your agency/organization use for applying chemical treatments for each of the methods checked (previously)? (check all that apply).” Eight (8) “other” responses to this question were not applicable and, therefore, not included in the analysis. Ninety-nine percent (99%; n = 142) of respondents indicated their agency uses a water tanker, most commonly for spraying directly onto the road surface, whereas, 53% indicated use of motor graders, and 25% or fewer indicated use of any of the other equipment designed more for stabilizing the soil (Figure 12). Seven (7) respondents offered “other” equipment-related information (APPENDIX A-VI).

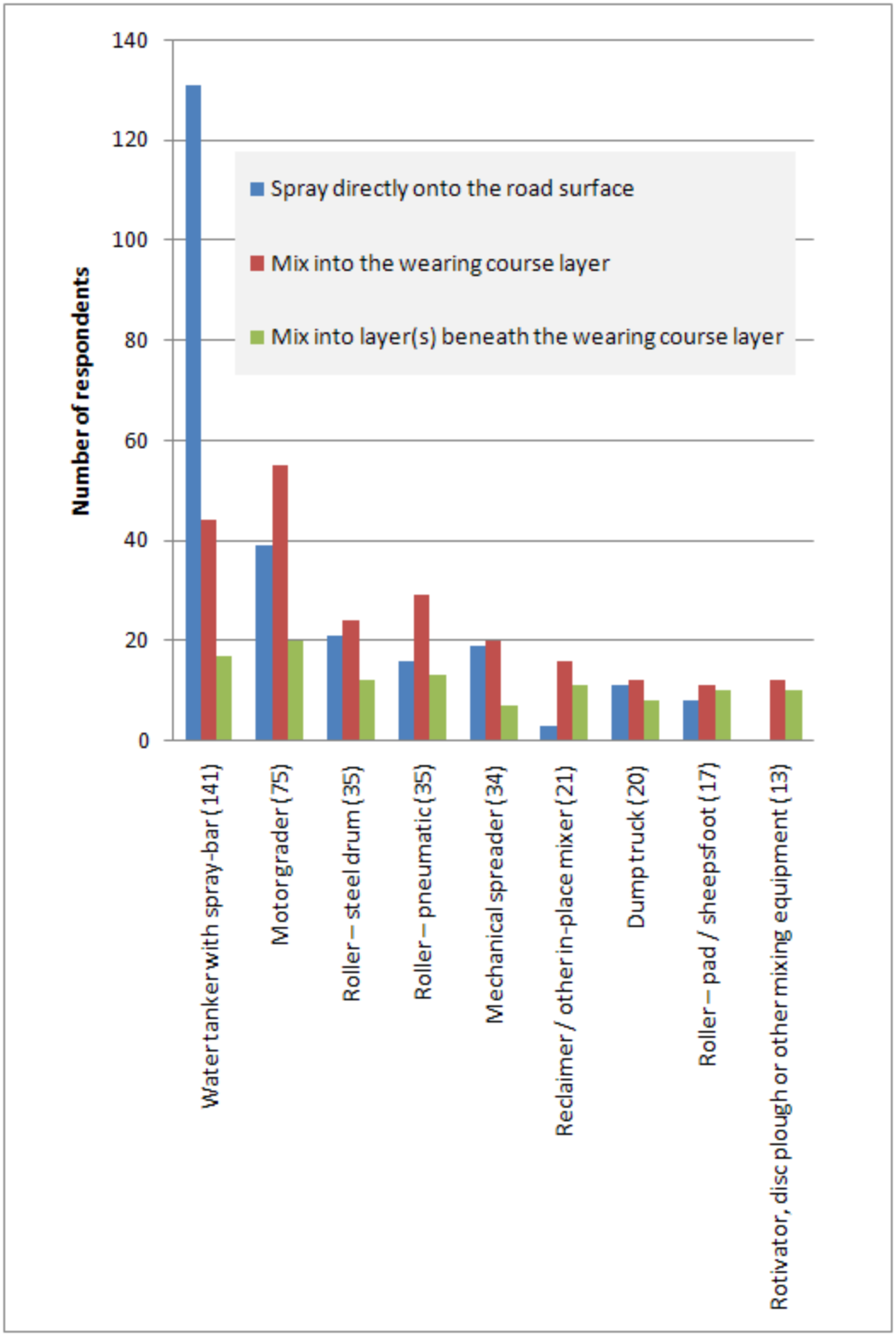


Figure 12. Graph. Type of equipment by application method. Parenthesized number refers to the total number of respondents per equipment type regardless of application method. Respondents were asked to check all that apply. (n = 142)

When asked for the rationale behind their agency's most commonly used treatment, 72% (n = 156) cited cost effectiveness. Environmental benefits (52%), experience from previous experiments (49%), and availability of the product (49%) were the next three most popular reasons for using a particular treatment. Additional reasons (all from options provided in the survey text) are shown in Figure 13 and "other" responses are listed in APPENDIX A-VII.

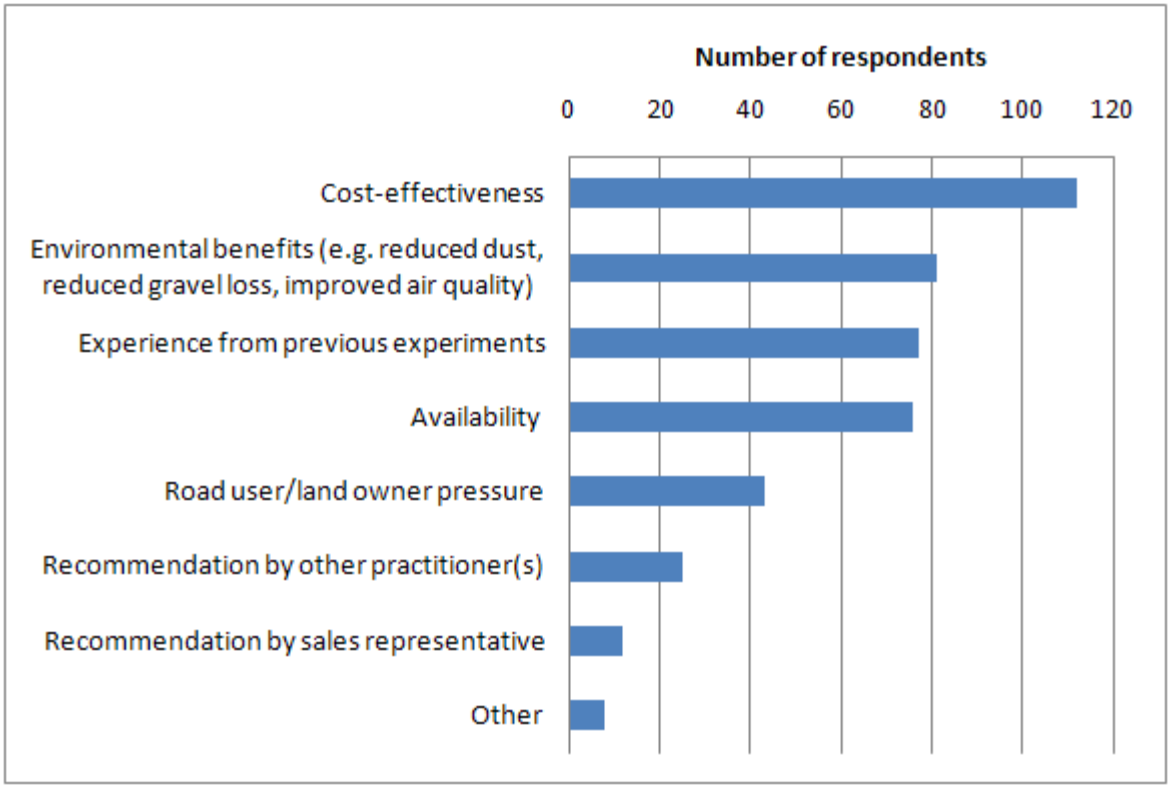


Figure 13. Graph. Rationale for choosing their agency's most commonly used chemical treatment. Respondents were asked to check all that apply. (n = 156)

Seventy five percent of respondents (75%; n = 153) indicated their agency has been using its preferred treatment for at least six years while the other 25% indicated the preferred treatment has been in use for five years or less.

Most respondents (95%; n = 156) were either very satisfied or generally satisfied with the performance of their agency's most commonly used treatment (Figure 14). Sixty-five respondents also provided open-ended comments describing the most important reason for their level of satisfaction (APPENDIX A-VIII).

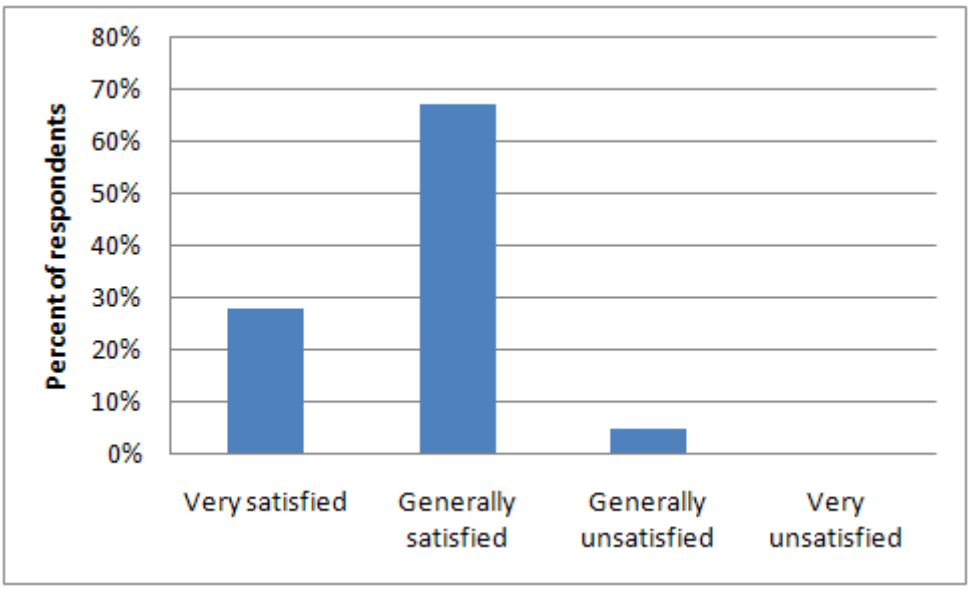


Figure 14. Graph. Respondent level of satisfaction with the performance of their agency's most commonly used treatment. (n = 156)

When asked how their agency assesses performance of chemical treatments, respondents overwhelmingly indicated a subjective and/or qualitative evaluative approach. The two most common methods were visual assessment/drive-by evaluation (93%; n = 158) and gauging feedback from the public (56%). Twenty-five percent (25%) of respondents or fewer indicated they take an objective and/or quantitative approach by documenting differences between treated and untreated roads or by taking measurements (Figure 15). Five (5) respondents provided "other" assessment-related information (APPENDIX A-IX).

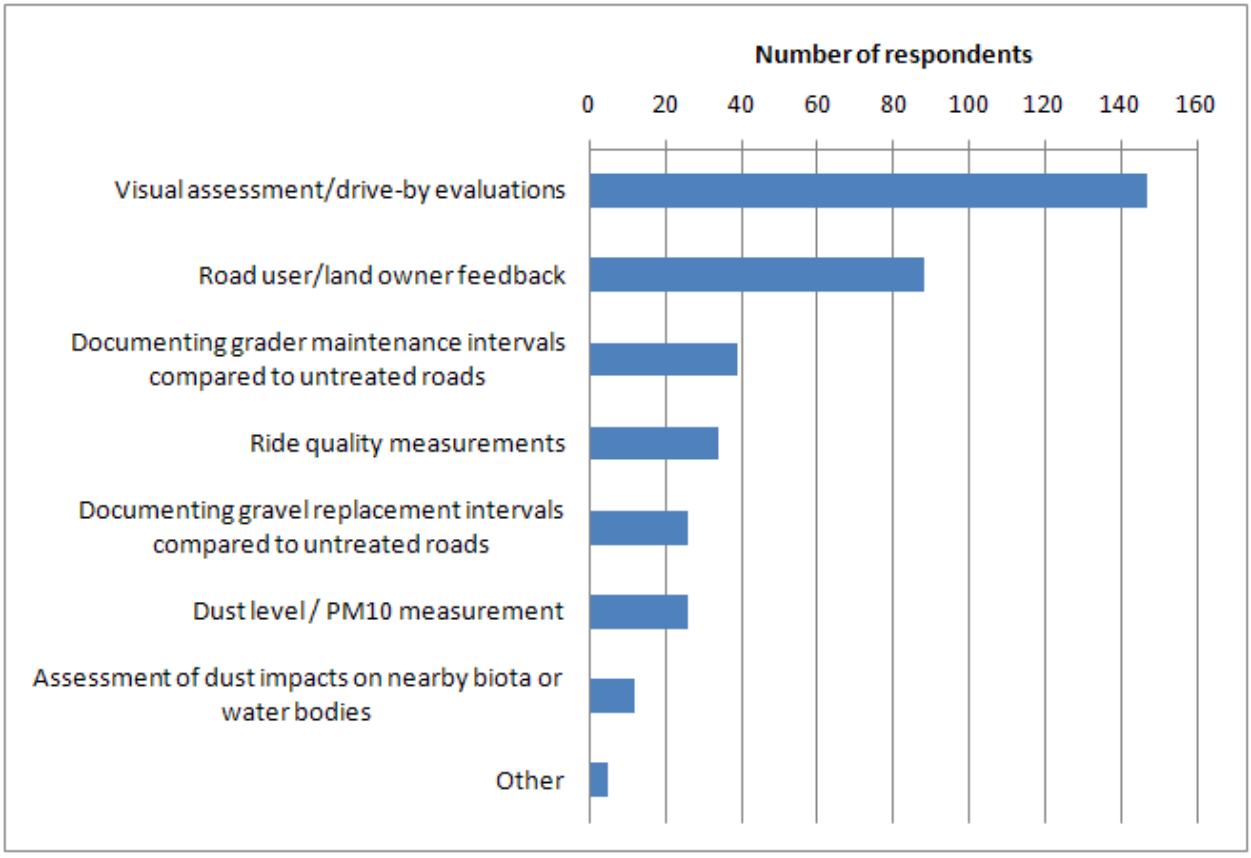


Figure 15. Graph. Methods used to assess performance of chemical treatments on unpaved roads. Respondents were asked to check all that apply. (n = 158)

APPROACH TO ROAD DESIGN

In terms of designing unpaved roads, most respondents indicated their agency relies on historical experience (56%; n = 151) and/or in-house written guidelines (51%) (Figure 16).

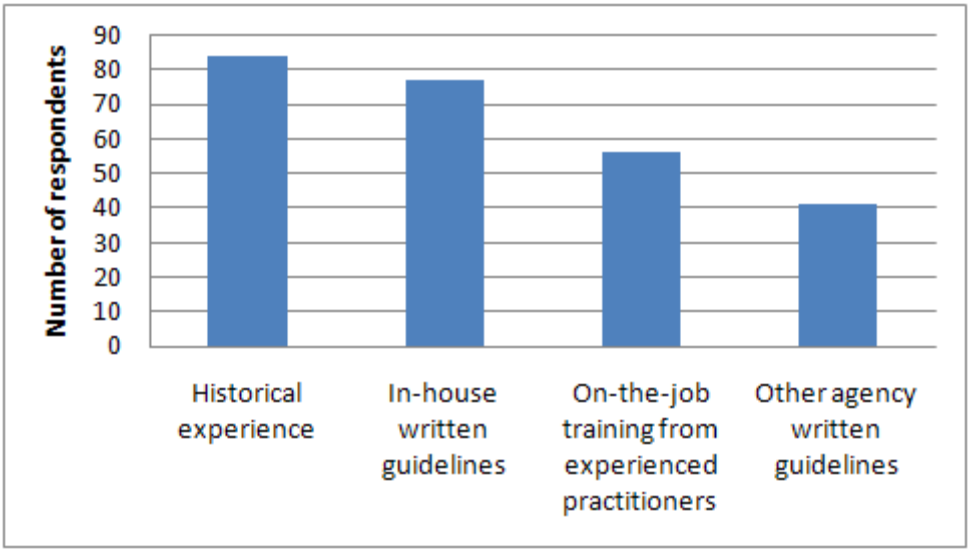


Figure 16. Graph. Agency approach to designing unpaved roads. Respondents were asked to check all that apply. (n = 151).

If written guidelines were used, in-house or otherwise, respondents were asked to provide the name of the document (Table 2). Fourteen (14) "other" open-ended comments regarding the design of unpaved roads are listed in APPENDIX A-X.

Table 2. Source of written guidelines used by respondent agencies (entries unedited).

Federal	State	County	Unknown
BLM Road Manual (9113) PASER Manuals, DOI Road Maintenance Training LTAP training We used to have the "Forest Service Standard Specifications" book as a guide. Our specs are based on FP-03 standards with supplemental specs developed by the Forest Service engineering. AASHTO design standards USDA Forest Service Earth and Aggregate Surfacing Design Guide for Low Volume Roads, September 1996, EM 7170-16 Bureau of Indian Affairs Design Manuals, other agency references that may be available. AASHTO A Policy on Geometric Design of Highways and Streets AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads	State DOT specifications New Hampshire Department of Transportation WYDOT VBCRC Standards for Road Development MDOT Specificastions for Construction Alaska Preconstruction Design Manual (coordinated w/ FHWA & AASHTO) Sate DOT Specifications Iowa DOT Design Guides & Design Aids Minnesota DOT specs Alaska DOT&PF Standard Specifications for Highway Construction Use MnDOT pavement design programs. Iowa DOT Standard Specifications, Iowa DOT Design Aids IM 3.210 Mn/DOT State Aid Standards state standards	County Road Standards Our county has developed a material specification for gravel that works best for us. Douglas County Local Road Construction Standards	Road standards approved minimum standards for design and construction We have a gravel road improvement standard that calls for a 24' surface with a minimum of 6" of compacted 23-A gravel. Standard Construction Specifications.

EXPERIENCE WITH MANUFACTURERS/SUPPLIERS

Most respondents (roughly 60% or more) indicated that their agency/organization has had generally positive experiences with product manufacturers and suppliers. Figure 17 lists a series of statements for which respondents were asked to indicate their level of agreement.

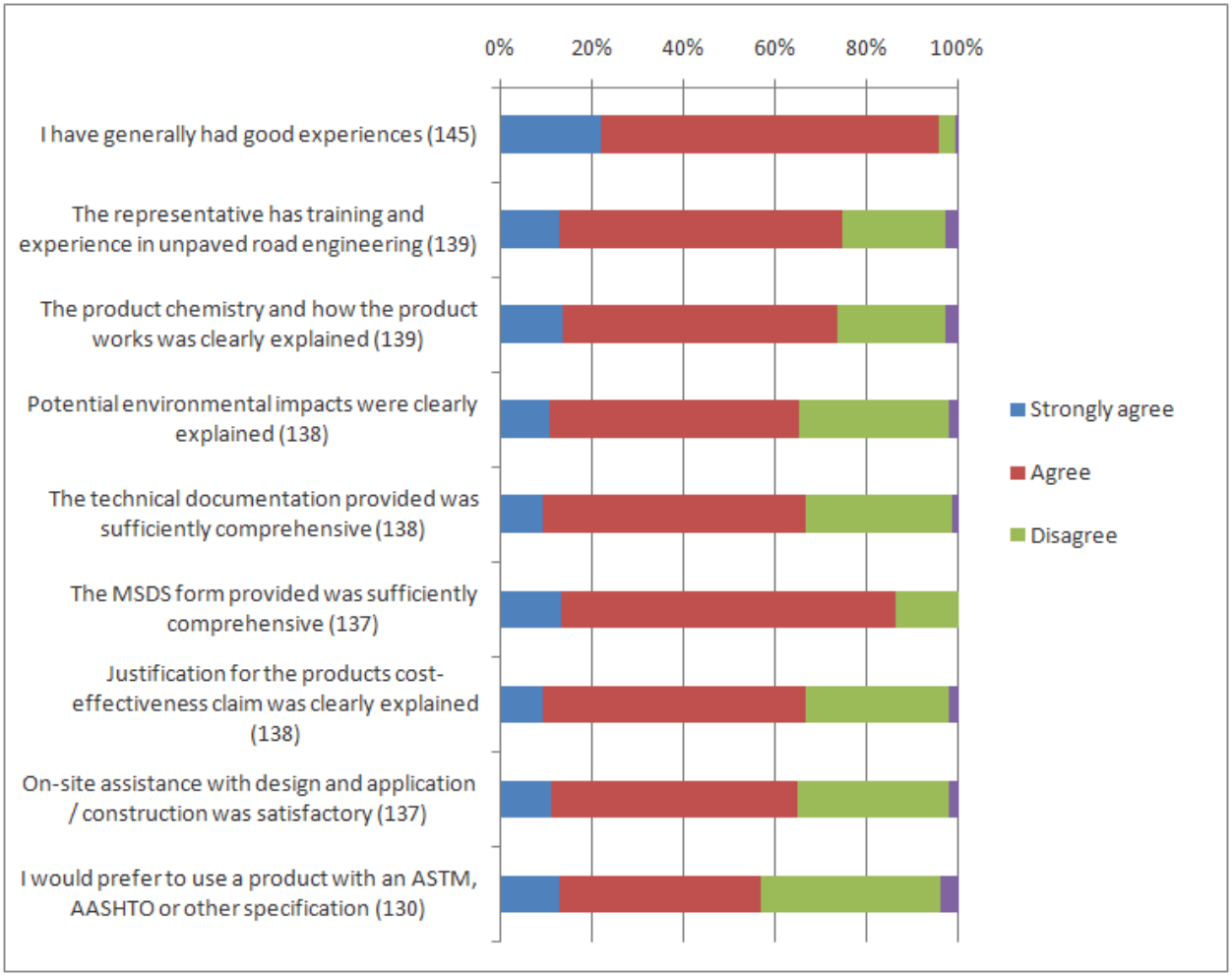


Figure 17. Graph. Degree of agreement with statements about agency/organization's experience with manufacturers and suppliers. Respondents were asked to answer all. Parenthesized numbers indicate the total number of respondents per statement, therefore, n ranged from 130 to 145.

Most respondents (80% or more) indicated that they believe chemical treatments can be considered an unpaved road best management practice, however, they also agreed that more research and more comprehensive guidelines for their use are needed. A solid 60% agreed that manufacturers and suppliers should form an industry association. Figure 18 lists a series of statements for which respondents were asked to indicate their level of agreement.

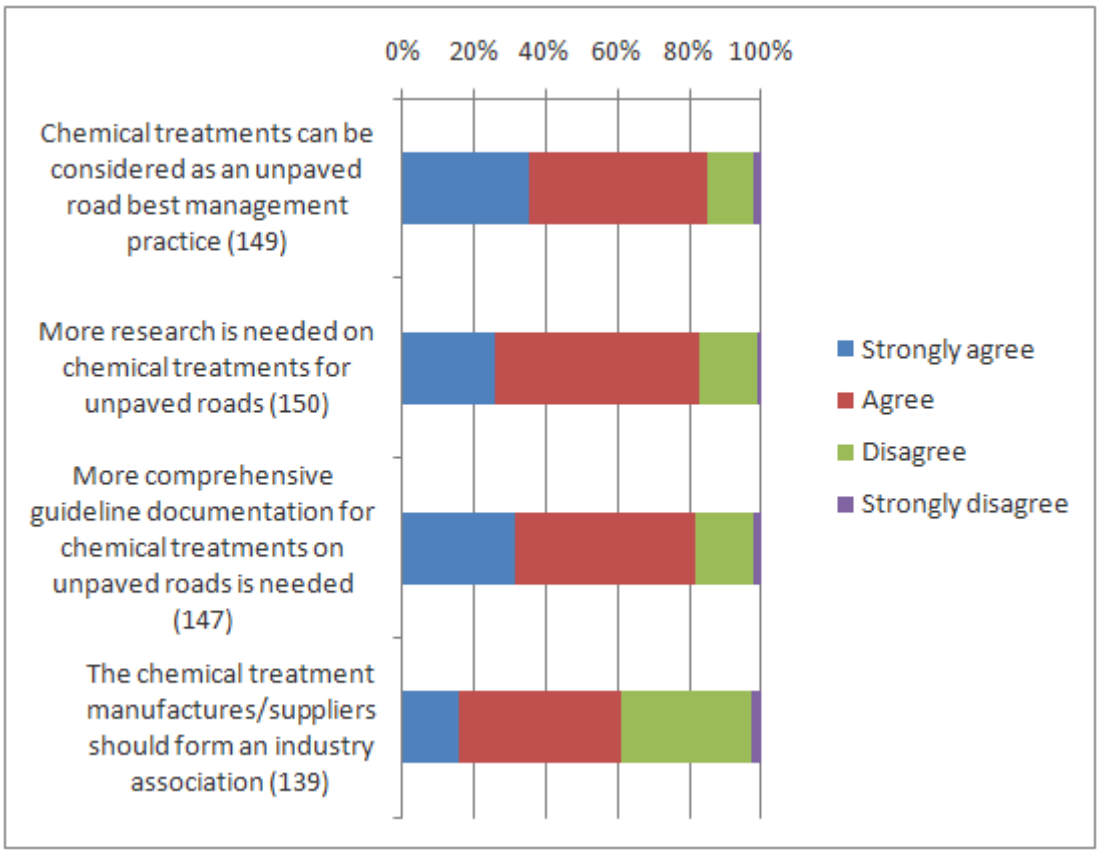


Figure 18. Graph. Degree of agreement with statements about chemical treatments. Respondents were asked to answer all. Parenthesized numbers indicate the total number of respondents per statement, therefore, n ranged from 139 to 150.

Seventy six percent of respondents (76%; n = 149) indicated their agency has evaluated chemical treatment experiments in the past. Sixty seven percent (67%; n = 147) indicated their agency/organization plans to evaluate chemical treatment experiments in the future. Sixty percent (60%; n = 140) considers their agency/organization's chemical treatment program a good example of a best management practice. Figure 19 lists a series of statements for which respondents were asked to indicate their level of agreement.

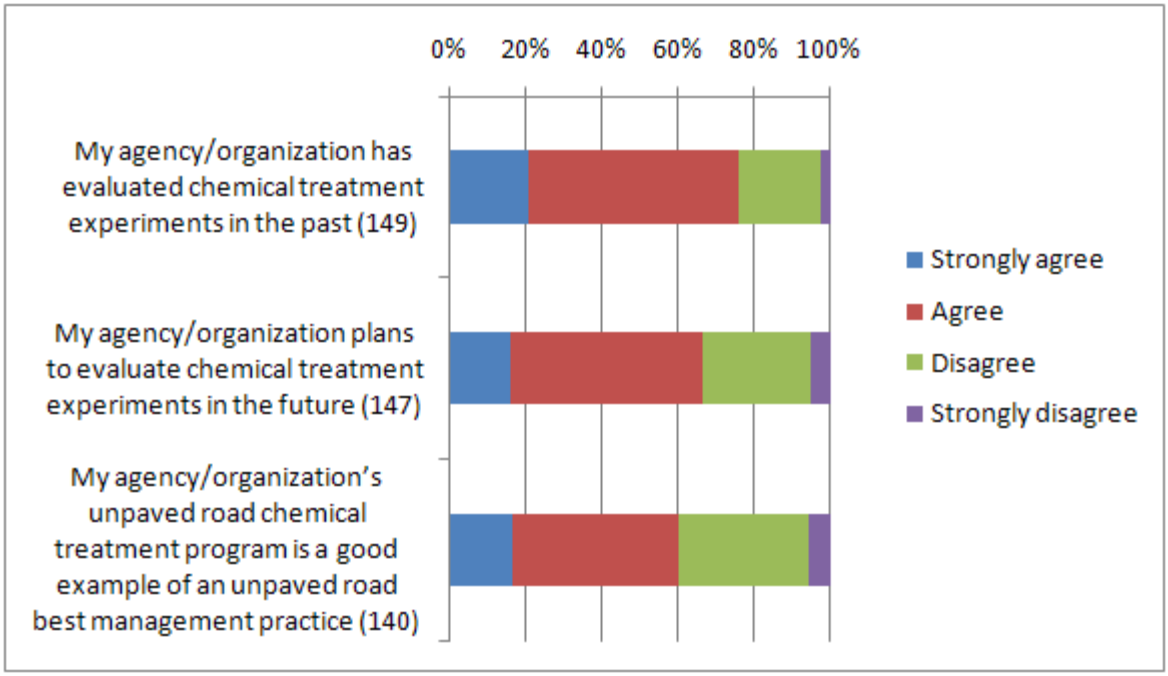


Figure 19. Graph. Degree of agreement with statements about agency/organization's chemical treatment program. Respondents were asked to answer all. Parenthesized numbers indicate the total number of respondents per statement, therefore, n ranged from 140 to 149.

The most commonly desired output from a national research program on unpaved road management practices was a "how to" manual for best practices in application (85%; n = 146). More than 60% of respondents were also interested in a web-based clearinghouse of resources and a database of summary reports on the performance of various practices. Figure 20 lists the output choices. Nineteen (19) "other" comments regarding desired outputs are listed in APPENDIX A-XI.

Questions 27 and 28 were aimed at identifying potential host sites for the *National Scan of Best Practices for Chemical Treatments on Unpaved Roads*. Some responses led to actual host sites visited on the Scan.

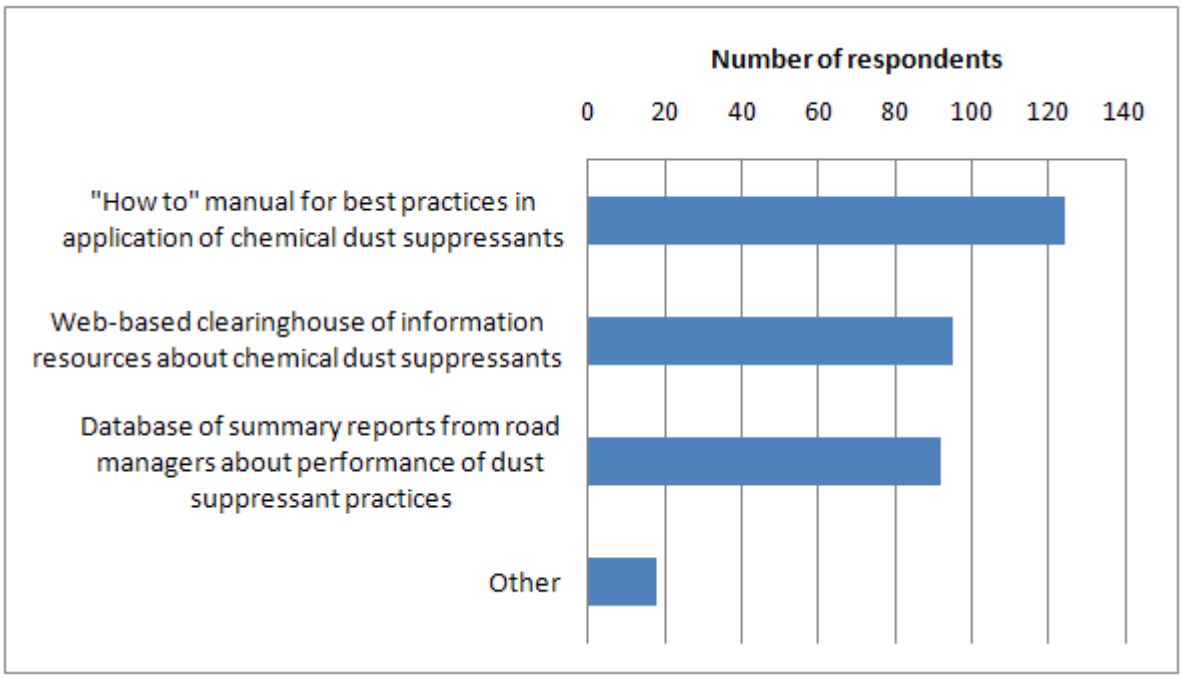


Figure 20. Graph. Desired outputs from a national program of managed research on unpaved road management practices. (n = 146)

(blank page)

CHAPTER 4 – SUMMARY

The target audience of this survey was unpaved road managers, practitioners and researchers. At least 2,500 people saw or received the targeted survey invitation with 199 respondents completing the online survey between December 8, 2009 and February 4, 2010. Not all respondents answered every question. The number of respondents to each question is specified in the body of the text but omitted here for ease. Therefore, percentages cited in summary below are calculated based on the number of respondents to individual questions and not the 199 figure above.

Fifty one percent (51%) of respondents indicated an affiliation with county level government. Fifty nine percent (59%) identified their job role as a decision maker or manager within their agency or organization. Twenty five percent (25%) indicated that their agency/organization *does not* apply chemical treatments. For those agencies that manage unpaved roads but *do not* apply chemical treatments, the top five most common reasons were 1.) lack of funding, 2.) cost ineffectiveness, 3.) environmental/health concerns, 4.) equipment limitations, and 5.) insufficient information to make informed decisions.

Seventy five percent of respondents (75%) represented agencies responsible for 3 to 500 miles (4.8 to 805 km) of *paved* roads. The average paved road network length for respondents of this survey was 1,235 miles (1,986 km). Fifty six percent of respondents (56%) represented agencies responsible for 2 to 500 miles (3.2 to 805 km) of *unpaved* roads. The average unpaved road network length for respondents of this survey was 2,001 miles (3,220 km). The average “per mile” budget reported was $4,989 for paved and $3,909 for unpaved. The majority of respondents (83%) indicated that 5% or less of their agency’s unpaved road maintenance budget is used for chemical treatments. Sixty one (61%) indicated that their agency will apply chemical treatments if a land owner pays for it.

Roughly 80% of respondents indicated that their agency has been employing chemical treatments for six or more years. Ninety eight percent (98%) of those that use or promote the use of chemical treatments indicated it was to control (fugitive road) dust, in part, to comply with federal regulations, for human and livestock health, in response to public complaints, or as a courtesy to the public. Other top reasons were to reduce maintenance costs and extend grader maintenance intervals.

By far, the most common method of chemical application is by spraying directly onto the road surface rather than mixing into road surface layers. The chemicals mostly commonly used by respondent agencies are magnesium chloride (MgCl) and calcium chloride (CaCl), with lignin sulfonates a distant third. When asked for the rationale behind their agency’s most commonly used treatment, 72% cited cost effectiveness. Ninety five percent (95%) of respondents were either generally satisfied or very satisfied with the performance of their agency’s most commonly used treatment.

Respondents overwhelmingly indicated a subjective and/or qualitative approach to evaluating the performance of their chemical treatments (e.g., visual assessment/drive-by evaluation and gauging feedback from the public). Twenty-five percent (25%) of respondents or fewer indicated they take an objective and/or quantitative approach by documenting differences between treated and untreated roads or by taking measurements. Interestingly, however, 76% of respondents indicated their agency has evaluated chemical treatment experiments in the past and 67%

indicated their agency/organization plans to evaluate chemical treatment experiments in the future.

Most respondents indicated that their agency/organization has had generally positive experiences with product manufacturers and suppliers. A solid 60% agreed that manufacturers and suppliers should form an industry association.

Respondents indicated that, typically, agencies rely on historical experience and their own in-house guidelines. A variety of guideline documents used are listed in Table 2. Most respondents (80% or more) indicated that they believe chemical treatments can be considered an unpaved road best management practice, however, they also agreed that more research and more comprehensive guidelines for their use are needed. Furthermore, 60% of respondents consider their agency/organization's chemical treatment program a good example of a best management practice. Still, 85% of respondents indicated that a "how to" manual for best practices in application would be a highly desired output from a national program of managed research on unpaved road management practices.

REFERENCES

JONES, D., A. Kociolek, R. Surdahl, P. Bolander, B. Drewes, M. Duran, L. Fay, G. Huntington, D. James, C. Milne, M. Nahra, A. Scott, B. Vitale, and B. Williams. 2013. **Unpaved Road Dust Management, A Successful Practitioner's Handbook.** Publication No. FHWA-CFL/TD-13-001, January 2013. Lakewood, CO. Federal Highway Administration, Central Federal Lands Highway Division.

(blank page)

APPENDIX A – OPEN-ENDED "OTHER" RESPONSES

The following are "other" responses to survey questions that allowed respondent-defined or open-ended comments. Responses have not been edited and are shown as they were received, unless otherwise noted.

I. Choose the best option that describes your affiliation or where you work (referenced in Figure 1).

1. Association of Counties
2. 33 miles of private road
3. Township
4. Township
5. **municipalities, county roads, ski area**
6. Independent road consultant specializing in un paved roads
7. township
8. Paving and Reclaiming Contractor
9. supplier
10. township
11. TTAP
12. township trustee
13. Mining
14. **retired**
15. SDLTAP

Note: Most open-ended responses were deemed similar enough to be combined with existing survey text choices. **Bold** responses constitute the "other" responses in Figure 1.

II. Choose the best option that describes your role/job description (referenced in Figure 2).

1. Technical Support/Advise to multiple counties
2. District Foreman
3. Recreation Planner
4. Traffic engineering Tech.
5. sales
6. road committee
7. streets supervisor
8. safety
9. Inspector
10. Fiscal Officer
11. County Engineer
12. Regulator
13. Air Policy Advisor -
14. independent consultant
15. Planner
16. Outreach/Education air quality

17. Air Quality Planning
18. Decision maker, project engineer, AND maintenance supervisor
19. zoning inspector
20. President of Company
21. County Engineer
22. trainer
23. County Engineer
24. County Engineer
25. Road Manager
26. Project Manager
27. Staff Engineer
28. Technology Consultant
29. Consulting engineer
30. Construction Review, & new inovations
31. HPMS Administrator
32. Watershed Program Manager
33. Tribal Transportation Planner
34. Road Inventory taker
35. Admin support
36. Technical Assistance Provider to local gov't.
37. Technical Sales Representative

III. If your agency/organization manages unpaved roads but does not use any form of chemical treatment, please state reasons why (check all that apply; referenced in Figure 3).

1. Does not last with our dry climate & poor aggregates
2. County Policy permits landowners whose property abuts our county roads to purchase a permit to hire a county pre-approved contractor to apply county approved dust abatement chemicals, to be paid by the landowner.
3. **Our agency does not manage unpaved roads but we are advocates for historic unpaved roads.**
4. We are exploring the desirabilty of using dust control. There has been a past belief that it is too expensive and benefits do not justify the cost.
5. **State Enforcement Agency - do not manage upaved roads**
6. **no dirt or gravel roads to maintain**
7. Dust s not a real big problem.
8. **we do not have any unpaved roads**
9. Serious durability issues
10. Almost all of the above, chemical treatments are toxic (poison), poor performance, medical repercussions, legal threats, corrosion of vehicles that use roads done with chemicals and the dangers to everything in the environment including our food chain and all human, animal, aquatic life and more.
11. I don't see any need for it. Taxpayer's are already paying for enough government.
12. Not effective with regular maintenance. Private residences put dust control down and those areas are not maintained regulary until they are in poor condition then it is graded out, so to do that on a large scale is not feasible or logical.
13. **my agency does not have any gravel surfaced roads**
14. Property owners requesting treatment for dust control are responsible for the cost of application
15. County Board Policy not to provide dust control

16. **We are a vendor offering a chemical-free application for dust abatement/road stabilization.**
17. we do use salt brine pumped from gas wells, and spread it only in the summer specifically for dust control. very cost effective
18. **We do not have any unpaved roads on our system. Dust control however is managed on our construction sites.**
19. cultural concerns
20. We do intend to start using products, particularly the chloride products.

Note: **Bold** responses share the common theme of not having unpaved roads to maintain and, therefore, are not included in "other" category in Figure 3 and are not included in the total number of responses (n) to this question.

IV. Why does your agency/organization use chemical treatments on unpaved roads? (check all that apply; referenced in Figure 9).

1. customer satisfaction
2. to aid in base stabilization prior to chip sealing
3. **Not applicable**
4. **don't have unpaved roads**
5. Flyash Base Stabilization
6. anti-skid (magnesium chloride sodium chloride)
7. comply with dust control regulations
8. curtesy to residents impacted by construction projects also allowed by permit by residents who desire to control dust, we do not use much but permit its use
9. **We don't, due to social concience and availability of certified proven environmentally friendly products that work better**
10. Though we don't use chem. treatments, I train others to use chem treatments for:dust control, improved level of service, reduced maint. costs, extend grader maint. intervals, preserve gravel, improve safety.
11. We will provide dust control if maintenance or construction activities cause temporary detour.
12. **Do not use chemical treatment.**
13. Response to citizen dust complaints.
14. **See 4 (referring to: We do not have any unpaved roads on our system. Dust control however is managed on our construction sites.)**
15. increase life of livestock teeth and improve general health
16. Dust is a Health issue and Enviornmental issue. Dust in food (drying fish as an example) and runoff into water is a problem for people, fish and other organizims.

Note: **Bold** responses were not applicable and, therefore, are not included in the "other" category in Figure 9 and are not included in the total number of responses (n) to this question.

V. What types of chemical treatments does your agency/organization use for each of the methods checked (previously)? (check all that apply; referenced in Figure 11).

1. EMc2
2. This is done in front of home sites only.
3. sodium chloride
4. used vegetable oils(used fryer oils)
5. water sprayed on road surface
6. M-70
7. **We do not prescibe the use of any of the above, some are banned and some are carcinogenic and more**
8. **Do not use chemical treatment**
9. Team Lab Base I
10. glycerol based suppressants
11. Base One from Team Lab

Note: **Bold** responses were not applicable and, therefore, are not included in the total number of responses (n) to this question.

VI. What equipment does your agency/organization use for applying chemical treatments for each of the methods checked (previously)? (check all that apply; referenced in Figure 12).

1. **We typically contract out chemical treatments.**
2. computerized asphalt distributor truck
3. chip spreader (50 psy class 5) over HFMS emulsified asphalt (0.5 gsy applied with distributor truck)
4. We use "picks" on our graders rather than smooth edges to scarify the gravel.
5. pug mill at the gravel crusher site
6. we are in the middle of purchasing a reclaimer
7. **Again, we don't use anything that threatens the environment and everything in it as chemicals have proven to do**
8. **we do not apply it, use third party contractors**
9. **Contract to outside vendor**
10. **Vendor**
11. **Do not apply chemical treatment**
12. **Application is contracted out and tanker is owned by the contractor.**
13. **Outside contractor**
14. Vein Feeder, excellent for controlled placement of hydraulic binders for base stabilization
15. These are the methods we do intend to use. Primarily spray, blade mix, or rototill.

Note: **Bold** responses were not applicable and, therefore, are not included in the total number of responses (n) to this question.

VII. For your agency/organization's most commonly used treatment, why do you choose this treatment? (check all that apply; referenced in Figure 13).

1. easily applied and cleanup of equipment and auto
2. Married to a successful past practice of Oil Stabilization, but the costs have risen dramatically.
3. It's free
4. **don't use**
5. minimal impact to indigenous flora and fauna
6. satisfactory experience
7. **we recently ceased our program**
8. zoning, gravel haulers must control there dust on county roads to and from the pit
9. Most agencies I work with choose treatments based on: cost-effectiveness, road user pressure, availability, and experience.
10. **Do not apply chemical treatment**
11. Direct experience

Note: **Bold** responses were not applicable and, therefore, are not included in the "other" category in Figure 13 and are not included in the total number of responses (n) to this question.

VIII. For your agency/organization's most commonly used treatment, how would you rate your satisfaction with performance? Provide most important reason for your answer (referenced in Figure 14).

For ease of reviewing, comments are categorized as negative, pro/con or neutral, and positive.

Negative comments

1. Mag. Chloride tends to "pot hole" unpaved roads when used continuously.
2. Stuck to vehicles better then it stuck to roads - no longer using this treatment.

Pro/con or neutral comments

1. It provides a solution that works, but only for a year.
2. While it works well for 3-4months and it is recognizable by the public, dust suppression drops off and the product isn't visible so we get less voluntary cooperation in reducing dust.
3. 50% +/- residents approve treatment, the other percentage of residents do not care or disapprove treatment.
4. Really works best where close to creeks, rivers for moisture.
5. Chlorides work fine when the weather is average, but hold moisture during wet weather, and don't work too good when it is dry. Asphalt gets potholes in wet weather, but works well in dry weather.
6. Always looking for something better
7. too early to tell...we are 3/4 of a year into the segments testing
8. Mag Chloride is not the most effective treatment for our region, but it is the least expensive (by a factor of 10).
9. Most common is Lignin Sulfonate. However, your poll assumes people stay in the same organization & same job forever. Most of my dust abatement work was in a prior job, and my former employer isn't doing much of anything anymore.
10. If funding was available, more applications per year would be more effective.
11. mag chloride works, but it gets slick and slimy when wet, and some prople complain about the corrosiveness of it.
12. We used to treat roads twice per year, and have reduced to once per year due to budget constraints

13. Our use of CaCl for road dust control, is satisfactory, but not exemplary. We can't afford better control?
14. Sustainable road treatments are a must if we want to live longer and are concerned about the environment, health, equipment maintenance, hazardous effects on all life forms of using chemicals and all this is highly proven.
15. Spot locations
16. One always wishes it would last longer. Ovarall works the best with our maintenance practices.
17. We would be very satisfied but eventually the treated area develops washboards and blading is required for public safety. We could apply three times per year but have chosen two times.
18. Works well - tends to stay and rejuvenate after rain events, will build up and stay if done every year.
19. For dust control in fire camps and fire travel road, if approved by the hosting agencies.
20. Mixed results.... having inconsistent gravel and lack of PI is probably the biggest reason for failure
21. Treatment is typically in front of occupied dwellings only.
22. Sometimes it does not hold up
23. Calcium chloride, mag chloride and lignon work adequately and give predictable performance. Continually increasing costs gives me concern for ability to maintain our application practices.
24. driving surface gravel must be to minnimum spec.
25. Depending on traffic flow and percent of application
26. This is the first year we've used magnesium chloride, and it was late in the year, so we've really hadn't had time to obsever how well it works.
27. None work 100%, mostly due to variations in surface mat'ls; type & quantity of fines, gradation, plus traffic volumes vary over road segments, etc.

Positive comments

1. My company has used almost every type of dust control/soil stabilizers on the market. We have found that the petroleum resin products to be the most satisfactory.
2. Good value and user satisfaction
3. Performance and public friendly application
4. it is easy to and pretty cost affective
5. Road preparation. We have found that properly preparing the road surface is the key to successful dust abatement. We have tried Calcium Chloride and have found Magnesium Chloride to work much better on our roads with the same preparation.
6. dust control and aggregate stabilazion
7. Application has worked at keeping the dust down and extending the life of roadway.
8. The oil stabilized base can be reclaimed and rejuvenated successfully, on a predicatable 7 year cycle for our weather and traffic. The initial cost can be recovered.
9. seems to work ok. Cheap.
10. Oil well brine controls the dust and doesn't cost us anything.
11. It helps to save money by not having to maintain and keeps complaints down from dust.
12. It works to control the dust and it serves to stabilize the road way so that it does not require as much grading.
13. The surface holds together, the dust is almost gone and the blading has decreased drastically.
14. No regulatory violations on unpaved road dust control in 10 years. Reasonably cost effective, yet expensive. Appropriate solution to citizen/stakeholder expectations to keep unpaved roads.
15. solves a problem
16. cost and effectiveness
17. Low cost per gallon and cost effectiveness.
18. The gravel surfacing sheds water, stays in place, and needs re-grading far less often.
19. Lower chloride content in oil field brine
20. Effective dust control at low cost, readily avaliable from more than one supplier
21. Overall value
22. very cost effective
23. Reduces dust

24. We use CaCl2 for dust control because it works well for us and is our least expensive alternative.
25. Cost effective, we are able to use it for pre-wetting our sand in the winter as well.
26. Products hold up reasonably well to routine traffic and will last the season with two and sometimes one application.
27. It works to achieve goals set out.
28. Proven track record
29. Commissioners and public comments justify.
30. treatment has shown the results hoped for, with no undue problems.
31. Our retention of gravel and reduced maintenance intervals continue to save money.
32. Cost effective, simple, good durability, okay longevity
33. Performance satisfaction would be rated very satisfied where the amount and type of additive for in-place crushed aggregate is stabilized is determined by the mix design process developed by Steve Monlux, Low Volume Road Consultants, Missoula MT
34. It is economical and effective
35. It lasts all summer and I get almost no phone calls
36. Overall, we see good success with the chloride products which are the largest family of dust cntrl/stalztn products used; other products have not been as successful.

IX. How does your agency/organization assess performance of chemical treatments on unpaved roads? (check all that apply; referenced in Figure 15).

1. five year comparable road evaluation of treated and untreated.
2. measure residual chlorides and weight of loose-float material on surface
3. performance of base prior to chip seal
4. **Health and food chain and much more are very negatively affected by hazardous chemicals**
5. Most agencies I work with assess performance on: visual assissments, dust levels, ride quality, grader maintenance intervals, and user feedback.
6. **Do not apply chemical treatment**

Note: **Bold** responses were not applicable and, therefore, are not included in the "other" category in Figure 15 and are not included in the total number of responses (n) to this question.

X. How does your agency/organization design unpaved roads (gravel specifications, layer thickness, compaction and strength requirements, etc)? Please provide document name(s) or other comment. (Referenced in Figure 16).

Titles of, or references to, documents are categorized by type in Table 2. The following are "other" comments that make no reference to a specific document.

1. Material spec and layer thickness. Agency has generally eliminated gravel roads.
2. not designed, they evolved
3. we don,t
4. Our soil types have a real bearing on what we do.
5. we do not construct unpaved roads
6. No design for unpaved roads
7. Gravel roads have just evolved and are not designed. We don't allow new gravel roads, because of maintenance issues like dust.
8. Continually evolve, using test segments on alternative techniques.

9. Grant provider
10. While we have engineered and board approved criteria, we are not creating "new" gravelled roads. Our existing gravel system is 75-100 years old and we provide basic routine maintenance. We incorporate fresh gravel when out townships can afford it, which isn't often.
11. We only subscribe to sustainable solutions. As is well known the present chemical treatments are much worse than the dust problem itself.
12. No unpaved roads allowed in Town Limits, just unpaved shoulders
13. Engineeres recommendation.
14. We apply mainly on state and federal road system. Sometime private landowners but mainly agency roads

XI. I would like to see the following output(s) from a national program of managed research on unpaved road management practices. (Referenced in Figure 20).

1. Need more information for dust suppesstion
2. I am tired of all the "green-washing" that is claimed by chloride and polymer vendors. I would like to see all dust control products have toxicity tests. I would like to see vendors that sell petro-chemically derived polymers admit that their product is derived from petroleum rather claiming that they are not a petroleum product.
3. Performance testing of products using mobile emission measurement techniques
4. A table of application rates for products that considers a range of variables such as soil type/silt, traffic type and volume and cost/reapplication frequency
5. Our agency has developed application practices and tactics that work extremely well, generally lasting the entire summer with minimal maintenance.
6. Cost analysis over time
7. Summary of reports about performance of product used for solidfying wear surface.
8. I have extensive prior experience with Lignin Sulfonate and Magnesium Chloride for Dust Abatement, and I have used Ionic Sulfonated Oils as a substitute for aggregate surfacing, and which also has dust suppression as a by-product of the subgrade stabilization. I would like to be involved in more research of sulphonated oils. In fact, I have considered entering Graduate Studies at a major University and making research on Sulphonated oils my Thesis. Or work with FHWA on such a research effort.
9. None
10. Life threatening and dubious chemical treatments should be banned outright and the sooner the better for everyone and everything
11. do not live or travel gravel road if you can't handle the dust
12. Do not apply chemical treatment
13. Cost-Benefit
14. One or two page summary flyers for field personnell.
15. Cost data on various products.
16. other than funding,National shouldn't there. These are regional issues. Dust abatement is geographicly changing.
17. Std. performance methods using science to rate effectivness - Dust & strength
18. ASTM STARNDARDS
19. Check with the US Forest Service