Research needs for Road Stabilization and Dust Suppression

David E. James, Ph.D. PE
University of Nevada, Las Vegas
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Research needs

• What information is needed to help
  – Road managers and environmental planners

• Make objective decisions about
  – Whether or not to use a suppressant / stabilizer instead of alternative approaches
  – If selecting a stabilizer, which kind, and in what amount and by what method should it be employed?
We need information about . . .

- Chemical composition, both “active” ingredients and potential trace contaminants
- Potential environmental toxicity and occupational risk
- Performance in representative conditions
- Cost
- A location from which we can retrieve these data
Organizations recently (last 5 years) publishing research

• Performance and toxicity
  – US EPA National Risk Management Research Laboratory (RMRL)

• Performance
  – US Army Engineer Research & Development Center
  – Federal Highway Administration - Central States - field study and major literature evaluation

• Runoff constituents and rates
  – US EPA ETV and US EPA RMRL
  – UNLV
Recent (last 5 years) published studies – Stabilization


- Virginia DOT 2004 – Bushman et al – evaluated 7 stabilization products for 9 months – 1.75 mile unpaved road northern Virginia – observed variations in IRI concluded constructing bituminous roadway is most cost-effective
Recent published studies
Dust suppression performance

• Rushing – 2007a – 4 types suppressants field tested up to 220 days – temperate climates
• Rushing – 2007b – lab studies 18 types suppressants
• Rushing – 2006 – 14 suppressants field tested up to 90 days – arid climates
• EPA ETV (MRI/RTI) – 2006 – 5 suppressants field tested up to 122 days with reapplication
### Example data – EPA ETV Ft. Leonard Wood – 77-79 days

<table>
<thead>
<tr>
<th>Suppressant</th>
<th>Type</th>
<th>TP control efficiency, %</th>
<th>PM10 control efficiency, %</th>
<th>PM2.5 control efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>DustGuard</td>
<td>hygroscopic salt</td>
<td>75</td>
<td>88</td>
<td>58</td>
</tr>
<tr>
<td>EK35</td>
<td>synthetic organic</td>
<td>74</td>
<td>86</td>
<td>56</td>
</tr>
<tr>
<td>Envirokleen</td>
<td>petroleum organic</td>
<td>&gt;99</td>
<td>&gt;98</td>
<td>&gt;90</td>
</tr>
<tr>
<td>PetroTac</td>
<td>resin emulsion</td>
<td>94</td>
<td>98</td>
<td>&gt;90</td>
</tr>
<tr>
<td>TechSuppress</td>
<td>natural resin + wetting agent</td>
<td>84</td>
<td>76</td>
<td>&gt;90</td>
</tr>
</tbody>
</table>
Recent published studies – suppressant toxicity data

- EPA ETV - 2006 – 3 tests (1 acute, 2 chronic) of 3 palliatives vs 3 species -
  - 1 palliative inhibited fathead minnows, mysid shrimp, *Ceriodaphnia*
- Irwin et al (EPA) – 2008 – acute tests of 6 suppressants vs 3 species at 3 rainfall ages
  - 2 palliatives inhibited water fleas (invertebrate – *Daphnia*) in lab – concluded probably wouldn’t inhibit in environment – or very localized
Sept 2008 EPA report – Irwin et al

- Simulated rough grading & heating/cooling
- 6 dust suppressants
- Plots - Surface runoff – 9 water quality parameters and fish, algal, invertebrate toxicity
- Columns - Subsurface leaching – 9 water quality parameters
Recommendations for follow-on in Irwin et al 2008 EPA report

• Best measure of potential real-world effects
  – Monitor sensitive invertebrate populations near application sites – upstream/downstream

• Longer (> 2 month) timeframes for runoff testing to better assess biodegradation potential
Recent published studies - runoff/leachate constituent data

• Irwin et al (EPA) – 2008 – measured 9 water quality indicators in 6 suppressants
  – All 6 suppressants met data quality objectives for 5 indicators – pH, TDS, TOC, DO and nitrate
  – For 4 indicators, at least 1 suppressant not consistent with data quality objectives, but most not cause for concern.
  – 2 suppressants showed elevated TSS
  – Soil source affected indicator values
Recent sources for runoff/leachate constituent data

• Irwin et al (2008) - runoff and leachate from cured, temperature cycled suppressants - lab results

• EPA ETV (2006) - standard EPA methods - developed for Clean Water Act and RCRA for 2 suppressants

• UNLV (2002) - surface runoff from applied 11 suppressants, as weathered - number of elevated constituents varied with suppressant
Conclusions from search of published literature

• Several suppressants/stabilizers perform well and have low environmental toxicity

• **Number of suppressants/stabilizers with independent performance data exceeds number with independent environmental toxicity data**

• Very few suppressant/stabilizers have been tested **simultaneously** for performance, water quality constituents and toxicity
Key words for path forward

• Standardize
• and
• Compare

• As stated by D. Jones et al, 2008,
• standardization has been established for paved road materials
• Similar model could be established for stabilizers and suppressants
State of Practice paper – D. Jones et al – Research needs

- Standard protocol to establish minimum research requirement for additives, including
  - Additive description / categorization
  - Laboratory studies of performance and environmental impacts
  - Field experiments
  - Data analysis
State of Practice paper – D. Jones et al – Research needs

• Environmental protocol describing
  – Internationally recognized laboratory & field procedures for assessing environmental impacts, especially to
    – Establish boundary conditions of performance (and potential toxicity)
    – Standardized risk-benefit analysis procedure
Recommendations of 2002 EPA Expert Panel

- Authors: Piechota et al 2004
- Potential Environmental Impacts of Dust Suppressants, Avoiding another Times Beach
- US EPA 600/R-04/031
EPA Expert Panel – dust suppressant constituents

• Sufficient chemical composition data to assess environmental risks
  – Standardized and sufficient constituent reporting in Material Safety Data Sheets
  – Exact composition data (FIFRA requires exact statement of active constituents herbicides, insecticides, fungicides etc)

• Uniform bioassay reporting – same tests, same species
There’s a potential backlog

- Number of *marketed* products (UNLV grad students found about 90 in 7 major categories)
- greatly exceeds
- Number of *tested* products!
  - 18 characterized for performance
  - 10 characterized for toxicity
  - However, test protocols sometimes not comparable
Applied research serving needs of agency managers

• To compare need standardized
  – Characterization of palliative formulations
  – Methods for performance testing – both stabilization and dust emissions
  – Methods for generating and measuring constituent runoff/leaching
  – Methods and organisms for environmental toxicity testing
Research needs - Evaluate performance & potential impacts

• To evaluate commercial palliatives and stabilizers - and get some characterization data on the plethora of commercial products

• Rapid characterization of both performance and environmental impacts

• Suggest lab-based testing with accelerated but standardized wear, dust measurement, runoff and leaching tests

• For standardized wear and dust measurement examples, see Rushing 2007b
Research need - standardized field test sites

• Done by the roofing industry for weathering studies - WSRCA sites for southwest in Las Vegas and northwest near Seattle

• Suggest several in each major climate / soil regime.

• Probably couldn’t economically set up all combinations, but set up several extremes in terms of particle size and surface chemistry
Standardized test sites (cont)

• Examples
  – Northeast, acidic soils, moderate organics - freeze/thaw, humid, moderate-high rainfall
  – Southwest, alkaline, low organic, no freeze/thaw, arid

• Apply on instrumented road section, with standardized maintenance

• Evaluate at fixed intervals

• Will help assess performance as stabilizer, dust suppressant, and potential migration of contaminants
Site characterization - Soil Chemistry

- 2002 EPA Expert Panel recommended
  - Moisture content
  - pH
  - Particle shape
  - Mineralogy
  - Particle surface chemistry (not specified)
    - The author might recommend cation exchange capacity
    - Surface charge (negative or positive) at specified pH
    - Sorption of standard compound
Site characterization : Engineering tests - EPA Expert Panel

- Geotechnical / Mechanical characterization
- Gradation - AASHTO T-11 and T-27
- Plasticity tests - AASHTO T-89 and T-90
- Particle size distribution (ASTM standards)
- Visual survey
- Other reports recommended
- CBR
EPA Expert Panel – Standard risk assessment protocol

• Standardized test protocols for chemical constituents and toxicity in
  – dust suppressant concentrate,
  – runoff
  – in soil after application.

• Initial recommended threshold levels
Research need - to develop accessible repository of test results

• Database combining performance data with toxicity data & metadata about test conditions

• currently performance and toxicity data scattered

• Need identified by both Jones et al, 2008 and EPA Expert Panel
EPA – Expert Panel – recommended Clearinghouse

• Composition
• Occupational and environmental toxicities
• Prohibited applications
• Weathering descriptions
• Guidelines for application
• Regulatory and manufacturer contacts
Exemplary Manufacturer’s web page

- Rohm and Haas
- Provide links to other databases
- Links to MSDS’s for Rohm and Haas products
- Including acrylate monomers potentially present in some palliative formulations
- Links to other web pages → next 2 slides!
Is toxicity/degradation data available for constituents?

- Links to 11 databases, including
- HPVIS (maintained by US EPA) [http://www.epa.gov/hpvis/](http://www.epa.gov/hpvis/)
- High Production Volume Information System – (> $1 \times 10^6$ lb/year)
- health and environmental effects information
Database examples in other countries

- Chemical Risk Information Platform (CHRIP) – Japan – (operated by National Institute of Technology and Evaluation)
- EnviChem (operated by Finnish Envt Institute)
- ESIS (operated by European Chemicals Bureau)
Mixture/formulation problem

• Toxicity of mixtures different from toxicity of single components!
• Synergistic – enhance toxicity
• Inhibitory – reduce toxicity
• Start with individual constituent data to formulate a low toxicity product
• still must test completed proprietary formulations
Solution -

- Proposed standardized toxicity protocols for palliative mixtures. Recommend
  - Acute - 48 hr LC50
  - Chronic 7 day LC50
- Put results into repository
- Provide tool to allow path analysis to work backwards from aquatic toxicity data to application site to determine if observed toxicity thresholds could be attained
- See EPA Expert Panel report for examples
But road surface stabilization & dust suppression all local

- 1,000’s of combinations of
  - Suppressant type
  - Suppressant application rate and method
  - Road base soil characteristics
  - Climate

- Database of toxicities, lab performance, chemical constituents may help guide selection, but

- Still need to test locally
EPA Panel recommended
Develop regulations that contain

- Application Practice Guidelines (APGs) include information about
- types of areas where can apply specific suppressants (predominant biota and soil types),
- Wind velocity limitations at the time of application,
- specific limitations on application in proximity to water bodies, runoff channels, and residential areas,
- Regulations on types of containers used to transport suppressants
Research should generate data to let us

• Know what’s in them
  – Clearinghouse for suppressant components & mixed suppressant MSDS’s (standards for MSDS’s)

• Be able to compare them
  – performance data
  – environmental & toxicity data
  – field protocols
Thank you!

Questions?
References - I

• Bushman, W., T. Freeman, E Hoppe “Final Report - Stabilization Techniques for Unpaved Roads” Virginia Transportation Research Council, VTRC 04-R18, Charlottesville, Va. 2004

• See http://matrix.vtrc.virginia.edu/698/Road_Stabilization
References - II

References - III

References - IV

• Jones. D, D. James and R. Vitale
  “Road Dust Management: State of the Practice” Overview White Paper - Road Dust Management Conference, San Antonio TX Nov 13-14, 2008, 15pp
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