

Module 4d: Wet-Weather Pollution from Commonly-Used Building Materials

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High Zinc Concentrations have been Found in Roof Runoff for Many Years at Many Locations

- Typical Zn in stormwater is about 100 µg/L, with industrial area runoff usually several times this level.
- Water quality criteria for Zn is as low as 100 µg/L for aquatic life protection in soft waters, up to about 5 mg/L for drinking waters.
- Zinc in runoff from galvanized roofs can be several mg/L
- Other pollutants and other materials also of potential concern.
- A cost-effective stormwater control strategy should include the use of materials that have reduced effects on runoff degradation.



Photos taken approximately 60 years apart of this statue show evidence of severe deterioration due to the effects of acid rain.

Questions to be Answered

- What is the potential pollutant release from common building materials both when new and after aging?
 - How does exposure to acid rain and road salts, and other adverse conditions, affect pollutant release?
- Can we use short-term laboratory testing to predict long-term pollutant release in the field?
- Can we modify existing roofing materials or develop a more environmentally-friendly roofing material (focusing on those materials that are used in large quantities as roofing surfaces and substrates)?

Laboratory and Field Tests

- Laboratory leaching tests (known amount of material left in de-ionized water for several days and standard TCLP, toxicity leaching tests using mild acids)
- Laboratory spraying tests (small panels of materials sprayed with rain water using varying spraying and dry periods)
- Outdoors exposure tests (panels installed on frames exposed to normal rains over several months)

Categories of Materials being Investigated

- galvanized metal
- aluminum gutters/siding
- vinyl siding
- asphalt roofing
- roofing tar and felt
- membrane roofing
- faux slate shingles (made from recycled materials)
- untreated wood (with and without paint)
- treated wood (with and without paint)

Analytes

- pH
- Conductivity
- Chemical oxygen demand (COD)
- Semi-volatile organics (EPA Method 8270 and 608) – laboratory testing only
- Heavy metals and major cations (copper, chromium, cadmium, lead, zinc, arsenic, calcium, magnesium, sodium, potassium)
- Nutrients (nitrate, ammonia, total nitrogen, phosphate, total phosphorus)
- Toxicity (Microtox™) on periodic field samples

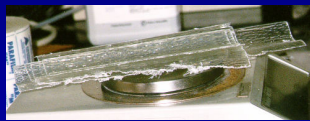
Tests Conducted to Date

- 1995: Series of laboratory leaching tests on common materials used in treatability tests
- Summer 2002: Laboratory TCLP (acid rain simulation)
- Fall 2002: Laboratory investigation of selected materials using rain water
- Spring 2003: Long-term, outdoor investigations using test frames. Destroyed by Hurricane Ivan.
- Winter 2004: Laboratory-testing of 60-year-old outdoor (painted) metal roofing panels.
- Spring 2005: Reconstruction of test frames and start of long-term outdoor investigations.

2002 Laboratory Testing: Roofing Panels and Roof Coatings and Sealers



Ondura™ Vinyl Roofing Panels

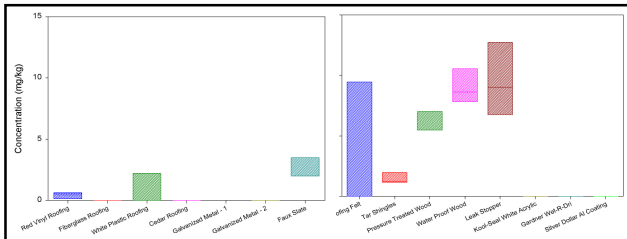
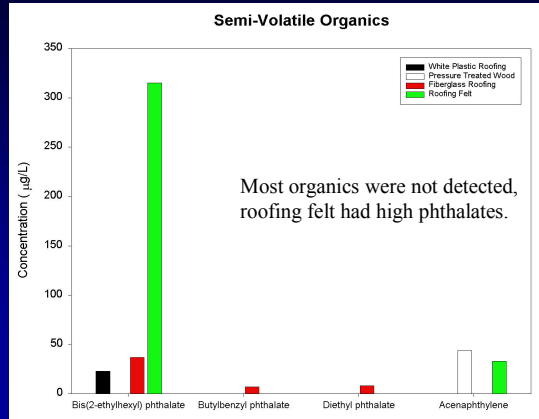


Fiberglass Roofing Panels



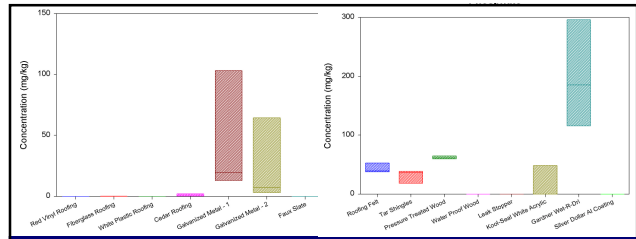
White Plastic Roofing Panels

Results: Laboratory Testing



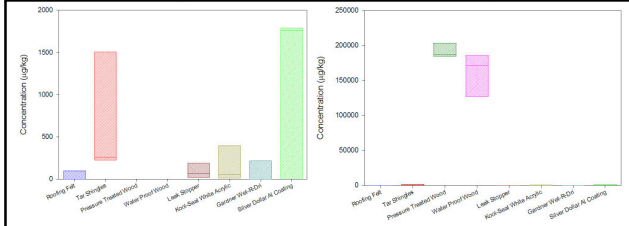
2002 Laboratory-Scale Tests: Nitrate (NO₃-N)

- Leak stopper and water proofed wood very high
- Roofing felt and pressure treated wood high
- Faux slate, white plastic roofing, and tar shingles elevated



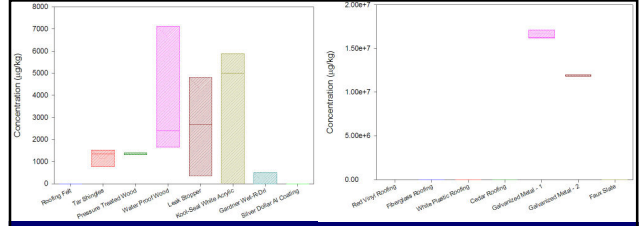
2002 Laboratory-Scale Tests: Phosphate (PO₄-P)

- Wet repair compound very high
- Galvanized metal high
- Roofing felt, tar shingles, and pressure treated wood elevated



2002 Laboratory-Scale Tests: Copper

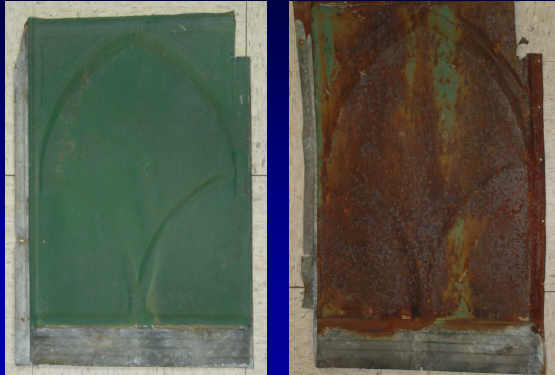
- Pressure treated wood and water proofed wood very high
- Aluminum coating and tar shingles high



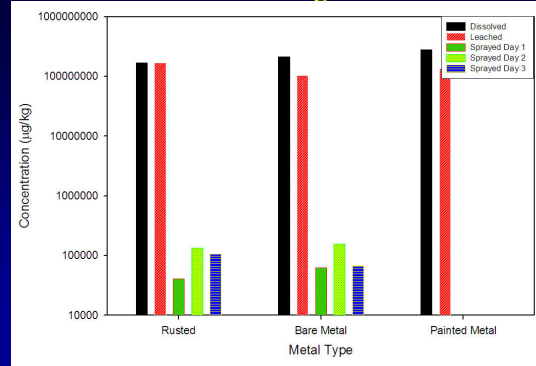
2002 Laboratory-Scale Tests: Zinc

- Galvanized metal extremely high
- Water proofed wood, leak stopper, and while acrylic very high

2004 Tests of 60 Year Old Roofing Panels (never used and exposed)



60 Year Old Roofing Panels: Zinc



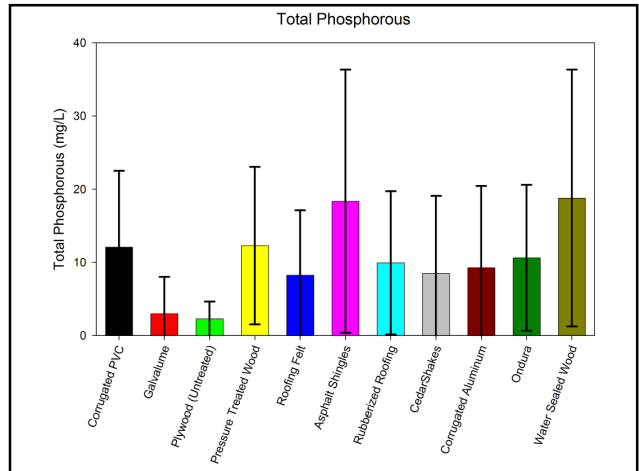
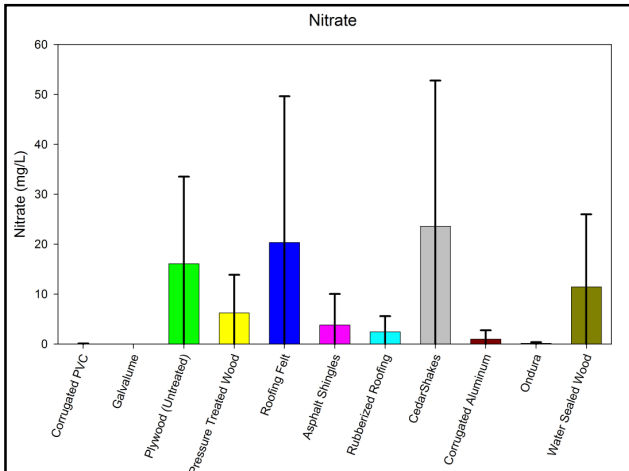
Leached results 3 orders of magnitude greater than sprayed results; Rusted and bare metal similar, painted metal very low when sprayed

2005: Testing Frame Set-Ups at Penn State-Harrisburg and the University of Alabama at Birmingham



2005 Field Test Frame Results

- 1 month of sampling and exposure complete.
- pH, conductivity, and COD values showed little variability between storms.
- Physical degradation of roofing panels, particularly the metal panels, was visible after two weeks of exposure.



Conclusions and Future Research

- Laboratory leaching tests can only be used to measure the relative contributions of stormwater contaminants from different materials.
- Materials with metallic preservatives or metal skin coatings (metal flakes a listed ingredient) tend to leach more of the measured metals. Treated woods contributed Cu much more than any other material.
- Initial outdoor frame tests indicate that nutrient contributions from most roofing materials could be considerable.

Conclusions and Future Research (cont.)

- Field installations required to determine the effects of weathering on intact pieces so as to predict stormwater loadings.
 - Installation practices such as exposing cut edges and use of sealers may impact the temporal pattern of pollutant release from these materials.
- Long term testing began this summer at UAB and PSH (to look at climatic differences in degradation).

Acknowledgements

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- US NSF REU (Research Experience for Undergraduates)
- Many undergraduate and graduate students participated on these projects