

Report 27-R09: Development of a Method to Identify and Quantify Microplastics Generated from the Roadway Environment

Background

Microplastics (MPs), plastic particles smaller than 5 mm, are increasingly recognized as an emerging pollutant in roadway environments, originating from the wear and degradation of transportation infrastructure and vehicle components and newer sources such as recycled plastic-modified asphalt. Despite growing concern, significant knowledge gaps remain regarding consistent analytical methods, the relative contributions of different roadway MP sources, and the transport of MPs through stormwater systems. Existing studies often rely on inconsistent extraction and analysis methods, limiting comparability and hindering efforts to understand MP occurrence in stormwater and roadside soils. To address these gaps, this research was initiated to develop, validate, and demonstrate a reproducible method capable of quantifying MPs generated within the roadway environment.

Research Objectives

The purpose of this research was to advance and apply analytical methods for the identification and quantification of MPs in roadway environments, building on prior investigations of MPs generated from recycled plastic-modified asphalt pavements.

Approach

The research combined a structural literature review, laboratory method development, and field-testing. First, the team reviewed roadway MP sources and existing analytical methods to identify gaps. Next, a three-step workflow—hydrogen peroxide digestion, zinc chloride density separation, and TGA-FTIR spectroscopy—was refined and validated using polymer-spiked sediment, achieving high recovery rates. Finally, the method was demonstrated using a rural Virginia roadway site, where stormwater and sediment samples were collected, processed, and analyzed to identify and quantify roadway-derived MP.

Outcomes

The study successfully produced and validated a reproducible analytical workflow for roadway MPs. Laboratory results showed near-complete recovery of spiked polymer material, confirming the reliability of the extraction and separation procedures. Field sampling demonstrated the method's practical application, identifying MPs in eight of 12 samples. Acrylic road markings and tire wear particles were the predominant MP sources, with concentrations ranging from 0.14 to 1.75 mg/g; erosion control netting was suspected in one sample. The study also identified key limitations. Current TGA-FTIR techniques cannot fully resolve mixed polymer samples because of overlapping thermal degradation and infrared signatures, limiting source-specific MP identification. The report recommends complementing or replacing TGA-FTIR with pyrolysis-gas chromatography-mass spectrometry for more detailed analysis.

Research Benefits

This research provides VDOT with a validated, reproducible method for evaluating MP in stormwater and roadside soils—an emerging environmental concern likely to draw increasing regulatory attention. The method enables VDOT to proactively assess whether roadway materials or maintenance practices contribute to MP pollution, identify opportunities for mitigation, and plan for potential future compliance requirements. Results also provide evidence of roadway-derived MPs in stormwater infrastructure, supporting further statewide sampling to better characterize MP occurrence, transport, and fate across diverse roadway settings. Overall, the work positions VDOT to respond effectively to emerging environmental expectations while supporting sustainable infrastructure stewardship.

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Research Findings

Sample ID	FTIR Confirmation	TGA-Quantified MP Mass (mg)	Initial Mean Sample Mass (g)	MP Concentration (mg/g)
A	road markings	16.41	32.57	0.50
B	none	*	*	*
C	road markings, tire wear	9.27	12.4	0.75
D	tire wear, erosion control netting	1.34	0.91	1.47
E	road markings	4.85	35.77	0.14
F	road markings, tire wear	45.73	41.97	1.09
G	road markings, tire wear	11.06	34.53	0.32
H	road markings, tire wear	7.99	4.56	1.75
I	none	*	*	*
J	road markings, tire wear	10.65	10.24	1.04
K	none	*	*	*
L	none	*	*	*

MP = microplastic; TGA-FTIR = thermogravimetric analysis-Fourier transform infrared spectroscopy; * = value not attributable to MPs.

Road Markings and Tire Wear

Road markings and tire wear particles were the most frequently identified microplastic sources, appearing in most samples with concentrations ranging from 0.135 to 1.75 mg/g.

Overlapping Polymer Signatures

Overlapping thermal degradation temperatures and infrared characteristics of the polymers evaluated limited the method's ability to determine the contribution of each polymer type to these concentrations.