

Where the Rubber Meets the Road: Regulatory Frameworks for Microplastics and PFAS in Roadside Environments

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The Problem

What are tire and road wear particles (TWRPs)?

- Tiny microplastics shed from tires, brake dust, and road paint and asphalt polymers
- TWRPs from tire wear, brake fluid, road marking paints, vehicle emissions, and sealants leach PFAS.

Why This Matters

- PFAS exposure is linked to thyroid disorder, immunosuppression, elevated cholesterol, asthma, and cancer in both human and animal populations
- Toddlers face the highest estimated daily intake due to frequent hand-to-mouth contact.

Results

Environmental Transport

- Urban surfaces including roads, pavements, and rooftops accumulate PFAS from vehicular activity and atmospheric deposition; rainfall events mobilize these into receiving waters.

Monitoring

- EPA Method 1633 enables detection of up to 40 distinct PFAS compounds across eight environmental matrices including stormwater, surface water, air, and biosolids.

Industry

- **Chemical:** PPDs and Graphene
 - Graphene improves crack resistance
- TSCA Section 4 order authority now requires PFAS manufacturers to fund toxicity testing

Ecotoxicity

- Short-chain PFAS such as PFBS and PFHxA exhibit high water solubility and low sorption affinity, making them mobile/persistent in urban systems.



(Saleh et al., 2025).

Methods

Research Question

- How can governance integrate tire design, transportation systems, and stormwater management to reduce both the quantity and toxicity of TWRPs and PFAS leachates?

Project

- Synthesis of 40+ journal articles into a review and application of policy frameworks specifically to roadside TWRP and PFAS pollution.

Government Misalignment

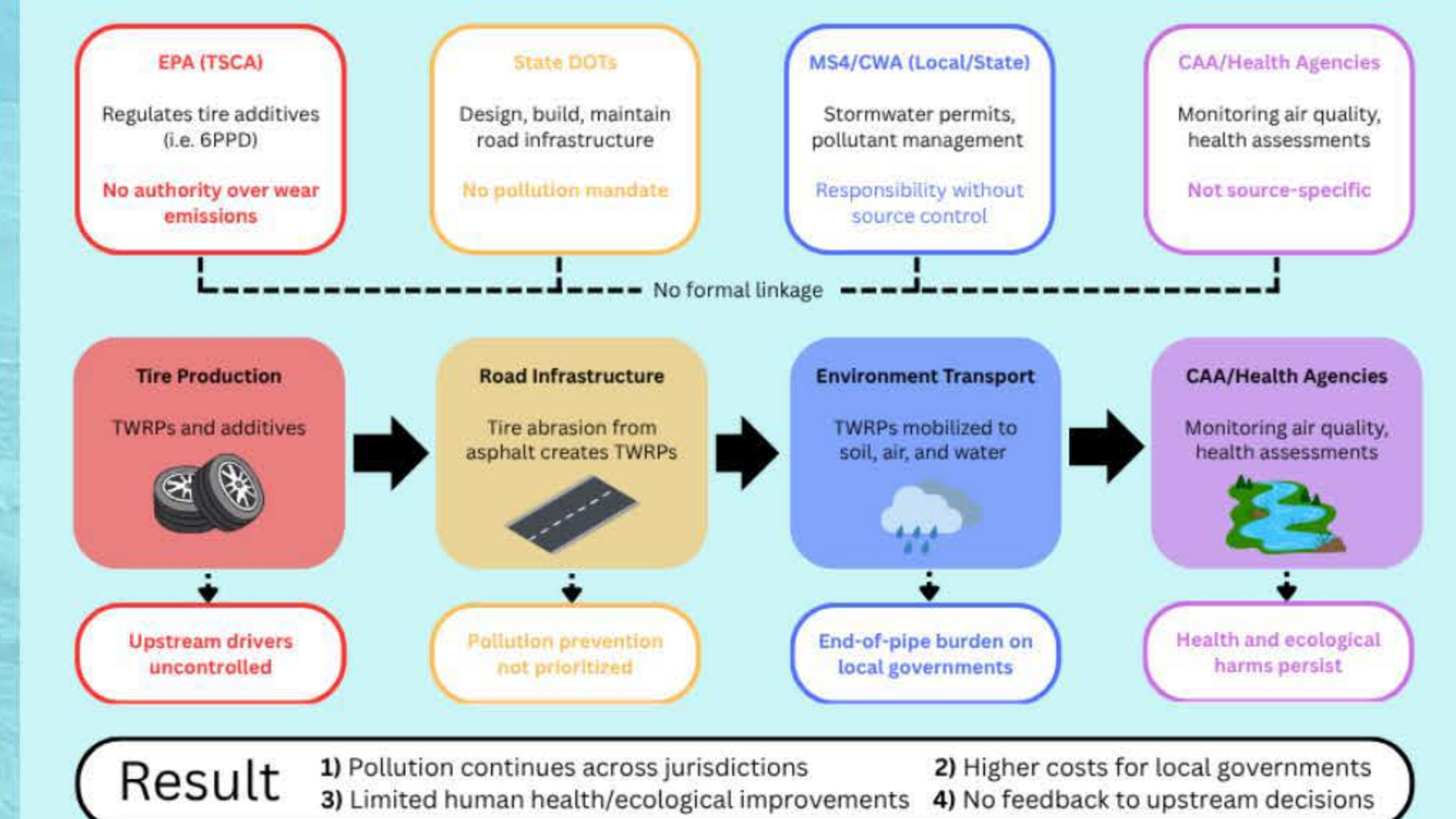
Polycentric Governance

- The EPA PFAS Strategic Roadmap's Research–Restrict–Remediate framework offers a cross-agency coordination model, but implementation requires harmonization across TSCA, CWA, SDWA, and CERCLA authorities.

Removal Mechanisms

- Conventional rain gardens show negligible PFAS removal: concentration only declined 0.03–1.10% across six storms representing moderate to large rainfall.

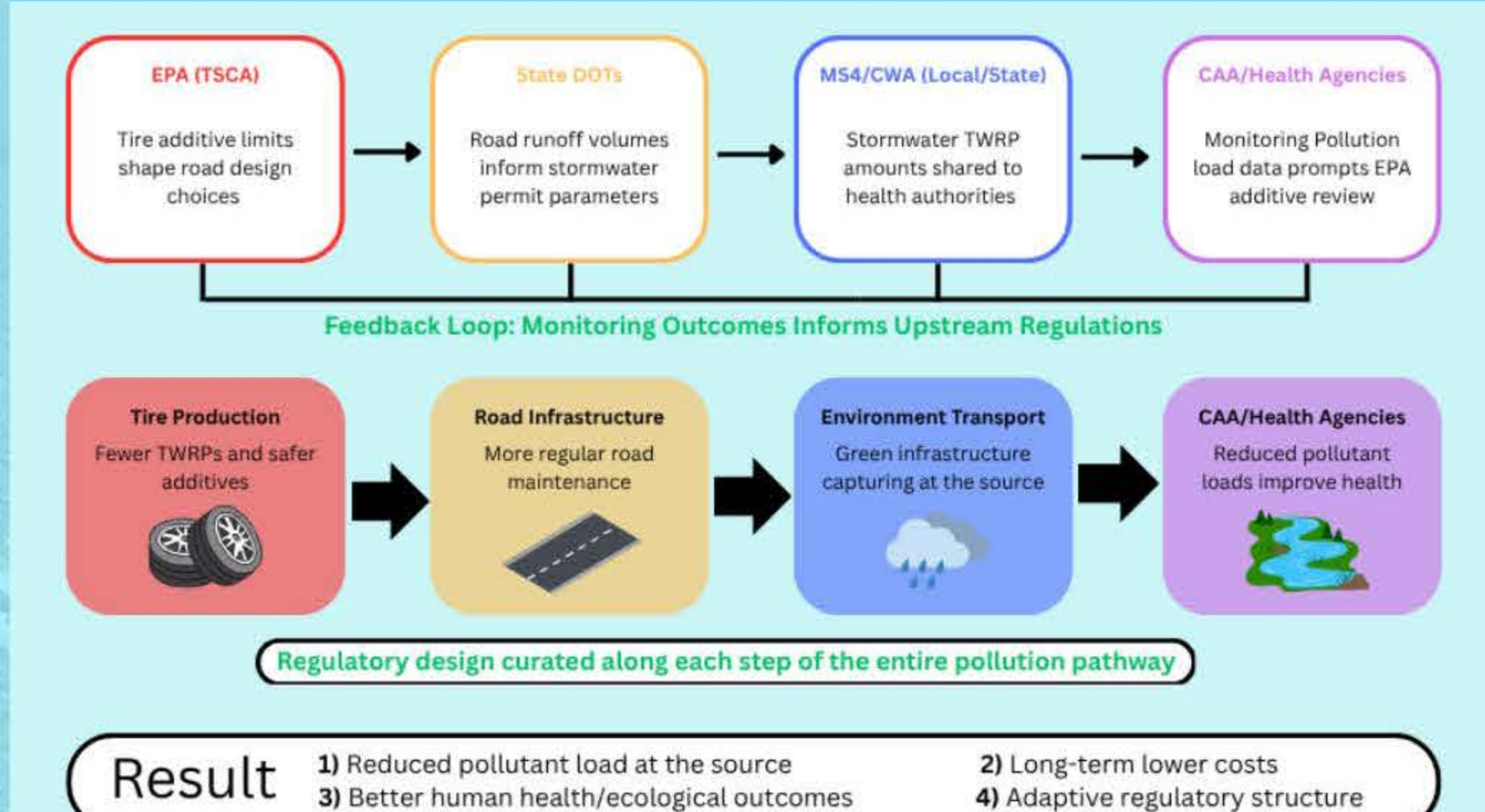
Figure 1: Current Fragmented System



Integrated Road-Shed Strategy

Key Takeaway: PFAS pollution in roadside environments is not merely a chemical persistence problem — it is a governance misalignment problem, resolvable through coordinated regulatory frameworks, engineered mitigation technologies, and cross-jurisdictional institutional integration.

Figure 2: Proposed Integrated Road-Shed Strategy



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