# Science-Based Guidance for Salt Management

Lessons from the Pooled Monitoring Initiative's Restoration Research Program on Pollutants of Emerging Concern

November 2025

## Key Takeaways for Resource Managers

### Reduce chloride loads at the source first

All common deicers mobilize contaminant cocktails, but NaCl is the strongest driver of copper release and strongly mobilizes nutrient release - mobilizing an order of magnitude more Cu and significantly more dissolved nitrogen (TDN) than $CaCl_2$ (though comparable to $MgCl_2$) at equivalent doses. Sodium displaces ammonium and phosphate on soil exchange sites and promotes organic colloid dispersion, releasing nutrients and metals together. Prioritize cutting NaCl and substituting $CaCl_2$/$MgCl_2$ where safety allows.

### Expect late-winter/spring water-quality risk windows

Following winter salt (NaCl) applications, bioretention outflows show pulses of P (+61%), Cu (+61%), Zn (+88%), and Total Suspended Solids (TSS; +66%) during thaw events. Nutrient removal within bioretention rebounds later in the growing season, but these early-spring spikes coincide with ecological vulnerability in receiving streams.

### Design and maintain for nutrient and salt resilience

Internal water-storage (IWS) zones and healthy, diverse vegetation sustain denitrification and nutrient uptake despite elevated salinity. Sites without IWS or with salt-damaged vegetation exhibit higher nutrient export. Routine maintenance - spring sediment cleanouts and replacement of salt-injured plants - helps maintain nutrient removal efficiency.

### Monitor smartly during storms

High-frequency data show rapid TDN and nitrate peaks concurrent with conductivity rises during road-salt events. Relationships between specific conductance (SC) and nutrients plateau near 1,000-2,000 uS/cm, suggesting operational thresholds and source-limited mobilization. Monitoring both SC and nutrients enables timely salt use adjustment.

## Policy and Implementation Guidance for Winter Salting

### 1. Set clear chloride-reduction strategies

**Adopt safety first, salt last** - Prioritize mechanical removal, pre-wetting, and brine application over dry granular salt. Brines deliver less chloride per unit area.

**Preferentially trim NaCl** - $Na^+$ exchanges with $NH_4^+$, $Ca^{2+}$, and $Mg^{2+}$, releasing N and P along with metals. Consider $CaCl_2$/$MgCl_2$ or blended products where temperature allows.

**Use ecological guardrails** - EPA chloride criteria are 230 (continuous) to 860 (acute) mg/L, but biological impacts occur at lower levels. Establish local thresholds.

### 2. Calibrate operations to minimize pulses

**Pre-wet and anti-ice early** - Avoid heavy reactive applications on saturated or frozen surfaces which leads to high spring nutrient export.

**Track spreader calibration** - Avoid re-application before residual salt dissipates; SC readings >1 mS/cm can indicate ample carry-over chloride.

**Stage-aware management** - Expect greater nutrient release late in winter as media storage fills; schedule BMP maintenance post-thaw.

### 3. Retrofit and maintain stormwater BMPs

**Integrate IWS zones** - Enhance nitrate removal under anoxic conditions, sustaining denitrification even during saline exposure.

**Select salt-tolerant vegetation** - Species such as *Juncus effusus* and *Carex vulpinoidea* tolerate moderate salinity while maintaining nutrient uptake.

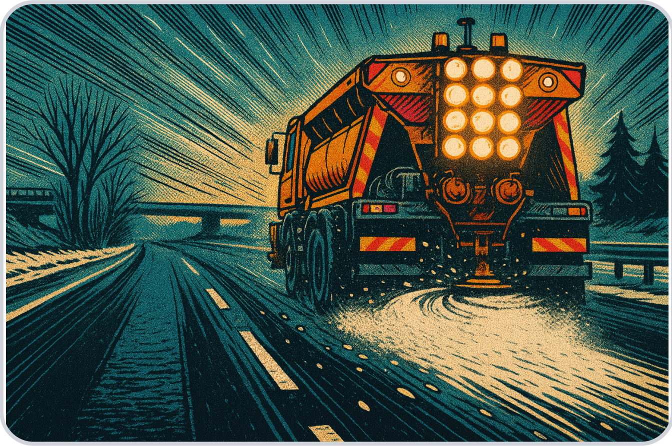
**Plan maintenance around nutrient pulses** - Schedule spring inspections for media clogging, colloid dispersion, and accumulated P/metal loads.

### 4. Monitor during events - then adapt

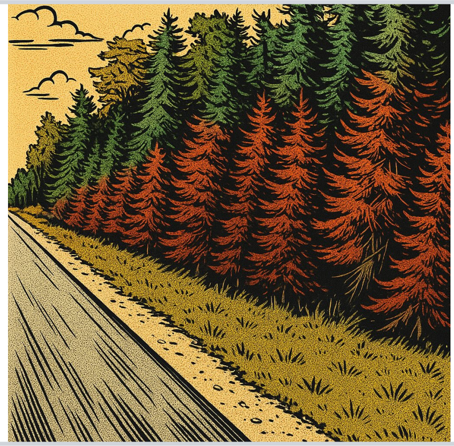
**Deploy high-frequency sensors** - Monitor TDN, $NO_3^-$, and $PO_4^{3-}$ alongside SC for early warnings of road-salt influence.

**Use SC plateaus as checkpoints** - SC plateaus (~1,000-2,000 uS/cm) serve as operational checkpoints for salt load reduction mid-season.

**Prioritize high-load catchments** - Bioretention units draining >70% impervious area show greatest DOC and TDN mobilization; target these for retrofits.



*Winter Road Treatment*



*Environmental Impact*

## References


[1] Galella, J.G., et al. (2023). Stormwater BMPs: experimental evaluation of chemical cocktails mobilized by freshwater salinization syndrome. *Frontiers in Environmental Science*. [PDF]

[2] Brown, A.H., Hoffman, M.C., and McPhillips, L.E. (2024). Impacts of deicer salt on water quality performance of stormwater bioretention systems with varied vegetation and hydrology. *ACS ES&T; Water*. [PDF]

[3] McPhillips, L.E. (2023). Impacts of salt loading on nutrient and metal processing in stormwater bioretention. *CBT PMI-RRP Final Report*. [PDF]

[4] McPhillips, L.E. (2023). Impacts of salt loading on nutrient and metal processing in stormwater bioretention. *CBT PMI-RRP Fact Sheet*. [PDF]

[5] Galella, J.G., Kaushal, S.S., Mayer, P.M., et al. (2023). Freshwater salinization syndrome alters nitrogen transport in urban watersheds. *Water*. [PDF]

[6] Kaushal, S.S., et al. (2022). Freshwater salinization syndrome alters retention and release of chemical cocktails along flowpaths. *Freshwater Science*. [PDF]


## About This Research Synthesis

This document synthesizes scientific research supported by the Chesapeake Bay Trust's **Pooled Monitoring Initiative (PMI)**, a collaborative program advancing science-based restoration across the Chesapeake Bay watershed. PMI brings together researchers, practitioners, and decision-makers to fill critical knowledge gaps and translate research into actionable guidance for resource managers.

Learn more: cbtrust.org/grants/restoration-research/

Chesapeake Bay Trust