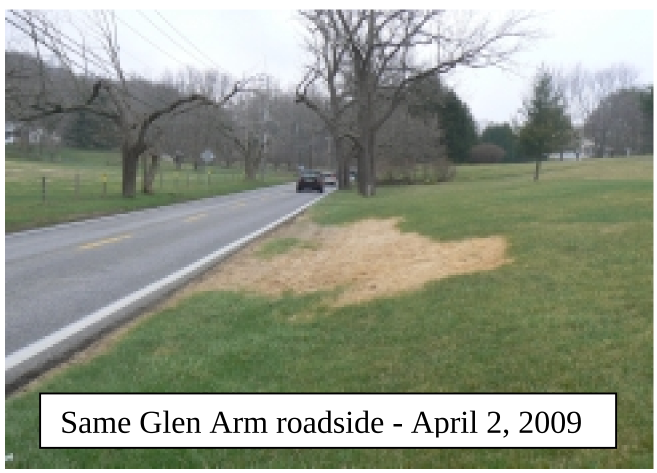
Road Salt Recommendations to the Baltimore County Council

Road Salt Working Group
Baltimore County Advisory Commission on Environmental Quality

Autumn 2009

Salt on Glen Arm roadside - March 6, 2009



Same Glen Arm roadside - April 2, 2009

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Executive Summary

In response to a request from Baltimore County Councilman Vince Gardina, the Baltimore County Advisory Commission on Environmental Quality (CEQ) reviewed the environmental impacts of road salt application in Baltimore County. The CEQ has identified many negative environmental and health issues emanating from the use of road salt to melt ice and snow.

The CEQ drew on a variety of resources, including key findings of the Baltimore Reservoir Watershed Management Program (e.g., "**Public drinking water may pose a health risk for persons on sodium-restricted diets."**). We are aware that the public may expect the County roads to be clean and dry shortly after a storm, and may expect that snow or ice storms will have little or no effect on their ability to drive anywhere, regardless of weather. We are also aware that the State policy, applicable to State roads in Baltimore County, mandates clear and dry roads. Baltimore County (at 1.2 tons of salt per lane mile per storm) and the State (at 3.2 tons of salt per lane mile per storm) apply more road salt than other jurisdictions. In our assessment, the use of road salt reflects the current County strategy for achieving clear and dry roads at a manageable short term, out-of-pocket financial cost.

The CEQ has concluded that the very significant negative environmental impacts—on drinking water, human health, ecosystem sustainability and the infrastructure—and the long-term financial costs associated with these impacts should outweigh any short-term financial benefits associated with the use of road salt. Therefore, the CEQ believes that ***the County should seek to balance public and environmental health with expectations of 'bare and dry' roads by reducing the use of road salt, by seeking alternatives, by educating citizens and salt truck operators, and by promoting sustainable road salt application practices for County operations and County citizens***. This approach would be consistent with Baltimore County's sustainable programs and initiatives.

Executive Summary of negative environmental impacts:

Road salt (NaCl) dissolves in water into sodium and chloride ions. Once the salt leaves the road surface, both sodium and chloride migrate into sources of drinking water and into natural systems. Road salt adversely impacts water quality, public health (e.g., through drinking water quality), plants, soil and soil chemistry, animals, built infrastructure, and private property. It disrupts the salt-water balances in natural systems—both at the landscape scale and within individual organisms. Impacts can occur far from the site of application since salt can seep into ground water and surface water, although impacts are greatest near the application site. In the Baltimore region road salt is measurably salinizing both ground water and surface water, which negatively impacts plants, animals, and humans. Suburban sprawl has accelerated this salinization process (i.e., more roads and therefore more salt). Salt can impact entire populations of plants and animals and can shift communities to those that are salt tolerant. It can degrade soils, which compromises the retention and processing of pollutants transported in storm water runoff and diminishes the beneficial value of buffer zones to groundwater sources and reservoirs. These impacts, which are very difficult and expensive to reverse, are described in more detail in charts in this report.

The environmental impacts of road salt in Baltimore County merit direct and immediate action. With this imperative, the CEQ recommends that the County create a task force made up of the Department of Health, DEPRM, the Department of Public Works, and the Office of Budget and Finance to:

1. Further Analyze and Evaluate.
   - A. Analyze and evaluate the effects of using salt and possible alternatives on Baltimore County roads. Consider all of the environmental, public health, and infrastructure impacts, not just the short-term financial costs.
   - B. Investigate the use of technology with the intent of reducing the overall use of salt applied to roads (e.g., highway monitors, pavement sensors, weather information systems, etc. during storm events to determine optimal timing, amounts, and application rates).
   - C. Prepare a comprehensive cost-benefit analysis on the use of road salt and alternatives, which includes long-term and environmental costs (e.g., costs of sodium removal from our drinking water).

2. Improve regulations, guidelines, and protocols.
   - A. Regulate distribution of road salt for both County and private applications.
   - B. Establish strict written protocols and guidelines for salt application by DPW to minimize environmental impacts (e.g., windrowing).
   - C. Verify compliance with protocols and guidelines, on an ongoing basis.
   - D. Regulate salt storage by the County and by private citizens to prevent contamination of adjacent streams and soil.
   - E. Establish a road salt spill hotline.

3. Increase awareness of environmental impacts of road salt through education.
   - A. Increase awareness of the public about the high costs to public health and infrastructure from road salt through public education.
   - B. Increase awareness of salt truck drivers through proactive education, with the goal for drivers to understand how to minimize the amount of salt application, and be aware of and clean up spillage.

4. Act with partners.
   - A. Act upon the findings and recommendations of the Baltimore Reservoir Watershed Management Partners to protect our drinking water.
   - B. Ask the County Executive and our State representatives to address at the state level with the Department of the Environment and State Highway Administration, the current policies and environmental impacts of salt.
   - C. Include in the planning and zoning processes the environmental impacts of road salt application on additional roads.

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Background

Background – Road Salt Chemistry

In common usage, 'salt' refers to the specific compound sodium chloride, NaCl, or common table salt. Chloride salts are the most commonly used salts for deicing roads because of their easy availability and their property of lowering the freezing point of water. Sodium chloride is most effective above 20º F; the effectiveness drops off rapidly below 20º F. While a pound of salt can melt about 45 pounds of ice at 30º F, its ability to melt ice drops to 5 pounds of ice at 5º F.

Beside sodium chloride, deicing operations may use calcium, potassium, and magnesium chlorides, which may be applied in crystalline form or as a liquid. They may be used in conjunction with abrasives such as sand, or they may be mixed with other substances that reduce the corrosive effects or enhance their effectiveness. These additives are often agricultural by-products of corn or sugar beets. Other additives such as sodium ferrocyanide may be used to prevent clumping.

Road salt (NaCl) dissolves in water into sodium and chloride ions. While the sodium may bond to soil particles or be taken up in biological processes, the chloride is less reactive and about 55% of the chloride from road-salt is transported in surface runoff and 45% through the soil to ground waters (Church and Friesz, 1993). **Either way, both sodium and chloride generally leach into sources of drinking water and into natural systems.**

Background – Overall Environmental Impacts

Road salt negatively impacts water quality, public health (e.g., water quality), plants, soil and soil chemistry, animals, built infrastructure, and private property. Impacts can occur far from the site of application and may seep into groundwater and surface water, although impacts are greatest near the application site. Road salt disrupts the salt-water balances in natural systems—both at the landscape scale and within individual organisms. Increased salt can impact plant and animal populations, causing a shift in the ecosystem to species that are salt tolerant. Salt pollution can affect the ability of the natural systems to buffer and filter. **The accumulation and persistence of salts in watershed waters pose risks to aquatic ecosystems and to water quality.**

Background – Negative Impacts on Humans

While small amounts of sodium are necessary for humans to function, too much can lead to kidney failure and increases the chances of high blood pressure. **Levels in the Baltimore water supply have already exceeded the EPA health advisory limit for persons with sodium sensitivities (such as diabetics and dialysis patients).** Chloride is normally used to purify water so is not so much of a health concern (at present levels). However, the primary issues are the corrosive action of salt when in direct contact with road infrastructures and its effects on vegetation and animals that are not tolerant.

These salts remain in solution and are not subject to any significant natural removal mechanisms, nor can they be easily removed during water purification for drinking water. Distillation and reverse osmosis are the only means of removing salt impurities.

Background – Baltimore Reservoir Watershed Management Program - Key Recommendations

The Baltimore Reservoir Watershed Management Program (a joint undertaking of Baltimore City, Baltimore County and other jurisdictions and organizations) assessed the water quality in the Baltimore Metropolitan water supply reservoirs and their watersheds and published a Technical Report in November of 2004--almost five years ago. The findings in this report were based on data collected at the reservoirs and from their tributaries as part of the on-going monitor program. The relevant data pertaining to sodium and more generally to chlorides were collected beginning in the 1980s and continuing thereafter. Road salt was identified as the major contributor to sodium levels and rising chloride levels in the reservoirs and the watersheds. The report noted that "elevated chloride levels in the raw [pre-treated] water are not reduced by the processes used at the city's treatment plants...Since 1973, sodium levels in the finished (treated) drinking water have increased almost three-fold in the water withdrawn from Liberty Reservoir (and treated at the Ashburton plant) and almost four-fold in the water drawn from Loch Raven (and treated at the Montebello plant)" (p.13). Noting that the current levels of sodium and chlorides are lower than those that cause "taste or health problems for the end consumers," the report stated that "**the trends observed in the reservoirs over the past two decades seem to represent a cause for concern**" (p. 14). The report also stated that "chlorides in the watershed most often originate from the use of road de-icing compounds" (p.14), while recognizing that some are due to animal wastes on farms and from residential septic systems.

Furthermore, the report noted that the EPA has advised that persons on a "very restricted diet for sodium," where intake should not exceed 500 mg/day, should not consume drinking water with sodium concentrations exceeding 20 mg/liter of sodium. "The sodium concentrations in the finished water leaving the Montebello plant repeatedly exceeded this level...and were consistently higher than the levels seen at that plant in the preceding decades" (p. 13). **Thus, public drinking water may pose a health risk for persons on sodium-restricted diets.**

See Appendix A.

These data and comments suggest that unless the use of road salt is substantially reduced throughout the metropolitan area, salty drinking water will become a serious problem within the next decade.

Background – Negative Impacts to Infrastructure and Personal Property

The impacts of road salt to infrastructure are costly and well documented (Transportation Research Board Special Report 235, National Research Council, Washington, D.C., 1991, *'Highway Deicing Comparing Salt and Calcium Magnesium Acetate' p.5).* In the early 1990s, Congress sponsored a study to examine the direct and indirect cost of road salt, quantifying costs which included damage to the environment, infrastructure, and motor vehicles. Experts in engineering, science and maintenance documented in detail the estimated total costs of use of road salt. The costliest impact on infrastructure is seen on motor vehicles, bridges and parking structures, and on concrete pavement, underground utilities, and roadside objects, all of which are corroded or degraded by salt.

In the 1991 study, the cost of corrosion-resistant technology for cars was found to add on average $500 to the cost of the vehicle (NRC, 1991, p38). Damage to bridge decks is well understood and 'under low or no-salt conditions [bridge decks] are normally protected from corrosion by the highly alkaline environment of the concrete' (NRC, 1991, p.43). Under high salt conditions, the damage is severe and replacement expensive.

Background – Cost Comparisons of De-Icer Products

It is commonly stated—and fervently believed—that salt is the 'best' choice because the material cost to purchase salt is thought to represent a 'lower cost' than any other alternative.

Comparisons of only the immediate, out-of-pocket cost of various deicing materials might lead to the erroneous conclusion that salt (NaCl) is the only financially viable choice for a road de-icer in Baltimore County. In the past year, NaCl has generally been available for $40-$60 per ton (although recent reports indicated that the price doubled in 2009). CMA (calcium magnesium acetate), for example, which otherwise appears to be a good alternative, costs about 15 times as much (by weight) and some estimate that it requires 50% more to be as effective. Faced with these figures, it is obvious why budget-conscious road departments have chosen salt.

However, the economic picture changes when long term costs are included. Numerous studies have examined the real overall or total cost of using salt as a deicer. While the upfront purchase price of salt has recently been about $40-60 per ton, analysis of the costs of repairing damage to infrastructure and vehicles raises the final cost to well above that of alternative materials. For example, a National Research Council study in 1991 conservatively concluded that the real overall cost of using salt was $2 - $4.5 billion and very likely as high as $7 billion per year. With total usage of about 12 million tons in 1991, that equates to as much as $600 per ton of salt used. Those estimates did not include environmental damage. Studies by Environment Canada in 2000 estimated the cost in the US at $15 billion.

(Special Report 235, Highway Deicing, Comparing Salt and Calcium Magnesium Acetate, Transportation Research Board, 1991)
http://onlinepubs.trb.org/onlinepubs/sr/sr235.html

Current Road Salt Practices in Baltimore County

According to Robert T. ("Tim") Burgess, Chief of the Bureau of Highways, Department of Public Works, Baltimore County, in 2009 DPW used sodium chloride (NaCl) with anti-caking agents added to treat County roads. The County purchases the same product each year, regardless of price or availability. No changes are made to the salt based on the temperature of the storm event.

DPW noted that the County "adheres to the industry standard of 500 pounds of salt per lane mile [per application]; however, refreezing often occurs, requiring multiple applications for a single storm event. **Baltimore County applies an average of 1.2 tons of salt per lane mile per storm.**"

The CEQ was unable to locate any industry standard, or source for the idea that 500 pounds of salt per lane mile was a standard. In 1993, New York specified 270 pounds per lane mile for each application during rapidly accumulating snow. A Cornell study recommended lesser amounts in most cases, with 500 pounds only for the worst case situation - 12-22º F with bonded/packed snow. Minnesota and New Hampshire recommendations call for no more than 400 lbs per 2-lane mile, and generally less than 300 pounds if the surface is pre-wetted. Other reports are for similar amounts—in the range of 100-300 pounds per lane mile.

The 1991 National Research Council Report, in listing the "official salt use policies" in numerous jurisdictions, indicated values of 200-300 lb/lane-mile (or less) for numerous states except for Maryland which reported 300-500 lb/lane-miles on state highways.

(Special Report 235, Highway Deicing, Comparing Salt and Calcium Magnesium Acetate, Transportation Research Board, 1991)
http://onlinepubs.trb.org/onlinepubs/sr/sr235.html

Tim Burgess noted that "There are no laws regarding this [road salt application in Baltimore County]. Nor are there any County or State laws or Federal regulations. There is a training course that all Baltimore County plow operators attend. You can obtain more information about the training by contacting Ray Bass at the DPW Training Academy at 410-887-1843."

According to the DPW 'Salt Fact Sheet,' "**there are no protocols, regulations or guidelines**" about Baltimore County's 'salting procedure.'

For more detail, see appendices B and C.

Maryland State Policy, Goal Statement, and Current Road Salt Practices

According to the Baltimore County DPW, **the State applies an average of 3.2 tons of salt per lane mile per storm to state roads**. The following is excerpted from the State Highway Administration's Business Plan:

- "Objective 3.4 Winter: Regain Bare Pavement: Regain bare pavement of Interstate and Primary State Highway Administration roadways in four hours or less after the end of frozen precipitation during all winter storms."

(Andre Futrell, Assistant District Engineer – Maintenance, District Four, Baltimore and Harford Counties, Office - 410-229-2361)

The State Highway Administration's Current Goals include:

- To achieve bare pavement as early as possible in a winter storm and maintain it whenever possible throughout the storm.
- To provide an exceptionally high level of service to our customers at the lowest possible cost in dollars and in damage to the environment and the highway system.

The State's policy and public expectations during storm events have led to a high use of road salt in Baltimore County. The impacts to humans and ecosystems are at a critical threshold.

Environmental Impacts of Road Salt

The chart below summarizes, topic by topic, each detrimental environmental impact of road salt. References are given for each statement.

System	Impact	References
Overall Water Quality	• Mean annual chloride concentration has increased as a function of increases in impervious surface (pavement) and **exceeds tolerance for freshwater life in many suburban and urban watersheds**. Analysis shows that if salinity were to continue to increase at its present rate due to changes in impervious surface coverage and current management practices, many surface waters in the northeastern United States would not be potable for human consumption and would become toxic to freshwater life within the next century. • Chloride concentrations are increasing at a rate that **threatens the availability of fresh water** in the northeastern United States. Increases in roadways and deicer use are now **salinizing fresh waters**, degrading habitat for aquatic organisms, and impacting large supplies of drinking water for humans throughout the region. Chloride concentrations of up to 25% of the concentration of seawater are reported in streams of Maryland, New York, and New Hampshire during winters, and chloride concentrations remaining up to 100 times greater than unimpacted forest streams during summers.	Increased salinization of fresh water in the northeastern United States. PNAS September 20, 2005. 102(38): 13517–13520 www.pnas.org_cgi_doi_10.1073_pnas.0506414102
Drinking Water – Effect on Public Health	• The EPA has advised that persons on a "very restricted diet for sodium," where intake should not exceed 500 mg/day, should not consume drinking water with sodium concentrations exceeding 20 mg/liter of sodium. "The sodium concentrations in the finished water leaving the Montebello plant repeatedly exceeded this level...and were consistently higher than the levels seen at that plant in the preceding decades" (p. 13). **Thus, public drinking water may pose a health risk for persons on sodium-restricted diets.** • **Impacts to water quality can be particularly acute when busy roads are adjacent to drinking-water reservoirs** insulated by narrow buffers. • Damage to vegetation can amplify adverse impacts on drinking-water quality in	2005 Action Strategy for the Reservoir Watersheds, Baltimore Reservoir Watershed Management Program, November 2005. http://www.baltometro.org/RWP/RWPActionStrategy2005.pdf

System	Impact	References
	watersheds; friable soils (crumbling) from bacteria die-off can **increase the suspension of sediment in runoff and contaminate drinking-water supplies** to levels that exceed standards. • Degradation of soils and vegetation in buffer areas between roads and watercourses **compromises the retention and processing of pollutants transported in stormwater runoff** and **diminishes the beneficial value of buffer zones to groundwater sources and reservoirs**. • The Federal Highway Administration (FHWA) noted, in its study of sodium in public water supplies, that consumers readily identify the "too salty" taste in drinking water, finding it unpalatable. • Drawdown by wells creates a cone of depression that allows recharge into the well from seepage. The latter mechanism **provides a local groundwater recharge system that captures surface water and dissolved salts and leads them directly to the well** at the center of the cone of depression. • Once a well is salty, dissipation of **salt requires many years** due to the slow travel times in groundwater.	http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm

System	Impact	References
		wr/environmental/teach/gwprimer/roadsalt/roadsalt.htmlhttp://www.iappo.org/pdf/IAPPO07_RoadSalt.pdf
Effects on Plants	• **Damage to vegetation can occur up to 200 meters from roadways** that are treated with deicing salts. • As a result of salt concentrations in roadside soils, **salt-tolerant halophytic plant species**, formerly found only in naturally salty coastal wetlands, **now colonize inland roadsides, replacing the naturally occurring native species**. • Elevated sodium and chloride levels in soils create osmotic imbalances in plants, which **inhibit water absorption and reduce root growth.** • **Salt disrupts the uptake of plant nutrients and inhibits long-term growth**. • Numerous studies attribute **tree injury and decline** to road-salt application, and conclude that NaCl can **cause severe injury to the flowering, seed germination, roots, and stems of roadside plant species**. • NaCl exposure as low as 100 ppm in soil **inhibits seed germination and root growth rates in grasses and wildflowers**. • Damage to plants includes **lack of flowering, stunted growth and lower resistance to disease and pests.** When native plants die because of high salt levels, invasive species, which are more tolerant, tend to take over. • Damage to roadside plants from road salt is commonly seen along County roads, where otherwise healthy looking shrubs are green on the non-street side, but brown and dying on the street side.	http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm Environment Canada. Priority Substances Assessment Report: Road Salts. www.ec.gc.ca/cceb1/eng/public/road_salts.html. 2000 (no longer online) http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/roadsalt/roadsalt.htmlhttp://www.iappo.org/pdf/IAPPO07_RoadSalt.pdf
Effects on Soil and Soil Chemistry	• **Changes in soil and soil chemistry**—the source of nutrients for all plants—is a **precursor to massive changes in local vegetation**. • Exposure to NaCl **inhibits some soil bacteria** at concentrations as low as 90 mg/l, which ultimately compromises soil structure and thereby inhibits erosion control. • The characteristics of the soil determine the movement of the salt through the soil	http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm

System	Impact	References
	down to the groundwater. Course textured soil allows infiltration fast while finer textured soils are characterized by slow infiltration. Also, the charges on the sodium and chloride accounts for the retention of higher percentage of sodium in the soil Jones et al. (1986), and the Maryland Department of Transportation. • Sodium chloride accumulation tends to **diminish permeability of the soil and tends to increase alkalinity**. It can also tend to reduce the aeration of the soil. • The creation of friable (crumbling) soils from bacteria die-off **can increase the suspension of sediment in runoff and contaminate drinking-water supplies** to levels that exceed standards. These changes in soil conditions could lead to turbidity violations and trigger a need for an automatic filtration order; in New York City, for example, a filtration plant estimated to cost of up to $8 billion is required. • Examining rates of deicing **salt accumulation and leaching in urban soils** is important for understanding the distribution and movement of salt in the environment. Researchers examined autumn concentrations of deicing salts in soils in a moderately dense urban landscape in eastern New York State. The study area contrasted an urban area with isolated, rural highway area. They discovered that leaching of sodium is rapid in this system. Leaching may ameliorate toxicity for land plants but accelerate inputs to aquatic systems. In contrast to rural highway studies, where salt levels declined rapidly with distance to pavement, sodium remained elevated at the maximum distance measured. • **Airborne salt dispersal and dense networks of pavement likely contribute to widespread elevated salt levels**. The semi-urban setting of one study had salt levels high enough to be toxic to terrestrial plants and soil protozoa. Even moderate levels of development can have dramatic effects on salt inputs into soils and aquatic systems.	http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/roadsalt/roadsalt.html Accumulation of deicing salts in soils in an urban environment. *Urban Ecosystems* (2008) 11:17–31.
Effects on Animals	• **Reproductive health**. Both **adult and larval amphibians are known to be particularly sensitive to changes in their osmolar environments (i.e., how much dissolved solid matter is in the water)**. • Demographic models suggest that such **egg and larval stage effects of salt may have important impacts on populations near roads, particularly in the case of *A. maculatum (the Spotted Salamander)*, for which salt exposure may lead to local**	Impacts of Road Deicing salt on the demography of vernal pool-breeding amphibians. *Ecological Applications*, 18(3),

System	Impact	References
	extinction. For both species, the effect of road salt was dependent upon the strength of larval density dependence and declined rapidly with distance from the roadside, with the greatest negative effects being limited to within 50 m. • Based on this evidence, we argue that **efforts to protect local populations of *A. maculatum* and *R. sylvatica* (Wood Frog) in roadside wetlands should, in part, be aimed at reducing application of road salt near wetlands with high conductivity levels.** • Salt damage to vegetation also affects the birds and animals which depend on the vegetation for food and habitat. Salt **destroys food resources, habitat corridors, shelter, and breeding or nesting sites.** • **Birds may ingest lethal quantities of salt crystals as grit to aid in grinding food**. Birds and mammals are attracted to salt on roads due to a natural inclination to acquire salt, thus leading to increased road kill. Deer are drawn to roads to lick salt. • Higher salt levels **decrease dissolved oxygen in water**. Many animals are not able to adapt. At levels above 220 mg/l, 10% of species could die after 30 days. **Trout are especially vulnerable**. • **Drinking salty water makes deer lose their fear of vehicles and humans**. • Deicing agents, primarily road salt, are applied to roads in 26 states in the United States and in a number of European countries, yet the **scale of impacts of road salt on aquatic organisms remains largely under-studied.**	2008, pp. 724–734. www.dot.state.co.us/publications/PDFFiles/deicers.pdf http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/roadsalt/roadsalt.htmlhttp://www.iappo.org/pdf/IAPPO07_RoadSalt.pdf
Effects on Infrastructure	• 'Although road salt rarely jeopardizes the structural integrity of bridges, its **corrosivity damages bridge decks.** Chloride ions penetrate concrete and corrode reinforcing rods, causing the surrounding concrete to crack and fragment' (NRC, 1991, p.3). • 'Road salt **causes reinforcing steel in parking garages to rust**, thereby compromising the structural integrity of the surrounding concrete.' (NRC, 1991, p.4). • 'Corrosion damage to utility lines, pipelines, and steel storage tanks buried under or alongside highways is sometimes linked to the use of road salt, especially in urban areas with a high density of underground utility lines and heavy salt usage' (NRC, 1991, p.144)	http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm http://onlinepubs.trb.org/onlinepubs/sr/sr235.html

System	Impact	References
Other Impacts to Private Property	• The Transportation Research Board's 1991 study documented the high cost of corrosion-resistant technology for cars, which in 1991 was identified as adding on average $500 to the cost of the vehicle (p.38).	http://onlinepubs.trb.org/onlinepubs/sr/sr235.html

De-icing Alternatives to Sodium Chloride (Salt)

The adverse effects of road salt, which are quite well known, have led to widespread efforts to find viable alternatives. The following chart summarizes the alternatives, noting pros and cons and identifying jurisdictions where each is used. 'Maryland' in this chart means the State of Maryland/State Highway Administration.

Alternative	Description	Pros	Cons	Reference	Jurisdictions Using this Method
Sand	Provides traction without any appreciable melting.	Cheap	Adds to degradation of air quality due to dust. Causes turbidity in water. May clog storm drains or lead to silting in of wetlands	www.dot.state.co.us/publications/PDFFiles/deicers.pdf	Maryland
Inhibited salt	Salt mixed with various chemicals which significantly reduce the corrosive effect. For example, the Pacific Northwest Firefighters (WA, OR, ID, MT, CO) requires inhibited salt to provide 70% reduction in corrosion.	Reduced corrosion	Additives may have other environmental impacts	www.wsdot.wa.gov/partners/ pns/pdf/IdahoSaltContract.pdf http://www.dot.state.co.us/http://www.dot.state.co.us/publications/PDFFiles/antiicing.pdf publications/PDFFiles/antiicing.pdf http://www.dot.state.co.us/publications/PDFFiles/antiicing.pdf	WA, OR, ID MT

Alternative	Description	Pros	Cons	Reference	Jurisdictions Using this Method
Magnesium Chloride	Effective to -13F.	Less corrosive than salt Magnesium ions increase stability and permeability of soil. Does not attract animals.	Appears to reduce germination even more than salt. Is corrosive.	www.dot.state.co.us/publications/PDFFiles/deicers.pdf www.dot.state.co.us/publications/PDFFiles/vegetation.pdf	Maryland
Magnesium Chloride as pretreatment (Ice B Gone 2)	De-icing treatment This product with a magnesium chloride wetting agent is applied as a pre-treatment before a winter storm, as weather permits, and is intended to prevent ice from adhering to roadway surfaces. Salt/sand mixture and liquid magnesium chloride may also be applied as needed. Can be applied during and after precipitation as needed	More effective than traditional sand/salt treatment Uses less material saving money in our winter operations budget. Less corrosive than traditional rock salt Is distributed more efficiently than traditional rock salt Lasts longer and melts faster at lower temperatures than regular salt. Prevents refreeze commonly associated with regular rock salt.		http://www.ci.bristol.ct.us/content/3240/6587/3264/default.aspx	Bristol, CT

Alternative	Description	Pros	Cons	Reference	Jurisdictions Using this Method
		Treatment of the salt results in less bounce and scatter when applied to the roadway. Residents may not be able to detect a visible material on the roads, but treated roads will have better traction and minimal icing once snow/ice begins to cover the road.			
Magnesium Chloride with agricultural by-products (Caliber M1000)	70% corn-based product and 30% Magnesium Chloride, Often used as pre-wetting for other material.	Less corrosive than pure Magnesium Chloride and 85% less corrosive than pure salt.		www.watershed-alliance.com/publications/Annual%20Reports/AnnualReport2008/2008%20ANNUAL%20REPORT.pdf http://www.anti-icers.com/caliber_m1000.htm	Maryland, Frederick County
Potassium Chloride	Normally used as fertilizer. Effective to 12º F	Minimal corrosion	Adds chloride to environment	Peters Chemical Company www.peterschemical.com	

Alternative	Description	Pros	Cons	Reference	Jurisdictions Using this Method
Urea	Urea is normally used as a fertilizer, since it provides the highest concentration of nitrogen. It is made from anhydrous ammonia. Effective to 15º F		Increases nutrient loading of waterways leading to algal blooms. Found to have higher damaging effect on asphalt concrete than salt		Note: not approved by Pacific Northwest Snowfighters (WA, OR, ID, MT, CO, BC).
Potassium Acetate	Effective to -15º F		Cost $700-800/ton Dust causes mild irritation to the respiratory tract	www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm	
Sodium Acetate	Effective to 0º F	No chloride Produces heat when in contact with water	Some degradation of concrete	www.facilitiesnet.com/groundsmanagement/article/Targeting-Ice-and-Snow--3354	Unknown
Calcium Magnesium Acetate	Generally just as effective as salt at temperatures typical in MD. Can be made from sludge, municipal waste, and cheese whey to produce acetic acid (vinegar) which is then reacted with lime.	No negative effect identified on vegetation. Calcium and magnesium ions are absorbed by the soil and have beneficial effects. Calcium causes fine clay particles to clump to form aggregates which	The only negative effect identified is an oxygen depletion of soil and water, during decomposition of the acetate, which has been observed to occur for short periods. Upfront cost (up to 15 times that of salt), (but must be balanced with downstream, long-term costs of salt).	www.tfhrc.gov/pubrds/novdec99/cmaupdate.htm netfiles.uiuc.edu/mcheryan/www/cma.htm www.dot.state.co.us/publications/PDFFiles/deicers.pdf	WA, WI, CA

Alternative	Description	Pros	Cons	Reference	Jurisdictions Using this Method
		results in improved water drainage and aeration. The acetate ion is an organic material and serves as a nutrient. Calcium and magnesium are essential elements for human nutrition. Production of CMA can use sludge and municipal waste.			
Calcium chloride	Similar to salt, but effective to -25º F.	Calcium ions increase stability and permeability of soil. Does not attract animals.	Introduces chloride into the environment.	www.dot.state.co.us/publications/PDFFiles/deicers.pdf www.jericoservices.com/ice_control_deicer_products.htm	Maryland

Application Techniques

Other jurisdictions use a variety of application methods. The choice of application method affects the amount of salt or other material used and its efficacy. The application method used also mandates the training procedures for the truck drivers/appliers, and in some instances uses sophisticated technology. The following chart summarizes application techniques.

Application Technique	Description	References
Road Weather Information Systems (RWIS)	Small weather measuring and transmitting stations provide better data to allow more efficient use of de-icing materials and personnel. These have been used by many states since the mid-1980s. They measure air and pavement temperatures, amount of precipitation, and the amount of deicing material on the road.	Source Water Protection Practices Bulletin, Managing Highway Deicing to Prevent Contamination of Drinking Water, EPA, August 2002 www.epa.gov/safewater/sourcewater/pubs/fs_swpp_deicinghighway.pdf
Pre-wetting	Dry mixtures (salt, sand, etc) spread on the roadway tend to bounce or be blown off of the surface. Pre-wetting, either prior to loading the material on the trucks or as it is being distributed, have been shown to reduce the amount of material needed by significant amounts and allow it to begin melting ice more quickly.	Source Water Protection Practices Bulletin, EPA, August 2002
Windrowing	A narrow strip (4-8 feet wide) is applied on the center of the road rather than scattered. This hastens melting in this area and provides traction for 2 wheels. The heating of the bare pavement by the sun and spreading by traffic then melts the rest. There is much less material	www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf

	lost off of the road.	
Fixed, local spraying systems	Automated applicators are mounted on bridges and alongside curves to spray de-icers directly onto these surfaces.	Source Water Protection Practices Bulletin, EPA, August 2002
Ground-speed controllers	Measures the ground speed to automatically adjust the rate of distribution of the material so that the driver does not need to do this.	www.des.nh.gov/organization/commissioner/pip/ factsheets/wmb/documents/wmb-4.pdf www.usroads.com/journals/p/rmj/9712/rm971202.htm

Recommendations

The environmental impacts of road salt in Baltimore County merit direct and immediate action. With this imperative, the CEQ recommends that the County create a task force made up of the Department of Health, DEPRM, the Department of Public Works, and the Office of Budget and Finance to:

1. Further Analyze and Evaluate.
   A. Analyze and evaluate the effects of using salt and possible alternatives on Baltimore County roads. Consider all of the environmental, public health, and infrastructure impacts, not just the short-term financial costs.
   B. Investigate the use of technology with the intent of reducing the overall use of salt applied to roads (e.g., highway monitors, pavement sensors, weather information systems, etc. during storm events to determine optimal timing, amounts, and application rates).
   C. Prepare a comprehensive cost-benefit analysis on the use of road salt and alternatives, which includes long-term and environmental costs (e.g., costs of sodium removal from our drinking water).

2. Improve regulations, guidelines, and protocols.
   A. Regulate distribution of road salt for both County and private applications.
   B. Establish strict written protocols and guidelines for salt application by DPW to minimize environmental impacts (e.g., windrowing).
   C. Verify compliance with protocols and guidelines, on an ongoing basis.
   D. Regulate salt storage by the County and by private citizens to prevent contamination of adjacent streams and soil.
   E. Establish a road salt spill hotline.

3. Increase awareness of environmental impacts of road salt.
   A. Increase awareness of the public about the high costs to public health and infrastructure from road salt through public education.
   B. Increase awareness of salt truck drivers through proactive education, with the goal for drivers to understand how to minimize the amount of salt application, and be aware of and clean up spillage.

4. Act with partners.
   A. Act upon the findings and recommendations of the Baltimore Reservoir Watershed Management Partners to protect our drinking water.
   B. Ask the County Executive and our State representatives to address at the state level with the Department of the Environment and State Highway Administration, the current policies and environmental impacts of salt.
   C. Include in the planning and zoning processes the environmental impacts of road salt application on additional roads.

Appendix A. Executive Summary, Reservoir Water Quality Assessment for Loch Raven, Prettyboy and Liberty Reservoirs

City of Baltimore, Department of Public Works, Bureau of Water and Wastewater Environmental Services Division, Water Quality Management Section, March 2009.

This study, conducted by the City of Baltimore, documents the increasing salinity of the City reservoirs, which supplies water to 90% of County households. The watersheds included in the study are located in Baltimore County, and many streams entering the reservoirs arise in Baltimore County. The following excerpts document the alarming facts of increased salinity in the reservoirs.

- There is at least a 3-fold increase in treated-water sodium concentrations from 1973 to 2008 in the data collected at the Ashburton Treatment Plant (Liberty watershed) and many highly elevated readings in the past 10 years from the Montebello Treatment Plants (Loch Raven). **Sodium is of particular concern since the levels in the treated water at times exceed EPA health advisories of concern (20 mg/L) for that segment of the population with sodium sensitivity.** See Figures 1-1 and 1-2.

- Conductivity and chloride concentrations showed increasing trends at all the reservoir tributary monitoring stations, as well as in the treated water at Ashburton and Montebello. The chloride levels are well below EPA advisory levels of 250 mg/L; however, the steadily increasing trend over the past two decades is a concern. See Figure 1-8.

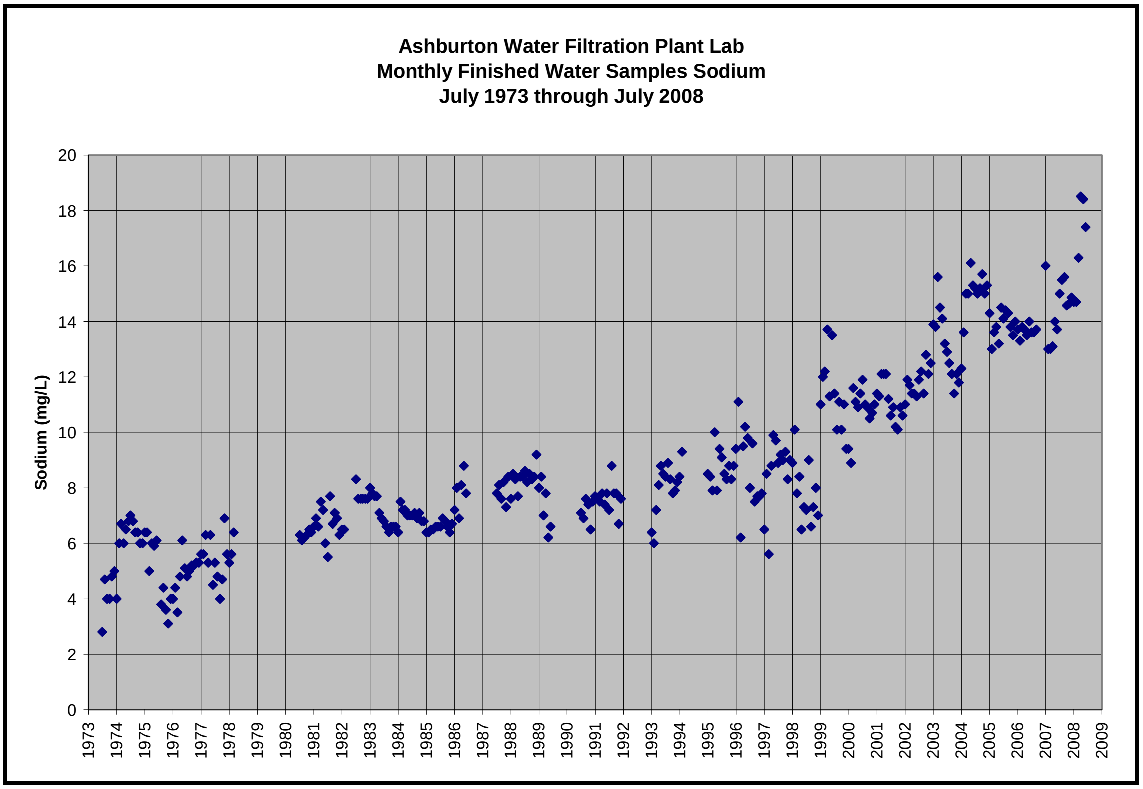

Figure 1-1

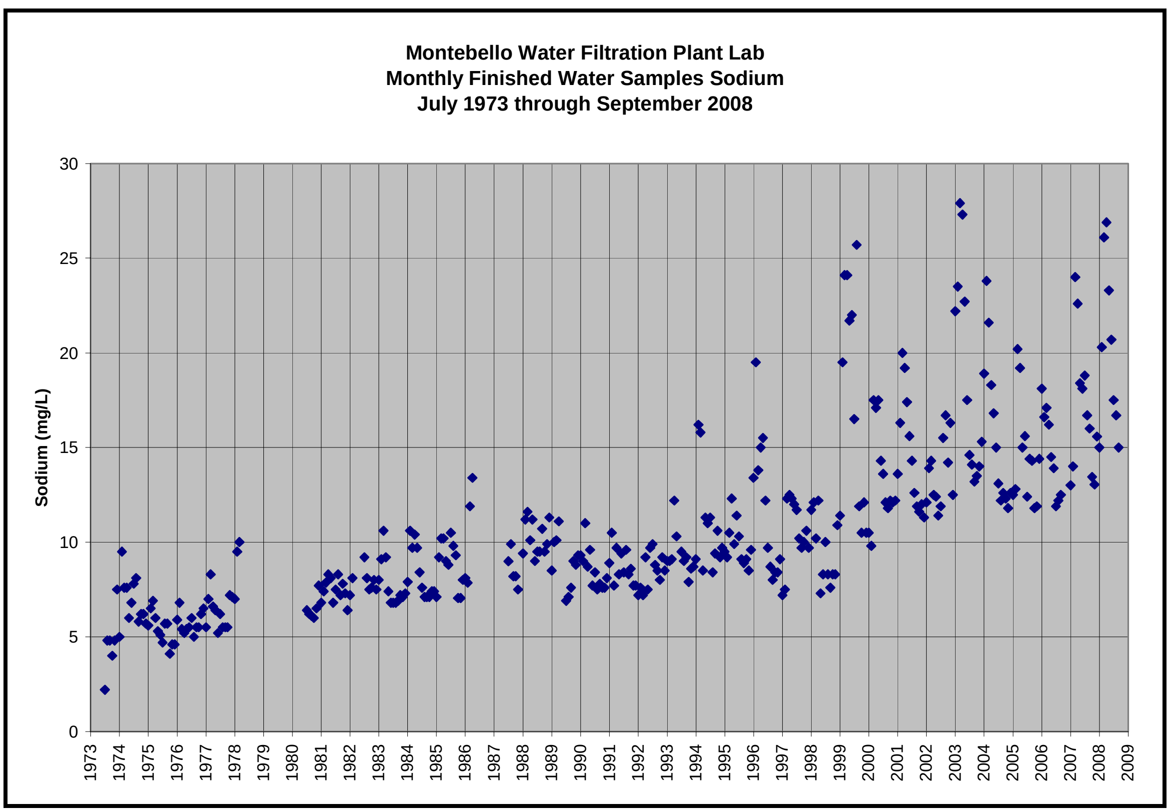

Figure 1-2

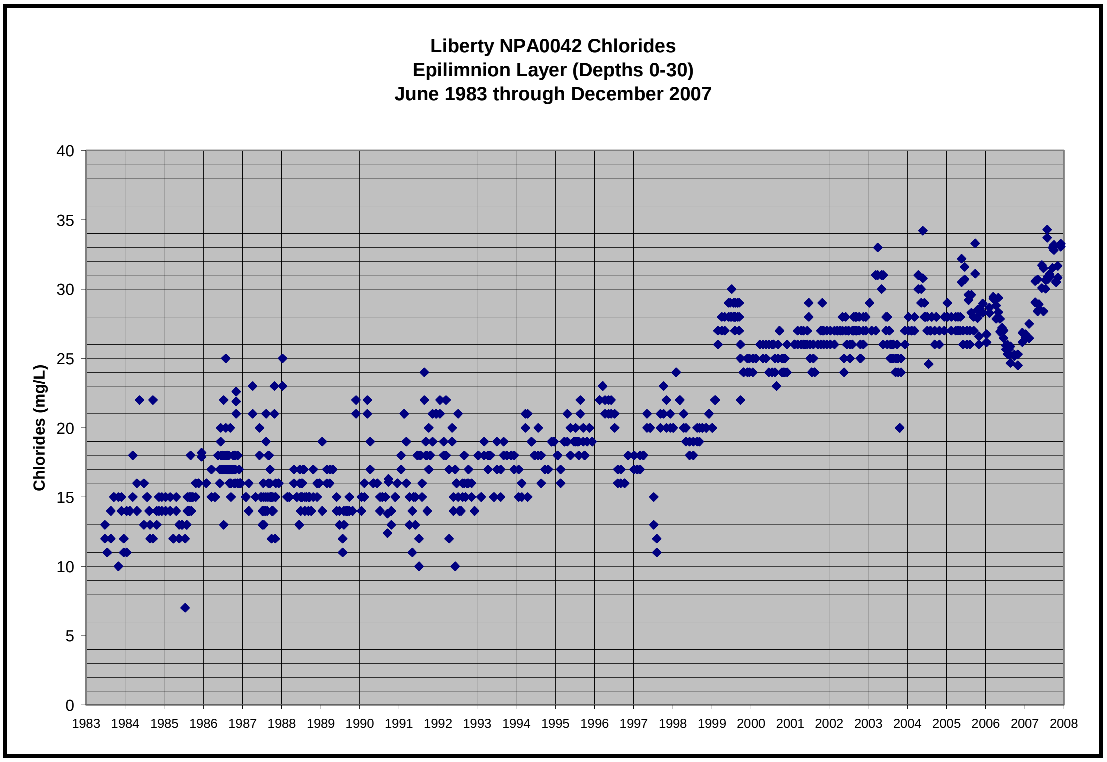
Liberty NPA0042 Chlorides
Epilimnion Layer (Depths 0-30)
June 1983 through December 2007
Chlorides (mg/L)
0
5
10
15
20
25
30
35
40
1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

Figure 1-8

Appendix B. Salt Fact Sheet – Department of Public Works, Baltimore County, Maryland

Baltimore County Salt Usage Compared to Roads Maintained in Baltimore County by SHA:

Fiscal Year	Number Of Storms	Salt Used BC	Salt Used By State In BC	Ln Miles Serviced By BC	Ln Miles Serviced By State	Tot Tons *I* Lane MI BC	Tot Tons *I* Lane Ml State	% County To State
04	8	73,380	47,420	6,640	1,561	11.1	30.4	36%
05	10	72,232	40,804	6,640	1,561	10.9	26.1	42%
06	4	33,947	22,878	6,640	1,561	5.1	14.7	35%
07	7	62,858	37,697	6,640	*1,561*	9.5	24.1	39%
08	7	47,806	30,901	6,640	1,561	7.2	19.8	36%
09	5	43,632		6,640	1,561	6.6		
	41	**333,855**	**179,700**			**50.3**	**115.1**	

Baltimore County adheres to the industry standard of 500 lbs per lane mile; however, refreezing often occurs requiring multiple applications for a single event. Baltimore County average salt per lane mile per storm: 1.2 tons

State average salt per lane mile per storm: 3.2 tons

Salting Procedure: **There are no protocols, regulations or guidelines.** De-icing is a very uncomplicated process. When a storm is in the forecast we mobilize our workforce. County crews that include the Bureau of Highways, Bureau of Utilities, Bureau of Solid Waste, DEPRM, School Board, Recreation and Parks and, depending on the severity of the prediction, contractors. Once snow or ice starts to accumulate on the road surface the salting of the highway system begins.

Highways, other county agencies and contractual equipment used to carry salt include 1 ton trucks, 8 ton trucks, 10 ton roll off vehicles and 20 ton trucks. Routes are assigned to each vehicle based on their salt carrying capacity and road type (two lane, four lane, courts, cul-de-sacs, etc).

Salt Alternatives: We have reviewed published articles and technical studies from various institutions, none of which were performed by or on behalf of Baltimore County regarding the environmental and social impact of de-icing salts. We believe that salt remains the fastest, most effective and most economical method of coping with ice and snow. There are no reliable or cost effective substitutes. We have an obligation to treat the roads in the winter and public safety is paramount to this operation.

Alternative abrasives such as sand have negative impacts on the environment as well. They can clog storm drains and sewers. Clean up is necessary in urban areas, on bridge decks and ditches. The material washes downstream and ends up in streams and lakes. Abrasives must also be treated with salt, at least 100 lbs of salt per cubic yard of sand to keep them frozen and useable. Therefore, the impact of salt, although less, still exists. While we do closely monitor industry trends and new developments, salt remains the most effective, economical and environmentally friendly deicing agent available.

Appendix C. National Pollution Discharge Elimination System (NPDES) – Baltimore County 2009 Annual Report - excerpts

County Property Management and Road Maintenance Activities, Sections 3.0 (E5 and E6), 3.1, and 3.6

Section 3 County Property Management and Road Maintenance Activities

3.0 Permit Requirements

E.5. <u>County Property Management</u>

Baltimore County shall identify all County–owned facilities requiring NPDES stormwater general permit coverage and submit Notices of Intent (NOI) to MDE for each. The status of pollution prevention plan development and implementation shall be submitted annually.

E.6. <u>Road Maintenance</u>

A plan to reduce pollutants associated with road maintenance activities shall be developed and implemented. At a minimum, an annual progress report shall be submitted that documents the following activities:

a. Street sweeping;

b. Inlet cleaning;

c. Reducing the use of pesticides, herbicides, fertilizers, and other pollutants associated with roadside vegetative management practices through the use of integrated pest management (IPM); and

d. Controlling the overuse of winter weather deicing materials through continual testing and improvement of materials, equipment calibration, employee training, and effective decision-making.

3.1 Introduction

Baltimore County has established several programs to control the amount of pollution that reaches the stream systems and landfills: a Storm Drain Cleaning Program, a Street Sweeping Program, and a Hazardous Waste Collection Program. Baltimore County DEPRM has also identified those county owned sites that require a NPDES stormwater general permit and is assisting them in preparing Pollution Prevention Plans. These include good house keeping and best management practices to prevent contaminants from leaving the site during rainstorms or a spill.

Both the Storm Drain Cleaning Program and the Street Sweeping Program are the responsibility of the Baltimore County Department of Public Works (DPW). Within the Department of Public Works, the Bureau of Utilities handles the Storm Drain Cleaning program. The Storm Drain Cleaning Program was originally created to remove the sediment from the storm drain systems in the watersheds of dredged tidal creeks, thereby increasing the longevity of the original dredging. The Program has since been expanded to clean the County's entire storm drain system, including the drain inlets, connecting pipes and outfalls. Debris, sediment, and pollutants can also be taken off the streets before they enter the storm drain system. This is accomplished with the Street Sweeping Program that is managed by the Bureau of Highways.

The Hazardous Waste Collection Program is the responsibility of the Baltimore County DEPRM Environmental Health Section. Citizens can come and drop off unwanted household chemicals, paints, pesticides, medicines, mercury thermometers, fluorescent bulbs, rechargeable batteries, computers and home electronics, ammunition and automotive fluids for recycling or proper disposal. These items are accepted at the Eastern Landfill from April until November. There are also two collection events in the fall and spring at additional locations.

3.6 Fertilizer, Pesticide, and Deicing Statistics

Members of the Baltimore County NPDES Management Committee have submitted statistics for usage of fertilizers, pesticides and deicing materials. Quantities of fertilizers and pesticides are reported in pounds, tons, gallons, and ounces. All results have been converted to pounds for this report. Fluid measure is assumed to have a density of 7.0 pounds per gallon. The statistics for 2008 by individual agencies are presented in Table 3-9. The amounts used by the entire County are presented in Table 3-10.

Among the County agencies that fertilize and use pesticides, golf courses are consistently the biggest users of these materials. Deicing materials are also used throughout County agencies. Logically, because of its responsibility to clear roads, the DPW– Bureau of Highways remains the biggest user of deicing materials. In 2008, the Bureau of Highways accounted for 99.6% of the deicer material used.

Table 3-9: 2008 County Agency Fertilizer, Pesticide and Deicing Materials Use (in Pounds) N/A stands for not available.

Agency	Fertilizer	Pesticide	Deicing
Golf Courses:			
Diamond Ridge	26,857	6,185	0
Greystone	4,082	69	50
Gunpowder Falls	11,650	3,379	0
Rocky Point	26,500	13,124	0
Longview	N/A	N/A	N/A
Woodlands	39,277	6,759	0
Golf Course Totals	**108,366**	**29,516**	**50**
Catonsville Comm. Coll.	N/A	N/A	N/A
Essex Comm. Coll.	N/A	N/A	N/A
Dundalk Comm. Coll.	N/A	N/A	N/A
County Public Schools	1,350	0	132,320
Bureau of Utilities	19	0	7,500
Bureau of Highways	0	2,100	65,200,000
Recreation and Parks	3,700	442.7	116,600
Non-Golf Course Totals	**5,069**	**2,542.7**	**65,456,420**
Totals Pounds =	**113,435**	**32,058.7**	**65,456,470**

Table 3-10 shows the annual usage of fertilizer, pesticides and deicing material from 1999 through 2008. The 58 inches of snow in the calendar year 2003 resulted in the highest salt usage recorded. The amount of deicing materials used depends not only on snowfall but also the number of events. Figure 3-8 shows the data Fertilizer and Pesticide Trends and Figure 3-9 shows the data for Deicing Material and Snowfall.

Table 3-10: Annual Fertilizer, Pesticide and Deicing Materials Used By County Agencies (in Pounds)

Calendar Year	Fertilizer	Pesticide	Deicing Mat.	Snowfall (in.)	Number of Winter Weather Events
1999	275,400	34,320	83,978,000	12.4	8
2000	213,114	21,028	94,467,750	27.2	7
2001	221,609	21,509	48,566,400	7.4	5
2002	200,060	21,229	100,437,859	12.0	7
2003	191,726	22,137	205,164,341	58.0	8
2004	227,309	34,762	147,537,040	8.7	5
2005	133,881	20,899	185,118,740	24.5	7
2006	166,870	29,607	23,888,950	13.1	1
2007	131,191	26,362	156,690,026	14.4	11
2008	113,435	32,059	65,456,420	4.3	15
Totals	**1,874,595**	**263,912**	**1,111,305,526**		

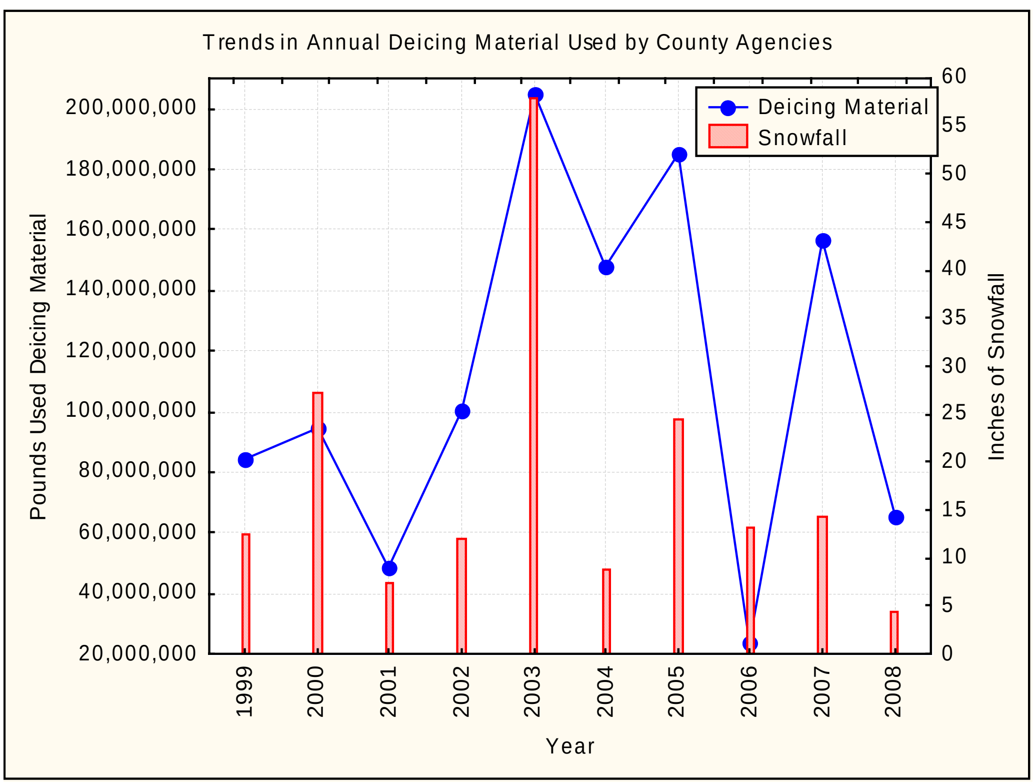

Figure 3-9: Trends in Annual Deicing Material Used by County Agencies

Appendix D. Road Salt Practices in Other Jurisdictions

This Appendix summarizes information on practices in other relevant jurisdictions.

State of Maryland
In 2007-2008 MD DOT (Maryland State Department of Transportation) applied on State roads: salt, salt treated with magnesium chloride and an agricultural by-product, calcium chloride, potassium acetate (at two bridges), and sand. (http://www.mdot.state.md.us/News/2007/November%202007/snow%20show%20fact%20sheet.doc)

Frederick County, Maryland
(from 2008 NPDES - National Pollutant Discharge Elimination System - report to Maryland Department of the Environment)
For deicing the County uses Caliber M1000, which is a 30% Magnesium Chloride solution with an agricultural by-product, in 41 of the County's trucks when the temperature is <= 20ºF. The trucks are equipped with 90-gallon tanks that apply the solution onto the salt/cinder mixture as it is spread onto the road. Overall, the County has 51 full-sized ten-ton dump trucks and nine smaller one-ton dump trucks for deicing. The additive makes the salt/cinder mix more effective and prevents corrosion. The County has not yet determined if the additive is cost-effective at temperatures above 20ºF. The State uses 100% Magnesium Chloride at all temperatures; however, it is very corrosive. according to product literature for Caliber M1000. (http://www.anti-icers.com/caliber_m1000.htm)

"As a pre-wetting agent for salt and sand, Caliber M1000 reduces bounce and scatter, increases the speed at which the salt begins working, increases the melting capacity of the salt, and permits the use of salt at lower temperatures. Additionally, Caliber M1000 also reduces corrosion, inhibits crystal formation and product fallout at lower temperatures, and improves roadway traction when compared to other liquid products."

Fredrick County reported that "a total of 15,902.9 gallons of liquid deicer (Caliber M1000), 13,558 tons salt, and 3,999 tons cinders were used in 2008 for all Frederick County watersheds. Starting in December 2008, one of the objectives of Highway Operations is to use more liquid deicer in an attempt to use less salt. They are also pre-treating the roads, whenever appropriate, to apply material under the snow/sleet/ice layer so that frozen precipitation cannot bond to the road, which should result in a significant reduction in materials used."
www.watershed-alliance.com/publications/Annual%20Reports/AnnualReport2008/2008%20ANNUAL%20REPORT.pdf

Montgomery County, Maryland
(from 2005 NPDES National Pollutant Discharge Elimination System permit report to Maryland Department of the Environment)
During the winter season for 2005, the DPWT-DHS applied 24,450 tons of sand and salt. The total removed by the once per year street sweeping program was 1,676 tons which is less than 7% of the total applied.
www.montgomerycountymd.gov/content/dep/NPDES/rpt05_all.pdf

St. Mary's County, Maryland
(from Snow Removal and Ice Control, Department of Public Works and Transportation, County Highways Division)

Facts

- The County contains 1,500 roads with almost 1250 total lane miles
- There are 27 different snow removal routes:
- Priority 1 Salt Routes total 231 centerline miles
- Priority 2&3 Routes total 354 centerline miles
- Average Priority 1 Route is 106 lane miles and takes 4-5 hours to treat and 8-10 hours if plowing is required
- Approximately 50 DPW&T employees are involved in snow removal
- 20 contractors assist in clearing roadways as needed
- 10-12 County vehicles are typically mobilized
- A typical "minor" snow event consumes about 100-150 tons of salt/calcium and 100-300 tons of sand
- Average "major" snow event consumes about 250-400 tons of salt/calcium and up to 1200 tons of sand
- The County budgets approximately $76,000 in materials each year
- The County is divided into 4 Service Areas; North, West , Central and South

Materials used

- Rock salt @ $78 per ton.
- Sand @ $15per ton - which can be mixed at a ratio of 1 bag calcium w/1 ton of sand.
- Calcium chloride @ $9.40per bag or $399 per ton

Training and preparation

- Annual snow advisory coordination meeting
- Operational Plan and Emergency Call-out list updated every year
- 100% annual equipment inspection and calibration
- Mandatory contractors meeting refresher training for all drivers/operators

Annual Snow Meeting

A series of coordination meetings are typically held in early November between the Department of Public Works, Emergency Management Agency, Recreation & Parks, the Office of Central Services. Public Safety Facilities such as the Volunteer Fire Departments, Rescue Squads and Advanced Life Support indicate the desired level of service for their respective operational areas. In addition, the Department also meets with the selected snow removal contractors. The purpose of these meetings is to ensure that the necessary personnel, capital equipment, maintenance inventory, communication and supplies/materials are available to provide adequate levels of service for the upcoming season.

Priorities
Priority 1 Routes are Primary Streets: arterials, major collectors, urban commercial roadways and locations where there are steep hills, bridges, severe horizontal curves and/or dangerous intersections. Snow accumulations of two inches or more typically require plowing prior to the application of salt. **Priority 2** Routes include Secondary Streets such as our minor collector roadways. **Priority 3** Routes: local subdivision roads, courts and dead end streets; are addressed once the first two priorities have been satisfactorily completed. Generally, Priority 3 roadways are not plowed or salted until conditions make it extremely difficult for prudent drivers using snow tires to travel safely.

Priority 1	Main roadways (arterials and major collectors), steep hills, sharp curves and bridges	Emergency Salt Routes, Volunteer Fire & Rescue, Hospital access is continuously treated during snowfall by County – operated equipment.
Priority 2	Secondary residential and commercial roadways (minor collectors)	May be plowed/treated by contractors simultaneously with Priority 1 Routes during major storms. Otherwise, by County equipment after minor storms.
Priority 3	Local subdivision roads, dead end streets and cul-de-sacs.	Plowed after snowfall and after Priority 1 and Priority 2 Routes have been cleared. May be plowed/treated by contractors starting simultaneously with Priority 2 roadways. If ice or only light snow occurs, and plowing is not required, County trucks will spread materials only.
Other	County building parking lots and sidewalks. Downtown Leonardtown.	Plowed/treated by available Parks and Recreation or Building Maintenance employees. Subdivision sidewalks are not treated by County Highway crews. Town has their own contractors.

Snow & Ice Spotters Program:
In conjunction with the Emergency Management Agency and County Sheriff's Department staff, the Highway Maintenance Foremen and County Inspectors observe the changing weather / roadway conditions in their specific service areas and report their findings to the Snow Operations Office Division. Road and weather conditions are continuously monitored by the drivers and foremen and reported to the Department of Public Works Snow Operations Office. In FY 1999, infrared Road-Watch Warning Systems were purchased and installed in foremen vehicles to measure the surface temperatures of asphalt and concrete. Early detection of unexpected icy road conditions can alter roadway treatment(s) in certain areas and help prevent accidents, property damage and lives. Both the road and outside air temperature are displayed on a dash mounted LED gauge. A warning light and a beeper sounds when the road surface temperature drops below 35F.

The Ice-Alert System
Look for this roadside reflector system in calendar year 2010. This pilot system is being tested to alert motorists and road maintenance crews about near freezing air temperatures--the first sign of freezing roads to come. Reflectors change color from white to blue at air temperatures below 36 degrees, and the "blue star" becomes more intense as the temperatures drop. We plan to test the system at the Pegg Road bridge crossing over Jarboesville Run"
(http://www.co.saint-marys.md.us/dpw/dpwtemplate.asp?content=snowandiceremovalcontent.asp)

Bristol, Connecticut

The City of Bristol Public Works Department is expanding their de-icing program throughout the city using a product called Ice B Gone 2 on city streets during the 2008-2009 winter season. This product with a **magnesium chloride wetting agent is applied as a pre-treatment before a winter storm, as weather permits, and is intended to prevent ice from adhering to roadway surfaces.** This de-icing and road treatment was used as a trial in the area around Redstone Hill Road with very positive results during the 2007-08 and 2008-09 winter seasons. In addition to being more effective than traditional sand/salt treatment, the de-icing treatment uses less material saving money in our winter operations budget.

Ice B Gone 2 is a treated rock salt material that is environmentally friendly, less corrosive and is distributed more efficiently than traditional rock salt. Ice B Gone 2 lasts longer and melts faster at lower temperatures than regular salt. Ice B Gone 2 also prevents refreeze commonly associated with regular rock salt. The treatment of the salt results in less bounce and scatter when applied to the roadway. Residents may not be able to detect a visible material on the roads, but treated roads will have better traction and minimal icing once snow/ice begins to cover the road. This product will also be applied during and after precipitation as needed. A salt/sand mixture and liquid magnesium chloride may also be applied as needed.

(The following information is from *Salt: No Easy Answers*. D. Talend. Stormwater 2009.)

Madison, Wisconsin

- **The use of Road Weather Information Systems (RWIS).** Weather stations installed adjacent to highways and airport runways, working in conjunction with infrared pavement and air-temperature sensors installed on maintenance vehicles, have provided forecasters with real-time weather conditions for computer modeling since the mid-1980s.
- **Anti-icing, or applying pre-wetted salt well in advance of a storm** to prevent a bond between snow and ice and pavement as a way to reduce the volume of salt required. A demonstration of anti-icing via the use of salt brine is being considered under the ordinance. Estimated cost: $5,000 to $10,000.
- **Limiting the amount of salt in abrasives.** Materials such as sand have been used to provide temporary traction. Typically, road salt is mixed with sand at 5% or 10% by volume to prevent the sand from freezing. The subcommittee pointed out that studies have shown that this amount of road salt does not provide snow-melting capacity, however, and small amounts of salt should be mixed with sand only to prevent the sand from freezing in stockpiles or spreader trucks. The subcommittee recommended striving to reduce the salt content of sand from 10% to 5%, continuing to work toward ways of more consistently mixing the sand/salt mixture, and continuing to test sand for salt content. Estimated savings: $500 per 100 tons of sand.
- **Providing more training for city-employee and private-company snowplow drivers.** Estimated cost: $500 per session, $3,000 for a training consultant. As of spring 2009, the city offered private-applicator training twice, and roughly 30 individuals showed up for each session.
- **Proactively working with other county municipalities** to systematically reduce the amount of salt used each year
- **Considering on-board air- and pavement-temperature sensors installed in city supervisors' vehicles.** Estimated cost: $400 to $800 per vehicle
- **Developing ordinances for regulating private commercial salt application, operating equipment, and annual compliance reporting requirements**
- **Measuring sodium and chloride levels** in stormwater runoff, lakes, and groundwater and determining future levels of chlorides in city lakes and streams; considering working with the United States Geological Survey (USGS), to project the impact on the environment via computer modeling
- **Considering development of an alert program** for informing the public about expected winter driving conditions
- **Mandating that the city of Madison annually update the Commission on the Environment (COE)** regarding the implementation of salt-reduction recommendations and programs

- Requesting that the Dane County Lakes and Watersheds Commission survey other area governmental agencies, municipalities, and private salt applicators to **determine their road salt policies**; establish benchmarks for chloride content in lake water; and recommend policies to all governmental agencies, municipalities, and private salt applicators to achieve benchmarks by a commission-established date.

Shingle Creek watershed, Minnesota

Best Available Technology (BAT) practices

- **Salt storage and handling.** According to the appendix, the BAT is covering both the storage and loading areas, diverting surface water runoff away from loading and storage piles, and containing any runoff that does come in contact with the salt pile. The appendix notes that the majority of Mn/DOT salt storage facilities in the metro area have covered storage piles and loading areas.
- **Operator training.** Mn/DOT (Minnesota Department of Transportation) supervisors commonly provide salt truck drivers with recommended application rates based on an RWIS and other sources. Operators have the authority to alter these conditions in the field based on training, which consists of sessions for new operators and an annual refresher course using the Salt Solutions Program, a nationally recognized program created by Mn/DOT in 1998. The training covers pre-wetting, anti-icing, deicing, and sensible salt and sand usage and also includes computer-based training on the RWIS.
- **Product application–equipment.** The spreader that distributes the anti-icing or deicing product should be calibrated to significantly reduce the amount of misapplied product. Installing speed sensors or ground-oriented controls results in further reductions in the amount of misapplied product. All Mn/DOT trucks in the Minneapolis metro area are currently equipped with ground-oriented controls, which automatically regulate application rates as truck speeds fluctuate. Trucks purchased after 2004 are fitted with controllers that also record the amount of material applied, and 15% of those trucks are also outfitted with pre-wetting equipment, which can reduce salt waste by 20% to 30% and may provide faster melting action by activating the dry chemical with moisture.
- **Product application–decision.** Mn/DOT has a network of 90 sensors embedded in roadways around the state, and eight RWIS sites are located in the Minneapolis metro area.
- **Information collected by Minnesota’s RWIS is available to other organizations via Mn/DOT’s Web site.** The sensors can be used to identify weather approaching the metro area and help determine optimal application rates of salt and deicing and anti-icing products. An anti-icing agent such as a magnesium chloride solution or a sodium chloride solution is used to keep the bond between ice and the pavement from forming and is applied to areas that tend to freeze first, such as bridge decks and curves.

- **Ongoing research**. Limited road tests can help determine how new products or techniques can replace or reduce the amount of chloride used to keep roadways free of ice and snow. Mn/DOT conducts its own lab tests on deicing products—e.g., a salt brine-corn byproduct and magnesium acetate—prior to road testing.

Porcupine Brook Watershed, Salem and Windham, New Hampshire

In 2006, the New Hampshire Department of Transportation (NHDOT) and the Department of Environmental Services (DES) established an interagency Salt Reduction Workgroup for the purpose of advising DES and NHDOT on Total Maximum Daily Load (TMDL) studies in the I-93 corridor until the studies are completed, and then to advise and assist with the implementation of required salt-load reductions. The workgroup determined that: ninety-six percent of the salt imports to the watershed were for deicing activities, so nearly all of the salt import reductions will need to come from reduced deicing loads. The allocation for salt pile runoff will be zero, because all salt and salt-sand piles should be covered. The existing loads from water softeners, food waste, and atmospheric deposition will be used as the allocation for these sources.

Ontario, Canada

- **Storage of salts and abrasives** to reduce losses through weathering, reduce losses during transfers, and minimize releases of stormwater and equipment washwater
- Reduction of the overall use of chloride salts in areas of high salt use and high road density via the use of **alternative products or of appropriate practices** of technology
- Release of salty snowmelt waters into surface waters with minimal environmental sensitivity or into storm sewers, or dilution before release
- Reductions in the addition rate of ferrocyanide to road salt

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