Calcium Magnesium Acetate: A Green Deicer

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Abstract

Road salt deicing started in the United States during the 1940s and is still commonly used today (Glancy & Hinkle, 1986, p.1). The consequences of using road salt on infrastructure and the environment were discovered in the 1970s, and in 1976 the Environmental Protection Agency completed its first assessments on road salt. The results lead the Federal Highway Administration to seek an alternative to road salt (Glancy & Hinkle, 1986, p.1).

This project shares the results of various studies that support calcium magnesium acetate as a noteworthy alternative to road salt. Several alternative deicers are analyzed. Based on several variables, calcium magnesium acetate is an environmentally friendly alternative. An implementation plan was devised for calcium magnesium acetate given the results of several studies.

Background

(Brown, 2011)

Rock salt is an economical solution to deice roadways; however its use damages infrastructure and the environment. Three possible solutions were considered: utilizing brine mixtures, creating filtration systems, or using alternative deicers.

Brine solutions for anti-icing and pre-wetting help road salt stick to the road and reduce the amount used. Machinery costs, inconsistency in effectiveness, and continued use of chloride are substantial reasons the brine solutions were ruled out.

Creating a sand filter for storm drains is beneficial for a decrease in road salt use and an increase in use of reusable sand. Problems with this method are an increase in road damage, a steady decrease in sand effectiveness, and a continued use of chloride.

Alternative deicers eliminate the issue of chloride contamination entirely. While contamination rates decreased, a significant cost increase eliminated products such as MAGic and Real Lite Plus. Calcium magnesium acetate (CMA) is biodegradable and does not contaminate the environment. With few problems, CMA was chosen as the most promising, sustainable solution.

Project Goals/Objectives

- **Decreasing or eliminating chloride contamination as a result of deicing**
- **Reducing overall environmental effects**
- **Reducing long term costs given a payback period after implementation**
- **Maintaining equal or greater deicing effectiveness for public safety**

Methods/Process

The United States Government conducted many studies in the late 1980s and 1990s in search of a new deicer that was environmentally and economically friendly. The large quantity of these studies by the United States Environmental Protection Agency, the United States Geological Survey and various local Departments of Transportation, ensured the data collected was accurate and thorough. These studies are public record, so the wealth of information gave no reason to design a prototype or collect more data.

After examining results of previous tests with calcium magnesium acetate (CMA), a new implementation method was created. The product will be used to deice public transportation routes. Before full implementation, CMA will be tested, as a final test run, in an urban city in the Northeast. Over the course of one winter, data and feedback will be collected. Given success, the implementation of CMA will be proposed to the city's local government in the Northeast. If the proposal is accepted, the large-scale implementation will be gradual, as areas are prone to different weather and public safety is a main concern. Road salt will still be stored as a backup if there is an extreme emergency in which it is needed.

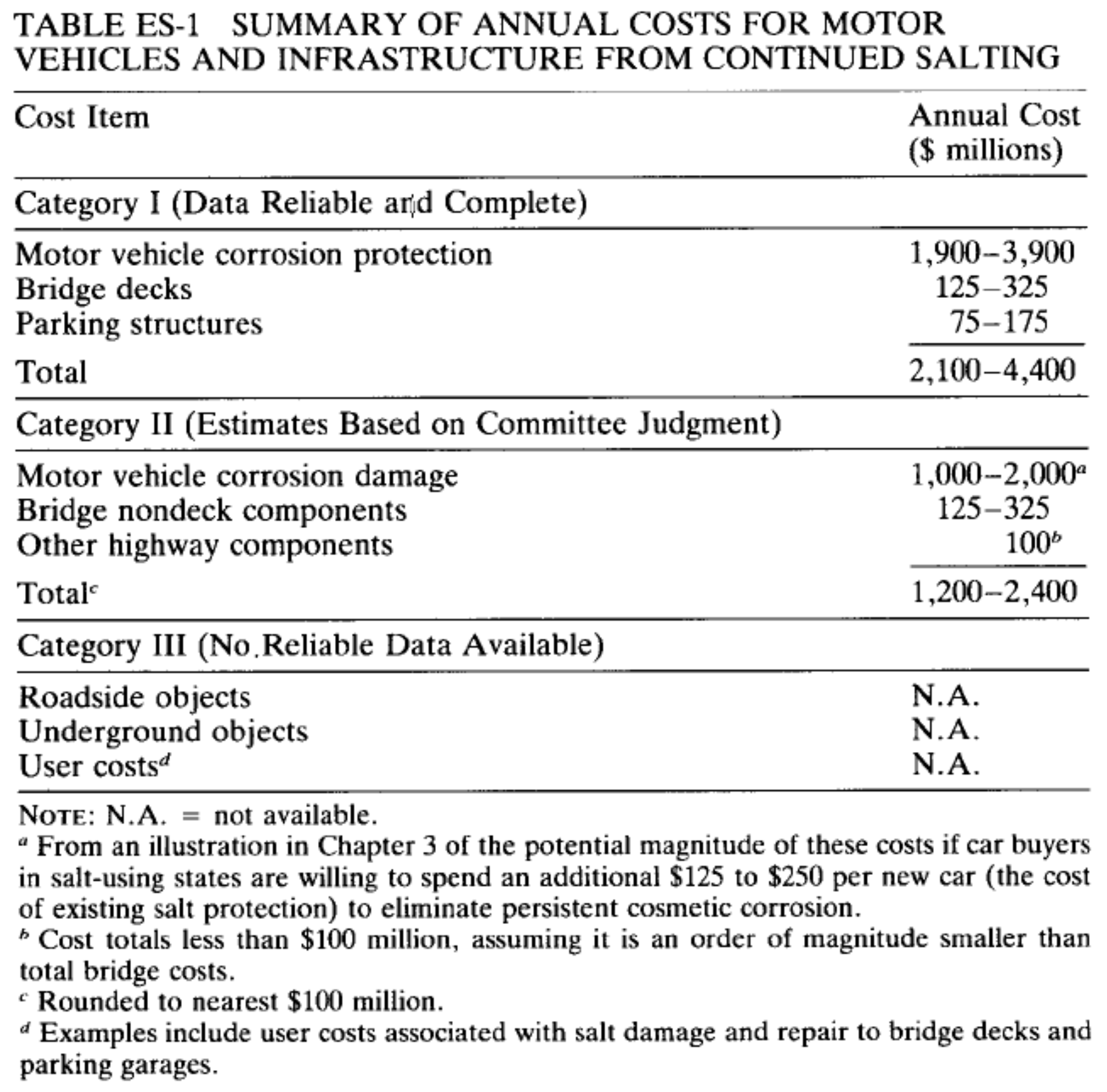

TABLE ES-1 SUMMARY OF ANNUAL COSTS FOR MOTOR VEHICLES AND INFRASTRUCTURE FROM CONTINUED SALTING

Cost Item	Annual Cost ($ millions)
Category I (Data Reliable and Complete)	
Motor vehicle corrosion protection	1,900–3,900
Bridge decks	125–325
Parking structures	75–175
Total	2,100–4,400
Category II (Estimates Based on Committee Judgment)	
Motor vehicle corrosion damage	1,000–2,000[a]
Bridge nondeck components	125–325
Other highway components	100[b]
Total[c]	1,200–2,400
Category III (No Reliable Data Available)	
Roadside objects	N.A.
Underground objects	N.A.
User costs[d]	N.A.

NOTE: N.A. = not available.

[a] From an illustration in Chapter 3 of the potential magnitude of these costs if car buyers in salt-using states are willing to spend an additional $125 to $250 per new car (the cost of existing salt protection) to eliminate persistent cosmetic corrosion.

[b] Cost totals less than $100 million, assuming it is an order of magnitude smaller than total bridge costs.

[c] Rounded to nearest $100 million.

[d] Examples include user costs associated with salt damage and repair to bridge decks and parking garages.

This is a projected repair cost breakdown for continued use of road salt over the course of 10 years. (Transportation Research Board,1991)

Results/Outcomes

Road Salt

+
- Cost effective
- Safe roads
- Commonly used
- Easily accessible

−
- Environmental damage
- Groundwater contamination
- Chloride damages infrastructure

Calcium Magnesium Acetate

+
- Biodegradable
- No chloride
- Safe residue increases effectiveness
- Not corrosive/ damaging to infrastructure

−
- Initial cost
- Less effective in colder temperatures
- Less effective in wet, heavy snow unless treated in advance

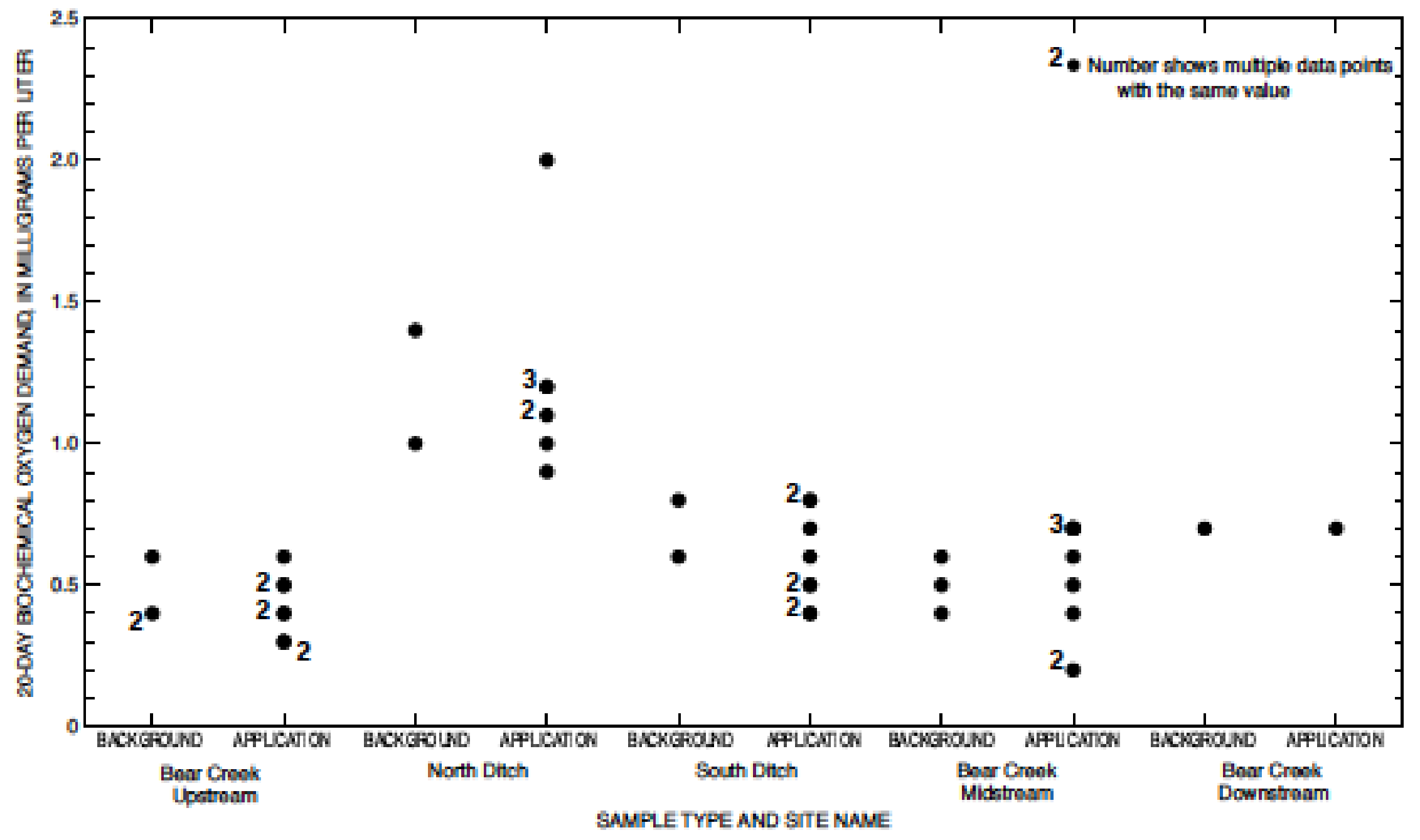

Figure 6. Values for 20-day biochemical oxygen demand of water samples from Bear Creek and its tributaries. (Background samples collected before and application samples collected after the application of calcium magnesium acetate.)

(Howard, K., & Haynes, J. (1993)

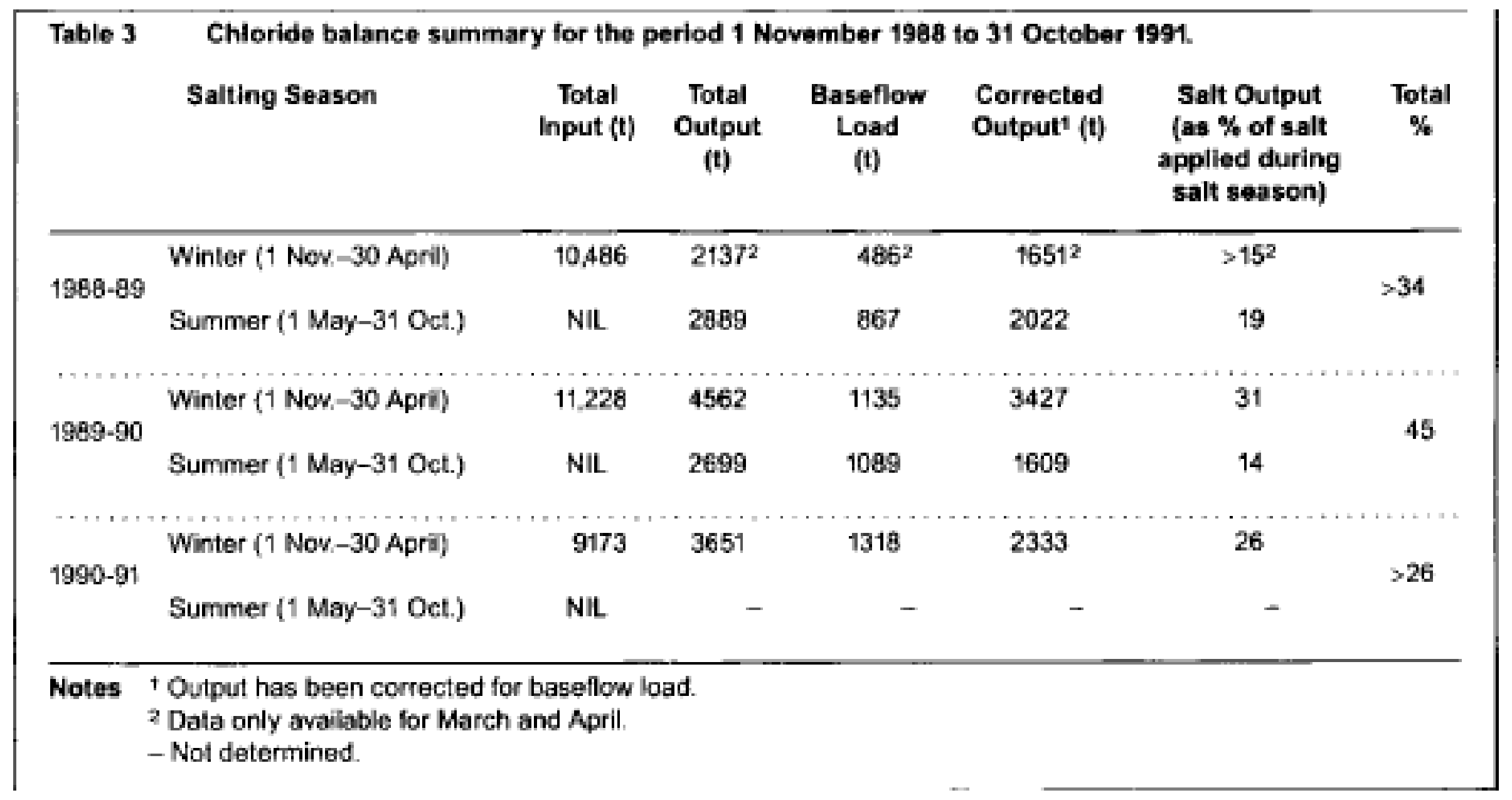

Table 3 Chloride balance summary for the period 1 November 1988 to 31 October 1991.

	Salting Season	Total Input (t)	Total Output (t)	Baseflow Load (t)	Corrected Output[1] (t)	Salt Output (as % of salt applied during salt season)	Total %
1988-89	Winter (1 Nov.–30 April)	10,486	2137[2]	486[2]	1651[2]	>15[2]	>34
	Summer (1 May–31 Oct.)	NIL	2889	867	2022	19	
1989-90	Winter (1 Nov.–30 April)	11,228	4562	1135	3427	31	45
	Summer (1 May–31 Oct.)	NIL	2699	1089	1609	14	
1990-91	Winter (1 Nov.–30 April)	9173	3651	1318	2333	26	>26
	Summer (1 May–31 Oct.)	NIL	–	–	–	–	

Notes [1] Output has been corrected for baseflow load.
[2] Data only available for March and April.
– Not determined.

The table illustrates how the amount of salt entering the Highland Creek Basin does not equal the salt leaving amount leaving the creek. (Howard, K., & Haynes, J. 1993)

Conclusions/Recommendations

- Chloride is the main, lasting contaminant in road salts which is corrosive and negatively impacts the environment.
    - Chloride creates sediments in bodies of water.
    - Chloride remains in soil for extended periods of time.
    - Chloride damages infrastructure.
- Of the three analyzed solutions, CMA is the most environmentally friendly and effective.
- CMA will be expensive initially.
    - If its components become more readily available, price will decrease.
    - Its residual effect decreases amount necessary to use.
- With an effectiveness similar to road salt, public safety is maintained.

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