UTC Project Information	
Project Title	MPC-499 – Reuse of Aqueous Waste Streams in Transportation-Related Applications
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Brief Description of Research Project	Aqueous waste streams can be produced from many commercial, industrial, and municipal processes or activities. Proper management, treatment and disposal or reuse of these waste streams are necessary to conserve natural resources and reduce their environmental impacts. In South Dakota, aqueous waste streams generating processes include municipal water and wastewater treatment, oil and gas production, ethanol production, food processing (cheese, meat and others), and other industrial processes (ion exchange, reverse osmosis, etc.). These aqueous waste streams can be recycled or reused to reduce the demand on natural water resources. Beneficial reuse of these waste streams will save the cost of waste treatment and disposal, reduce the

	consumption of natural resources, and minimize the environmental impacts. Aqueous waste streams have been used by transportation agencies as alternative anti-icing and deicing materials and dust suppressants on unpaved roads to reduce maintenance costs (USEPA, 2002; Michigan DEQ, 2002; Federal Highway Administration, 2013). This practice also reduces the costs associated with management, treatment and disposal of the waste materials. Most departments of transportation (DOTs) rely on chloride-based anti-icing and deicing compounds for treating roadways during winter weather events to ensure the safety of transportation. The most common chloride-based compound is sodium chloride (rock salt). Magnesium chloride and calcium chloride are also frequently used. The traditional method of pavement deicing is applying dry, granular rock salts and sands to the roadway during the storm event. In recent years, there has been growing interest in using salt brine as an anti-icing compound (Minnesota DOT, 2013). Pre-wetting using salt brines has been shown to increase the performance of salts and abrasives, as well as their longevity on the roadway surface, thereby reducing the amount of materials required (Levelton, 2007; Minnesota DOT, 2012). Oil-field brine is a saline byproduct that is generated during oil and gas drilling, completion, and production operations. This salt brine is permitted by Michigan, New York, North Dakota, Ohio, Pennsylvania, and other states for snow and ice control. Oil-field brine has been proven to be an effective pretreatment for winter storms (Ohio DNR, 2004). Other aqueous waste streams that have been used as anti-icing and deicing agents include corn wet-milling waste byproducts, cheese brewing waste, beer brewing waste, beet juice and others (Iowa DOT, 2010). In Polk County, Wisconsin, liquid cheese brine has been used to mix with rock salts and pre-wet the roadway surface since 2008, which results in approximately 30% reduction in salt usage. Aqueous waste streams can also be used to control dust on unpaved roads, construction sites and agricultural fields (Federal Highway Administration, 2013). Transportation agencies use dust suppressants to control erosion and reduce maintenance costs on unpaved roads. Materials used as dust suppressants include water, salts, asphalt emulsion, vegetable oils, molasses, synthetic polymers, mulches, and lignin products (USEPA, 2002). Many of the dust suppressants are formulated with waste products recycled from other industries. Approximately 75-80% of all dust suppressants used by transportation agencies are chloride salts and salt brine products (Travnik, 1991). These salt products stabilize the soil surface by absorbing moisture from the atmosphere. Oil-field brine has also been used as a cost effective dust suppressant and road stabilizer, and its efficiency for dust control has been well recognized (Pennsylvania DEP, 2015).

Lime sludge is another waste stream that can be potentially used for transportation-related applications. Lime sludge is produced by the lime softening treatment process where lime is added to the water to reduce the hardness. Disposal of lime sludge remains a major challenge to many municipalities in the Midwest. Lime sludge may be potentially used on gravel roads to reduce dust generation and used as an aggregate in cement production (Iowa DOT, 2004).

Overall, waste brine and other aqueous waste streams have been used by many state DOTs for transportation-related applications. The experiences of these state DOTs suggest that salt brine solutions can be effective ice control agents and dust suppressants. When application rate and volumes are properly controlled, waste brine can be spread on roadways with minimum environmental risks.

The Watertown Municipal Water Treatment Plant operates a magnetic ion exchange (MIEX) system to treat its source water. The MIEX system produces brine wastewater that requires proper treatment and disposal. The City currently discharges the waste stream into a lime sludge pit. The dewatered solids are eventually disposed of in the landfill. The City is evaluating other alternatives to landfilling to reduce the cost of disposal. The brine wastewater produced by the MIEX system is expected to have similar salinity as other salt brine solutions that have been used for ice and dust control. Therefore, the MIEX brine may be used by transportation agencies in South Dakota for winter road maintenance and dust control on unpaved roads. Beneficial reuse of the salt brine will reduce costs of disposing and treating waste materials and purchasing new materials, and lead to more sustainable operations at state and local highway departments and municipal utilities.

Beneficial reuse of waste streams in transportation applications requires a comprehensive evaluation of the benefits and risks, and this depends on several major factors including the effectiveness, safety, economics, environmental benefits and risks, and local, state, and federal regulations associated with transportation-related applications of the waste streams. Guidance should be developed to help state and local agencies determine how to evaluate waste streams for potential reuse in transportation applications and establish sound procedures to manage their reuse.

Research Objectives

In this study, we will investigate beneficial reuse of aqueous waste streams for transportation related applications in South Dakota. The objectives of this study are to:

1. Provide a comprehensive literature review to summarize the current state of knowledge of beneficial reuse of aqueous waste streams for transportation related applications.
2. Identify potential transportation-related applications for aqueous waste streams available in South Dakota.

	3. Develop guidance for evaluating the suitability of aqueous waste streams for transportation-related applications. 4. Demonstrate application of the guidance in a case study of the brine waste stream generated by the Watertown Municipal Water Treatment Plant.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The guidance developed for beneficial reuse of aqueous waste streams was adopted by state agencies to produce formal guidelines for regulating aqueous waste streams reuse in transportation related applications in South Dakota.
Impacts/Benefits of Implementation (actual, not anticipated)	The results of this research could help transform waste streams that are now environmentally and financially expensive to discard into valuable materials for transportation-related applications. This research developed guidance to describe best practices for evaluating and regulating the use of waste streams in transportation applications in South Dakota. This guidance can be used by state agencies to manage the reuse of waste streams for transportation applications in South Dakota. Beneficial reuse of the MIEX® brine and other waste streams for transportation applications will reduce the consumption of natural resources, and reduce the costs associated with waste management, treatment and disposal.
Web Links • Reports • Project Website	https://www.ugpti.org/resources/reports/details.php?id=923