During the winter season the state of Vermont becomes a playground drawing people from across the country to enjoy activities such as skiing, snowboarding and snowmobiling. Unfortunately, the very same snow and ice that creates a winter wonderland in the mountains also creates a winter gauntlet on Vermont’s roads. The agency tasked with keeping the roads safe and travelable is Vermont’s Agency of Transportation, or VTrans. Keeping Vermont’s roads safe is no easy task with thousands of miles of roads that all require some degree of mitigation to keep them safe for travel during winter storms. To aid in the fight against slippery roads, VTrans developed a partnership with the University of Vermont (UVM) Transportation Research Center to advance more efficient approaches to snow and ice control on Vermont roadways and to measure the overall success of keeping Vermont’s roads safe for travel.

Safe approach
Maintaining Vermont’s roads during the winter requires a highly strategic use of very limited resources. The state has to balance...
Comparison Chart of American Association of State Highway Transportation Officials (AASHTO) Standards for Base Material to Field Test Results of BASE ONE® Stabilized Base Material

<table>
<thead>
<tr>
<th>Property</th>
<th>Unstabilized Base (AASHTO)</th>
<th>Stabilized Aggregate Base (with BASE ONE®)</th>
<th>Stabilized RAP/Aggregate Base (with BASE ONE®)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilient Modulus (PSI)</td>
<td>10,000 - 30,000</td>
<td>60,000 - 120,000</td>
<td>122,000 - 147,000</td>
</tr>
<tr>
<td>Structural Layer Coefficient</td>
<td>.06 - .14</td>
<td>.18 - .24</td>
<td>.21 - .24</td>
</tr>
<tr>
<td>Effective Granular Equivalency</td>
<td>0.5 - 1</td>
<td>1.3 - 1.5</td>
<td>1.5 - 1.8</td>
</tr>
</tbody>
</table>

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needs material. Ultimately, the researchers found that the state has done an outstanding job in being as efficient as possible with their current routes despite the constraints of their material locations. VTrans has an expert team of snow-removal personnel who have years of experience in this process and they know what they are doing, but the UVM research team believed they could improve things a bit further.

The research assumed that the salt sheds and material storage locations were stuck at fixed locations, specifically at the existing VTrans district garages, where the trucks also are housed. This spurred the idea for a new research project that aimed to explore the possibility of finding new material storage locations or adding satellite storage locations strategically around the state. If trucks could access salt more easily it was believed that they could refill their salt more efficiently and spend less time and fuel driving empty or returning to their garages. The UVM team would once again work with VTrans to squeeze even more efficiency out of its current operations.

The research team’s approach was built on the concepts of traditional facility-location modeling that exists in the operations-research literature. The team also decided to utilize concepts from existing literature on emergency-response logistics modeling. The logistics research the team utilized examined questions relating to the location of emergency-support facilities and distribution centers, and the distribution and routing of emergency resources. Emergency-response logistics focuses on using extremely limited resources as timely as possible since lives may depend on those personnel and materials. The research team believed that if these approaches could work in the extreme environment of a disaster, then they would work for RSIC operations in Vermont. Ultimately the team was simply trying to find the most efficient method possible to access and transport materials.

Surprisingly, there is little research available specifically related to winter RSIC despite the fact that RSIC is a major concern for any state that has to deal with winter weather. The UVM team had to break new ground and draw on research that was only loosely connected to their project and ultimately provide VTrans with new options for their material storage. The research team not only had to come up with a new way of modeling for material locations, but also had to convince VTrans to possibly change their routes and build new satellite material storage locations.

The UVM research teams started the new research project by developing a process to site and rank storage facilities for salt. The method they created identifies an optimal location for each existing VTrans district, then evaluates and ranks their benefit to the network as a whole in terms of the total lane-miles of state-maintained roadway brought to within 20 minutes of a salt-loading location. In other words, the research team was able to find the most ideal locations for a satellite salt storage facility. Unfortunately you can’t simply build a storage facility anywhere you want so the team next had to try to find areas that the state could conceivably install new facilities.
An example of a possible location for a new satellite storage facility would be the Sharon rest area on I-89. The state owns this land and the facilities already, and it has the space available to build a new storage facility. In general the team found that other satellite salt facilities can best serve the state’s RSIC operations by being sited near or on interstate highways or within the right-of-way of the existing infrastructure. Locating these facilities near the interstate highways and other right-of-way locations allows trucks to quickly and easily access the materials from areas already owned by the state; thus, there is a cost savings aspect built in. The research team was able to identify several areas they considered to be the most effective to build new satellite facilities including some along the busiest roadways in the state. The research team determined the most critical aspect to siting new facilities will be the ability to utilize existing right-of-way around the interstates creatively and to explore partnerships with other landowners adjacent to the state highway right-of-way. For land not owned by the state, VTrans will have to work with landowners who may be willing to sell a small portion of cleared land for a facility. While not ideal, VTrans regularly works on privately owned land to build infrastructure and improve roads but this process can take a great deal of time to accomplish.

More to look at

The research team concluded that there is still much to be explored relating to RSIC operations and specifically on designing infrastructure with RSIC in mind. An example of such infrastructure could be an interchange designed to incorporate salt storage within the right-of-way for RSIC operations. Interstate exchanges offer easy access and are within the right-of-way making it far easier to build new facilities. Finding ways to utilize current infrastructure is especially important in urban and highly developed areas with limited options to build new facilities. The team also believes that there are more research opportunities to be found in the process of contracting with private landowners to utilize their land for the development of storage facilities. Unused or underused land parcels could benefit RSIC operations and be lucrative to private land owners willing to rent out the locations to state agencies.

Vermont’s winters provide the state with ample opportunities for recreation and tourism but will continue to challenge those responsible for keeping the roadways open and safe to travel. The partnership between the UVM Transportation Research Center and VTrans has allowed for cutting-edge exploration of RSIC operations throughout the state. The research also will benefit all the other states that battle the wintery elements and hopefully open up the opportunity to expand RSIC research and ultimately help save state budgets while keeping the roads safe. ReB

Borst is an outreach professional at the UVM Transportation Research Center, Burlington, Vt.

For more information about this topic, check out the Maintenance Channel at www.roadsbridges.com.