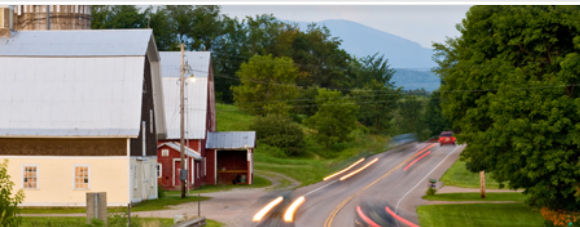


# Establishing Roadway Priority in Statewide Roadway Snow & Ice Control Routing



**Jim Sullivan, UVM Transportation Research Center**  
**Jonathan Dowds, UVM Transportation Research Center**  
**David Novak, UVM School of Business Administration**  
**Darren Scott, McMaster University School of Geography**

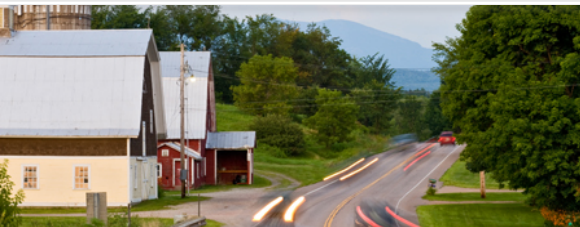


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# Establishing Roadway Priority in Statewide RSIC Routing

- Motivation for RSIC Research
- Research Objectives
- Methods
- Results
- Conclusions



# Motivation for RSIC Research

- Speed
- Efficiency

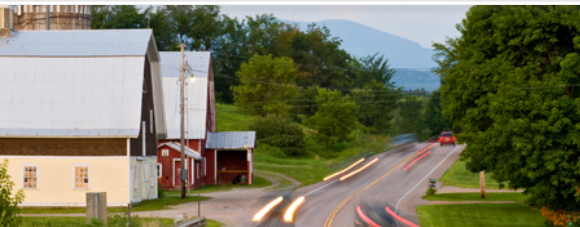
Motivation for  
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# Motivation for RSIC Research

- Speed
  - Speedy return to safe operating conditions
  - Inspires need for Levels of Service for RSIC:

LEVEL OF SERVICE	SUGGESTED MAXIMUM SPEED DURING STORM
 FULL WIDTH BARE PAVEMENT TRAVEL LANES ON THESE ROADS BEFORE ALL OTHERS AS SOON AS PRACTICAL FOLLOWING STORM	50 M.P.H. OR 10 M.P.H. BELOW POSTED SPEED LIMIT WHICHEVER IS LESS
 FULL WIDTH BARE PAVEMENT AS SOON AS PRACTICAL FOLLOWING STORM	45 M.P.H. OR 10 M.P.H. BELOW POSTED SPEED LIMIT WHICHEVER IS LESS
 FULL WIDTH BARE PAVEMENT AS SOON AS PRACTICAL NEXT WORKING DAY FOLLOWING STORM	40 M.P.H. OR 10 M.P.H. BELOW POSTED SPEED LIMIT WHICHEVER IS LESS
 1/3 BARE PAVEMENT AS SOON AS PRACTICAL NEXT WORKING DAY FOLLOWING STORM	35 M.P.H. OR 10 M.P.H. BELOW POSTED SPEED LIMIT WHICHEVER IS LESS
 ROAD CLOSED IN WINTER	

LOW SALT AND NO SALT ZONE ROADWAYS MAY BE SNOW COVERED AND ICY

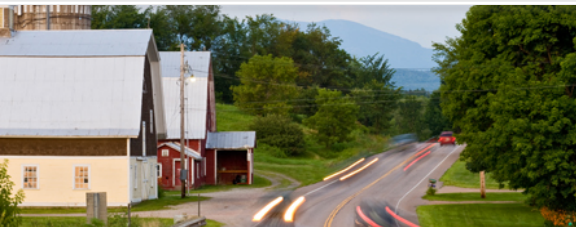
Motivation for RSIC Research

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# Motivation for RSIC Research

- Speed
  - Minimize disruption to normal daily traffic flow (economic benefit)

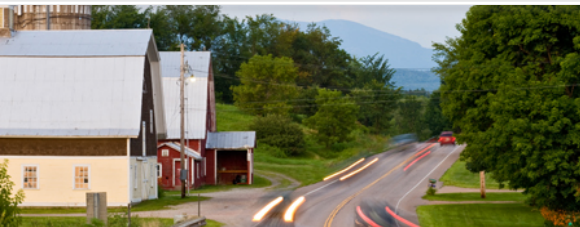
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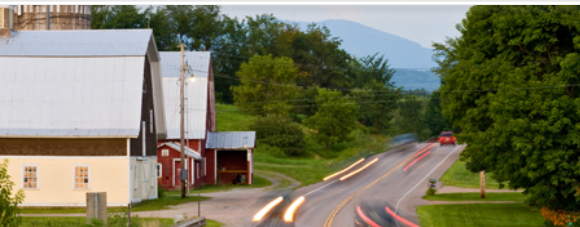
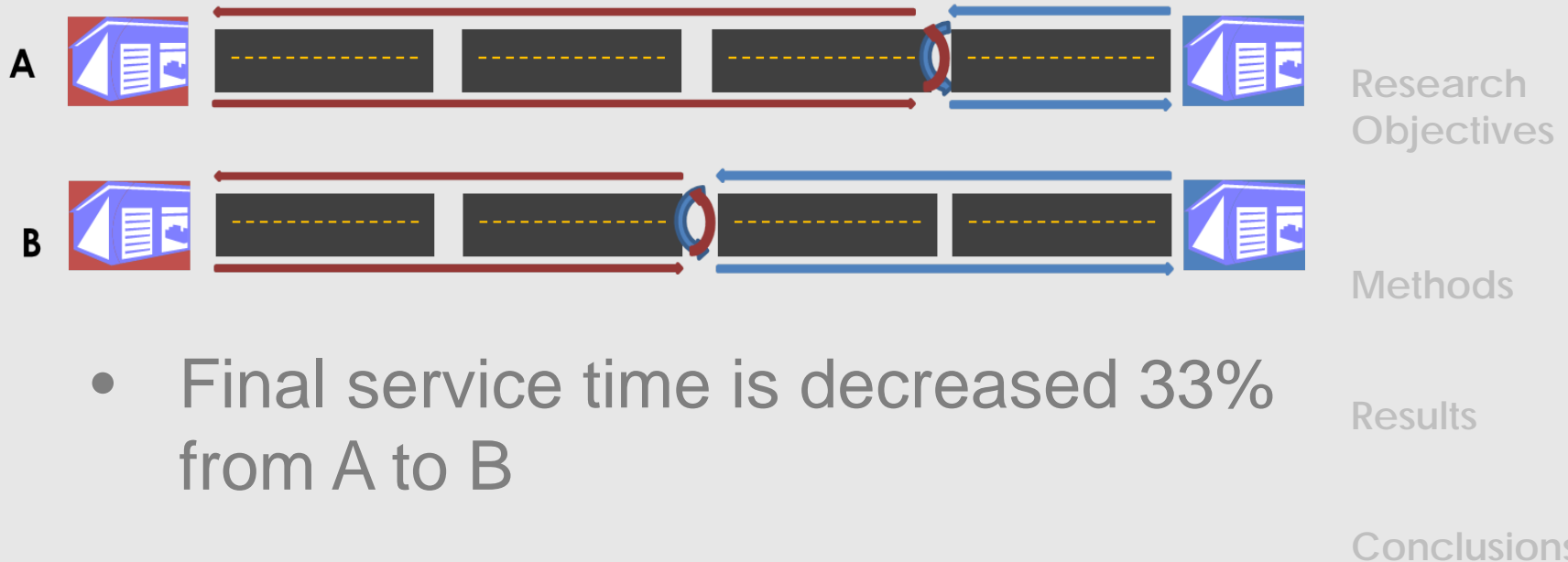
Conclusions



# Motivation for RSIC Research

- Speed
  - Ex: Service Territory Clustering

Motivation for  
RSIC Research





# Motivation for RSIC Research

- Efficiency
  - Minimize fuel use
  - Minimize material use
  - Minimize labor and vehicle hours

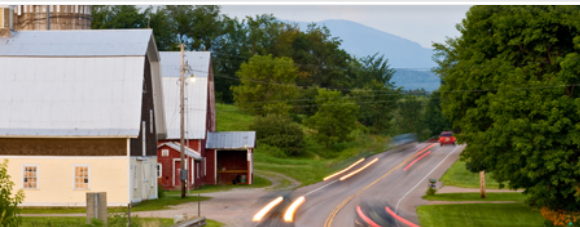
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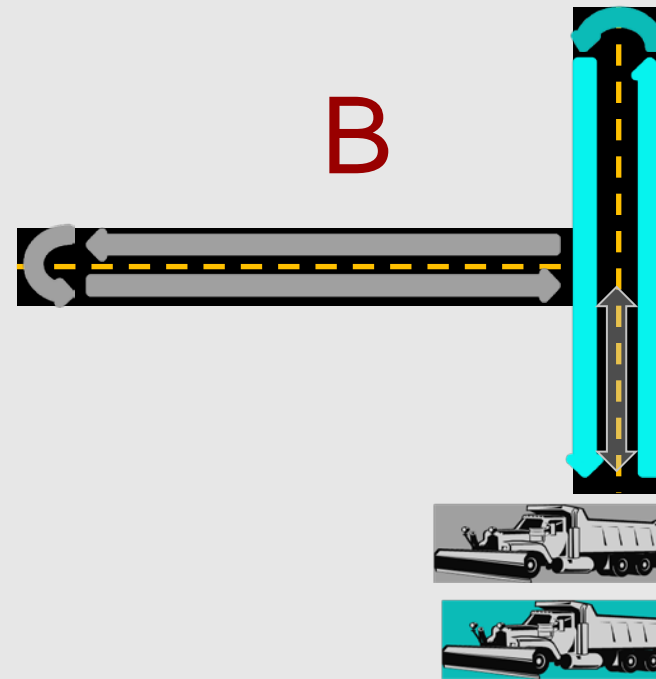
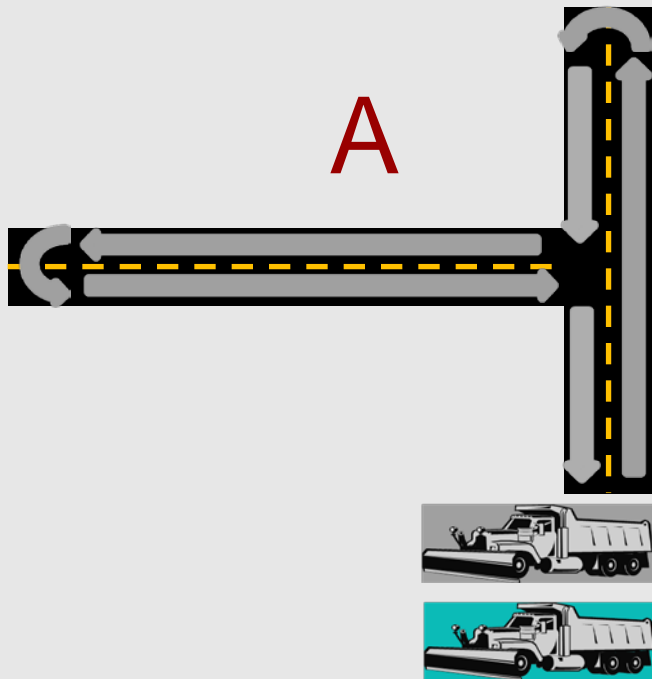
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# Motivation for RSIC Research

- Efficiency
  - Ex: Allocation and Routing

Motivation for  
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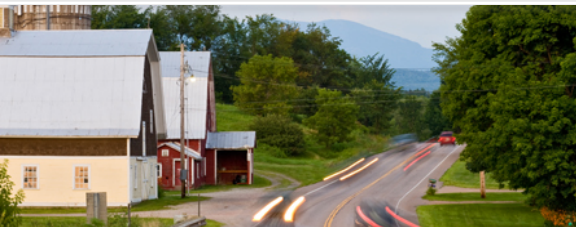


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# Research Objectives

- “No truck left behind”
- Continuous measure of priority

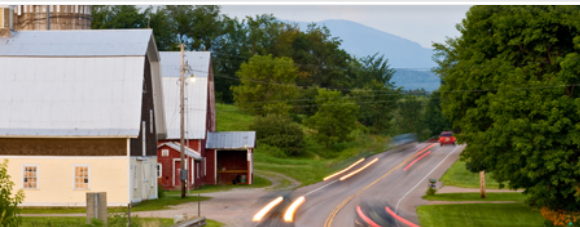
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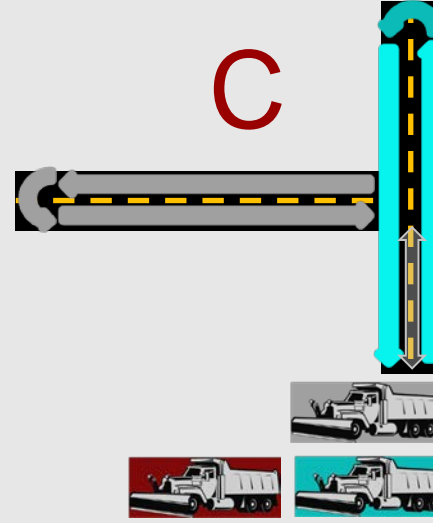
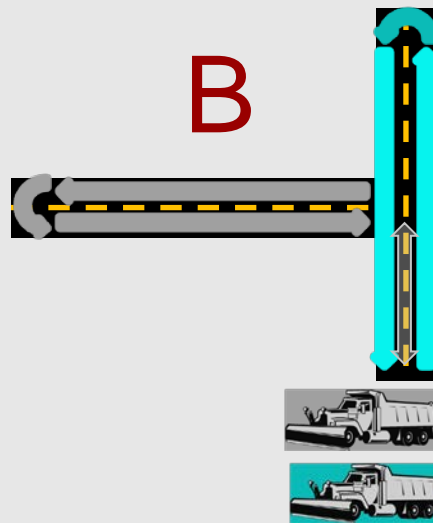
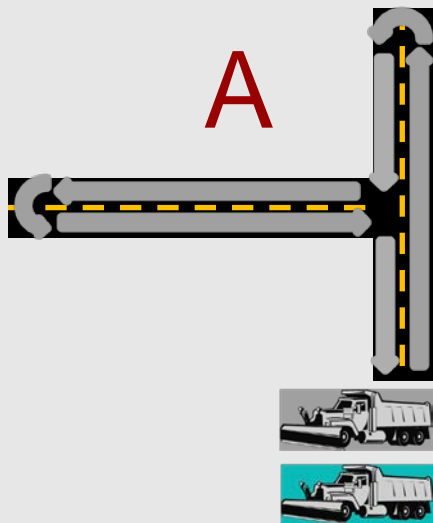
Conclusions



# Research Objectives

- “No truck left behind”

Motivation for  
RSIC Research

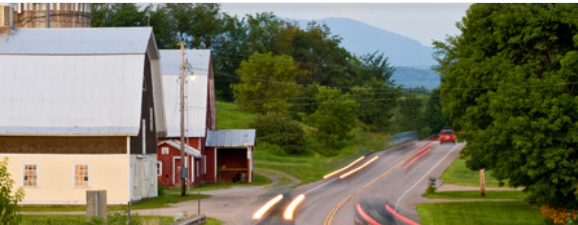


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# Research Objectives

- Continuous measure of priority

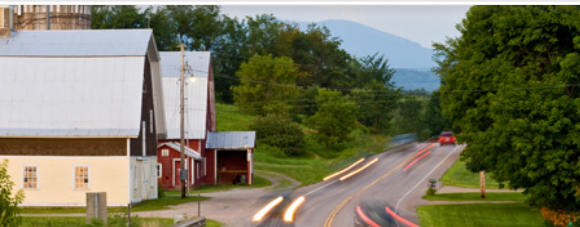
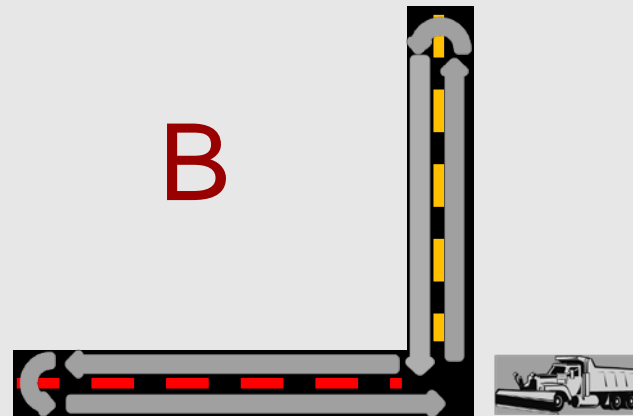
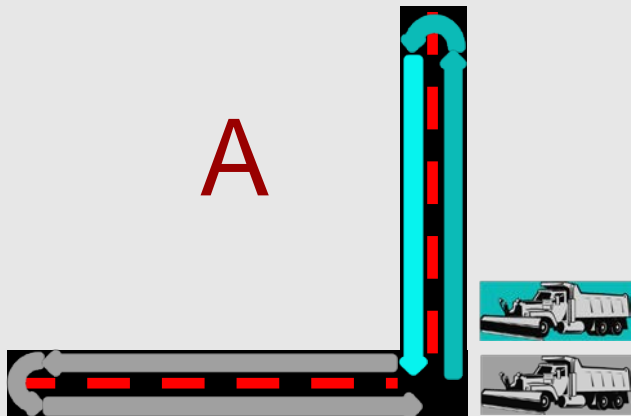
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# Methods

- RSIC routing sequence
- Using a priority measure
- Ensuring all vehicles got routed

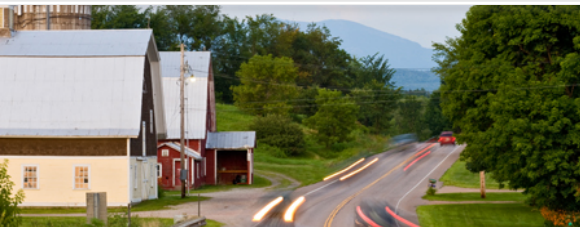
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# Methods

- RSIC routing sequence
  - Cluster the road network
  - Allocate vehicles (plow trucks)
  - Route vehicles

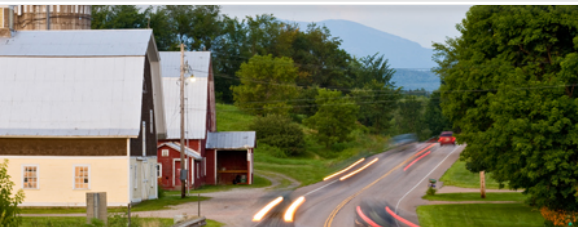
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# Methods

- Using a priority measure
  - When we allocate vehicles
  - Network Robustness Index (NRI)
    - Increase in vehicle-hours of travel (VHTs) of normal daily traffic when that link is disrupted
    - An indication of how critical the link is to the entire network

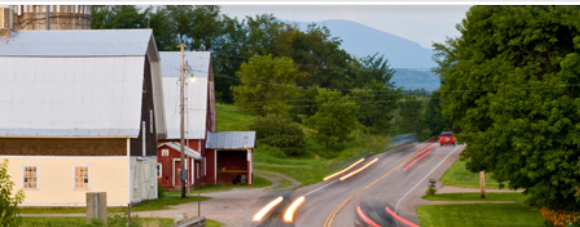
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# Methods

- Using a priority measure
  - Clusters with more critical links are given more vehicles to service those links faster:

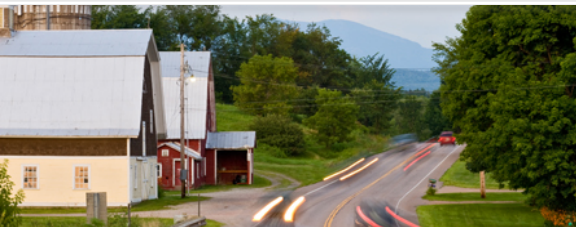
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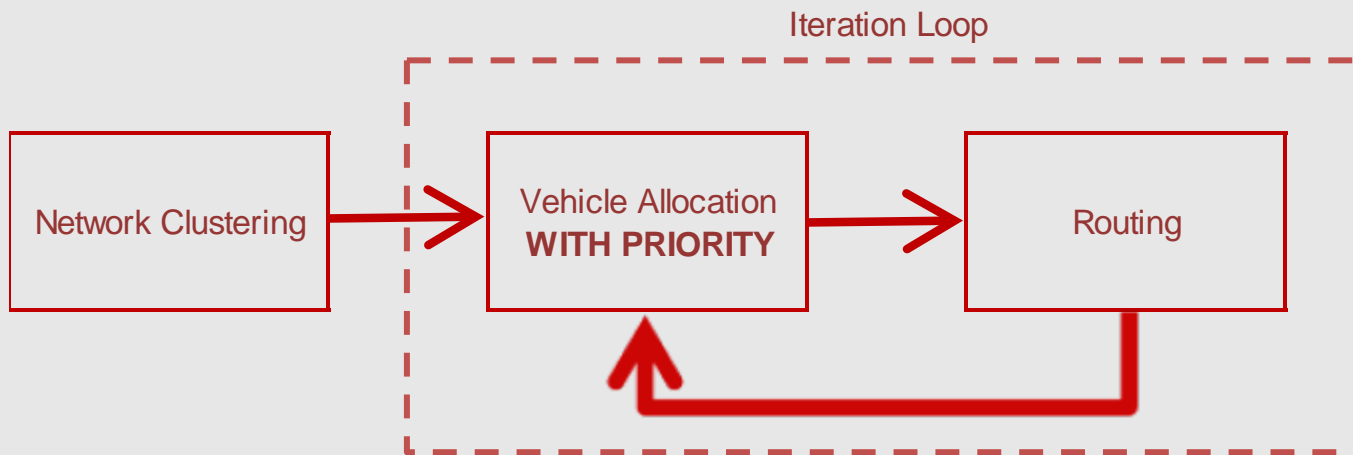
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# Methods

- Ensuring all vehicles got routed
  - Added an iterative loop:



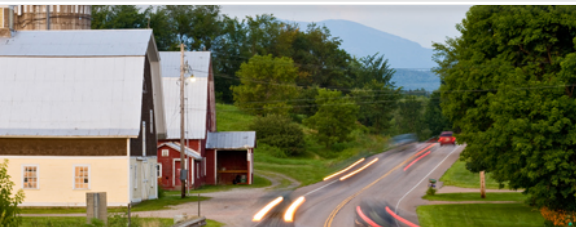
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# Results

- Sequence was run for two storm-intensity levels, each with and without the NRI
- 249 vehicles were allocated and routed
  - Did not include
    - Trucks dedicated to left lane
    - Trucks dedicated to park n' rides, rest areas, and emergency access gates
    - Dedicated spares and support trucks

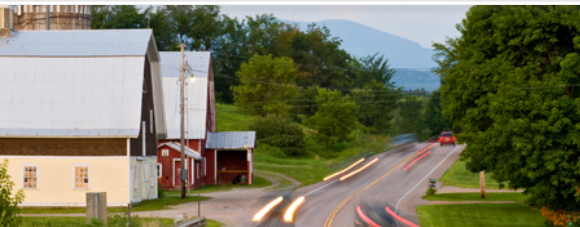
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# Results

- Allocation Results:

Allocation Approach	Max. Trucks per Garage	Min. Trucks per Garage	Avg % Difference
<i>Low-Salt Scenario (200 lbs per mile)</i>			
Roadway Length	10	1	35%
Roadway NRI	10	1	39%
<i>High-Salt Scenario (500 lbs per mile)</i>			
Roadway Length	11	1	33%
Roadway NRI	11	1	40%

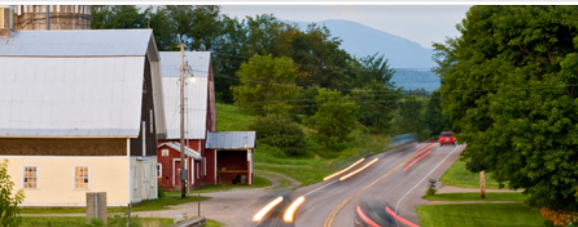
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# Results

- Efficient routes were created for all 4 allocation approaches
- Routing was also conducted for an unlimited hypothetical fleet
- Procedures were implemented with TransCAD and MATLAB

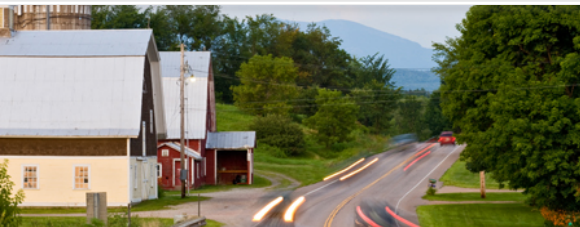
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# Results

- Routing results:

Allocation Approach	90% NRI (hrs)	Total VHTs	Longest Route / Final Service Time (hrs)	Average Route Length (hrs)
<i>Low-Salt Scenario (200 lbs per mile)</i>				
Roadway Length	1.37	281	2.1	1.15
Roadway NRI	1.36	280	1.9	1.15
<i>High-Salt Scenario (500 lbs per mile)</i>				
Roadway Length	1.29	282	2.5	1.18
Roadway NRI	1.26	280	2.0	1.16
<i>Unlimited Fleet Allocation (317 Trucks)</i>				
Unlimited	1.28	299	1.6	1.20

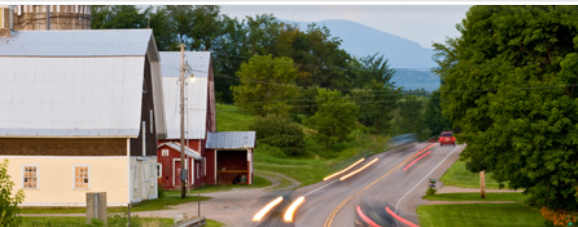
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# Conclusions

- Using a measure of roadway priority in developing new RSIC vehicle allocations would improve the time to service the most critical links in the state, especially during more intense storms
- The Agency's current RSIC vehicle allocation and routing are efficient, but efficiency and time to completion might be improved with an optimized routing solution

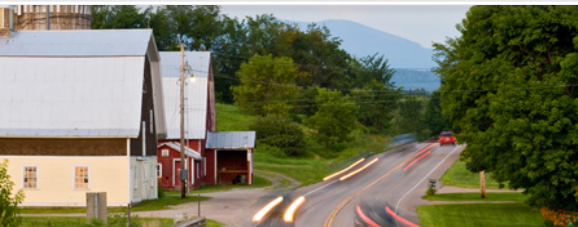
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# Conclusions

- Adding vehicles to its fleet will have a limited return on investment for the Agency, mainly serving only to decrease the total time to service all roads in the state

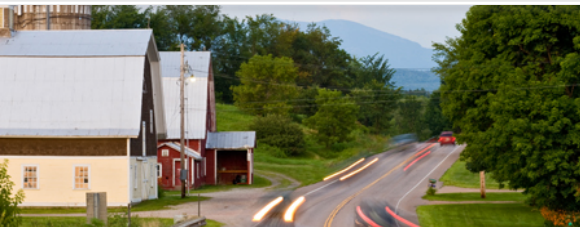
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# Establishing Roadway Priority in Statewide RSIC Routing

- Questions?

