89th Annual Meeting of the Transportation Research Board

TRB Paper #10-2118

January 12, 2010

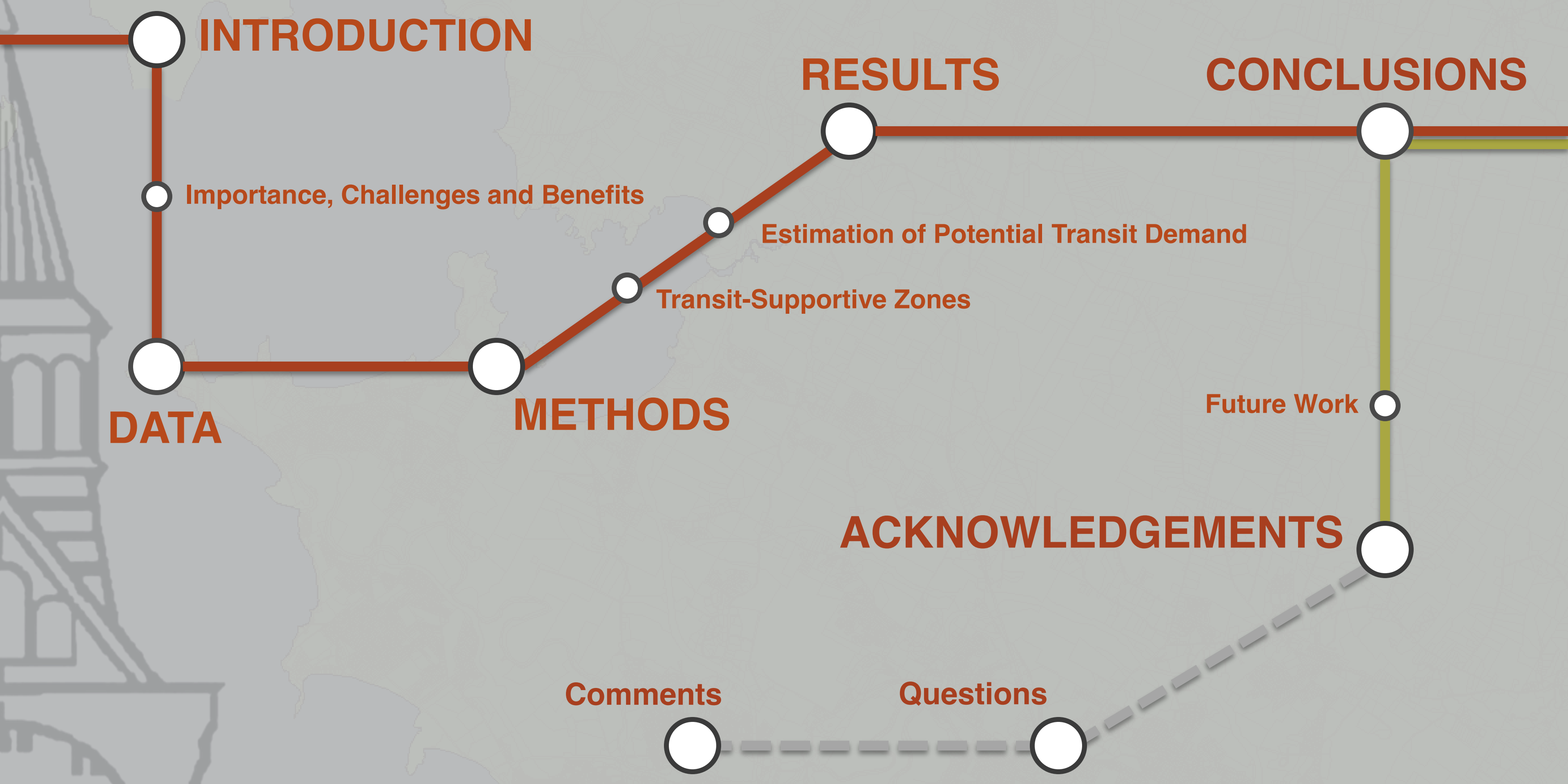
SPATIAL MODELS FOR THE STATEWIDE EVALUATION OF TRANSIT-SUPPORTIVE ZONES

Nathan P. Belz, M.S., E.I., University of Vermont

Lisa Aultman-Hall, Ph.D., University of Vermont

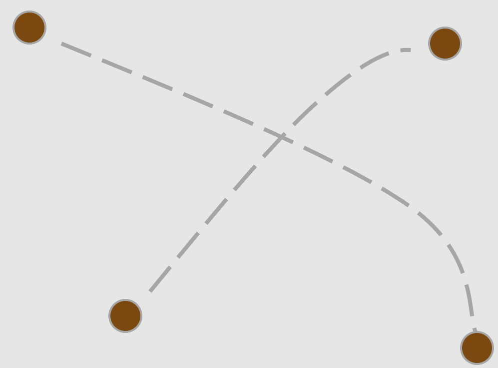
Gopal R. Patil, Ph.D., Indian Institute of Technology Bombay

OVERVIEW


INTRODUCTION
Importance, Challenges and Benefits
DATA
METHODS
Transit-Supportive Zones
Estimation of Potential Transit Demand
RESULTS
CONCLUSIONS
Future Work
ACKNOWLEDGEMENTS
Questions
Comments

What are the challenges of transit in rural states?

- Spatial Constraints
  - Long Travel Distances
  - Low Densities

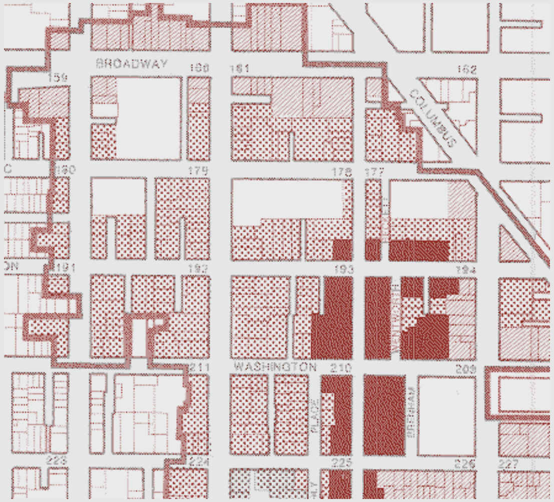


What needs to be done?

- Move beyond large-rural analysis for local services
- Define areas that are transit serviceable statewide
- Develop objective process to determine transit demand
- Determine demand potential and VMT reduction

What has been done for spatial transit demand research?

- Quality of Transit Service
- Access and Coverage
- Density and Land Use



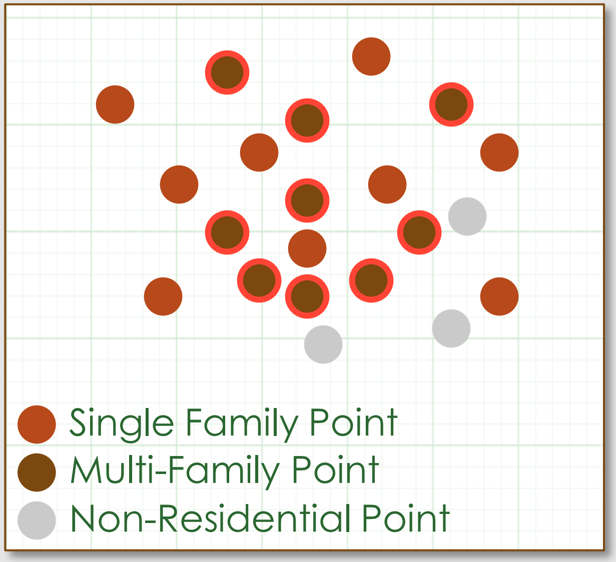
What are the shortfalls of past spatial research?

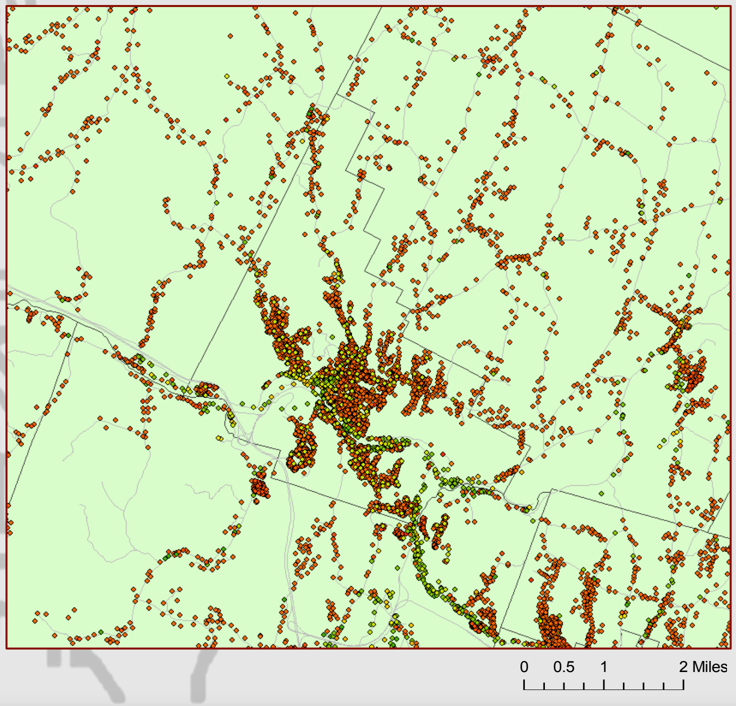
- Zonal level and/or small extents with urban focus
- Assumptions of homogeneity within zones

DATA

- Vermont E911 Database
- Number of Dwelling Units for Multi-Family Structures
- Employment Statistics by Land-Use Type
- Trip Generation Rates by Land-Use Type
- Hourly Distribution of Trips
- Vermont Statewide-Travel Demand Model

STEP 1: Apply dwelling unit values to multi-family structure points



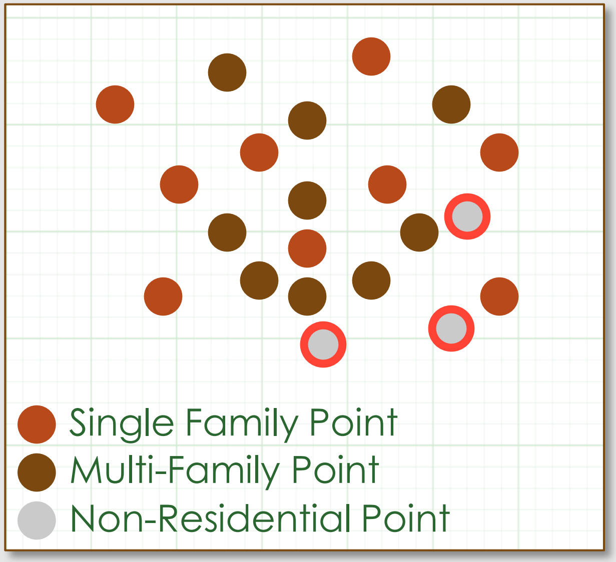


E911 Points

- Single-Family Structures
- Multi-Family Structures
- Non-Residential Structures

STEP 1: Apply dwelling unit values to multi-family structure points

STEP 2: Apply employment levels to each non-residence point

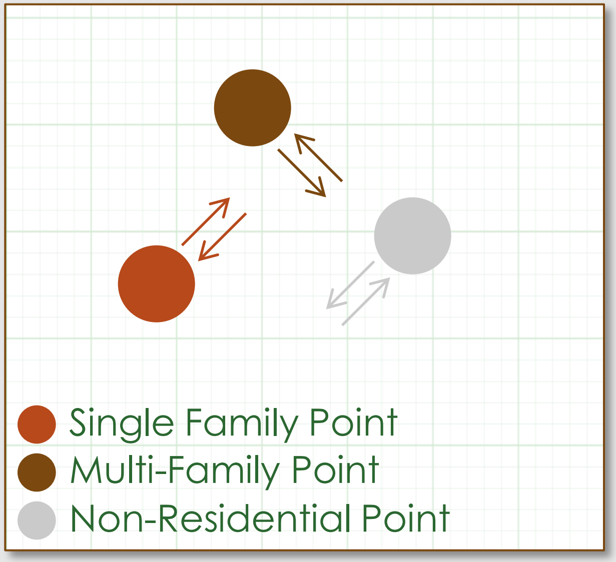


METHODS Transit- Supportive Zones

STEP 1: Apply dwelling unit values to multi-family structure points

STEP 2: Apply employment levels to each non-residence point

STEP 3: Apply trip generation rates to all points



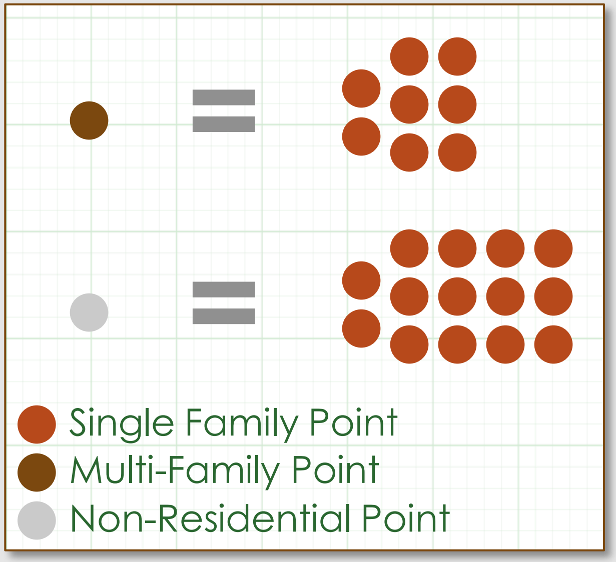
Demand Potential (DP)

METHODS Transit- Supportive Zones

STEP 1: Apply dwelling unit values to multi-family structure points

STEP 2: Apply employment levels to each non-residence point

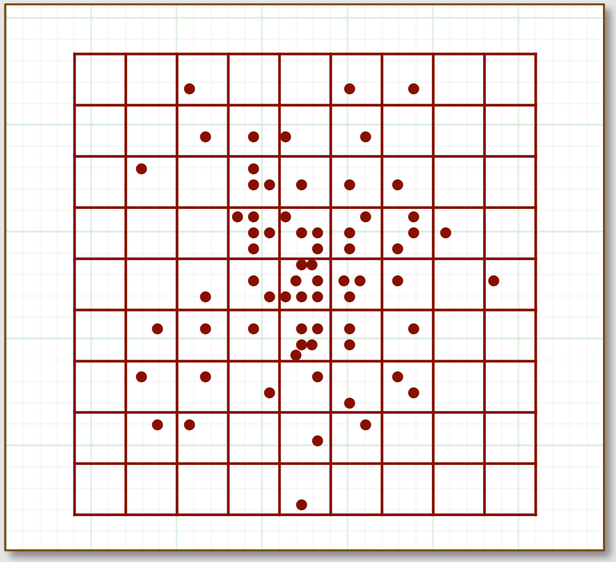
STEP 3: Apply trip generation rates to all points

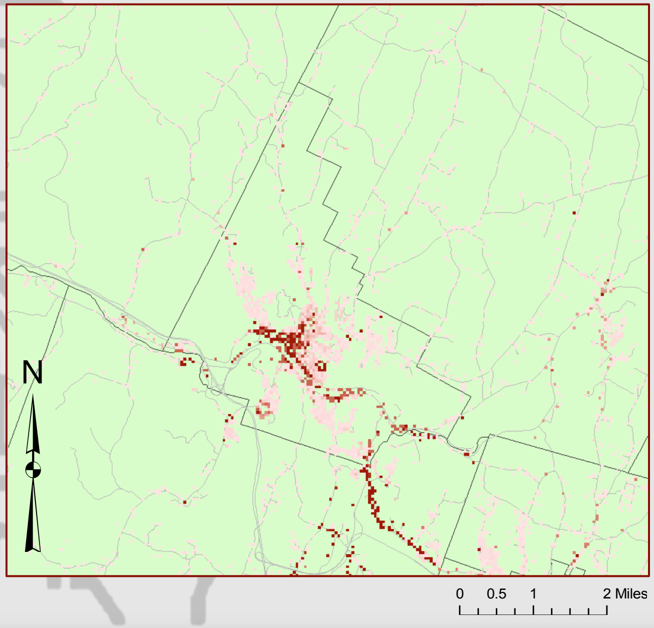


Equivalent Demand Potential (DP)

STEP 4: Divide demand potential for each point by the demand potential for a single-family home

STEP 5: Sum the EDP for each acre





EXAMPLE: Montpelier, VT

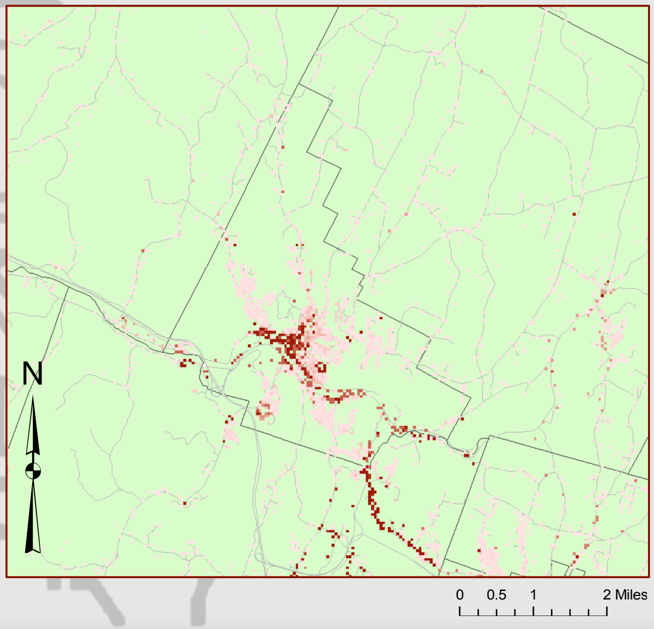
EDP

High : 2846

Low : 0

STEP 5: Sum the EDP for each acre

		1			1	1		
		1	1	1	1			
	1		3	1	1	1		
			5	4	3	3	1	
		1	2	7	3	1		1
	1	1	1	5	2	1		
	1	1	1	1	1	2		
	1	1		1	1			
				1				



EXAMPLE: Montpelier, VT

EDP

High : 2846

Low : 0

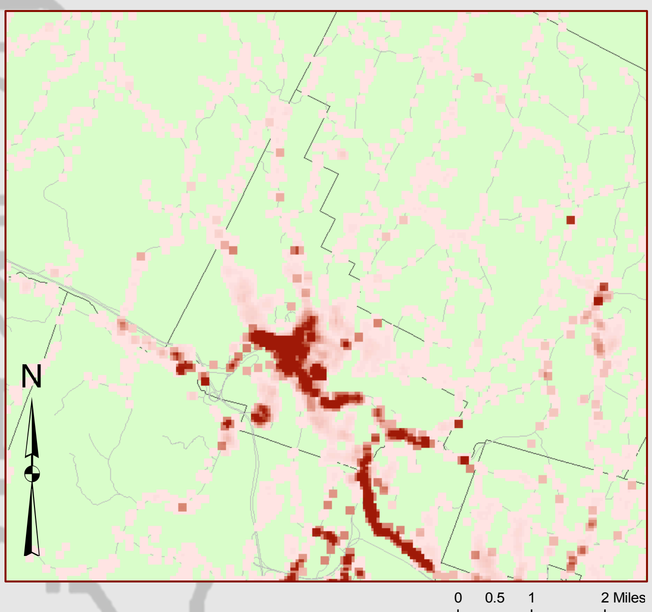
METHODS

Transit- Supportive Zones

STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

		1			1	1		
		1	1	1	1			
	1		3	1	1	1		
			5	4	3	3	1	
		1	2	7	3	1		1
	1	1	1	5	2	1		
	1	1	1	1	1	2		
	1	1		1	1			
				1				



EXAMPLE: Montpelier, VT

Neighborhood Measure

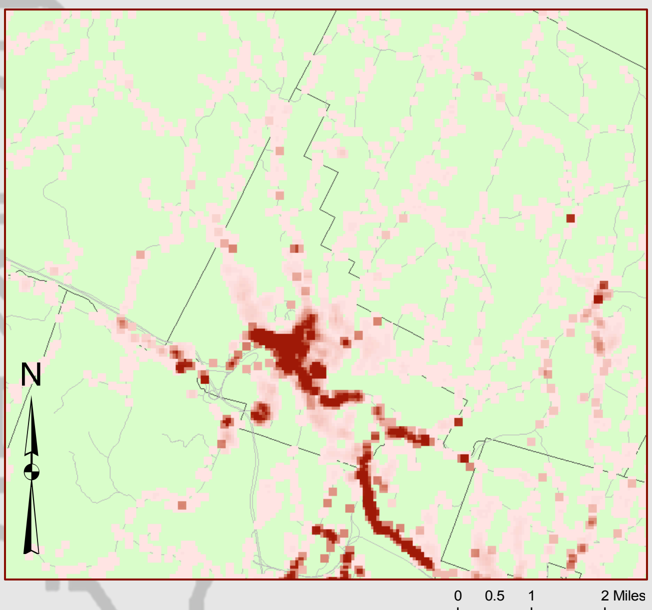
High : 11742

Low : 0

STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

	2	3	4	4	4	3	1	
1	2	7	8	9	6	5	2	
1	2	10	16	20	15	10	5	1
1	2	12	21	29	27	13	7	2
1	3	11	26	$\boxed{32}$	29	14	7	2
2	6	9	20	23	23	10	5	1
3	6	8	12	13	14	7	3	
2	4	5	6	6	7	4	2	
1	2	2	3	3	3	1		



EXAMPLE: Montpelier, VT

Neighborhood Measure

High : 11742

Low : 0

STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

STEP 7: Determine the spatial grid Neighborhood Maximum value

	2	3	4	4	4	3	1	
1	2	7	8	9	6	5	2	
1	2	10	16	20	15	10	5	1
1	2	12	21	29	27	13	7	2
1	3	11	26	**32**	29	14	7	2
2	6	9	20	23	23	10	5	1
3	6	8	12	13	14	7	3	
2	4	5	6	6	7	4	2	
1	2	2	3	3	3	1		

METHODS Transit- Supportive Zones

STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

STEP 7: Determine the spatial grid Neighborhood Maximum value

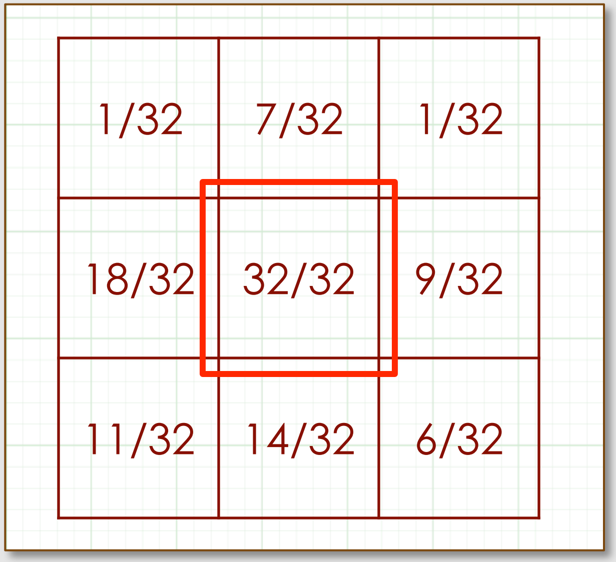
2	7	8	9	9	9	6	5	2
2	10	16	20	20	20	15	10	5
2	10	21	29	29	29	27	13	7
2	12	26	32	32	32	29	14	7
6	12	26	32	32	32	29	14	7
6	11	26	32	32	32	19	14	7
6	9	29	23	23	23	23	10	5
6	8	12	13	14	14	14	7	3
4	5	6	6	7	7	7	4	2

STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

STEP 7: Determine the spatial grid Neighborhood Maximum value

STEP 8: Identify local maximums



METHODS Transit- Supportive Zones

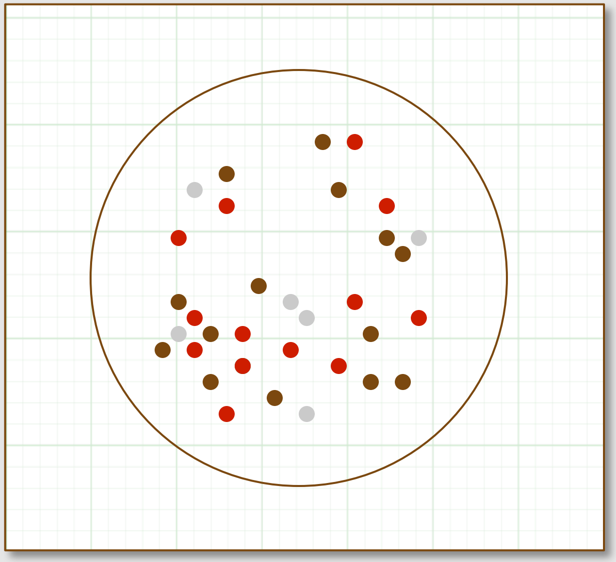
STEP 5: Sum the EDP for each acre

STEP 6: Calculate the spatial grid Neighborhood Measure value

STEP 7: Determine the spatial grid Neighborhood Maximum value

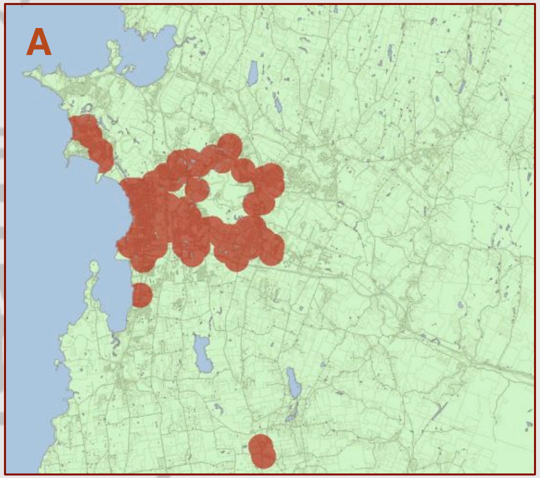
STEP 8: Identify local maximums

STEP 9: Apply service area to local maximum centroids and sum EDPs within service area

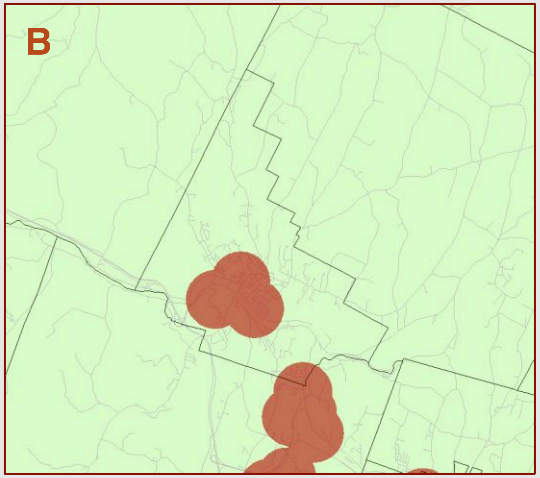


Criteria to be a Transit-Supportive Zone

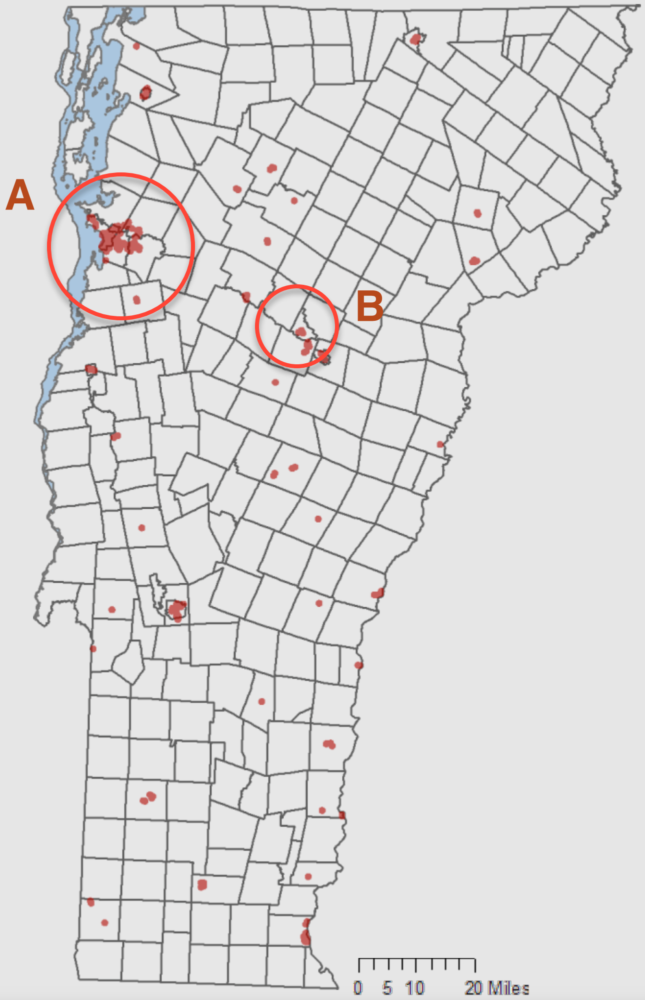
- Must have a local max as centroid
- Σ EDP must be greater than or equal to seven at the central acre
- Σ EDP must be greater than or equal to 3520 for the entire service zone



Burlington, VT & Surrounding



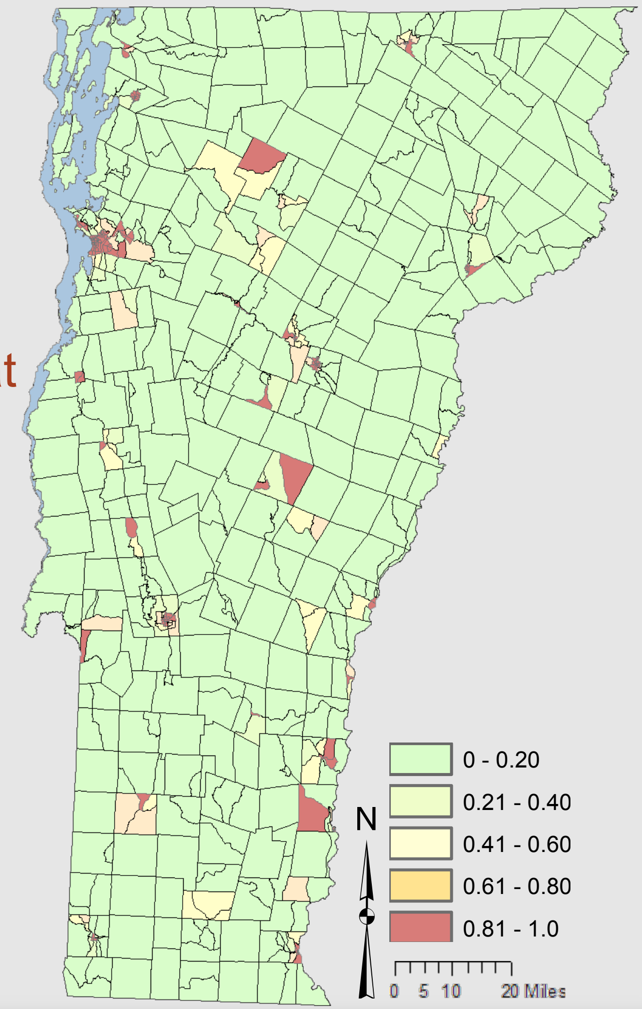
Montpelier, VT



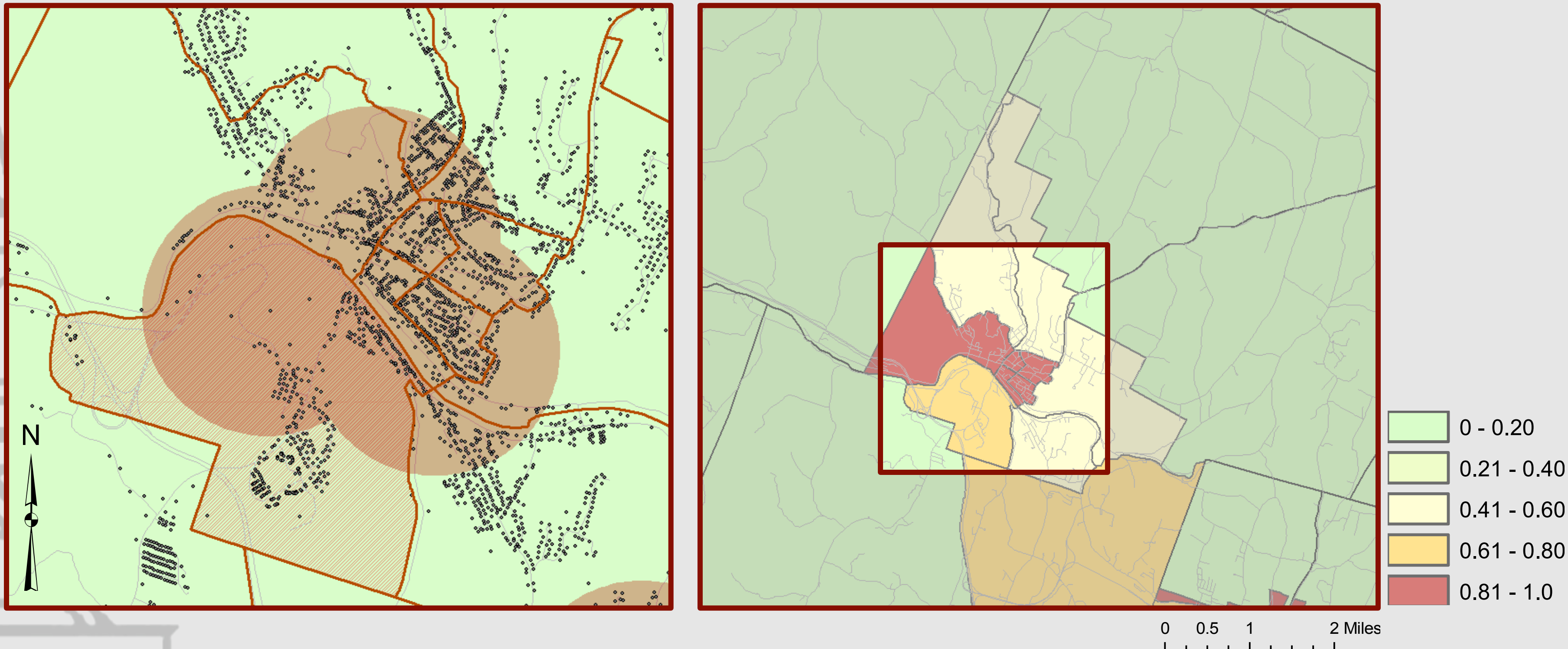
Transit-Supportive Demand Proportion

- Sum of EDP in the portion of each TSZ falling within the n[th] TAZ (X)
- Sum of EDP in the n[th] TAZ (Y)
- Divide (X) by (Y)
- Represents the proportion of trips within a TAZ that could *theoretically* be served by transit

$$TSDP = \frac{EDP_{TSZ}(n)}{EDP_{TAZ}(n)} \boxed{= \frac{X}{Y}}$$

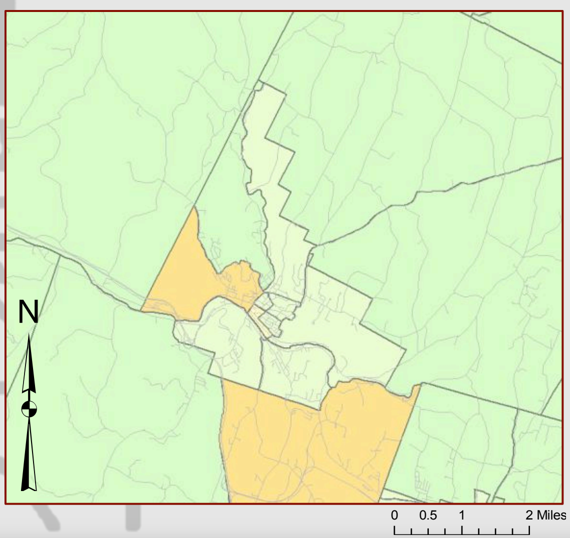


Transit-Supportive Demand Proportion



Potential Transit Demand (Person Trips)

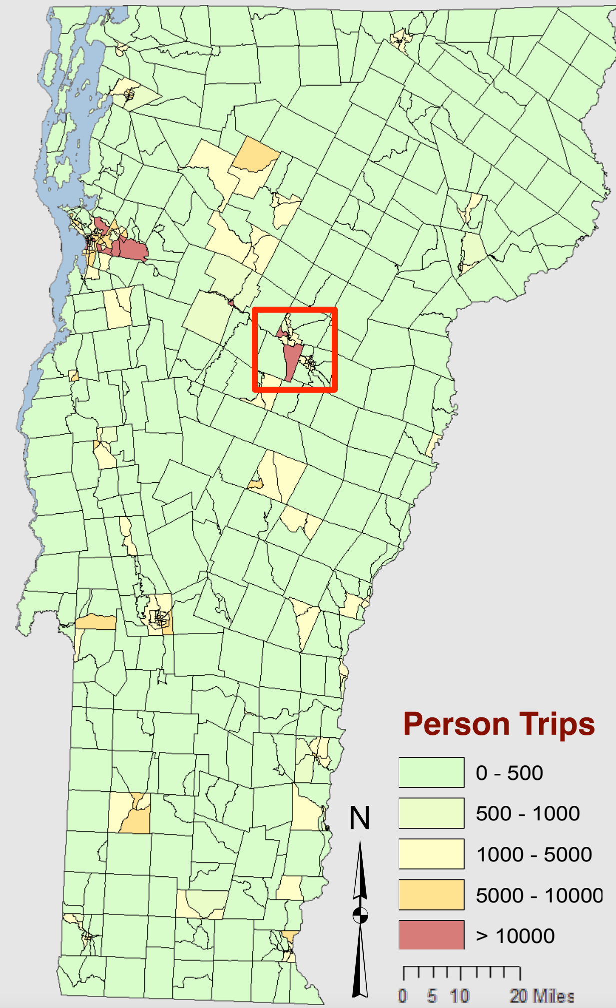
- Trip must originate in and be destined for a TSZ
- Gravity update of state model using TSDP as the "growth" factor
- Reduced by 7.6% for trips occurring outside of typical transit operation hours
- Subtracted existing transit trips



EXAMPLE: Montpelier, VT

Person Trips

- 0 - 1000
- 1000 - 5000
- 5000 - 10000
- 10000 - 20000
- > 20000



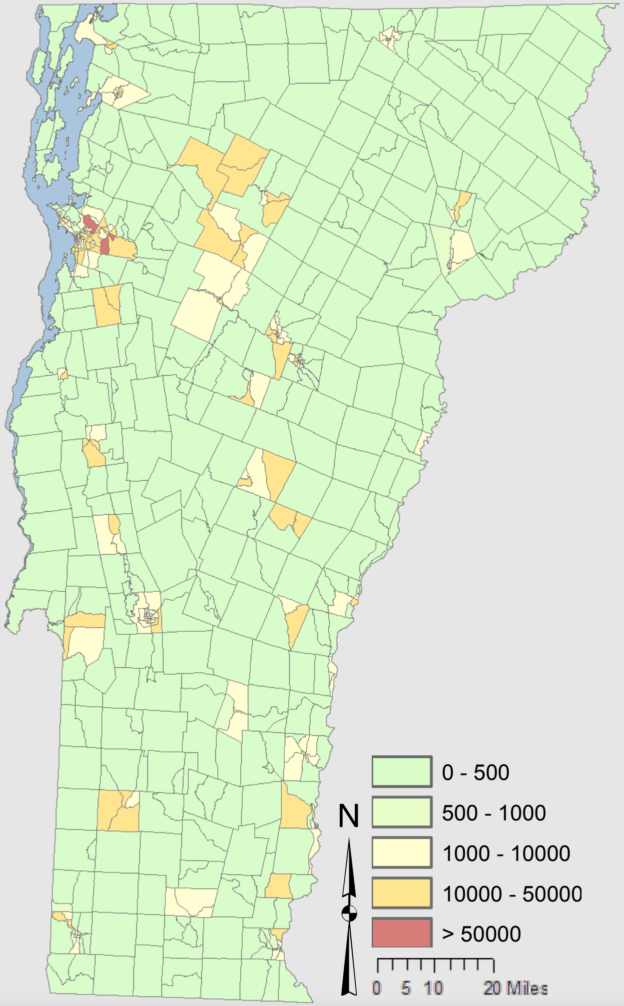
Estimation of VMT Reduction

- Divide person-trips (T) by auto-occupancy for a given trip-purpose (P)
- Number of trips (A) occurring between OD pairs
- Shortest network distance (B) between OD pairs
- Number of trips (C) occurring within TAZ
- Intrazonal trip length (D) approximated as radius of a circle with area equivalent to TAZ area

$$AT_{ij} = \sum_p [\sum_{ijp} \frac{TT_{ij}^{(p)}}{AO_p}] \quad \boxed{= \frac{T}{P}}$$

$$R_{VMT} = \sum_{ij}(AT_{ij} * Min[DN_{ij}]) + \sum_i (AT_i * D_{TAZ})$$

$$\boxed{= (A * B) + (C * D)}$$



RESULTS

	% WITHIN TSZs BY REGION		
	MPO	*Non-MPO*	*Vermont (Total)*
Land Area	6	0.6	$\boxed{0.9}$
Residence Points	37	12	17
Employment Points	66	33	39

RESULTS

TRIP PURPOSE	AUTO TRIPS	AUTO VMT *(miles)*	% "REDUCTION"	
			Trips	*VMT*
Home-Based Work	137,210	938,895	37	21
Home-Based Shopping	62,910	392,408	38	20
Home-Based School	4,964	25,443	38	19
Home-Based Other	133,599	601,829	34	16
Non-Home Based	194,161	635,924	64	33
TOTAL	532,844	2,594,499	43	21

Transit-Supportive Zones

- Data and methodology used
- TSZs are spread throughout the state
- 1% of VT land area is transit-supportive

Estimation of Demand

- 43% of all trips occur within or between TSZs
    - 86% Intercity
    - 14% Intracity
- Theoretically if all “potential” could be served
    - 21% statewide reduction in VMT

CONCLUSIONS

Importance of disaggregate data

- Generally much more available for urban areas
- Illustrates application of E911
- Identifies need for similar data on national scale
- Application as data-driven decision tool

TSZs and Potential Transit Demand

- Relatively large proportion of substitutable intercity trips
- Not just in the one Vermont MPO
- Unlikely *all* identified potential can be connected

Spatial analysis is not stand-alone

- Supplementary material
    - Social equity and need
    - Energy efficiency and network walkability

Indication of location and level of demand

- Increase transportation system efficiency
- Develop spatially-optimal fixed-route transit network
- Where to serve with fixed route or demand responsive

Preliminary work

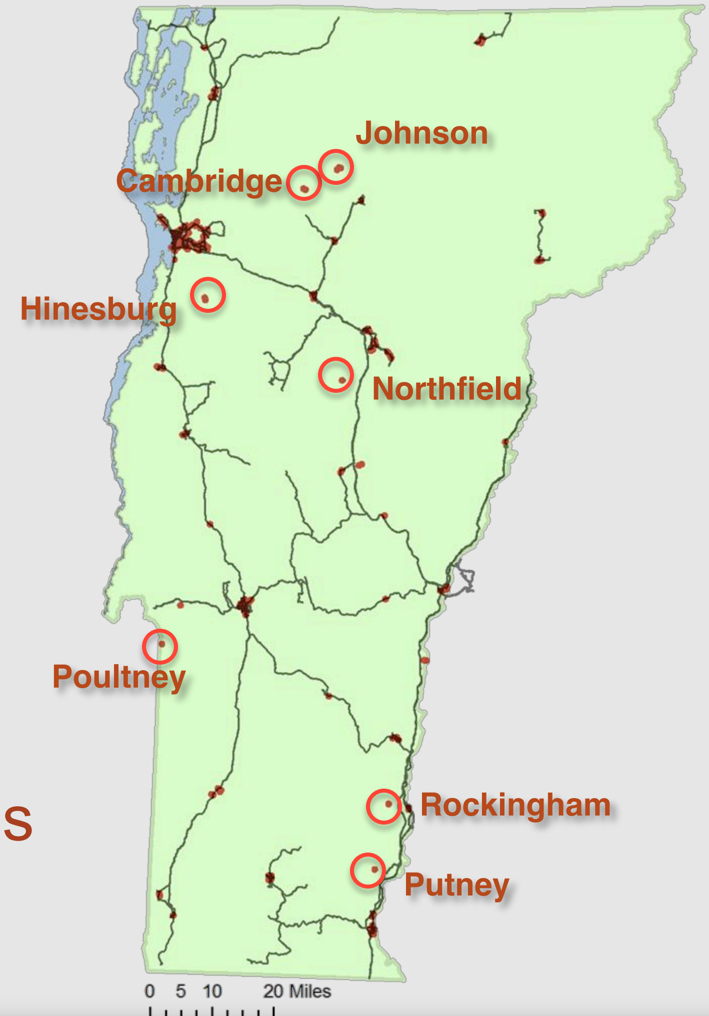
- Model transit networks
  - Spatially-optimal
  - Equitably-augmented
  - Socially-equitable

- Able to identify
  - Underserved locations
  - Over-served locations
  - Shortest-path discrepancies

Preliminary work

- Model transit networks
  - Spatially-optimal
  - Equitably-augmented
  - Socially-equitable

- Able to identify
  - Underserved locations
  - Over-served locations
  - Shortest-path discrepancies



ACKNOWLEDGEMENTS

Funding provided by:

US Department of Transportation

Research and Innovative Technology Administration

Collaboration with:

Dr. Austin Troy

Assistant Professor, UVM RSENR

James Sullivan, P.E.

Research Engineer, UVM TRC

Andrew Weeks, P.E.

Research Engineer, UVM TRC

QUESTIONS/COMMENTS