Potential for Telecommuting in New England

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The potential impact of telecommuting on vehicle miles of travel (VMT) and the number of vehicle trips (cold starts) is estimated. Estimates are also made of the costs associated with the institution of home and satellite telecommuting per employee and per VMT saved. The factors that affect the amount of telecommuting are discussed and research into the values of these factors is cited. The factors are then assigned values on the basis of the research. Using these values, hypothetical examples are calculated of the potential ranges of VMT reductions and vehicle trip reductions for Massachusetts and Rhode Island and for the three southernmost counties of New Hampshire.

The purpose of this paper, based on research sponsored by the Conservation Law Foundation, is to estimate the effectiveness of telecommuting as a transportation control measure in Massachusetts and Rhode Island and for the three southernmost counties of New Hampshire. Because vehicle emissions are a function of both the amount of vehicle travel, measured by vehicle miles of travel (VMT), and the number of vehicle trips or "cold starts," the impact of telecommuting is estimated on the basis of both VMT and cold starts. Two distinct types of telecommuting are reviewed: home telecommuting and satellite telecommuting, where a worker travels to a site provided by the employer near home to perform daily work functions.

FACTORS INFLUENCING THE EFFECTS OF TELECOMMUTING

The factors discussed in this section are likely to influence the effects of telecommuting on VMT and cold starts. Most obvious is the number or share of the work force that represents the telecommuting market, either as home or satellite telecommuters. The potential market may vary by type of industry and job classification most susceptible to telecommuting. Because home and satellite telecommunication are fundamentally different phenomena, the proportion of each is a key factor too.

The average number of days in the work week that the telecommuter participates in telecommuting will have an effect. The average trip length of telecommuters for their trip to their work sites on nontelecommuting work days will affect VMT. If telecommuters travel to a satellite center, the travel distance saved is the difference in the trip length to the satellite center and the usual work site. If they work at home, the difference is merely the distance to the usual work site. Trip length saved may also be based on "self-selection," that is, those who choose or volunteer to telecommute may have longer or more arduous work trips than the average worker. This will tend to skew the impact of telecommuting upward.

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There may be a change on telecommuting days in the amount of driving that occurs either for nonwork purposes by the telecommuter or by other members of the household when there is an additional automobile available. The amount of VMT saved is also determined by the mode of travel by telecommuters on days that they travel to their usual work sites. If they are transit riders or passengers in a carpool, the home telecommute will not save the full amount of the trip distance from home to the usual work site. The mode to the satellite center must also be considered.

In the long run, workers may consider changes in where they live if they can telecommute. This will tend to result in long commutes because they are traveling less frequently to the usual office site, negating some of the VMT savings associated with telecommuting.

REVIEW OF LITERATURE

The literature has been reviewed with an eye toward providing quantitative estimates of the factors described earlier. Data are now becoming available as studies of telecommuting are being reported. Because the phenomenon of telecommuting is relatively new, more data can be expected to become available to provide more refined estimates of these factors.

Participation Rates

Nilles (*1*) estimates that 40 percent of all workers could telecommute. He bases this estimate on the assumption that telecommuters will come from those with "information" jobs, that 50 percent of all jobholders hold information jobs, and that 80 percent of those workers can telecommute. The *Urban Transportation Monitor* survey (*2*) estimated (using a very crude arithmetic method) that 32 percent of employees working for the employers in telecommuting demonstration projects could eventually telecommute.

The question of who participates in telecommuting and whether their travel characteristics differ from the population at large remains an important one. The *Urban Transportation Monitor* survey asked about the distribution of telecommuters among managers, professionals, and clerical and data entry workers in telecommuting demonstration programs. Although not scientific, it suggests that the telecommuters tend to be skewed toward professional workers, which will suggest a higher-than-average trip length, as will be discussed in the section on length of trip saved.

Frequency of Telecommuting

The *Urban Transportation Monitor* survey asked how many days a week the participants telecommuted. The results for the 15 usable employer responses are shown in Table 1. It indicates a wide variation among respondents, with an average of 1.72 days per week. Note that one respondent (Los Angeles County), with over 2,600 telecommuters, registered more than half of all the telecommuters in the survey, skewing the results. Fifty-three percent of their participants telecommuted 2 days per week, raising the overall average. The other respondents averaged well below 1.5 telecommuting days per week.

In a report of the Los Angeles experiment 2 years earlier, in 1990, JALA Associates (*3*) found that the average days per week was 1.5, when only 1,100 workers participated. On the basis of the *Urban Transportation Monitor* survey, the frequency of telecommuters had climbed considerably.

Length and Number of Trips Saved

Nilles (*4*) reports that 108 telecommuters traveling to two satellite centers had an average commute of 3.8 mi, compared with the company average (2,700 employees) of 10.7 mi, or a savings of 65 percent. He points out that among home-based telecommuters the average commute varied by job type, with professionals and managers commuting farther than the average of all employees. If telecommuting is proportionally more prevalent among these groups, the VMT savings could be greater, if it were based on the average work trip lengths of all workers.

A telecommuting demonstration with 73 telecommuters in southern California reports that the average miles driven per day by telecommuters on telecommuting days dropped by 76 percent, from 49.7 mi before telecommuting to only 12.0 mi afterward. The number of trips per day per person dropped to half from 4.0 to 1.94 (*5*).

In the Puget Sound area, data from 119 telecommuters indicated that they averaged 52 mi/day before telecommuting began, and once they telecommuted they traveled only 13 mi/day, a 75 percent savings (*6*). The number of trips dropped from 4.3 per day before telecommuting to 2.6 per day on telecommuting days afterward.

TABLE 1 Telecommuting Participation: Percent Distribution by Number of Days per Week

	Days Per Week, Percent					
Number of Telecommuters	less than 1	1	2	3	4	5
441	-	-	100	-	-	-
10	-	-	-	-	-	-100
150	-	-85	15	-	-	-
200	-	99	1	-	-	-
120	-	90	6	1	3	-
300	57	11	13	5	14	-
2600	18	8	53	14	61	-
40	-	100	-	-	-	-
59	-	38	33	13	16	-
64	-	10	80	8	2	-
24	-	-	-	-	20	80
100	-	40	30	20	5	5
20	-	100	-	-	-	-
8	-	95	5	-	-	-
7	-	57	29	14	-	-
Weighted %	15.4	30.3	37.5	10.0	5.4	1.4

Weighted Average per Week = 1.72 days*

* Assumes less than once per week equivalent to once every two weeks.

Source: Urban Transportation Monitor

In San Diego the average trip length saved per telecommute day was 24 mi round-trip (*7*). In Phoenix 134 telecommuters avoided an average of a 31-mi round-trip when they telecommuted an average of 1 day per week (*8*). This was confirmed by a telephone conversation with Susan Sears of AT&T (personal communication). In both demonstrations the average miles traveled before telecommuting or on nontelecommuting days was either not asked for or reported so percentage changes cannot be estimated. An average was not provided for any control group.

Both the southern California and the Puget Sound data indicate that telecommuters travel even less on days that they traveled to their normal employer work site. In the former case they traveled only 44.4 mi on nontelecommuting days, compared with their travel habits before they became telecommuters of 49.7 mi/day. In the latter case, the drop-off was less, 52 to 49 mi/day. JALA Associates reported a drop of 22 percent in VMT in telecommuter households. This surprising result may be the "anchoring" phenomenon of nonwork activities cited by Mokhtarian (*9*), whereby telecommuters begin to do their nonwork trips closer to home once they become accustomed to services nearer their home, rather than along their commutes.

Self-Selection Factor

Self-selection is borne out by data reported by Nilles (*1*) of a study of 44 telecommuters and a control group of 35 workers with the same job profiles. The telecommuters had an average trip length of 30.2 mi, whereas the others had an average trip length of only 14.8 mi to work. The Puget Sound demonstration shows a similar relationship, with telecommuters having an 18-mi trip to work compared with an average of 8 mi for the control group. Moreover, in the Puget Sound area those who dropped out of the program had shorter trip lengths, suggesting that the motivation to remain telecommuters was greater among those with longer trips. A contrary result from San Diego reported that distance did not appear to be a factor when workers chose to enter the telecommuting program (*7*). However, the findings of this demonstration project can be discounted because only 14 telecommuters participated. The San Diego experience seems to be the exception. The *Urban Transportation Monitor* survey reported that in many cases the motivations were higher for longer-distance commuters and that participation was greater among managers and professionals, two factors that go hand in hand.

Relocation of Residences

In California, the question of whether telecommuting prompts a change of residence was explored (*3*). Of the 16.8 percent of the telecommuters who moved since telecommuting started, and the 11.2 percent of telecommuters considering it, 19.4 percent said that their telecommuting experience was a significant influence and another 9.7 percent said it was decisive. Among those who moved, the average added distance was 1 mi farther from the home office.

Other VMT on Telecommuting Day

The JALA Associates report on the California experiment (*3*) indicated that only a very modest number of additional trips are made because the automobile is available on telecommuting days. The

Puget Sound study could not determine whether there was an increase in nonwork trips on telecommuting days. However, Bowman and Davis (*7*) reported that about 20 percent of the VMT savings was offset by travel for nonwork purposes on telecommuting days.

Mode Splits on Nontelecommuting Days

In San Diego, 17 percent of the telecommuters were carpoolers when they did not telecommute. In Puget Sound, 61 percent commuted in single-occupant vehicles (SOVs). The Puget Sound teleworking center experiment started with only 56 percent as SOVs to the main office, but that increased to 83 percent for travel to the satellite center, partially offsetting the reduction of VMT. This result suggests that if the home office is in a city center with transit available and the satellite center is in the suburbs, much of the VMT savings hoped for with telecommuting can be lost.

Trips Avoided During Congested Periods

Another consideration is whether the congestion relief created by telecommuting will be evenly spread over the work week. There is evidence that Tuesdays and Thursdays are preferred, followed by Wednesdays and Fridays. This might suggest uneven relief from peak period congestion by day of week.

Travel Avoided by Highway Type

Nilles (*1*) suggests that traffic patterns could be changed by telecommuting. Home-based telecommuters will clearly not use their home office commute routes on the days they work from home but likely will add to local road use to run midday errands, for example. Telecommuters bound for satellite centers may also switch from arterials or expressways used to reach the home office to local streets to reach the center.

SCENARIOS TESTED AND ASSUMPTIONS MADE

Four scenarios are constructed to examine the VMT and trip-making reductions attributable to telecommuting for the entire states of Massachusetts and Rhode Island and for the three southernmost counties in New Hampshire. A step-by-step methodology is also presented. The values of the various factors used for this exercise are based on the evidence presented in the literature review.

The scenarios are as follows: minimal (a maximum of 5 percent of employees telecommute), modest (10 percent), major (20 percent), and maximum (40 percent). Whether the maximum is reached for any of the scenarios is likely to be a function of the difficulty of commuting in an area. The surrogate for the difficulty of the trip is trip length. For short trips, the incentive for telecommuting diminishes. It is assumed here that in municipalities in New England with average work trip lengths above 10 mi, the "nominal" participation within each scenario (5, 10, 20, and 40 percent) could be reached, but where the trip lengths are shorter, the participation rate will likely drop as a function of the average trip length for workers in the municipality. The drop-off in participation is assumed to be 10 percent for each mile less than 10 mi.

Existing average work trip lengths were based on the estimates made for each municipality in the study area in 1990 as part of the analysis in an earlier phase of this work (*10*).

Because the proportion of telecommuters who work at home or in a satellite center will have an effect on travel impacts, that proportion too must be assumed. Intuitively, it would appear that as the overall participation in telecommuting rises, so would the share of telecommuters who travel to satellite centers. The reasoning behind this is that involvement with higher and higher percentages of workers would require the management and structure found in a satellite center. The assumption is made that for the 5 percent scenario, one in five would be a satellite telecommuter, for the 10 percent scenario, one in four, for the 20 percent scenario, one in three, and for 40 percent, one in two would be a satellite telecommuter.

The VMT saved is next calculated by making the assumption that telecommuters average longer travel distances to the home office than the average worker and that the satellite telecommuters also average longer distances to the home office, but not as far as the home telecommuters. Moreover, it is assumed that as participation increases from scenario to scenario, the average trip length of participants to the home office decreases. An adjustment is made to increase the round-trip distance by 5 percent for 15 percent of the home telecommuters to account for housing relocation. The factors that address distance and home versus satellite telecommuters for the four scenarios are given in Table 2.

The assumption is made that telecommuting occurs an average of 1.75 times per week, or 35 percent of the work days. On telecommuting days the home telecommuters travel 75 percent less than they would have otherwise and the satellite telecommuters travel 67 percent less than they would have. The lower reduction in travel accounts for the fact that they will be inclined to carry out personal business and errands once they leave their home in an automobile. On nontelecommuting days home telecommuters are assumed to travel 10 percent less than on days when they travel to the office. No difference is assumed for satellite telecommuters.

Finally, all reductions in commuting distances account for the estimated share of workers who did not commute in SOVs in 1990. Although there is evidence that those telecommuting to satellite centers may shift to SOVs, diminishing the VMT savings, much will depend on the location of satellite centers relative to the location of the home office. This phenomenon is too speculative to permit any adjustments at this time to account for an increase in SOV share for satellite center-bound trips. However, this is a concern that could threaten the effectiveness of telecommuting to reduce VMT and should be watched closely.

The number of workers in each municipality to allow these calculations was determined using the data files assembled from the earlier effort (*10*).

TABLE 2 Participation and Trip Length Factors for Four Telecommuting Scenarios

Scenario	Home/Satellite	% Home TC	Trip Length Factor
5 percent	Home	80	2.00
	Satellite	20	1.50
10 percent	Home	75	1.80
	Satellite	25	1.40
20 percent	Home	67	1.70
	Satellite	33	1.35
40 percent	Home	50	1.50
	Satellite	50	1.25

RESULTS OF SCENARIO TESTING

Table 3 gives annual VMT estimates for the base condition. The impacts on VMT of applying these assumptions to the four scenarios are given in Table 4. The data are presented on an annual basis by using a factor of 250 weekdays in the year. Table 4 gives the VMT saved in three ways. First, it indicates VMT reductions as a percent of all VMT for each state. Second, it shows the VMT saved as a percent of all work VMT. Finally, the table presents percent VMT savings as a portion of VMT generated by SOVs as part of the daily work trip itinerary, including VMT not strictly to and from the work site.

The VMT reductions increase with rising participation rates, from 0.5 percent of total regional VMT savings in the 5 percent participation scenario to 3.0 percent in the maximum participation scenario. As a percent of work VMT the savings is much higher, ranging from 1.8 to 9.9 percent. The third column of savings, the savings as a percent of work-related SOV VMT, is still higher, ranging from 2.3 to 12.7 percent. But each successive scenario, with double the nominal rate of participation, does not yield a doubling of VMT savings. Two assumptions are largely responsible for this, both dealing with a changing character of telecommuters and telecommuting with the higher nominal participation rates—that "normal" trip lengths of participants will diminish and that more workers will use satellite centers.

Also significant is the variation in percent savings between eastern Massachusetts and the rest of the study area. The longer work trip lengths in that area led to much higher assumptions of the participation rates in telecommuting. Eastern Massachusetts is estimated to have about double the percent VMT savings of the other parts of the study area.

Suburban locations in particular tend to have greater absolute and relative savings because trip lengths are long and few potential telecommuters use transit. Rural areas, typified by western Massachusetts, have low gains because of the short trip lengths, which encourage fewer telecommuters.

The change in the number of cold starts is determined by estimating the vehicle trip reductions, assuming that each day a home telecommuter telecommutes, two trips (and two cold starts) are saved if they would otherwise have been SOVs. Telecommuters to satellites are assumed not to save vehicle trips. Telecommuters in carpools also are assumed not to save any vehicle trip making. In Table 5 the regionwide reduction in cold starts is shown to range from 50,000 for the minimal (5 percent) scenario to 260,000 per day for the maximum (40 percent) scenario. Here again, the savings increases more slowly with each scenario because the higher scenarios are assumed to have proportionally more satellite commuters, and traveling to satellite telecommuting centers does not reduce the total number of trips. The volume of cold starts associated with the trip to and from work from which these reductions are taken includes two cold starts for each SOV.

TABLE 3 Annual VMT Estimates, Base Condition

	Total VMT (mil.)	Work VMT (mil.)	Work-Related VMT by SOVs (mil.)
E. Mass.		8,480	8,319
W. Mass.	38,145*	3,091	1,516
R.I.	4,444	1,397	732
N.H.(3 cos.)	5,588	1,830	931
Total	48,177	14,799	11,499

* - eastern and western Massachusetts combined

TABLE 4 Impact of Telecommuting on VMT

	VMT Saved (mil.)	Percent Saved: Total VMT	Percent Saved: Work VMT	Percent Saved: Work-Related VMT by SOVs
5 % Telecommuting				
E. Mass.	220	--	2.6	2.6
W. Mass.	20	0.6*	0.7	1.3
R.I.	11	0.2	0.9	1.5
N.H.(3 cos.)	13	0.2	0.7	1.4
Total	264	0.5	1.8	2.3
10 % Telecommuting				
E. Mass.	387	--	4.6	4.7
W. Mass.	36	1.1*	1.2	2.4
R.I.	19	0.4	1.4	2.6
N.H.(3 cos.)	23	0.4	1.3	2.5
Total	465	1.0	3.1	4.0
20 % Telecommuting				
E. Mass.	714	--	8.4	8.6
W. Mass.	66	2.0*	2.1	4.4
R.I.	36	0.8	2.6	4.9
N.H.(3 cos.)	42	0.8	2.3	4.5
Total	858	1.8	5.8	7.5
40 % Telecommuting				
E. Mass.	1,214	--	14.3	14.6
W. Mass.	113	3.5*	3.7	7.5
R.I.	61	1.4	4.4	8.3
N.H.(3 cos.)	72	1.3	3.9	7.7
Total	1,460	3.0	9.9	12.7

* - eastern and western Massachusetts combined

TABLE 5 Cold Start Reductions by Telecommuting

Scenario/Region	Cold Starts Saved Per Day
5 Percent Telecommuting	
Eastern Massachusetts	37,233
Western Massachusetts	8,492
New Hampshire	5,212
Rhode Island	4,101
Region Total	*55,039*
10 Percent Telecommuting	
Eastern Massachusetts	69,812
Western Massachusetts	15,923
New Hampshire	9,773
Rhode Island	7,688
Region Total	*103,198*
20 Percent Telecommuting	
Eastern Massachusetts	124,731
Western Massachusetts	28,450
New Hampshire	17,462
Rhode Island	13,737
Region Total	*184,380*
40 Percent Telecommuting	
Eastern Massachusetts	186,166
Western Massachusetts	42,462
New Hampshire	26,062
Rhode Island	20,503
Region Total	*275,193*

ADDITIONAL EMPLOYER COSTS OF TELECOMMUTING

In this section an attempt is made to estimate the added costs for employers to establish telecommuting for their employees. Among the studies cited earlier in this paper, only one addresses the issue of costs for telecommuting quantitatively. JALA Associates (*3*), in its report on the California Telecommuting Pilot Project, tried to estimate the cost of added equipment in the home. The firm found that 83 percent of telecommuters already own their own personal commuters, and some own other such relevant equipment as answering machines (79 percent), facsimile machines (5 percent), and even copying machines (2 percent). The percent of nontelecommuters who owned their own equipment was not provided in a usable form. JALA also found that most of those who have computers have a personal preference to own them rather than have their employer provide them. The report also found that the added cost of computers is offset, in large part, by the reduced costs of providing computers at the workplace. Researchers were unable to do a complete cost accounting that would incorporate these factors and proceeded to make an assumption that computer costs were small per telecommuter but did not provide the estimate they used in their cost modeling.

JALA was able to be more definitive for some costs. The researchers found that the cost of training for a telecommuter/supervisor pair is \$300, added telephone charges are \$30/month, and computer maintenance is \$250/year. Other costs were either negligible or too difficult to estimate.

The difficulty of making these estimates is largely tied to the rapid advances in the capabilities of equipment related to telecommuting. Nevertheless, in an attempt to dimension the costs, personal experiences were relied on to a greater degree than is usual in this type of technical paper. Assumptions are as follows.

Home Telecommuting

It is assumed that a personal computer costs \$3,000 and is replaced every 5 years for an annual cost of \$600. However, not every telecommuter will require a computer because some will own them already. Also, there may be an offset because fewer computers may be needed at the home office, because workers are telecommuting. Still, to be conservative it is assumed that five of six acquire a new personal computer for an average annual cost of \$500.

Training comes to \$300, a cost repeated every 5 years at a cost of \$60/year. Telephone charges are \$30/month or \$360/year. Computer maintenance costs \$250/year. The assumption that two in three home telecommuters need a printer at a cost of \$800 each, with replacement in kind after 5 years, brings the cost per telecommuter to \$107/year. Printer maintenance is assumed to be \$80/year—the cost of one cartridge replacement on a laser printer. The total annual cost for each home telecommuter comes to \$1,357, or \$5.43/day.

Satellite Telecommuting

The cost of a personal computer of \$600/year can be shared by more than one telecommuter using the facility. With the average telecommuter telecommuting 1.75 days/week, the share of the computer cost per computer is lowered by a factor of 0.35 to \$210 per person.

Training is assumed to be the same as it was for home telecommuters, \$60/year. Annual computer maintenance charges of \$250/year are factored by 0.35 to bring that cost to \$88. The printer costs are divided among more people at the satellite centers. The combined annual cost of \$240 for purchase and maintenance is factored with the assumption that there will be 1 printer for every 10 persons, resulting in \$24 per telecommuter. Added telephone charges are assumed to be \$180/year, discounting the full \$360 cost to reflect some cost sharing of this item among telecommuters. The rental of space at the satellite center is assumed to be \$17.50/ft^2/year inclusive of all utilities and other services, factored by 0.35 because the space can be shared, yielding \$1,531 per telecommuter. The total annual cost for a satellite telecommuter equals \$2,039, or \$8.16/day.

The cost per day for home and satellite telecommuting is applied to the number of telecommuters assumed for each scenario, and the results are given in Table 6. The cost per VMT saved is considerably lower for eastern Massachusetts, a result of the long trip lengths there. Also, home telecommuting is less costly per VMT saved by about half, the result of lower costs per telecommuter combined with the lower VMT savings associated with satellite centers. Satellite center telecommuting may turn out to be even less cost-effective in reducing VMT if many trips now made to central cities by transit are replaced with travel by automobile to satellite centers in suburban automobile-oriented locations. Furthermore, the absence of reductions in cold starts for satellite telecommuting renders it highly questionable that satellite telecommuting will reduce vehicle emissions.

STEP-BY-STEP METHODOLOGY

The methodologies described in this section were applied to each municipality in the study area to obtain the results discussed earlier in this paper.

Calculation of VMT Reductions

1. Assume that the number of telecommuters equals the nominal participation rate (5, 10, 20, or 40 percent) multiplied by the number of workers in a municipality (from the earlier work) adjusted downward in municipalities where the work trip length is less than 10 mi, using a reduction factor for participation of 10 percent for every mile less than 10.0. Work trip lengths are those determined for each municipality in the study area in the earlier phase of this study.
2. Determine the number of participants on any given day by multiplying the number of telecommuters in Step 1 by 0.35 (the average days per week of telecommuting assumed as 1.75, divided by 5 work days per week).
3. Using the assumed splits for each scenario in Table 2, determine the number of telecommuters who work at home versus the number who work at satellite centers.
4. To account for the longer trip lengths for the subset of telecommuters compared with the average worker, use a trip length factor for each scenario and for both home and satellite telecommuters. These factors are also provided in Table 2. Note that the factors get smaller as the nominal telecommuting participation rates rise, reflecting the reduced effect of self-selection among longer-distance commuters. Note also that the factor is lower for satellite telecommuters because they are assumed to be less motivated to save commuting distance than are home commuters.

TABLE 6 Cost of Telecommuting

Scenario/Region	Daily Number of Telecommuters	Daily Work VMT Saved	Total Cost	Cost Per Work VMT Saved
5 Percent Telecommuting (Home)				
Eastern Massachusetts	27,149	740,272	$147,360	$0.20
Western Massachusetts	5,497	68,693	29,837	0.43
New Hampshire	3,293	44,020	17,872	0.41
Rhode Island	2,664	37,111	14,461	0.39
Region Total	*38,603*	*890,097*	*$209,530*	*0.24*
5 Percent Telecommuting (Satellite)				
Eastern Massachusetts	6,787	140,824	55,365	0.39
Western Massachusetts	1,374	13,066	11,210	0.86
New Hampshire	823	8,373	6,715	0.80
Rhode Island	666	7,059	5,433	0.77
Region Total	*9,651*	*169,321*	*$78,723*	*0.46*
10 Percent Telecommuting (Home)				
Eastern Massachusetts	50,905	1,222,072	276,300	0.23
Western Massachusetts	10,307	113,388	55,944	0.49
New Hampshire	6,174	72,661	33,511	0.46
Rhode Island	4,995	61,256	27,114	0.44
Region Total	*72,381*	*1,469,378*	*$392,868*	*0.27*
10 Percent Telecommuting (Satellite)				
Eastern Massachusetts	16,968	324,239	138,413	$0.43
Western Massachusetts	3,436	30,084	28,025	0.93
New Hampshire	2,058	19,278	16,787	0.87
Rhode Island	1,665	16,253	13,583	0.84
Region Total	*24,127*	*389,854*	*$196,808*	*0.50*
20 Percent Telecommuting (Home)				
Eastern Massachusetts	90,950	2,035,043	493,656	0.24
Western Massachusetts	18,415	188,818	99,953	0.53
New Hampshire	11,031	120,999	59,873	0.49
Rhode Island	8,925	102,007	48,443	0.47
Region Total	*129,321*	*2,446,867*	*$701,924*	*0.29*
20 Percent Telecommuting (Satellite)				
Eastern Massachusetts	44,796	819,269	365,409	0.45
Western Massachusetts	9,070	76,014	73,986	0.97
New Hampshire	5,433	48,712	44,318	0.91
Rhode Island	4,396	41,066	35,858	0.87
Region Total	*63,696*	*985,061*	*$519,572*	*0.53*
40 Percent Telecommuting (Home)				
Eastern Massachusetts	135,747	2,594,416	736,800	0.28
Western Massachusetts	27,485	240,718	149,183	0.62
New Hampshire	16,464	154,258	89,362	0.58
Rhode Island	13,321	130,045	72,303	0.56
Region Total	*193,017*	*3,119,437*	*$1,047,648*	*0.34*
40 Percent Telecommuting (Satellite)				
Eastern Massachusetts	135,747	2,260,076	1,107,301	0.49
Western Massachusetts	27,485	209,697	224,201	1.07
New Hampshire	16,464	134,379	134,298	1.00
Rhode Island	13,321	113,287	108,660	0.96
Region Total	*193,017*	*2,717,439*	*$1,574,461*	*0.58*

5. To account for the effect of shifts in residential location among telecommuters, assume that 15 percent of telecommuters will move to locations an average of 5 percent further away.

6. Calculate the driving distances saved on telecommuting days by assuming that each home telecommuter drives 75 percent less on nontelecommuting days and that each satellite telecommuter drives 67 percent less.

7. Reduce the driving distances on telecommuting days by 10 percent for the home telecommuters to account for the lower amount of driving observed for the home telecommuters on non-telecommuting days (the "anchoring" effect).

8. In Steps 6 and 7, to account for telecommuters who did not drive alone, discount the distances for only those who were assumed to travel in SOVs on the basis of the SOV shares for each municipality derived in the earlier work. Assume no change in modal shares for telecommuters on nontelecommuting days.

9. Calculate the percentage reduction in VMT by determining the work VMT, multiplying the average work trip lengths by the number of workers.

Trip Reductions

Calculate the vehicle trips to and from work saved as 2 × the number of workers × the SOV share × the nominal participation rate × the fraction of days home telecommuting occurs. This assumes that no trip savings occurs for satellite telecommuting or for home telecommuters on nontelecommuting days.

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Publication of this paper sponsored by Task Force on Transportation Demand Management.