Getting Results from TSM Planning: Baltimore's Corridor Study Approach

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A series of transportation system management (TSM) corridor studies was performed in the Baltimore region in conjunction with 1982 transportation control plan (TCP) activities. The primary objective of the studies was to identify specific implementable TSM actions that could improve the performance of the transportation system and reduce automobile emissions and energy consumption. A total of 27 corridors were initially selected for study, of which 7 were completed in preparation of the TCP. A detailed analytic and management approach was developed in order to conduct each corridor study efficiently. Continuing technical and policy guidance was provided by a project management committee consisting of federal, state, and local agency personnel. Public participation was also a major element of the process and provided valuable insight into local transportation concerns. A wide variety of TSM actions was considered, including traffic operations, transit programs, ridesharing, parking management, commercial vehicle programs, and bicycle and pedestrian programs. Each alternative action was evaluated by using several measures of effectiveness. The recommended TSM actions, with responsibilities specified, were grouped into packages as part of the implementation plan. The recommended TSM actions were found to be effective in meeting the project objectives, contributing significantly to the improvement of transportation services and the environment. Finally, the study process was determined to be transferable to other corridors in the region and has since been used for additional TSM studies.

In preparation for the 1982 transportation control plan (TCP), the Baltimore Regional Planning Council (RPC) initiated a major planning effort in 1979 to pursue intensive examination of the measures that had been identified in the 1979 TCP for further study or implementation. The transportation system management (TSM) and TCP activities were combined into a single TSM-TCP program to avoid duplication of effort.

The major emphasis was placed on implementation. The primary objective of the TSM-TCP planning was to identify specific TSM measures that could be implemented to improve the performance of the transportation system and reduce automobile emissions and energy consumption. A serious shortcoming of TSM planning to date had been its inability to stimulate implementation of significant TSM improvements.

Up to that time, the main approach to TSM planning was to study individual measures on a regional scale, mostly to investigate overall feasibility and impact, and to resolve major institutional constraints. However, this approach often failed to reach the level of detail needed to identify specific applications. Although this type of regional study was still needed, particularly for previously unstudied measures, a more detailed level of study was necessary to identify specific TSM projects.

To expedite the selection of implementable TSM projects, a series of corridor-subarea studies was initiated to allow site-specific analysis of problems and opportunities amenable to the application of TSM strategies. These were intended to be reasonably low in cost and fast-paced and to use available data as much as possible. It was expected that many of the major corridors in the region could be examined within a three-year period.

The ultimate success of this approach to TSM planning depended on both the development of a sound analytic process and the early and continued involvement of local and state agency personnel responsible for project implementation as well as the general public directly affected by travel conditions in the corridor. Direct participation in the studies helped to build a sense of ownership toward the study findings among implementors and the public alike, and this helped the study team to develop acceptable recommendations that had a high probability of implementation.

Corridors and subareas were initially recommended for study by the local jurisdictions and the state highway and transit agencies based on their knowledge of existing travel conditions in their respective areas. An evaluation of these initial recommendations by a committee of RPC, local, and state staff resulted in the designation of a corridor for a prototype study, six major multijurisdictional corridors to be studied by a consultant, and 20 smaller corridors to be subsequently studied by the RPC and the local jurisdictions. The prototype study was initiated by RPC and local staff primarily to test the overall study approach and to establish project management procedures and a meaningful public participation process.

JHK and Associates was selected to perform the six major multijurisdictional studies (1-6). These corridors are diagrammed in Figure 1. The corridors ranged in length from 7 to 20 miles, and the corridor widths were generally limited to the vicinity of the primary radial arterials under study. One corridor included several parallel facilities within a major transportation subarea. JHK developed the detailed analytic approach for the studies, incorporating the project management and public participation processes developed earlier in the prototype. This overall study approach was then used for all subsequent studies by RPC and local staff.

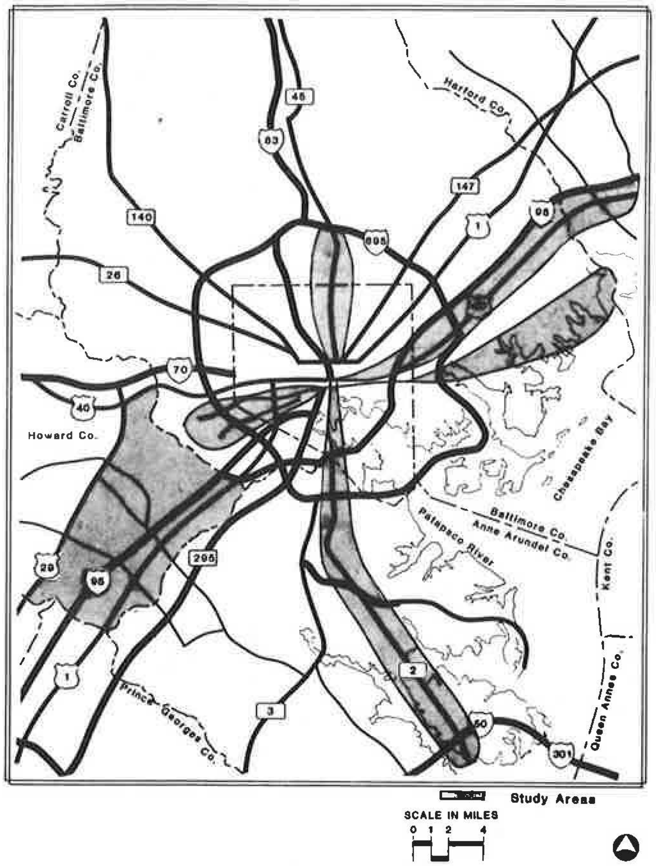
LOCAL INPUT: PROJECT MANAGEMENT AND PUBLIC PARTICIPATION

JHK and Associates was responsible for designing and carrying out the technical analysis for the corridor studies. In addition to working from data gleaned from its own observations and the results of previous studies, JHK took full advantage of the information and advice offered by technicians and citizens versed in the transportation problems and resources of each study area.

Technical and policy guidance for each corridor study was provided throughout by a project management committee (PMC). The PMC consisted of transportation planners and engineers from each of the participating jurisdictions as well as technical staff from relevant state agencies. A typical project management committee roster is outlined below:

1. Local transportation planning, traffic engineering, and air pollution control departments;
2. Planning and Operations Sections of the Maryland Mass Transit Administration (MTA);
3. Office of Planning and Preliminary Engineering of the Maryland State Highway Administration (SHA);
4. Planning Department of the Maryland Department of Transportation;
5. Maryland Air Management Administration of the State Department of Health and Mental Hygiene;
6. Transportation Planning Division of the RPC; and

Figure 1. Arterial TSM studies.



7. Regional Air Quality Task Force (RPC advisory committee on the TCP).

Given the multijurisdictional and multimeasure approach of the studies, the PMC meetings provided a particularly important forum for the exchange of views and cooperative decisionmaking among the various agencies involved.

PMC meetings were supplemented with localized technical meetings that focused on the characteristics of the corridor within each jurisdiction. A typical corridor under study might begin in a densely populated urban area, continue through commercial strip development, and terminate along a major thoroughfare in a rural setting. At these meetings, jurisdictional staff were usually the key source for much of the necessary technical data and provided valuable understanding about the local process for implementing projects.

The study approach also included a process for obtaining input from people who lived and worked in the study area. Because the corridor studies emphasized local transportation problems, it was considered essential to the study to involve people who experienced day-to-day travel conditions in the corridor.

Public participation was built into the work program at two critical points. The first round of community meetings was designed to assist in identifying transportation problems, opportunities, and potential actions. The input received at these meetings was used to refine the preliminary list of recommendations and to discover additional problems that had not been previously addressed. The second round of meetings was held to subject the study findings to citizen critique. The citizens' responses were used to determine whether the proposed actions adequately and feasibly addressed community transportation problems and needs. At the end of the study, final reports were made available at library branches and a special "popular" summary report was distributed directly to the citizens who had participated.

Staff from each of the participating jurisdictions took responsibility for initiating local publicity, communicating with interested individuals and groups, and organizing public meetings in their section of the corridor. Other members of the study team attended these meetings, but the local planners took the lead in public involvement activities because of their familiarity with the community and their ability to tailor the process accordingly.

In Baltimore City, where a cadre of "district planners" maintain ongoing connections with the numerous community organizations, public discussion of the corridor studies took place at the regular monthly meetings of interested groups. Other jurisdictions held special meetings open to the general public. Local transportation advisory boards, where they existed, were also involved in the study. Elected officials were kept apprised through periodic briefings.

Community meetings and the study in general were publicized through a variety of channels. These included press releases, which sometimes generated substantial newspaper feature stories or television news coverage; articles in the newsletters of key community or business organizations; and brochures and announcements that were distributed through the mailings of these same organizations as well as through merchants, employers, park-and-ride lots, libraries, and other available means.

In summary, the project management and public participation processes complemented the analytic work and were essential components of the overall study approach.

ANALYTIC APPROACH

The corridor studies were approached through a series of analytic activities. These activities included the definition of study goals and objectives, the identification of problems and opportunities in the corridor, and the selection of alternative TSM actions. The alternatives were then evaluated against each of the project objectives before recommendations were made for project implementation.

A set of goals and objectives was developed prior to the initiation of the corridor study. These goals and objectives were used to guide each step of the study process. Three major goals were identified:

1. Reduce air pollution,
2. Reduce energy consumption, and
3. Improve the efficiency and productivity of the transportation system.

These goals placed a heavy emphasis on the environmental impacts of the TSM actions. Improving transportation system efficiency and performance, while emphasizing improved mobility within the corridor, often supported the air quality and energy goals.

Associated with these goals were the following specific objectives:

1. Reduce air pollution emissions,
2. Reduce vehicle miles of travel (VMT),
3. Increase transportation system productivity,
4. Reduce delay and travel time,
5. Reduce energy consumption,
6. Improve system safety,

7. Promote desirable and minimize undesirable social and economic impacts of transportation improvements,
8. Spend monetary resources in the most cost-effective manner, and
9. Implement actions that are compatible.

Several technical tasks formed the basis of the study approach as diagrammed in Figure 2. These tasks included the following:

1. Perform preliminary activities (e.g., define study area, establish schedules, and determine groups),
2. Identify corridor problems and opportunities,
3. Identify alternative TSM-TCP actions,
4. Evaluate alternative TSM-TCP actions,
5. Recommend TSM-TCP actions, and
6. Prepare final report.

These tasks were documented in a series of technical memoranda (7-13).

ACTIONS CONSIDERED

As the corridor problems and opportunities (task 2) were being identified, a list was made of specific TSM actions to correct these situations. These alternative actions ranged from minor, low-cost improvements to major reconstruction projects or policy changes. Emphasis was placed on selecting those alternatives that could reasonably be expected to meet the primary objectives of the study in a cost-effective manner. The methodology used to identify problems and opportunities and to select possible actions combined a technical analysis of available transportation data, extensive field investigations, meetings with area citizens, and several interviews with key local and state agency personnel.

The types of actions that were considered are listed below and cover a wide spectrum of TSM improvements:

1. Transit programs--Bus route and schedule changes, express bus service, transfer improvements, marketing, bus stop changes, and bus turnouts;
2. Traffic operations and signalization--Intersection and roadway improvements, lane use restrictions, one-way streets, intersection signal improvements, reversible lanes, route diversion techniques, and corridor surveillance and control;
3. High-occupancy-vehicle priority treatments--High-occupancy-vehicle lanes, park-and-ride lots, bus signal priority, priority parking spaces and rates, and automobile-restricted zones;
4. Ridesharing--Employer-based carpool-vanpool matching program, residential-based carpool-vanpool matching program, and transit pass subsidy;
5. Parking management--Curb parking restrictions, off-street parking restrictions, residential permit parking program, and parking rate changes;
6. Commercial vehicle programs--Loading zone management, peak-period on-street loading prohibitions, and truck route designation; and
7. Bicycle and pedestrian treatments--Bicycle lanes, bicycle storage facilities, pedestrian crosswalks and signalization, and pedestrian malls.

These alternatives included actions aimed at improving overall vehicle movement (e.g., traffic operations and signalization) as well as actions primarily oriented toward improving the mobility of people (e.g., transit programs, high-occupancy-vehicle priority treatments, and ridesharing). Other actions such as parking management, commercial vehicle programs, and bicycle and pedestrian programs served multiple objectives, including the enhancement of residential and commercial areas.

As described above, the possible TSM actions selected for analysis responded to both specific corridor problems and opportunities. Problems were related to deficiencies in transportation service and safety. They included congestion points, locations with a high incidence of accidents, unreliable transit services, excessive truck movements, inadequate bicycle and pedestrian facilities, and inefficient parking patterns. Opportunities, on the other hand, focused on ways to enhance available services. For instance, high employment and residential densities were identified as potential ridesharing targets. Similarly, several locations were identified as possible sites for new park-and-ride lots.

A description of each corridor problem or opportunity with the associated TSM actions and a map depicting locations were prepared for discussion with the PMC and the community. Examples from the MD-2 corridor (8,10) are shown in Figures 3 and 4.

It was soon determined that many problems and opportunities could be best addressed with combinations of TSM actions. As a result, some packaging of TSM actions occurred early in the analysis. Because packaging generally strengthened the positive qualities of each individual action, this strategy enabled a wider variety of actions to be considered.

EVALUATION OF ACTIONS

To ensure that each action was evaluated in relation to the key study objectives, a set of 27 specific measures of effectiveness (MOEs), or criteria, was developed. The MOEs, given in Table 1, were selected as the most appropriate indicators of how well each action fulfilled the objectives.

The evaluation process included two elements: impact estimation and comparison of impacts. Impact

Figure 2. Corridor study process.

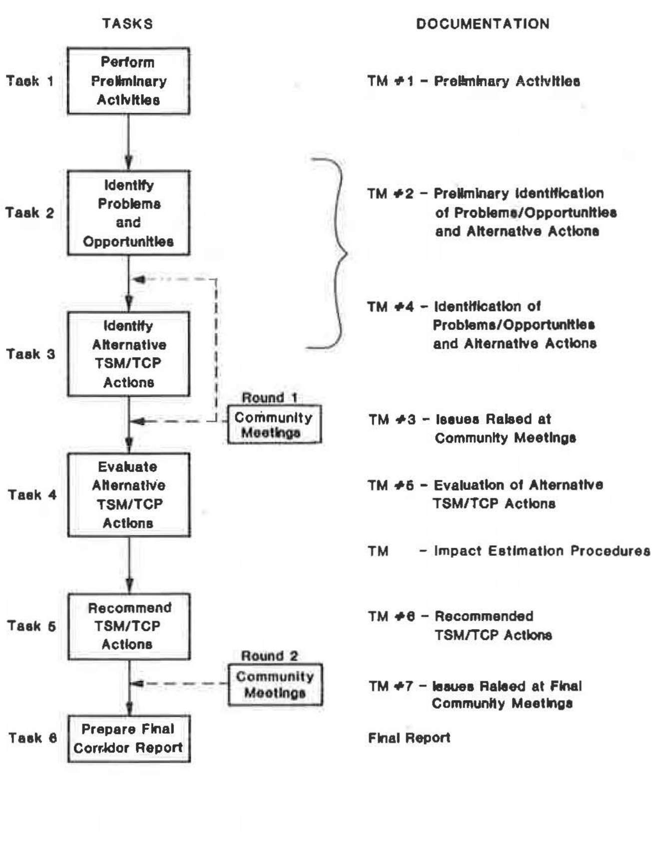
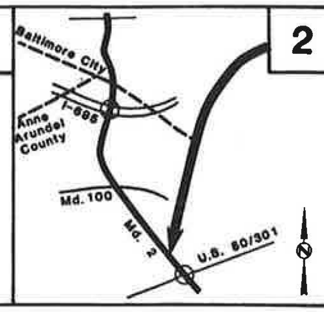


Figure 3. Example of identification of problems and opportunities and TSM actions.

MD. 2 CORRIDOR **2**



LOCATION : MD 2 and College Parkway

PROBLEM / OPPORTUNITY :

Intersection congestion

DESCRIPTION OF PROBLEM / OPPORTUNITY :

- Residential development and Anne Arundel Community College generate congestion during both peak periods. Expansion of the residential areas around Cape St. Clair is anticipated to exacerbate the problem. During the spring and summer College Parkway also receives heavy recreational traffic.

ALTERNATIVE TSM/TCP ACTIONS :

- Intersection improvements to include:
  - .. Extending RT lane from WB College Parkway to NB MD 2
  - .. Extending double LT lane from SB MD 2 to EB College Parkway
  - .. *Coordinating signals at MD 2/College Parkway and College Parkway/ Peninsula Farm Rd. to accommodate EB traffic*

    OR

  - .. *Coordinating signals at MD 2/College Parkway and College Parkway/ Peninsula Farm Rd. to accommodate WB traffic.*

Comments :

Figure 4. Locations of problems and opportunities.

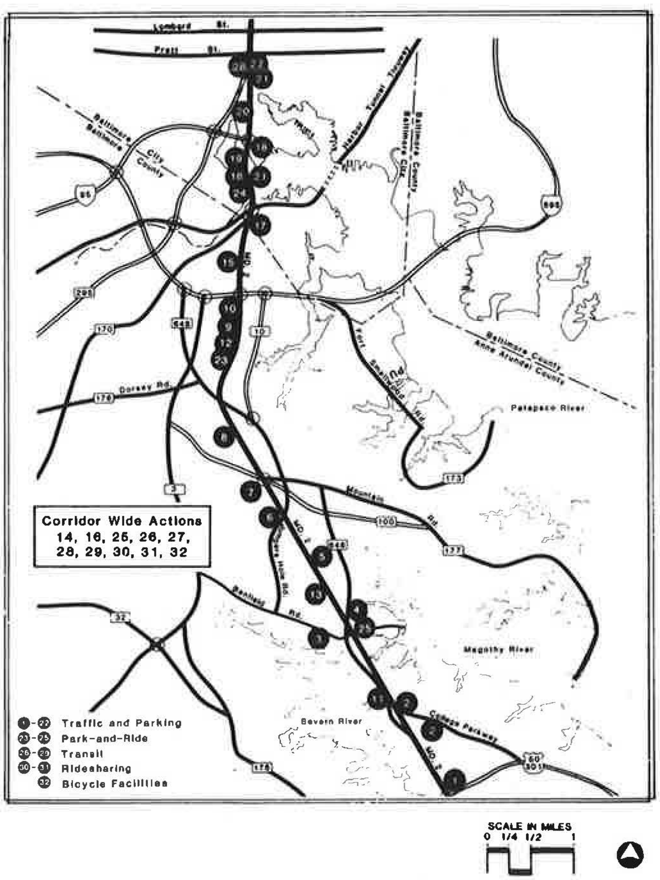


Table 1. MOEs used in TSM-TCP evaluations.

Category	MOE	Unit
Air quality	Changes in HC, NO_x, and CO	Kilograms per day
Energy	Changes in fuel consumption	Gallons per day
Transportation system productivity	Changes in VMT	Vehicle miles per day
	Changes in modal split	Bus riders per day and carpools per day
	Changes in vehicle occupancy	Occupants per vehicle
Transportation system efficiency	Changes in travel time	Minutes per vehicle
	Changes in speed	Miles per hour
	Changes in delay	Seconds per vehicle
	Changes in level of service	Vehicle hours per day
	Changes in vehicle hours of travel	Vehicle hours per day
Safety	Changes in system safety	Descriptive
Cost	Capital cost	Dollars
	Operating cost	Dollars per year
	Total annualized cost	Dollars per year
Cost-effectiveness	Cost per emission change in HC, NO_x, and CO	Dollars per kilogram
	Cost per change in fuel consumption	Dollars per gallon
	Cost per change in VMT	Dollars per vehicle mile
	Cost per vehicle hour of travel	Dollars per vehicle hour
Social and economic	Social impacts	Descriptive
	Economic impacts	Descriptive
Compatibility	Compatibility with other actions	Descriptive
Implementability	Likely public and/or political reaction	Descriptive
	Implementation process	Descriptive
	Funding source(s)	Agency(s), organization(s)
	Time required for implementation	Months, years

Figure 5. Example display of impacts.

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CORRIDOR: MD 2

TSM/TCP ACTION: Provide intersection and traffic flow improvements at MD 2 and College Parkway

DESCRIPTION OF ACTION:

Implement intersection improvements to include:

- Extending RT lane merge (at MD 2 and College Parkway) from WB College Parkway to NB MD 2
- Extending double LT lane from SB MD 2 to EB College Parkway

In addition to the above,

a) Coordinate signals at MD 2/College Parkway and College Parkway/Peninsula Farm Rd. to accommodate EB traffic 1/

b) Coordinate signals at MD 2/College Parkway and College Parkway/Peninsula Farm Rd. to accomodate WB traffic 2/

AIR QUALITY

Changes in HC: (Kg/day)	a) - 2.9	b) - 1.2 2/
Changes in NOx: (Kg/day)	a) - 3.9	b) - 1.0 2/
Changes in CO: (Kg/day)	a) -31.9	b) -13.4 2/

ENERGY

Changes in Fuel Consumption: (gal/day)	a) -43.2	b) -15.8 2/

TRANSPORTATION SYSTEM PRODUCTIVITY

Changes in VMT: (veh mi/day)	a) Negligible	b) Negligible
Changes in Mode Split:	a) No Effect	b) No Effect
Changes in Vehicle Occupancy:	a) No Effect	b) No Effect

TRANSPORTATION SYSTEM EFFICIENCY

Changes in Travel Time/Speed:	a) Negligible	b) Negligible
Changes in Delay / Level of Service:	a) -34.4 veh-hr/day	b) -23.5 veh-hr/day 2/
Changes in VHT: (veh hr/day)	a) -34.4	b) -23.5 2/

SAFETY

Changes in System Safety: a) and b) Both options will reduce conflicts between through and turning traffic on MD 2. Negligible change on College Parkway.

COST

Capital Cost: ($)	a) $72,000	b) $60,000 2/
Operating Cost: ($/yr)	a) $ 1,600 (maintain interconnect)	b) Negligible 2/
Total Annualized Cost: ($/yr)	a) $14,350	b) $10,620 2/

2

COST EFFECTIVENESS

Cost*/Emission Change: ($/kg)	HC	$190.60
	NOx	$190.60
	CO	$ 17.30
Cost*/Fuel Consumption Change: ($/gal)		$ 13.60
Cost*/VMT Change: ($/veh mi)		High
Cost*/VHT Change: ($/veh hr)		$10.60

SOCIAL AND ECONOMIC

Social Impacts: Negligible

Economic Impacts: Will improve accessibility to industrial parks on Patuxent Range Road.

COMPATIBILITY

Compatibility with Other Actions: Compatible with all actions, particularly Action #1.

IMPLEMENTABILITY

Likely Public / Political Reaction: Expected to receive positive reaction from truckers. Other reaction should be minimal.

Implementation Process: Include in State (SHA) capital program. Probably not a separate CIP project.

Funding Source(s): State (SHA); possible contribution from industrial park

Time Required for Implementation: 1 to 2 years.

COMMENTS

1/ The analysis of the phasing at this intersection indicated that a separate SB LT phase is not necessary to accommodate this movement. At the same time, total intersection delay would increase if a separate phase were implemented.

Coordination of this signal with Baltimore Street could feasibly be implemented along with Action #1, although this impact was not evaluated.

*= Total Annualized Cost

estimation was performed by using analytic tools that were appropriate for the evaluation of the specific types of TSM actions listed above. In most cases, state-of-the-art "quick response" analysis methods were combined with localized knowledge of the corridor to produce realistic assessments of the impact of each action. A technical memorandum was prepared that documented the impact estimation procedures (14).

Figure 5 shows a typical form used to display the impacts for the TSM actions being considered in a corridor (11). One evaluation sheet was prepared for each alternative action. The number in the corner of the form was keyed to the locations on the map shown previously in Figure 4. This allowed jurisdictional members of the PMC to assess quickly the potential impacts for their respective jurisdictions.

The second element of the evaluation task was to compare the impacts. A two-tiered analysis was performed. First, each action was reviewed for technical impacts. Pursuant to the primary goals of the study, emphasis was placed on the air quality, energy, and transportation efficiency impacts. In most cases, these three goals complemented each other. In some cases, other technical impacts were key factors in the evaluation. For instance, some actions that showed negligible environmental or mobility improvements but produced significant safety improvements were given a favorable evaluation. Conversely, some actions that were expected to degrade safety were placed lower in the final evaluation even though they exhibited good environmental or mobility impacts.

Once the technical review was completed, a critical examination was made of the degree to which the action met the institutional objectives. The key institutional objectives were those that pertain to cost and implementability. In most cases, the cost of the action had a direct bearing on its implementability, and in several cases these two factors overshadowed the technical impacts. In particular, cost was carefully scrutinized in light of the decreasing funds available for implementation of these kinds of actions.

To provide some comparisons between the technical and fiscal impacts, the cost-effectiveness of each action was analyzed. Cost-effectiveness was most useful for assessing more expensive actions in order to determine whether or not the level of expenditure was justified. The remaining objective, compatibility, was a major factor in the comparison of packages of actions.

MOE ratings for each alternative action were presented in a comparative format, as given in Table 2 (12). These ratings condensed the detailed impact information found in Figure 5 and assisted in the formulation of recommendations. The ratings also permitted packages of actions to be concisely evaluated across a wide range of impact areas.

PACKAGING OF RECOMMENDED TSM ACTIONS

The TSM actions recommended were the direct result of the impact evaluation. The findings of the technical and institutional evaluations resulted in a prioritized list of TSM actions and packages.

Packaging was considered essential for several reasons:

1. Some individual actions produced negligible impacts in relation to the project objectives; however, by packaging several actions, the combined impact was often more significant. For example, expanded express bus service in the MD-2 corridor indicated small ridership impacts as an individual action. However, when packaged with park-and-ride lots, the express bus service became more attractive.
2. Many TSM actions, such as traffic signal or transit service improvements, would be largely "invisible" to the public and might fail to gain the

Table 2. Example comparison of TSM-TCP actions.

			MOE											
Action No.	Location	Action	Air Quality	Energy	Cost	Cost-Effectiveness	Productivity	Efficiency	Safety	Social-economic	Compatibility	Implementability	Priority Level	Reason for Priority Level
1	MD-2/US-50/301	Improve signs and lane markings	o	o	+	+	o	+	++	o	+	+	1	Low cost; very good safety benefits; good compatibility with other actions
2a	MD-2/College Parkway	Provide intersection and traffic flow improvements	+	+	-	o	o	+	+	o	+	+	1	Moderate air quality, energy savings, and cost-effectiveness; slight safety improvement; high capital cost
2b	MD-2/College Parkway	Provide intersection and traffic flow improvements	+	+	-	-	o	+	+	o	+	+	3	Only slight air quality and energy savings; high cost and poor cost-effectiveness
3	Robinson/Benfield	Install traffic signal	-	-	o	-	o	-	++	+	+	+	2	In spite of negative air quality impacts, offers very good safety benefits at moderate cost
4	MD-2/Robinson/MD-648	Provide intersection improvements	+	o	o	-	o	+	++	o	+	+	2	Moderate air quality and energy improvements; good safety benefits; moderate cost
5	MD-2/Pasadena	Provide intersection improvements	+	o	o	o	o	+	+	o	+	+	2	Slight air quality and energy improvements; good system efficiency and safety benefits; moderate cost
6	MD-2/Jumpers Hole	Provide intersection improvements	+	o	-	-	o	+	o	+	+	+	2	Slight air quality, energy, and efficiency improvements; good compatibility with other actions; relatively high cost

Note: + = favorable, ++ = very favorable, o = negligible or average, and - = adverse or poor.

support necessary for implementation. Packaging these actions with higher-visibility projects such as improved intersection geometrics or bus stop amenities often improved their chances of being carried out.

3. The costs involved in undertaking groups of similar projects in a given location were considered to be less in some cases than the costs of implementing each action separately.

4. Packaging provided a convenient means of categorizing actions for inclusion in a capital improvement program.

To produce realistic packages of recommendations, three priority levels of actions were identified:

Priority Level	Definition
1	Highly recommended
2	Recommended if additional funds are available
3	Not recommended

Priority level 1 included those actions that were recommended for implementation. These actions were generally those that showed favorable mobility, energy, and air quality impacts, a good cost-effectiveness value, and reasonable implementability. Priority level 2 actions were those that typically showed negligible or, in some cases, adverse mobility, energy, or air quality impacts but that favorably met other objectives such as improving safety or social and/or economic conditions. Some priority level 2 actions showed moderate air quality improvements or energy savings but were costly and thus produced poorer cost-effectiveness values. These were also considered to be more difficult to implement because of budget constraints. Priority level 3 actions were those that were not recommended for implementation. The three priority levels were shown in the evaluation results (Table 2).

The result of the evaluation was a set of recommended TSM packages. Within priority levels 1 and

Table 3. Example of recommended TSM-TCP actions.

TSM/TCP Package	Action No.	Action	Priority Level	Primary Implementing Agency: Baltimore City	Anne Arundel County	State: SHA	MTA	Cost: Capital ($)	Operating ($/year)	Package Impact Emissions (kg/day): ΔHC	ΔNO_x	ΔCO	ΔFuel
Traffic operations	1	Improve signs and lane markings at MD-2/US-50/301	1			x		4 000	*	-0.4	-0.5	-5.5	-3.0
		Provide intersection and traffic flow improvements at MD-2/College Parkway	1		x	x		72 000	1 600	-2.9	-3.9	-31.9	-43.2
		Install traffic signal at Robinson Road/Benfield Road	2		x			30 000	3 000	+3.8	+6.2	+40.4	+46.9
		Provide intersection improvements at MD-2/Robinson Road/MD-648	2			x		50 000	*	-1.0	-0.8	-10.5	-11.7
		Provide intersection improvements at MD-2/Pasadena Road	2		x			25 000	*	-0.6	-0.9	-6.2	-8.9
		Provide intersection improvements at MD-2/Jumpers Hole Road	2		x	x		80 000	*	-0.6	-0.5	-6.0	-7.4
		Improve signs and lane markings at MD-2/MD-100	1			x		40 000	*	-0.7	-0.8	-9.8	-4.1
		Provide intersection improvements at MD-2/Aquahart Road	1			x		100	*	*	*	*	*
		Provide intersection improvements at MD-2/Burwood Avenue/New Ordnance Road	1		x	x		37 000	*	-3.5	-2.5	-40.2	-45.8
		Provide traffic safety improvements at MD-2/MD-648 connector north of College Parkway	2			x		75 000	*	-2.0	-2.8	-28.9	-21.9
		Provide intersection improvements along Hanover Street north of Patapsco River Bridge	1	x				8 000	5 000	-1.6	-1.3	-16.6	-18.9
		Improve directional sign messages along MD-2 within Baltimore City	1	x				1 000	*	*	*	*	*
Subtotal			1					428 000	12 700	-123.6	+36.4	-1517.9	-1720.3
			2					440 000	3 000	-0.7	+0.5	-26.5	-17.8
Total package								868 100	15 700	-124.3	+36.9	-1544.4	-1738.1
HOV priority treatments	9	Improve signing for Glen Burnie park-and-ride lot	1				x	1 000	500	-0.2	-0.5	-2.3	-8.1
	21	Provide parking lot improvements at Hanover Street park-and-ride lot	1	x			x	6 700	+7 030	-0.4	-1.1	-5.3	-18.6
	31	Establish and promote park-and-ride lots using off-street locations	1		x	x	x	206 450	+9 400	-4.3	-12.1	-56.9	-198.1
Subtotal			1					214 150	+15 930	-4.9	-13.7	-64.5	-224.8
Total package								214 150	+15 930	-4.9	-13.7	-64.5	-224.8

Note: * = negligible.

Table 4. TSM corridor study results.

Corridor	No. of Recommended Actions[a]	Mobility Impact		Energy Impact (gal/day)	Air Quality Impact (kg/day)			Capital Cost ($000s)	Operating Cost[b] ($000/year)
		VHT per Day	VMT per Day		HC	NO_x	CO		
1	26	1 879	54 183	2 642	70	158	896	1800	-35
2	28	2 795	79 144	3 527	99	202	1262	2500	+286
3	14	1 490	44 000	2 385	68	154	843	1900	-4
4	19	2 680	89 890	4 371	102	270	1324	790	+18
5	32	5 564	87 803	5 797	227	245	2896	1253	+55
6	15	4 862	158 220	7 048	169	428	2167	1340	+123
Total	134	19 270	513 240	25 770	735	1457	9388	9583	+443

[a]Total of priority level 1 and 2 actions. [b]+ = net annual cost; – = net annual cost savings.

2, the actions were grouped by functional category (e.g., traffic operations and parking, ridesharing, etc.) and by primary implementing agency. Several agencies often shared responsibility for implementing a particular TSM action or package.

Table 3 gives a selection of the TSM actions recommended for the MD-2 corridor (12). In addition to displaying the packaging of actions, priority level, and primary implementing agencies, Table 3 gives the key financial (capital and operating) and environmental (air quality and energy) impacts. The impacts for each package were subtotaled for each priority level and then summed for the total package. This format provided each implementing agency with a clear indication of its responsibilities as well as the impacts to be expected of each recommended TSM action.

STUDY RESULTS

These studies showed that TSM actions can provide substantial transportation and environmental improvements along arterial corridors. Table 4 summarizes the expected impacts for all recommended actions in the six corridors studied. These impacts were found to be significant when compared with other transportation actions in the Baltimore region. For example, the expected 735-kg daily reduction in HC represented more than 15 percent of the region's goal for reducing HC from transportation sources. Together, these corridor improvements could be accomplished at a lower cost than a typical major highway construction project.

The packages of TSM actions each contributed differently to the impacts given in Table 4. The ridesharing packages were found to contribute more than two-thirds of the mobility, energy, and air quality benefits at less than 5 percent of the total cost of all the recommended actions. Traffic operations and parking management actions together constituted roughly half of the total costs while contributing about 20-30 percent of the mobility, energy, and air quality benefits. Transit operational packages, combined with park-and-ride lots, were found to provide 5-10 percent of the benefits at about 25 percent of the costs. Other packages, such as bicycle and pedestrian actions, commercial vehicle programs, and high-occupancy-vehicle priority treatments (exclusive of park-and-ride lots), had relatively low costs but did not contribute significantly to mobility, energy, or air quality benefits in these corridors. However, these actions often fulfilled other social or economic objectives that were important in the evaluation.

CONCLUSIONS

Several conclusions emerged from the TSM corridor studies. The analysis process used in the studies enabled a full range of TSM actions to be identified and evaluated in a cost-efficient manner. The use of standardized presentation formats assisted in the review and comparison of results by technical staff and decisionmakers. The final recommendations were depicted in sufficient detail to enhance the prospects for implementation. Agency responsibilities and costs were specified, and the interactions among projects within various TSM packages were explained.

Overall, the recommended packages of TSM actions were found to be effective in meeting the project objectives of improved air quality, conserved energy, and reduced traffic congestion. In particular, the studies demonstrated that traffic-flow improvements on congested arterials could have positive air quality impacts, which contradicted previous notions that such improvements invariably resulted in more travel and more pollution. The analyses allowed the RPC for the first time to estimate potential regionwide impacts of traffic-flow improvements at alternative funding levels.

The corridor study recommendations were a major source of committed projects for inclusion in the Baltimore region's 1982 TCP. In fact, many of the recommendations are now being implemented or are included in current operating or construction programs. The success of the study approach is further verified by the inclusion of additional corridor studies in the current work programs of several jurisdictions in the region.

Public participation played a vital role in identifying corridor problems and opportunities, in selecting appropriate packages of actions, and in determining the implementability of various alternatives. The public meetings allowed community members to air some longstanding concerns about transportation in the corridor area and to suggest workable alternatives. In turn, the corridor study meetings and accompanying publicity sparked a greater public awareness about the issues being addressed.

Finally, the corridor study process provided a forum in which local, state, and federal agency personnel could meet and discuss TSM projects that require multiple-agency participation. The cooperative project management process, together with public participation efforts, complemented the analytic work and resulted in recommendations that were both better and more likely to be accepted.

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Summary of Operational Characteristics and Anticipated Evaluation of I-66 HOV Facility

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In late 1982, the final section of I-66 in the Washington, D.C., suburbs in Northern Virginia was opened to traffic after a lengthy and controversial developmental process. The final product of that process is a four-lane, limited-access, parkway-type facility from which heavy-duty trucks are excluded at all times. Peak-period, peak-direction use is restricted to high-occupancy vehicles (HOVs), emergency vehicles, and vehicles bound to and from Dulles Airport. Finally, to maintain safe and efficient traffic flows on the facility, a comprehensive, computer-controlled traffic management system (TMS) will be installed. Basic elements of the system include closed-circuit television, ramp metering, motorist advisory signing, and interface with adjacent traffic signal systems. The Virginia Department of Highways and Transportation, with funding from the Federal Highway Administration, has undertaken a study of this section of highway. The objective is to evaluate I-66 and the HOV restrictions and the TMS. The results of the study will prove valuable in assessing the merits of the concepts used and in planning projects of this nature. A summary of the history, design elements, operational characteristics, and anticipated evaluation of the final section of I-66 is presented.

The approximately 10-mile-long section of I-66 between the Capital Beltway (I-495) in the Virginia suburbs of Washington, D.C., and the Potomac River was opened to traffic on December 22, 1982 (see Figure 1). Estimated to cost $300 million, the facility is heavily traveled by commuters to and from the nation's capital.

Considerable controversy has surrounded the project, which has evolved into a four-lane, limited-access facility. Heavy-duty trucks are excluded at all times, and high-occupancy vehicles (HOVs)--buses and vanpool and carpool vehicles carrying four or more persons--emergency vehicles, and vehicles bound to or from Dulles Airport are the only vehicles allowed on the facility in the peak direction during peak hours. A detailed plan to enforce these restrictions has been developed. Consideration has also been given to environmental issues in the design of the facility to ensure maximum compatibility with the surrounding area.

In addition, a comprehensive traffic management system (TMS) to control and facilitate the flow of traffic will be implemented by the spring of 1983. The elements of this system include an enforcement plan, ramp metering, closed-circuit television (CCTV), variable message signs, incident detection, lighting, and central control. The system will also be implemented on an existing segment of I-395 that contains the reversible HOV lanes. That segment extends from the vicinity of the Springfield interchange just south of the Capital Beltway to the District of Columbia (Figure 1). Both facilities will be under interim control by the TMS for approximately one year as the various elements are implemented. The TMS should be fully operational by early 1984.

The concepts being incorporated into these sections of I-66 and I-395 represent the most recent technology in traffic control and management and offer the potential for the most efficient use of the facility. Accordingly, the Virginia Department of Highways and Transportation, with funding from the Federal Highway Administration (FHWA), has initiated a study to investigate and evaluate the operation of the section on I-66 and the TMS on both I-66 and I-395.

In light of the national interest in the I-66 facility, this paper has been developed to (a) briefly recount the history of I-66, (b) describe the TMS to be used, and (c) outline the evaluation to be undertaken.