

Roles of Metropolitan Planning Organizations in Pavement Management

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In recognition of the need for local pavement management and the issues surrounding the possible involvement of the metropolitan planning organization (MPO), the ways in which MPOs have participated in local pavement management activities were studied and a framework that could be used as a guide to identifying the appropriate role and set of responsibilities of MPOs in the conduct of local pavement management studies and projects was formulated. Case studies of the pavement management experiences of four regional planning agencies (RPAs) in Massachusetts are reviewed. These RPAs, which provide staff support to their MPOs, have participated in local pavement management studies and have attempted to integrate such efforts into the regional transportation planning process. The framework consists of eight elements covering the major issues and activities pertaining to pavement management and is intended to be used as a guide for MPOs in the conduct of local pavement management activities. In addition, the flexibility of the framework facilitates the incorporation of the results of pavement management studies into the urban transportation planning process and specifically into the transportation improvement program. A number of conclusions pertaining to the variety of roles MPOs could play in local pavement management are presented, and the need for MPOs to seek assistance from individuals who are not members of the MPO staff is described.

The promotion, development, and implementation of a proper pavement management system has been of interest to both metropolitan planning organizations (MPOs) and local governments (1). Typically the road network in any planning region may be identified as a component of a system under various jurisdictional controls, namely, federal, state, county, city, and town. As a result, requirements and funding responsibilities depend on who has jurisdictional control and several other factors, including traffic volumes, environmental conditions, and the original pavement structure. Therefore, it is important for all levels of government within a specific regional area to establish the proper cooperative effort and the required communication channels to maximize fully the benefits of pavement management.

The benefits to be derived from the use of a pavement management system (PMS) accrue to local and regional agencies. For example, local agencies would be able to maintain a data base for assessing the condition of the road networks within their communities and also to identify the competing infrastructure needs. In addition, the PMS would provide the local agency with an objective tool that would aid decision makers in scheduling roadway investments and maintenance actions, and for those local communities in which a PMS is in place, an added benefit would be the formulation of more cost-effective alternatives at the project level. Benefits realized by the MPOs include the ability to develop a comprehensive

data base for their respective regions that would help address the regional transportation needs and also perhaps help state transportation agencies improve the state PMS data base. The PMS could be used to help in selection of projects for the transportation improvement program (TIP). At any point the regional pavement infrastructure needs could be generated from the PMS data base and the potential funding requirements could be determined; MPOs may then be in the position of helping local communities develop and assess alternative forms of funding for locally maintained roads. Finally, MPOs may also assist in the coordination of resources between local communities with similar needs. Given the nature of this cooperative effort, it is reasonable for the MPO to be directly involved in local pavement management. Further discussions of local and regional benefits associated with the use of a PMS have been presented by others (2,3).

This paper presents a framework to assist MPOs in the determination of their proper roles and responsibilities in pavement management. The framework essentially consists of elements (or activities) in which MPO involvement may be limited or extensive, with MPO involvement being determined by factors such as expertise of MPO staff, local roadway conditions, and available funding for improvements.

PAVEMENT MANAGEMENT SYSTEMS

Billions of dollars are invested in roadway infrastructure annually to ensure the mobility of people and goods. As a component of these investments the restoration of roadway infrastructure requires the continuous flow of resources to maintain and rehabilitate highway pavements for the purpose of protecting the required surface conditions and structural capabilities. In view of the problems of inflation, deteriorating road conditions, increasing traffic loading, and reductions in funding, the maintenance and rehabilitation process presents a complex management challenge (4). This task involves studying pavement networks and conditions, deciding on maintenance strategies, setting priorities, and making investment decisions, which together constitute the pavement management process.

In the past 20 years the concept of pavement management has become an active process at federal, state or provincial, regional, and local levels (3,5,6). This concept has become increasingly important in the highway community in the past 10 years (7). The pavement management concept continues to expand and is considered for use at all levels of government at varying levels of detail and sophistication. As described elsewhere (8) PMSs are primarily a set of analytical tools or methods that assist decision makers in finding optimum strategies for maintaining pavements in a serviceable condition over a given period of time. For some systems implementation is labor-intensive and time-consuming, whereas for others it is

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simple and the PMSs are easy to use. It has also been determined that data requirements can be extensive, and computer facilities may be required (2).

CASE STUDIES

This section summarizes case studies of the pavement management activities of four regional planning agencies (RPAs) in Massachusetts, all of which represent the staffs of the MPOs. The geographic locations of the four MPOs are shown in Figure 1. The regional areas served by these MPOs include rural and urban settings.

Tables 1 to 3 provide a comparison of various characteristics of the pavement management (PM) processes in each of the four RPAs, which include Pioneer Valley Planning Commission (PVPC), Old Colony Planning Council (OCPC), Southeastern Regional Planning and Economic Development District (SRPEDD), and the Metropolitan Area Planning Council (MAPC). The major findings of the case studies are as follows:

1. The four RPAs—PVPC, OCPC, SRPEDD, and MAPC—participated in local pavement management primarily to develop and implement a continuous and systematic method of optimizing scarce public funds available for local road maintenance, rehabilitation, and reconstruction.

2. RPA involvement in local pavement management in Massachusetts has been encouraged because of the availability of federal and state funding in the comprehensive, continuing, and cooperative (3C) transportation planning program. This involvement began in the early to middle 1980s.

3. Before the conduct of the present research the Massachusetts Department of Public Works (now the state Department of Highways) indicated that local PM activities may be proposed within the annual work program of each RPA. Therefore, if an RPA considered PM to be a priority it would include PM within the proposed work plan. At the time of the present research only the four RPAs listed had included major PM activities in their work plans and had conducted substantive PM work. In the past year several additional RPAs have included PM in their work programs. Given that PM activities are considered for inclusion in annual work plans, PM activities compete with other work plan activities such as transit, bicycle, air quality, and other work plan projects.

4. In general, the roles and levels of involvement of RPAs have varied from promotion, education, software development, and training to participation in the conduct of the individual activities within the respective PMS. The level of involvement in the pavement management programs consisted of policy planning and network-level analysis in a limited number of towns in each region.

5. Two potential PMS development strategies are observed. Whereas PVPC and MAPC developed their own software without major outside assistance, OCPC and SRPEDD used available software packages and modified them to satisfy the needs of the local communities. OCPC used software available from the San Francisco Bay's Metropolitan Transportation Commission, and SRPEDD selected the New Hampshire Rural Technical Assistance Program's software.

6. Local community participation increased steadily as a result of the promotional aspects currently present in some RPA areas. It should be emphasized that very little local pavement management activity has occurred in these regional areas apart from those efforts initiated by the respective RPAs.

7. The focus of these regional and local efforts has been on roads under local jurisdiction. For this and other reasons, integration of the various PMS results into the 3C transportation planning process has been absent. In addition, the absence of a defined and systematic approach makes it difficult for MPOs to integrate such pavement management efforts into the annual TIPs.

8. Almost no follow-up of local pavement management studies has occurred, and no steps have yet been taken to incorporate pavement management study results into the TIP. However, it should be noted that actions are being initiated by the RPAs to address the issues of follow-up and TIP programming.

9. Table 4 provides a summary of the highway programs that the four RPAs coordinate and presents the programs within which pavement management results might be programmed and integrated into the transportation planning process. The federal aid programs are standard programs for which all MPOs in the United States are eligible. In addition, there are non-federal aid programs unique to Massachusetts, including the Chapter 90 Program and the Public Works and Economic Development program.

FRAMEWORK

As presented in Figure 2 the framework consists of eight major elements. An element is an activity or group of activities with specific purposes. This framework is designed to provide flexibility for different pavement management models, systems, and procedures to be used in the major elements listed. Table 5 presents examples of such activities within each of the eight major elements.

Five important roles identified for the MPO in the conduct of local pavement management may be described as follows: an initiator, in which the MPO might give a presentation to a local public works committee of the costs and benefits of local pavement management, which would lead to the conduct of a network-level study carried out by the city or town; a facilitator, in which the MPO makes it easier for the local government to perform an activity, for example, the MPO might provide computer expertise by processing the distress data collected by local officials; a coordinator, a role in which the MPO brings local communities together to a joint activity such as bulk purchasing of materials or services; a trainer, in which the MPO is involved in providing instruction to local personnel, perhaps related to the conduct of a distress survey; and a doer, in which the MPO executes or performs a task such as actually carrying out the survey.

A detailed description of the elements in the framework follows. In addition, the extent of an MPO's involvement and the various roles are discussed.

Education and Promotion

The education and promotion element covers the promotional and educational aspects of the PM process. It initiates the PM process and constitutes an important aspect that fosters different levels of local community involvement. Results from the four case studies indicate greater participation in regions where MPOs embarked on educational and promotional activities.

MPOs involved in this element might be termed *initiators*. At the regional level MPOs may have a higher degree of involvement in this activity aimed at creating PM awareness within local communities and convincing communities to participate in the ongoing

Massachusetts
City & Town Lines

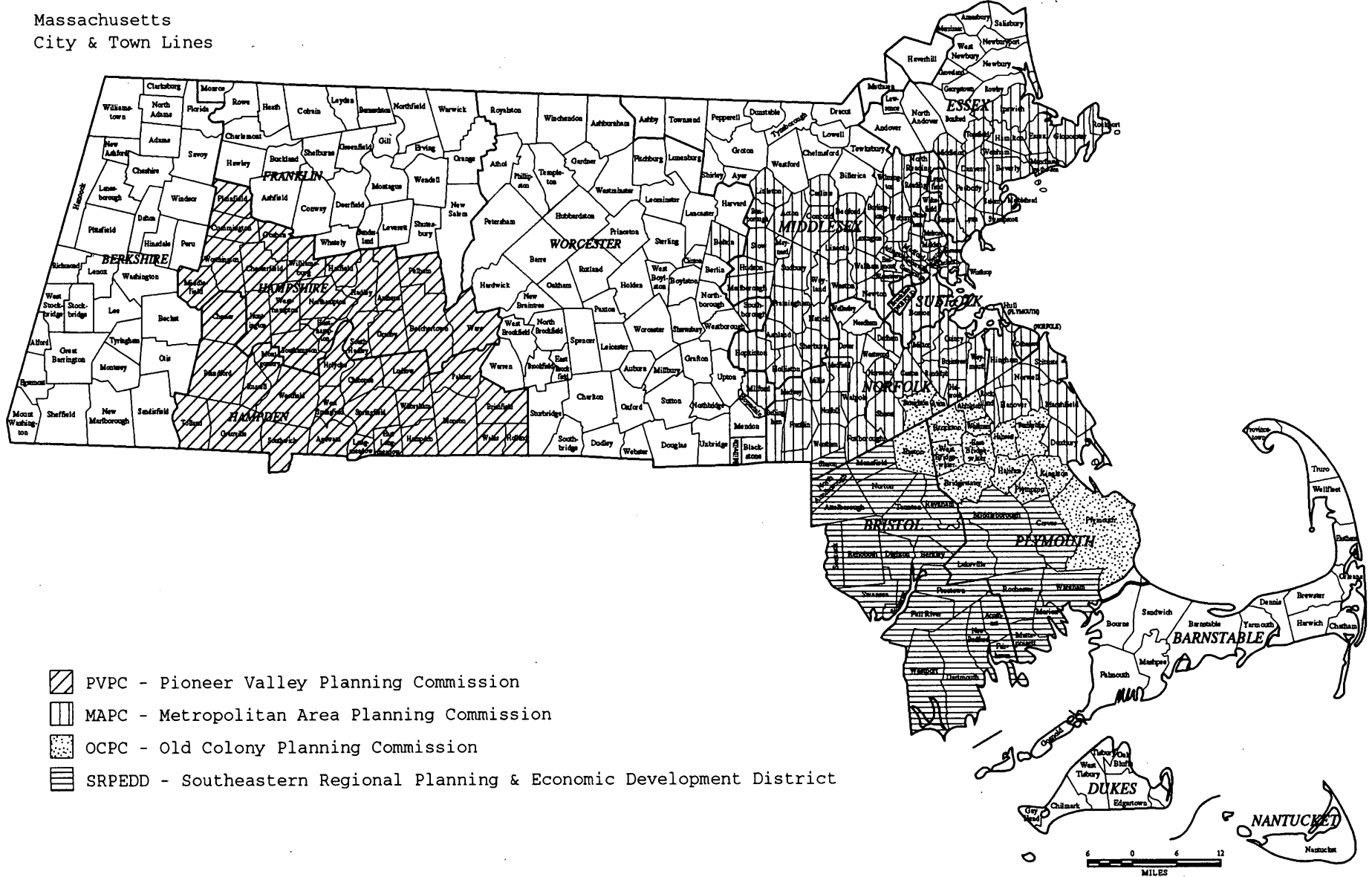


FIGURE 1 Geographic locations of case study areas.

TABLE 1 General Information on RPAs

AGENCY	URBANIZED AREA	**AREA POPULATION	CITY/* TOWN ROAD MILEAGE	DATE OF PM INVOLVEMENT
PVPC	Springfield-Chicopee-Holyoke urbanized area (43 cities and towns)	602,878	3,252.50	1984
OCPC	Brockton Urbanized area (15 cities and towns)	293,745	1,634.48	1987
SRPEDD	Fall River-New Bedford-Taunton urbanized area (28 cities and towns)	565,514	2,589.00	1984
MAPC	Boston metropolitan area (101 cities and towns)	2,922,934	9,520.00	1984

*Source: Massachusetts Dept. of Public Works, Road Inventory Program.

**Source: U.S. Census Bureau, 1990 Population.

process. This effort should present PM concepts to town and city managers, elected officials, selectmen, highway superintendents, and public works officials. Activities that are part of this element might include public presentations and the preparation of brochures on the concepts, contents, benefits, and extent of commitment associated with PM. Emphasis is often placed on the benefits achieved with minimal expenditure of resources. Expected results would be the adoption by communities of a PM program and personnel and funding commitments toward its development and implementation. MPOs may only have to deal with communities in their planning regions with a work activity already defined in the 3C planning work program. It should be noted that some RTAP centers and private consultants have already participated in promoting PM and in offering PM training workshops to local officials.

Policy Planning

The Policy planning element addresses issues pertaining to the formulation of local policies, goals, and objectives. When necessary and appropriate local officials such as the town highway superintendents may solicit assistance from the MPO. Key issues within this activity include assessing current and past maintenance policies, defining managerial and physical objectives, and investigating funding requirements to maintain an acceptable road network con-

dition and to meet future needs. The local commitments necessary to ensure a continuous PM process are also identified. The extent of MPO involvement in this element may not be extremely extensive, and the MPO role might be that of facilitator.

Network-Level Analysis or Systems Planning

Of those PM efforts in which MPOs have been involved, the network-level analysis or systems planning element has been the one in which MPOs have been very active. A review of the literature indicated that the majority of the PMSs developed and implemented in local communities have been geared toward addressing network-level needs. A number of activities ranging from network section definition, data selection and collection, and manual or computerized data processing and analysis to priority setting, budgeting, the generation of reports, and implementation are contained within this element.

The network analysis might be executed by using one of the several computerized network-level PMSs available. The roles and responsibilities of the MPO and local agency within this element largely depend on the particular PMS to be adopted and the development and implementation goals.

Depending on the level of expertise within the respective local agency and MPO, local personnel might require training on the

TABLE 2 RPA PM Level of Operation and PMS Development

AGENCY	PM LEVEL OF OPERATION	PMS DEVELOPMENT	PMS CHARACTERISTICS			
			Data Collection		Data Analysis	
			Manual	Computerized	Manual	Computerized
PVPC	Network Level	In-house	X	X	X	X
OCPC	Network Level	Adopted MTC system		X		X
SRPEDD	Policy Planning	MAPC's PM forecasting model				X
	Network Level	Adopted NH RTAP RSMS	X	X		X
MAPC	Policy Planning	In-house				X
	Network Level	In-house	X		X	

PMS. This basic training may cover data collection and processing and computer hardware and software techniques. For the PMS adopted and implemented by local communities with MPO assistance, this training role may be carried out by the MPO, the state RTAP center, or a private consultant. In some communities MPOs may be involved in data collection and analysis at the initial stages of the pavement management program. When computerized techniques are used in the PMS, MPOs may provide equipment or coordinate sharing of hardware and software for those communities that cannot afford the initial capital costs. It should be noted that the extent of MPO involvement in this element may range from minimal to extensive, and roles may be as a facilitator, trainer, or doer.

Project-Level Analysis

The project-level analysis element usually involves more technical and engineering activities, including pavement design. Results of case studies show the absence of MPO involvement in this aspect of the PM program. Project-level analysis is usually well executed through professional engineering organizations. However, MPOs may be useful in coordinating the hiring or joint hiring of consulting services and the preparation of contract documents for those local communities that may need project-level assistance. This will enable communities with limited resources to combine such resources and also to control and monitor such consulting activities. MPOs may therefore be coordinators within this element, with a relatively minimal extent of involvement.

Programming

The programming element is primarily aimed at directing and integrating the final products of both the network- and project-level elements into the respective regionwide transportation planning program.

Final priority ranked projects for pavement rehabilitation, reconstruction, and maintenance selected through the network and project analyses may be integrated into the 3C planning process through their inclusion in the regionwide TIPs.

Pavement rehabilitation and reconstruction projects resulting from network- and project-level analyses on roads under the federal aid system may be listed in the regionwide multiyear element in the TIP if funding is expected or in the annual element if funding commitments have been made. Non-federal aid projects may also be listed in the respective sections of the TIPs to provide a comprehensive documentation of the various regional transportation needs and improvements for both capacity deficiency and surface condition.

An important issue in the programming element is the criterion or set of criteria to be used. Primarily, these criteria may depend on both funding and the pavement condition assessment. In most PMSs an index or set of indexes is established as a measure of a pavement segment's condition or the condition of individual sections within the network. This index or set of indexes is usually used as a basis for recommending treatments. Examples of such pavement condition measures include a pavement condition index and a pavement serviceability index. Other indexes include the ride comfort index,

TABLE 3 Local Community Participation and RPA Roles

AGENCY	LOCAL COMMUNITY PARTICIPANTS	DATE OF PM STUDIES	RPA ROLES AND RESPONSIBILITIES						
			Initiated PM Study	Data Collection	Data Analysis	Funding for PM Study	Report Preparation	Training	Report Presentations
PVPC	Westhampton	1988							
	Middlefield	1988							
	Williamsburg	1988							
	Goshen	1989	X	X	X	X	X	X	
	Chesterfield	1989							
	Worthington	1989							
	Pelham	1990							
Agawam	1990								
OCPC	Kingston	1987		X	X	X	X		
SRPEDD	Somerset	1984							
	Plainville	1986							
	Somerset	1988		X	X	X	X	X	X
	Rochester	1990							
	Seekonk	1990							
MAPC	Wenham	1986		X	X		X	X	
	Medfield	1986							

the structural adequacy index, the surface distress index, and a composite pavement quality index (9).

The key inputs into the programming element may include pavement condition, which is addressed through the PMS; safety, which is addressed through the highway safety and improvement program; and capacity deficiency, which is addressed through the transportation system management. A benefit to be derived from this composite approach would be an improvement in the use of the scarce funds available for preserving the road's infrastructure. This approach would enable safety improvements, road widening, and pavement rehabilitation or reconstruction to be coordinated and perhaps combined and programmed together.

An example of an approach similar to that used previously for ranking deficient roads was developed and recommended for use by members of the Southeast Michigan Council on Regional Development in 1984. This approach, outlined in Figure 3, is composed of six basic steps and uses capacity and pavement condition as measures in identifying deficient roads. Capacity is defined in terms of both present and future levels of congestion, whereas pavement condition is defined by both surface and base deterioration. The primary aim of the ranking methodology is to enable the agencies involved to develop a realistic listing of deficient corridors to be programmed for project implementation. The congested roadways are grouped into one of two categories in terms of length (i.e., less than or greater than or equal to 2 mi). The congested road sections

greater than or equal to 2 mi are further classified into high, medium, and low congestion. Each congested road less than 2 mi long together with the medium- and low-congested roadways, are referred to the county-level TSM committees for analysis, whereas roadways classified under high congestion are grouped into corridors for improvement under the region's transportation plan (10).

To carry out this element there is a need for effective communication between the MPO and local governments. Because this element is mainly a planning-related activity, the extent of MPO involvement will likely be high and, hence, the MPO role will be that of a doer.

Construction

This is the element in which the programmed projects are constructed. This element results from the projects selected during the network- or project-level elements. Included in construction are contract control, contract scheduling, construction inspection, and the main construction activities.

MPOs may have very little role in this element. However, depending on the existing MPO-community relationship, MPOs may help communities schedule contract activities and project construction. MPOs may assist in coordination of joint construction programming for communities within their regions undertaking similar construction projects and may encourage joint inspection control.

TABLE 4 Highway Programs Coordinated by RPAs

AGENCY	PVPC	OCPC	SRPEDD	MAPC
PROGRAM				
<i>Federal-aid programs (FA)</i>				
Interstate (const.)				X
Interstate (4R)	X	X	X	X
Interstate (transfer)			X	X
Urban Systems	X	X	X	X
Consolidated primary	X	X	X	X
Bridge R&R	X	X	X	X
Rural secondary	X	X	X	
Hazard Elimination	X	X	X	X
Rail / highway hazard crossing		X	X	
Other (VSPD)	X			X
<i>State funded highway programs</i>				
Non federal-aid (NFA)	X	X		X
PWED		X		X

PWED - Public Works and Economic Development
VSPD - Various Special Project Developments

The activities within the construction element include a maintenance element, which is needed to keep the existing and rehabilitated pavements in their acceptable conditions, managing the various maintenance activities, and maintaining an accurate maintenance record. Potential roles might include coordinating equipment sharing in communities undertaking similar maintenance jobs and assisting such communities in scheduling similar jobs.

Follow-Up

The follow-up element deals with monitoring local pavement management efforts to ensure that such efforts are being carried out with continuity, where appropriate. It also concerns issues regarding the use of new technology to improve the pavement management program when necessary and updating initial budget and pavement planning data inputs. Results of project implementation through the construction element would be used to update highway historical records.

The follow-up element might also include the dissemination of information about pavement management activities, perhaps through an MPO newsletter or the RTAP centers.

The extent of MPO involvement might be high, depending on the local community participation in the pavement management process and the size of the pavement management data base.

Research

The research element may include evaluation of the conduct and performance of the pavement management process within each respective region and identifying possible changes, if necessary. Efforts should be initiated to develop performance models, to evaluate the cost-effectiveness of maintenance and rehabilitation strategies, and to develop improvements to the overall local pavement management process. The extent of MPO involvement might be more extensive, depending on the role and commitment of local communities and the participation of other agencies, for example, RTAP centers and local communities.

Summary

Table 6 presents a summary of the possible roles and extent of MPO involvement in each element.

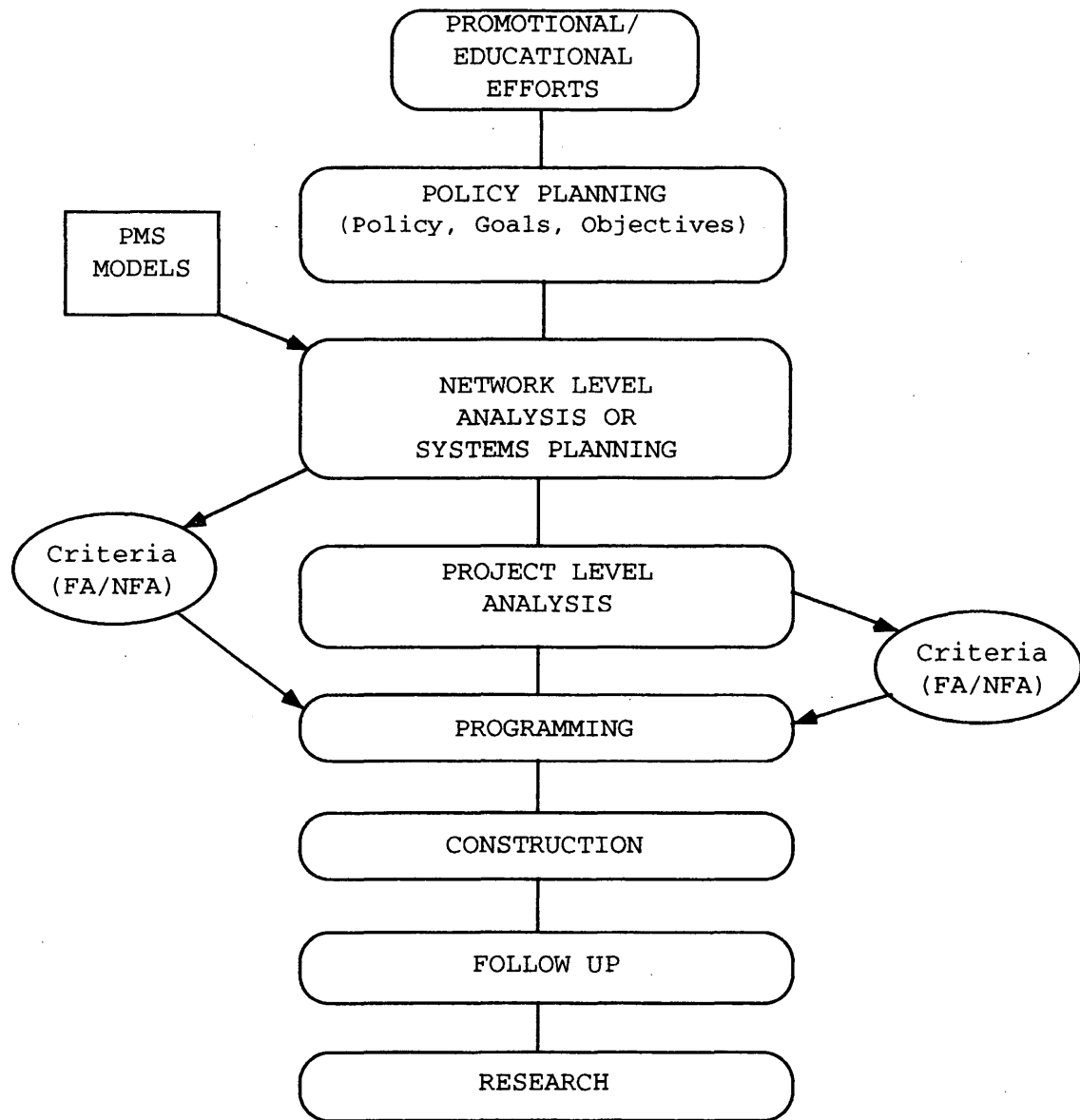
The possible extent of involvement ranges from low (2 to 4 person-days a month) to medium (4 to 8 person-days a month) to high (10 to 15 person-days a month). The results of the case studies and the literature review were used as a basis for developing these estimates of possible involvement.

SUMMARY AND CONCLUSIONS

Interest in the pavement management process has increased substantially at the local level in an effort to improve the overall condition of local roads with limited resources. However, the structures and institutional characteristics of local highway agencies bring about a complex set of managerial issues in attempting to organize a broader pavement management program that considers

regional goals and objectives. These difficulties are due in part to differences in local road maintenance policies, resources, practices, and priorities.

Considering the nature of the regional road network and the benefits to be gained from a PMS, MPOs should play a greater role in the initiation, development, and implementation of local pavement management. As discussed previously, the institution of pavement management programs in local communities and the participation of MPOs in local pavement management would result in a number of benefits ranging from the judicious use of limited local resources to the improvement in both the local and regional road network conditions. The PMS data base at the local and regional levels would enhance and encourage efficient decision making, which would facilitate the development of appropriate road maintenance and



FA = Federal Aid

NFA = Non Federal Aid

FIGURE 2 Framework for MPO involvement in PM.

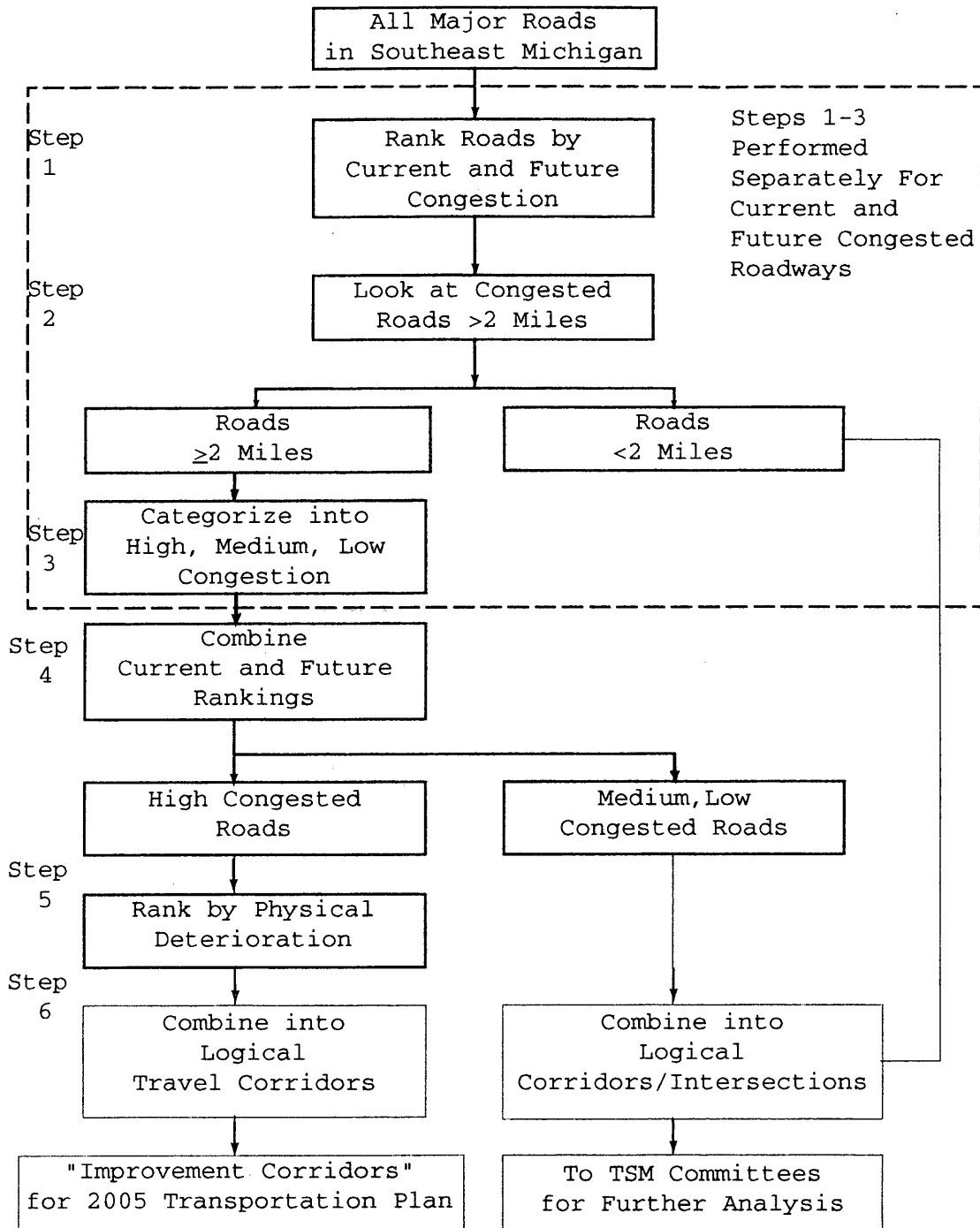
TABLE 5 Framework Activities

MAJOR ELEMENTS	ACTIVITIES
Promotion	<ul style="list-style-type: none"> * public presentations on PM * design of PM brochures for cities and towns
Policy Planning	<ul style="list-style-type: none"> * past and current maintenance policies assessment * definition of managerial and physical objectives
Network Level Or Systems Planning	<ul style="list-style-type: none"> * network sections definition * data collection * data analysis * priority setting (network sections) * budgeting * implementation of results * training
Project Analysis	<ul style="list-style-type: none"> * coordination of pre-constructed activities * detailed engineering design * selection of best alternative * economic analysis * budgeting
Programming	<ul style="list-style-type: none"> * programming reconstruction & rehab. into TIP including fed-aid roads and non fed-aid roads * integration of network and project level in the development of local master plans
Construction	<ul style="list-style-type: none"> * contract scheduling & control * construction inspection * actual construction
Follow Up	<ul style="list-style-type: none"> * overall PM process monitoring * data base update * changes to overall process * information dissemination about PM activities through MPO newsletter or RTAP sources
Research	<ul style="list-style-type: none"> * PM process assessment * pavement performance evaluation * performance models development * cost effectiveness of maintenance and rehabilitation strategies evaluation

improvement policies. Local agencies would be able to work with the MPOs in investigating alternative funding sources in situations in which such needs arise, and longer lives would be achieved for roads before they require substantial rehabilitation or reconstruction. Perhaps this will address the needs of TIP and reduce the number of roads receiving federal and state aid that need to be programmed.

Results of this study highlight that pavement management efforts of those MPOs that have participated in local pavement management have been extensive. In addition, the contribution of RTAP centers in local pavement management has been quite significant. For example, the Baystate Roads Program has contributed toward the promotion of local pavement management through several workshops held in the commonwealth of Massachusetts and has worked closely with cities and towns in implementing such programs. The New Hampshire RTAP center has been instrumental in the development and testing of a personal computer-based pave-

ment management software package. However, on the basis of the information in the literature and a limited survey conducted as part of the present project, only a small number of MPOs in the country have been involved in local pavement management, and furthermore, those MPOs that have been involved have not incorporated the results of such pavement management projects into the 3C process. It should be noted that local PM results in Massachusetts have not been incorporated into the 3C process, because it was not clear to the RPAs how it should be done. The results were documented in a report that was given to the local city or town officials, some of whom used the results for local programming and budgeting purposes. At present, one RPA (PVPC) is considering the inclusion of such results in its TIP and is formulating an approach similar to the one used by southeastern Michigan's COG. It is also noteworthy that a local PM workshop was held at the University of Massachusetts in which a hands-on session addressed the need to



Source: Southeast Michigan Area Council of Governments.

FIGURE 3 Corridor ranking process.

consider integrating results into the TIP. In that session the participants (six to seven RPAs were represented) were given fictitious results of PM studies and other transportation analysis projects, and they had to conduct an evaluation using an approach similar to the process used in southeastern Michigan, and then each of the groups had to present their findings, conclusions, and recommendations. It is believed that the development of a regional transportation plan

that predominantly addresses highway capacity and safety needs would benefit from the inclusion of pavement condition needs.

The present study has suggested that the role of an MPO in a local pavement management program can be achieved through one or more of the eight major elements represented in the framework. However, the roles and responsibilities of the MPO in the eight elements may vary because of a number of factors such as local

TABLE 6 Possible Roles and Extent of MPO Involvement in Framework Elements

FRAMEWORK ELEMENTS	EXTENT OF INVOLVEMENT	ROLE
PROM./EDUC.	→ MEDIUM-HIGH	* INITIATOR
POLICY PLANNING	→ LOW-MEDIUM	* FACILITATOR
NETWORK LEVEL or SYSTEMS PLANNING	→ MEDIUM-HIGH	* FACILITATOR * TRAINER * DOER
PROJECT LEVEL	→ LOW	* COORDINATOR
PROGRAMMING	→ HIGH	* DOER
CONSTRUCTION	→ LOW	* COORDINATOR
FOLLOW UP	→ MEDIUM-HIGH	* DOER
RESEARCH	→ LOW-MEDIUM	* FACILITATOR * COORDINATOR * DOER

LOW - 2-4 person-days / month

MED. - 4-8 person-days / month

HIGH - 10-15 person-days / month

agency resources in terms of equipment and manpower, MPO and local technical capabilities, and the overall willingness of the MPO and local communities to make commitments to the pavement management program.

The possible use of technical support from outside the MPO and local agency needs to be considered. Some MPOs contracted with private consulting firms that have the experience in the selected framework elements that does not exist in the MPO; other MPOs have made use of the expertise of RTAP centers. It should also be emphasized that the required technical support for training and dissemination of information can be accomplished with support from various RTAP centers and state highway agencies.

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