APPENDIX F

Development of a Standard Needs Assessment Approach

> ***"All long-term plans are about change. There can be disagreement about precisely which changes the future will bring, or how fast they will occur, or what can and should be done about them — but no one doubts that conditions 25 or 30 years hence will be different than they are today. Change is a certainty, and to plan means to reckon with change."*** [12]

The quote above is from a draft of the current Regional Transportation Plan undertaken by the Metropolitan Transportation Commission (MTC), and it rings true for planning studies such as this one. Engineering and planning studies of this nature, where a "snapshot" of existing conditions is taken and the results used for policy decisions such as funding, are applicable only for a short duration. The key is to continue to maintain and update the results of these studies as things change i.e. as the state continues to grow in both population and the resulting transportation infrastructure. Typical examples include Regional Transportation Plans (RTP) and the Caltrans SHOPP, which are updated biennially.

Ten years elapsed between SR 8 and this study – and it was the consensus of the Oversight Committee that this lapse led to a loss of momentum in the on-going need for funding to maintain local streets and roads. During this time, the cost of pavement construction materials increased dramatically, the pavement network and traffic volumes continued to grow, and new regulatory requirements materialized but the funding levels were not commensurate with these changes. As a result, pavement maintenance levels began to fall behind.

With the completion of this study comes the opportunity to develop a framework that will institutionalize the effort required to maintain and update this study periodically and to incorporate any future changes. This will ensure that any momentum generated by this study is not lost. In essence, this study is really just the first step in a process to continually update the status and needs of the local streets and roads infrastructure.

Therefore, one of the key tasks of this study was to establish a consistent method to update and determine the needs on a cyclical basis.

> ***The overall goal would be to have an institutional framework available that would generate the analyses required to update the study every two or more years, as required. Ideally, this approach would require all Cities and Counties to provide their infrastructure information in a format to an umbrella entity that would then be able to aggregate the data and perform the analyses in an efficient manner.***

To arrive at this overall vision requires that we address some key questions and issues as discussed in the following pages.

1. How can we assure data consistency and quality in future updates?

The most challenging aspect of any study such as this is the aggregation of data from 536 sources (at least 538 in future updates since two new Cities were incorporated in late 2008).

[12] *Transportation 2035: Change in Motion – Transportation 2035 Plan for the San Francisco Bay Area*, Draft, December 2008.

Several technical issues relating to the data collection process and data quality are discussed below.

a. Pavement Management Systems (PMS)

It is difficult, if not impossible, to perform any accurate and rational needs assessment without the use of a pavement management system. A PMS sets up a formal process where pavement data are collected in a systematic and consistent manner, analyzed so that budgeting and planning decisions can be made in the most cost-effective manner. In particular, PMS assist in assessing the long-term ramifications of different budgeting levels as well as the identification of funding needs to reach pavement goals set by cities and counties.

Therefore, one of the first things we did in the survey was to identify who used a pavement management system (PMS). An excellent sign was that at least two-thirds of the agencies in California (66%) use a PMS (see Figure F-1) and 11% indicated that they did not have a PMS. Almost a quarter (23%) did not respond to the survey, so we have no information on whether they have a PMS or not.

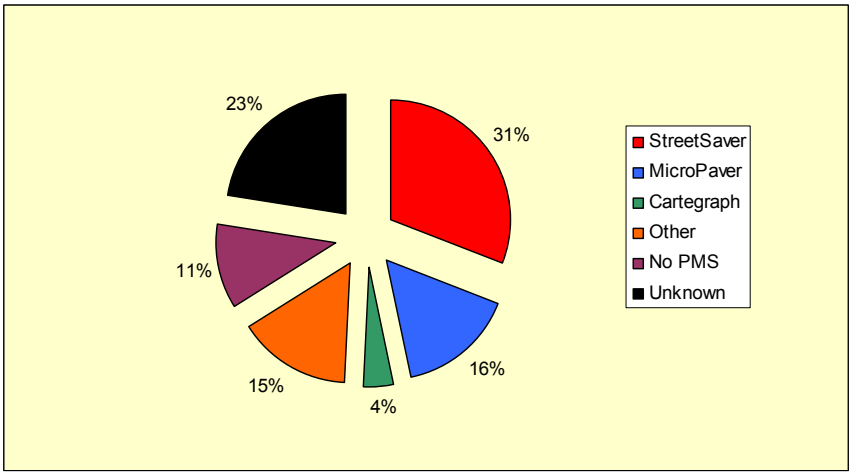


Figure F-1. Types of PMS Software Used by Agency

In terms of centerline miles, the numbers are even more encouraging. We can see from Figure F-2 that 86% of the states local street and road network is included in a PMS.

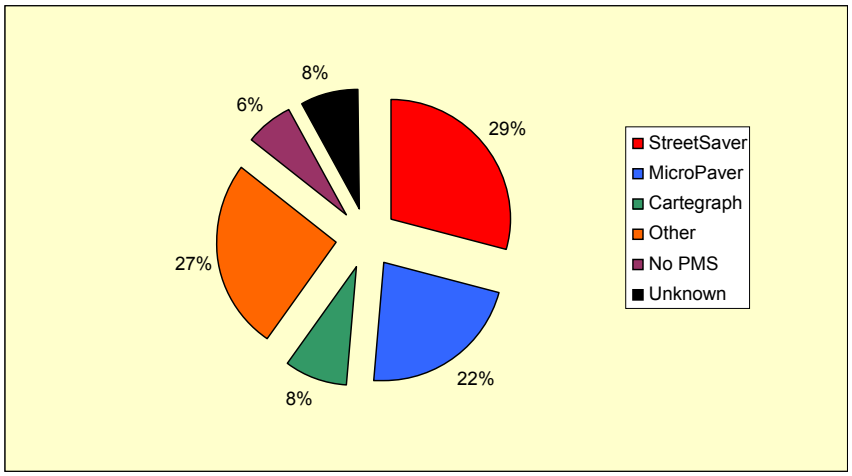


Figure F-2. Types of PMS Software Used by Centerline Miles

This had a huge implication for this study. First, the fact that 86% of the pavement network was included in a pavement management system (PMS) was extremely encouraging. **As was noted in Chapter 2, the presence of a PMS greatly added to the data quality and the validity of the results from this study.**

Both Figures F-1 and F-2 indicate that the three most common PMS software used are StreetSaver, MicroPAVER and Cartegraph. The first two are public domain software, developed by public agencies (MTC and the Corps of Engineers, respectively). The latter is a proprietary system.

Briefly, all three programs have the following common elements that are found in a PMS i.e.

- An inventory of all pavements, with basic information such as street or road name, limits, lengths, widths, areas, functional classifications, surface type and age
- Pavement condition data i.e. pavement distresses collected and condition index (0-100 scale)
- The use of deduct values in calculating a pavement condition index
- Maintenance treatments and unit costs

The key differences lie in the use of performance prediction models (family curves, straight-line or custom models) and how they prioritize which streets to fix first given limited funding (ranking based on condition index, cost-benefit analysis, priority matrix). These range from relatively simple ranking methods to more complex multi-year prioritization algorithms. Attachment F-1 is an excerpt from the FHWA's "Pavement Management Catalog" where each of these three PMS programs are described in more detail.

In the development of the statewide needs estimate, we utilized the pavement condition index from each of the PMS and the StreetSaver program to perform the statewide analyses. This program was selected for several reasons:

- By using the common elements of the software and standardizing the approach for determining the pavement needs, it greatly improved the accuracy of the needs assessment.
- The default prediction models are based on California cities and counties. The other two programs default to a straight-line or require significant data to create custom curves.
- The prioritization algorithms are based on an approach that is analogous to a cost-benefit analysis. The principles of pavement preservation are key to this approach.
- The ability to use different treatments as well as different unit costs for different classes of pavements i.e. arterials vs. local streets.
- The ability to program multiple treatments within an analysis period. This was particularly important since the study looked at both 10 and 25-year horizons, and a series of treatments are typically programmed for a pavement section within that analysis period.

A small percentage of the state reported **not** having a PMS. This is despite Section 2108.1 of the Streets and Highways Code, which requires all Cities and Counties receiving state funding to implement a PMS.

Section 2108.1 of the Streets and Highway Codes states:

> *By July 1, 1990, the City, County, State Cooperation Committee in the department shall develop and adopt a pavement management program to be utilized on local streets or highways that receive funding under the state transportation improvement program. The pavement management program shall be transmitted to every County or City for possible adoption or incorporation into an existing pavement management program. The City, County, State Cooperation Committee shall solicit recommendations from transportation planning agencies and any other entity the committee deems appropriate.*

While it would be desirable to ensure that all Cities and Counties have a PMS in place for future updates, many small agencies, due to limited resources, do not have one. To put their impact in perspective, there are 275 Cities with less than 100 centerline miles of streets, and 167 Cities with less than 50 centerline miles of streets. However, they comprise only 8.7% and 3.2% of the total miles in the state, respectively. Their impact on the statewide needs is consequently minimal.

Therefore, any benefit derived from obtaining data from small agencies would be offset by the considerable cost and effort required to implement and maintain a PMS. One recommendation would be for a larger neighboring agency to assist them in their efforts. For example, Mendocino County is responsible for Point Arena's 3.8 miles of pavements. Humboldt County is in the process of including tribal roads within their PMS database, since many reservations and Rancherias have less than 10 miles of roads. For future updates, we recommend that the efforts be focused on larger agencies with no PMS i.e. more than 100 centerline miles of roads.

Although we recommend that the focus for future updates should be on agencies with no PMS and with more than 100 miles, nonetheless, an effort should be made to encourage all local agencies to implement and use a PMS. Not only will this greatly ease future updates, it will allow for better and a more efficient use of public funds in road maintenance and pavement preservation. One way would be for entities such as the League of California Cities or the California State Association of Counties (CSAC) to endorse or encourage the use of a pavement management system. For example, one reason why the MicroPAVER PMS is so widespread in the United States is that the American Public Works Association (APWA) has formally endorsed its use to member agencies. Both the League and CSAC are the closest to a statewide entity; both hold annual conferences and both have both technical and policy committees where transportation is a key issue.

Another effective means to encourage the use of a PMS is a grant program. The Metropolitan Transportation Commission (MTC) has used a portion of STP funding to assist their jurisdictions (smaller ones have received a higher priority in the past) in implementing or updating their PMS since 1999. The PTAP (Pavement management Technical Assistance Program) grant program is relatively small; it averages around $1 million a year spread out over 100 agencies. Grant amounts range from $7,500 to $40,000 per agency, depending on size. The goal is to allow all agencies to receive a grant at least once every 2 or 3 years. In addition to the grant, MTC selects a list of qualified consultants and assigns them to agencies; they also administer the grant and contracts with the assigned consultant. Therefore, agencies do not have the contract administration responsibilities that can be onerous with the receipt of federal funds. This is particularly helpful for those smaller jurisdictions. The results of the PTAP program are impressive; all agencies are actively using a PMS today.

Further, to encourage agencies to implement and maintain a PMS, we recommend that any future funding sources be linked with compliance with Section 2108.1. The enforcement or monitoring would be left to the administrative entity described in a later section. The Orange County Transportation Authority (OCTA), similarly to MTC, has required the use of PMS to be eligible for Measure M funds (1/2 cent sales tax). A recent survey (June 2009) by NCE showed that all but one agency has a PMS.

b. Distress Survey Protocols

Of the 415 agencies who responded, 60% employed the distress survey protocols established by either the U.S. Army Corps of Engineers (MicroPAVER) or the Metropolitan Transportation Commission (MTC StreetSaver). Both methods of surveying pavement distresses are well-documented, similar, and share common deduct curves. Both result in a Pavement Condition Index (PCI) that are, largely, the same. The PCI uses a 0-100 rating scale.

The Cartegraph program has two distress survey protocols as defaults; one is the MicroPAVER protocol, the other is the SHRP (Strategic Highway Research Program) protocol which is used mostly by state highway agencies. Most local agencies will use the MicroPAVER protocols. This ensures a high comfort level in the quality of the data collected, since 65% of the responding agencies use similar distress survey procedures.

The most common distress types collected for asphalt pavements are fatigue (alligator) cracking, block cracking, longitudinal and transverse cracking, rutting, patching, shoving/distortions, weathering and raveling. For Portland cement concrete pavements, they are corner breaks, divided/shattered slabs, faulting, linear cracking, scaling/map cracking/crazing and spalling.

The remaining 20% collected the same kind of pavement distresses that are found in either MicroPAVER or StreetSaver, but may have different protocols for collection and calculating the condition ratings. Of the differences found, most were related to collecting additional types of data, primarily deflection and ride quality. However, not all the information collected was used in the calculation of the condition rating or index (see Table F-1).

Table F-1. Summary of Additional Distress Data Collected and Usage

	Deflection	Ride Quality	Friction	Drainage	Structure/Core	Citizen Complaints	Pavement Age
Number of Agencies	38	37	4	6	12	1	3
How is Data Used?							
Project level (design)	27	4	1	1	6	0	0
Condition Rating	11	31	3	4	6	1	3
Inventory only	0	2	0	1	0	0	0

In terms of using a rating scale, 90% of the agencies reported using a 0-100 scale.

One of the original concerns at the outset of this study was that there would be so many variations in survey procedures that comparing apples and apples would be extraordinarily difficult. However, given that almost 65% of the respondents use MicroPAVER or StreetSaver protocols, this ensured that the comparisons made were largely valid.

While it is desirable to have all agencies use the same distress survey protocols to arrive at a common condition rating scale, it is difficult to impose this requirement on all agencies. Many agencies, particularly the larger ones, have invested significant funds in customizing or integrating their distress protocols and rating systems with other programs, and adopting a new rating scale may result in wholesale abandonment of many years of historical data.

However, the industry trend is leaning towards adoption of a 0-100 scale, with similar distress types and deduct values found in either the MicroPAVER or StreetSaver programs. For example, there is an on-going study in Orange County to adopt one standard methodology for distress surveys. The enforcement of this requirement is linked to a "stick" i.e. Measure M funds as previously mentioned. We believe that time and local/regional efforts will gradually result in a more or less consistent rating system statewide.

The method of collecting data was not explicitly requested in the survey but does have an impact on the data reported. There are three primary types of data collection, and each has its own advantages and disadvantages:

Windshield surveys - These are performed with two-person crews in a vehicle traveling at low speeds (under 15 mph). The major advantage is that 100% of the roadway is surveyed, and it can be accomplished very quickly, safely and inexpensively. However, the disadvantage is that the data collected tends to be of variable quality. In particular, low-severity distresses are typically not visible from a moving vehicle. This results in a higher than expected condition rating of the streets, and consequently, a lower estimate of the backlog and pavement needs.

Walking Surveys - These are performed with a one-person crew where distresses are collected for a representative portion of the pavement. For high volume streets like expressways or major arterials, two-person crews may be needed for safety. The major advantage of this survey method is that it is highly accurate, since cracks and all other pavement distresses are measured and recorded. However, walking surveys are more labor-intensive and are thus more expensive than windshield surveys.

Automated surveys – These are typically performed with a customized vehicle that is equipped with a video or digital camera and/or laser bars. The major advantage is that they are equipped to perform surveys very quickly and safely. However, post-processing time can offset cost-savings in the field, and the quality of the data can be variable depending on light conditions (e.g. tree-lined streets with contrasts in light and dark) because shadows can mask some distresses. Typically, only the outer travel lanes are surveyed, and for most residential streets, only one lane is surveyed.

The MicroPAVER, StreetSaver and SHRP protocols call for walking surveys; however, it is our experience that all of the above types of surveys (or combinations) have been used for these three programs. While the method of data collection affects the condition index, for a statewide study, the impacts are probably not significant.

A standardized list of distresses to be collected and included in a rating scale (0 to 100) is recommended to facilitate future updates. The distresses should include, as a minimum:

Asphalt Concrete	Portland cement concrete
Fatigue/alligator cracking	Corner breaks
Block cracking	Divided (shattered) slab
Distortions/swell	Faulting
Longitudinal and transverse cracking	Longitudinal, transverse and diagonal cracking
Patching and utility cuts	Patching and utility cuts
Rutting and depressions	Scaling/map cracking/crazing
Weathering and raveling	Spalling

The three most common PMS software described previously i.e. MicroPAVER, StreetSaver and Cartegraph all include these distresses as a minimum.

c. Data Collection

Since this was the most time intensive and consequently, the most expensive, portion of the study, we spent considerable efforts at rethinking this process and looking for ways to get more data in as efficient a manner as possible. We also looked at ways to improve data quality. If a similar collection effort is performed for the next update, the following observations and suggestions are included to assist future efforts.

Online Questionnaire/Survey – This still remains a very comprehensive method of collecting and storing data in a reasonably cost effective manner. An online survey website service was originally selected due to time constraints – we had to get started on the data collection very quickly, which meant that a readily available commercial service was utilized rather designing a database from scratch.

However, the limitations of the survey website we used (i.e. www.surveygizmo.com) was quickly reached. As we discovered, most online survey websites were not intended for the detailed qualitative and quantitative analysis such as that required for this study. These online surveys work well when responses are in yes/no or multiple choice formats, which facilitates the quantitative analyses. However, since the responses we received were more open format, i.e. where explanations or text descriptions were common, it limited our use of the analytical tools available.

Another problem was the inability to apply restrictions to any fields, so any data could be entered without the ability to perform automatic validation checks e.g. lane widths that were 24 feet wide, or users entering “3 million” instead of “3,000,000” or the wrong units applied (feet instead of yards). While these may seem minor problems, in reality, it was easily a 150 to 200 hour effort to filter out what was reasonable or unreasonable when faced with almost 40,000 individual data fields that had to be analyzed. Even though we were able to automate a large percentage of the data validation checks, in many cases, we still had to contact the agency which submitted the data in an effort to ensure that there were no errors.

In some cases, we needed to clarify or provide more instructions on how to fill out the survey. This has to be balanced with keeping the survey short so as to retain the attention span of the user. Other changes recommended include using radio buttons to minimize the amount of text entered, allowing users to print results so they can check/preview their responses before submitting, ask for more details on unit costs etc. All these changes are minor in nature, but addressing them will result in a more efficient and higher quality data set in the future.

Therefore, if a survey is used for future data collection, we recommend modifications to the online survey based on the lessons we learnt, and more importantly, we recommend

developing a custom database with MS Access (or similar) that may then be linked to the current www.SaveCaliforniaStreets.org website. This will facilitate future data collection efforts and minimize the time required to check and validate the responses received.

Attachment F-2 contains a list of the data recommended for future updates. This is a simplified list and focuses the data collection effort at the pavement condition index as the key input. The data needed for the other elements (safety, traffic, regulatory and funding) are largely unchanged.

Filling in the Gaps – There were 121 agencies who did not respond at all to the survey; of the remaining agencies, a significant percentage had data gaps, especially for the safety, traffic and regulatory components. For many, the main reason cited was a lack of resources, particularly in those small (less than 100 centerline miles) Cities.

In the case of pavement condition, averages from surrounding agencies were used to fill in the gaps. However, a more accurate process may be to provide these Cities with information on their neighbors and let them make the assessment as to what best matches their agency. The online survey would need to be populated with this information. We feel that this would provide a "quick and easy" method for those agencies with limited resources to provide us with the required data.

d. Pavement Condition Thresholds

Most of the responses used thresholds for treating their pavements that were similar to the example provided in the survey (see Table F-2). However, it was not always possible to determine if they did, in fact, trigger similar treatments. For example, an agency may have programmed reconstruction in the "poor" category, and another may have programmed an overlay. This results in inconsistent standards, and may not be consistent with pavement preservation principles.

Table F-2. Example of Thresholds Used in Survey

Condition Description	Agency's Condition Rating Ranges
Excellent	85-100
Good	70-85
Fair	50-70
Poor	25-50
Very Poor	0-25

To help remove this inconsistency, we recommend that Table F-2 be modified to reflect the thresholds that trigger maintenance activities instead (see Table F-3), as this would more explicitly link condition to maintenance in the agency. We suspect that this would also engender more thought (and thereby more accuracy) when filling out the survey. In addition, if other factors are used to make these decisions, such as ride or deflection data, this would be more likely to draw out that information.

Future surveys should also look at the differences between an urban street and a rural road. Treatment decisions are likely to be different, and the thresholds that trigger that treatment.

For the needs assessment, the thresholds used should be consistent with pavement preservation principles i.e. ensuring that good roads are maintained and preserved. This was also indicated in the original RFP.

Table F-3. Example of Thresholds for Future Surveys

Maintenance Activity	Condition Thresholds	
	Urban	Rural
Do Nothing	86-100	75-100
Preventive Maintenance	70-85	60-75
Surface seal e.g. slurry, cape	70-85	60-75
Thin AC overlay	50-70	40-60
Thick AC overlay	25-50	0-40
Reconstruction	0-25	Never

e. Maintenance Costs

Since maintenance costs play such a critical role in determining the pavement needs, it is important that accurate costs be obtained. In this study, we used a statewide average based on 50 agencies to determine appropriate unit costs. However, this data was not part of the questionnaire.

For future updates, we would recommend that the survey be expanded to include gathering this information. Appropriate instructions are also needed to ensure that agencies provide the same kind of information. For example, some agencies provided us contract costs only, others included design and inspection, and still others included materials costs but no labor when the work was done in-house.

To our knowledge, only one region (MTC) requires their member jurisdictions to supply their unit cost data with the same set of assumptions. This is performed through a biennial survey, and costs are then averaged by County. All regional needs assessments are then performed at the County level and aggregated regionally.

In the study, a consistent set of assumptions was used. Future surveys should also tease out in more detail the differences between rural and urban roads and streets. Anecdotal evidence suggests that the costs for an overlay on a rural road would be less than that for an urban street, but we did not have sufficient information from the surveys in this study to arrive at this conclusion, so a statewide average was used.

For future updates, standard unit costs should be used statewide. These unit costs should reflect the full cost of construction, and include design and engineering costs, construction inspection and testing, contract administrations as well as ancillary elements required by law e.g. upgrading curb ramps as per the American Disabilities Act (ADA).

f. Pavement Performance (Prediction) Models

For any needs assessment, prediction models are required to determine future conditions and hence, future needs. In this study, we used default prediction models developed by MTC – these were based on data from Cities and Counties in the San Francisco bay area. These models are usually known as “family” curves i.e. each curve represents a “family” such as asphalt concrete (AC) arterials. Family curves are available for all combinations of functional

classifications (arterial, collector and residential/local) and surface types (AC, AC over AC, Portland cement concrete (PCC), AC over PCC and surface treated).

While these curves were more than adequate for this study, questions may arise about the different climatic regions, and therefore, different pavement performances e.g. alpine environment vs. the desert. While it is desirable to develop unique prediction models (the RFP specifically also addressed this issue of regional curves), which will lead to greater accuracy in our needs assessment, a note of caution is needed. The effort required to develop these models will be significant, and very few agencies have the data or resources to develop unique models. This level of effort is usually only undertaken at the state Department of Transportation level, or for very large Cities/Counties. In California, not even Caltrans has yet developed different prediction models based on climate or facility for their PMS.

Therefore, if funding is a constraint, we do not recommend developing unique models. However, as more information is obtained in future updates, this option should be reviewed and adopted if necessary. It is also important that the entity responsible for future updates have the ability and technical expertise to perform these analyses and develop new models if required.

g. Pavement Needs Calculations

We are confident that the methodology that was developed for this study will be appropriate for future updates, and do not have any modifications to recommend. This is described in detail in the appendices of the final report, but briefly, the procedure is as follows. Eight benchmark databases were created to perform the needs assessment (two functional classes, major and local pavements, and four condition categories, PCI from 0-25, 26-50, 51-70, 71-100). Each database contains sections that have a range of distresses and PCIs and include maintenance and rehabilitation decision trees that have appropriate treatments and costs. The needs and scenarios analyses were performed for each section over the analysis period. The resulting PCI and backlog were also determined for every year.

Once an agency reports their pavement condition rating for both their major and local roads, the appropriate database is used to determine their needs. These databases are provided as part of the Final Report.

h. PMS Software

For software companies to include the aforementioned capabilities in their software is a policy issue. Ultimately, the profit motive drives the private-sector vendors. Therefore, if an agency were to specify the above items in its Request for Proposals (RFPs), most vendors would undoubtedly adapt. The question is – who will pay the cost of modifying the software to meet the above noted requirements? We would expect that there will be resistance from local agencies if they have to bear additional software costs, particularly if they have already invested significant resources elsewhere.

However, there are various approaches that may be considered, some of which are briefly discussed below.

- Let the market rule – The local agency can specify the requirements, and the vendor who wishes to be successful in winning the work will respond/comply. This is somewhat similar to the policies adopted by the California Air Resources Board and the auto industry: To continue to serve the very profitable California market,

automobile manufacturers will eventually adapt. However, agencies will still have to be persuaded that their current software needs modification.

- Create incentives (carrots) for agencies to comply – MTC, for instance, subsidizes the software cost so that all local agencies can afford to implement or maintain at a minimal cost to them. OCTA has also made available funds to assist agencies in transitions costs.

- Create disincentives (the stick) – OCTA, for example, requires all agencies to have a PMS. Also, OCTA imposes certain requirements, e.g., consistent distress types, before the agency is eligible for Measure M funds. MTC requires the agency to be certified before it is eligible for federal funds. Both approaches have been successful.

- Fund the cost of software modifications to the two primary PMS programs i.e. MicroPAVER and StreetSaver so that agencies do not have to bear the costs. This would allow compliance with any future updates to be relatively painless.

- Combinations of all the above.

As a minimum, the software should have distresses collected using either the MicroPAVER or StreetSaver protocols. Since this is the baseline for future needs assessment, this should be the standard.

i. Safety, Traffic and Regulatory Components

The main challenge we encountered in this area was that not many agencies were able to provide the data requested. This is partly because many agencies do not maintain good inventories, electronic or otherwise, and partly due to lack of staff time to gather this information. However, it is a huge component of the needs assessment for the state's infrastructure (an estimated 32% of the total needs), and therefore cannot be ignored.

We recommend that future surveys continue to ask for this information as we believe that the data quality will continue to improve over time, and that the regression equations be modified as necessary to accommodate any changes in the data. However, in order to facilitate this process, we recommend that future surveys be more streamlined and include more instructions on what data to include. Again, it is important that the entity responsible for future updates have the ability and technical expertise to perform these analyses and develop new models if required.

In the case of NPDES and ADA requirements, it was clear that agencies are, largely not tracking these costs separately. Therefore, to be able to quantify these costs, we recommend a case study approach. A range of agencies (large, medium and small) should be selected and interviewed to examine their costs in complying with both NPDES permits and ADA requirements.

j. Funding & Expenditures

As was expected, the data received on funding and expenditures was mixed. In some cases, expenditures exceeded the available funds. This could be due to the lack of understanding of the funding process by the person filling out the survey (in some cases, we had engineering technicians filling out the surveys). Therefore, for this study, expenditure data were used to indicate the funding available.

We recommend that additional guidance or examples be provided to assist future updates. The survey will need to emphasize the importance of accurate data, and the implication if it is not. One possibility is to address this portion of the survey to the finance division for their feedback.

2. How can we best collect the data at regular intervals?

The time required to gather data was about 5-6 months, with data trickling in as late as three months after our deadlines had elapsed. The high percentage of responses received were a result of a huge effort by CSAC, the League and member groups represented in the Oversight Committee. Literally thousands of letters and emails were sent out to City Mangers and County Administrative Officers all the way down to the Public Works Departments and the engineers or planners responsible for the data requested.

This level of effort is expensive and time consuming. And yet, there is no current requirement for agencies to provide this information outside of their goodwill. There needs to be some incentive or disincentives where Cities and Counties are required to provide this information.

Currently, there are only two RTPAs in California that have a formal process in place to collect this information biennially. **OCTA** in Orange County employs a "stick" approach; it requires that all its member jurisdictions update their arterial and major collectors every 2 years in order to be eligible for Measure M (local sales tax) funds. A report indicating that this update has been performed is submitted biennially. Further, projects that are submitted for competitive funding must have information on the pavement condition. The pavement condition index reported meets guidelines established by OCTA in the late 1990s.

In the San Francisco Bay area, **MTC** has a similar requirement. The "stick" ties eligibility for federal funds with compliance to maintaining a PMS. Agencies are required to update the condition ratings for arterials and collectors every two years, and residential streets every five years. MTC's website also lists their expiration of individual agency certifications, so that all are aware of when they need to perform their updates.

However, a "carrot" approach is also included – as preciously mentioned, approximately $1 million a year is available to assist Cities and Counties with updating their condition ratings through a competitive grant process. This is to assist primarily small agencies who do not have the staff or financial resources to update their pavement networks. In the 10 years that this grant program has been in place, the agencies who actively use and maintain a PMS went from approximately 35-40% to 100%.

Finally, MTC publishes the pavement conditions of all the agencies annually – this is often picked up by the local media and becomes front page news of local papers. It can generate a lot of local interest from elected officials, and has contributed to institutionalizing the concept of pavement conditions and maintaining pavements in both the public and elected officials' mindsets.

Other regions (Mendocino, El Dorado, Butte, Lake etc) have a more ad hoc approach – typically, they assist their member agencies in implementing or updating their PMS by obtaining the funding and then administering the project Countywide. This may occur once, or at irregular intervals. There is no formal process to require agencies to submit data on a consistent and regular basis, nor are they required to do so.

In future updates, there are two categories of agencies that need to be addressed:

- Agencies with data need to be encouraged to submit it.
- Agencies without data need to be encouraged to collect and submit it. If financial or staff resources are an issue, then a grant program will assist them.

Funding is the most compelling reason for compliance - if an agency sees their eligibility for funding tied to maintaining their PMS and submitting this information, they will usually find the resources to do so. The caveat is that the requirements for this funding cannot be too onerous e.g. many small Cities forego federal funds because of the lack of staffing to comply with the regulatory requirements.

Therefore, it is recommended that any future funding sources generated as a result of this study be tied to some requirement to maintain a PMS, and to submit this data to an entity on a regular basis. The pavement data should be from a pavement management system.

3. Who will do the work? What umbrella entity is needed, and what is the institutional framework in which they will function? What mechanisms or policies are needed to be in place in order for this entity to function and perform the analyses?

As this study wraps up, one of the most difficult challenges facing the Oversight Committee is "***Who will perform the updates in the future?***" This study has resulted in valuable information to assist Cities and Counties in developing policies regarding future sources of funding. But as was pointed out earlier, consistent updates are needed to accommodate changes in the future, and also to maintain the momentum in the on-going discussion on transportation funding. This study is only the first step in a continual process to update and maintain the discussion on the funding needs for the local streets and roads infrastructure.

Getting the study off the ground required significant effort from member Cities and Counties, as well as funding. The County of Los Angeles stepped forward and volunteered to both provide a significant portion of the funding, as well as the project management in order to get this project started.

For future updates to be successful and to be institutionalized, much as RTPs and the SHOPP are, an entity has to be identified that will include this effort as part of their responsibilities. Unfortunately, there is no one umbrella organization that represents all the Cities and Counties. The state highway system has one agency, Caltrans, that is responsible for maintenance, but the state's local streets and roads network have (now) 538 Cities and Counties, with 538 different governing Councils/Boards and departments of transportation or public works overseeing the maintenance.

In our evaluation of what is needed in order to develop the institutional framework for future updates, we focused on several key criteria for a responsible entity which are discussed below.

a. Statewide Perspective & Credibility

Since this is a statewide study, the entity must have a statewide perspective, and not get bogged down with their local or regional needs. The strategy that makes most sense from a statewide perspective may not necessarily be advantageous at the local or regional level. An impartial and wider viewpoint is absolutely essential.

Related to this is the entity's standing statewide. It must have the credibility to have its results accepted by the Legislature, the California Transportation Commission and Caltrans.

Although CSAC, CEAC and the League are well known in Sacramento, the agency that undertakes the technical study must be able to complement their efforts.

b. Technical Skills

Generally, the staff required to perform this study will require formal training in civil engineering, asset or pavement management systems, statistics, operation research techniques, databases and good analytical and communication skills. Since pavement engineering and technology is a specialized field, very few civil engineering programs include courses in this area. Most of the experienced staff we have encountered have usually developed their expertise or experience in pavements from on-the-job training or more formal educational workshops.

This combination of technical skills is usually found only in state highway agencies or other large agencies, whether local or regional. The technical skills are essential to understanding and performing the analyses required.

c. Pavement Management Software Expertise

Although knowledge of pavement management software is part of the technical skills required, it is important enough to warrant additional discussion. The analyses used in this study require an in-depth knowledge of issues such as prediction models, decision trees and prioritization or optimization techniques. The analytical routines are heavily dependent on computers, databases and PMS software. It is therefore incumbent that the entity performing the update have the specialized knowledge to be able to understand the software and algorithms used, and perhaps more importantly, to understand the limitations of the PMS software or methodology.

A plus would be an entity with the capability to undertake software development. Future updates may require, say, new prediction models, or different pavement distresses, so the ability to accommodate this in the PMS software would be extremely helpful. Few agencies will have in-house software programmers on staff, so the ability to contract this service out will be needed.

An implicit assumption is that there needs to be a fundamental understanding of pavement engineering and design principles e.g. what a slurry seal is and what the appropriate applications are, and when it may be more appropriate for an overlay.

d. Familiarity With User Community

Since the user community is comprised of Cities and Counties, it is important that the entity be familiar with the organizational structure and constraints on local agencies, particularly the staff and financial limitations. Well established lines of communication with Cities and Counties are essential, as data collection is a critical component of this type of study.

Given that small agencies (i.e. less than 100 centerline miles) comprise 51% of the Cities and Counties in California, a special sensitivity to their constraints is needed. Many of these agencies have only one full time Director of Public Works and a part time engineer on staff to take care of the entire City's infrastructure needs. Demanding data that is outside of their capabilities to provide would be counterproductive.

e. Advisory Group/Stakeholders

An advisory group is required to provide strategic guidance and technical advice. Most, if not all, RTPAs or MPOs will have a Technical Advisory Committee (TAC) that can function as the advisory group. In the case of MTC, they have a Local Streets and Roads Working Group (LSRWG) that meets monthly to discuss regional needs and have a similar function. Alternatively, it is common to set up a Technical Steering Committee that meets only to discuss a specific study or project.

The responsibility of the advisory group should include:

- Ensuring that the overall goals are met and that they are consistent with the overall program
- Setting priorities
- Developing communication strategies to maximize awareness of the study, to facilitate data collection and to disseminate the results
- Monitoring progress on study

The members should include representatives from both the Cities and Counties' departments of public works or equivalent, as well as from the RTPAs. All regions of the state should be represented i.e. north, south, rural, urban, cities, counties etc. The Oversight Committee should be represented in this group as well.

f. Contractual Framework

The entity may need to enter into a Memorandum of Understanding (MOU) with CSAC, CEAC and/or the League. This will be a joint responsibility for all agencies.

Further, should specialized skills be needed e.g. software development or media strategies, a contract and procurement process is required to obtain these skills. This includes developing a competitive process such as a Request for Proposals (RFP) for selecting a consultant or vendor.

g. Stable Funding Source

A stable source of funding will be required to perform future updates. Currently, funding for this study came from contributions from member Cities and Counties. However, future updates will require a more stable source of funding. Current regional efforts at similar studies come from a variety of sources – some are funded by federal funds (STP), some are local. Many are handicapped by the lack of a funding source for what is, essentially, a planning study.

h. Experience

Finally, a logical question to ask is who or what organization has performed similar studies. Regional agencies, such as the Regional Transportation Planning Agencies (RTPA) or Metropolitan Planning Organizations (MPOs) are the only candidates since they encompass multiple Cities and Counties. Examples of these agencies include:

- Mendocino County Council of Governments (MCOG) was the lead agency to implement and update a pavement management system for the Cities and County.

There results were aggregated for the RTP and information used to generate support for a local sales tax measure in the mid 2000s.

- Lake County/City Area Planning Council (LC/APC) was the lead agency to implement and update a pavement management system for the Cities and County, similar to that for MCOG.

- Stanislaus County Council of Governments (StanCOG) undertook a similar study for all the Cities and the County in Stanislaus County as far back as 2001. However, sales tax measures were not successful.

- Orange County Transportation Authority (OCTA) has required that all Cities and the County use a pavement management system in order to be eligible for Measure M funds (a local sales tax measure). In 2005-06, the results were aggregated in a study similar to this one to assist in determining if Measure M should be renewed.

- Metropolitan Transportation Authority (MTA) performed a condition and needs assessment study for all Cities and the County in Los Angeles in 2005.

- Metropolitan Transportation Commission (MTC) in the San Francisco Bay area has performed these regional needs assessment for its Cities and Counties since the 1990s. It is also the only agency that has included the safety, traffic and regulatory components in their needs assessment.

- The County of Los Angeles, while not a regional agency, is currently the Project Manager for this study in consultation with the Oversight Committee.

Of the examples above, almost all are regional agencies – all but MTC have contracted with consultants to assist in performing the studies. This is because most do not have engineers with the technical background on staff to perform the work.

Summary and Recommendations

The use of a PMS in 86% of the state's local streets and roads network greatly added to the data quality in this study. Even more importantly, we discovered that there was a lot of consistency in distress surveys and condition ratings overall. Therefore, our recommendations include:

1. To comply with Section 2108.1, an overall goal should be to have all agencies implement and maintain a PMS with the following minimum requirements:
   - Pavement distresses to be collected for asphalt pavements should include fatigue (alligator) cracking, block cracking, longitudinal and transverse cracking, rutting, patching, shoving/distortions, weathering and raveling. For Portland cement concrete pavements, this should include corner breaks, divided/shattered slabs, faulting, linear cracking, scaling/map cracking/crazing and spalling.
   - Deduct values used should be the same as those used in StreetSaver or MicroPAVER.
   - A condition rating scale from 0-100 should be used.
   - The ability to program maintenance treatments based on pavement condition thresholds or triggers, including pavement preservation treatments should be included.
   - The ability to include user modified unit costs for maintenance treatments.
   - The ability to modify or incorporate new or regional prediction models in the

future should be included.

Currently, both the MicroPAVER and StreetSaver programs have the ability to perform the requirements above. The primary distinction between these two programs is the ability to perform multi-year prioritization based on a cost-benefit analysis approach. This is a key requirement for long-term needs assessment as multiple treatments need to be considered within the analysis period.

2. Although the overall goal is to have all agencies implement and maintain a PMS, the initial focus (on implementing a PMS and collecting data) should be on agencies with more than 100 centerline miles.

3. To encourage the implementation and use of a PMS, we recommend :

    a. Future funding requirements to be tied to the use of a PMS
    b. Funding assistance provided at the regional level to encourage the implementation and continual update of a PMS
    c. Using the "bully" pulpit of the League and CSAC to promulgate the benefits of a PMS

4. Use the StreetSaver software and methodology developed in this study to calculate future needs assessments.

We have also identified various technical issues that need to be addressed in future updates. They include:

5. If an online survey is to be used for future updates, then the following modifications should be made:
    a. Develop a custom database for the online survey instead of using a commercial survey.
    b. Populate future surveys with known information to facilitate the data collection process.
    c. Include maintenance thresholds.
    d. Distinguish between urban and rural streets/roads.
    e. Include maintenance costs.

6. Continue to collect safety, traffic and regulatory data.

7. Adopt a case study approach for NPDES and ADA categories.

8. Include finance departments/divisions in data collection.

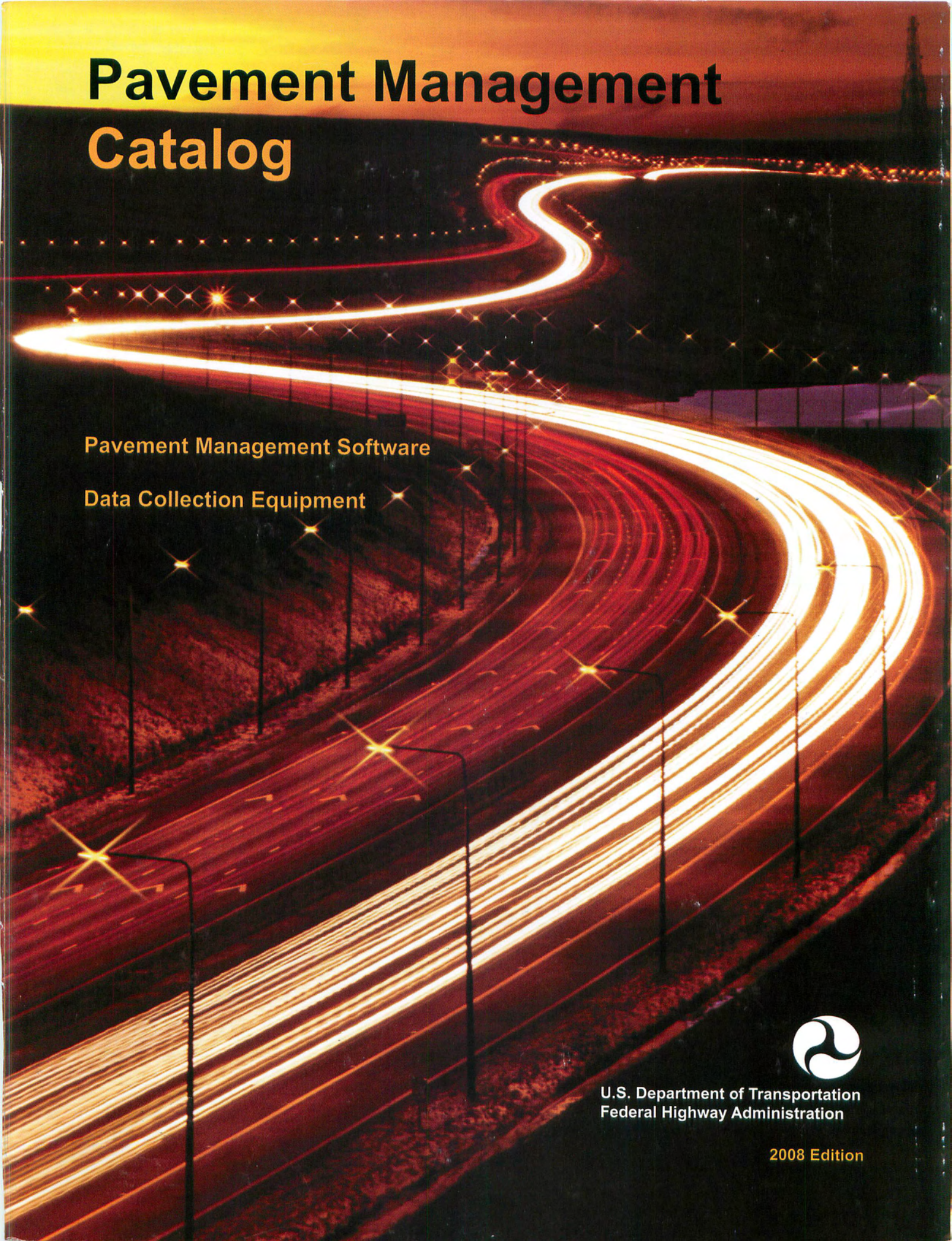
We also identified several key criteria that are needed in establishing the institutional framework for future updates. This is a key policy decision, and our objective was to ensure that the entity responsible must posses:

- Statewide perspective & credibility
- Technical skills
- Pavement management software expertise
- Familiarity with user community
- Advisory group/stakeholders
- Contractual framework
- Stable funding source for future updates
- Experience

Attachment F-1

Excerpt from "Pavement Management Catalog" Published by the FHWA, 2008 Edition

Pavement Management Catalog



Pavement Management Software

Data Collection Equipment

U.S. Department of Transportation
Federal Highway Administration

2008 Edition

Pavement Management Catalog

Pavement
Management Software

Data
Collection Equipment

U.S. Department of Transportation
Federal Highway Administration

2008 EDITION

Technical Report Documentation

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7. Author(s) Rohan Perera, A.S. Pulipaka, and S.D. Kohn		8. Performing Organization Report No.
9. Performing Organization Name and Address Soil and Materials Engineers, Inc. 43980 Plymouth Oaks Blvd. Plymouth, MI 48170		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-04-D-00010
12. Sponsoring Agency Name and Address Federal Highway Administration Office of Asset Management 1200 New Jersey Avenue S.E. Washington, DC 20590		13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

Mr. Thomas Van of the Federal Highway Administration served as the program manager for this project. Mr. Mark Swanlund of the Federal Highway Administration served as Contracting Officers Technical Representative.

16. Abstract

This document is a new edition of the Pavement Management Catalog that was last published in 2002, and contains a pavement management software catalog and a data collection equipment catalog.

The pavement management software catalog provides information about twelve software developed by private companies and four software developed by public agencies. Each software was evaluated based on a pre-determined list of criteria.

The data collection equipment catalog presents information about various equipment that collect pavement data to support pavement management systems. Details about ground penetrating radar equipment, falling weight and rolling wheel deflectometers, road profilers, skid testers, and multifunction data collection systems that are equipped with a variety of systems to collect various data (e.g., photographs of the pavement surface to evaluate pavement distress, a profiling system to evaluate pavement roughness, a rut depth measuring system, etc.) are presented together with information about manufacturers of such equipment.

This catalog is intended as a sourcebook of information to assist officials in selecting systems to meet the needs of their communities.

17. Key Words	18. Distribution Statement
Pavements, Pavement Management Systems, Pavement Management, Pavement Management Software, Pavement Data Collection, Ground Penetrating Radar, Road Profiler, Falling Weight Deflectometer, Skid Testing	No restrictions.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	179	

ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
AALRS	Agile Assets Linear Referencing System
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ADA	Automated Distress Analyzer
ADT	Average Daily Traffic
ARAN	Automated Road Analyzer
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
CMS	CitiTech Management Software
CSV	Comma Separated Value
DAPS	Deflection Analysis of Pavement Structure
DHDV	Digital Highway Data Vehicle
DMI	Distance Measuring Instrument
DOT	Department of Transportation
ESAL	Equivalent Single Axle Load
ERI	Engineering & Research International, Inc.
FHWA	Federal Highway Administration
FWD	Falling Weight Deflectometer
GIS	Geographic Information System
GPMS	Geographic Pavement Management System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GSSI	Geophysical Survey Systems Incorporated
HWD	Heavy Weight Deflectometer
ICON	Infrastructure Consultant
IMS	International Roughness Index
IRIS	Integrated Radar Inspection System
LTAP	Local Technical Assistance Program
LTPP	Long Term Pavement Performance
LVDT	Linear Variable Differential Transformer
MDB	Microsoft Database
MHIS	Multimedia-Based Highway Information System
MPD	Mean Profile Depth
M&R	Maintenance and Rehabilitation
MUC	Maintenance Urgency Categories
MTC	Metropolitan Transportation Commission
PCC	Portland Cement Concrete

PCA	Pavement Composition Analysis
PCI	Pavement Condition Index
PCR	Pavement Condition Rating
PDDX	Pavement Deflection Data Exchange
PDI	Pavement Distress Index
PERS	Performance and Economic Rating System
PI	Profile Index
PM	Preventive Maintenance
PMS	Pavement Management System
POS LV	Position and Orientation System for Land Vehicles
PQI	Pavement Quality Index
RN	Ride Number
ROW	Right-Of-Way
RSL	Remaining Service Life
RWD	Rolling Wheel Deflectometer
SDI	Surface Distress Index
SN	Structural Number
SQL	Structured Query Language
TAMS	Transportation Asset Management System
TIGER	Topologically Integrated Geographic Encoding and Referencing System
USACE	U.S. Army Corps of Engineers
XML	Extensible Markup Language

PAVEMENT MANAGEMENT SOFTWARE CATALOG

OVERVIEW OF PAVEMENT MANAGEMENT SOFTWARE

A pavement management system (PMS) provides the engineer with the tools necessary to perform cost-effective management of a roadway network. A PMS can be used to store a variety of information related to pavement segments. This information can include inventory data, construction and maintenance data, and condition data such as distress data, pavement roughness, and skid resistance. A PMS can be used for a variety of applications such as [1]:

- Obtain an overview of the current condition of the pavement network.
- Predict future conditions of the pavement network.
- Identify candidate projects for maintenance and rehabilitation.
- Develop a prioritized list of candidate sections for rehabilitation.
- Generate budget requirements for planning purposes.
- Analyze "what-if" policy questions for various budget scenarios.
- Forecast future conditions based on various funding levels.
- Retrieve data of pavement segments for informational purposes.

Many pavement management software have the ability to store the severity and quantity of various distresses present on the pavement. These distress data can then be used to compute an index that represents the condition of the pavement. The Pavement Condition Index (PCI) procedure developed by the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers is widely used to assess the condition of a pavement surface. This procedure is described in ASTM Standard D 6433.[2] In this procedure, the quantity and severity of various distresses on the roadway are recorded by performing a field survey. The ASTM standard presents guidelines for determining the severity level of a distress and how to measure the quantity of each distress. The data recorded in the field are then used to computes the PCI for the pavement. The PCI ranges from 0 to 100, with 100 being a pavement with no distress and 0 being a pavement in a failed condition.

FORMAT FOR PRESENTING THE RESULTS OF THE EVALUATION

Information about sixteen pavement management software is presented in this catalog. In order to develop the catalog, pavement management software providers were identified from the 2002 pavement management catalog, internet searches, and the authors' knowledge of software vendors. Twenty-one private companies and four agencies were identified as providers of pavement management software. These companies/agencies were contacted and requested to provide a copy of their software for evaluation. If a company/agency indicated they had difficulties in sending a copy of the software for evaluation, they were requested to fill out a questionnaire about their software. A total of eleven companies and four agencies indicated they wanted to be included in the catalog. One company (Stantec) provided information about

two of their software. All of the participants except two provided a copy of their software for evaluation; the companies that did not provide software for evaluation (Agile Assets and Stantec) filled out a questionnaire.

Each pavement management software was evaluated according to the criteria presented later in this section. The results of the evaluation are presented separately for each software. The software has been divided into two categories, private company software and public agency software. Under each category, the software programs are listed in the alphabetical order of the company or agency name.

When presenting the results of the evaluations, the following information is presented for each software on the first page: name of the software, company (or agency) name, address, phone number, website, contact name, the e-mail of the contact, an overview of the software, and three users of the software. The next pages contain the results of the evaluation based on the following criteria: Inventory and Historical Information, Pavement Condition Data, Storing and Managing Data, Identifying Sections Needing Repair, Cost/Prioritization, Impact Analysis and What-if Budget Scenarios, Unpaved Roads, and Training/Support. The following format is used to present the results of the evaluation.

Overview of the Software

A brief summary of the capabilities of the software is presented.

A remark is made to indicate if the software is a stand-alone program or if it is a part of an asset management program. If other modules can be incorporated with the pavement management module, a brief description of those modules is presented.

A remark is made to indicate if the software can handle data in metric units.

A brief description of the Geographic Information System (GIS) capabilities of the software is presented.

A statement is made regarding the availability of a user manual and help functions in the software.

The version of the software that was evaluated is indicated.

User Contacts

Name, agency, address, and phone number of three users of the software that were provided by the vendor is presented in this section.

Inventory and Historical Information

This section indicates if the software can store the following information.

Item	Description
Length/Width/Area	Length, width, and area of the pavement section.
Surface Type	Surface type of the road (e.g., asphalt concrete, portland cement concrete, surface treatment).
Functional Class	Functional class of the road.
Number of Lanes	Number of lanes in the road.
Current ADT	Current average daily traffic (ADT) of the road.
Construction History	Date and type of construction (e.g., original construction, reconstruction, overlay).
Maintenance History	Date and type of maintenance (e.g., chip seal, microsurfacing, patching, crack sealing, joint sealing).
Historical Costs	Historical construction/maintenance cost for each section.
Layer Types and Thickness	Layer types and thickness of the pavement.
Programmed Work	Future plans for maintenance or rehabilitation.
Traffic History	Historical traffic information.
Projected Traffic.	Future traffic of the section either inputted by the user or predicted by the program based on current traffic and a traffic growth factor.
Images	Photographs of the section.

A "Yes" answer for any of the parameters indicated in the table above means there is a specific field in the software for that parameter. Some software programs have "User-Defined Fields" where a user can define an item to be stored. In such software, if a field is not available to store a parameter shown in the table above, the user may be able to use a "User-Defined Field" to store that item. The section "Additional Information" indicates if the software has "User-Defined Fields."

Pavement Condition Data

This section indicates if the software is capable of storing the following items, and if these items are used in analysis.

Item	Description
AC Distresses*	Can distresses in asphalt concrete (AC) surfaced pavements be stored?
PCC Distresses*.	Can distresses in portland cement concrete (PCC) surfaced pavements be stored?
Condition Index**	Is an index for pavement condition computed from distress data?
User-defined Index**	Can a user define a pavement condition index to be computed from the recorded distresses (e.g., select specific distresses to be included in the index, change deduct values)?
Subjective Rating**	Can a subjective rating for the pavement condition be recorded?
Roughness**	Can the roughness of the pavement section be recorded?
Skid Resistance**	Can the skid resistance of the pavement section be recorded?
FWD Data/Structural Capacity**	Can Falling Weight Deflectometer (FWD) data or structural capacity of the pavement section be recorded? The comment field indicates the type of information recorded.

* A "Y" under "Used in Analysis" indicates a condition index computed using the distresses is used in analysis.
** A "Y" under "Used in Analysis" indicates this value is used in analysis.

Note: In the evaluations, "Y" indicates Yes and "N" indicates No, and "N/A" indicates Not Applicable. A "Yes" answer for Subjective Rating, Roughness, Skid Resistance, and FWD Data/Structural Capacity is shown only if there is a specified field in the software for the parameter. Some software programs have "User-Defined Fields" where a user can define an item to be stored. If the software does not have a field to store the previously described parameters, the user may be able to use a "User-Defined Field" to store that item. The section "Additional Information" indicates if the software has "User-Defined Fields."

Managing Data

This section indicates if the software has the following features.

Item	Description
Password Protection	Can the software have password protection so only authorized personnel can enter or update information?
Importing Data	Can data obtained by data collection equipment (e.g., distress data collection vehicles, hand held devices) be imported?
Inventory Reports	Can inventory reports be generated?
Condition Summary	Can summary reports indicating pavement condition be generated?
Distress Reports	Can reports that indicate the type, severity, and quantity of distress present on the pavement be generated?
Future Conditions	Can future pavement conditions be predicted for each section?
Prediction Modeling	Can the existing pavement condition data be used to develop models to predict future pavement conditions for user-defined pavement groups?

Identifying Sections Needing Repair and Specifying Treatment

This section indicates if the software has the following features.

Item	Description
Sections Needing M&R	Can a list of sections needing Maintenance/Rehabilitation (M&R) be generated?
Trigger Parameters: Single Multiple	Can a single trigger parameter be used to identify sections for M&R (e.g., pavement condition only), and if so which trigger parameter is used? Can multiple trigger parameters be used to identify sections for M&R (e.g., pavement condition and functional class), if so what are the parameters?
Recommend Treatment	Does the software recommend a treatment type (e.g., chip seal, slurry seal, overlay) for pavement sections?
Treatment Type: Interval Distress	 Is preventive maintenance treatment based on years between treatments? Is treatment type based on type/quantity of distress?
Maintenance/Rehab Policy	Can a user assign a maintenance/rehabilitation policy based on pavement condition?

Cost/Prioritization

This section indicates if the software has the following features.

Item	Description
Budget Reports	Can budget reports for maintenance/rehabilitation be generated?
Cost Per Year	Can the total cost per year for M&R be obtained?
Prioritized Candidate Sections	Does the software give a list of prioritized candidate sections for rehabilitation/maintenance?
Multi-Year Prioritization	Can a multi-year prioritization list of candidate sections for rehabilitation/maintenance be developed?
Prioritization – Pavement Condition	Can a prioritization list based on pavement condition be generated?
Prioritization – First Cost	Can a prioritization list based on cost of repair be generated?
Prioritization – Distress	Can a prioritization list based on user-defined (or in-built) distress type and quantity be generated?
Prioritization – Functional Class	Can the functional class be used as a parameter for prioritization?
Prioritization – Composite Criterion	Can prioritization be based on a composite criterion (e.g., pavement condition and functional class)?
Prioritization – Life Cycle Cost	Can the program use life cycle cost for prioritization?
Force Repair to a Specific Year	Can the user force a section to be repaired in a specific year?

Note: A "Yes" answer is indicated for the questions dealing with prioritization only if the software is able to do that function internally. In many software, the output can be exported to an Excel file, and then manipulated, to suit a user's prioritization criterion. A "No" answer is indicated if the prioritization is not done internally by the software.

Impact Analysis and What-if Budget Scenarios

This section indicates if the software has the following features.

Item	Description
Overall Condition.	Can the impact of budget level on overall condition be computed?
Condition by Category	Can the impact of budget levels on condition by category be shown (e.g., show percent of pavement area in excellent, good, fair, and failed condition)?
Backlog of Needs	Can the impact of budget level on backlog of needs be shown?
Remaining Life	Can the impact of budget level on remaining life of the pavements be shown?
Projected Condition w/wo Repair	Can the projected condition with and without repair be shown?

Unpaved Roads

This section indicates the ability of the software to handle the items indicated in the following table for unpaved roads.

Item	Description
Condition	Can distress be recorded, or a subjective rating given for the pavement condition?
Prediction	Can future pavement conditions be predicted?
Repair Cost	Can repair costs be computed?

Additional Information

Additional information about the software that was not covered previously is listed in this section. A comment is made regarding the availability of user-defined fields in the software.

Training and Support

This section indicates the type of training and support provided by the vendor.

Item	Description
Training Classes	Are there regularly scheduled training classes?
Support	What type of customer support does the vendor provide?

Note: In the evaluations, "Y" indicates Yes and "N" indicates No.

StreetSaver™Metropolitan Transportation Commission (MTC)
101 Eighth St, Oakland, CA 94607
Phone: (510) 817-5700
www.mtcpms.org
Contact Person: Sui Tan
Contact e-mail: stan@mtc.ca.gov

OVERVIEW OF THE SOFTWARE

StreetSaver™, with more than 350 users nationwide, is designed specifically to help local cities and counties better allocate resources, predict the future condition of their pavements at different levels of funding, and demonstrate the impacts of under funded road programs. StreetSaver™ is developed with pavement preservation principles. Cities and counties can plan and manage road improvement projects, document budget needs and shortfalls, and use the collected data to build support for additional transportation funding. Streetsaver™ utilizes seven distress types for AC and surface treated pavements as well as PCC pavements. A distress identification manual published by the MTC is available. Streetsaver™ can be utilized to generate GASB 34 reports for road assets utilizing the depreciation method. The event-based calculation method allows users to view the impact of different events, such as maintenance and rehabilitation treatments, on a road segment.

The program is a stand-alone pavement management program.

The software can handle data in U.S. customary or metric units.

Various consulting firms familiar with Streetsaver™ currently provide GIS/PMS related linkage products.

A user manual is provided. A help menu is available in the software.

Version 8 of the program was evaluated.

USER CONTACTS

Joel Condor Marion County PWD 5155 Silverton Rd NE Salem, OR 97305 Phone: (503) 373-4334	Vijay Sinha City of Stockton PWD 1465 South Lincoln St Stockton, CA 95206 Phone: (209) 937-7004	Tawfic Halaby City of Oakland PWD 250 Frank Ogawa Plaza, Suite 4314 Oakland, CA 94612 Phone: (510) 238-2293

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	
Construction History	Y	
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	N	
Programmed Work	Y	Plan M&R work up to 30 years.
Traffic History	Y	Traffic Index and ADT can be recorded.
Projected Traffic	N	
Images	Y	MPEG files can also be attached.

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	7 distress types for AC as well as PCC. Severity and extent of distress in sample units recorded.
PCC Distresses	Y	Y	
Condition Index	Y	Y	Modified PCI (Corps of Engineers).
User-defined Index	N	N/A	
Subjective Rating	N	N/A	Can be added as user-defined fields.
Roughness	N	N/A	
Skid Resistance	N	N/A	
FWD Data/Structural Capacity	N	N/A	

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	Allows multiple users with different securities.
Importing Data	Y	
Inventory Reports	Y	Standard and customized reports
Condition Summary	Y	
Distress Reports.	Y	
Future Conditions	Y	Default family curves are provided. Curves can be adjusted by observed conditions in the field.
Prediction Modeling	Y	

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters: Single Multiple	 Y Y	PCI and condition category, surface type, functional class.
Recommend Treatment	Y	
Treatment Type: Interval Distress	 Y N	
Maintenance/Rehab Policy	Y	Based on user-defined PCI ranges.

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	Various standard and customized reports.
Cost Per Year	Y	
Prioritized Candidate Sections	Y	A portion of budget can be earmarked for Preventive maintenance (PM) and those funds used to select PM projects.
Multi-Year Prioritization	Y	Up to 30 years.
Prioritization – Pavement Condition	N	
Prioritization – First Cost	N	
Prioritization – Distress	N	
Prioritization – Functional Class.	N	
Prioritization – Composite Criterion	Y	First cost, pavement conditions, cost-effectiveness.
Prioritization – Life Cycle Cost	Y	
Force Repair to a Specific Year	Y	Also can delay section(s) for treatment.

IMPACT ANALYSIS AND WHAT-IF BUDGET SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	Y	
Projected Condition w/wo Repair	Y	

UNPAVED ROADS

Item	Y/N?	Comment
Condition	N	
Prediction	N	
Repair Cost	N	

ADDITIONAL INFORMATION

Five user-defined fields are available. Funding source and shoulder width for a section can be stored. Supplemental information about a section can be attached in the following file formats: PDF, Rich Text, Word, Excel, etc. Reports and results of analysis can be exported to various formats (e.g., Excel, PDF, text). The software has capabilities to generate a variety of graphs.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	Training classes 3 times a year during user meetings. Technology transfer seminars, and various workshops on specific features associated with Streetsaver™ such as distress identification, budget analysis, report generation, etc.
Support	Y	Phone support and virtual on-site support.

Micro PAVER

U.S. Army Corps of Engineers, Construction Engineering Research Laboratory
Principal Investigator: M.Y. Shahin, E-mail: m-shahin@cecer.army.mil,
Phone: (970) 377-9474
www.cecer.army/mil/paver

Distribution/Support: University of Illinois Technical Assistance Center
302 E. John St., Suite 202, Champaign, IL 61820
Phone: (800) 895-9345, E-mail: techctr@uiuc.edu

Distribution: American Public Works Association
2345 Grand Blvd, Suite 500, Kansas City, MO 64108
Phone: (816) 472-6100, E-mail: paver@apwa.net

OVERVIEW OF THE SOFTWARE

The Micro PAVER Pavement Maintenance Management System was developed by the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers. It is distributed to non-Department of Defense users by the University of Illinois Technical Assistance Center and the American Public Works Association.

Micro PAVER uses distress data to compute the pavement condition index (PCI) that ranges from zero (failed) to 100 (excellent). Micro PAVER provides pavement management capabilities to: (1) develop and organize the pavement inventory, (2) assess the current condition of pavements; (3) develop models to predict future conditions, (4) report on past and future pavement performance, and (5) develop scenarios for M&R based on budget or condition requirements. The distress data and PCI values are used for predicting the M&R needs of a pavement network for future years.

Micro PAVER is a stand-alone pavement management program.

The software can handle data in U.S. customary or metric units.

GIS capabilities are integrated into the software. The GIS assignment tool links the Paver data for individual segments to GIS data. Once links are established, GIS Selector can be used to select sections from maps. The GIS feature can be used to point and click on a roadway segment and obtain information about that section. Information such as the latest PCI value and impact of various budget scenarios can be viewed on maps using GIS Reports feature.

A user manual is available. The user can open the manual through the help feature in the software as a PDF document. Version 5.3 of the software was evaluated.

USER CONTACTS

Justin Rabidoux City of Burlington 32 Kilburn St Burlington, VT 05402 Phone: (802) 863-9094	Greg Belancio Washoe County P.O. Box 11130 Reno, NV 89520 Phone: (702) 328-2052	Starr Kohn Soil and Materials Engineers 43980 Plymouth Oaks Blvd Plymouth, MI 48170 Phone: (734) 454-9900

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	ESALs can also be stored.
Construction History	Y	
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	Y	
Programmed Work	Y	
Traffic History	Y	
Projected Traffic	Y	
Images	Y	

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	19 distresses are available for AC and PCC roads. Severity and quantity of distress can be recorded.
PCC Distresses	Y	Y	
Condition Index	Y	Y	PCI computed from distress data.
User-defined Index	Y	Y	User can define an index using distresses.
Subjective Rating	N	N	Can be added as a user-defined condition type.
Roughness	Y	N	
Skid Resistance	N	N	Can be added as a user-defined condition type.
FWD Data/Structural Capacity	Y	N	FWD deflection values and load transfer values for PCC pavements can be stored.

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	
Importing Data	Y	The data must be in a specified format. A hand-held data collector can be used to record data and these data can be uploaded to the database.
Inventory Reports	Y	Standard reports can be generated. User-defined reports can be created.
Condition Summary	Y	
Distress Reports.	Y	
Future Conditions	Y	
Prediction Modeling	Y	

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters: Single Multiple	 Y Y	
Recommend Treatment	Y	
Treatment Type: Interval Distress	 Y Y	
Maintenance/Rehab Policy	Y	

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	
Cost Per Year	Y	
Prioritized Candidate Sections	Y	
Multi-Year Prioritization	Y	
Prioritization – Pavement Condition	Y	Sections above a critical PCI that have load-related distress are given highest priority.
Prioritization – First Cost	N	
Prioritization – Distress	Y	
Prioritization – Functional Class.	Y	
Prioritization – Composite Criterion	Y	
Prioritization – Life Cycle Cost	N	
Force Repair to a Specific Year	N	

IMPACT ANALYSIS AND WHAT-IF BUDGET SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	N	
Projected Condition w/wo Repair	Y	

UNPAVED ROADS

Item	Y/N?	Comment
Condition	Y	Seven distress types recorded by severity and quantity
Prediction	Y	
Repair Cost	Y	

ADDITIONAL INFORMATION

User-defined fields can be added. A user-defined condition type can be added to rate any item (e.g., condition of shoulder, curb and gutter), and a numerical value can be entered to rate that item. There is a field to add comments for each section. The created reports can be exported into Excel. Graphs showing various inventory information and pavement conditions as well as results for various budget scenarios can be generated. Other items that can be stored are: shoulder type, street type, grade, and results of any types of tests performed on a pavement layer (e.g., surface, base) or subgrade.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	Offered through the University of Illinois at Urbana-Champaign Technical Assistance Center.
Support	Y	American Public Works Association offers a four-part web-based training course. Phone and e-mail support is available.

CartêGraph PAVEMENTview/PAVEMENTview Plus

CartêGraph Systems, Inc.
3600 Digital Dr, Dubuque, IA 52003
Phone: (800) 688-2656
www.cartegraph.com
Contact Person: Keri Samson
Contact e-mail: kerisamson@cartegraph.com

OVERVIEW OF THE SOFTWARE

PAVEMENT*view* is the basic pavement management module that helps maintain a pavement segment inventory that includes inspection and maintenance information. PAVEMENT*view* Plus is an optional module that works with the basic PAVEMENT*view* module to create budget scenarios, develop maintenance priorities on road segments, and create maintenance suggestions. For paved roads all distresses included in the Long Term Pavement Performance (LTPP) manual are provided, while for unpaved roads they are based on the U.S. Army Corps of Engineers procedures. Most of the fields and features in the software can be customized to suit a user's needs. Using the Report Builder feature of the software, user-defined indices can be created by building formulae from numeric data and the results can be printed as a report.

PAVEMENT*view* is a stand-alone program that is a part of the CartêGraph software suite. Other modules that aid in managing assets such as bridges, signs, utilities, signal lights, etc. are also available. A module for work management activities such as managing the vehicle fleet, keeping track of complaints, managing maintenance activities of infrastructure assets is also available.

The software can handle data either in U.S. customary units or metric units.

CartêGraph offers different levels of GIS integration depending on the user's needs. The CartêGraph MAPdirector can be used as a mapping tool or as an interface with ArcView or ArcGIS to view pavement segments, their condition, and the impact of budgets on the condition.

A user manual is provided. Help is available from the software's built-in help features and the website.

Version 7.0e of the software was evaluated.

USER CONTACTS

Available on request from Cartegraph.

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	GPS information, roadway geometric information (e.g., grade, shoulder type, width, etc.) can be stored.
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	ESALs can be estimated from axle load spectra data.
Construction History	Y	Many other details such as reason for activity, work order number, agency involved, etc. can be stored.
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	Y	
Programmed Work	Y	
Traffic History	Y	
Projected Traffic	Y	Can be projected for a user-defined set of sections.
Images	Y	

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	All distress types in the LTPP Distress Manual are available. User can customize them. Distress severity and quantity are stored.
PCC Distresses	Y	Y	
Condition Index	Y	Y	PCI is computed.
User-defined Index	Y	Y	Distresses to be included in computing PCI as well as deduct values can be customized. An overall condition index that is defined by the user is calculated using PCI, ride, friction, etc.
Subjective Rating	Y	Y	
Roughness	Y	Y	
Skid Resistance	Y	Y	
FWD Data/Structural Capacity	Y	N	Field for entering strength of layer (e.g. modulus or SN).

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	
Importing Data	Y	The user can customize the file format needed for import.
Inventory Reports	Y	Reports can be customized.
Condition Summary	Y	
Distress Reports.	Y	
Future Conditions	Y	
Prediction Modeling	Y	A family of pavements for prediction can be defined by the user.

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters: Single Multiple	 Y Y	An user-defined decision matrix can be created to include one or many factors.
Recommend Treatment	Y	All maintenance or rehabilitation decisions can be customized. The user can setup M&R protocol to disallow specific activities if a related type of activity has already been recommended.
Treatment Type: Interval Distress	 Y Y	
Maintenance/Rehab Policy	Y	

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	GASB 34 compatible financial summaries can be generated.
Cost Per Year	Y	
Prioritized Candidate Sections	Y	Priority method can be customized to include one or many of these factors and other factors such as speed limit, usage of the road, etc.
Multi-Year Prioritization	Y	
Prioritization – Pavement Condition	Y	
Prioritization – First Cost	Y	
Prioritization – Distress	Y	
Prioritization – Functional Class.	Y	
Prioritization – Composite Criterion	Y	
Prioritization – Life Cycle Cost	Y	
Force Repair to a Specific Year	Y	

IMPACT ANALYSIS AND WHAT-IF BUDGETING SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	Can also be viewed on a map.
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	Y	
Projected Condition w/wo Repair	Y	Many user-defined scenarios can be tested.

UNPAVED ROADS

Item	Y/N?	Comment
Condition	Y	Uses U.S. Army Corps of Engineers rating methods by default.
Prediction	Y	
Repair Cost	Y	

ADDITIONAL INFORMATION

Many fields are available to input a variety of data such as: speed limit, right-of-way width, presence of sidewalks and bike paths, jurisdiction, service level, detour length, detour route, median type, median width, storm drain information, etc. Any kind of associated file (e.g., .doc, .jpeg, .txt) can be attached with a segment. Any type of information can be typed in the Notes section. The user has the ability to define their own distresses, and also customize the distress list. Many customization features are available in the software, which gives the user an opportunity to customize the software to suit their needs.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	
Support	Y	Toll-free customer support phone number.

For more information:

Federal Highway Administration
Office of Asset Management
1200 New Jersey Avenue S.E.
Washington, DC 20590

Tel: 202-366-1341
Fax: 202-366-9981
www.fhwa.dot.gov/infrastructure/asstmgmt

Notice:

FHWA-HIF-08-007

Attachment F-2

Minimum Data Collection Requirements for Future Updates

Minimum Data Collection Requirements for Future Updates

1. **Contact Information**
   a. Agency and County
   b. Name, title, address, phone number and email address

2. **Pavement Data**
   a. Type of PMS software used
   b. Roadway system, separated into:
      i. Urban vs. rural
      ii. Major streets, residentials/locals and unpaved
      iii. Data should be reported by centerline miles, lane-miles, area
      iv. AC vs. PCC
      v. Comments
   c. Distress Surveys
      i. Description of rating procedure i.e. MicroPAVER, StreetSaver etc
      ii. Types of AC and PCC distresses collected
      iii. Other pavement data e.g. deflection, ride etc – how are these data used?
      iv. How is data collected? Walking surveys? Windshield? Automated?
   d. Pavement Condition Ratings
      i. What type of pavement rating scale is used? Describe.
      ii. What is agency's weighted (by area) average condition rating on a 0-100 scale? Report for major vs. residential/local roads
   e. Maintenance and rehabilitation thresholds (see example below)
   f. Typical unit costs for treatments applied

Maintenance Activity	Condition Thresholds	
	Urban	Rural
Do Nothing	86-100	75-100
Preventive Maintenance	70-85	60-75
Surface seal e.g. slurry, cape	70-85	60-75
Thin AC overlay	50-70	40-60
Thick AC overlay	25-50	0-40
Reconstruction	0-25	Never

3. **Safety, traffic and regulatory components**
   a. Categories to include (each category should include inventory, replacement cost and data source)
      i. storm drains
      ii. curb and gutters
      iii. sidewalks
      iv. ADA requirements and curb ramps
      v. traffic signals
      vi. street lights
      vii. Other
      viii. Source of data

4. **Past and Future Expenditures**
   a. Include previous 2 fiscal years for baseline comparison
   b. Estimated annual expenditures for next five fiscal years for each category below
      i. Pavements
         1. Preventive maintenance
         2. Rehabilitation and reconstruction
         3. Other pavement related costs
         4. Operations and maintenance
      ii. Safety, traffic and regulatory components
         1. storm drains
         2. curb and gutters
         3. sidewalks
         4. ADA requirements and curb ramps
         5. traffic signals
         6. street lights
         7. Others