GOING BEYOND PERFORMANCE TARGETS
IN MAP-21 FOR LOCAL AGENCIES

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Words: 2,530 Tables: 3 Figures: 3 Total: 4,280 Date: August 31, 2014

ABSTRACT

Since 1984, the Metropolitan Transportation Commission (MTC), the San Francisco Bay Area regional planning organization (MPO), has continued to develop and enhance its pavement management system (PMS) software - StreetSaver®. StreetSaver was chosen by the League of California Cities and the California State Association of Counties to power the California local streets and roads statewide needs assessment. In the MTC region, the software is used to assist all 109 local jurisdictions allocate resources, predict the future condition of their pavements, and demonstrate the effects of different funding scenarios.

More recently, MTC's efforts to encourage pavement preservation strategies have also paid dividends and jurisdictions have shifted away from "worst first" strategies. The performance-based, outcome-driven approach that incentivizes preventive maintenance was well documented, and has been modeled by other MPOs to meet the Moving Ahead for Progress in the 21st Century Act (MAP-21).

Not surprisingly, setting the MAP-21 performance targets for pavement condition in the MTC region is straight forward. However, relating regional targets to the local environment is a different story. In order to see the fuller picture, MTC has worked with local agencies to interpret the targets and developing key performance indicators (KPI) that will help them to gauge their performance at the local level. The KPIs were developed to inform local decision making and pavement maintenance strategy decisions to support their local investment policy. Specifically, the information provided will assist local agencies in answering:

- What is the existing condition of the road network?

- What amount of funding is currently invested in pavement preservation?

- What amount of funding is needed to achieve the state of good repair?

- How effective is the pavement preservation effort?

The intent of the KPIs is to improve agency's overall performance and promote increased transparency and accountability for their pavement management programs, beyond the basic performance measures set in MAP-21.

Key Words: Pavement Management System, StreetSaver, Performance Measures, key performance indicators, MAP-21

1.0 INTRODUCTION

MTC has long recognized maintenance of existing street and road as a regional priority with the development of its own pavement management software, StreetSaver®, in 1984. "They are the conduits to the highways, ports and farmlands that are vital to the economic vitality and sustainability of the San Francisco Bay Area," as stated in the MTC's 2013 Plan Bay Area, the latest adopted long range regional transportation plan (RTP). Today, all 109 Bay Area local jurisdictions – and 300+ jurisdictions outside of the San Francisco Bay Area – use StreetSaver. The software 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 underfunded road programs.

At the regional level, StreetSaver makes it possible to gauge the local street and road's pavement condition and funding needs easy. MTC annually releases the regional pavement condition report for all the 109 local jurisdictions, representing pavement conditions over nine counties. This state of the system report serves as a way to inform general public and elected officials on the Bay Area's 43,000 lane-miles of local streets and roads. StreetSaver measures pavement conditions according to the ASTM D6433 standard based on a pavement condition index (PCI) that ranges from 0 to 100, where 100 is the best possible score indicating a newly paved street. From 2008-2013, the regional PCI has hovered at 66 as shown in Figure 1.

FIGURE1 Bay Area Local Roadways by Condition Category

|	Lane Miles of Local Street & Road Pavement									
	Excellent PCI=90-100	Very Good PCI = 80-89	Good PCI = 70-79	Fair PCI = 60-69	At Risk PCI = 50-59	Poor PCI = 25-49	Failed PCI = 0-24	No Data	Totals	Weighted Avg PCI
Bay Area	3,581	9,717	9,094	5,731	4,581	6,975	3,109	120	42,908	66
Percent	8%	23%	21%	13%	11%	16%	7%	0%	100%	

A sample of agencies' pavement conditions is also shown in Table 1.

TABLE 1 2013 Regional Pavement Condition by Jurisdiction

Current Level of Service by County and Jurisdiction											
	2013				Annual PCI				3-YR Moving Average		
Jurisdiction	Total Lane Miles*	Total Centerline Miles*	% Poor or Failed	% Excellent or Very Good	Arterial	Collector	Residential	Network	2011	2012	2013
Alameda	7950.6	3520.8	25%	34%	71	68	64	67	67	68	67
Alameda	305.2	138.5	27%	26%	77	73	62	68	67	68	67
Alameda County	990.3	471.8	16%	24%	72	74	68	71	73	72	71
Albany	59.0	29.3	37%	16%	61	56	52	55	58	57	56
Berkeley	452.9	216.2	41%	26%	71	53	57	58	59	59	58
Dublin	254.1	116.0	0%	85%	86	83	86	85	84	86	85

Besides performing regional needs assessment, StreetSaver was chosen by the League of California Cities and the California State Association of Counties as the basis of the California Local Streets and Roads Statewide Needs Assessment since 2008. The latest report, released in 2013 shows the statewide average PCI has deteriorated from 68 in 2008 to 66 in 2012, while backlog has increased critically from $40 billion to $66 billion. The maps below (Figure 2)

illustrate the pavement condition change in each county from 2008 (California Needs Assessment, 2013).

FIGURE 2 Comparisons of Pavement Conditions between 2008 and 2012
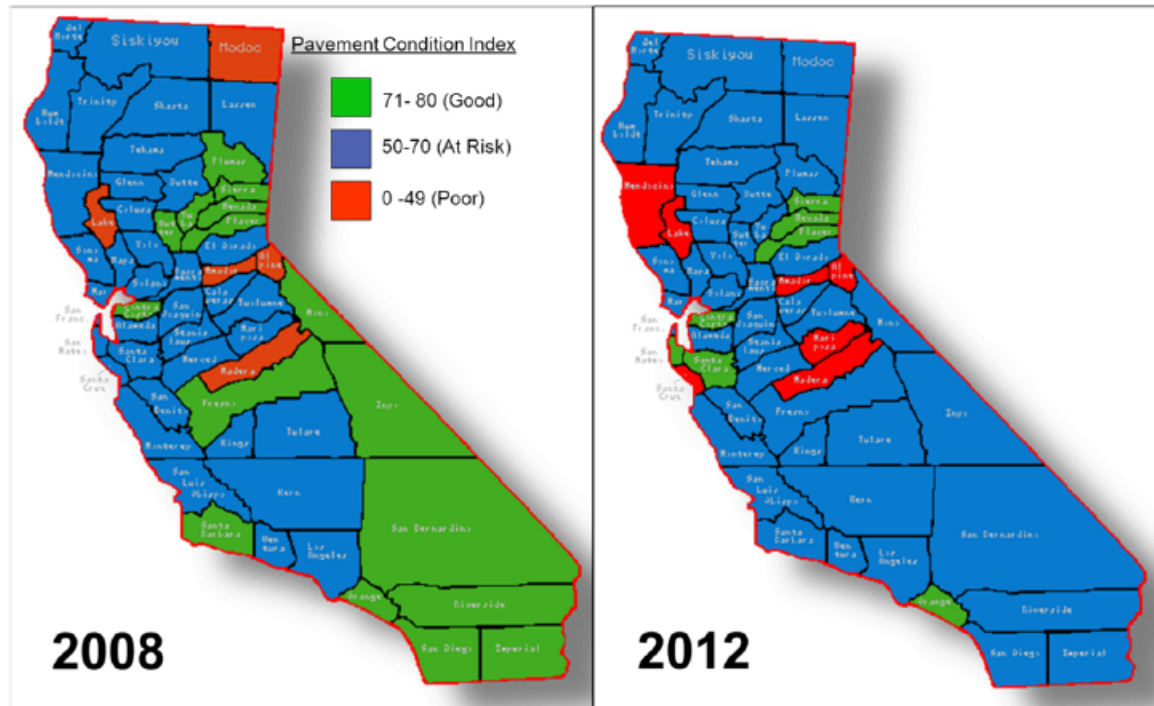
The Moving Ahead for Progress in the 21st Century Act (MAP-21), which was signed into law in June 2012 by President Obama, creates a performance and outcome-based and multimodal program to strengthen the U.S. transportation system. The national performance goals for the Federal highway programs as established in MAP-21 focus on safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays. By focusing on these national goals, increasing accountability, and improving transparency, these changes will improve decision-making through better informed planning and programming. The U.S. Department of Transportation will promulgate rulemaking to establish performance measures for these goals, while state Department of Transportations (DOT) and metropolitan planning organizations (MPO) are required to set performance targets.

As an MPO that is already ahead of the game in regard to asset management and measuring performance, MTC is in full support of MAP-21's establishment of a performance and outcome-based program that holds state DOTs and MPOs accountable for improving the conditions and performance of their transportation assets. Once the national measures are finalized in 2015, MTC should be able to set performance targets without difficulty.

This paper will focus on setting performance targets for infrastructure condition, specifically in pavement conditions, under the Federal's National Highway Performance Program. (Disclaimer: at the time of writing, FHWA has just released the Notice of Proposed Rulemaking for pavement and bridge condition performance measures.)

2.0 OBJECTIVE

MTC has long standing commitment to a "fix-it-first" policy for maintaining existing transportation infrastructure. Plan Bay Area (Regional Transportation Plan for 2013-2040) strives to achieve a target PCI of 75 by year 2040. The total amount of funding needed to achieve this goal over the plan period is $45 billion. Committed revenues and discretionary funds make up about $25 billion, leaving the region with a remaining need of $20 billion to meet the plan's performance target. Analyses by StreetSaver suggest that the average regional PCI is only expected to increase to 68 by 2040 (Plan Bay Area, 2013). Without increased funding from stable and dedicated sources such as a regional gas tax or a vehicle miles traveled tax, achieving the state of good repair for the region's street and road network will be an ambitious target.

MTC will continue to use and monitor the performance target adopted through the RTP. Additionally, MTC will set performance targets based on FHWA's performance measures on pavement condition. However, pavement condition alone does not provide a full picture of the state of street network. It is beneficial to include other performance indicators as a way to show progress towards meeting the regional, state, and local performance targets.

MTC has proposed several Key Performance Indicators (KPIs) to inform local decision making and pavement strategy decisions to support their local investment policy. Specifically, the information provided will assist local agencies in answering:

• What is the existing condition of the road network?

• What amount of funding is currently invested in road maintenance?

• What amount of funding is needed to achieve the state of good repair (state of good repair is uniquely defined for each jurisdiction based on a jurisdiction's current conditions and maintenance policies)?

• How effective is the pavement preservation investment strategy?

With the wealth of information that resides in pavement management databases, the intent of this paper are (1) to illustrate how data mining within a pavement management database can harvest KPIs that benefit local agencies in setting performance measures and targets, (2) to improve agencies overall performance management reporting, and (3) to promote increased transparency and accountability for their pavement management programs, beyond the basic performance measures set in MAP-21.

3.0 PROPOSED KEY PERFORMANCE INDICATORS

Other performance indicators were considered by the local agencies, along with performance measure guiding principles. However, ultimately, the proposed KPIs as categorized into three groups in Table 2 were selected. These KPIs are deemed necessary to answer the four questions posted in previous section. And they met the criteria of the guiding principles (Romell and Tan, 2010):

- It is measurable
- As objective as possible
- Can be fairy applied
- Uses data that is widely available

- It is meaningful (promotes pavement management objectives)

TABLE 2 Category of KPI

Category of KPI	Proposed KPI	Regional Average
Current Conditions	• Pavement condition index (PCI) • Remaining Service Life (RSL) • Current Backlog	66 18.1 years $5.6 billon
Pavement Preservation Performance	• Pavement Preservation Index (PPI)	1.06
Maintenance and Rehabilitation Investment Level	• Maintenance and Rehabilitation (M&R) Investment Ratio • Current backlog/NAV	39% 15%

A sample of Bay Area agencies using the StreetSaver data as of December 31, 2012 was used to calculate the KPIs. Table 3 shows the KPIs at jurisdiction level. Regional benchmarks or averages are provided for comparison. This data is based on annual basis; however, local agencies can run this analysis at any time to get a snap shot of the situation.

TABLE 3 Key Performance Indicators by Jurisdiction

		Key Performance Indicators										
		Current Conditions		Pavement Preservation Performance			Maintenance and Rehabilitation Investment Level					
				A	B	A/B	C	D	C/D	E	F	E/F
County	Jurisdiction	Network PCI	Network RSL	$PM/Lane Mile	% Actual PM	% PM Needs	Pavement Preservation Index	Actual M&R /Lane Mile	Needs/ Lane Mile	Investment Ratio	Current Backlog (millions)	Network Asset Value (millions)	Backlog/ Asset Value
	Regional Benchmarks	66	18.1	$ 1,336	17%	16%	1.06	$10,400	$27,000	39%	$5,645	$38,814	15%
Alameda	ALAMEDA	66	17.7	$ 1,271	13%	15%	0.88	$9,800	$26,900	36%	$32	$229	14%
	ALAMEDA COUNTY	71	19.9	$ 671	18%	28%	0.67	$3,600	$16,200	22%	$55	$647	8%
	ALBANY	58	14.0	$ 1,247	10%	13%	0.78	$12,700	$29,800	43%	$9	$41	22%
	BERKELEY	58	16.2	$ 263	2%	11%	0.20	$11,600	$32,400	36%	$77	$298	26%
	DUBLIN	87	28.5	$ 3,124	50%	79%	0.62	$6,300	$5,600	113%	$4	$180	2%

A more detailed description of each key performance indicator is as follows:

3.1 Current Conditions

Network PCI

The network PCI, weighted based on the pavement section area, is calculated on last day of the year. PCI scores of 90 or higher are considered "excellent." These are newly built or resurfaced streets that show little or no distress. Pavement with a PCI score in the 80 to 89 range is considered "very good," and shows only slight or moderate distress, requiring primarily preventive maintenance. The "good" category ranges from 70 to 79, while streets with PCI scores in the "fair" (60-69) range are becoming worn to the point where rehabilitation may be needed to prevent rapid deterioration. Because major repairs cost five to 10 times more than routine maintenance, these streets are at an especially critical stage. Roadways with PCI scores of 50 to 59 are deemed "at-risk," while those with PCI scores of 25 to 49 are considered "poor."

These roads require major rehabilitation or reconstruction. Pavement with a PCI score below 25 is considered "failed." These roads are difficult to drive on and need reconstruction. For the Plan Bay Area, the regional PCI target to achieve the state of good repair is 75. Current Network PCI for 2012 was 66.

Remaining Service Life (RSL)

The remaining service life of a pavement is defined as the period of time (calculated in years) from today to when the pavement reaches an unacceptable condition requiring construction intervention. StreetSaver sets minimum PCI threshold for defining a pavement's serviceable life at a PCI of 25. In other words, when pavement condition reaches or falls below a PCI of 25, its level of service is considered unacceptable and needs to be reconstructed.

The design life of a pavement is typically 20 years, if left without any intervention. However, generally pavement receives preventive maintenance (PM) treatments periodically to extend its service life. If a pavement is maintained in good condition and regular preservation treatments are applied at appropriate times, a pavement's RSL will increase or stay steady. The amount of extended life depends on the pavement preservation treatment and the condition of the pavement at the time of the treatment. In order to be effective in extending service life, PM treatments need to be applied to arterial and collector streets with a PCI of 70 and above, or a PCI of 60 and above for residential streets. It is therefore not uncommon to observe useful life of 25 years or more for pavements in the region (possibly due to advances in treatment technologies). Hence, for most of the roadway network, a RSL of 25 years or more is desired. Current RSL for the network in 2012 was 18.1 years.

Current Backlog (from first year of 10-year Needs)

During the needs analysis, all sections that needed work will be identified over the 10-year period (see Figure 3). The Current Backlog is the amount of maintenance and rehabilitation (M&R) funding that is needed to bring the network condition to the state of good repair in first year. However, since this is usually a large amount of funding, local agencies do not have the funding to fund this work. Instead only a portion of the network will be funded. Hence it is important to gauge what is the amount of current backlog (or repairs) needed as shown in Figure 4.

The needs assessment evaluates the investment needed to extend the pavement life to the state of good repair using best management practices for pavement preservation, while minimizing costs. Nine sets of countywide decision trees were applied to the needs assessment based on the latest unit cost survey. To achieve the state of good repair, a 10-year period is deemed as a minimum cycle to realize the benefit of preventive maintenance.

To further breakdown the needs assessment for comparison between different sized jurisdictions, the needs by lane miles per year was calculated. The needs per lane mile represent the average annual funding needed to maintain the state of good repair by lane miles. The average annual funding over the 10-year period is used because the assessment is front loaded with major rehabilitation projects with preventive maintenance occurs in the later years (which is the most cost effective pavement management practice). Current backlog in 2012 was $5.645 billion.

FIGURE 3 Needs Analysis Report Generated by StreetSaver

Needs - Projected PCI/Cost Summary

Inflation Rate = 3.00 %   Printed: 07/09/2013

Year	PCI Treated	PCI Untreated	PM Cost	Rehab Cost	Cost
2013	87	80	$1,971,500	$2,605,770	$4,577,270
2014	86	79	$188,587	$1,139,811	$1,328,398
2015	86	77	$123,315	$989,282	$1,112,597
2016	86	76	$520,334		$520,334
2017	84	74	$19,932	$0	$19,932
2018	84	72		9,276	$1,078,821
2019	84	71		8,892	$705,802
2020	86	69		$0	$2,140,727
2021	85	67		$0	$407,418
2022	85	65		$0	$574,048

This is the Current Backlog. If an investment of ~$4.6million is made, then the optimal PCI will be 87.

% PM	PM Total Cost	Rehab Total Cost	Total Cost
53.93%	$6,722,316	$5,743,031	$12,465,347

3.2 Pavement Preservation Performance

Pavement Preservation Index (PPI)

The PPI is a measure of the effectiveness of the pavement preservation effort and compares the actual investment on PM to the PM investment needs. As a jurisdiction's pavement condition improves, the amount of preventive maintenance needed will increase and rehabilitation will decrease, relatively. The goal is to achieve is a ratio of 1.0 or more. The following are supporting calculations to the PPI.

$PM/Lane Mile

This is the average preventive maintenance expenditure for the last three years per lane mile.

% PM Needs

The pavement 10-year needs are generated based on the state of good repair scenario. StreetSaver will recommend a percentage of PM work assigned to the overall budget.

% Actual PM

This is the average percentage of preventive maintenance expenditures spent out of the total M&R budget for the last three years (based on total M&R expenditures reported by local agencies).

Unusually low PPI suggests that a local agency is responding to "worst first". Vice versa, high PPI indicates that an agency is focusing on PM and not taking care of rehabilitation work cost effectively. The PPI for the region in 2012 has achieved the desired target and was at 1.06.

The PPI was used exclusively as a performance-based, outcome-driven performance measure for local street and road funding allocation in the MTC's 2035 RTP (Romell and Tan, 2010).

3.3 Reasonableness of Investment Level

M&R Investment Ratio

The M&R Investment Ratio compares actual M&R expenditures to M&R investment needs. It indicates if sufficient funds have been invested in maintaining a jurisdiction's pavement network. In another word, it represents if a local agency is financially sustainable in maintaining its infrastructure over the long term. FHWA has proposed the term "Asset Sustainability Index", a broader index that can be applied to both asset class and program level (FHWA ASI, 2012). A percentage of 100 is desired, signifying sufficient recommended investment is made. The actual M&R/Lane Mile is the average maintenance and rehabilitation expenditure for the last three years per lane mile, while the M&R investment needs is based on a 10-year analysis and a regional PCI target of 75. In 2012, the region invested at 39 percent of the total maintenance needs. A ratio of 100 percent or 1.0 is desired for the state of god repair.

Current Backlog/NAV

This percentage is the built up amount of M&R investment (backlog) that is needed to maintain the network to the state of good repair divided by the value of the pavement network for a particular jurisdiction. The network asset value (NAV) is the total costs to replace all pavements based on the 9-countywide decision trees. All pavements, new and existing, will deteriorate due to natural environmental conditions and traffic. However, with proper maintenance, the rate of deterioration can be reduced and thereby reduce the backlog. Over time, the goal is to see a decrease in the current backlog/NAV indicator. For the state of good repair scenario, a ratio of less than 10 percent is targeted.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The PCI alone provides a fair overall indicator on pavement performance. It is important to understand in order to gauge the health of the street network, local agencies have to rely on additional KPIs discussed in this paper. It is envisioned that local agencies will be able to use the KPI's to:

1) Gauge the financial sustainability of current investments

2) Set funding goals to achieve a desired state of good repair

3) Report in more detail to upper management and elected officials on pavement performance

4) Evaluate the effectiveness of current pavement preservation effort

5) Improve decision trees and treatment strategies on pavement management program

6) Implement long term planning and seek funding solutions now to avoid problems down the road

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